
# वार्षिक रिपोर्ट

## 2022-23

## Annual Report

**यू.जी.सी.-डी.ए.ई. वैज्ञानिक अनुसंधान संकुल**

**UGC-DAE Consortium for Scientific Research**

विश्वविद्यालय परिसर, खंडवा रोड, इंदौर–452001

University Campus, Khandwa Road, Indore-452001

# यू.जी.सी.-डी.ए.ई. वैज्ञानिक अनुसंधान संकुल

(विश्वविद्यालय अनुदान आयोग का स्वायत्त संस्थान)

# वार्षिक रिपोर्ट

# 2022-23

विश्वविद्यालय परिसर, खंडवा रोड, इंदौर–452001

www.csr.res.in

**UGC-DAE CONSORTIUM FOR SCIENTIFIC RESEARCH**

**(An Autonomous Institution of UGC)**

# Annual Report

## 2022-2023

**University Campus, Khandwa Road, Indore 452001**

**www.csr.res.in**

# यू.जी.सी.-डी.ए.ई. वैज्ञानिक अनुसंधान संकुल

## मुख्य कार्यालय

**निदेशकः** प्रोफेसर अम्लान जे. पाल

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## मुंबई केंद्र

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## कल्पाक्कम नोड

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यू.जी.सी.-डी.ए.ई. सी.एस.आर., कल्पाक्कम नोड, कोकिलामेडू गेट, कोकिलामेडू - 603104, तमिलनाडु.

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# UGC-DAE CONSORTIUM FOR SCIENTIFIC RESEARCH


## Head Office

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## Indore Centre

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## Mumbai Centre

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## Kalpakkam Node

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# विषयसूची

# Table of Contents

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**Director**

**UGC-DAE Consortium for Scientific Research**

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Indore-452001, M.P. India.

**Phone:** 0731- 2463945, 2463945, 2463913, 2762267

The year 2022-23 has been a year of momentum and normalization of our research activity to achieve our mandate of providing access to the big-science facilities of DAE and the state-of-art in-house research facilities to the researchers in the University system. In terms of experiments and visiting researchers we are back to normal i.e. pre-lockdown days. The success of these reflects in publications which also is on a positive trend.

Conscious efforts were made to strengthen the culture of collaboration. In this direction, a joint Ph.D. programme is envisaged, in which the students will work on selected topics under the co-supervision of scientists from DAE and Consortium. The induction of students in this programme will start from the academic year 2023-24. Another positive development is that the PhD students of Mumbai Centre can be registered at Savitribai Phule Pune University for the PhD degrees. It was much needed to recharge and strengthen the in-house research activity of the Centre. Kalpakkam Node also reached a milestone with the award of PhD degrees to in-house students for the first time.

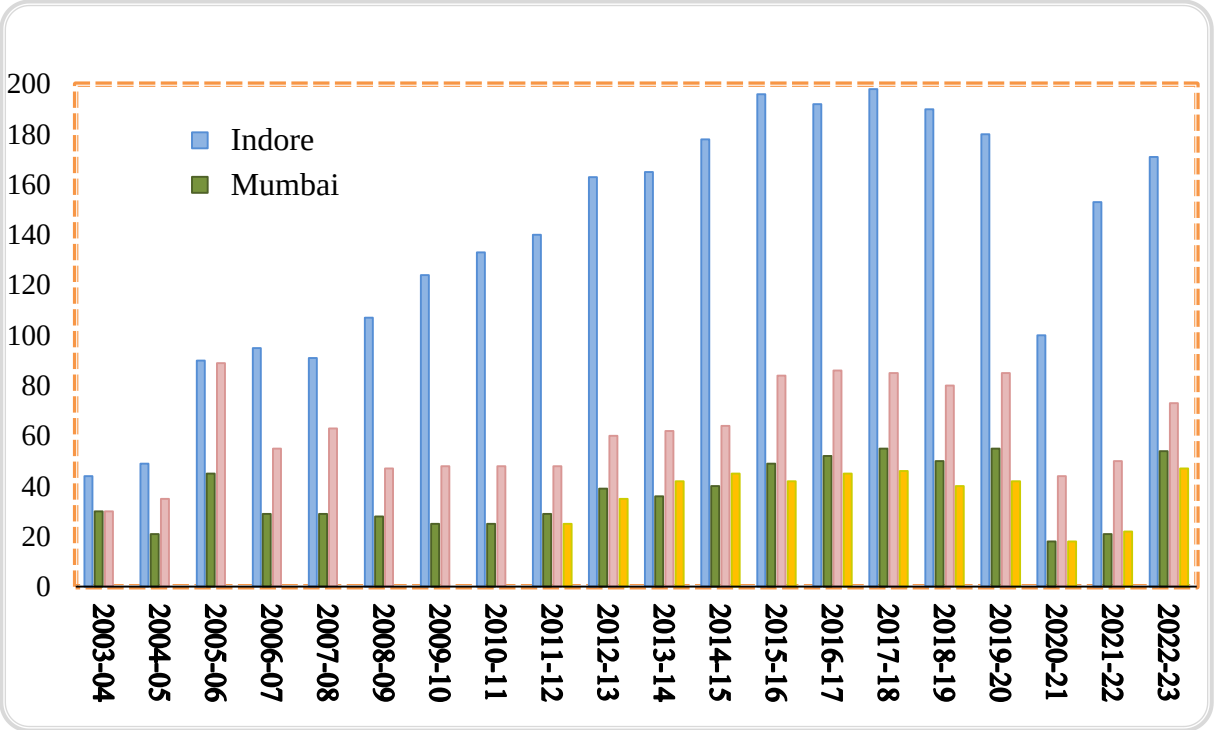
Consortium along with IUCAA, Pune and IUAC, Delhi are preparing a proposal for the formation of a deemed-to-be-university.

To increase the awareness about the collaborative research schemes of the Consortium, we conducted a series of six online awareness workshops in partnership with 12 universities/institutes. These workshops covered the length and breadth of the country and have been receiving a huge response. The year showed a flurry of in-person meetings, workshops/schools and conferences after a long period. These events were more interactive and covered topics related to the consortium activity e.g. probing matter with X-ray, neutron, ion sources. For the first time, Indore Centre organised an international conference, which was on the Prespective of Vibrational Spectroscopy. We were honoured by the visit of Dr. Anil Kakodkar to Indore Centre on our Annual Science Day.

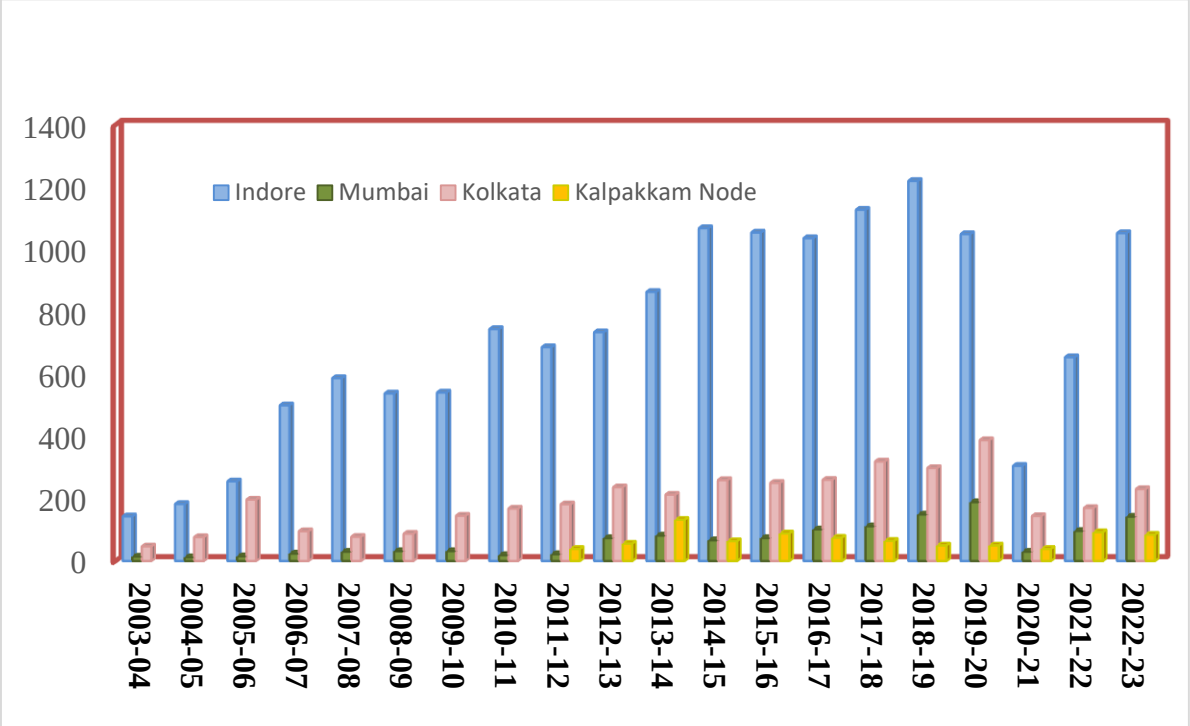
Among infrastructure activities, the Guest house at Indore Centre is fully operational now. The plan for the proper utilization of space at Panvel for Mumbai centre is in progress. The building at the Kolkata Centre is in the final state of occupation.

Dr. Govindraj R, Head DDSD, MSG, IGCAR, Kalpakkam has taken charge of Scientist in-Charge of Kalpakkam Node from Dr. N V Chandrashekar. I am sure that Node will excel in fulfilling its mandate under his guidance.

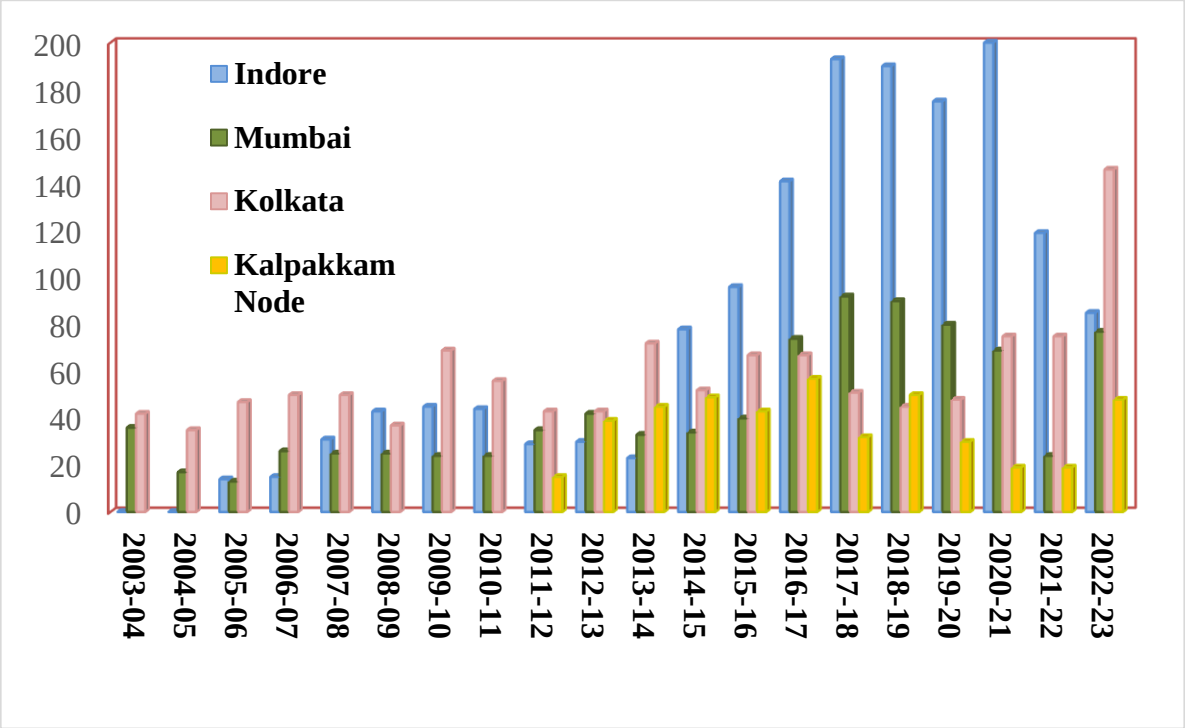
## Number of Universities/ Institutions participating in UGC-DAE CSR programmes



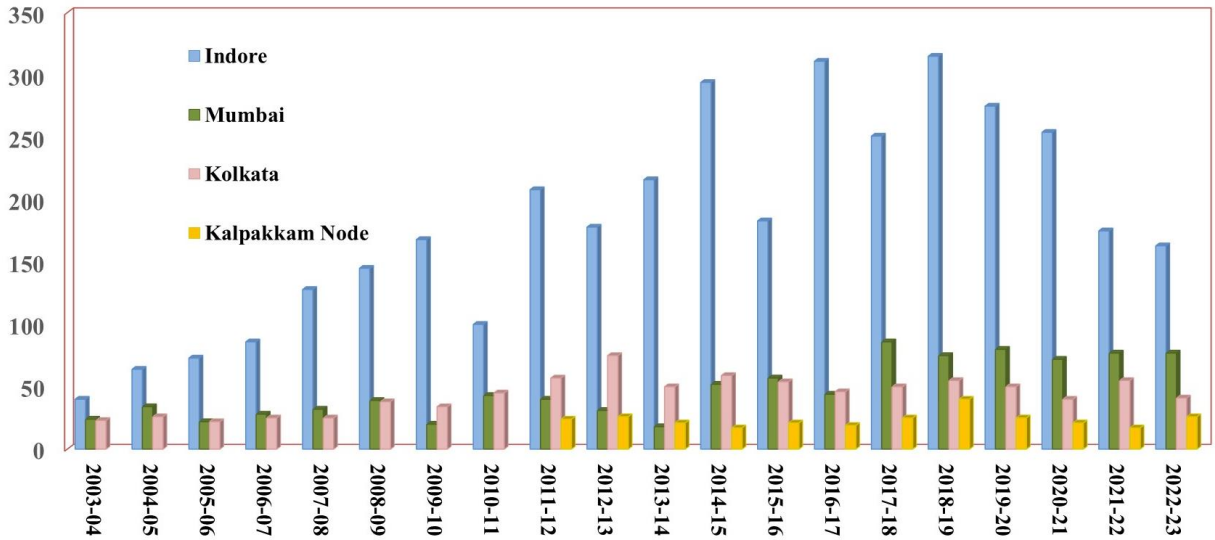

## Utilisation of UGC-DAE CSR Facilities



## Collaborative Research Schemes Sponsored by UGC-DAE CSR



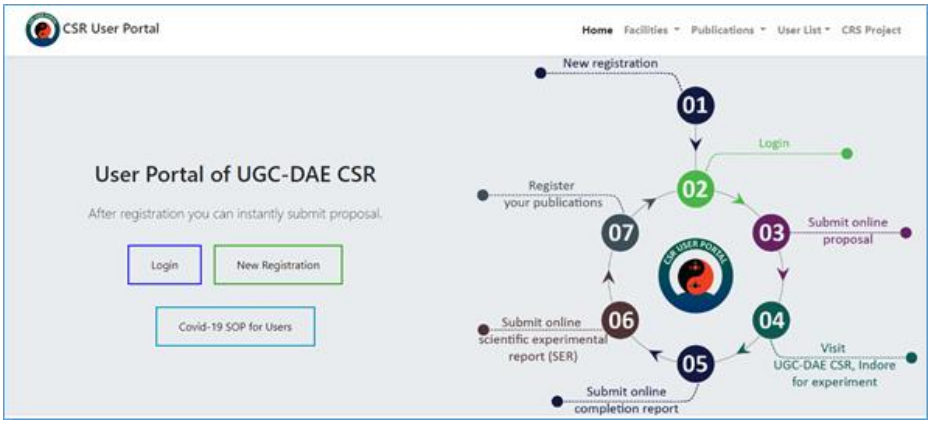

## In-house and Collaborative Research Publications of UGC-DAE CSR



# Research Activity of Indore centre


**AIPES Beamline at Indus 1**

**Linde 140 Helium liquefier**




**Online user portal**
(https://csruserportal.com)

**DR. VASANT. SATHE**

**Centre Director, Indore Centre**

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The mandate of the consortium is to provide advance level of support to the university researchers. The Indore Centre is providing state of the art research equipment required for research in the field of condensed matter physics. The main theme revolves around synchrotron radiation and low temperature high magnetic field based research. The scientists not only provide high quality data but also support the university users in data analysis and preparation of manuscript. Further, the university faculties are supported to through CRS projects which provides small contingencies along with fellowship support for few projects. This report covers the activities from 1st April 2022 to 31March 2023. The user activity has been running smoothly apart from a break in low temperature measurements for few months due to technical fault in cryogenic plants. Over all the user program which is driven through our new web portal has been running well and several hundred research students from universities got benefited last year. For making university researchers aware of the facilities of the consortium and CRS projects, two awareness online workshops were organized last year in collaboration with Guru Ghasidas University, Bilaspur and G.J. College, Rambag, Bihata, Patna. The workshops were well attended by university researchers resulting in more than 150 new CRS project proposals this year.

An International Conference on Perspectives in Vibrational Spectroscopy (ICOPVS-2022) was organized in collaboration with DAVV, Indore from 13 December to 17 December 2022. It is a very prestigious event organized biannually and was attended by renowned scientists and researchers across the globe. Nearly 250 participants attended the event and was a grand succuss.

As far as in-house research is concerned, 14 students completed their Ph.D. degree with quality publications in high impact journals. Many of them also got the post-doctoral fellowship at renowned institutes within the country as well as in foreign countries. Faculty and students of the Centre received national awards and best oral and poster award in various conferences. Many of the PIs and students under CRS projects also received best poster/presentation award for work presented in national and international conferences giving confidence that the centre is well on its track in fulfilling the mandate. Under the leadership of Director, Prof. Pal, the scope of the activities of the Indore Centre is widen through its collaboration further with RRCAT in other areas like non-linear optics, quantum optics, mesoscopic physics etc., besides ongoing synchrotron activity. A joint Ph.D. program is initiate where scientists from Indore Centre and RRCAT will jointly supervise a Ph.D. student in above mentioned areas.

On the infrastructural front the new user guest house has been made operational this year which was inaugurated by Hon. Chairman UGC, on 8th November 2021.

The Scientific and administrative staff of the consortium are motivated for serving the university research community. We are working hard to enhance the collaborative research between university researchers and DAE establishments and to make impact at international level.

## DR. SUDIPTA ROY BARMAN

**Scientist-H**

barman@csr.res.in; barmansr@gmail.com

Research Area/expertise: Electron spectroscopy, surface science

**Group Members:** (1) Mr. Shuvam Sarkar (SRF), (2) Mr. Pramod Bhakuni (SRF), (3) Mr. Sajal Barman (JRF), (4) Mr. Mohammad Balal (JRF), (5) Mr. Mrinal Manna (JRF) , (6) Dr. Rajib Batabyal (Scientist D)

**Ph.D. Completed:** 11

**Facilities:** (1) X-ray photoelectron spectroscopy, (2) Angle resolved photoemission spectroscopy, (3) Inverse photoemission spectroscopy, (4) UHV Scanning tunneling microscopy, and (5) Low energy electron diffraction.


## In-house Research Activity

**Decagonal Sn clathrate on *d*-Al-Ni-Co**

Using scanning tunneling microscopy (STM), low-energy electron diffraction, and density functional theory (DFT), a decagonal quasiperiodic ordering of Sn thin films on d-Al-Ni-Co is demonstrated. Intriguingly, the decagonal structural correlations are partially reserved up to a thick film of 10 nm grown at 165 K. The nucleation centers referred to as "Sn white flowers" identified by STM at submonolayer thickness are acknowledged as valid regions of the decagonal clathrate structure with low adsorption energies of these motifs. The interfacial energy favors clathrate over the competing Sn crystalline forms because of the exceptional lattice matching (to within 1%) between columns of Sn dodecahedra in the clathrate structure and pentagonal motifs at the d-Al-Ni-Co interface. DFT study of the Sn/Al-Ni-Co composite model shows good mechanical stability, as shown by the work of separation of Sn from Al-Ni-Co slab that is comparable to the clathrate self-separation energy. The relaxed surface terminations of the R2T4 clathrate approximant are in self-similarity correspondence with the motifs observed in STM images from monolayer to the thickest Sn film. *[Ref: V. K. Singh et al., Phys. Rev. B **107**, 045410 (2023)]*

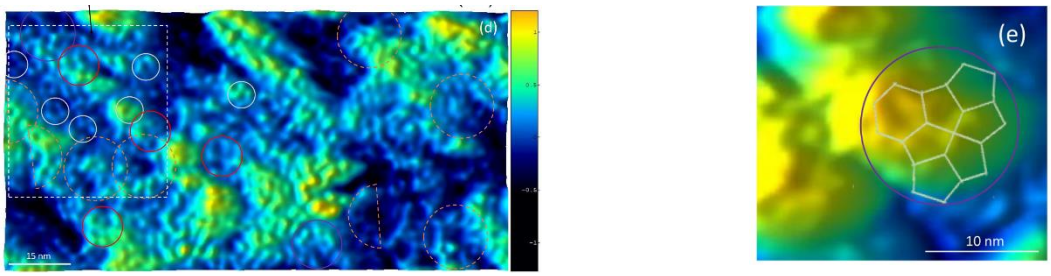


Fig 1. *The left panel shows a 121nm × 62 nm high resolution STM image showing uasiperiodic motifs highlighted by colored circles. These motifs are defined by the clathrate theoretical model. The right panel shows a zoomed image of the largest thickness (≈ 13 nm) that is traced with a quasiperiodic motif*

## Collaborative Research Activity:

➢ **Alloy engineering in $In_xSn_{1-x}S$ for enhanced photodetection application (collaboration with the group of Dr. C. K. Sumesh, Charotar University of Science and Technology, CHRUSAT, Gujarat):**

Doping is an effective parameter for altering the physical and chemical properties of SnS. Using a hydrothermal process, pure and indium (In)-doped tin sulfide (SnS) can be easily synthesized. Doping with indium significantly modifies the crystalline size in the range of 52–44 nm. Modifications were made to the optical band gap in the range of 1.42 to 1.20 eV. The XPS analysis indicates a red-shift in binding energy, confirming the p-type doping of In in SnS. Doping In into SnS-based photodetectors improved their efficacy. The highest responsivity

➢ **Role of Eu and Fe in $TiO_2$ for magneto opto electronic applications (collaboration with the group of Dr. S. N. Sharma, NPL, Delhi)**

Wearable technology results from the demand for low operating voltage, rapid resistive switching, cost-effective material materials, and devices. Using a solid-state reaction route, nanoparticles of titanium dioxide TiO2 and iron (Fe3+) and europium (Eu3+) as Fe: Eu (1:1, 2:1, and 1:2) TiO2 samples were prepared. X-ray diffraction (XRD) revealed an increase in particle size with Eu doping due to larger ionic size, whereas for Fe, it is substituted as ionic radii are almost identical to that of Ti. Using the W–H plot, the average crystallite size was calculated to be 44.75 nm. X-ray photoelectron spectroscopy and X-ray fluorescence revealed comparable atomic weight percentages of all the elements present, corroborating the results of energy-dispersive X-ray analysis (EDAX). Maximum magnetization at ambient temperature was measured for 2:1 FeEuTiO2. UV–Vis absorption spectroscopy (UV–Vis) revealed that the band gap decreased from 3.46 to 2.40 eV. In photoluminescence (PL), broad spectra are observed, which shift to the visible spectrum with 2% Eu: 1% Fe: TiO2 having the sharpest peak. Cluster nanoparticles of 42.94 nm were observed for 2% Fe: 1% Eu: TiO2. TEM analysis is corroborated by XRD lattice planes that match the d spacing calculations precisely. Pure TiO2 is more electrically conductive than Fe: Eu (1:1, 2:1, and 1:2) doped TiO2 particle samples due to oxygen valences and more defects. A stable bipolar resistive rapid time-switching memory device is produced by a thorough investigation of the materials that can be used in the fabrication of memory devices based on their optical, magnetic, and electrical properties at their optimal level. The study determined that 2% Fe: 1% Eu-doped titania can be used for magneto-opto-electronic, i.e. switching memory device, applications. *[Ref: D. Rehani et al., Applied Physics A 128, 737 (2022)]*

## Lectures Delivered:

1. "Nanomaterials on surfaces studied using ultrahigh vacuum scanning tunnelling microscopy and photoelectron spectroscopy" at Symposium on Material organized by Indian Association for Cultivation of Science, Kolkata, 10th February, 2023.
2. "Quasicrystalline elemental thin films" at Indian Institute of Technology, Kharagpur, 15th February, 2023.
3. "Bulk electronic structure of materials studied by hard x-ray using synchrotron radiation" at workshop entitled Spectroscopy using Indus
4. Synchrotron Radiation organized by RRCAT and BARC at Indore, 23rd March, 2023


## DR. RAJIB BATABYAL

**Scientist- D**

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Topological phases of matter, Semiconductor-superconductor heterostructures, Surface and Nanoscale Physics

**Group Members:** (1) Mr. Pramod Bhakuni, (2) Mr. Shuvam Sarkar, (4) Mr. Sajal Barman, (5) Mohammad Balal, (6) Mrinal Manna (7) Dr. Sudipta Roy Barman

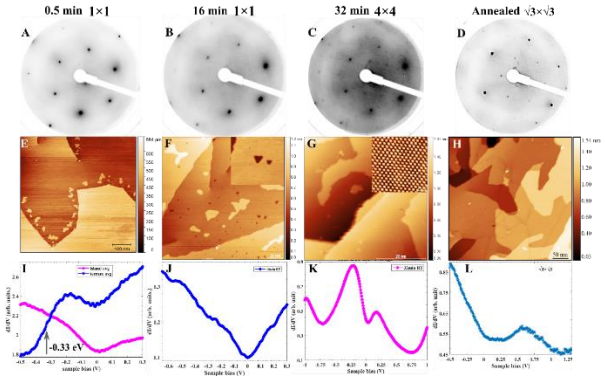
**Ph.D. Completed:** None

**Facilities:** (1) Scanning tunneling microscope (STM), (2) Angle resolved photoemission and X-ray photo emission spectroscopy (ARPES and XPS)

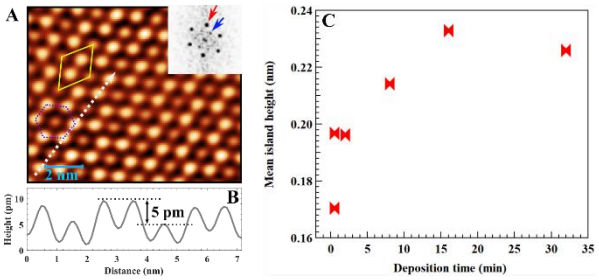
## In-house Research Activity:

### I. Diverse morphological and electronic properties of Ga/Cu(111) surfaces

we have studied detailed growth mechanisms of epitaxial Ga ultrathin films on Cu(111) surfaces grown in both low temperature (LN2) and RT and measured STM and STS in both at RT and LT (~ 30K). This shows an enriched structural phase diagram indicating the diverse two-dimensional crystal structures of Ga film. Consequently, in STS, we have measured distinctly different spectroscopic features in their electronic density of states corresponding to the differently probed structures. Figure below shows the various phases of Gallium ultrathin films.



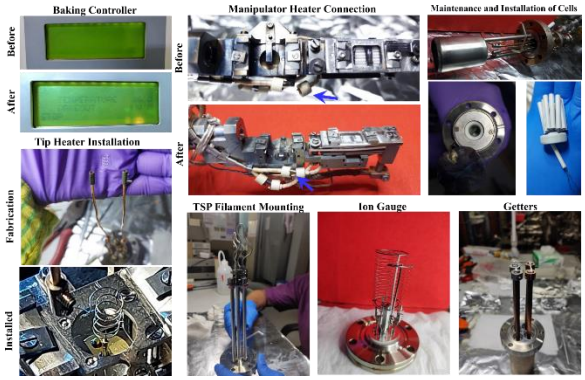

We further analysed the atomically resolved structure of 4×4 reconstructed Ga films which immediately indicates formation of two-dimensional (2D) graphene-like gallenene honey comb structure at the surfaces. Figure below displays such an example.




### II. Upgradation of UHV Systems

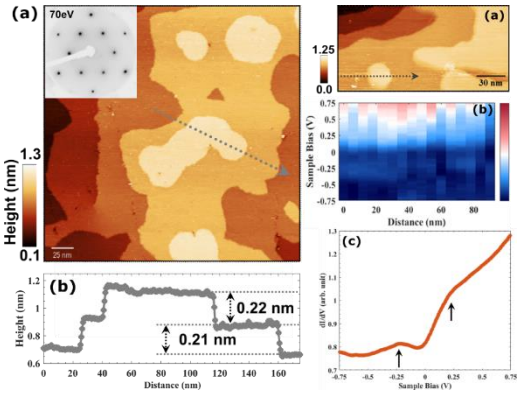
We have carried out the following jobs:

Change TSP filament, Instal newly made ion gauge filament, STM tip heater stage installation, Repair the manipulator heating wire under rotation, Installation of newly made UHV exfoliation stage, Installation of few evaporator cells, swapping main gate valves and *Solve temporarily the system baking controller specifically* its main display.




### III. Electronic states of the stable $\sqrt{3}\times\sqrt{3}$ R30$^{O}$ phase of Al films

We have carried out STM and STS measurements to probe local structure and electronic density of states of a ultrathin epitaxial aluminium films grown on Cu(111) surfaces at RT. This leads to stable $\sqrt{3}\times\sqrt{3}$ R30$^{O}$ reconstructed phase with its spectroscopic signature. Figure below shows the morphological and electronic properties of Al thin films.




### IV. Electronic band topology of 2D materials

We have investigated a newly predicted novel phase of matter characterized by their nontrivial band topology. In addition, we are performing experiments to manipulate these topological band structure via growing adlayers on the surface of the pristine topological materials. Our experiments precisely quantify proximitized metallic states from nonmagnetic elements at the interface.

## Collaborative Research Activity:

We have carried out X-ray photoemission spectroscopy (XPS) of the various samples from the users listed below:

(1) **Dr. Sandipan Chatterjee,** CSIR-Central Leather Research Institute, Kolkata, India, (2) **Dr. Bhasker Soni**, The Maharaja Sayajirao University of Vadodara, India, (3) **Dr. Abhijit Bera,** Assistant Professor, Midnapore College, India, (4) **Dr. Biplab Kumar Patra,** CSIR - Institute of Minerals and Materials Technology, Bhubaneswar, India, (5) **Ms. S. Pavithra,** Department of Chemistry, SRM Institute of Science and Technology, Kattankulathur, India, (6) **Dr. Bismita Nayak,** Department of Life Science, National Institute of Technology Rourkela, India, (7) **Dr. Soumya Ranjan Mohapatra,** Dept. of Physics & Astronomy, NIT, Rourkela, India

## Sponsored Project:

- Starting Research Grant (SRG)/SERB

"***Viewing topological states in quantum structures and their controllability***"
Sanctioned amount: Rs. 29,26,800/-


## DR. R. J. CHOUDHARY

**Scientist-G**

ram@csr.res.in


Research Area/expertise: Electronic and magnetic properties of transition metal oxides thin films and heterostructures.

**Group Members:** (1) Mr. Suresh Bhardwaj, J.Eng-F (2) Mr. Avinash Wadikar, J. Eng.-F (3) Mr. Manoj Kumar, Jr. Eng.-E (4) Mr. Sharad Karwal, Jr. Eng. –D

**Research Scholars:** Ms. Anita Bagri, Ms. Sophia Sahoo, Mr. Sumit Sarkar, Ms. Pooja Narwat, Mr. Subho Saha, Mr. Rajan Mishra

**Ph.D. Completed:** 5 (supervisor) + 8 (co-supervisor)

**Facilities:** (1) RHEED assisted PLD (2) SQUID-VSM (3) AIPES beam line BL2 @ Indus-1 SRS, RRCAT, Indore (4) 9T Magneto-dielectric (5) DSC

❖ **Light-controlled magnetoelastic effects in Ni/BaTiO3 heterostructure.**

Here, we demonstrate the remote-controlled tunability of these effects under the visible, coherent and polarized light. The combined surface and bulk magnetic study of domain-correlated Ni/BaTiO3 heterostructure reveals that the system is strong sensitive about the light illumination via the combined effect of piezoelectricity, ferroelectric polarization, spin imbalance, magnetostriction, and magnetoelectric coupling. Well-defined ferroelastic domain structure is fully transferred from a ferroelectric substrate to the magnetostrictive layer via interface strain transfer.

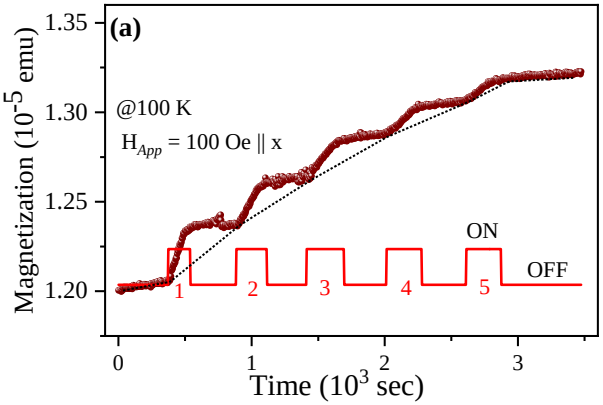



Fig.: Light (532 nm) pulse dependent magnetization

The visible light illumination is used to manipulate the original ferromagnetic microstructure by the light-induced domain wall motion in ferroelectric, consequently the domain wall motion in the ferromagnetic layer. Our findings mimic the attractive remote-controlled ferroelectric random-access memory write and magnetic random-access memory read application scenarios.

**Reference:** *Anita Bagri et al. ACS Appl. Mater. Interfaces 15 18391(2023).*

❖ **Mott-Hubbard insulator to negative charge transfer metal transition in $LaNi_xV_{1-x}O_3$ films.**

The room temperature (300 K) electronic structure of pulsed laser deposited $LaNi_xV_{1-x}O_3$ thin films have been demonstrated. The substitution of early-transition metal (TM) V in $LaVO_3$ thin films with late-TM Ni leads to the decreasing in out-of-plane lattice parameter. Doping of Ni does not alter the formal valence state of Ni and V in $LaNi_xV_{1-x}O_3$ thin films, divulging the absence of carrier doping into the system. The valence band spectrum is observed to comprise of incoherent structure owing to the localized V 3*d* band along with the coherent structure at Fermi level. With increase in Ni concentration, the weight of the coherent feature increases, which divulges its origin to the Ni 3*d*-O 2*p* hybridized band. The shift of Ni 3*d*-O 2*p* hybridized band towards higher energy in Ni doped $LaVO_3$ films compared to the $LaNiO_3$ film endorses the modification in ligand to metal charge transfer (CT) energy. The Ni doping in Mott-Hubbard (MH)insulator $LaVO_3$ leads to the closure of MH gap.

## Collaborative Research Activity:

A transition from bandwidth control Mott-Hubbard insulator $LaVO_3$ to negative CT metallicity character in $LaNiO_3$ film is observed.Ref.: *A. Jana et al. Phys Rev B 106 205123 (2022)*

- **Qualitative study of structural phase transition in nickel doped $La_2CoTi_{1-x}Ni_xO_6$:** $La_2CoTi_{(1-x)}Ni_xO_6$ ($x$ = 0, 0.2 and 0.6) were prepared by sol-gel method. A structural phase transition occurred from monoclinic (*P21/n*) to orthorhombic (*Pbnm*) to rhombohedral ($R\bar{3}c$) as the nickel content is increased. XPS study reveals the distribution of mixed oxidation state of cobalt ions ($Co^{2+}/Co^{3+}$) with Ni doping causes the significant changes in the structure of the studied samples. *Ref:- Neha et al., **J. All. Comp. 943** 169126 (2023).*

**Efficient solar cells of $CuBi_2O_4$:** Solar Cell Capacitance Simulator-1D (SCAPS-1D) software is used to optimize the performance of CuBi2O4 (CBO) based kusachiite solar cells with various n-type ABO3 perovskite oxide (PO) buffer layers. Among investigated solar cell devices, ITO/SrSnO3/CBO/Au optimized in terms of thickness and doping density with theoretical PCE of 22.19%. *Ref:- Vishesh, et al. **Mater. Today Commun. 32** 104061 (2022*

## Lectures Delivered:

- "**Probing valence band structure of transition metal oxides using resonant photoemission spectroscopy**." at RRCAT, Indore on 24-3-23.
- "**Engineering Electronic and Magnetic Ground States via Strain in Transition Metal Oxides**" at iCOLD-2023 at DIAT, Pune on 22-3-23.
- "**Strain Effects in Transition Metal Oxides**" at Holkar College on 16-3-2023.
- "**Probing electronic and magnetic correlation using Indus synchrotron source**" at College of Commerce, Arts and Science, Patna on 1-3-23
- **"Photoelectron spectroscopy"** at Holkar College, Indore on 28-2-23.
- **"Learning from nature for emerging technologies"** at Shri Vaishnav Institute of Management, Indore on 28-2-23.
- **Engineering the Electronic and Magnetic Ground States via Strain in Transition Metal Oxides**" at DAVV, Indore on 18-2-23.
- "**Photo-electron spectroscopy for materials characterization** " at BITS Pilani on 19-01-2023.
- "**Engineering the Electronic and Magnetic Ground States via Strain in Transition Metal Oxides**" at IUMRS, IIT Jodhpur on 23-12-23.
- "**Electronic structure using spectroscopy techniques @ Indus synchrotron sources.**" at MS University, Vadodada on 20-11-23.
- "**Electronic structure studies using Indus synchrotron source**" at Refresher Course by UGC-HRDC at DAVV Indore on 17-11-22.
- "**Magnetic oxide semiconductors.**" at Refresher Course by UGC-HRDC at DAVV Indore on 16-11-22.
- "**Synthesis and characterization of thin films.**" at Refresher Course by UGC-HRDC at DAVV Indore on 15-11-22.
- **"Thin film techniques"** at Amity Noida on 4-11-22.
- "**Awareness of Trends and Technology: Nature's Perspective**" at IPS, Indore on 13-10-22.
- "**Tuning the Magnetic Ground State in Thin Films of Correlated Oxides via Strain Engineering**" at AN College, Patna on 17-9-22.
- "**Surface, Interface and bulk materials characterisation using Indus synchrotron sources**". at online CSR Awareness Program.
- "**Strain controlled electronic and magnetic properties of the transition magnetic oxide systems** " at Medicaps, Indore on 12-7-22.
- "**Thin Film Platform for Emerging Technologies**" at CUJ, Ranchi on 25-4-2022.
- **"Photo-electron spectroscopy using Indus synchrotron source"** at CUSB, Gaya on 19-3-23.

## Sponsored Project:

DST-SERB project entitled, "*Understanding the interplay between charge transfer energy, charge disproportionation, strain and spin ordering in transition metal oxides thin films*" Sanctioned amount: Rs. 24,51,860/-

## Honours/ Recognitions/Awards:

**MRSI Medal-2023**


## DR. UDAY DESHPANDE

**Scientist-F**

uday@csr.res.in


Optical and electronic properties of metal oxide nanostructures

**Group Members:**

Parveen Garg, JRF (2020), Ankita Agrawal, JRF (2021), Sachin Kumar, J.E

**Ph.D. Completed:** 0

**Facilities:**

(1) ESCA (2) UV-Vis-NIR spectroscopy (3) FTIR spectroscopy (4) Tube furnace

## In-house Research Activity

Our group is engaged in synthesis of nanomaterials, and study of surface electronic and optical properties in view of their application to photoanodes for hydrogen production. The chemical reaction at the electrode-electrolyte interface, absorption of light, generation and transport of carriers at the electrode surface are determining factors for overall performance of the PEC cell. Surface morphology also plays important role in the process. Surface chemical properties are studied using photoelectron spectroscopy, and optical properties using UV-Vis, PL, and FTIR spectroscopy.

❖ **$\alpha$-$Fe_2O_3$ and $WO_3$ nanosheet photoanodes**

Haematite is an attractive photoanode material being low-cost and stable in chemical environment. A serious limitation of iron oxide is short diffusion length of photo-generated charge carriers. Single crystalline iron oxide nanostructures have shown improved charge-carrier separation and PEC performance. We have fabricated dense single crystalline $\alpha$-$Fe_2O_3$ nanostructures such as nanosheets (NSs) by controlled oxidation of pure Fe. Dense, highly textured Haematite (a-$Fe_2O_3$) nanosheets were grown on pure Fe substrate. Fig. 1(a) shows vertically grown nanosheets and grown on polycrystalline the Fe substrates. Time resolved photoluminescence measurements shows longer decay time in the NSs samples as compared to that in the bulk, indicating prolonged electron-hole recombination time that can enhance efficiency. The photocurrent is found to be higher compared to a smooth $\alpha$-$Fe_2O_3$ thin film. Also, pure and Ti, Bi doped $WO_3$ nanosheets were grown using hydrothermal method, and their PEC performance was studied for oxygen evolution.

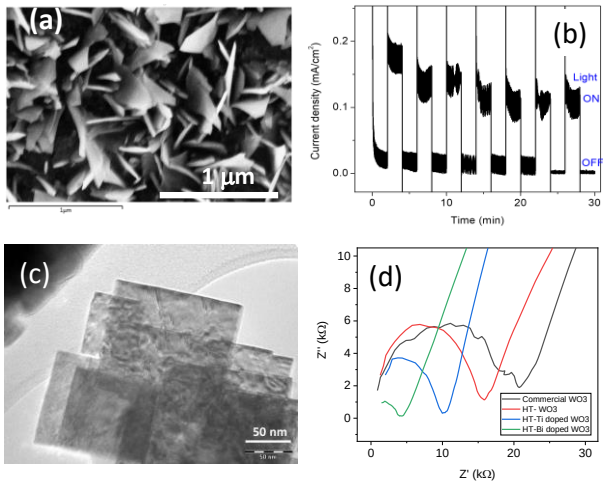



**Fig.1.** SEM image of the $\alpha$-$Fe_2O_3$ nanosheet photo anode (b) Chronoamperometry of $\alpha$-$Fe_2O_3$ nanosheets under 1 sun illumination on-off pulses, shows stability of the photocurrent with time (c) TEM image of $WO_3$ nanosheets (d) EIS plots recorded on $WO_3$ commercial powder, and pure and Ti, Bi doped $WO_3$ nanosheets synthesized by hydrothermal route. The impedance is found to be highest to lowest in the same order.

## Collaborative Research Activity:

❖ **Structural and optical properties of Nd doped $LaPO_4$**

Effect of Nd doping, on the structural, optical and electronic properties of lanthanum monazite structure has been studied. Oxidation states of the elements were confirmed from X-ray photoelectron spectroscopy (La and Nd) and X-ray absorption near edge structure studies (La).

*[Yogesh Kumaret al.,J. Alloys and Compounds 922 (2022) 15166772]*

❖ **Temperature-Dependent n–p–n Switching and Highly Selective Room-Temperature n-$SnSe_2$/p-SnO/n-SnSe Heterojunction-Based $NO_2$ Gas Sensor**

XPS spectra were analysed to examine the oxidation state of Sn in the heterojunction sample. It showed fast response, recovery, and selective detection of $NO_2$ at RT which is discussed on the basis of physisorption and charge transfer.

*[Sanju Rani et al., ACS Appl. Mater. Interfaces 14 (2022) 15381]*

❖ **Nonpolar Growth of GaN Films on Polar Sapphire Substrate Using Pulsed Laser Deposition: Investigation of Substrate Temperature Variation on the Quality of Films**

The growth of GaN films along nonpolar crystallographic planes, especially s-plane, on c-$Al2O_3$ substrate using pulsed laser deposition (PLD) is reported. Detailed XPS investigations are carried out to analyse the Ga-N bonding.

*[Tahir Rajgoli et al., Phys. Status Solidi B 2023, 2200587]*

❖ **Effective role of vibrational annealing in enhancing room temperature physical properties of Co doped ZnO nanoparticles by using novel TVA technique**

A thermo-vibrational annealing (TVA) setup for processing nanocrystalline materials was designed and fabricated, and XPS studies were performed yo analyse of oxidation states of the dopant Co in ZnO, besides other measurements.

*[Nirlipta Kar et al., J. Mat. Res. Technol. 24 (2023) 2522]*

❖ **A single-step plasma method for rapid production of 2D, ferromagnetic, surface vacancy-engineered $MoO_{3-x}$ nanomaterials, for photothermal ablation of cancer**

The $MoO_3$ nanoflakes were synthesized by plasma-chemical technique with integrated hydrogenation process for biomedical applications. A detailed XPS analysis is presented for the α-$MoO_3$, and $MoO_{3-x}$ which shows a fraction of Mo in +5 state.

*[Mizanur Rahman et al., Nanotechnology 34 (2023) 195601]*

## Lectures Delivered:

1. B.A.M. Univ., Aurangabad, National Seminar on Recent Trends Mat Sci., 30-06-2022

2. Gov. Sci. College, Jabalpur, Appl. of XRD and FTIR Techniques in Sci. and Technol., 4-11-2022

3. Holkar Sci. College, Indore, A reflection of the Multidisciplinary nature of Forensics" 10-10-2022

4. D.A.V.V. Indore, International Conf. on Recent Trends in Physics, 18-02-2023

## M.Sc. Projects:

1. Mr. Krishnapratap Singh

2. Ms. Nandini Solanki

3. Ms. Shruti Kushawah

4. Ms. Meenal Jain

5. Ms. Lakisha Choudhary


## DR. MUKUL GUPTA

**Scientist-G; Email: mgupta@csr.res.in**


Soft X-ray absorption spectroscopy, Thin films deposition, study of surface, interfaces and depth profiling in thin film multilayers

**Group Members:**

**Staff:** Layanta Behera, Rakesh Sah, Avinash Wadikar
**Ph.D. students**: Shailesh, Ashish, Akshaya, Nikita, Rohit
**Ph.D. Completed:** 5 as supervisor and 2 as co-supervisor
**Facilities:**

(1) Polarized light soft XAS beamline at Indus-2 Synchrotron Radiation Source (2) Thin film deposition using sputtering – ion beam, 2-inch, & 3-inch magnetrons (3) Secondary ion mass spectroscopy (4) D8 Advance - Powder XRD (5) Thermal annealing using - UHV-RTA & HV systems

## In-house Research Activity

The activities of our group are related with sputter deposition of thin films, their characterization and study. Major phenomenon being probed are: synthesis of transition metal nitride (TMN), oxide (TMO) and oxinitride (TM-O-N) thin films; structural, magnetic, electronic, electrochemical and optical properties; interdiffusion and depth-profiling of thin films and multilayers. Highlights of in-house research activities carried out in 2022-23 are:

### ❖ *e-ph interactions and superconductivity of β-Nb2N thin film*

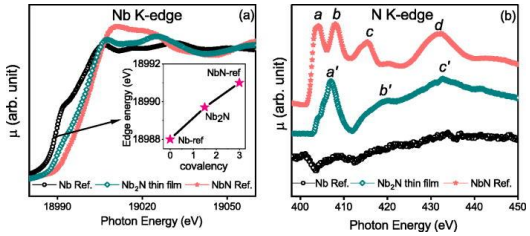



Fig.1: Nb (a) and N (b) K-edge XANES spectra of β-$Nb_2N$ thin film along with Nb and NbN references. In the inset, Nb edge energy as a function of the Nb covalency has been plotted.

A detailed study of β-$Nb_2N$ thin films prepared using a simple synthesis route was carried out in this work. It was found that controlled annealing of amorphous Nb(N) produces a single phase β-$Nb_2N$ and the electrical transport measurements revealed a dominance of electron–phonon interactions with a superconducting transition around 4.74 K and an upper critical field 4 T. Nb and N K-edge XANES as shown in fig.1 confirmed the electronic structure of β-$Nb_2N$. [Ref: S. Kalal, A. Tayal, S. Karmakar, R. Joshi, R. Rawat, M. Gupta, Electron–phonon interactions and superconductivity of β-Nb2N thin films, Applied Physics Letters 122, 072602 (2023). https://doi.org/10.1063/5.0142370]

### ❖ Detailed study of ScN thin films

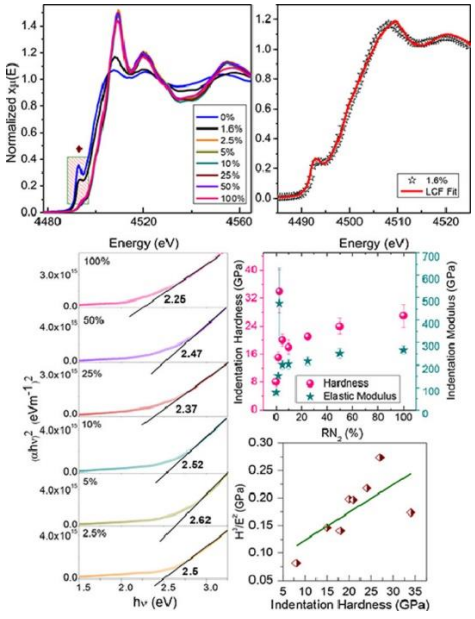



Fig. 2: Sc K-edge XANES, bandgap and hardness measuremnets on a series of ScN thin films.

To contemplate an alternative approach for the minimization of diffusion at high temperature, present findings impart viability of room-temperature deposited reactively sputtered ScN thin

films. To eradicate the skepticism of appearance of N K-edge and Sc L-edge absorption spectra adjacent to each other, the first-ever Sc K-edge study has been adopted to validate complementary insight on the metrical parameters of the Sc-N system. [Ref. S. Chowdhury, R. Gupta, P. Rajput, A. Tayal, D. Rao, R. Sekhar, S. Prakash, R. Rajagopalan, S.N. Jha, B. Saha, and Mukul Gupta, Detailed study of reactively sputtered ScN thin films at room temperature, Materialia 22, 101375 (2022). DOI: https://doi.org/10.1016/j.mtla.2022.101375]

- **Fe-C phase formulations through Fe self-diffusion**

We studied diffusion process during the growth of FeC thin films by studying the broadening of a 57FeC marker layer using secondary ion mass spectroscopy. It was found that C occupies the grain boundary region augmenting Fe self-diffusion. [Ref: P. Kumar, O. Leupold, I. Sergueev, H.-C.Wille, M. Gupta, Study of Fe-C phase formulations through Fe self-diffusion during thin film growth, Applied Surface Science 597, 153611 (2022). https://doi.org/10.1016/j.apsusc.2022.153611]

- **stability of β-W phase through reactive N sputtering**

We demonstrated the stabilization of β-W phase in 70 nm thicker W films at a relatively higher deposition rate of 3.13 nm/min as compared to earlier works. [H. Singh, M. Gupta, P. Gupta, Rafaela F. S. Penacchio, Sergio L. Morelhao, H. Kumar, Role of nitrogen partial pressure, deposition rate and annealing on stability of β-W phase, Applied Physics A 129, 312 (2023). DOI: https://doi.org/10.1007/s00339-023-06552-x]

## Collaborative Research Activity:

**Summary of CRS activities**

**Users's Statistics:**

SXAS beamline: 65 external users; 569 samples | 26 internal users; 282 samples
D8 XRD: 172 external users; 1157 Samples | 39 internal users; 614 samples
Sputter deposition: 29 Users; 203 Samples | 17 internal users; 290 samples
SIMS system: 14 external users; 67 Samples |4 internal users; 29 samples
Vac. Annealing: 11 external users; 91 Samples | 3 internal users; 41 samples
Total: 291 external users; 2037 samples | 97 internal users;1306 samples
Grand total: 380 users | 3343 samples in 2022-23

**Publication Statistics:**

In-house publications: 4
Co-author publications:32
Acknowledged publications:14
Conference proceedings: 12
Total number of journal publications in 2022-23: 50

## Lectures Delivered by Mukul Gupta:

Dr. Mukul Gupta delivered 16 invited talks at following institutions/conferences

- Colloquium at KIIT University, Bhubaneshwar 27th May 2022 (online)
- UPES, Dehradun 27th June 2022
- ICETFM, MediCaps Univ., Indore 12-14 July 2022
- Awareness meet at Kalpakkam Node of UGC-DAE CSR, 19th July 2022 (online).
- FDP at IIIT Jabalpur, 6th September 2022 (online).
- Awareness meeting of UGC-DAE CSR, September 6-15, 2022 (online).
- A 4-lecture series at UGC-HRD Centre, DAVV, Indore, Nov. 2022 (online).
- National Conference on Electronic Structure, Goa University, November 14-16, 2022.
- NPCM-2022, UGC-DAE CSR Mumbai, Nov. 14 – 19, 2022.
- 66th DAE SSPS BIT Mesra, Ranchi, Dec. 18-22, 2022.
- ICRTP-2023, DAVV, Indore, 17–18 February 2023.
- STC (NIT Uttarakhand) 02 March 2023 (online).
- SISR-2023, RRCAT, Indore 24-25 March 2023.

## Honours/ Recognitions/Awards:

- Dr. Mukul Gupta is mentoring a TARE project from SERB with Dr. Ghadai from SMIT, Majitar, Sikkim.
- Dr. Mukul Gupta is serving as Advisory Editorial Board Member for Applied Surface Science Advances (Elsevier) and Associate Editor of Hybrid Advances (Elsevier).

## Foreign visits by faculty and students:

Dr. Mukul Gupta and Mr. Shailesh Kalal visited Petra III Germany and PSI Switzerland to carry out synchrotron and neutron scattering experiments during 23 Sep.- 02 Oct. 2022.

Dr. Mukul Gupta, Mr. Shailesh Kalal and Mr. Ashish Gupta visited Elettra Italy carry out synchrotron experiments during November 21-28, 2022.


## DR. DEVENDRA KUMAR

**Scientist F**

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Quantum materials, Topological semimetals and insulators, Single crystal growth, Low temperature physics

**Group Members:**

(1)Megha (Ph.D Student) (2) Shivam Rathod (Ph.D Student) (3) Nitin Chaudhary (Ph.D Student)

**Facilities:**

(1) 16T PPMS for resistivity, magnetoresistance and thermal expansion

## In-house Research Activity

Our group is involved in study of topological materials using Shubnikov-de Haas quantum oscillations and other quantum transport measurements. We grow high quality single crystals and thin films of these materials in our laboratory and utilize the low temperature high magnetic field measurements to probe the Fermi surface topology, topological phase transitions, and quantum transport of topological surface states.

**Quantum oscillation studies of topological nodal line semimetal near the quantum phase transition:**

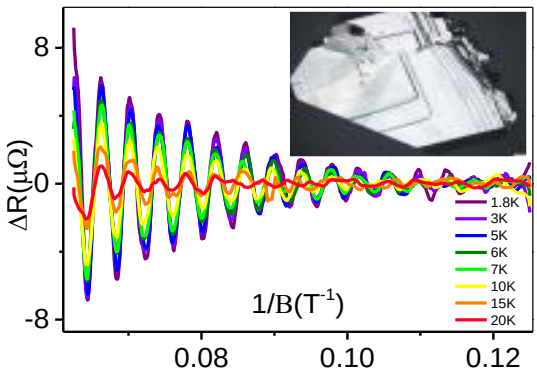



**Fig.1:** *Shubnikov-de Haas oscillations of ZrSiS at different temperatures. The inset shows the optical image of the single crystal.*

The topological nodal line semimetals with narrow bandwidth around the nodal line are susceptible to quantum phases transition. At the quantum critical regime, quantum fluctuations may modify the quasiparticle characteristics of these system. The experimental signatures of quantum criticality in topological Dirac materials are scarce. Here, we report the transport studies on nodal line semimetal ZrSiS, which is predicted to exist in the quantum critical regime. Our quantum oscillation studies show the exeprimenatl indication of system lying near quantum criticality, which is stabilized at higher magnetic fields. [*Reference: Megha Malasi, Shivam Rathod, Archana Lakhani, and Devendra Kumar, Under review]*

**Electron-magnon scattering in an anisotropic half-metallic ferromagnetic Weyl semimetal $Co_3Sn_2S_2$**

$Co_3Sn_2S_2$ is a magnetic Weyl semimetal, anisotropic ferromagnet, and type I-A half metal. Here we have investigated the half metallicity of $Co_3Sn_2S_2$ using high quality single crystals. $Co_3Sn_2S_2$ exhibits exponential suppression of spin-flip electron-magnon scattering below a characteristic crossover temperature which separates the regime of anomalous magnon scattering from one-magnon scattering. Suppression of spin-flip electron-magnon could also occur from Weyl fermions mediated anistropic gap, but the presence of anomalous magnon scattering at low temperatures evince the half metallicity.

[*Reference: Shivam Rathod, Megha Malasi, Archana Lakhani, and Devendra Kumar, Phys. Rev. Materials* ***6****, 084202 (2022)*]

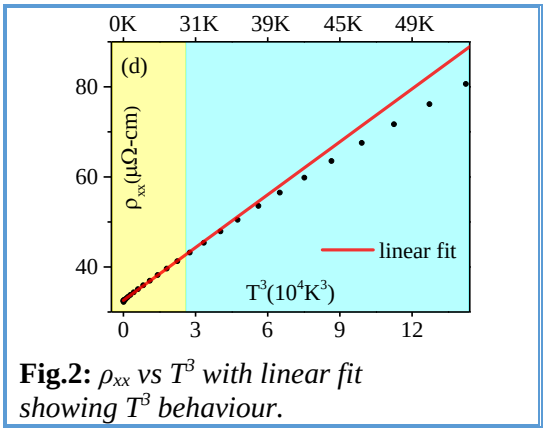



**Fig.2:** *$\rho_{xx}$ vs $T^3$ with linear fit showing $T^3$ behaviour.*

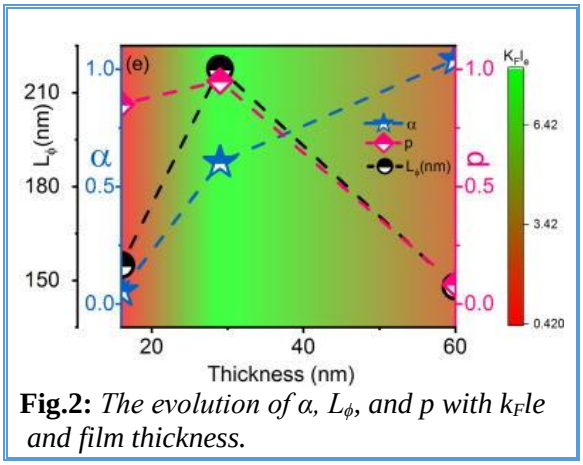



**Fig.2:** *The evolution of α, $L_\phi$, and p with $k_Fle$ and film thickness.*

**Evidence of surface delocalization in ultrathin films of topological insulator in presence of inter-surface hybridization and disorder**

The surface states of topological insulators are expected to be immune from Anderson localization. Experimentally the possibility of Anderson localization in TI thin films is not much explored. Here we discuss the thickness and disorder dependent studies on TI films to resolve the effect of inter-surface hybridization and disorder-induced localization on TI surface transport. Our results show that on increasing the disorder, the bulk of topological insulator transforms from diffusive to hopping transport while surface states remains in quantum diffusive regime. The weakening of WAL effect in thinner films is due to intersurface hybridization.

[*Reference: Megha Malasi, Shivam Rathod, Archana Lakhani, and Devendra Kumar,* Appl. Phys. Lett. ***121***, *093101 (2022)*

## Collaborative Research Activity:

**Quantum oscillations and scattering effect in InAlGaN/GaN quaternary 2DEG:**

Quantum transport properties of large bandgap $In_{0.15}Al_{0.79}Ga_{0.06}N$/GaN quaternary GaN high electron mobility transistor (HEMT) heterostructure is studied at low temperature upto 2K. Herein, we report the first evidence of weak localization (WL) in quaternary GaN two dimensional electron gas system. We observe negative magnetoresistance behavior and extracted dephasing time $\tau_\varphi$= 5.4 ps using HLN model at 2.2K. Linear dependency of dephasing rate with temperature ($\tau_\varphi \propto T$) is stablished below 20K. [*Chiranjit et. al. Under Review ]*

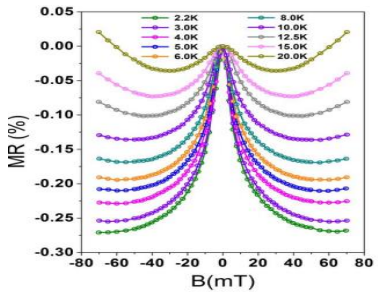



**Fig.3:** *MR versus field at different T.*

## Sponsored Project:

Early carrier research award scheme/DST SERB: "**Quantum Transport studies of topological semimetals**"Sanctioned amount~51 Completed: September 2021.


## DR. DILEEP KUMAR

**Scientist**

dkumar@csr.res.in


Growth & in-situ investigation of ultra-thin films, Epitaxial Magnetic Thin Film, Patterned Magnetic Nanostructures, Organic and metal interfaces, Exchange bias and magnetic anisotropy in thin films and multilayers

**Group Members:** (1) Arun Singh Dev, SRF (CSR Indore) (2) Anup Kumar Bera, SRF (CSR Indore) (3) Shahid Jamal, SRF (CSR Indore) (4) Sonia Kaushik, SRF (CSR Indore), Sharanjeet Singh, JRF (CSR, Indore)

**Ph.D. Completed:** 02

**Facilities:** (1) Organic thermal evaporator (2) In-situ UHV system (under maintenance)

## In-house Research Activity:)

In-situ thin film group at CSR, Indore Centre, is actively involved in in-house as well as collaborative research work through CRS. Some of the research highlights from 2022 to 2023 are as follows.

❖ **Interface-resolved study of magnetism in MgO/FeCoB/MgO trilayers using [1]**

Interfaces in MgO/FeCoB/MgO trilayer have been studied with grazing incident nuclear resonance scattering using the x-ray standing waves technique. High depth selectivity of the present method allows one to measure magnetism and structure at the two interfaces of FeCoB, namely, FeCoB-on-MgO and MgO-on-FeCoB independently, yielding an intriguing result that both interfaces are not symmetric. A high-density layer with an increased magnetic hyperfine field at the FeCoB-on-MgO interface suggests different growth mechanisms at the two interfaces. The azimuthal angle-dependent MOKE measurements reveal the presence of unusual uniaxial magnetic anisotropy (UMA) in the trilayer. The trilayer becomes isotropic at 450°C with an order of magnitude increase in coercivity. The asymmetry at the interfaces is in turn explained by boron diffusion from the FeCoB interface layer into the nearby MgO layer. Stress-induced UMA is observed in the boron-deficient FeCoB layer, superimposed with the bulk FeCoB layer, and found to be responsible for unusual UMA. The temperature-dependent variation in the UMA and coercivity can be understood in terms of variations in the internal stresses and coupling between FeCoB bulk and the interface layer.

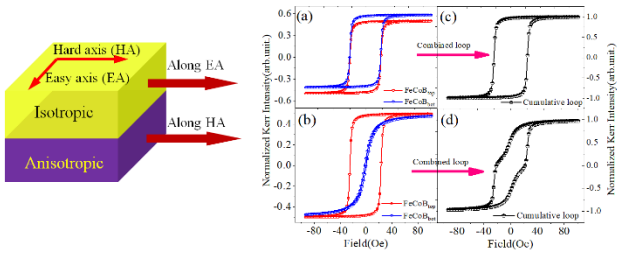
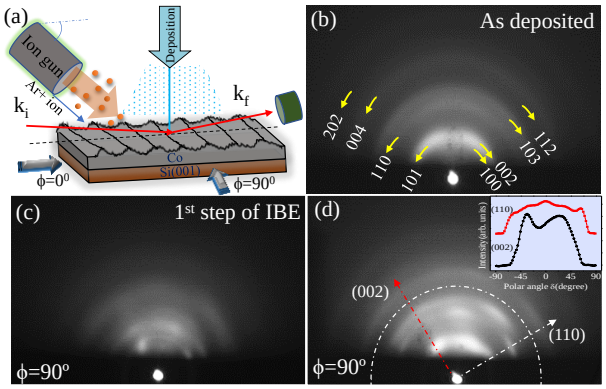



**Fig.1:** *Simulated loops along the easy and hard axis of magnetization with (a) and without (b) magnetic anisotropy. Combined loops along easy (c) and hard (d) directions if both are combined in a single layer.*

❖ **Enhancing the limit of uniaxial magnetic anisotropy induced by ion beam [2]**

This letter reports an approach to engineering and enhancing the strength of oblique incidence ion beam erosion (IBE) induced in-plane uniaxial magnetic anisotropy (UMA) by simultaneous modification of film morphology and film texture. Cobalt film and Si substrate have been taken as a model system to meet this objective. Unlike conventional thin film deposition on ripple patterned substrate or post-growth IBE of film, we direct our effort to the sequential deposition and subsequent IBE of the film. Detailed in-situ investigation insights that the film grows in a textured polycrystalline state with the formation of nanometric surface ripples. The film also exhibits pronounced UMA with an easy axis oriented parallel to the surface ripple direction. Remarkably, the induced UMA is about one order of magnitude larger than the IBE induced UMA reported earlier. The capability of imposing in-plane crystallographic texture throughout the entire film layer gives rise to magneto-crystalline anisotropy along with the shape anisotropy of nanometric surface ripples enhances the strength of the UMA,




and illustrates the universal applicability of the present method.

**Fig. 2:** *(a) Schematic of experimental geometry. (b) In-situ RHEED images taken at ϕ=90˚ direction after 1nm film deposition. RHEED images taken after (c) 1st and (d) 20th step of deposition-erosion process along ϕ=90º direction.*

**Reference:**

[1] *Md. Shahid Jamal, Dileep Kumar et. al, Phys. Rev B* ***107****, (2023) 075416*
[2] *Anup Kumar Bera, Dileep Kumar, et. al, Appl. Phys. Lett.* ***122,*** *(2023) 022405.*

## Lectures Delivered:

- **"*2D nanostructure -materials of the future spintronics application*"** at DAVV Indore on 09/11/2022.
- **"*In-situ investigation of thin films and multilayers*"** at institute/place on 1011/2022.
- **"*X-ray standing wave - a unique tool for depth-resolved studies*"** at DAVV Indore on 11/11/2022.
- **"*Extending limits of magnetic anisotropy in polycrystalline magnetic structures*"** at DAVV Indore on 09/12/2022.

## Foreign visits by faculty and students:

***Proposal: I-20210237***, Visited P03 beamline, PETRA-III, DESY, Germany, 12th- 19th May 2022 with PhD students *Mr Anup Kumar Bera* and Ms Sonia Kaushik ***Proposal: I-20220458***, visited P01 beamline, PETRA-III, DESY, Germany, 17th Oct to 22th Oct 2022, with PhD students *Mr Mohammad Shahid Jamal* and *Mr Sharanjeet Singh*

## Sponsored Project:

- SERB-DST, CRG/2022/001805 (Co-PI)

"***Tunable functional properties and exploration of double-well energy landscape in lead-free ferroelectric thin films and heterostructures*** "
Amount -28K

- SERB- DST, CRG/2021/003094 (PI)

"***Interface resolved studies of Fullerene (C60) and Alq3 based organic spin valve structures under in-situ & depth-resolved x-ray standing wave conditions***."

## DR. ARCHANA LAKHANI

**Scientist-F**

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Magneto transport studies of Topological Quantum Materials like topological Insulators, XMR materials, semimetals and Magnetic properties of Functional magnetic materials including Heusler alloys

**Group Members:**

(1) Ms. Sonali Baral, Ph.D Student (2) Ms. Indu Rajput, Ph.D Student and (3) Mr. Mukesh Kumar Dasoundhi, Ph.D Student 4) Ms Rachana Antil

**Facilities:**

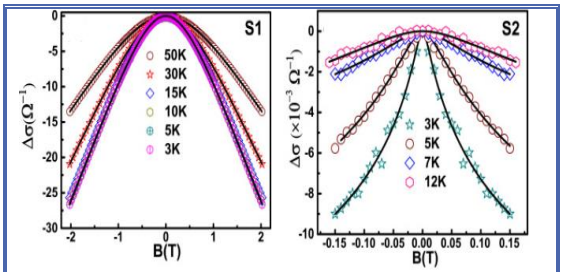
1) 9T PPMS system for Resistivity and Hall measurements 2) Furnace

## In-house Research Activity

Our current research is focused on magneto transport properties of Quantum materials including topological Insulators, topologically non trivial semimetals, Heusler alloys and other functional magnetic materials.

### Quntum coherent transport and electron electron interaction in $BiSbTe_3$ single crystals

A detailed magnetotransport study on two cleaved crystals S1 and S2 has been carried out. S1 shows metallic behavior whereas S2 represents the multiple transport mechanism which includes




*Magnetoconductance curves of S1 and S2*

thermal activation behavior, hopping conduction of localized charge carriers, quantum coherent transport and electron–electron interaction at high, moderate and low temperatures respectively. The resistivity and magnetoresistance analysis confirm the presence of weak antilocalization behavior explained by Hikami-Larkin-Nagaoka formula. These crystals indicate the presence of multichannel quantum coherent transport which depends on the thickness of sample. *[Ref: Indu Rajput, Sonali Baral, Mukesh Kumar Dasoundhi, Devendra Kumar, Archana Lakhani, Materials Today Communications* 33, 104537 (2022)]

### Growth of rare-earth monopnictide DySb single crystal by novel self-flux method

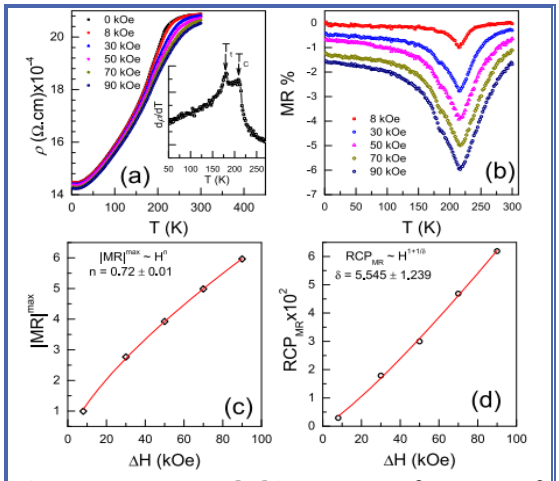
A new method for the single crystal growth of rare-earth monopnictide DySb is reported. Detailed structural, transport and magnetic characterisation of the crystal has been carried out by using X-ray diffraction (XRD), High resolution X-ray diffraction (HRXRD), resistivity and magnetisation measurements, respectively. The HRXRD and rocking curve analysis reveals the high-quality of the grown crystal.

*[ Ref: Journal of Crystal Growth , Mukesh Kumar Dasoundhi and Archana Lakhani ]*

## Collaborative Research Activity:

### Experimental and Theoretical Investigations of Fe-Doped Hexagonal MnNiGe

A comprehensive magnetic, caloric, and electrical transport study of $MnNi_{0.7}Fe_{0.3}Ge$ alloy has been carried out. A ferromagnetic transition and a weak antiferromagnetic transition occurs across $T_C \sim 212$ and $T_t \sim 180$ K respectively followed by a spin-glass transition below $T_f \sim 51.85$ K. A second-order phase transition across $T_C$ with mixed short and long-range magnetic interactions is confirmed through the critical exponent study and universal scaling of magnetic entropy and magnetoresistance. A weak first-order phase transition is observed across $T_t$ from magnetization and specific heat data. The frequency dependent cusp in $\chi_{AC}(T)$ along with specific heat $C(T)$ and resistivity $\rho(T)$ establishes the spin glass behavior below $T_f$.

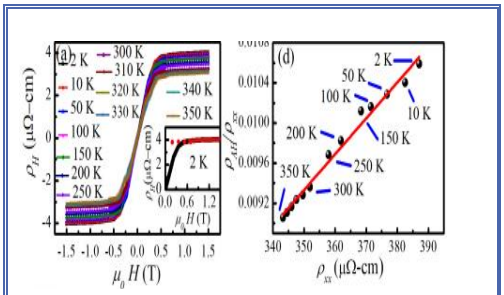



*(a) Resistivity and (b) MR as a function of temperature, at different magnetic fields. (c)Absolute MR and (d) power law fit*

*[Ref : S. Shanmukhrao Samatham , Akhilesh Kumar Patel, Ashish Kumar Mishra, Alexey V. Lukoyanov, Lyubov N. Gramateeva, Archana Lakhani, Ganesan Vedachalaiyer and Suresh Krishnawarrier Gopinatha Warrier, ACS Omega 7, 181100 (2022)]*

### Antisite disorder and Berry curvature driven anomalous Hall effect in the spin gapless semiconducting Mn2CoAl Heusler compound

A detailed investigation of the crystal structure and anomalous Hall effect in Mn2CoAl using experimental and theoretical studies is reported here. The analysis of the high-resolution synchrotron x-ray diffraction data shows antisite disorder between Mn and Al atoms within the inverse Heusler structure. The temperature-dependent resistivity shows semiconducting behavior and follows Mooij's criteria for disordered metal. The scaling behavior of the anomalous Hall resistivity suggests that the anomalous Hall effect in Mn2CoAl is primarily governed by an intrinsic mechanism due to the Berry curvature in momentum space. *[Ref: Nisha Shahi, Ajit K. Jena, Gaurav K. Shukla, Vishal Kumar, Shivani Rastogi,K. K. Dubey, Indu Rajput, Sonali Baral, Archana Lakhani, Seung-Cheol Lee, Satadeep Bhattacharjee,Sanjay Singh Phys. Rev. B 106, 245137 (2022*




*Hall Resistivity Vs Magnetic field at different temperatures and (b) ratio of anomalous Hall resistivity and longitudinal resistivity*

## Lectures Delivered:

1) *Invited talk at IC ETFM in Medicaps, July 2022*
2) *Invited talk at Amity University Jaipur , Invited as Guest of Honour at Amity Jaipur for International Conference on Women and Careers in STEM: Representations, Challenges and Opportunities (WSTEM-2022) on December 7, 2022*
3) *Four talks in Refresher course oraginized by DAVV ( Nov 2022)*
4) *Invited talk at Vaishnav Institute of Managemnet studies , 12 Oct 2022.*
5) *Invited talk at Chaitanya Bharathi Institute of Technology, Hyderabad, 17 Dec 2022.*


## DR.NIRANJAN PRASAD LALLA

**Scientist-H**

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Research Area/expertise: Structural, Magneto structural and multiferroic studies on oxide perovskites / expertise in low-temperature high-magnetic field XRD and low-temperature transmission electron microscopy

**Group Members:**(1) Dr. Arvind Yogi (2) Dr. Debalaya Sarker (3) Ms. Preeti Bhardwaj (4) Tusita Sau (5) Ms. Pooja Jain (6) Isha Lallar and (7) Mr. Kaushick

**Ph.D. Completed:** 8

**Facilities:**(1) Transmission Electron Microscope (2) Low-temperature High magnetic Field XRD (3) CCR-XRD

## In-house Research Activity

### Low-Temperature Dielectric and Magneto-Dielectric studies on $SmCrO_3$ rare-earth Chromate

Tusita Sau et. al [*Tusita Sau et. al, Phys. Rev. B 103, (2021) 144418*] have shown that in $SmCrO_3$the immediate post SRPT spin-structure, Pbn′m′:$\Gamma_2$, the Z-component of the rare-earth (Sm) moment order remains absent, leaving the possibility of independent ordering of $Sm^{3+}$ moments resulting an interaction along Z-axis. It has been shown [*Yamaguchi et. al. Phys. Rev. B 8 (1973) 5187*] that such possibilities can be fulfilled by mixing of either $\Gamma_6(-,-,-\ ;\ -,-,F^R_z)$ or $\Gamma_7(-,-,-\ ;\ -,-,G^R_z)$ irreps with the $\Gamma_2$ , while the $Sm^{3+}$ moments get independently ordered through $Sm^{3+}$-$Sm^{3+}$ direct interaction. The mixing of $\Gamma_2$ with $\Gamma_6$ and $\Gamma_7$ irreps transforms Pbn′m′:$\Gamma_2$ to P2′$_1$2′$_1$2$_1$:$\Gamma_{26}(F_x,C_y,G_z;F^R_x,C^R_y,G^R_z)$ and Pn′a2′$_1$:$\Gamma_{27}(F_x,C_y,G_z;F^R_x,C^R_y,G^R_z)$ respectively, which both are polar phases. Time of flight (*ToF*) neutron scattering study[*Tusita Sau et. al, Phys. Rev. B 103, (2021) 144418*] does indicate the occurrence of either $\Gamma_{26}$ or $\Gamma_{27}$ ordering.

In the present study the occurrence of the above mentioned possible polar-order has been investigated through zero-field and in-field dielectric susceptibility measurements on well characterized $SmCrO_3$ sample down to 2K. Before conducting the actual magneto-dielectric measurements, the "*dielectric impedance spectroscopy*" measurements were carried out to distinguish various effects, like grain-boundary and electrode-effect due to space-charge (SC) activation. Figure 1 shows the SC activation to be 0.096 eV.

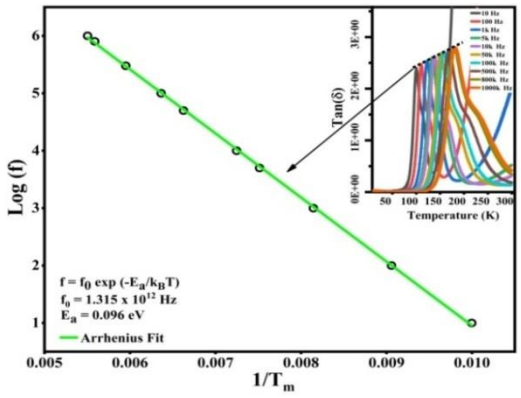


**Fig. 1:** *Arrhenius plot showing frequency dispersion of the tan(δ) loss peak maxima temperature ($T_m$).*

Figure 2(a) shows ~ 3 orders of magnitude drop in the permittivity $\varepsilon'_r$ below ~ 125K, representing the colossal dielectric nature of $SmCrO_3$ dominated This clearly evidences the occurrence of MD effect and hence the ME coupling across the SRPT in $SmCrO_3$. Below the SRPT the $\varepsilon'_r$-T keeps increasing

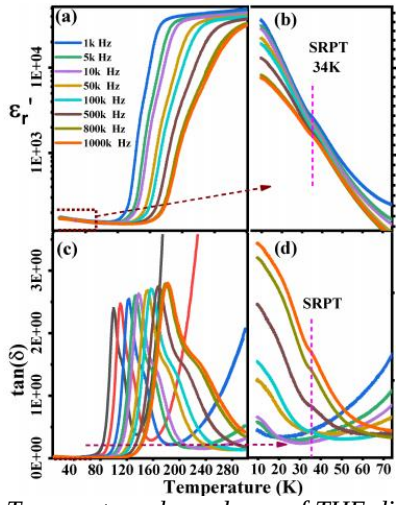


**Fig. 2:** *Temperature dependence of THE dielectric permittivity ($\varepsilon'_r$-T) and the Tan(δ) in $SmCrO_3$.*

but below ~15K it shows a saturating trend down to 10K, see Figure 2(b).

Figure 3(a) shows the occurrence of another non-dispersive zero-field peak in -T at ~ 7.3K. This dielectric anomaly represents the occurrence $Sm^{3+}$-$Sm^{3+}$ ordering, which, as predicted through *ToF* neutron studies [*Tusita Sau et. al, Phys. Rev. B 103, (2021) 144418*], represents the possible polar orders $\Gamma_{26}$ or $\Gamma_{27}$. The in-field -T maxima only slightly shifts towards the high-temperature to 7.8K.

The presence of ME coupling and the variation of its strength in $SmCrO_3$ are directly probed through isothermal magneto-dielectric (MD) measurement upto 6 to 8 Tesla fields at various temperatures. Figure 4 shows the occurrence of negative magneto-dielectric effect in $SmCrO_3$.

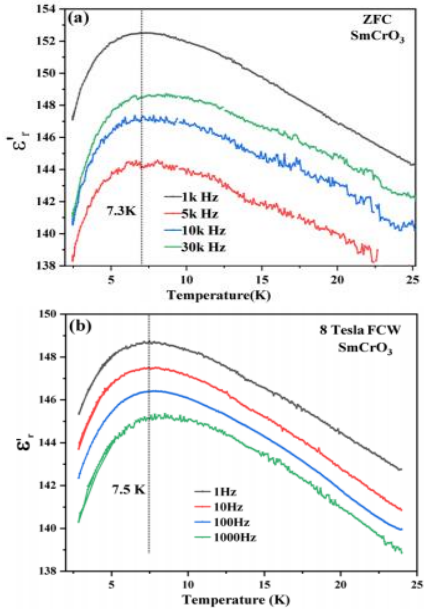


**Fig. 3:** *(a) Occurrence of maxima at ~ 7.3K in $\varepsilon'_r$-T and (b) its high-temperature shift under 8 Tesla field.*

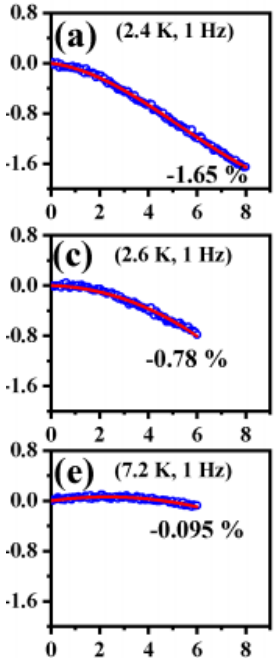


**Fig. 4:** *Occurrence of Magneto-dielectric (MD) effect in $SmCrO_3$.*


## DR. SANJOY KR MAHATHA

**Scientist-D**

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Electronic structure of low-dimensional quantum materials

**Group Members:** (1) Sambit Choudhury (JRF)

**Facilities:** (1) Synchrotron radiation beamlines at Indus synchrotron radiation facility of RRCAT

## In-house Research Activity:

Our research interests primarily focus on exploring the electronic structure of low-dimensional quantum materials such as transition metal chalcogenides (TMDCs), topological insulators and Dirac materials. Angle-resolved photoemission spectroscopy (ARPES) and *ab-initio* calculations are routinely employed for understanding and engineering the band structure of these materials. In addition, synchrotron-based X-ray absorption spectroscopy (XAS) is applied to probe the local geometric and electronic structure in an element sensitive manner.

❖ **Polarization-dependent ARPES of Ag/$MoS_2$**

The electronic band structure of clean and Ag-induced quantum well states (QWSs) on the $MoS_2$(0001) surface has been investigated using polarization-dependent ARPES at the APE-LE beamline of Elettra Synchrotron along with first-principle-based density functional theory (DFT) calculations. Using selective linearly polarized light, the orbital symmetry and *k* dispersion of the surface localized electronic states have been unambiguously determined as shown in Figure 1. The QWSs originating from the Ag $p_z$ orbitals are confined within the Ag overlayer, while the quantum well resonance states (QWRSs) are hybridized with substrate Mo $4d_{z2}$ and S $3p_z$ orbitals. Our ARPES experiments using 3incident circularly polarized light on $MoS_2$(0001) surface show circular dichroism effects, similar to recent studies where it is used to probe the initial state orbital angular momentum or Berry curvature. While the QWSs on the Ag overlayer does not exhibit any intensity asymmetry with the helicity of the incident light, the Ag QWRSs show circular dichroism characteristics. The observed circular dichroism from the QWRSs is attributed to the hybridization of these quantum states to the substrate states. *[A. Kar, et al., Phys. Rev. B **106**, 235146 (2022)]*

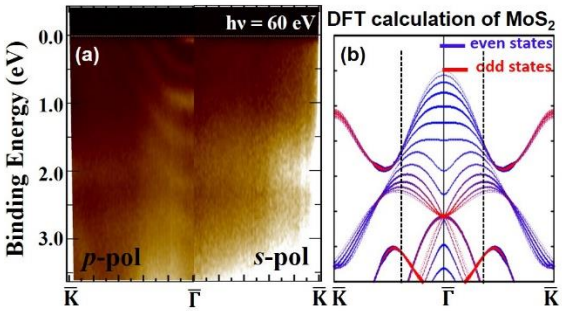



**Fig.1:** (a) *Polarization-dependent ARPES data obtained from 17 ML thick Ag(111) film on MoS2(0001) using photon energy of 60 eV. (b) DFT computed projected band structure for even and odd orbital states of Mo and S atoms.*

❖ **Electronic structure of $PdSe_2$**

Using a sub-micron sized focused photon beam from a Schwarzschild objective at the Spectro-microscopy beamline of Elettra Synchrotron Trieste, Italy, we have investigated the valence band structure of $PdSe_2$ as shown in Figure 2. The valence band maximum disperses isotropically, mainly along the $\Gamma X$ and $\Gamma Y$ symmetry directions, with almost similar in-plane hole effective masses and no signature of conduction band minimum (CBM) along the *SY* symmetry direction. This suggests the sample is a *p*-type semiconductor and the CBM lies

above the Fermi level thus inaccessible in ARPES measurement. These micro-ARPES results are crucial to explain the tuneable electron transport in defect engineered $PdSe_2$ as a field effect transistor. *[T. Kundu, et al., arXiv:2302.06491]*

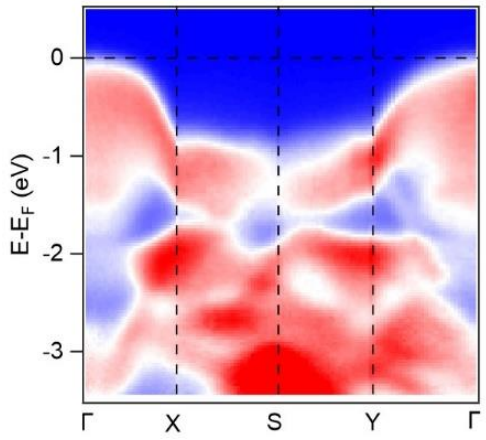



**Fig.2:** *ARPES spectra of $PdSe_2$ along the high symmetry directions.*

❖ **XAS at BL-01 of Indus2, RRCAT**

BL-01 is a bending magnet beamline, comprising 3 gratings, offering a photon energy range of 100-1200 eV suitable for probing $L_{2,3}$ edges of *3d* transition metals and $M_{4,5}$ edges of early rare-earths. The end-station is equipped with an electro-magnet with a reversible maximum field value of nearly ±2T at the sample position and a closed cycle cryostat that can cool down the samples to ~15 K. Using these, routine X-ray magnetic circular dichroism (XMCD) measurements can be performed. Fe and Co thin films grown on Si and Cu foils were used to test the cryostat and reliability of XMCD measurements. We found below 100 K, the XAS data measured with magnetic field are quite noisy to quantify the magnetic moments from the dichroism signal. Figure 3 shows the XMCD measurements performed on Fe/Cu foil at room temperature and at lowest temperature of 14 K. Evidently, the XAS spectra measured at 14 K are noisier than that of at room temperature. We are working to rectify this so that spectra with excellent signal/noise ratio can be recorded.

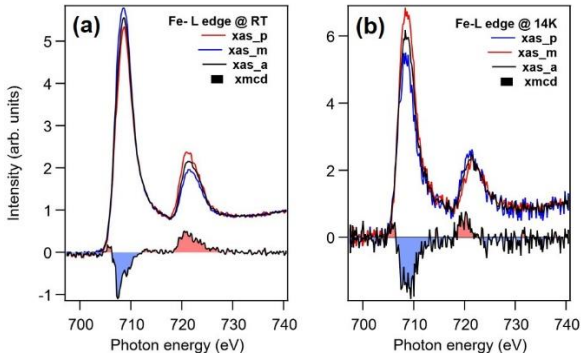


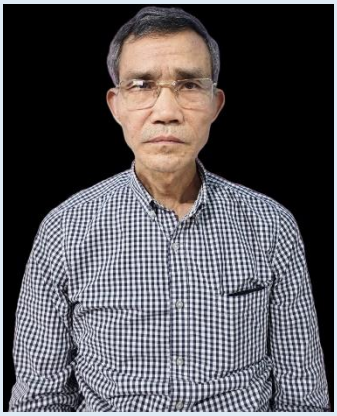

**Fig.3:** *XAS spectra under ±1T magnetic field measured at (a) room temperature and (b) 14 K.*

## Lectures Delivered:

- **"*Visualizing electronic band structure of materials using angle-resolved photoemission spectroscopy*"** at Indian Association for the Cultivation of Science, Kolkata on 26.12.2022.

## Foreign visits by faculty and students:

**December 11-21, 2022:** Synchrotron beamtime experiment at the Spectromicroscopy beamline of Elettra Sincrotrone Trieste, Italy.




## DR. GUNADHOR SINGH OKRAM

**Scientist-G/ Engineer-G**

okram@csr.res.in; okramgs@gmail.com


Research Area/expertise Nanoscale Thermoelectricity

**Group Members:** (1) Mr. Vinod Savaner (2) Ms Monika Saxena (3) Mr. Bodhoday Mukherjee and (4) Mr. Ramchandra Baniya

**Ph.D. Completed:** #4

**Facilities:** (1) Home-fabricated Resistivity and Thermopower setups (10 - 330 K) (2) Dynamic Light Scattering setup

## In-house Research Activity: Nanoscale Thermoelectricity research

❖ **Improved Thermoelectric Figure of Merit in Polyol Method-Prepared $Cu_{1-x}Bi_xS$ ($x \leq 0.06$) Nanosheets**

The first thermoelectric (TE) properties of simple polyol method-synthesized $Cu_{1-x}Bi_xS$ ($x$ = 0, 0.02, 0.04, 0.06) nanosheets with detailed characterizations are reported here. They show their single-phase nature of hexagonal crystal structure with space group P63/mmc, stoichiometric nature, valence states of the elements, nominal elemental composition and nanosheets (NSs) with an average thickness of 27 nm. The doping of Bi atoms in the CuS lattice has been evident from systematic change in various physical parameters including thermoelectric figure of merits (ZTs) with $x$. An enhancement of 231% in the thermoelectric power factor and a 6-fold increase in ZT, both at 300 K for x = 0.06 compared to x = 0, are found. [*Ref:- B. Mukherjee, R. Chatterjee, Tarachand, A. Lakhani, N. P. Lalla, S. Hussain, Y.-K. Kuo, and G. S. Okram. Cryst. Growth Des. Pub. on 13 April (2023). DOI: 10.1021/acs.cgd. 3c00029*].

❖ **Metal-insulator transition, colossal Seebeck coefficient and large violation of Wiedemann–Franz law in nanoscale granular nickel**

We report on the electrical and thermal transport properties of nickel nanoparticles with crystallite size ($D$) from 23.1±0.3 to 1.3±0.3 nm. They show a systematic metal-insulator transition (**Fig. 1**) with the change in the conduction type from n- to p-type as $D$ drops. They also reveal a dramatic change in the electronic excitation spectrum with the opening of an energy gap, cotunneling, Coulomb blockade of the charge carriers and transport level moving away from the Fermi level with decrease in $D$. The Lorenz number in the metallic regimes rises to whopping four orders of magnitude with drop in $D$, showing a huge violation of the Wiedemann–Franz law. [*Ref:- V. Sharma, G. S. Okram and Y.-K. Kuo. Nanotechnology **34**, 035702 (11pp) (2023)*].

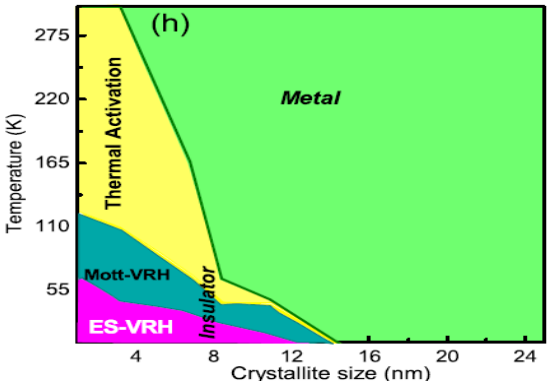



**Fig. 1** Schematic illustration of metal-insulator transition versus crystallite size.

❖ **Experimental observation of spin glass state in highly disordered quaternary Heusler alloy FeRuMnGa**

The realization of spin-glass (S-G) state in Heusler alloys is very rare in the presence of inherent structural and elemental disorder. Although a few half and full Heusler alloys are known to exhibit S-G state, there is hardly any manifestation of the same in quaternary Heusler compounds. Here we

report the observation of a S-G state in between canonical S-G and cluster glass in a highly disordered equiatomic quaternary Heusler alloy FeRuMnGa. Different intricate features of S-G state including non-equilibrium magnetic dynamics at low temperature are unveiled through our comprehensive magnetic, heat capacity and neutron diffraction studies. The structural disorder in the sample is neither conventional A2- nor B2-type commonly found in other Heusler alloys. The presence of disorder also is reflected with its exhibition of semi-metallic behaviour and anomalous Hall effect at low temperature. [*Ref:- S. Gupta, S. Chakraborty, S. Pakhira, A. Biswas, Y. Mudryk, A. Kumar, B. Mukherjee, G. S. Okram, A. Das, V. K. Pecharsky and C. Mazumdar. Phys. Rev B Accepted 2023]*.

## Lectures Delivered:

- ***"Thermoelectrics near room temperature."*** 3rd Edition of International Conference on Materials Science and Engineering held Online, Chicago, IL, USA September 21-22, 2022.
- ***"Harvesting electricity using nanostructures."*** 4th Edition of World Nanotechnology Conference (Virtual Event), USA, April 25-27, 2022.
- ***"Nanotechnology."*** *Keynote speaker*. One-day National Conference on Emerging Trends of Nanoscience in Modern Technology (virtual), Ideal Girls' College, Imphal, Manipur, 16 April 2022.

## Sponsored Project:

❖ CRS project, CSR Indore, MP. ***"Design of Hybrid Materials of Carbon Sphere with Vanadium and Manganese Oxides for Cathode Fabrication in Aqueous Zinc Ion Batteries"*** Dr. D. Mahanta, Gauhati University, Guwahati, Assam (2022-2024).

❖ ***Six similar others*** *(see other information)*.

## Honours/ Recognitions/Awards:

1. ***Young Scientist Award*** to Ms Disha Harinkhere by MPCOST, Bhopal (2023). CSR-IC-MSRSR-02/CSR-210/2017-18/1291, 31 March 2018.
2. ***Young Scientist Award*** to Dr. M. Maghimaa (CRS project PI) in 3rd Intl. Conf. on Applications of Natural compounds, Nanomaterials, Oncolytics in Cancer Biology and Biotechnology (ICANNO CB-22) of School of Life Sciences and ACER, B. S. Abdur Rahman Crescent Instt. Science & Technology, Chennai, India and Purdue University, USA on 27-28 October, 2022.
3. ***The best young Researcher Award*** to Dr. M. Maghimaa (CRS project PI) in the National Conf. on Recent Trends in Microbial Biotechnology, Bharthidasan University, Tiruchirappalli, Tamil Nadu on 24 February 2023.
4. ***The best paper award*** to Mr. Bodhoday Mukherjee, in the National Conf. on Physics and Chemistry of Materials (NCPCM2023), Holkar Sci. College, Indore during 16 - 18 March, 2023.
5. ***Invited and Reviewed one manuscript of the journal Nature.***
6. ***Invited, evaluated and included XRD data*** from Tarachand *et al.* Mater. Today Energy, **21** 100700 (2021) in The Intl. Centre for Diffraction Data (ICDD) by The ICDD Editorial Team, 12 Campus Boulevard, Newtown Square, Pennsylvania 19073, USA (May 2022). Reference #64033
7. ***QS Global Academic Survey***. QS World University Rankings®. Survey invitation. 7 February 2023.
8. ***Times Higher Education World University Rankings,*** London. ID MA2805030753. THE's Global Academic Reputation Survey Invitation. 11 November 2022.

## Dr. Rajamani Raghunathan

**Scientist-E**

rajamani@csr.res.in

Condensed Matter Theory/Computational Materials Science


**Group Members:**

(1) Dr. Dayasindhu Dey (RA)
(2) Mr. Sumit Sarkar (SRF)
(3) Ms. Priyanka Yadav (SRF)
(4) Mr. Shivam Choudhary (JRF)
(5) Mr. Sishir Jana (JRF)

**Ph.D. Completed:** 0

**Facilities:** High-Performance Computing Cluster (4 node)

## In-house Research Activity

- Our group is primarily interested in understanding the electronic structure and magnetism of materials and low-dimensional systems using semi-empirical model Hamiltonians and density functional theory.

- **Modeling the role of electron filling on the interplay between spin-orbit interactions and electron correlations in $Na_2TmO_3$ (Tm=Ta,Ir,Pt,Tl)**

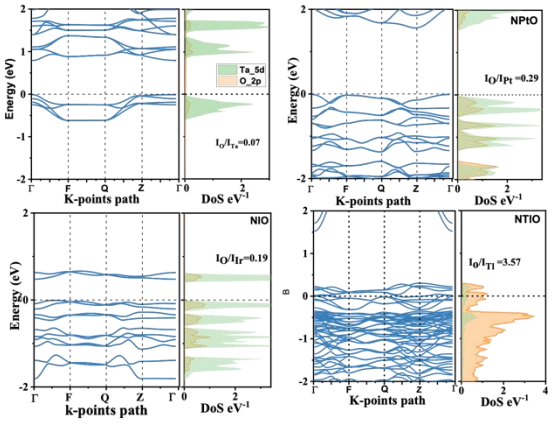



**Figure 1**: *Role of electron filling on the electronic band structures of $Na_2TmO_3$.*

Recently, transition metal oxides (TMOs) containing 5d metal ions are gaining popularity due to their competing electron correlations, crystal field energy and spin-orbit (SO) interactions giving rise to a variety of novel quantum properties including quantum spin liquid (QSL) behaviour, topological phases and SO assisted Mott insulator. Our group is focussed currently on exploiting band filling as a tool to understand and engineer the electronic and magnetic ground states of $Na_2TmO_3$ (figure 1).

- **Understanding the coupling between charge disproportionation and spin ordering in bismuth and lead oxides**

Our group is also interested in understanding the intriguing charge disproportionation mechanism of $BaBiO_3$ (BBO). A molecular orbital theory based model involving fluctuation between two different Bi – O hybridizations has been developed. This is followed by a systematic study of the electronic structure as a function of strain, which shows that BBO is at the boundary of intermediate and negative charge-transfer insulating regimes. This is supplemented by systematically introducing spin in $BiTmO_3$ (Tm=Ni,Cu and Zn). Our numerical calculations show that it is possible to stabilize non-trivial electronic and magnetic ground states by controlling the hole density associated with Bi-O bonds, leading to spin-charge coupling. Next aspect

we are looking into is the unusual metallicity and semiconducting nature of a related compounds $BaPbO_3$ and $Ba2PbO_4$.

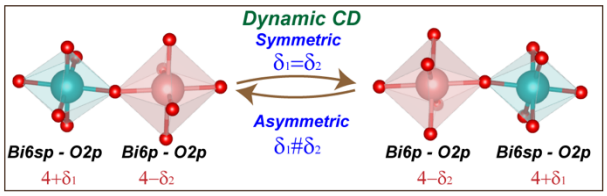



**Figure 2**: *Mechanism of CD in $BaBiO_3$.*

- **Quantum phase transitions in low-dimensional systems**

Our group also employs solving extended Hubbard model based many-body Hamiltonians using exact diagonalization technique (ED) to model quantum phase diagrams. We have also developed a mean-field approach to solve multi-band Hubbard models. Both these techniques are being employed to study spin-charge coupling and charge frustration in oxides. Our activities on this topic also include understanding phase transitions in quantum spin systems using ED and density matrix renormalization techniques.

## Collaborative Research Activity:

- **Tunable bandgap in self-assembled transition metal-incorporated heterometallic $M_2Sb_4$ (M = V, Mn, Co, Ni, and Cu) oxo clusters**

Here we have investigated the reactivity and optical properties of transition metal incorporated organoantimony (V) clusters prepared by a solvothermal route. The detailed structural characterizations of novel heterometallic M2Sb4 oxo clusters are reported. Single crystal X-ray diffraction revealed the formation of hexanuclear organoantimony (V) based oxo clusters [(p-ClC6H4Sb)4V2(O)2(μ3-O)2(μ2-O)2(t-BuPO3)4(μ2-OCH3)4] (1), [M2(p-iPr-C6H4Sb)4(μ3-O)2(μ2-O)2(μ2-OCH3)4(t-BuPO3)4(py)2]. xCH3OH, where M=Mn, x=2 (2), Co, x=1 (3), Ni, x=2 (4) and Cu, x=2 (5). Magnetic behaviour of the clusters were probed by magnetic susceptibility measurements. Optical absorption studies show that bandgap reduction can be achieved by incorporating appropriate transition metal into the homometallic Sb6 oxo cluster.

- **Modeling electronic structure and magnetism of Zigzag-1D (2-Bromoethylammonium)$_3$MnBr$_5$**

The intriguing long-range antiferromagnetic ordering of the compound at low temperature along with a typical low-dimensional broad susceptibility hump has been modelled using exact diagonalization technique. Our theroretical calculations show a very strong intrachain and weak interchain interaction with $J$ and $J'$ = 30.12 and 0.13 K, respectively, suggesting excellent one-dimensionality. Further, the electronic structure of this compound has also been modelled within the framework of density functional theory.

## Sponsored Project:

- **Core Research Grant/DST-SERB**

"***Interplay between electron correlation and spin-orbit interaction in oxides***"
Sanctioned amount: Rs. *56.5 lac (approx.)*

.

***Invited Talks:***

1. *"UGC Refresher course" November, 2022.*
2. *"Charge and spin odering in bismuth oxides" in Spins in molecular systems 2022, organized by IISc Bangalore, during December 1-3, 2022*


## DR. RAJEEV RAWAT

**Scientist-G**

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Magnetocaloric and transport properties of magnetic materials, magnetic transitions near zero K, Phase co-existence.

**Group Members:** (1) Satish Yadav (SRF) (2) Suman Karmakar (SRF) (3) Rajeev Joshi (JRF) (4) Priyanshi Tiwari (JRF) (5) Kranti Kumar (J. Engg)

**Ph.D. Completed:** 6

**Facilities:** (1) Calorimetry (2) Magnetization measurements (2) LTHM SPM

## In-house Research Activity:

❖ **Room temperature giant magnetocaloric effect in Pd doped FeRh and the effect of martensitic transition**

The effect of sample history on transition temperature (Tt) and the magnetocaloric effect (MCE) has been studied. In $FeRh_{0.8}Pd_{0.2}$ cooling below 170 K results in partial transformation in to

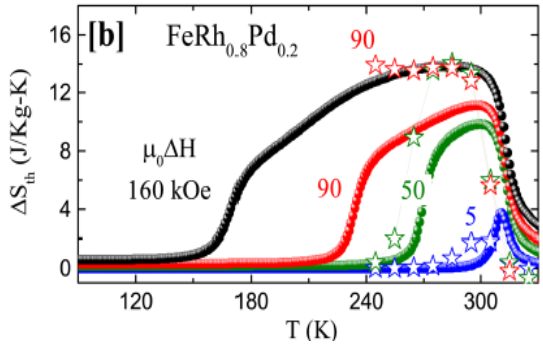



**Fig.1:** *Reduction of isothermal change in entropy ($\Delta S_{th}$) in the presence of martensite phase (solid circle) when compared to predominantly austenite phase(open star).*

martensite (MS) phase. This MS phase transform back at much higher temperature during warming, and may overlap with AF-FM transition under suitable magnetic field. This peculiar hysteretic behaviour is used to study the influence of structural change on associated functional properties of AF-FM transition. As shown in Fig. 1, in the presence of the MS phase, the peak value of MCE is shifted to higher temperatures but with a significantly reduced magnitude compared to that observed without the MS phase. (Fig. 1). The experimentally determined MCE parameters across FM to AF transition induced either by isothermal magnetic field sweep or by temperature sweep showed a large isothermal change in entropy around room temperature, i.e., 14 J/kg K for 50 kOe magnetic field change (Star symbol, here, both the quantities were related to predominantly austenite phase). [*Rajeev Joshi et al., J. Appl. Phys. 133 (2023) 173904*]

❖ **Anomalous Raman effect in $CoS_2$**

Fig. 2(a) shows some representative Raman spectra in the temperature range 300 – 4 K. The results of

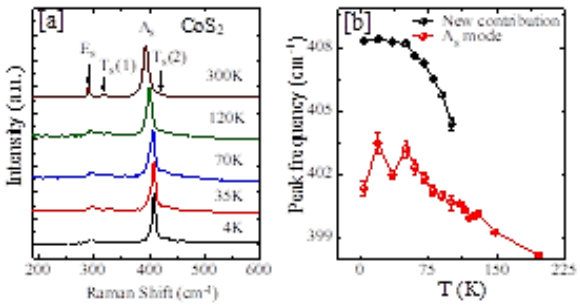



**Fig. 2:[a]** *Raman spectra of $CoS_2$ single crystal at labelled temperature.* **[b]** *$A_g$ mode position which consists of two components below 120K*

the analysis of the Ag mode peak (~400 $cm^{-1}$) are shown in Fig 2(b) It shows that the peak is a sum of two Lorentzian in the FM region, which otherwise is satisfactorily represented by a single Lorentzian in the PM region. The contribution of the new peak

gradually increases at the expense of pre-existing peak with a decrease in temperature below $T_C$. This is novel in contrast to the generally observed shift in peak position rather than the development of new components.

❖ **GdPdGe evidence of short range ordering**

The ternary RPdGe compound is known to crystallizes in structures related to $CeCu_2$-type and has been studied for magnetic frustration. However, studies related to the chemical ordering of Pd/Ge on magnetic properties remain incomplete. We took up this study with GdPdGe. Our magnetic, transport and thermal measurement showed that paramagnetic-ferromagnetic transition changes by about 5 K due to the ordering effect. A detailed analysis of heat capacity data showed the presence of residual magnetic entropy well above $T_N$, as shown in Fig.3. [*Priyanshi Tiwari, Rajeev Joshi, Suman Karmakar, Arvind Yogi and, R Rawat*]

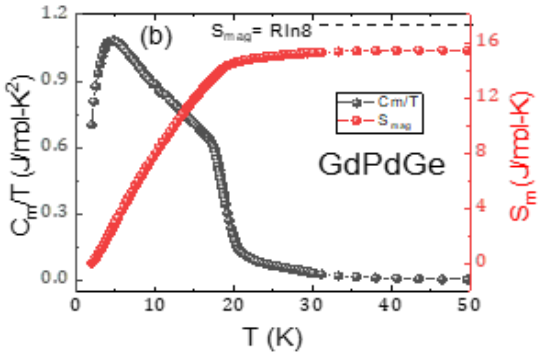
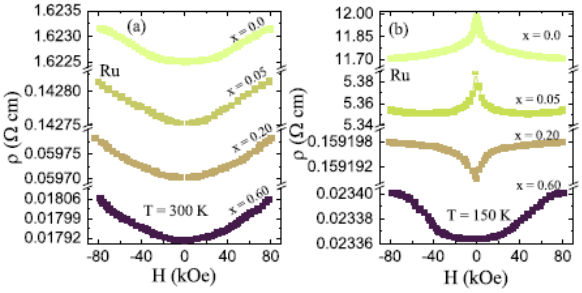



**Fig.3:** *The magnetic contribution to heat capacity/temperature on left axis and magnetic entropy ($S_{mag}$) on right axis of GdPdGe.*

## Collaborative Research Activity:

❖ **Weak localization in the layered iridates $Sr_2Ir_{1-x}M_xO_4$($M$ = Ru,Ti): Role of interplay between spin-orbit coupling and magnetism**

In $Sr_2Ir_{1-x}Ru_xO_4$ series, a complete suppression of the magnetic and insulating state is observed with x ~ 0.6. However, an opposite result is seen in $Sr_2Ir_{1-x}Ti_xO_4$ series, where the magnetic ordering temperature is minimally influenced, and the insulating state is significantly strengthened. This contrasting effect on magnetism has a different impact on the crossover in magnetoconductance and allied weak localization behaviour, which basically follows the evolution of the magnetic and conducting state in both series. [*Bhatti et al., Phys. Rev B 107 (2023) 144410*]




## Lectures Delivered:

➢ "**Magneto-structural transition and metastable states**" at "Metal and Alloys for Defense Applications" organised bySchool of Materials Science and Technology Indian Institute of Technology (BHU), Varanasi, 2-6, March 2023.

➢ "**Influence of Martensite transition on magnetocaloric properties of FeRh System"** at "International Conference on Advanced Materials and Applications (ICAMA-2022)" organized by Siksha 'O' Anusandhan, Bhubaneswar, Odisha, India, 15-17, December 2022.

➢ "**Magnetocaloric effect in Pd doped FeRh: Role of Martensite Transition**" at "DST Synergistic Training program Utilizing the Scientific and Technological Infrastructure Program (STUTI)" organised by The Department of Physics, M.S. University of Baroda, 21-27, November 2022


## DR. VARIMALLA RAGHAVENDRA REDDY

**Scientist-H**

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Multiferroic materials, magnetic thin films and multilayers

**Group Members:**

(1) Mr. Anil Gome, Jr. Eng. (2) Dr. Ganesh Bera (Kothari Fellow) (3) Mr. Rakhul Raj, SRF (Institute) (4) Ms. Meenal Dhantewal, JRF (DST-Inspire) (5) Ms. Smritiparna Ghosh, JRF (Institute)

**Ph.D. Completed:** 08

**Facilities:**

(1) Mössbauer spectroscopy (2) Kerr microscopy (3) Thin film x-ray diffractometer (4) Ferroelectric loop tracer

## In-house Research Activity

The research activity of the group is primarily in the area of experimental condensed matter physics focussing on ferroic materials viz., ferromagnetic, ferroelectric and multiferroic materials in bulk and thin films form such as Aurivillius compounds, rare-earth iron garnets, lead free ferroelectrics, exchange bias, exchange spring magnets etc.

❖ **Electro-caloric effect in lead-free ceramics: covering a broad temperature range**

Electro-caloric (EC) coefficients are calculated in polycrystalline $BaTi_{1-x}Sn_xO_3$ (x = 0.15, 0.20, 0.30) ceramics. Dielectric and polarization studies are carried out in a temperature range of 100-300 K to calculate the EC coefficients employing the indirect method based on Maxwell's equations. It is demonstrated that the EC effect is enhanced near the dielectric maxima for all the samples, including that of samples which exhibit relaxor behavior (x=0.30). Furthermore, the maximum change in temperature, the temperature at which the maximum EC coefficient is achieved and the working range for EC effect are shown to be tunable with electric field and Sn substitution. [*Ref:- Akash et al., Ferroelectrics 589 (2022) 64]*.

❖ **Magnetic ordering in $Bi_5FeTi_3O_{15}$ Four-layered Aurivillius compound at high pressures**

Synchrotron based $^{57}Fe$ Mossbauer spectroscopy measurements (nuclear forward scattering, NFS) at high pressures and low temperatures are carried out on four-layer Aurivillius compound $Bi_5FeTi_3O_{15}$ (BFTO) to probe the development of magnetism in BFTO at high hydrostatic pressure conditions in the context of multiferroic nature. NFS measurements reveal the development of magnetic ordering in BFTO at 5K with high pressures. A progressive increase in magnetic order is observed with increase in pressure at 5 K. Further, NFS measurements carried out at constant pressure (6.4 GPa) and different temperatures indicate that the developed magnetism disappears at higher temperatures (20 K). The observations are explained in terms of structural parameter variation with pressure, as probed with high pressure x-ray diffraction and Raman spectroscopy measurements. Further, the detailed analysis of structural data indicates that the evolution of the local structure under applied pressure seems to not follow crystallographic changes (long range order). [*Ref:-Deepak P et al., Journal of Magnetism and Magnetic Materials 562 (2022) 169783]*.

❖ **Robust perpendicular magnetic anisotropy (PMA) in epitaxial garnet thin films**

Cerium substituted yttrium iron garnet (Ce:YIG) epitaxial thin films are prepared on a gadolinium gallium garnet (GGG) substrate with pulsed laser deposition. It is observed that the films grown on a GGG(111) substrate exhibit perpendicular magnetic anisotropy (PMA) as compared to films grown on a GGG(100) substrate. The developed PMA is confirmed from a magneto-optical Kerr effect, bulk

magnetization, and ferromagnetic resonance measurements. Furthermore, the magnetic bubble domains are observed in the films exhibiting PMA. The observations are explained in terms of the growth direction of Ce:YIG films and the interplay of various magnetic anisotropy terms. The observed PMA is found to be tunable with the thickness of the film, and a remarkable temperature stability of the PMA is observed in all the studied films of Ce:YIG deposited on a GGG(111) substrate. [*Ref:- Manik Kuila et al., J. Appl. Phys., 131 (2022) 203901]*.

## Collaborative Research Activity:

❖ **Ferroelectric liquid crystals**

Electro-optic measurements reveal improved molecular ordering of ferroelectric liquid crystals (FLCs) by the presence of greener ternary CuGaS2/ZnS core/shell (CGZ) quantum dots (QDs). Experimental findings show that ternary CGZ QDs improve the anchoring of FLC which is validated by the increased primary- and secondary-order parameters (θ and Ps, respectively). The improved ordering of host FLCs is attributed to the enhanced localised charges by carrier trapping at intrinsic defect deep states in core assisted by reduced charge leakage probability, due to ZnS shell of CGZ QDs. The ternary CGZ QDs also improve photoluminescence and optical contrast of FLCs due to increase in molecular alignment. [*Ref:-Nilesh Pote, Swapnil Doke (Pune) et al., Liquid Crystals (2023)]*.

❖ **$^{57}$Fe Mossbauer study of spin-state crossover molecular systems**

$^{57}$Fe Mössbauer spectroscopy measurements were performed at different temperatures (100, 300, and 350 K) in order to understand the switching mechanism (spin-state switching or the electron transfer coupled with spin-state switching) and to identify the oxidation and spin states of different iron centers present in a new mixed-valence $[Fe^{III}_2Fe^{II}_2]$ molecular square complex, $\{[Fe(pzTp)(CN)_3]_2[Fe(bik)_2]_2\}\cdot[Fe(pzTp)(CN)_3]_2\cdot 4$ MeOH which exhibits single-crystal-to-single-crystal (SC−SC) transformation while increasing the temperature. [*Ref: Dr. Abhishake Mondal (IISc, Bangalore) et al., Inorganic Chemistry (2023)]*

❖ **$^{57}$Fe Mossbauer study thermal conversion of iron(III) citrate to iron oxide nanomaterials**

Solvent-less synthesis of iron oxide nanomaterials is obtained on thermal conversion of iron(III) citrate in presence of malonic acid and glucose as co-precursors. Pure phase of hematite was found only for a particular combination of precursor and co-precursor and else a mixture of hematite and magnetite is obtained. The $^{57}$Fe Mössbauer spectroscopy is used to identify these phases unambiguously in the present work. [*Ref:-Prof. Ashis Bhattacharjee (Santiniketan) Applied Physics A (2023) 129:264]*.

## Lectures Delivered:

- **"*Activities, and Facilities at UGC-DAE CSR, Indore Centre*"** at SERB sponsored workshop under Accelerate Vigyan (Karyashala) schemeat IIIT-DM Kancheepuram, 12-18 December 2022
- ***"Magnetism in ferroelectric four-layered Aurivillius $Bi_5FeTi_3O_{15}$ compound"*** 33rd AGM of MRSI and the 4th Indian Materials Conclave, (IUMRS-ICA 2022), IIT Jodhpur (Dec 19-23, 2022)
- **"*Microstructure, substitution effects in some lead-free ferroelectric materials"*** at National Seminar on Ferroelectrics and Dielectrics (XXII NSFD -2022), VIT, Amaravati, AP (Dec 2022)
- **"*$^{57}$Fe Mössbauer study of functional materials"*** at 2nd Asian Conference on Molecular Magnetism (ACMM II) IISER, Bhopal (Dec 6-10, 2022)
- **"*Mössbauer spectroscopy"*** at Basic materials characterization Techniques and data interpretation tools, MRSI Nagpur Chapter & Nagpur University (March 2023)
- **"*Multiferroic nature in four-layered Aurivillius $Bi_5FeTi_3O_{15}$ compound"*** at International Conference on Recent Trends in Physics (ICRTP-2023) School of Physics, DAVV, Indore, 17 – 18 February 2023.


## DR. DEBALAYA SARKER

**Scientist-D**

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Experimental/Computational Material Science

**Group Members:** (1) Isha Lallar, (2) Preeti Bharadwaj, (3) Dr. Arvind Yogi


**Facilities:** TEM.

## In-house Research Activity:

In our group we study different functional materials in an aim to explore structure-property (viz. thermoelectric, bio-sensing *etc.*) relationships. With the aid of temperature dependent XRD/TEM, we probe the structural evolution as a function of temperature. We apply machine learning techniques on experimental/theoretical datasets for predicting and/or, synthesising better performing materials.

❖ **Investigating the origin of anomalous Raman signals from centrosymmetric $BaZrO_3$**

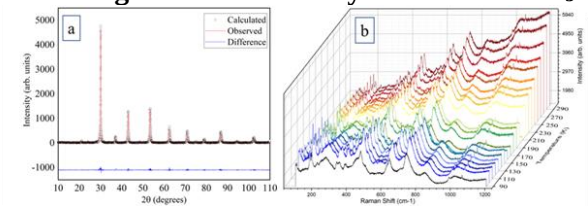


Fig 1: (a) XRD at room temperature and (b) variation of Raman signal with temperature for BZO

Recent XAS studies highlight that an anomalous Debye-Waller factor associated with Ba-O bond vibrations breaks symmetry of $pm\bar{3}m$ phase and *I4/mcm* phase occurs. While in our study, we don't notice any phase transitions with XRD, the strong Raman signals directly contradicts BZO's centrosymmetric structural claim. The Raman signal in BZO is claimed to arrive from second-order Raman scattering. In absence of 1st order scattering, the 2nd order scattering would dominate the Raman spectra. However, this explanation is seldom debated and the Raman signal is argued as a result of local symmetry breaking. In view of this, the local structure will be thoroughly investigated with EXAFS measurements and DFT studies.

➢ **Iterative cluster expansion approach for predicting the structure evolution of mixed Ruddelsden-Popper oxides $La_{2-x}Sr_xNi_{1-y}Fe_yO_{4\pm\delta}$**

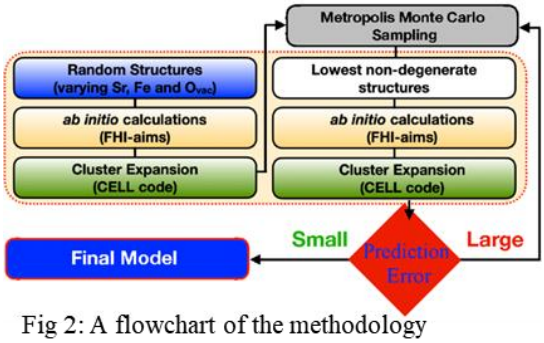


Fig 2: A flowchart of the methodology

Although the versatility of Ruddlesden-Popper (RP) compounds' compositional space is the key to tune their stability and applicability, its complexity also makes the understanding and design of new functional RP-materials difficult. Herein by parameterizing a cluster expansion model Hamiltonian with density-functional inputs, we have successfully scanned over the complex configurational space of $La_{2-x}Sr_xNi_{1-y}Fe_yO_{4\pm\delta}$. We found that apical vacancies in the rock-salt layer are more favourable due to lesser steric forces, but changes in A-site oxidation state due to Sr substitution can facilitate equatorial O-vacancy formation even in the perovskite layers. A critical Sr concentration is required to stabilize Fe. With increasing Sr, the A-site charge state changes gradually from $La^{+3}$ to $Sr^{+2}$, which facilitates both O-vacancy formation and stabilization of the B-site dopants. D. Sarker et. al. Phys. Rev. Mater. (minor revision).

➢ **Synthesis and structural properties of Hf substituted $BaTiO_3$**

Electric field induced polarization causing the ferroelectricity in piezoelectrics, is a direct function of structural symmetry. Thus, temperature dependent phase transitions (PT) in this class of materials play a crucial role. We plan to study the effect of substitution of Ti with Hf in $BaTiO_3$ in modulating PT & dielectric properties. As a first step, we have successfully synthesised phase pure Hf doped $BaTiO_3$ different Hf concentrations.

## Collaborative Research Activity:

❖ **Tuning LSPR by Shape Engineering Au Nanoparticles Embedded in Thin $Si_3N_4$ Matrix** *(PI: Prof. S. Ghosh & Prof. P. Srivastava, IITD)***:**
Swift Heavy Ion irradiation is used to tune the structural and optical properties of spherical gold NPs. With the aid of HRTEM, we demonstrate the shape evolution of a single layer of Au NPs inserted between amorphous $Si_3N_4$ thin films as a function of fluences of 120 MeV $Au^{+9}$ ions ranging between $1x10^{11}$ and $1x10^{13}$ ions $cm^{-2}$. This shape evolution results in the gradual blueshift of the localised surface plasmon resonance dip till $1x10^{12}$ ions/$cm^2$ and then a sudden diminish at $1x10^{13}$ ions/$cm^2$. **[**P. Malik, D. Sarker et. al. (submitted).]

❖ **Synthesis and physical properties of $La_{1.85}Sr_{0.15}Cu_2O_4$** *(PI: Dr. Arvind Yogi, UGC-DAE CSR Indore)***:**
We have studied the highly intertwined electronic ground state of $La_{1.85}Sr_{0.15}CuO_4$ with the aid of structural, electric transport, magnetic, and thermodynamic properties. [DAE SSPS 2022]

❖ **Synthesis and OER properties of layered double hydroxides** *(PI: Prof. Minghua Huang **BRICS** Partner)***:**
By modulating synthesis conditions, we show FeNi-LDH with a Fe/Ni ratio of 25/75 exhibits one of the best performances so far reported. [Angew. Chem. **2023**].

## Lectures Delivered:

- ***Where are the solvated electrons in alkali metal doped zeolites?,*** at Psi-K 2022, held at EPFL, Switzerland (August 2022).
- , ***कार्यात्मक पदार्थों की स्वायत्तशासी संगणकीय और प्रायोगिक खोज,*** at UGC-DAE-CSR Indore, on 29.10.1022 (Hindi Divas Talk).

## Sponsored Project:

➢ Start-up Research Grant by SERB,
"***Decoupling Electron and Phonon Transports in All-Inorganic Ruddlesden-Popper Oxides as Thermoelectric Materials*** "
Sanctioned amount: Rs. 23 Lakh (excl. of TA, contingency, overheads).

➢ 5thcoordinated call for BRICS multilateral projects 2021 by DST, Govt. Of India,
"***Active Machine Learning Guided Discovery and Optimization of Effective MOF-based Catalysts for Electrolysis of Water***"
Sanctioned amount: Rs. 25 Lakh (excl. of TA, contingency, overheads, JRF/RA).

## Honours/ Recognitions/Awards:

1. Participated as *Judge in poster award selection* for Psi-K, 2022, EPFL, Laussane, Switzerland [August 22-25th, 2022]
2. Received BEST THESIS AWARD 2017, IIT Delhi [August 2022].

## Foreign visits by faculty and students:

Dr. Debalaya visited EPFL, Switzerland to participate in Psi-K 2022 in August 2022.


## DR. VASANT SATHE

**Scientist-H & Centre Director**

vasant@csr.res.in ; cd.indore@csr.res.in


Structural, vibrational, electrical and magnetic properties of oxide single crystals, bulk and epitaxial thin films

**Group Members:**

(1) Dr. Praveen Velpula (2) Shri Ajay Rathore (Scientific Assistant) (3) Shri Vivek Dwij (SRF) (4) Shri Binoy Krishna De (SRF) (5) Shri Hemant Singh Kunwar (SRF) (6) Ms. Divya (JRF) (7) Ms. Pragati Sharma (JRF)

**Ph.D. Completed:** 8

**Facilities:** (1) Raman spectroscopy

## In-house Research Activity

❖ **Optical control of domain configuration through light polarization in ferroelectric $BaTiO_3$**

Optical control and switching of domain configuration is intriguing to overcome the sluggish time response, hysteresis and Joule heating losses present in conventional methods where resistive contacts are involved. The effective optical control of the domain configuration has remained challenging and far from fully understood. It has been reported earlier that light polarization can be used to control the domain configuration in $BaTiO_3$, however, without much focus on origin of its mechanism. By combining the experimental techniques that are sensitive to the local and average crystal structure and to electric polarization and electronic structure, we detect and demonstrate the optically guided variations in the domain configurations of $BaTiO_3$ and show that the strain field generated through the bulk photovoltaic effect plays a key role in domain reconfiguration. Complete mechanism of reversible domain control via light polarization is discussed. The photoinduced strain/electric field generated through bulk photovoltaic effect causes a modification in local polarization which triggers the domain wall motion and domain reconfiguration through assistance of the piezoelectric and flexoelectric coupling.

*[Ref. Vivek Dwij et al* Phys. Rev. B **105** (2022) 134103*]*

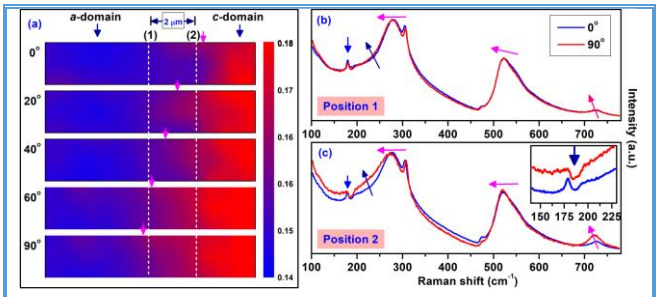


**Fig.1:** (a) Raman map of the BTO single crystal as a function of light polarization angle, colour code denotes the intensity of the $E(LO_4)/A(LO_3)$ modes, illustrating domain wall motion (marked by pink arrows). (b,c) Raman spectrum measured at the extreme points marked by white line for 0° and 90° light polarization. Inset of (c) shows a magnified view of light polarization-dependent Fano line shape switching. The major changes in the Raman spectra incited due to light polarization is depicted by arrows.

## Collaborative Research Activity:

➢ **Graphene-based surface-enhanced Raman scattering as an efficient tool in the detection of toxic organic dyes in real industrial effluents (A book chapter)**

This chapter has demonstrated the efficiency of graphene-based nanoparticles as effective sensors for the detection of dyes in textile industrial waste effluents. TEM images show the possibilities in the formation of critically important "hotspots" in the nanogaps along plasmonic NPs and the possible "hot surface" due to the overlapping rGO layers. This efficient detection of four different classes of dyes describes the efficiency of G-SERS as a platform to replace traditional SERS.

Despite the unsimulated nature of TE, favorable results for detection were observed in the presence of graphene-boosted nanoparticles. The toxicity of the studied dyes further necessitates the development of commercially viable G-SERS platform as an effective pollutant sensor in water processing and treatment plants for industrial effluents.

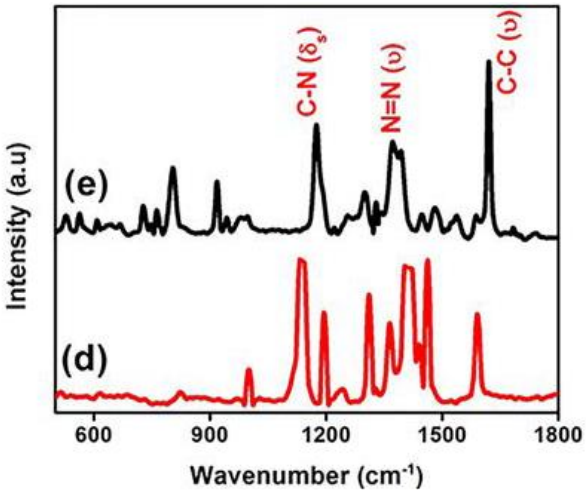


**Fig. : (d)** Raman spectrum, and **(e)** G-SERS spectrum of MY, respectively. [V. Poornima Parvathi, R. Parimaladevi, Vasant Sathe, and M. Umadevi **(A book chapter)** Carbon Nanomaterials-Based Sensors - Emerging Research Trends in Devices and Applications, **Copyright © 2022 Elsevier Inc.***]*.

## Lectures Delivered:

- **"*Discovery of Raman Effect*"** key note address on National Science day function organized on 28th February 2023, Department of Physics, J.P. University, Guna, M.P.
- **Chief Guest Address and Key Note Lecture** Inaugural Function of One day workshop on characterization techniques organized by Saint Paul Institute of Professional Studies, Indore in November 2023.
- ***"International Conference on Recent trends in Physics"*** Chief guest in Inaugural Function and special lecture on "Optical Control of Ferroelectric Domains" organized by D.A.V.V. Indore on 17.02.2023.
- ***""Raman Spectroscopy and applications"*** two lectures in refresher course organized by UGC-Human Resource Development Centre, Goa, University on 29/08/2022.
- **"Optical control of ferroelectric domain structure in $BaTiO_3$"** *International Conference on Advanced Materials: properties and Applications*, February, 20-24, 2023 at School of Physics and Applied Sciences, Goa University Goa.

## Honours/ Recognitions/Awards:

Dr. Vasant Sathe, Centre Director, Indore Centre have received the "Science Excellent Award" for 2023. By Charotar Moti Sattavis Patidar Kelavani Mandal, Anand, Gujrat.

As recipients of this medal, the awardee delivered an invited lecture (online) at the Charotar University during March 2023.


## DR. DINESH KUMAR SHUKLA

**Scientist-F**

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X-ray scattering and spectroscopy, Multiferroicity, Piezoelectricity, Thermoelectricity, Strongly correlated electron systems.

**Group Members:**

(1) Shikha Rani Sahu (SRF) (2) Abinash Tripathy (SRF) (3) Najnin Mansuri (JRF) (4) Samanway Mohanta (JRF)

**Ph.D. Completed:** 4

**Facilities:**

(1) Home developed thermopower measurements (2) Piezoelectric coefficient (d33) and dielectric measurements (3) 14 T VSM (4) Low-Temperature High-magnetic field XRD (AY-DK)

## In-house Research Activity

Our group is engaged in growth, electrical & magnetic measurements, and X-ray scattering & spectroscopic studies of complex oxide materials useful for energy harvesting and for advanced technological applications. In recent years, materials of our research interest have been those belonging to lead-free piezo ceramics, thermoelectric materials, and multiferroics. Our main aim is to acquire deeper understandings of the structure-property relationships in these materials. Some of the key findings during the year 2022-23 is as follows:

- **Kinetically-decoupled electrical and structural phase transitions in $VO_2$**:- Vanadium dioxide has drawn significant attention for its near room temperature insulator-to-metal transition and associated structural phase transition. We investigated the kinetics of the phase transitions of $VO_2$ with the help of resistivity measurements and Raman spectroscopy. Resistance thermal hysteresis scaling and relaxation measurements across the temperature induced insulator-to-metal transition revealed an unusual behavior of this first-order phase transition, whereas relaxation phenomena investigated by Raman spectroscopy show that the temperature induced monoclinic to rutile phase transition in $VO_2$ follows usual behavior and is consistent with mean field prediction. Insulator-to-metal and structural phase transitions have been found to decouple with an increased temperature sweep rate. The observed unusual thermal hysteresis scaling behavior with temperature sweep rate during insulator-to-metal transition may be the consequences of independent diffusion of charge and heat due to unconventional quasiparticle dynamics in $VO_2$. Unconventional quasi particle dynamics, i.e., significantly lowered electronic thermal conductivity across insulator-to-metal transition in our sample is verified by ultrafast optical pump-probe time domain thermoreflectance measurements. [ref: *Shikha Sahu et al., Phys. Rev. B* ***107****, 134106 (2023).*]

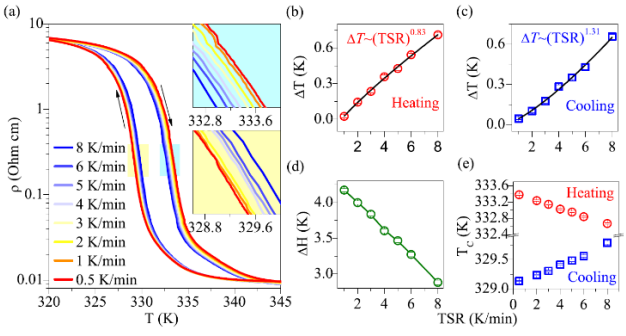



**Fig. 1.** Thermal hysteresis scaling measurements of $VO_2$ thin film [ref: Sahu *et al*., PRB (2023)].

## Collaborative Research Activity:

Apart from in-house research activities our group performs collaborative research with various research group from universities and institutes. Some of the recent key works related to the collaborative research activities are highlighted below.

➢ **Magnetoelectric coupling and energy harvesting in 2/3Pb(Mg1/3Nb2/3)$O_3$-1/3$PbTiO_3$: $CoFe_{1.97}RE_{0.03}O_4$ (RE = $La^{3+}$ and $Eu^{3+}$) composites:** This study focused on coupling between above piezoelectric and the rare earth substituted magnetostrictive cobalt ferrite composites. The M-H loop and P-E loop measurements confirmed the ferromagnetic and ferroelectric nature of the composites, respectively. The well-saturated hysteresis loop suggested the ferromagnetic nature of composites ascribed to the ferromagnetic ferrites. In both sets of composites, the 80:20 composition shows the maximum αME value, which is ~ 4.104 mV/cm-Oe for 80PMN-PT:20CFLO and ~ 3.142 mV/cm-Oe for 80PMN-PT:20CFEO at 1 kHz. Besides, at the resonance frequency (fr) the 90:10 compositions show a higher αME, ~3118 mV/cm-Oe at 288 kHz for 90PMN-PT:10CFLO and ~ 2580 mV/cm-Oe at 282 kHz for 90PMN-PT:10CFEO. The energy harvesting application are demonstrated by placing the sample atop the rotating AC axial exhaust fan. The 80PMN-PT:20CFLO composite produced the highest peak-to-peak AC voltage (Vpp) of about 4.24 V. The outcomes of this study showed that the studied composites can be employed effectively for energy-harvesting applications. [Ref: Channagoudra & Dayal *et al*., JMMM **570**, 170544 (2023); MIT Mysore].

➢ **Effects of 120 MeV $Ag^{9+}$ swift heavy ion irradiation on the structural, optical and electrical properties of pristine and Ni doped $BiFeO_3$ thin films grown by pulsed laser deposition:** In this work, the effects of swift heavy ion (SHI) irradiation on the structure, morphology, optical and electrical properties of pristine and Ni-doped $BiFeO_3$ thin films were explored. The thin films with composition of $BiFe_{1-x}Ni_xO_3$ (x = 0, 0.01, 0.03 and 0.05) were deposited on the n-type single crystal Si(100) substrates through pulsed laser deposition technique. Further, irradiation on the thin films was performed with 120 MeV $Ag^{9+}$ ions at different ion fluences, i.e., $1 \times 10^{13}$, $5 \times 10^{13}$ and $1 \times 10^{14}$ ions/$cm^2$. The effects of the irradiation on the crystal structure and phase of the thin films were analyzed by the XRD and Raman measurements, and it has been observed that irradiation tends to amorphize the thin films. A decrease in the band gap has been observed for the irradiated thin films with the increase of ion fluence. The current-voltage plots of all the unirradiated and irradiated thin films demonstrate the rectifying diode type characteristics. [Ref: M. Nadeem & Wasi Khan et al., Thin Solid Films 760, 139487 (2022); AMU, Aligarh

## Lectures Delivered (2022-23):

➢ An expert lecture on "***X-ray absorption and photoemission spectroscopic studies of materials***" in short term course (STC) on advanced materials processing and characterization techniques at NIT Hamirpur, H.P., India, during May 26-30, 2022 (ONLINE).

## Foreign visits by faculty and students (2022-23):

➢ Ms. Najnin Bano, Mr Abinash Tripathy & Dr. Shukla visited, P01 beamline, PETRA III, DESY, Germany, during 8-12 April 2022, for experiments.

➢ Mrs. Shikha Rani Sahu & Dr. Shukla visited P24 beamline, PETRA III, DESY, Germany, during 10-15 June 2022, for experiments.

➢ Dr. Shukla visited 'Centre of Quantum Materials' at University of Minnesota, Twin Cities, Minnesota, USA, as a Visiting Scholar, from September 2022.

➢ Mr Abinash Tripathy visited 18B beamline, Photon Factory, Japan, during 23-26 Dec 2022, for experiments.


## Dr.R.Venkatesh

**Scientist-E**

rvenkatesh@csr.res.in


Morphological,Low temperature magneto transport,Heat capacity and thermoelectric properties of nano-topological insulators and chalcogenide nanostructures

**Group Members:**

Mr. Mohan Kumar Gangrade (SA-F),Students: Mr..Vinay koushik, Mr.Afzal Hasan, Mr. Satyendra singh,Mr.Sushil kumar

**Ph.D. Completed:** 2

**Facilities:** 14T PPMS,LSCOM, AFM,CCR based TEP setup ,FESEM

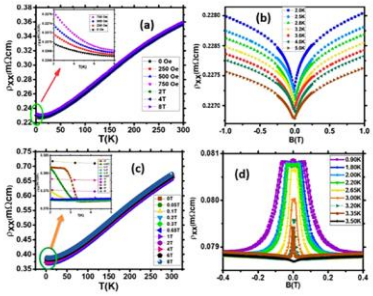
## In-house Research Activity

➢ **Magnetotransport and thermoelectric properties of cobalt doped $Bi_2Te_3$nanostructures**

Magnetotransport and thermoelectric properties of $Bi_{2-x}Co_xTe_3$nanomaterials have been studied. Temperature-dependent electrical resistivity of the materials shows a drastic change from degenerate semiconductor to a metal-like behavior with incorporation of cobalt in the sample. The observation of T and ln(T) dependent electrical conductivity is predicted to have electron–electron interaction (EEI), and quantum interference effect (QIE) dominated transport mechanisms respectively. Low field MR of the materials exhibits sharp dips demonstrating the appearance of QIE, and a crossover from linear MR at low temperature to linear plus quadratic MR at high temperature indicates the quantum transport of the materials. Quantum correction of the low field magnetoconductivity follows 2D Hikami-Larkin-Nagaoka equation and the temperature variation of phase coherence length $l_\varphi$ indicates the existence of 2D transport in the materials. [Sumit et al, 309, Mater.lett.( 2022) 131389]

➢ **Intricate interplay between superconductivity and topological surface states of c axis oriented $MoTe_2$**

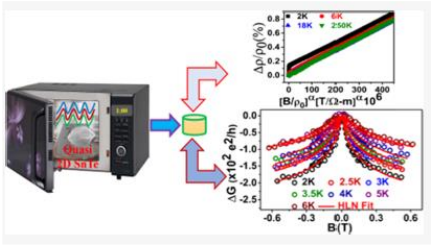
The interaction between superconductivity and spin-polarized surface states of topological




materials provides an exciting platform for the research and development of proximity induced coupling effects, Majorana fermions, spin valves, spintronics, etc. and so on. In this work, the inverse proximity effect observed exactly at the super conducting transition temperature of indium (3.5 K) demonstrates the complex interplay between robust 2D spin-polarized surface states observed in our (002n) oriented MoTe 2 nanolayer sheets with that of superconducting states. Interestingly, our phenomenological model based on the Werthamer-Helfand-Hohenberg (WHH) model and Ginzburg–Landau formalism, invoked to validate the experimental observations, indicates a competition between superconductivity and topological order, marked by a close correspondence between the temperature of crossover (T cr = 2.45 K) of their respective length scales, ξ and L φ , and the saturation temperature in resistivity.[ Hasan et al, J.Appl. Phys. 131(19) (2022):193902] **Qualified for Editors pick**

- **Two-Dimensional Weak Antilocalization Signatures Due to Quantum Coherent Transport in Nanocrystalline SnTe**

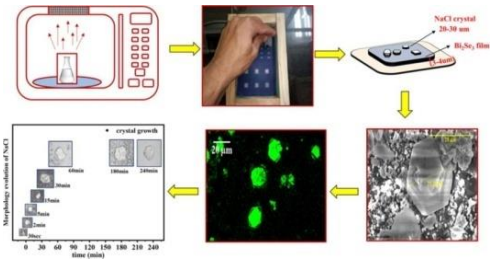
Nanostructured topological crystalline insulators (TCIs) in the




presence of exotic surface states with spin momentum locking reported in individual nanostructures are predicted to hold a great promise for spintronics and quantum computing applications. However, practical application demands a strategy with large-scale production and integration for device applications. In this work, we demonstrate through prominent signatures of weak antilocalization (WAL), arising predominantly from destructive quantum interference on robust surface states, that a correlated TCI phase is possible in the nanobulk assembly of carefully nanostructured quasi-two-dimensional SnTe (edge-to-edge length ~ 382 nm) synthesized by a simple, rapid, and scalable microwave-assisted solvothermal method. Hikami–Larkin–Nagaoka analysis ($T^{-0.71}$), as well as the temperature dependence of resistivity, illustrates an interplay of both conductions from 2D channels and 3D EEI effects as the precursor for the observed WAL at low temperatures (2–6 K). Interestingly, the enhanced thermoelectric power of the sample of ~45 μV/K, with a p-type carrier concentration of ~$10^{18}$/$cm^3$ at 300 K, makes this SnTe nanocrystalline assembly more attractive as a multifunctional material for large-scale technological applications.[Satyendra singh et al, *Langmuir* 2022, 38, 10, 3122–3128]

- **Screen-Printed Film Deposited using Quasi 2-Dimensional Bi2Se3 Nanostructures for Desalination Membrane Filler Application**

In this work quasi-2-dimensional bismuth selenide (Bi2Se3) nanostructure synthesized by microwave-assisted solvothermal method - mixed in ethylene glycol is used as the ink for depositing screen-printed film (SPF). A laboratory-scale experiment




univocally demonstrates the possibility of application of SPF as an efficient membrane filler material for desalination processes such as in direct contact membrane distillation (DCMD). Morphology and topography studies confirm the growth of homogeneous hexagonal micro structures with an edge-to-edge length of 20 to 40 μm with a thickness of ~2-3 μm respectively and elemental mapping studies confirm the growth of sodium chloride (NaCl) crystals over the Bi2Se3 SPF. Growth of different morphology of NaCl (20-40 μm) including the metastable (111) oriented NaCl depicts that Bi2Se3 film assists the efficient crystallization process and helps in retaining the morphology of NaCl crystals with an enhanced crystal growth rate of the order of $10^{-8}$ to $10^{-9}$ m/s. Interestingly, thermoelectric power measurement in these Bi2Se3 nanostructures with n-type carriers and with Seebeck coefficient value of -98 μV/K around the room temperature open up a new possibility for a combined desalination membrane filler application along with thermoelectric (TEP) application where the waste heat used for desalination/membrane crystallization can also be harvested in the form of useful electrical energy.*[Sushil et al, Journal of Environmental Chemical Engineering 10(38):10712]*


## DR. PRAVEEN KUMAR VELPULA

**Scientist-D**

praveen@csr.res.in


Nonlinear Optics, Ultrafast Dynamics, Nonlinear Microscopy, Raman Spectroscopy, and Ferroelectric Materials.

**Group Members:** (1) Dr. Vasant Sathe (2) Ms. Divya (3) Ms. Pragati Sharma

**Ph.D. Completed:** None

**Facilities:** (1) **L**aser scanning confocal optical microscopy

## In-house Research Activity:

Our group mainly focuses on the optical aspects of the various condensed matter physics problems including probing the ferroelectric materials using a nonlinear optical microscopy, ultrafast hot-carrier dynamics in functional materials for solar cells and photovoltaic applications using the pump-probe setup, laser scanning confocal imaging and nonlinear/multiphoton imaging of various biological samples.

❖ **Nonlinear optical microscopy for probing the ferroelectric materials:**

The second order nonlinear interactions are possible only in non-centrosymmetric materials for which nonlinear susceptibility $\chi^{(2)}$ is non-zero. With this unique feature, nonlinear optical methods particularly second harmonic generation (SHG) become a powerful tool to probe the ferroelectric and multiferroic transitions and examine whether a crystal possesses an inversion symmetry. For this purpose, we are planning to establish a SHG technique to study the thermal dynamics of crystalline phases of various ferroelectric materials in a wide temperature range (~2K to 1000K). Polarized nonlinear imaging can be used to study the orientation of the domains and relative fractions of the domain structures.

The scaling down of the ferroelectric materials with multifunctional properties are much needed for the miniatured electronic and photonic device applications. In this context, 2D van der Waals layered materials provide opportunities owing to the unique strong intralayer coupling and weak interlayer interaction, which can be easily integrated into substrates, making them promising candidates in realizing low-dimensional ferroelectric devices. We are in preparation of various potential 2-D materials to demonstrate the ferroelectricity using the developed SHG technique.

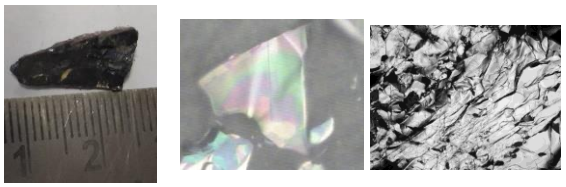


**Fig.1:** *Grown bulk single crystal of $In_2Se_3$(left) and it's mechanically exfoliated 2-D flakes (right).*

❖ **Laser scanning confocal microscopy and nonlinear imaging:**

The confocal principle provides the optical sectioning of the sample which enables to image deep into the samples with high contrast and high resolution. For the highly absorptive and scattering samples to the laser excitation and emission which could not allow into deeper imaging of the sample, we have an IR femtosecond laser integrated to a confocal microscopy (Zeiss-LSM 510 META NLO)

which conquers these limitations. This is because of the longer wavelength of the femtosecond laser and confinement of the fluorescent excitation due to nonlinear mechanisms. As confocal microscopy provides the clear images from a thin section of the thick sample, therefore it can be used for various fluorescent biological/biomedical and material science applications.

## Collaborative Research Activity:

- **Ultrafast dynamics of functional materials**

  The joint collaboration project is being established to utilize the high energy ultrafast laser sources at RRCAT. In this project, we are planning to study the photo-induced carrier dynamics which has a paramount importance for fundamental research as well as to explore the material's functionalities and their application limitations for instance in light-harvesting applications and optoelectronic devices etc. The nonequilibrium carrier thermalization i.e., ultrafast energy loss during the hot carrier's cooling is one of the major limitations to enhance the solar cell's efficiency. To improve the solar cell's efficiency beyond 33.7% (Shockley-Queisser limit), there are ongoing efforts to find out the efficient materials with long living hot carriers, studying their transient transport behaviour and dynamics. Also, studying the transport length of the photo-excited hot carriers before their relaxation is extremely important for efficient optoelectronic devices specifically for photovoltaics. We are planning to setup a pump-probe experimental setup which explore the behaviour of nonthermal hot carrier dynamics and their relaxation channels. A study of transient hot carrier transport in various perovskite materials in different forms like microcrystals and different thin film thicknesses can infer the optimal materials for energy harvesting and optoelectronic devices applications. In this regard, $Cs_2AgBiBr_6$ double perovskite and perovskite inspired $Cs_3Sb_2I_9$ microcrystals were synthesized for transient dynamic studies.

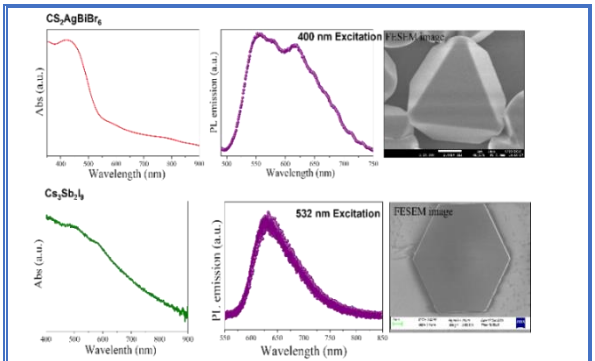



***Fig.2:*** *Optical absorption, Photoluminescence and FESEM characterization of $Cs_2AgBiBr_6$ and $Cs_3Sb_2I_9$ microcrystals.*

[*Dr. Tarun Kumar Sharma, RRCAT, Indore, Dr. Salahuddin Khan, RRCAT, Indore and Dr. K. D. M. Rao, IACS, Kolkatta]*

## Sponsored Project:

- SERB- SRG, SRG/2022/000118 "***Polarized nonlinear microscopy for probing ferroelectric materials*** "

Sanctioned amount: Rs. 30,72,000/- (Approx.)

## Honours/ Recognitions/Awards:

Conference Co-Chair, 9th International Conference On Perspectives in Vibrational Spectroscopy (ICOPVS-2022), 13-17 December 2022.


## DR. ARVIND KUMAR YOGI

**Scientist D**

akyogi@csr.res.in


X-ray diffraction, single-crystal growth and low-dimensional quantum materials

**Group Members:** Master students: (1) Sunidhi Chouhan, (2) Kanak Kumrawat, (3) Ritu Kumawat, (4) Ram Lakhan Patel, Ph.D. students: (5) Isha – JRF, (6) Koushik Chakraborty – JRF (7) Priyanshi – JRF [Co-PI], Lab members: (8) Pooja, (9) Preeti Mahajan – Eng., (10) Dr. Debalaya Sarker, (10) Dr. N. P. Lalla

**Ph.D. Completed:** None

**Facilities:** (1) Optical Floating Zone, (2) LTHM-XRD, (3) High-Temperature box and tube Furnaces

## In-house Research Activity:

- At our group we focus condensed matter systems, particularly on low-dimensional quantum materials & emergent phenomena's originating from quantum degree of freedom. One of our main interests is to design and explore new materials, and study them by using several experimental techniques. It includes crystal growth by various methods, detailed study of crystal structures and phase-transition using x-ray based techniques, characterizing their anisotropic physical properties and finally explores their ground states.
- **Lattice-coupling drives charge density waves formation in cuprate superconductor**

We use high-resolution temperature dependent x-ray diffraction measurements (**Fig.1**) to probe the structural phase-transition in $La_{1.85}Sr_{0.15}CuO_4$ (LSCO) superconductor and investigate the manifestation of charge density waves (CDW) which have been observed in all families of superconducting cuprates, but the origin is still unclear. Our detailed structural investigation for the low-temperature (LT) phase as a function of temperature suggests the presence of strong lattice-coupling that gradually develops unprecedentedly alternating $CuO_6$ octahedra rotation (+ve and -ve; $\phi \approx 3$ °) in the crystallographic *bc*-plane just below the structural-phase transition $T_s$ = 150 K), leading to symmetry-breaking in LSCO. The coupling of alternative octahedral rotation of $CuO_6$ introduces $3d^9$ $Cu^{2+}$ charge modulations (CDW), indicating lattice-coupling drives CDW phase-transition. [*Isha, M. Isobe, Debalaya Sarker, R. Rawat, N. P. Lalla and A. K. Yogi; manuscript submitted*].

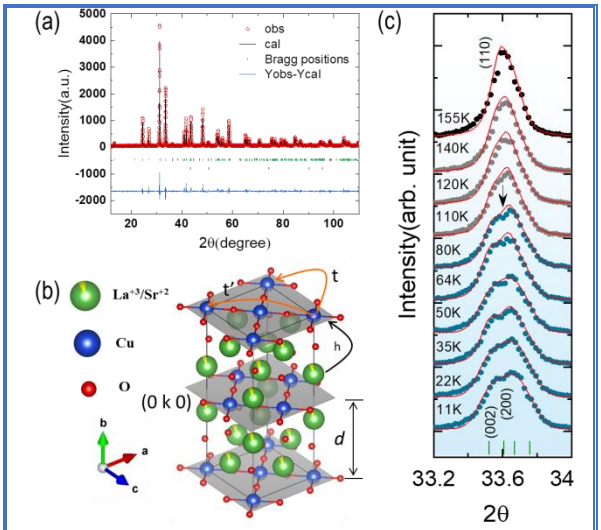



**Fig.1:** *Rietveld refined HR x-ray diffraction pattern* **(a),** *crystal structure of LSCO* at *140 K* **(b)**, *signature of CDW phase [↓]* **(c)**.

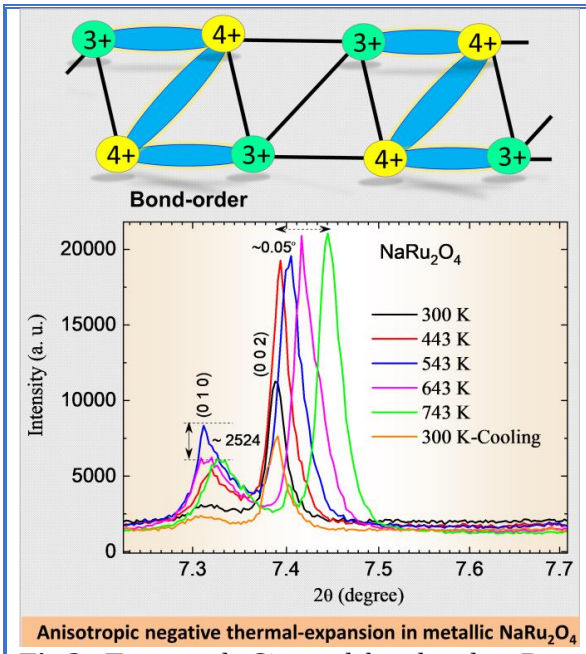



**Fig.2:** Top panel: Site and bond order. Bottom panel: *Synchrotron x-ray diffraction below and above $T_c$ = 575 K.*

❖ **Anisotropic negative thermal-expansion in metallic $NaRu_2O_4$**

We have been exploring and designs of advanced quantum materials, mainly new 4*d* transition metal with modest SOC based materials such as $NaRu_2O_4$. The $NaRu_2O_4$ compound with $CaFe_2O_4$ type structure shows a novel type of Z-ordering (**Fig.2**). Here we have use a cumulative approach of synchrotron/x-ray diffraction experiments and theoretical modelling to develop a strategy to understand unconventional charge ordering dynamics in our discovered 4*d* tunnel ruthanates. We have identified several new interesting features in these Na-Ru oxide materials including soft-phonons, rare anisotropic negative thermal-expansion, and robust $Na^+$ ionic motion/diffusion (**Fig.2**) —all in one at room temperature! Our detailed studies on this material suggest that the alkali metal $Na^+$ ions inside the tunnel geometries enable flexible Columbic repulsion which leads to higher ionic conductivity in 4*d* $NaRu_2O_4$ compound. [*Isha, Koushik Chakraborty, M. Isobe, Archna Sagdeo, N. P. Lalla, R. Rawat and Arvind Kumar Yogi, manuscript under preparation*].

## Collaborative Research Activity:

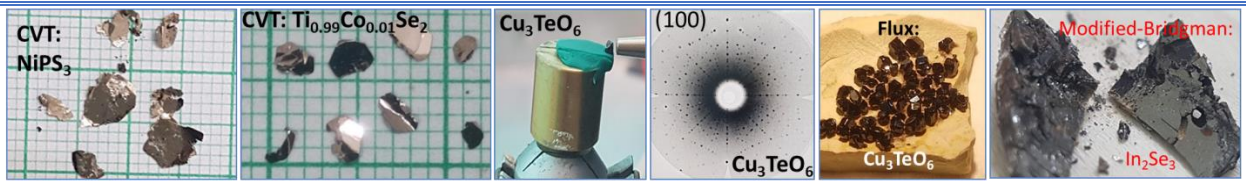



**Fig.3:** Optical images of as grown crystals at CGL. The Laue image indicating excellent crystal quality

❖ **In-house collaborative research activities:**

I have been involved for various collaborative crystal growths for our consortium faculty members and users. The main collaborative research activities at UGC-DAE, CSR, Indore for which I contributed by growing various single crystals are (1) vdW-materials: $TMPS_3$, (2) 2D-materials: TM doped $TiSe_2$, (3) $Cu_3TeO_6$ (4) $CoSO_4$, (5) $BaSnO_3$ and (6) $In_2Se_3$ as shown in (**Fig.3**).

## Honours/ Recognitions/Awards:

•**Isha** received Max-Planck fellowship for MPI-Stuttgart visit during **January-March, 2023**. • **Koushik Chakraborty** received visiting research scholar Max-Planck fellowship to visit MPI-FKF, Stuttgart, Germany **May-June, 2023**. •**Bhabha-Newton funding** for ISIS-UK experiments **June, 2023**.


## DR. CHANDANA MONDAL

**Ramanujan Faculty Fellow**

chanmon@csr.res.in


Active Matter, Mechanical properties of Amorphous Materials, Rheology, Colloidal Gel.

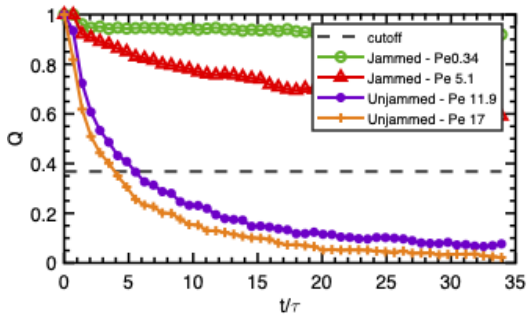
## In-house Research Activity:

➢ **Distinct impacts of polar and nematic self-propulsion on active unjamming:**

We characterize the impact of active and passive microstructural features on the unjamming of dense active filaments using a semiflexible self-propelled worm-like chain model. Throughout the study, we contrast the transition for polar filaments with that of nematic filaments for different filament flexibilities and variable packing fractions, consistently showing that the jamming–unjamming transition is markedly different in the two cases. We are able to tune the polarity of the filaments by controlling the reversal time for the active driving force. We find a remarkable difference between polar and nematic filaments when we study the jamming/unjamming transition in the rigidity–activity plane. While for nematic filaments, the activity required for unjamming monotonically decreases with decreasing rigidity, we find a re-entrant jamming transition at lower rigidity for polar filaments. Interestingly, we show that the efficacy of polar or nematic driving in unjamming an active jammed system is density dependent: At densities close to typical packing fractions for passive systems, nematic filaments require more activity to unjam compared to polar filaments; however, this trend changes significantly in the very high-density regime where we find that the activity required for unjamming in polar filaments is far greater than that for nematic filaments.

➢ **The impact of the reversal time: Polar and nematic driving:**

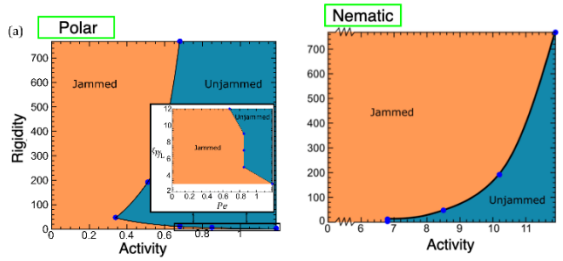
We begin by exploring the impact of varying the parameter $\tau_n$, the reversal time period of active forces, on transitioning from the jammed to unjammed state. The two extremes of this parameter correspond to filaments that are either polar ($\tau_n > \tau_{tot}$) or nematic ($\tau_n = 1$), where $\tau_{tot}$ is the total simulation time. In this section, we keep the other parameters constant; the rigidity is fixed at $\xi_p/L = 48$




and the packing fraction at $\varphi = 0.8$. Starting from nematic filaments, we incrementally increase the reversal time, until $\tau_n > \tau_{tot}$, which corresponds to the case of fully polar driving. As the reversal time increases, the system undergoes transition from a jammed to unjammed state when all other parameters are fixed.

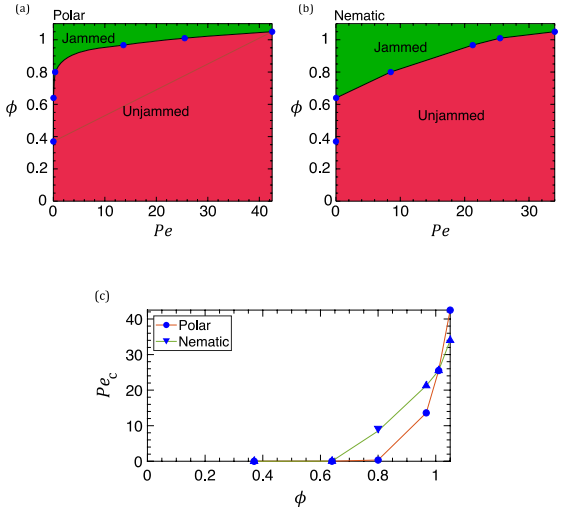
**The impact of filament flexibility on active unjamming:**

Next, we study the impact of filament flexibility, by varying the bending rigidity ξp/L of a filament on the jamming/unjamming transition. We vary ξp/L between ξp/L = 3 and ξp/L = 768, with a higher value corresponding to a more rigid filament. We keep the packing fraction fixed at φ = 0.8. We do the same study for both nematic and polar filaments and find that the nature of jamming transition is very different in the two cases. For nematic driving, filaments need monotonically higher activity to unjam as the rigidity is increased. In other words, higher rigidity promotes jamming for nematic filaments. However, this is not true for polar filaments. Rather, for more flexible filaments, i.e., ξp/L < 48, we observe a re-entrant unjamming–jamming transition in the rigidity–activity phase space for polar driving. This can be seen in the above figure.




➢ **The impact of packing fraction on active unjamming:**

Having established the distinct impacts of polar and nematic driving on active unjamming and their subtle interplay with filament flexibility, we next explore the effect of varying the packing fraction φ of filaments on the dynamics, for polar and nematic driving at var- ious activities, while keeping the filament rigidity fixed at $\xi p/L = 48$. For φ > 0.64, at higher density, a higher activity is needed to unjam the dense assembly of filaments. It is apparent that




a high activity is required to unjam both systems when φ is increased. For φ < 1.0, nematic filaments require more activity to unjam compared to polar filaments. Interestingly, however, this trend changes at higher densities, φ ~ 1.0, where we find that the activity required for unjamming of polar filaments becomes as much as that for nematic filaments and can even exceed it.

❖ **Publication:**

1. Distinct impacts of polar and nematic self-propulsion on active unjamming,

Varun Venkatesh, ***Chandana Mondal***, and Amin Doostmohammadi,

*J. Chem. Phys.* **157**, 164901 (2022).

## Investigation of Topological Phases in Weyl semimetals and Dirac Semimetal

Dr. Pradip Das, Department of Pure and Applied Physics,Guru Ghasidas Vishwavidyalaya

Recently, it was revealed that the kagome metal $Ni_3In_2Se_2$ contains endless Dirac nodal lines [Tiantian Zhang *et al. npj computational materials* ***8.*** *(2022 ) 155.*]. The Dirac nodal line caused giant magnetoresistance, and the quantum oscillations in the magnetization data also indicate high carrier mobility. These findings served as inspiration to look for analogous system. The single crystals of $Ni_3In_2Se_2$ were grown using the modified Bridgeman method, and their structural characteristics were examined using x-ray diffraction, temperature-dependent Raman scattering measurements to examine their vibrations, and energy dispersive spectroscopy to examine their elemental analysis. Electronic transport (longitudinal and transverse) studies on the single crystals are performed to examine their topological phases.

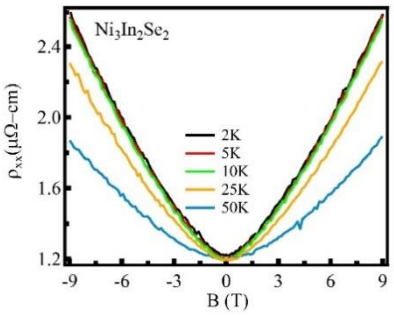



***Fig.1:*** *linear resistivity as a function of applied magnetic field (//a-b plane)*

## Study of d0 ferromagnetism, dielectric, optical and transport properties of (Ag/A) co-doped SnO2 compounds (A=Mg, Sb) for Spintronics Application

Dr. Sandeep Kumar Srivastava, Central Institute of Technology, Kokrajhar

Samples of compounds $Sn_{1-x}Sb_xO_2$, $Sn_{0.94}Ag_{0.06-y}SbyO_2$, $Sn_{1-x}Mg_xO_2$, $Sn_{0.94}Ag_{0.06-y}MgyO_2$ were prepared by solid-state reaction method and these samples were characterized by XRD, RAMAN, Optical properties, and Hall Effect measurements. The XRD results of $Sn_{1-x}Sb_xO_2$ revealed that these materials crystallize in a single tetragonal rutile phase of $SnO_2$. Moreover, the XRD data indicated that the solubility limit of Sb was only upto 8% and thereafter secondary phase of $Sb_2O_3$ starts to appear. Using the equation developed by Debye and Scherrer, it was discovered that these samples had an average crystallite size of around 32-36 nm. The rutile phase of $SnO_2$ has been reconfirmed by Raman spectroscopy, and it

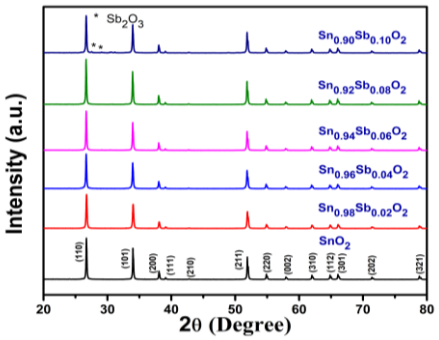



**Fig.1:** *XRD patterns of* $Sn_{1-x}Sb_xO_2$

further shows that there is no lattice disorder upon inclusion of Sb into the $SnO_2$ lattice

## Improved (001) texture and enhanced $L1_0$ transformation in FePt with Cu addition

Dr. Kavita Sharma, Amity Univ., Noida

Enhanced $L1_0$ ordering kinetics with improved crystallographic texturing in [001] direction and high magnetic coercivity of about 6 kOe is observed in $L1_0$ ordered $Fe_{(1-x)}Cu_xPt$ films, after successive isochronal vacuum annealing of multilayer structure $[(Fe_{(1-x)}/Cu_x)/Pt]_x10$. In-plane and out-of-plane GIXRD measurements validates texturing of magnetic easy axis [001]. Enormous increase in magnetic coercivity is observed from MOKE measurements in $L1_0$ ordered state. Lower ordering temperature with enhance (001) texturing and high magnetic coercivity is desirable for potential device applications of FePt. Effect of Cu and annealing temperature on structural and magnetic properties is investigated systematically in $Fe_{(1-x)}Cu_xPt$ films. Structural investigation discloses that lattice distortion in $L1_0$ ordered state caused by Cu addition and high interfacial energy associated with the initial multilayer structure drives faster interdiffusion. Both of these aspects collectively work for FCC to FCT transformation, hence results in enhanced kinetics and texturing effects of $L1_0$ FePt.

*[Shubam Kumar et al., J. Magn. Magn. Mater., 567 (2023) 170327]*

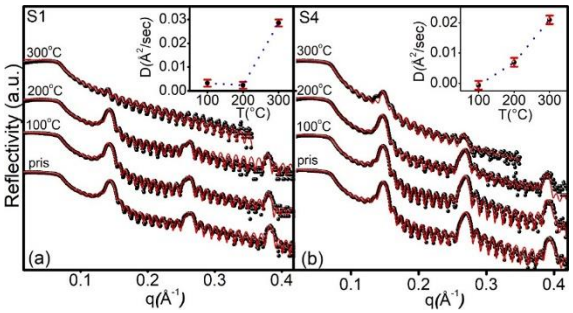



Fig.1: *X-ray reflectivity profiles of the multilayers*.

## Study of crystal structure, optical and transport properties of Sb-doped $SnO_2$ compounds for Optoelectronics Application

Dr. Sandeep Kumar Srivastava, Central Institute of Technology Kokrajhar, Assam

The polycrystalline samples of $Sn_{1-x}Sb_xO_2$ (with x=0-0.10) were synthesized using a solid-state route reaction approach. From the XRD data, it was revealed that these materials were crystallized in a single tetragonal rutile phase of $SnO_2$. Moreover, the XRD data indicated that the solubility limit of Sb was only upto 8%. The rutile phase of $SnO_2$ has been reconfirmed by Raman spectroscopy, and it further shows that there is no lattice disorder upon inclusion of Sb into the $SnO_2$ lattice. An analysisof the optical property by means of a UV-vis Photo-spectrometer indicates that the value of optical band gap reduces as the amount of Sb doping in the material increases. Whereas, the optical transmittance value was found to enhance with Sb doping concentration. The Hall effect measurement indicate the p-type behaviour of these samples and the carrier concentration of holes rises as the amount of Sb doping concentration increases

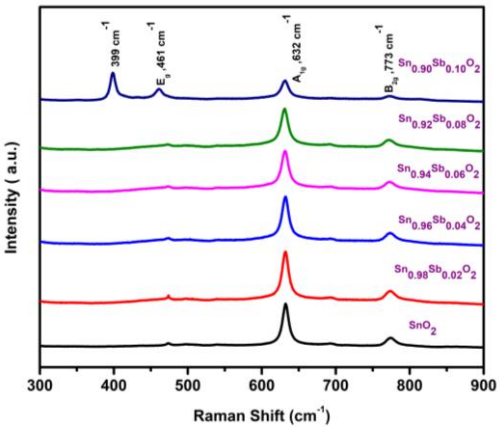



**Fig.1***: Raman spectra of $Sn_{1-x}Sb_xO_2$ compounds*

## Growth of sputter deposited cobalt palladium multilayer thin films for magnetic memory deviceapplications

Dr. Bharati Tudu, Department of Physics, Jadavpur University

Magnetic/ non-magnetic (NM)multilayer thin films exhibiting perpendicular magnetic anisotropy (PMA) have a huge potential for future non-volatile memory devices with higher data storage density, higher operational speed, high thermal stability etc.[1]PMA of Co-based multilayers can be tailored according to growth conditions. Also, insertion of a heavy metal can give rise to enhanced PMA due to interfacial hybridization [2]. Here, our goal is to study the magnetic anisotropy in $[Co/(NM)]_n$ multilayers and the role of heavy metals insertion on the PMA. At this initial stage, we prepared few preliminary samples with the aim to identify the growth parameters which may affect the film growth and hence the magnetic properties. These parametersare the deposition rate which can be achieved by changing the power supplied to the sputtering targets and the Ar gas pressure inside the chamber(Fig.1a). A typical Co/Pd multilayer film with the composition:Si(substrate)/Pd2nm/ (Co0.4nm/Pd0.6nm)x10/Pd3nm was deposited. The sample was annealed at 300 °C. It can be infered from XRD data (Fig.1b) that annealing changes the crystal structure of the mutilayer which in turn may have also changed the magnetic properties(also reported earlier). Detailed magnetic characterization and systematic study on the PMA of these films will be done soon.

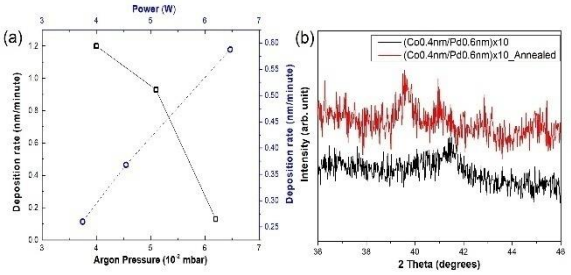



**Fig.1:** (a)*Dependence of cobalt deposition rate on the Ar pressure [Co Power= 10 W] and on the Co power supplied[Ar pressure=0.06 mbar] (b) XRD pattern of Co/Pd multilayer before and after annealing at 300 ℃*

**References:**[1]*B Tudu et al. Vacuum 146 (2017) 329-341*
[2]*A. S.Samardak et al. NPG Asia Materials 12.1 (2020) 1-11.*

## Exploring morphological effects on the Photophysical properties of Lead Free Halide Perovskite Nanocrystals,

Dr. Dharmendar Kumar Sharma, Maulana Azad National Institute of Technology Bhopal, India

All-inorganic Lead Free Halide Perovskite (LFHP) nomaterials of type $ABX_3$/ $A_2BX_6$ has been synthesized using solution-based procedure*i.e.*, hot injection methods and size and shape of the LFHPs controlled using temperature and ligand facilitated methods.Appearance of multiple peaks in LFHPs emission spectra (Fig. 1) are currently under investigation to understand its homogeneous and/or inhomogeneous contributions. It is planned to perform SEM/TEM and EDX for size/shape and crystal analysis followed by photophysical characterization at single particle level.

**References:**
[(1)*D.K.Sharmaet al. Nanoscale* ***8,*** *(2016)13687*]
[(2)*D.K.Sharmaet al. ACS Nano****13,*** *(2019)624]*.

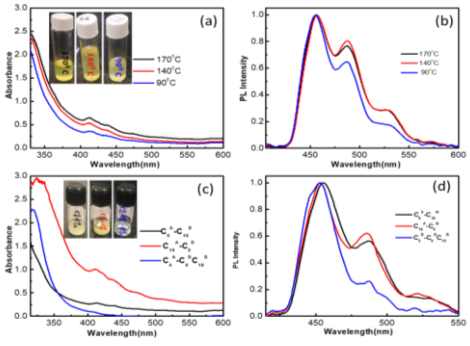



**Fig.1:** *Absorption (a,c) photoluminescence (b,d)of LFHPsnanomaterials dispersed in toluene.*

## Spin dynamic investigation and structural co-relation of the ensembles of two dimensional primary nanosystem:

Prof. Pritam Deb, Department of Physics, Tezpur University

We have aimed to develop a two-dimensional system in order to study its intrinsic magnetic properties. A 2D non van der Waal system of iron oxide (α- $Fe_2O_3$) wassynthesized using liquid exfoliation method. To study and compare the effect of the morphology of the nanosystem on its intrinsic properties, we developed an ensemble of spherical iron oxide nanoparticles. This system has been verified for its size and type ofassembly with the help of SANS/SAXS experimental data.

The microstructural studies for the 2D system show the planar flakes-like structure. When compared to that of the reference HRTEM images of 2D iron oxide, the prepared sample shows clustered flakes with a higher degree of opacity. This indicates that the thickness of the prepared sample is more than that what is desired for thin sheets of the reduced bulk iron oxide..*[K. Bhattacharya et al.,* ***Dalton Trans.****,* ***44 (2015)*** *9221.]*

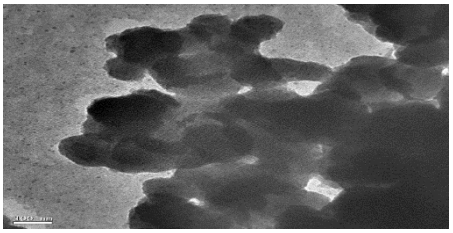


**Fig.1:** *TEM images of the 2D iron oxide at 100 nm magnification*

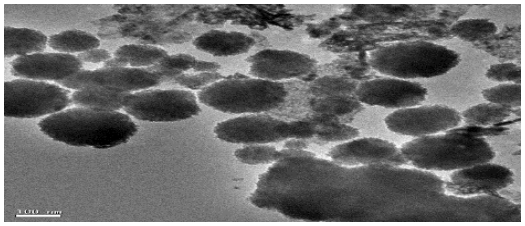


**Fig.2:** *TEM image of spherical iron oxide nanoparticles*

## Unravelling the trivalent ion electrochemistry of niobium and bismuth-based chalcogenides and understanding the electrochemical mechanism by X-ray photoelectron spectroscopy for aluminium-based energy storage devices

Shyamal Kumar Das, TezpurUnivesity, Assam

The project initially focuses on the identification of current collectors for $Al^{3+}$ ion storage in Bi-based electrode materials for aluminum-based energy storage devices. Therefore, four different types of current collectors namely titanium, nickel, graphite and copper were investigated. As starting electrode materials, $Bi_2MoO_6$ and $Bi_2WO_6$ are chosen for the study after preliminary assessment. As a representation, Figure 1a shows the FESEM images of $Bi_2WO_6$.Figure 1b shows the charge/discharge profiles of $Bi_2WO_6$in 0.5 M $Al_2(SO_4)_3$ aqueous electrolyte. A long discharge plateau around -0.2 V could be notice. Although the initial discharge and charge capacities are very high, there is a gradual decline in the storage capacities. We are presently working on to achieve long term stability with high storage capacityby modification of the current collector.

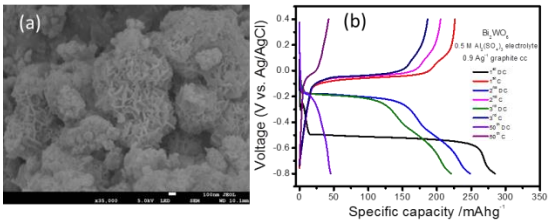



**Fig.1:** *(a) FESEM image of $Bi_2WO_6$ and (b) Charge/discharge curves of $Bi_2WO_6$ in $Al^{3+}$ ion electrolyte*

## Development of fluorescent carbon dots and mesoporous silica-based nanohybrids for cancer theranostics,

Dr. Jasaswini Tripathy, Associate Professor, School of Applied Sciences, KIIT Bhibaneswar

Abstract-Recently, fluorescent carbon dots (CDs) are emerging luminescence nanomaterials because of their small size, easy preparation, and excellent biocompatibility. Due to their surface chemistry and optical properties, they are ideal candidates for cancer theranostic. Carbon dots can be integrated with drug carrier nanoparticles such mesoporous silica nanoparticles to form a multifunctional hybrid system for chemo-photothermal therapy and imaging applications. Furthermore, the synthetic protocols of CDs usually require expensive or even toxic chemicals. Hence, this work reports developing facile methods that use precursors directly from nature resources to produce NIR-CDs with superior optical properties for cancer theranostics. Fluorescent CDs were synthesized using a *Mimusopselengi* pulpextract. Thesynthesized CDs were characterized using UV-Vis, FTIR. Further, the successful synthesis of CDs was confirmed throughFE-SEM and EDAX (Fig.1).

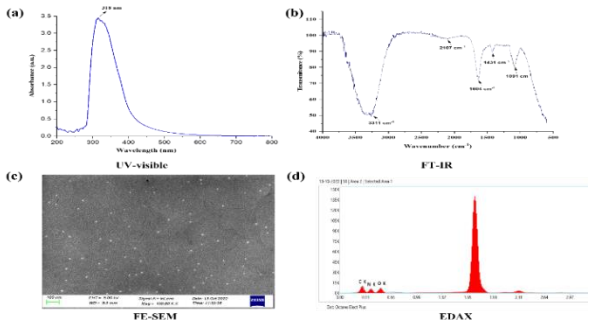



**Fig.1:** *(a) UV-Visible, (b) FT-IR, (c) FE-SEM, (d) EDAX of N-CDs*

**Reference:**

[1. *J. Liu et al. ACS Cent. Sci.* 2020, 6,12,2179–2195.

*2.M Kurian, et al.Carbon Trends,2021,3,* 100032

## Thermoelectric performance of hybrid composite materials: Bismuth Tellurides and conducting polymers on a flexible substrate

Dr Sukanti Behera,Materials Chemistry Lab, Department of Chemistry, Maulana Azad NIT, Bhopal

In this work, synthesis of n-type thermoelectric material Bismuth Telluride has been carried out by hydrothermal method.Bismuth chloride and Tellurium powder wereused as precursors and reaction is being conducted in an autoclave reactor vessel, and time & temperature parameters are being optimized over each time.From the experimental result - powder X-ray diffractionconfirms the formation of bismuth telluride $Bi_2Te_3$ phase along with other impurities peaks. Then,theoretical - DFT calculation through Quantum Espresso are being performedto understand structural and electronic properties for thermoelectric material. Currently, ermi Energy Level and band Gap values are obtained within limits as shown in the figure - 1.

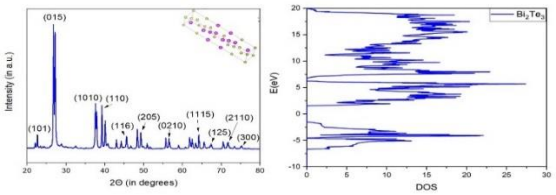



**Fig.1:** *Experimental Powder X-ray pattern of Bismuth telluride& Density of state (DOS) from DFT calculation*

## Development of low-cost cellulose-based SERS substrate with plasmonic core@ LDH shell nanoparticles for improved environmental monitoring

Kamali Kesavan, CSIR-Institute of Minerals and Materials Technology, Bhubaneswar

To synthesise SERS substrate with plasmonic core@LDH shell nanoparticles, the plasmonic gold nanorods (NRs) were synthesised by a two-step seed-mediated techniquewith an aspect ratio of 3.3. NiAl layered double hydroxide (LDH) has been synthesised through urea hydrolysis route with required optimisation. The band gap is found to be 2.77 eV and the suitable organic dye is crystal violet for environmental monitoring applications. The optical properties of the synthesised Ni-Al LDH were investigated using UV-vis DRS (Figure 1). Specifically, three absorption bands in the UV and visible-light regions were observed: the first from 200 to 300 nm, the second from 300 to 500 nm, and the third from 600 to 800 nm The UV intrinsic absorption band (200 to 300 nm) could be attributed to ligand-to-metal charge transfer (LMCT) from the O 2p orbital to the Ni $3d_{t2g}$ orbital, whereas the bands from 300 to 800 nm correspond to d-d transitions, which are, which are characteristics of $Ni^{2+}$ ions in an octahedral geometry.

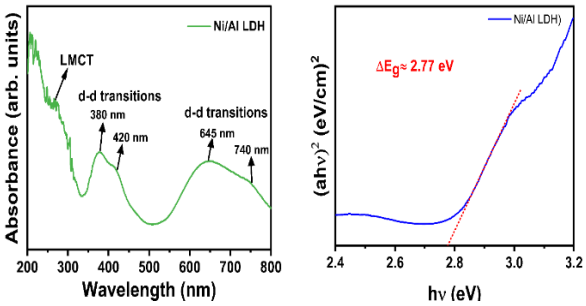



**Fig.1(a)** *UV-Vis DRS and* ***(b)*** *The Tauc plot of as-prepared Ni-Al LDH.*

## Developing ultrafast, large area and flexible broadband photodetectors based on metal doped SnX (X= S, Se, Te) 2D Nano-heterostructures

Dr.C.K.Sumesh, P.D.Patel Institute Of applied sciences, CHARUSAT, Chang

SnS is one of the members of the 2D layered material family. Here in the present work, we carried doping of In element in pristine SnS and investigated improvement in photodetection properties. We studied different doping concentrations of In such as 2%, 5%, 6%, 7%, 8%, 10%, and 12%. All these pristine and In doped SnS were synthesized by hydrothermal method. Paper based flexible, large area Photodetector devices were fabricated from as-synthesized materials. Among these devices, all concentrations of In doped devices shows improved results than pristine SnS except 2% and 7%.

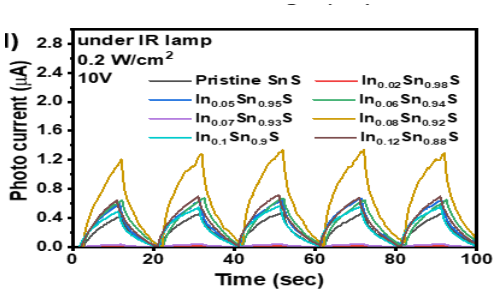
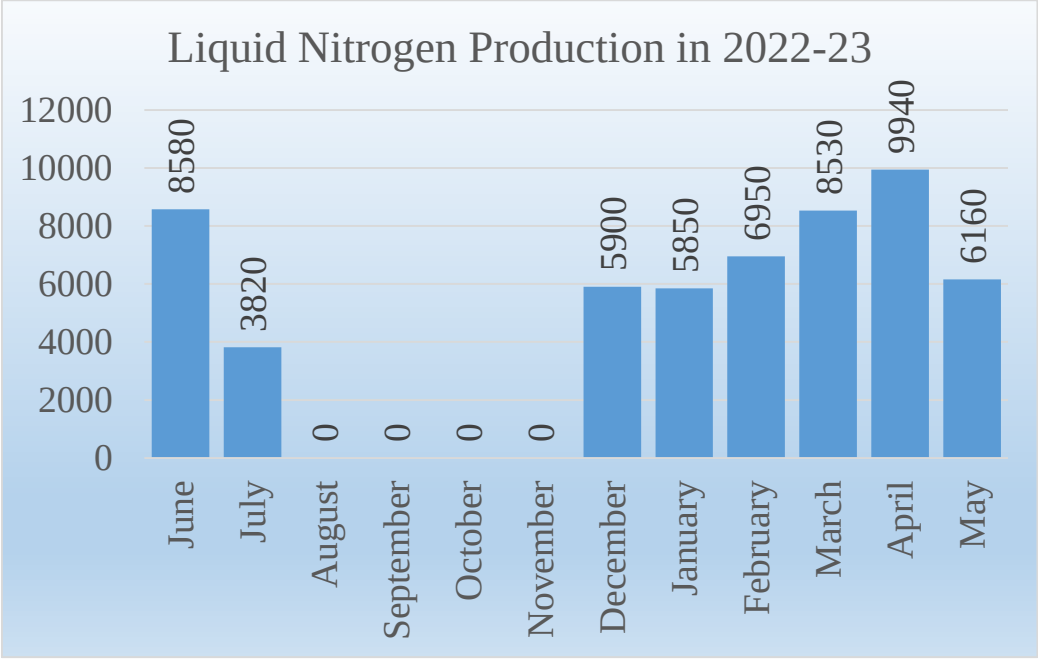


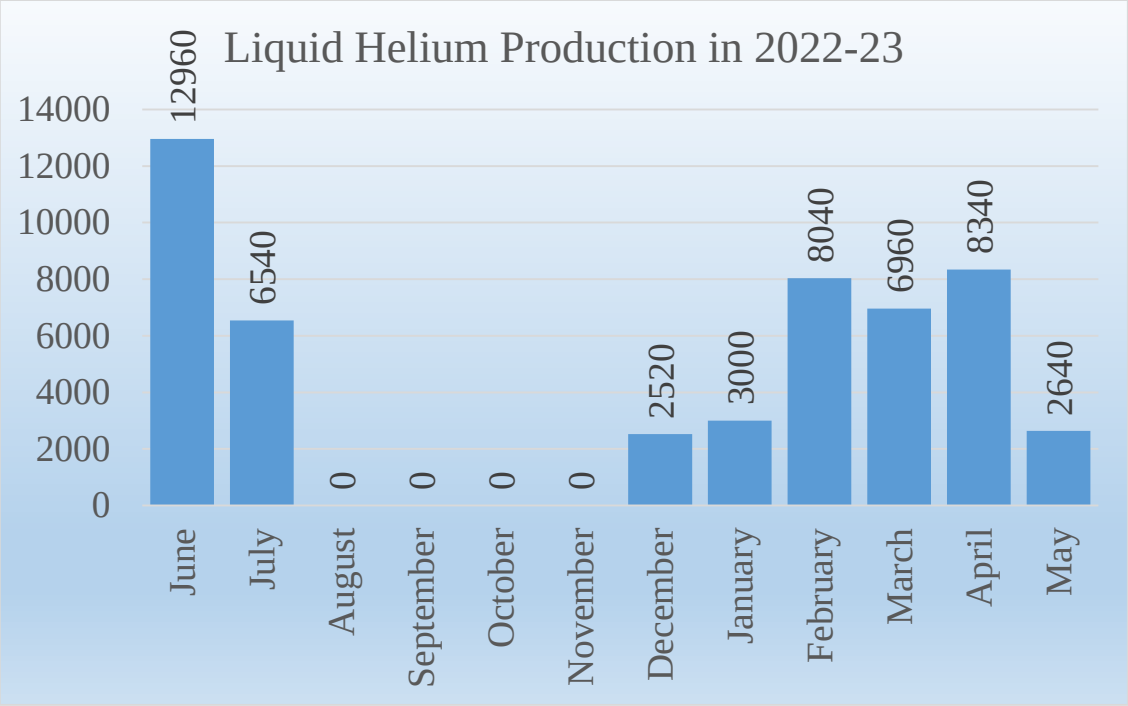

**Fig. 1.** *photo response*

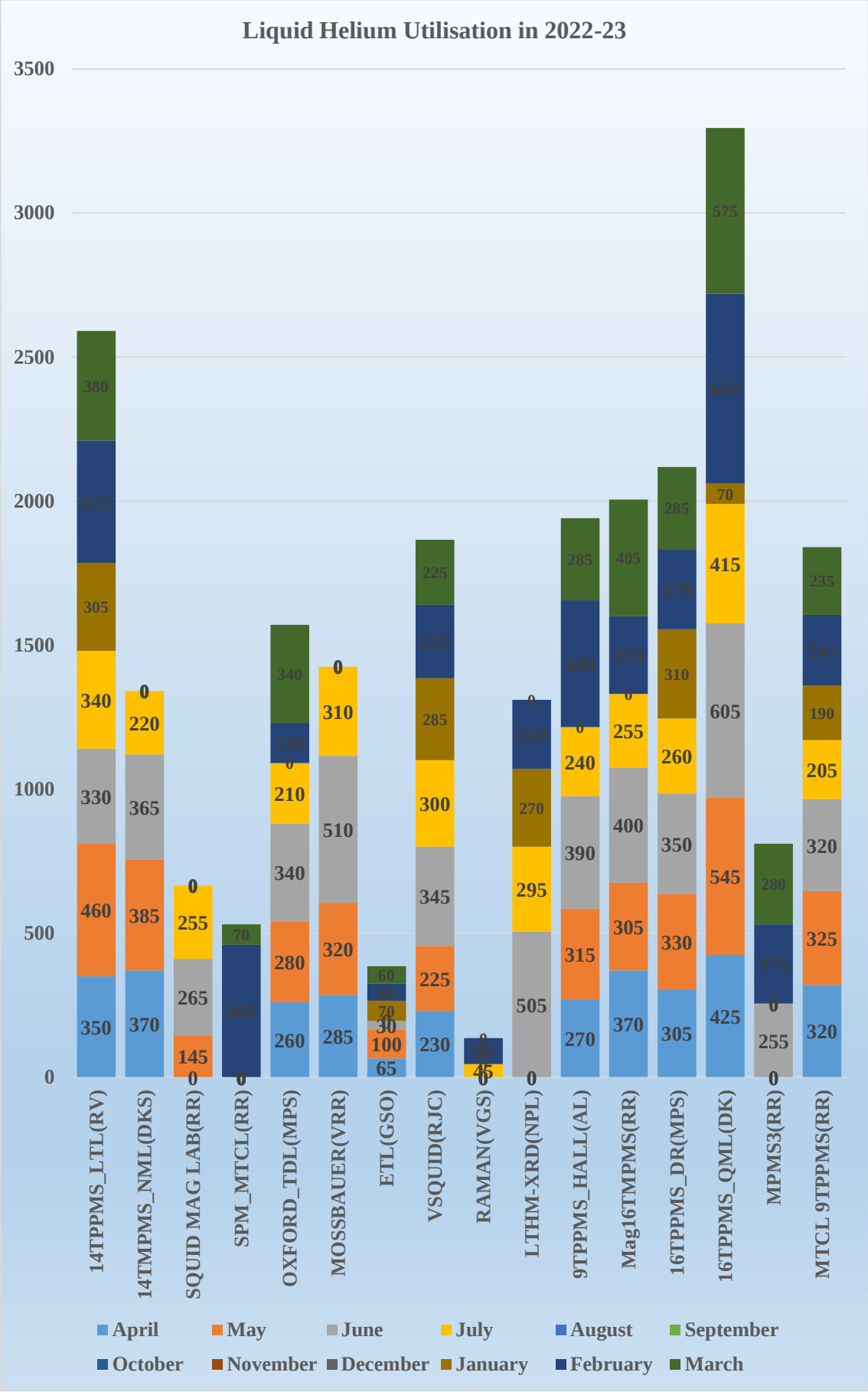
## CRYOGENIC ACTIVITIES

### In-charge: Er.M.P.Saravanan

Group: M.P.Saravanan, N.Vijaya Kumar, S.Thilakraj Kumar, Md Ziaul Haque, Sanjay Shrivastav, Sushil Kumar Sharma




Liquid Helium Utilisation in 2022-23
3500
3000
2500
2000
1500
1000
500
0
14TPPMS_LTL(RV)
14TMPMS_NML(DKS)
SQUID MAG LAB(RR)
SPM_MTCL(RR)
OXFORD_TDL(MPS)
MOSSBAUER(VRR)
ETL(GSO)
VSQUID(RJC)
RAMAN(VGS)
LTHM-XRD(NPL)
9TPPMS_HALL(AL)
Mag16TMPMS(RR)
16TPPMS_DR(MPS)
16TPPMS_QML(DK)
MPMS3(RR)
MTCL 9TPPMS(RR)
April
May
June
July
August
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October
November
December
January
February
March

# Research Activity at Kolkata Centre

**DR. SANDEEP S GHUGRE**

**Centre Director, Kolkata Centre**

**E-mail:** ssg@alpha.iuc.res.in; sandeep@csr.res.in

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**Phone:** 91-33-23358035 / 23351866 (D: 23356542)

The Kolkata Centre continues to pursue its mandate of implementing and supporting interdisciplinary research centred around the use of radiation both as a probe as well as a tool to investigate matter, living and otherwise. The myriad research programmes include those being carried out in close collaboration with the associated groups at VECC, Kolkata, and, in addition, efforts have been directed towards increasing the usage of other accelerator facilities (of the DAE) at IOP, Bhubaneswar and the BARC-TIFR Pelletron Linac Facility, Mumbai.

The Centre has partnered with 2 Central, 7 State, and 1 Private Universities along with 6 postgraduate colleges and a Cancer hospital for a submission under the DST-SATHI grant scheme. The objective of the proposal is to augment the research infrastructure for the radiation biology programme. The Centre has sustained its support to Users from the teaching institutions under the Collaborative Research Schemes (CRS) as well as those visiting the Centre for use of specific facilities. Most of these endeavours are not just limited to the measurements but assume a holistic approach towards encompassing the different stages, from submission of the proposal to the preparation of the manuscript.

The Nuclear Physics Group hosted Prof. Umesh Garg, from University of Notre Dame, as a Senior Fellow under the Fulbright Nehru program. The group continues to play a pivotal role in the INGA collaboration, particularly as the resource group for the digital DAQ for the experimental campaigns at VECC. In addition, the Group continues to support the Users during the analysis of the acquired data from the previous campaigns. The interdisciplinary research in the domains of synthetic nano-chemistry, material science and biology remains the primary focus of the Macro-Molecular & Radiation Chemistry Group at the Kolkata Centre. The Condensed Matter Group has performed experiments at different international synchrotron and neutron facilities (DESY-Germany and Rutherford Appleton Laboratory-UK) while continuing their efforts in the synthesis and characterization of materials of contemporary interest. The Radiation Biology group continues the investigations on the effect of radiation induced stress on cellular systems. The recent developments with the EDXRF Facility has made it possible to investigate the response of cellular systems to low energy photon radiation.

As a part of its outreach initiatives, the Centre has hosted UG and PG students, from different institutions, for their curricular projects. One such study with the students from the Panskura Banamali College, West Bengal, progressed to win 5$^{th}$ position in the Regional Science & Technology Congress.

Further to the research and developmental activities, the faculty members of the Centre, as a part of its continuing legacy, have been invited speakers at different forums of the national and the international academia.


## DR. ANINDITA CHAKRABORTY

**Scientist-G**

anindita.iuc@gmail.com


Stress Biology

**Group Members:**

(1) Dr. G. Ghosh (Scientist-G) (2) Dr. Souradyuti Ghosh (Scientist-D) (3) Sharmi Mukherjee (ICMR SRF) (4) Anindita Dutta (UGC SRF) (5) Ms. Sulagna Dutta (UGC-JRF) (6) S. Selvaraj (SA F)

**Ph.D. Completed:** 9 + 1 submitted

**Facilities:**

(1) Flow cytometer (2) UV-Visible Spectrophotometer (3) Electrophoresis with western blot and Geldoc system (4) Cell culture facility (5) Ultra and High speed Refrigerated Centrifuge (6) Ultra and Deep freezers (7) Sonicator.

## In-house Research Activity:

The group has been studying on molecular mechanism of stress response in cell systems. This includes prokaryotic systems to higher mammalian cells. The main parameters studied are cell cycle regulation, apoptosis, mitochondrial and/or nuclear DNA functionality and genetic instability through in vivo, ex vivo and in vitro experiments. Work on radiosensitization and protection are also pursued along with study of radiation induced bystander effects

- **The interactions of cell survival signaling and DNA repair kinases in γ-radiation-induced bystander cells**

Irradiated cells are characterized by oxidative imbalance. The production of various effects on cellular macromolecules and signaling cascades is linked to oxidative stress. The present study investigates the effects of ionizing radiation on oxidative stress induction in bystander cells and their interactions with cell signaling mediators. At early (1hr, 2hr) and later (24hr) time points after irradiation, the effect of irradiated cell-conditioned medium (ICCM) from γ-irradiated hepatocellular carcinoma (HepG2) cells was examined in bystander normal liver (Brl-3a) cells.

Although ROS generation and lipid peroxidation had the most significant effects at the early time

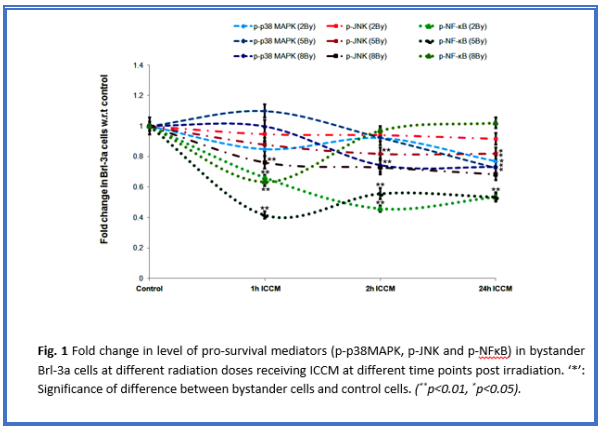



**Fig. 1** Fold change in level of pro-survival mediators (p-p38MAPK, p-JNK and p-NFκB) in bystander Brl-3a cells at different radiation doses receiving ICCM at different time points post irradiation. '*': Significance of difference between bystander cells and control cells. *(** p<0.01, * p<0.05).*

points, antioxidant enzymes such as superoxide dismutase and catalase had the least activity. Oxidative stress was persistent up to 24hrs, but the highest level was observed in 1 hr ICCM treated 8By cells. In bystander Brl-3a cells, all pro-survival signaling factors (p-PI3K, p-Akt, p-p38MAPK, p-JNK, and p-NFκB) showed a significant decrease. Increased activation of DNA damage sensors ATM, ATR, and cell cycle inhibitor p21 were noted. Elevated ROS levels down regulated the activation of PI3K, Akt, JNK, and NF-κB in bystander cells

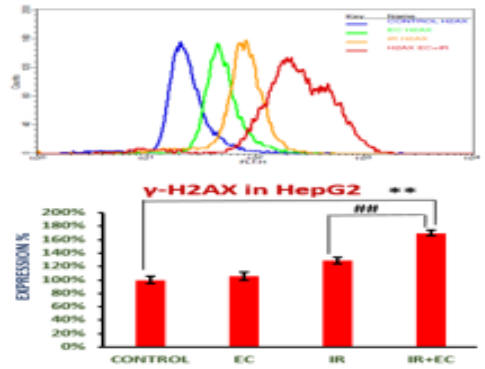
but enhanced the activation of ATM and p21. p-ATR levels, although increased in bystander cells, showed no association with other factors. The responses are regulated by cross talk between those signaling mediators, which is dependent on the radiation dose and period of incubation post-irradiation.

- **Interplay among DNA damage markers to determine the fate of EC treated γ-irradiated normal and cancer cells**

The current study examines the potential of ethyl cinnamate (EC) in modulating radiation responses in cancerous (HepG2) cells. HepG2 cells were pre -treated with EC (75 µg/ml) for 24 hours before being subjected to a single 7.5 Gy dose of γ -ray. By using flow cytometry and western blotting, DNA damage indicators (ATM, ATR, γ -H2AX) were analysed. Pretreatment with EC effectively upregulated the radiation -induced DNA damage in HepG2 cells by stimulating p -ATM, p -ATR, γ -H2AX. The potential of EC as a radio -sensitizer in HepG2 cells was observed in this investigation. Based on the elucidated molecular mechanisms, EC might be considered a promising adjuvant to enhance radio -therapeutic efficacy in cancer treatment.

findings show that signaling mediator expression in bystander cells is highly dynamic. Bystander

**Fig: Upregulation of γ-H2AX expression in HepG2 cells by EC+IR**




(A) The overlaid histogram plots represented the level of γ-H2AX in HepG2 cells. . The right shift of histogram indicated higher level of γ-H2AX. Along the X-axis intensity of Alexa Flour 488 in FL1-H (Alexa Flour 488) channel and along the Y-axis count was taken. (B) The bar diagrams represented the expression % of γ-H2AX in different experimental groups of HepG2 cells. Statistical comparison was done between control vs. IR+EC designated by '**' and IR vs. IR+EC designated by '##' in figure. $p < 0.01$ considered as significant.

## Collaborative Research Activity:

Apart for the in-house activity there are 21 research programs under Collaborative Research Schemes with various universities and colleges. The research community of these CRSs utilise the facilities of our laboratory and some of the highlights of these programs have been given in the collaborative research section of the report.

## Lectures Delivered:

- "***Radiation Biology Research: Past, Present and Future***", at KIIT, Bhubaneswar March 15 2023.

## Sponsored Project:

- SERB-DST- TARE. Title: "*Correlation between mineral nutrient levels, interleukins and endothelial growth factors in foetal growth restriction among antenatal women from rural West Bengal.* Sanctioned amount: - **18,30,000/-INR**

## Honours/ Recognitions/Awards:

Awarded "Distinguished Scientist in radiation Biology 2023" by Asian International Research Council


## DR. SOUVIK CHATTERJEE

**Scientist-F**

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Magnetic and electrical properties of transition metal alloys and oxides

**Group Members:**

(1) D. Rajib Mondal (Scientist-D), (2) K. Mondal, SRF (DST-Inspire), recently joined school as an assistant teacher, (3) S. K. Adhikari, JRF (Institute), (4) R. Roy, JRF (DST-SERB project fellow), (5) Mr. Bikram K Behera (JE-E)

**DST-SERB TARE visitor:**

Dr. Kalyanashis De (Assistant Professor, The Neotia University)

**Ph.D. Completed:** 3

**Facilities:**

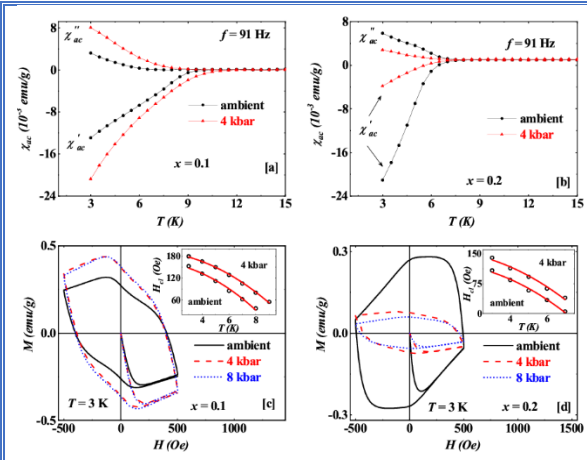
(1) x-ray powder diffractometer, (2) SQUID magnetometer, (3) 15 Tesla cryogen free system with VSM, Resistivity, Dielectric, and Pyroelectric measurement options, (4) 4 K CCR for zero-field resistivity and dielectric measurements, (5) Ferroelectric loop tracer, (6) Tri-arc furnace, (7) resistive furnaces.

## In-house Research Activity

Our main aim is to probe structural, electrical, magnetic, and magneto-functional properties of various transition metal-based alloys and oxides. Some of our recent work is focussed on magnetic equiatomic alloys, Mn-base binary alloys, and Fe-based superconductors. The experimental tools we use includes dc magnetization study, electrical transport measurements, x-ray and neutron powder diffraction etc. Some of the key findings during 2022-23 are as follows:

➢ **Effect of S-doping on the magnetic and electrical properties of FeSe superconductor**

Here we report on the magnetic and magneto-transport behavior of Fe-based superconductor with nominalcompositions $FeSe_{1-x}S_x$ ($x$ = 0.1 and 0.2). The impact of external hydrostatic pressure ($P$) and chemical pressure on the superconducting state of the FeSe system has been investigated in this work. Superconducting transition temperature ($T_c$) is found to be shifted towards higher temperatures with 10% S doping at the Se site of the FeSe alloy. On further increase in the doping concentration (for $x$ = 0.2), the superconducting $T_c$ decreases. We have also observed a significant effect of external $P$ on the superconducting properties of these S-doped alloys. Different superconducting parameters calculated from our experimental data confirm the type-II superconducting nature of the studied compounds. The signature of flux flow resistance is




*Temperature variation of ac susceptibility and field variation of magnetization in ambient and high pressure conditions.*

observed in the isothermal resistivity data as a function of the external magnetic field. [*P. Dutta et al., Physica C: Superconductivity and its applications*, ***602***, *1354126 (2022)*]

## Collaborative Research Activity:

Apart from the in-house research activity, there are twenty (20) ongoing collaborative research schemes (CRS) with various university and college groups. The research groups involved in CRS have used different instrumental facilities of the materials science laboratory. During 2021-22, one such collaborative research activity is highlighted below:

➢ **Impurity level substitution of Cr and Ni in $CaBaCo_4O_7$ – a dielectric study**

The fascinating physical characteristics of the 114-cobaltate, $CaBaCo_4O_7$, like alternate stacking of two-dimensional layers of $CoO_4$ tetrahedra in triangular and kagomé patterns, geometrical frustration, and magnetoelectric coupling have attracted several studies in the magneto-structural and dielectric sectors. But the study of electrical conduction dynamics remains practically unknown. Here we have presented dc conduction studies and ac dielectric spectroscopy intending to understand the charge conduction and charge carrier relaxation dynamics of $CaBaCo_4O_7$, along with two chemically substituted derivatives – $CaBaCo_{3.96}Cr_{0.04}O_7$ and $CaBaCo_{3.96}Ni_{0.04}O_7$, of impurity level (1%) substitutions. We observe that dc conduction at low temperatures is mediated by variable range polaron hopping, while the ac conduction study points out small-polaron-tunneling across strongly localized states. Electric modulus obeys the Havriliak-Negami equation, with parameters $\alpha$ and $\gamma$ significantly less than unity, indicating strong distribution in relaxation times; and its non-exponential nature, pointing out the cooperative motion of charge carriers. Imaginary electric modulus is not scaled to a single master curve for the three samples, signifying differences in charge relaxation dynamics. [*Materials Research Bulletin* ***161,*** *112173 (2023)*]

## Lectures Delivered:

- Invited talk: ***"Magnetic equiatomic alloys: A new class of shape memory alloy"*** at the Faculty Development Programme for Engineering College (FDP-Engineering) organized by Reva University; during 22-26 August 2022
- Invited talk: **"*Magnetic Materials and its Characterization Techniques*"** at the Annual Departmental Seminar of Jogamaya Devi College; on 25th November 2022

## Foreign visits:

- ***Dr. Souvik Chatterjee*** and ***Mr. Sanat Kumar Adhikari***; during June 25 to July 03, 2022; DESY, Germany; To perform experiments at P65 XAFS beamline.
- ***Dr. Souvik Chatterjee***; during December 08-13, 2022; ISIS facility, Rutherford Appleton Laboratory, UK; To perform experiments at WISH diffractometer, Rutherford Appleton Laboratory.
- Performed neutron powder diffraction at Oak Ridge National Lab, USA, in Mail-in mode.

## Honours/ Recognitions/Awards:

- ***Dr. Souvik Chatterjee*** invited to be the member of the "*Facility Access Panel*" (FAP1 Crystallography) of ISIS facility, Rutherford Appleton Laboratory, UK.

## Sponsored Project:

➢ Core Research Grant from SERB-DST. Title: "*Structural, Magnetic and Electronic investigation of some Mn-based alloys having first-order phase transition*".
Sanctioned amount:- **33,70,629/-**


## DR. GOUTAM GHOSH

**Scientist-G**

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Radiation-induced side effect in cancer therapy and its countermeasure using functional nanoparticles

**Group Members:** (1) Dr. Anindita Chakraborty (Scientist-G & Group Leader), (2) Dr. Souradyuti Ghosh (Scientist-D), (3) Sharmi Mukherjee (SRF, ICMR), (4) Anindita Dutta (SRF, UGC), (5) Ms. Sulagna Dutta (JRF, UGC), and (6) S. Selvaraj (SA-F).

**Facilities:** (1) Flow cytometer, (2) UV-Visible spectrophotometer, (3) Electrophoresis with western blot and GelDoc system (4) Cell culture facility (5) Ultra and high speed refrigerated centrifuge (6) Ultra and deep freezers (7) Sonicator, and (8) Inverted optical microscope.

## In-house Research Activity

Have recently (October 2022) joined the Radiation and Stress Biology Group at the Kolkata Centre and during this brief period have been introduced to the programs of the group and supplement the activities in the domain of radiation-induced bystander effect and the development of an appropriate protocol towards its countermeasure using functional nanoparticles.

- **Radiation induced bystander effect and role of nanoparticles:** Ionizing radiation is now a panacea to numerous theranostic challenges in the domain of radiation oncology. This is mainly due to the fact that the radiation to the targeted cells also affects the non-targeted cells (cancerous or healthy) to a large extent due to production of damaging signals by the irradiated cancer cells. The un-irradiated spectator cells are referred to as "bystander cells". The role of whom needs to be investigated if one were to design the radiation based evaluation and treatment. A contemporary development in the domain of nanoparticles with specific radio-sensitizing properties has made it possible to explore the possibilities of understanding the role of the theranostic properties of these nanoparticles through the prism of bystander effect.

Accordingly, a Ph.D. program has been developed to study the basic pathways of counter measuring the "bystander effect" of radiation on cancer cell lines using specially designed ion—conjugated nanoparticles. A student (Ms. Sulagna Dutta) is working in this program.

## Collaborative Research Activity:

CRS with emphasis on the biological application of the nanoparticles have been recently submitted by several users. The proposals addresses the contemporary issue wherein the nanoparticles would be investigated for their specific nutritional properties.


## DR. SOURADYUTI GHOSH

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Biology of low dose radiation exposure; Analysis of radiation-induced biomarkers

**Group Members:**

(1) Ms Saba Parveen (DST INSPIRE JRF Ph.D. student)

## In-house Research Activity

Cancer affects 13.9 million patients in India (2020). The number of affected patients are predicted to grow to 15.7 million by 2025. Predominantly, cancer patients in India suffer from tobacco-related, breast, and cervical cancer. Among these, radiotherapy is administered to 2/3$^{rd}$ of the cancer patients. Our research group investigates methods to improve radiotherapeutic outcome through use of adjuvants and by identifying cancer-specific biomarkers that are predictive of radiotherapeutic outcomes. Some of our current activities are as follows.

➢ **Investigating the effect of low dose radiation treatment in 3D spheroid breast cancer cells**

The correlation between the effect of radiation exposure to living tissue and dose is an underexplored and debated topic. The established model relies on a linear-no-threshold (LNT) model having a linear correlation among dose and radiological effects. This model predicts 3 mGy per day to be the threshold radiation level for life shortening. However, other threshold models are believed to be functional that hypothesizes low radiation level induced continually adaptive mechanism of protection. In our ongoing study, we probe the effect of low dose ionizing radiation (in the order of μGy/h, X-ray) on the mitochondrial redox homeostasis. We have used breast cancer cell (MCF-7) derived spheroids as models mimicking in vivo systems. We are administering low irradiation dosage to these using in house microXRF systems. In addition, we are also investigating whether such low dose of irradiation could alleviate or aggravate other external stresses such as ethanol stress, $H_2O_2$ stress, DMSO stress etc. Furthermore, the role of adjuvants such as various phytochemicals, nanoparticles in regulating such stresses are being probed. We are using MTT cell mortality assay and flow cytometric analysis for investigating the effects of low dose radiation exposure.

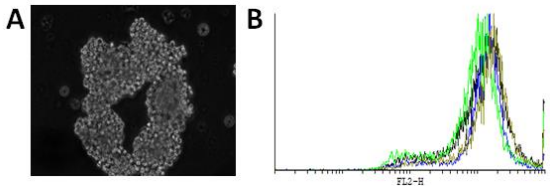


**Fig.1:** *A, MCF-7 spheroid formation in low melting agarose scaffolds. B, Flow cytometric analysis after low dose radiation exposure*

➢ **Investigation of radiation-induced RNA biomarkers using enzyme-free nucleic acid amplification**

The socio-technical importance of detecting ionizing radiation-biomarkers in living systems spans not just the field of radiotherapeutic oncology, but also in finding radiological toxicities in people working in nuclear power plants, side effects of radiotherapy as well as defence applications. The gold standard method in these aspects is usually real time PCR, which is time-intensive, resource consuming, and requires several centralized instruments. We are currently investigating enzyme free nucleic acid amplification methods such as hybridization chain reaction and cascade signal amplification strategy. The former creates a long concatemeric DNA nanowire chain upon identification of a biomarker sequence. The latter creates a self-feeding loop

signal amplification. With radiation induced biomarker gene expressions such as CDKN1A or GDF, these signal amplification strategies would be used for identification and quantification of gene expression.

## Collaborative Research Activity:

In addition to in house research activities, the following collaborative research activities are being pursued.

➢ **Reduction of post-harvest rot of tomato caused by *Alternaria sp*. through the application of gamma-radiation**

Tomato fruit contains a rich variety of nutrients and bioactive compounds and are considered highly important towards maintaining human health. However post-harvest, it is susceptible to fungal pathogens such as Alternaria sp., causing severe economic loss. In this project, we would be investigatng gamma ray induced elicitation and sterilization towards protecting tomato fruit from fungal infection without the loss of key nutritional values.

➢ **Development of novel supramolecular thio urea-amide spacer hydrazone chemosensor having effective anion/cation sensing results to heteronuclear complex formation having DNA/HSA binding, lysosome tracking and antiproliferative property**

Organic chemosensors have vast applications in the field of health, environment, and defense applications. With the aim of selective anion and cation sensing, we would be designing supramolecule based chemosensors based on thiourea-amide based motifs. After synthesis of such supramolecular sensors, their activity in ion sensing as well as utility as anti-cancer cells through induction of apoptotic pathways are to be investigated.

➢ **Structural characterisation of glycation associated protein aggregation: Unravelling the cellular decision of AGE-RAGE axis induced inflammatory response versus amyloid associated toxicity**

Underregulated or misregulated glycation of proteins may lead to unwanted presence of glycation end products, causing "glycation stress" and varieties of maladies. The pathways involve recognition of these adducts by cellular surface receptors, causing triggering of downstream signalling pathways such as MAPKs and NF-kB. Despite their importance, the information about folding or confirmation of glycated proteins by themselves or in these signalling pathways remain unknown. In this project, the correlation between glycated proteins and various disease markers are to be investigated.

## Lectures Delivered:

- **"*γ-Irradiation Induced Damage on Normal Hepatocytes and Its Protection by Ethyl Cinnamate*"** at Application of Radiotracers and Energetic Beams in Sciences (ARCEBS) 2023, held at Sidho-Kanho-Birsha University, Purulia on 05-02-2023.
- "***Radiation: Tool for Multi-disciplinary Research in Biology and Chemistry***" by Dr. Souradyuti Ghosh organized by Internal Quality Assurance Cell (IQAC), Kalyani University on 17-11-2022


## DR. SANDEEP S GHUGRE

**Centre Director**

ssg@alpha.iuc.res.in; sandeep@csr.res.in


Structure of rapidly rotating nuclei as perceived using In-beam Gamma-ray Spectroscopy, Nuclear Instrumentation, Radiation based characterization techniques.

**Group Members:**

(1) Dr. R Raut, Scientist-F (2) Dr. P V Rajesh, SA-F, (3) Mr. K. Basu, SA-F (4) Mr. Mukesh Kumar, SA-F, (5) Mr. J Biswas, SA-E (5) Dr. Aparna Datta SA-F

**Ph.D. Completed:** 9

**Facilities:**

(1) Clover detectors being used with INGA (2) Scintillator detectors for fast timing applications (3) Standalone digitizer based pulse processing electronics (NIM) (4) Energy Dispersive X-ray Fluorescence Spectrometer

## In-house Research Activity

The research programmes of the nuclear physics and trace element science group spans the domains of pure and applied nuclear physics. Efforts have been undertaken towards developing open source based software analysis tools which would facilitate the basal methodology in this domain.

- **Pulse processing in the digital domain:** The electrical pulse output from a radiation detector (usually a voltage pulse) encodes the information of the incident radiation. The subsequent pulse processing techniques are optimized to extract the energy and timing information from the recorded pulse. Recent advances in the domain of fast sampling ADC and FPGA have made it possible to utilize the digital signal processing techniques to process the output signal. The processing is essentially based on the applications of recursive algorithms. Attempts have been made to understand these algorithms with the help of open source tools. This exercise is expected to help the end user develop an understanding and insights of the pulse processing. It is expected that the next stage of these developmental activities would render these algorithms into the FPGA hardware for real time applications.

- **Novel method for the quantification of trace elements using EDXRF:** The conventional X-ray fluorescence (XRF) measurement data is analysed to obtain the intensity of the characteristic X-ray peak, which is related to the corresponding elemental concentration in the emitting sample. However, extraction of the intensity needs to be preceded by conventional denoising and background subtraction of the spectrum. Given the experimental dependence of these variables, a unique methodology for the spectrum processing techniques is not feasible. Open source based resources have been used for developing methods to pre-process the X-ray spectra for denoising and background subtraction. Further, spectral parameters such as the background, Compton and Rayleigh scattered Rh $K_\alpha$ peaks are known to be influenced by the matrix effect (presence of other elements in the sample). This information has been used to scale the intensity of the characteristic X-ray peaks for reliable quantification of the concentration. The concentrations thus extracted for the Standard Reference Material are in agreement with the reported values, thus validating the developed method. The undemanding nature of this method is an added merit.

## Collaborative Research Activity:

Support has been extended to the earlier CRS users to finalize the results of their respective measurements and communicate the same for publications. The Calicut University group of Prof Mustafa have recently investigated alpha induced reactions on natural Zirconium, a material having relevance in reactor technology. Samples of natural Zirconium of thickness 6.49 mg/cm$^2$ were irradiated with alpha particles of 30 MeV and 40 MeV from VECC, and the offline gamma decay was investigated. The $^{nat}$Zr(α, x) reaction results were interpreted within the statistical model calculations using the TALYS code. The total neutron production cross section from all possible exit channels at the relevant alpha energies have been estimated. The isomeric cross section ratio for the production of the radionuclide $^{95}$Nb has been successfully measured

## Lectures Delivered:

- "***Basic Science : To Pursue or Not : Research Opportunities Over the Horizon***" 7th Anantakumar Sarker and Snehalata Sarker Memorial Lecture on 20th September 2023, organized by Department of Physics, Bethune College, Kolkata.
- ***"The Cyclotron & Us: Nuclear Physics at the Kolkata Centre",*** at the Symposium on Nuclear Reaction and Structure up to Intermediate Energy Collision (NRSIC-23) organized by the Variable Energy Cyclotron Centre, Kolkata during January 24th - 25th , 2023.
- ***"Radiation & Kolkata: A Twosome Tale"*** at the Fifth International Conference on Application of RadiotraCers and Energetic Beams in Sciences, ARCEBS-2023 organized by Sidho-Kanho-Birsha University in collaboration with the International Atomic Energy Agency (IAEA) during January 31st - February 5th , 2023
- Set of 3 invited lectures on ***"Pulses & Physics: A Twosome Tale "*** at the School on Data Acquisition & Analysis organized by the Inter University Accelerator Centre, New Delhi during 22nd-24th February, 2023.
- ***"The Light of Gray : On the Many Blisses of Radiation Science",*** Keynote address at the conference "Stress Biology: Recent Advances in Biochemical & Biophysical Research" organized by the University of Kalyani, March 22nd – 24th 2023.
- Resource personnel at the ***"Beginner level 2-day workshop on Arduino microprocessors",*** organized by Department of Physics, Kirori Mal College, March 24th-25th 2023.
- Lectures on "***Radiation Detectors"***
- for Post M.Sc Diploma Course in Medical Physics, Jadavpur University, during September-December, 2022.
- Lectures on ***" Concepts in Nuclear Physics",*** for the M.E course in Masters of Nuclear Engineering, Jadavpur University, September 2022 -January 2023.
- Lectures on ***"Nuclear Reactors",*** for B.E course in Power Engineering, Jadavpur University, January – April 2023.


## DR. RAJIB MONDAL

**Scientist - D**

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Single crystal growth and anisotropic physical properties studies of intermetallic compounds and alloys

**Group Members:** (1) Dr. Souvik Chatterjee (Scientist-F), (2) Rosni Roy (Junior Research Fellow), (3) Mr. Bikram K. Behera (JE-E)

**Facilities:** (1) Mössbauer Spectrometer (2) High Temperature Furnace (3) Ultrasonic Cleaner

## In-house Research Activity:

The current research activities of our materials science group are focussed on the single crystal growth and characterization of various intermetallic compounds and alloys and the experimental investigations of the structure-property correlations of the materials. To explore the materials physics, various experimental facilities are used to characterize and study the anisotropic physical properties of the grown crystals, for examples, x-ray diffraction, Mössbauer spectroscopy, magnetic measurements, electrical transport, magneto-transport measurements, Hall Effect etc. Some of our recent research works are the following:

➢ **Single crystal growth, structure, Mössbauer spectroscopy and anisotropic physical properties studies of two-dimensional magnetic van der Waals materials**

Of late, there is an intensive research interest for exploring new physical phenomena on quasi two-dimensional (2D) magnetic van der Waals (vdW) materials. These magnetic 2D-vdW layered materials attract special attention to the researchers over a decade due to their technological applications in miniaturization such as in spintronics and nanoelectronics devices in addition to the underlying physics. Many such magnetic 2D-vdW materials have been discovered and investigated, such as, $CrSiTe_3$, $CrGeTe_3$, $FePS_3$, $NiPS_3$, $CrI_3$, $VSe_2$, $MnSe_2$, $Fe_3GeTe_2$, etc. In the present research activity, we report the single crystal growth, Mössbauer spectroscopy and various anisotropic physical properties of iron based 2D vdW materials. Single crystal of $Fe_3GeTe_2$ was grown by chemical vapor transport method. Few grown single crystals were ground to fine powders and room temperature powder x-ray diffraction was performed using a BRUKER D8 Advance diffractometer (Cu-Kα source, λ = 1.5406 Å). Room temperature powder XRD confirmed the hexagonal crystal structure with space group *$P6_3/mmc$* (No. 194). Temperature and field dependent magnetic susceptibility measurements revealed a ferromagnetic transition at 179 K ($T_C$). $^{57}Fe$ Mössbauer spectra at room temperature and 5 K was collected and analyzed as shown in Fig. 1. Room temperature Mössbauer spectrum of $Fe_3GeTe_2$ revealed an asymmetric paramagnetic doublet. Further measurements at low temperature at 5 K revealed the presence of three sextet from three iron sites indicating long range magnetic ordering in the material. We have also studied the nature of exchange interaction and type of magnetic ordering in the materials by the analysis of critical behavior near the ferromagnetic transition.

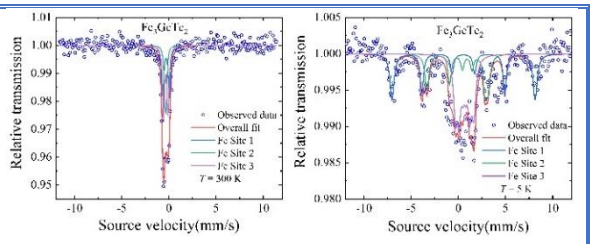


**Fig.1:** *Mössbauer spectra of $Fe_3GeTe_2$ at room temperature and at 5 K*

➢ **Crystal growth and anisotropic physical properties studies of single crystalline rare earth intermetallic compounds**

In the past few decades, rare earth based intermetallic compounds attracted considerable attentions owing to the richness and variety of their physical properties. In the present report, single crystals of rare earth based quaternary compounds $RAuAl_4Ge_2$ (R = La, Ce, Pr, Gd) were grown by self-flux method. Flat platelets type shiny single crystals with dimension of about few mm were obtained wherein the flat plane corresponds to the *ab*-plane. They crystallized in the trigonal crystal structure with space group *R*-3*m* (No. 166). In the crystals structure, the rare earth ions form the infinite triangular nets in the basal *ab*-plane which are separated by about 10 Å. This kind of arrangement of magnetic ions may lead to geometric frustration of magnetic spins in the system. We have investigated the anisotropic magnetic, magnetocaloric, electrical transport, magnetotransport, and thermodynamic properties of the grown $GdAuAl_4Ge_2$ crystal.

## Collaborative Research Activity:

In addition to in-house research activities, we are actively collaborating with the different university and institute groups. Some of the collaborative research activities during the period 2022-2023 are the following:

➢ **Structural, morphological, magnetic and optical properties of Jeanbandyite prepared by the co-precipitation method**

Jeanbandyite is one of the rare and unique structured minerals in perovskite family. Jeanbandyite is a hydroxide perovskite having a formula of $(Fe^{3+}_{1-x}, \square_x)$ $(Sn^{4+}_{1-y}, \square_y)$ $(OH)_6$ ($\square$ = vacancy). The novel $FeSnO(OH)_5$ compound is synthesized by a coprecipitation method, and the product has been analysed using different characterization techniques, e.g., X-ray Diffraction, Mössbauer spectroscopy, Raman spectroscopy, Scanning Electron Microscopy, Transmission Electron Microscopy, Scanning Transmission Electron Microscopy, Fourier Transform Infrared spectroscopy, and Vibrating Sample Magnetometer. Magnetic and Mössbauer spectroscopy studies revealed the superparamagnetic property [Abdelhadi El Hachmi, *Materials Today Communications* **34** (2023) 105358.].

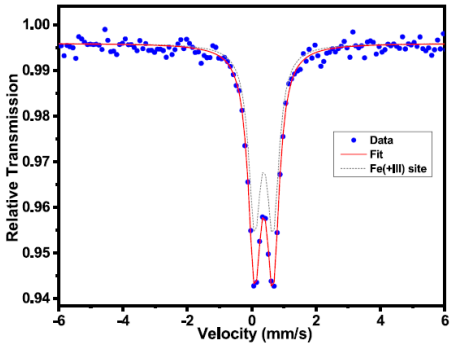


**Fig.2:** *Room Temperature Mössbauer spectrum of Jeanbandyite structure.*


## DR. GOUTAM PRAMANIK

**Scientist - D**

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Synthesis, characterisation and study of nanomaterials for various applications

**Group Members:** (1) Moupriya Mukherjee (PhD student)

**Facilities:** (1) FTIR (2) Raman Spectrometer (3) Steady-state cum Time Resolved Luminescence Spectrometer (4) UV-Vis NIR Spectrophotometer (5) Dynamic Light Scattering (6) Isothermal Calorimetry.

## In-house Research Activity:

Our group works at the interface of synthetic nano-chemistry, material science and biology to understand the role of chemistry on controlling the functionalities of nanomaterials for the applications in bio-imaging, bio-sensing and diagnostics. Our research directions are the following:

➢ **One step rapid edge selective fluorination of graphene oxide:** Currently, one of our research directions is tuning the properties of graphene oxide (GO) by selective edge functionalisation with minimal/no damage to the basal plane. A rapid one-step selective edge fluorination of GO was achieved by chemoselective substitution of the carboxylic acid with fluorine following a decarboxylative fluorination technique using 1-chloromethyl-4-fluoro-1,4-diazoniabicyclo[2.2.2]octane bis(tetrafluoroborate) (SELECTFLUOR) and silver ion catalyst. The structure and composition of FGO was characterized by multiple analytical techniques such as TEM, SEM, XRD, EDS, FTIR, XPS, Raman spectroscopy etc. As observed in XPS and NMR analysis, the decarboxylative fluorination of GO resulted in the formation of covalent C-F bonds at the edge. Most importantly, proton decoupled $^{19}F\{1H\}$ and proton coupled $^{19}F$ NMR spectra of FGO suggest that the fluorine atoms are bonded to the tertiary carbon atom. This simple edge controlled fabrication method provides a facile pathway to fabricate multifunctional GO and expand their potential applications.

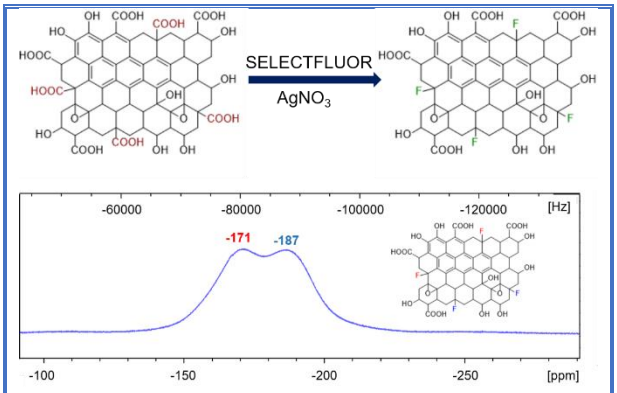



**Fig.1:** *The synthetic scheme for the preparation of FGO from GO. $^{19}F$ NMR spectrum of the FGO.*

**Surface ligand mediated tuning of the optical properties of the metal nanoclusters:** - Metal nanoclusters (MNCs) with the size comparable to the de Broglie wavelength of electrons have attracted attention of researchers during the last decade due to their photoluminescence, good photostability, high emission rates, large Stokes's shift, extremely high surface-to-volume ratio and low toxicity. Due to the ultrasmall size, the ligands used for MNCs preparation influences on their optical properties. Currently, we are studying the effect of surface chemistry on the optical properties of MNCs.

## Collaborative Research Activity:

In addition to in-house research activity, there are several collaborative research projects with various universities are ongoing.

➢ **Fluorosensing of benzaldehydes by CuI-graphene: A spectroscopy, thermodynamics and docking supported phenomenon: -** In this study, the surface of the graphene nanoplatelets were functionalized with CuI nanoparticles for specific and selective detection of harmful volatile organic compounds (VOCs), such as Benzaldehyde and 4-methyl benzaldehyde by fluorescence spectroscopy. CuI-Gr nanoparticles exhibited higher efficiency towards the detection of benzaldehyde derivatives as compared to pristine CuI nanoparticles with detection limit (LOD) 2 ppm and 6 ppm for benzaldehyde and 4-methyl benzaldehyde respectively in aqueous medium. This novel graphene-based sensor was also found to be highly selective for the benzaldehyde derivatives as no changes in signal were detected in presence of other VOCs like formaldehyde and acetaldehyde. [*Ref:- D. Das et al. Analytica Chimica Acta* ***1249*** *(2023) 340897.*]

➢ **Fabrication of a parallel interpenetrating 2D hydrogen-bonded zig-zag Zn(II) coordination polymer: Characterization and band gap study: -** A Zn(II) based coordination polymer (CP) $[Zn_2(cis,cis\text{-}muco)_2(bpe)_2(H_2O)_2]$ (1) ($H_2$cis,cis-muco = cis, cis-muconic acid and bpe = 1,2-bis(4-pyridyl)ethylene) has been synthesized by slow diffusion method at room temperature. The single crystal X-ray diffraction study revealed that compound 1 consists of one-dimensional (1D) zig-zag chain with distorted tetrahedral Zn(II) center. The 1D chain forms two-dimensional (2D) supramolecular architecture by means of ample hydrogen bonding interactions. The semiconducting nature of compound 1 has been confirmed by theoretical and experimental evidences. [*Ref:- K. Rahaman et al. Journal of Molecular Structure,* ***1276.*** *(2023) 134682.*]

➢ **Nucleic acid extraction from complex biofluid using toothpick-actuated over-the-counter medical-grade cotton: -** Nucleic acid amplification technique (NAAT)-assisted detection, such as quantitative real-time polymerase chain reaction (qPCR) require prior purification or extraction of target nucleic acid from the sample of interest since the latter often contains polymerase inhibitors. In this collaborative work, instrument-free nucleic acid extraction methods, utilizing readily available medical-grade cotton, has been developed to extract genomic DNA (gDNA) spiked in 30 %, 45 %, and 60 % serum or cell lysate. The extraction was carried out in a completely instrument-free manner using cotton and a sterilized toothpick and was completed in 30 min (with using chaotropic salt) or 10 min (without using chaotropic salt). The quality and extraction efficiency of the extracted DNA were probed using PCR, agarose gel analysis and qPCR experiments. [Ref:- *S. Kumar et al., Bioorganic & Medicinal Chemistry,* ***73.*** *(2022), 117009.*]

## Lectures Delivered:

- **"*Synthesis, Characterization and Applications of Near Infrared Emitting Nanoparticles*"** at the faculty recharge program organised by Reva University on 30/09/2022.
- **"*Radiation and material Chemistry for bio-medical applications*"** at the seminar organised by IQAC & CWSLS Kalyani University on 17/11/2022


## DR. RAJARSHI RAUT

**Scientist-F**

rajarshi@csr.res.in


Nuclear Structure Studies through In-beam Gamma-ray Spectroscopy, Nuclear Instrumentation and Software Development for Data Reduction/Analysis.

**Group Members:**

(1) Dr. S. S. Ghugre, Centre Director (2) Mr. K. Basu, SA-F (3) Dr. P. K. Giri, RA-I (SERB) (4) Mr. A. Sharma, JRF (Institute)

**Ph.D. Completed:** 3

**Facilities:**

(1) PIXIE-16 digitizer based pulse processing and data acquisition system (2) Single crystal HPGe detector (3) Pulse processing electronics (NIM) (4) Multichannel Analyser (MCA)

## In-house Research Activity

The research activities of the Group primarily include studies on excitations of nuclei, particularly those in the vicinity of the shell closures, through in-beam gamma-ray spectroscopy as well as on the development and/or implementation of hardware and computational tools required in the exercise.

➢ **Nuclear Structure Studies in A~200 Region:** Nuclei around the doubly-magic $^{208}$Pb-core (Z=82, N=126) are of interest in varied contexts, ranging from validation of shell model calculations in (such) heavy systems to observation of isomers and identification of the associated single particle configurations. The excitation scheme of the $^{203}$Po (Z=84, N=119) nucleus has been investigated under this programme, following its population in $^{194}$Pt($^{13}$C,4n) reaction at $E_{lab}$ = 74 MeV. The experiment was carried out at the 15UD Pelletron in IUAC, New Delhi and the setup of the Indian National Gamma Array (INGA) therein was used as the detection system. Twenty five new gamma-ray transitions have been identified in the level structure and the same has been extended upto and excitation energy ~ 5 MeV and spin ~ 18ħ. The observed excitation scheme has been satisfactorily interpreted in the framework of large basis shell model calculations. The results are published in Phys. Rev. C 106, 044329(2022).

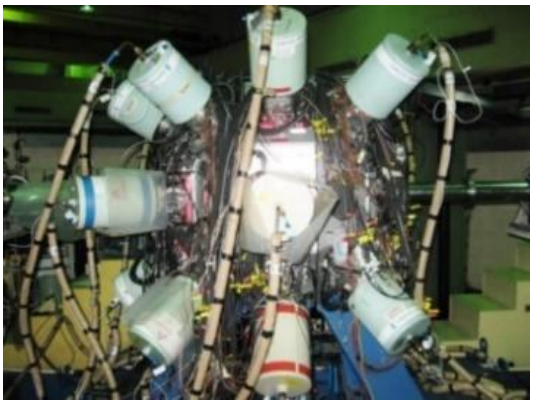


**Fig.1:** *Setup of the Indian National Gamma Array at IUAC, New Delhi.*

➢ **Model Calculations on Alpha-induced Nuclear Reactions:** Many of the radioisotopes for therapeutic and diagnostic applications are typically produced at the particle accelerators using light ion (beam) induced reactions. Modelling these towards faithful representation of the experimental cross sections is expected to facilitate optimization of conditions for producing the relevant isotopes. In a research programme initiated by the Group, cross-sections of several alpha-induced reactions have been calculated in the framework of the TALYS [Koning *et al.*] code that combines a list of models associated with different reaction mechanisms (possibilities). The choice of models and the parameters have been optimized for overlap between the calculated and the experimental cross sections available in literature and databases [www-nds.iaea.org/relnsd/vcharthtml/MEDVchart.html].

Some of the reactions studied in the process are $^{27}Al(\alpha,n)^{30}P$, $^{35}Cl(\alpha,n)^{38}K$, $^{40}Ar(\alpha,p)^{43}K$, $^{50}Cr(\alpha,2n)^{52}Fe$, $^{63}Cu(\alpha,n)^{66}Ga$, $^{65}Cu(\alpha,n)^{68}Ga$, $^{72}Ge(\alpha,3n)^{73}Se$, $^{75}As(\alpha,3n)^{76}Br$, $^{85}Rb(\alpha,3n)^{86}Y$, $^{89}Y(\alpha,3n)^{90}Nb$, $^{108}Cd(\alpha,2n)^{110}Sn$, $^{115}Sn(\alpha,n)^{118}Te$, $^{92}Mo(\alpha,n)^{95}Ru$, $^{144}Sm(\alpha,n)^{147}Gd$, $^{209}Bi(\alpha,2n)^{211}At$, etc. The principal models that were tested in the exercise are that of the alpha optical model potential ($\alpha$-OMP), the preequlibrium (PE) reactions, the gamma strength function (GSF) and the level density (LD). The results have been presented in the DAE Symposium on Nuclear Physics (2022) [sympnp.org/snp2022] and the ARCEBS-2023 [indico.cern.ch/event/1155596]. This work is being carried out under the funding from SERB (DST) through Sanction No. CRG/2021/001011.

## Collaborative Research Activity:

➢ **Spectroscopy of $^{197}$Hg**

Excitation scheme of the $^{197}$Hg (Z=80) nucleus has been probed in an experiment using the digital INGA setup at VECC. The nucleus was populated using the $^{198}Pt(\alpha,5n)$ reaction at $E_{lab}$ = 52 MeV. The data has been processed using the IUCPIX package, developed by our Group, and analysed using RADWARE. The excitation scheme of the nucleus has been considerably extended and satisfacotorily interpreted in the light of shell model calculations. The results have been partially presented at the DAE Symposium on Nuclear Physics (2022) [sympnp.org/snp2022]. This work has been led by a group from Victoria Institution (College) under the CRS scheme.

## Lectures Delivered:

- **"*Talking to an Excited Nucleus*"** at the Department of Physics, Bangabasi College, Kolkata on 9th September, 2022.
- **"*The Digital Highway to Nuclear Spectroscopy*"** at IEMPHYS-22 (Online), IEM, Kolkata on 22nd September, 2022.
- **"*Digital Route to Gamma Spectroscopy*"** at Workshop on Detectors and Allied Instrumentation (Online), IUAC, New Delhi on 24th November, 2022.
- **"*Data in Nuclear Physics Experiments*"** (2 Lectures) at the School on Data Acquisition and Analysis, IUAC, New Delhi on 22nd and 23rd February, 2023.
- Online Lectures on Nuclear Instrumentation for M.Sc. students with specialization in Nuclear Physics at the Department of Physics, SSSIHL, Andhra Pradesh during March-April, 2022.
- Lectures on Nuclear Instrumentation for M.Sc. students of final semester with specialization in Nuclear Physics at the Department of Physics, University of Calcutta, during March-May, 2022.

## Sponsored Project:

SERB (DST) sponsored project "Programme for Measurement of Cross Sections of Alpha-induced Nuclear Reactions of Multidisciplinary Interests using the Activation Technique" under CRG scheme.
Sanctioned amount **Rs. 2654726/-**.

# 3.3 Collaborative Research Schemes

## Mechanochemical synthesis and structure analysis of binary cocrystals of extended bis-pyridyl spacers with resorcinol and orcinol (CRS/2021-22/02/504)

Dr. Goutam Kumar Kole, SRM Institute of Science and Technology, Tamil Nadu, India

**Mechanochemical synthesis and structure analysis of binary cocrystals of extended bis-pyridyl spacers with resorcinol and orcinol: -** Mechanochemical solid state synthesis has become one of the popular green methods over the decade for synthesising crystalline materials in crystal engineering. Such process requires only grinding the components in the desired ratio in a mortar with a pestle, and often does not require a solvent, or just a drop of solvent for liquid assisted grinding or kneading. Such solvent-less mechanochemical grinding route is very important in green-synthesis, for it does not use any or minimizes the use of hazardous solvents. Binary cocrystals of 1,4-bis(4′-pyridyl)-2,3-diaza-1,3-butadiene (4,4′-bpdb, L1) and 1,4-bis(3′-pyridyl)-2,3-diaza-1,3-butadiene (3,3′-bpdb, L2) in combination with two templates, resorcinol (T1) and orcinol (T2) were synthesized by mechanochemical dry grinding. Their structures were elucidated by single crystal X-ray crystallography, powder X-ray diffraction (PXRD) and characterized by other spectroscopies, such as optical, nuclear magnetic resonance, and FTIR spectroscopy. Expected 2:2 cocrystals were obtained, except for the combination of L2 and T1, crystals of 2L2:T1 cocrystal was obtained via solution crystallization. **Reference:** [*B. Kubendiran et al., Journal of Molecular Structure, **1274**, 134470 (2023)*]

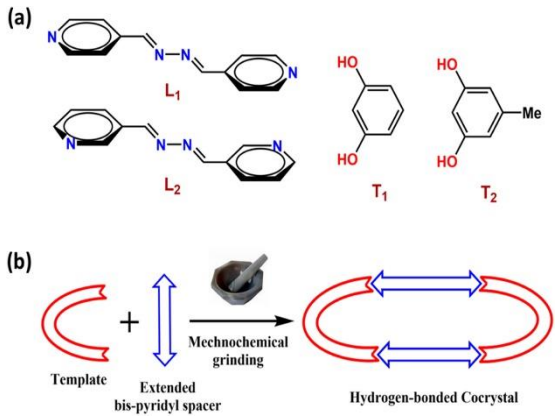



**Fig.1:** *(a) Structures of the bis-pyridyl spacers (L1 and L2) and templates (T1 and T2) used in this study, (b) schematic description of synthesising binary cocrystals by mechanochemical grinding.*

## Exploration of Cl···Cl and π···π stacking contacts along with the conductivity properties of a Cu-MOF featured with paddle-wheel SBUs (CRS/2021-22/02/538)

Dr. Mohammad Hedayetullah Mir, Aliah University, Kolkata, India, India

A Cu(II)-based metal–organic framework (MOF) [Cu(muco)(3,5-DCP)]n (1) has been synthesized by using linear rigid aliphatic dicarboxylic acid, trans, trans-muconic acid ($H_2$muco) and 3,5-dichloropyridine (3,5-DCP) as an auxiliary ligand. The MOF adopts a square-grid two-dimensional (2D) structure with paddle-wheel [$Cu_2(OOC)_4$] robust secondary building units (SBUs). The 3,5-DCP ligands are perpendicularly projected from the SBUs at both sides and undergo interdigitation via antiparallel π···π stacking interactions among 3,5-DCP ligands to fabricate three-dimensional (3D) supramolecular architecture. The π···π interactions favour the formation of Cl···Cl stacking contacts. These non-covalent interactions are further validated by density functional theory (DFT) calculation. In addition, the synthesized MOF is tested for conductivity measurements via current density–voltage characteristics, as well as impedance spectroscopy, which reveal that the MOF is semiconducting in nature and can be used as a Schottky diode. **Reference:** [*S. Naaz et al. CrystEngComm **25.** (2023) 813.*]

## Structural, morphological, magnetic and optical properties of Jeanbandyite prepared by the co-precipitation method

Dr. Goutam Biswas, Cooch Behar Panchanan Barma University

Jeanbandyite is one of the rare and unique structured minerals in the perovskite family. Jeanbandyite is a hydroxide perovskite having a formula of $(Fe^{3+}_{1-x}, \square_x)$ $(Sn^{4+}_{1-y}, \square_y)$ $(OH)_6$ ($\square$ = vacancy). Herein we report for first time the synthesis of jeanbandyite with superparamagnetic properties. The novel $FeSnO(OH)_5$ compound is synthesized by a coprecipitation method, and the product has been analyzed using different characterization techniques, e.g., X-ray Diffraction (XRD), Mössbauer spectroscopy, Raman spectroscopy, Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Scanning Transmission Electron Microscopy (STEM), Energy-Dispersive X-ray spectroscopy (EDS), Fourier Transform Infrared spectroscopy (FT-IR), and Vibrating Sample Magnetometer (VSM). The optical property (band gap) was measured using the UV-Vis spectroscopy. The characterization technique confirms the synthesis of the jeanbandyite, and the VSM study further reveals the superparamagnetic property. The band gap was found to be 2.85 eV, which indicates that this compound can be an effective photocatalyst in the near future. [*Abdelhadi El Hachmi et al., Materials Today Communications* ***34*** *(2023) 105358.*]

## Spin reorientation behavior and enhanced multiferroic properties of co-doped $YFeO_3$ towards a monophasic multiferroic ceramic $Co_{0.05}Y_{0.95}Fe_{0.95}Ti_{0.05}O_3$

Pabitra Kumar Chakraborty, Burdwan University

Monophasic nanocrystalline lead-free relaxor ferroelectric samples of $YFeO_3$ and $Co_{0.05}Y_{0.95}Fe_{0.95}Ti_{0.05}O_3$ were prepared via the standard sol-gel synthesis method. The influence of Co and Ti co-doping on the structural, dielectric, ferroelectric, and magnetic properties were investigated using X-ray, Neutron Diffraction, Electric Polarisation, and magnetization measurement techniques. The structural analysis by the Rietveld method revealed an orthorhombic (Pnma) distorted perovskite structure. The analysis of the neutron diffraction data showed a spin reorientation from IR Γ4 to Γ2 in the doped sample. The universal dielectric response (UDR) phenomenon was used to explain the dielectric behavior. The temperature-dependent dielectric constant measurement shows a shift in the ferroelectric to paraelectric phase in $Co_{0.05}Y_{0.95}Fe_{0.95}Ti_{0.05}O_3$. The observed P-E loops indicate lossy ferroelectric nature for YFO and CYFTO. Enhancement in the value of saturation magnetization at room temperature was observed on co-doping. Furthermore, the presence of magnetodielectric coupling was established for the co-doped sample. Co-doping with Co and Ti in YFeO3 enhanced the multiferroic properties of the pristine sample which may be helpful for future device applicability. [*S. Das et al. Advanced Powder Technology* ***33*** *(2022) 103622*]

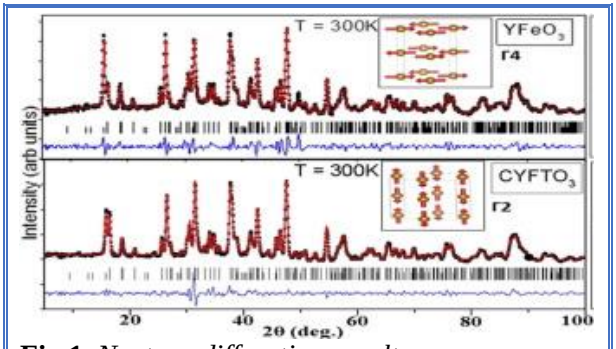



**Fig.1** *Neutron diffraction results.*

## Environmentally Relevant Hexavalent Chromium Disrupts Elemental Homeostasis and Induces Apoptosis in Zebrafish Liver

Ansuman Chattopadhyay, Visva-Bharati, Santiniketan

Although hexavalent chromium Cr [VI] is known as a toxicant in the aquatic environment, its effect in low, environmentally relevant concentration (ERC; 2 mg $L^{-1}$) is less characterized. Against this backdrop, the effects of Cr [VI] in ERC on zebrafish liver has been investigated in this study. Fluorescence microscopy and gel electrophoresis detected excess DNA damage and cell death via apoptosis in 2 mg $L^{-1}$ Cr [VI]-treated fish when compared with that of control. Besides, there were transcriptional activations of *p53*, *Bax*, *Caspase 9* and *Caspase 3* genes but down regulation of *Bcl2* gene in the treated group, confirming the apoptotic pathway. Energy dispersive X-ray fluorescence (EDXRF) data showed significant ($p < 0.05$) increase in hepatic content of Cr, selenium, iron, manganese, calcium, sulfur and magnesium but depletion of zinc, copper and cobalt in the treated group. Collectively, the study shows that even a low, ERC of Cr [VI] is toxic to the zebrafish as it elicited marked apoptosis in the hepatocytes and altered the liver elemental profile. *[Pallab Shaw et al. Bull Environ Contam Toxicol.* ***108*** *(2022) 716]*

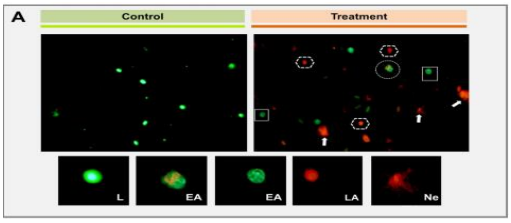



**Fig.A** *Fluorescence microscopic examination of hepatocytes. A. AO/EtBr dual staining revealed cells in both early (EA; cells within dotted circles and rectangles) and late apoptosis (LA; cells within dotted hexagons). Evidences of necrotic cells too (Ne; white arrow).*

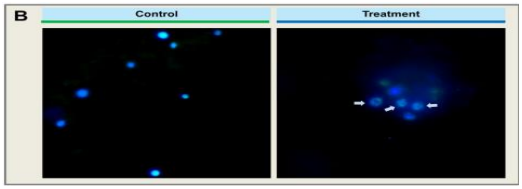



**Fig.B** *Hoechst staining revealed occurrence of hepatocytes with fragmented nucleus (white arrow)*

## Effects of vanadium doping on the charge ordering and low-temperature spin-glass phase in $Pr_{0.45}Ca_{0.55}MnO_3$

Sudipta Pal; Kalyani University

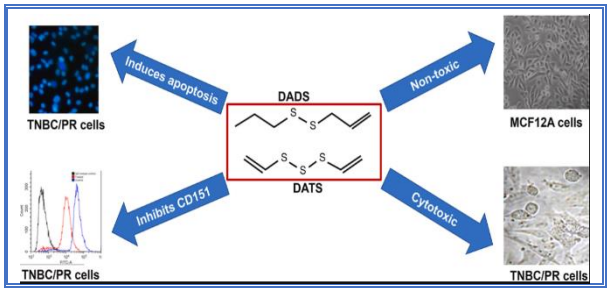
We report structural, magnetic, and dielectric properties of the $Pr_{0.45}Ca_{0.55}Mn_{1-x}V_xO_3$ ($x$ = 0.05 and 0.1) polycrystalline compounds, prepared by solid state reaction method. *Pnma* space group and orthorhombic crystal structure of the compounds are confirmed by the Rietveld refinement of X-ray diffraction data. Magnetic study reveals a multiple-phase-separated metastable magnetic behavior with charge ordered phase followed by a spin-glass state at the low-temperature region. For a single change of vanadium content from $x$ = 0.05–0.1, the charge ordering temperature decreases from 245 K to 239 K, the antiferromagnetic ordering temperature decreases from 131 K to 127 K, and the ferromagnetic cluster-glass ordering temperature increases from 41 K to 44 K. This indicates the weakening of charge ordering strength and development of ferromagnetic components in the antiferromagnetic background, which is also confirmed by isothermal hysteresis. Colossal dielectric constant is observed in both samples. In the measured temperature range, an implication of a ferroelectric phase transition around 253 K is observed in $Pr_{0.45}Ca_{0.55}Mn_{0.90}V_{0.10}O_3$ compound. The calculated results indicate that the low-temperature relaxation follows variable range hopping behavior, whereas the high-temperature one takes place according to the Arrhenius model. The fitting parameters ascribe the low-temperature relaxation process to the hopping of polaron charge

carriers at localized sites, whereas the high-temperature relaxation is related to Maxwell-Wagner relaxation, caused by blocking of charge carriers at grain boundaries. *[M. Debnath et al. Journal of Alloys and Compounds* ***921*** *(2022) 166048]*

## Insight into drug sensitizing effect of diallyl disulfide and diallyl trisulfide from Allium sativum L. on paclitaxel-resistant triple-negative breast cancer cells

Rama Rao Malla, GITAM (Deemed to be University)

This study estimates the non-toxic concentration of Diallyl disulfide (DADS) and diallyl trisulfide (DATS) against normal healthy breast epithelial cell line (MCF-12A) by using a trypan blue viability assay. Also, it evaluates the effect of DADS and DATS on the sensitization of established stable TNBC/PR cell clones (MDA-MB 231 PR and MDA-MB 468 PR) by MTT, BrdU incorporation, intracellular ROS, cell cycle, and apoptosis assays. The results show that DADS and DATS are non-cytotoxicity against MCF-12A cells. Nevertheless, DADS and DATS have shown significantly high cytotoxicity against MDA-MB 231 PR and MDA-MB 468 PR cells. They also inhibited PTX-resistant cell proliferation by blocking the cell cycle. Further, they induced apoptosis by activation of caspase 3 and 9. N-acetyl cysteine pre-treatment inhibited DADS and DATS-induced intracellular ROS release. *In silico* study shows that DADS and DATS




interact with a large extracellular loop (LEL) of CD151 with a binding energy of −4.0 kcal/mol and transmembrane domain (TM) with a binding affinity of 11.7 and 13.6 kcal/mol, respectively. They also inhibited the surface expression of CD151 in TNBC/PR cells. This study implies that DADS and DATS could be considered for sensitizing drug-resistant breast cancers. [*R.Marni et al. Journal of Ethnopharmacology*, ***296*** *(2022) 115452*]

## Strong modulation effects on magnetoelectric behavior of Co-ferrite nanoparticles incorporated in ZnO medium in nano-regime synthesized in chemical routes

Pabitra Kumar Chakraborty, Burdwan University

The dielectric and piezoelectric host of ZnO nanoparticles was chosen for the incorporation of ferrimagnetic and magnetostrictive $CoFe_2O_4$ (CFO) nanoparticles to achieve magnetic and electric orderings simultaneously, under coupled conditions. Two composite samples of CFO@ZnO including the bare one, for comparison, were synthesized under different chemical reaction conditions to observe the influence of particle size on the different magneto-electric properties. The modified synthesis routes were considered due to which modified magnetoelectric behaviors were found in the samples. The particle size plays an important role in the different physical properties. Rietveld analyses of the recorded XRD patterns of all samples confirmed pure phase formation and also provide various structural information to understand the magnetoelectric behavior of these samples. Particle size obtained from this for CFO@ZnO-1 is ~ 20 nm and for CFO@ZnO-2 is ~ 10.9 nm. This size difference is also reflected in the observed FESEM and TEM micrographs. The EDAX spectra and mapping confirm the absence of impurity elements and the uniform distribution of constituent phases of composites. The dielectric properties of ZnO are substantially modified by the presence of CFO nanoparticles in each composite sample and this also depends on the size of the nanoparticles. Dielectric spectroscopy studied in the temperature range 300–425 K, provides detailed

electrical properties of both composites. Both composites show enhanced dielectric constant with a very low dielectric loss along with strong magnetic properties. Magnetic investigations were performed on all samples with a maximum applied field of 3 T at different temperatures ranges with a minimum value of 10 K to a maximum value of 850 K. Ferrimagnetic behavior and Curie temperature were observed in case of CFO and CFO@ZnO-1 and presence of superparamagnetism was detected in CFO@ZnO-2. Presence of ferroelectricity was observed in composites at 300 K and 273 K. Coupling between magnetic and electric orderings generated due to magnetostriction of CFO and piezoelectricity of ZnO together with crystallographic strain originated from structural mismatch of these components. This magnetoelectric coupling was investigated through magnetocapacitance measurements, which show a high value of magnetocapacitance (~ 10%) indicating the presence of good magnetoelectric coupling. Thus, the present composite having good magnetoelectric coupling may be interesting in the family of multiferroics. [*S. Sadhukhan et al., Applied Physics A* ***129*** *(2023) 68*].

## Redox status and metabolomic profiling of thioredoxin reductase inhibitors and 4 kGy ionizing radiation-exposed *Deinococcus radiodurans*

N. Rajendra Prasad, Department of Biochemistry and Biotechnology, Annamalai University

The gram-positive bacterium *Deinococcus radiodurans* can survive under extreme ionizing radiation environment. This study aims to rationalize the role of redox balance, antioxidant status, and metabolite content on the radiation survival of *D. radiodurans*. It is found that the TrxR inhibitors, i.e., ebselen, auranofin, and epigallocatechin gallate (EGCG) (10 µM) treatment affects the radiation survival of *D. radiodurans*. The TrxR inhibitors treatment affects the redox status, activities of antioxidant enzymes, increases the intracellular ROS levels and protein carbonylation upon 4 kGy ionizing radiation treatments. Moreover, the alteration in cellular redox status affects the metabolites content of the organism. In addition, we noticed differential metabolomic profiles in sham control, radiation control (4 kGy), and TrxR inhibitors plus radiation-treated *D. radiodurans*. The TrxR inhibitors plus radiation treated groups exhibit more variation compare to sham control and 4 kGy radiation-exposed *D. radiodurans*. Further, some novel metabolites can possess the high antioxidant property and involved in vital cellular metabolism were found in sham control and radiation treated cells of *D. radiodurans*. Thus, the results illustrate the role of intracellular redox status in the survival and metabolomic profile of *D. radiodurans*. [*Sudharsan M et al. Microbiol,Res.****261*** *(2022)127070*]

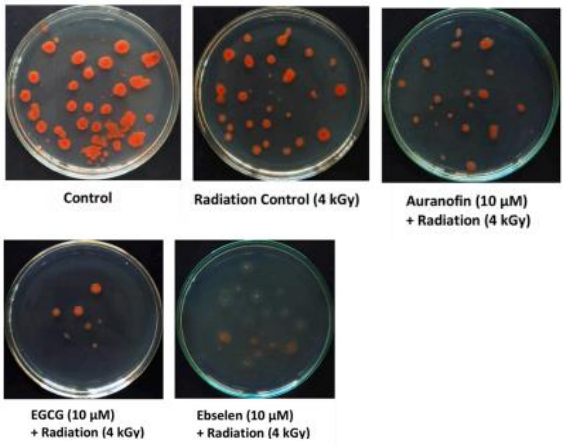



**Fig.1** *Effect of TrxR inhibitors pre-treatment on radiation survival. Survival of TrxR inhibitors pretreated and 4 kGy radiation treated D. radiodurans on TGY agar plate.*

# Research Activity at Mumbai Centre

**DR. P.D. BABU**

**Centre Director, Mumbai Centre**

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Mumbai Centre has been instrumental in the promotion and use of neutron scattering facilities at BARC by the university research community in the country. In this regard, Mumbai Centre has also designed, developed and installed a Tandem Neutron Beamline with high resolution powder diffractometer with low temperatures (down to 1.6 K) and magnetic fields up to 70 kOe can be applied at any temperature in the range of 1.6K to 300K. Over the years 350 Collaborative Research Schemes (CRS) utilizing neutron have been completed.

With the success of above neutron scattering program BARC has now opened up many newer facilities for utilization by university researchers. These are (a), Pelletron-LINAC facility at TIFR for nuclear research (b) Folded Tandem Ion Accelerator (FOTIA) and LEHIPA facilities for ion beam studies (c) Neutron irradiation facilities utilizing research reactors (d0 Nuclear and radio-analytical (NAA, IBA, XRF) and spectroscopy facilities for chemical characterization and Positron Annihilation Spectroscopy (e) Chemical Characterization and Material Science facilities for microstructural and surface investigations using TEM, SEM, EPMA, ESCA, 3DAP, (f) Electron beam Accelerators, Pulsed neutron source and Pulsed electromagnetic systems and high impact (Ballistic) studies.

During this year 56 new CRS have sanctioned at beginning of April 2022. In addition to these there were 24 ongoing CRS which were in third year. These CSR in general performed well and resulted in good no. publications in internationally reputed journals. Following a fresh call for CRS proposals combined for all centres Mumbai Centre received 57 CRS proposals have been received. These were evaluated by the user committee and 31 CRS proposal were accepted out which 9 were with JRF.

During this year, a total of 10 Ph.D. students joined Mumbai Centre. Eight of them are from S.P. Pune university through PET exam and remaining two are through JEST exam. First eight students have joined around April -May 2022 and other two have joined around August 2022. Out of 10 students 8 are female students. These students are doing Ph.D course work offered at Mumbai Centre and also started their research

Mumbai Centre together with Solid State Physics division of BARC organized 19$^{th}$ School on Neutrons as probes of Condensed matter" during Nov. 14 to 19, 2022 held at BARC. This is the first workshop held in physical mode after lockdown and is well attended. Detailed report is in subsequent sections.

During this year large number university users have utilized Mumbai Centre's facilities. Apart from regular universities and colleges, there were users from reputed institutions such I.I.Sc, IOP Bhubaneswar, CSIR labs and I.I.Ts, not only neutron scattering but also other laboratory facilities such as physical property measurements. There are 75 publications in reputed international journals from Mumbai Centre, which is very good number.

During this year one of the Centre's scientist Dr. Ghosh has been transferred to Kolkata Centre and one new scientist Dr. Sumanta Chattopadhya has joined the Centre

.


## DR. P.D. BABU

**Centre Director**

pdbabu@csr.res.in


Magnetic, Electrical and thermal properties of alloys and novel functional materials, Neutron diffraction and scattering

**Group Members:** **Ph.D. Students:** (1) Ms. Bhagyashree Pol and (2) Mayuri Kamble (3) Ms. Anu

**Ph.D. Completed:** 1.

**Facilities:**

(1) Neutron Diffractometer, (2) 9T PPMS based Magnetometer, ac susceptibility, (3) 14T DynaCool PPMS based Heat Capacity electrical thermal properties.

## In-house Research Activity

Our group is involved in the study of magneto-structural properties using neutron diffraction, and magnetic, electrical and thermal transport properties of various rare-earth and transition metal based intermetallics and multifunctional materials. experiments.

➢ **Spin semimetal with spin-valve behaviour at RT in FeRhCrSi**

Spin semimetals are new class of spintronic materials with a band gap in one spin channel and a a semimetallic character other spin channel and provides opportunity for tunable spin transport. FeRhCrSi is shown to exhibit such a behaviour. it shows a weakly temperature-dependent electrical resistivity with a negative temperature coefficient, indicating normal semimetal or spin semimetal behavior. Anomalous magnetoresistance data reveal the dominant contribution from the asymmetric part, a clear signature of the spin-valve nature, which is retained even at room temperature. The asymmetric part of the magnetoresistance shows an unusual increase with increasing temperature. Hall measurements confirm the anomalous nature of the conductivity originating from the intrinsic Berry curvature, with holes being the majority carriers. Abinitio simulation confirms a unique long-range ferrimagnetic ordering to be the ground state, High entropy alloys (HEA) are expected to show unusual superconducting behaviour due to chemical disorder along with highly distorted lattice. Equiatomic single phase nearly disordered Critical explaining the origin behind the unexpected low saturation moment. The ferrimagnetic disordered structure confirms the spin semimetallic feature of FeRhCrSi, as observed experimentally [*Y Venkateswara et al. Phys. Rev. B* ***107, L****100401 (2023)*]

➢ **Successive magnetic transitions with large refrigerant capacity of Fe doped $Mn_3Sn_2$**

The magneto-caloric effect and critical behavior in arc melted $Mn_{3-x}Fe_xSn_2$ ($x$ = 0.3, 0.7) alloys were investigated. These alloys show two successive magnetic transitions at $T_{C1} \approx 254$ K (261 K) and $T_{C2} \approx 205$ K (185 K), respectively for $x$ = 0.3 (0.7).

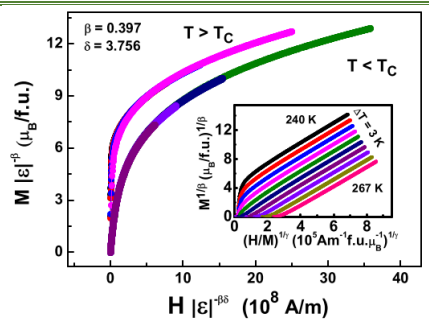



***Fig.1*** *plot of scaling equation of state, inset shows the modified Arrot plot for* $Mn_{2.7}Fe_{0.3}Sn_2$

behaviour analyses around paramagnetic–ferromagnetic transition at $T_{C1}$ reveals the critical exponent, $\beta$ = 0.397 (0.378) with long-range of magnetic interactions for $x$ = 0.3 (0.7). Importantly,

the magneto-caloric study for $x$ = 0.3 (0.7) gives large refrigerant capacity (RC) of 330 (250) J/kg at 5 T applied magnetic field. The large RC value and two successive magnetic transitions makes these earth abundant-based $Mn_{3-x}Fe_xSn_2$ alloys highly promising for magnetic refrigeration in a wide temperature span.

[*Sonam Parween et al. J. Magn. Magn. Mater.* ***541, 168466 (2022)]***

## Collaborative Research Activity:

- **Neutron diffraction and ab initio studies on the fully compensated ferrimagnetic $Mn_2V_{1-x}Co_xGa$ Heusler alloys:**

Neutron diffraction and ab initio studies were carried out on $Mn_2V_{1-x}Co_xGa$ Heusler alloys which exhibits high $T_C$ fully compensated ferrimagnetic characteristics for x = 0.5. A combined analysis of neutron diffraction and ab initio calculations revealed the crystal structure and magnetic configuration which could not be determined from the x-ray diffraction and magnetic measurements. Rietveld refinement of neutron diffraction data confirmed L21 structure for x = 0 and Xa structure for x = 1. The alloys with x = 0.25 and 0.5 possess L21 structure with Mn(C)–Co disorder. As the Co concentration reaches 0.75, a structural transition has been observed from disordered L21 to disordered Xa. Detailed ab initio studies also confirmed this structural transition. The disordered L21 structure with antiparallel coupling between the ferromagnetically aligned magnetic moments of (Mn(A)–Mn(C)) and (V–Co) atom pairs is mainly responsible for the compensation in these systems, which is different from the origin of moment compensation previously reported (MnCo)VGa. [*P.V. Midhunlal et al, J. Phys. Condens. Matter* ***35****, 125801 (2022)]*

## Lectures Delivered:

- **"Probing magnetism through *Neutron Diffraction*"** at nation conf. on "Frontiers in Physics" at Univ. of Hyderabad, during Marc 3-4, 2023.
- **"Complex magnetism in some rare-earth intermetallic compounds**" at Int. Conf. on Emerging technologies and material science held at Medicaps Univ. Indore during July 12-14, 2022
- **"Utilization of Neutron Scattering Facilities at BARC by Indian Universities and Institutes"** at a Conf. on Research Reactor Utilization held during May 6-7, 2022 at BARC.


## DR. SUMANTA CHATTOPADHYAY

**Scientist-D**

sumantac@barc.gov.in


Quantum Materials; Neutron and X ray diffraction; Extremely condition magnetometry

**Group Members:**

**Ph.D. Ongoing:**

**Facilities:**

## In-house Research Activity:

➢ **Study of exotic magnetism in frustrated quantum magnets**

Quantum magnetic systems such as pyrochlores, Kitaev spin systems etc. show diverse exotic magnetic behaviours in presence of magnetic frustration. Such magnetic states include quantum spin liquid, spin ice, fractional magnetisation plateau etc. We aim to study such systems through various thermodynamic and scattering techniques to unfold their unconventional spin states.

➢ **Spin-charge-lattice coupling in spin induced multiferroic systems**

Multiferroic systems where ferroelectricity is induced through magnetic ordering are very interesting from both fundamental and applied perspectives. Using the combination of magnetometry, dielectric spectroscopy, X-ray and neutron diffraction techniques, we aim to examine the details of spin-charge-lattice coupling present in these materials and its role to stabilise diverse magnetoelectric properties.

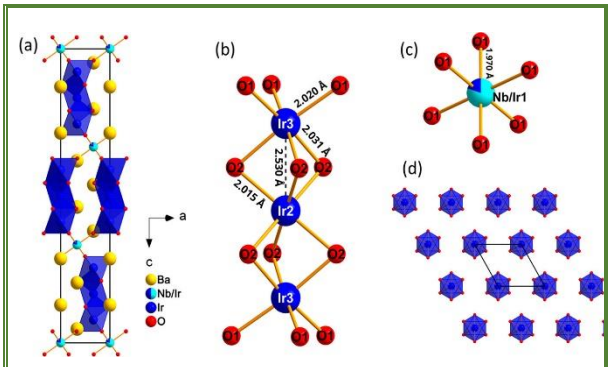



**Fig.1:***Crystal structure of quantum spin liquid candidate* $BaNb_{0.8}Ir_{3.2}O_{12}$

## Lectures Delivered:

- ***"Spin-charge-lattice coupling in Cairo pentagonal RMn2O5 (R = Lanthanides, Bi, Y) multiferroics."*** at DAE-SSPS 2022, BIT Mesra, Ranchi, India on 21 December, 2022.


## DR. S. K. DESHPANDE

**Scientist H**

skdesh@csr.res.in


Dielectric Spectroscopy

**Group Members:** (1) Dr. J. V. Joshi (JE-F) (2) Mr. Nitin Kumar (Ph.D. student)

**Ph.D. Completed:** 0

**Facilities:** (1) Broadband Dielectric Spectrometer

## In-house Research Activity:

➢ **Role of annealing conditions in tuning the dielectric properties of rare-earth double perovskite**

The crystal structure and electrical properties of two types of $A^{I}M^{III}(PO_3)_4$ metaphosphates, namely $LiCe(PO_3)_4$ and $LiPr(PO_3)_4$ (monoclinic, C2/c), and $NaCe(PO_3)_4$ (monoclinic, P21/n) were studied. Impedance spectroscopy revealed that the dc-conductivity of all compounds increases with temperature and is attributed mainly to the alkali metal ion diffusion. All compounds show a discontinuity in the temperature dependent dc conductivity plots at higher temperature, with an increase in activation energy above about 973K. The analysis of ac-conductivity and modulus spectra indicated a correlated movement of ions in the structure. It is observed that the structure and electrical properties of these metaphosphates are dependent more on the nature and ionic radii of the alkali ions than on that of the rare-earth ions.

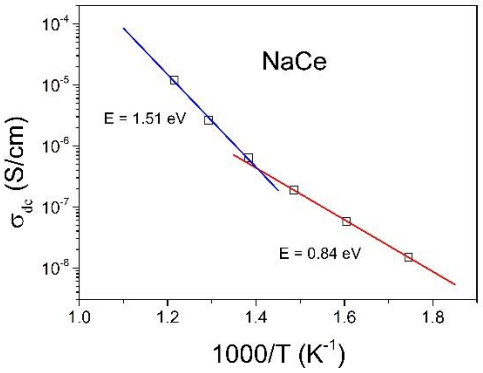



**Fig.1:** *Variation of DC conductivity with inverse of temperature for $NaCe(PO_3)_4$*


## DR. S. D. KAUSHIK

**Engg -F**

sdkaushik@csr.res.in


Research Area/expertise: Strongly Correlated Electron Systems, Study of Crystal and Magnetic structure of magnetic materials by neutron diffraction

**Group Members:** (1) Mr. B. Mendole (SA-F), (2) Mr. M. Imran (JE-F) (3) Mrs. R. Athira (PhD student) (4) Ms. Pragati Pheswani (PhD student) (5) Mr. Akshay S. Kamble (PhD student)

**Ph.D. Completed:** 3 (On going)

**Facilities:** (1) Neutron Powder diffractometer with temperature and magnetic field variation (2) Material synthesis by solid state and are melting

## In-house Research Activity:

Our research group aims to understand the microscopic origin of the physical properties by understanding the crystal and magnetic structure of the magnetic materials.

➢ **Structural and magnetic properties of $Pr_3Ni_2NbO_9$ double perovskite**

We report a formation of $Pr_3Ni_2NbO_9$ double perovskite compound by solid state reaction method, which has not been reported so far in the literature. To unveil the property of this compound, we have systematically examined this for structural and magnetic characterisation. X-Ray Diffraction (XRD) pattern was recorded using a benchtop X-ray diffractometer (D2 Phaser, M/s. Bruker, Germany). The wavelength of copper $K_\alpha$ ($\lambda$=1.5406 Å) was used for the collection of XRD pattern. The XRD data was collected over a 2θ range of $20^0$ - $80^0$.

In order to ascertain the phase formation, the neutron diffraction study at room temperature was also performed by employing the neutron diffractometer (PD-3) at Dhruva. The neutron beam of wavelength 1.48 Å was used for ND experiment. The structural refinements of XRD as well as neutron diffraction were performed using the FULLPROF suite. The temperature dependent zero field cool and field cool (ZFC-FC) study was carried out with a measuring magnetic field of 50 Oe in the temperature range of 3 K to 325 K. The magnetic field dependent magnetization was also

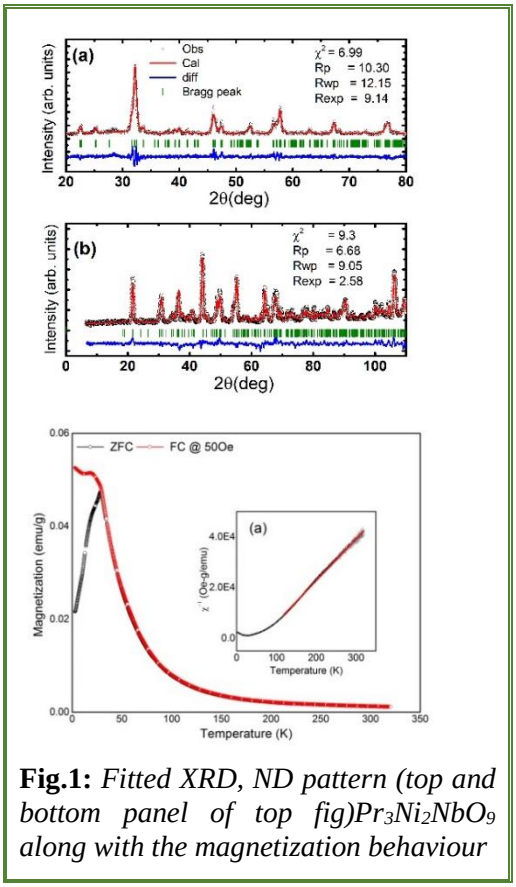



**Fig.1:** *Fitted XRD, ND pattern (top and bottom panel of top fig)$Pr_3Ni_2NbO_9$ along with the magnetization behaviour*

recorded at 5 K and 300 K to further elucidate the magnetism in more details. The temperature dependent neutron diffraction is underway to elucidate the magnetic structure more carefully in this novel compound. **Reference:** [*R. Athira, J. Saha, S. D. Kaushik, Presented in 66th DAE-SSPS ]*

➢ **Temperature dependent crystal structure of $Nd_2CuTiO_6$**

Herein we report the crystal structure and crystal chemistry of orthorhombic perovskite type $Nd_2CuTiO_6$ in between 2K and 290 K as observed from the *in situ* temperature dependent powder neutron diffraction (PND) studies. It is observed that the cations in octahedral sites are statistically occupied, and the ambient temperature orthorhombic structure is retained throughout the temperature range of the study. Absence of any long-range magnetic ordering down to 2 K is confirmed from both low temperature PND and magnetization studies. The lattice shows strong anisotropic thermal expansion with increasing temperature, viz. almost no or feeble negative expansion along a-axis while appreciably larger expansion along the other two axes ($\alpha_b = 10.6 \times 10^{-6}$ $K^{-1}$ and $\alpha_c = 9.8 \times 10^{-6}$ $K^{-1}$). A systematic change in the rotation of octahedral units with temperature was observed in the studied temperature range while the expansion of unit cell is predominantly associated with the polyhedral units around the $Nd^{3+}$. The temperature dependent relative change in unit cell parameters as well as coefficients of axial ermal expansion show anomalous behavior at lower temperature, and that seems to be related to the electronic contributions to lattice expansion.

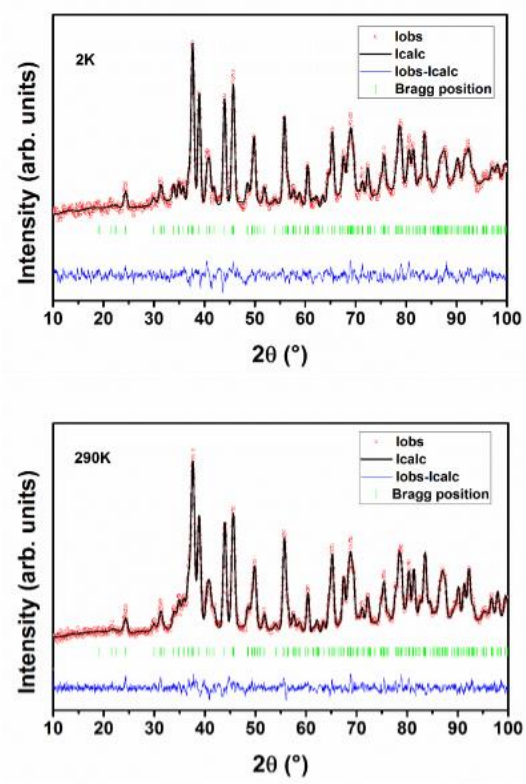



**Fig.2:** *Rietveld fitted ND pattern of $Nd_2CuTiO_6$ at 2 K and 290 K*

**Reference:** [*N. Kumar, S. D. Kaushik, et. al. Crystal 13, 503 (2023)*]

## Lectures Delivered:

**"*Neutron as tool for material characterizations*"** Speaker (online) Course on "Material Characterization" organized by Dept of Physics, Univ. Kalyani on Mar 2022.

**"*Neutron diffraction and other research facilities at Mumbai centre Exploring*** AWARENESS MEETING OF UGC-DAE CSR Organized by CSR Mumbai, Aug , 2022.

**"*Chemical structure by neutron diffraction*"**

**"*Study of magnetic structure and tutorials on neutron diffraction data analysis"*** invited lecture in XIX NPCM held during Nov 2022

**"*Role of Neutron Diffraction in Pursuit of Multifunctional Material"*** lecture delivered in SSPD seminar series at BARC Mumbai held during 20 Feb 2023

**Sponsored Project:** SERB CRG Scheme ,"***Microscopic origin of spatial inversion symmetry breaking and ferroelectricity in $R_2MnMO_6$ (R:Y, Lu, Tb, M:Co, Ni) couble perovskites***"Sanctioned amount: Approx Rs. 35,50,000/-


## DR. SUDIP MUKHERJEE

**Scientist-F**

sudipm@csr.res.in


Surface Nanomagnet/Molecular magnetism; Strongly correlated systems; Effects of spin fluctuations and magnetic ordering on the dielectric properties of materials at nano sale and disordered systems; magnetic resonance spectroscopy

**Group Members:** (1) Mr. Manoj Kumar Verma (JE -F) (2) Mr. P. Deshmukh (PhD student), (3) Ms. S. Kashyap (PhD student), (4) Ms. Swastika Mukherjee

**Ph.D. Ongoing:** 3 nos.

**Facilities:** (1) Laser assisted electric transport and dielectric spectroscopy

## In-house Research Activity:

The major focus of our work is the experimental Condensed Matter Physics of novel magnetic properties and field/temperature dependent dielectric spectroscopy of transition and rare-earth-based compounds (bulk/nano) with various experimental techniques such as magnetization study, transport measurement, neutron powder diffraction, magnetic resonance spectroscopy etc. Recently, we focus our research on Photo-excitation (optically assisted charge transfer) where cross coupling of multiple functionalities like ferroelectric (P), ferromagnetic (M), and ferroelastic (ε) interplay between magnetoelectric and photovoltaic properties (magnetophotovoltaic effect)

- **Multifunctional magnetoelectric materials: Photoferroics Revisited**

The ferroelectric-photovoltaic effect refers to generation of a steady photovoltaic response (photocurrent or photovoltage) along the polarization direction in a ferroelectric material without central symmetry. This phenomenon is distinctly different from the conventional photovoltaic effect in the semiconductor p–n junction, where an internal built-in electric field at the interface of two doped semiconductors separates photo-generated charge carriers. Harvesting solar energy from multiferroics is still a new field of research due to the coexistence in their phases of ferroelectricity and magnetic order with low band gap which has got considerable attention in the recent years. Moreover, photo-excitation (optically assisted charge transfer), accompanied by the reversal of the spin direction of an electron of a magnetic system can strongly disturb the equilibrium between the mobile carriers (holes), localized spins and the lattice. This leads to an increase in spin concentration, causing the magnetic transition. The photo-induced effect triggers a variety of dynamical processes whose characteristic time scales and strengths can be investigated. The magnetization reversal dynamics in various magnetic materials, specially 'multi-ferroics', attracts a significant attention because it is directly related to the speed of data storage in the magnetic recording.

- **Strain mediated magnetoelectric response in self-assembled nanocomposite systems and heterostructure**

The mechanical constraint arising from the film on substrate, and the good bonding between the two phases in the nanostructured composite films can significantly affect the ME coupling. However, in nanoscopic magnetostrictive/piezoelectric multilayers the magnetoelectric coupling is small due to the clamping effect of the substrate. Self-assembled nanostructures are believed to have good interactions between the two constituent phases,

thus enhancing the ME effect. However, the formation, controlled growth and reproducibility of self-assembled vertical desired ME nanostructures is a difficult problem. An alternative approach is to produce granular-type nanostructures where the magnetostrictive grains are dispersed inside the piezoelectric matrix. Magnetostrictive-piezoelectric composites of this type were prepared using sol-gel. The ME effect and phase separation of the different phases (magnetic and ferroelectric properties) in the composite system was verified with magnetic bias and magnetic field frequency. However, comparatively very few works were reported on the nanogranular-type nanostructures and it needs to be further explored. The systematic study will provide a better understanding on magnetoelectric interactions of the micostructure at the nanometer level and develop technologically very promising new class of composite multiferroics.

## Collaborative Research Activity:

➢ **Room temperature ferromagnetism and ferroelectricity in 2D layered $(CH_3NH_3)_3Sb_2Cl_XI_{9-X}$ microcrystal for magnetic field controlled optoelectronics**

We found 2D layered $(CH_3NH_3)_3Sb_2I_8Cl$ lead-free perovskite phase is a ferromagnetic semiconductor. M-H curve reveal room temperature ferromagnetism in$(CH_3NH_3)_3Sb_2I_8Cl$. Antisymmetric exchange interaction between the orbital magnetic moments of reorienting $CH_3$ and $NH_3$ groups contribute to the magnetization. M-T curve revealed $(CH_3NH_3)_3Sb_2I_8Cl$ is a phase separated system. A low magnetic field enhanced pyroelectric effect at room temperature in zero bias conditions suggests the magnetic ferroelectricity in $(CH_3NH_3)_3Sb_2I_8Cl$. A field of 100 mT changes the polarity of the zero bias current and voltage from$(CH_3NH_3)_3Sb_2I_8C$ in light and dark conditions. Magnetic field effect on the optoelectronic nature of $(CH_3NH_3)_3Sb_2I_8Cl$ has applications in spin dependent optoelectronic actions.

This work is in Collaboration with Dr. Sudip K. Batabyal, Amrita Center for Industrial Research and Innovation, Amrita Vishwa Vidyapeetham, Coimbatore.

## Lectures Delivered:

- **"*In-house facilities at Mumbai centre and Neutron Scattering facilities at Dhruva Reactor, BARC"*** AWARENESS MEETING OF UGC-DAE CSR Organized by CSR Indore, Department of Physics, G.J. College Rambagh, Bihta, Patlipura University, Patna and Department of Pure and Applied Physics, Guru Ghasidas University (A Central University) Koni, Bilaspur, September 14, 2022

***In-house facilities at Mumbai centre"*** Neutrons as Probes of Condensed Matter (NPCM) organized by UGC-DAE Consortium for Scientific

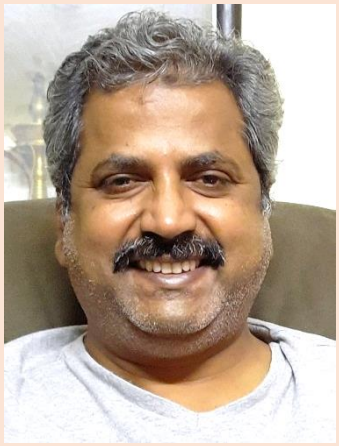
**"**Research, Mumbai Centre and Solid State Physics Division, Bhabha Atomic Research Centre, Mumbai, November 14- 19, 2022

## Sponsored Project:

➢ DST SERB CRG Scheme,

"***Flexomagnetoelectric response in self-assembled nanocomposite system*** "

Sanctioned amount: Rs. 21,33,360




## DR. SUDHINDRA RAYAPROL

**Scientist-G**

sudhindra@csr.res.in


Synthesis and Characterization of Novel Magnetic Materials for Exotic and Multifunctional Properties; Structural Studies; Magnetic Structures

**Group Members:** (1) Mr. M. Venugopal (JE-F) (2) Ms. N. Kurawle (PhD student), (3) Ms. S. Borole (PhD student) (4) R. Kamble (PhD Student)

**Ph.D. Ongoing:** 2

**Facilities:** (1) Mini-Arc Melter (MAM-I), (2) High Energy Planetary Ball Mill (dual station, milling media available: $ZrO_2$, WC, A (3) Powder X-ray Diffractometer (Bruker D2 Phaser)

## In-house Research Activity:

Our interest is in synthesizing novel quantum materials and studying the correlations between the structure and physical properties using various tools such as x-ray and neutron diffraction, magnetization, electronic and thermal transport etc. Our focus area has been investigating exotic low dimensional geometrically frustrated compounds and strongly correlated electron systems.

- **Neutron diffraction studies on $Tb_5Si_3$ under external magnetic fields: Melting of long-range magnetic order**

Compounds containing honey-comb network of magnetic ions in two- and three-dimensional lattice geometries giving rise to formation of non-trivial spin textures are called Kitaev insulators, which are known as a family of spin-orbit assisted Mott insulators. In Kitaev insulators, Quantum Spin Liquid (QSL) state is achieved from the zero-field antiferromagnetic state under the influence of external magnetic fields, which suppresses other exchange interactions responsible for magnetic order.

We observe that the features attributable to long-range magnetic ordering of the intermetallic compound, $Tb_5Si_3$, ($T_N$ = 69 K), containing honey-comb network of Tb ions, are completely suppressed by a critical applied field, $H_{cr}$, in heat-capacity and magnetization data, mimicking the behavior of Kitaev physics candidates. The neutron diffraction patterns as a function of H reveal that it is an incommensurate magnetic structure that gets suppressed, showing peaks arising from multiple wave vectors beyond $H_{cr}$.

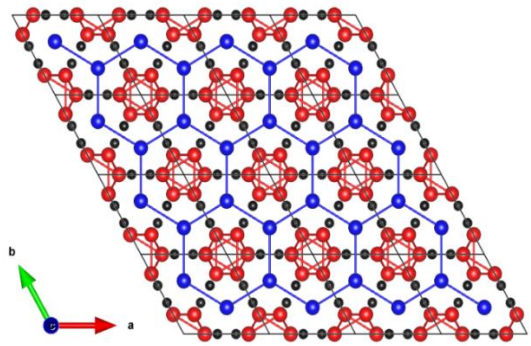



**Fig.1:** *Crystal structure of $Tb_5Si_3$ (only along the basal plane). Tb ions are at two sites (Red and Blue) and Si ions are shown in black spheres*

Increasing magnetic entropy as a function of H with a peak in the magnetically ordered state is in support of some kind of magnetic disorder in a narrow field range after $H_{cr}$. Such a high-field behavior for a metallic heavy rare-earth system has not been reported in the past and therefore is intriguing.

**Reference:** *Rayaprol et al. J. Phys. Condes. Mater. (2023) Article in Press*

➢ **Relevance of Canting angle in magnetoelectric coupling in Y-substituted $Tb_2BaNiO_5$**

The Haldane-spin chain compound, $Tb_2BaNiO_5$ has been known to be an exotic multiferroic system, exhibiting antiferromagnetic anomalies at $T_{N1}$= 63 K and $T_{N2}$= 25 K, with ferroelectricity appearing below $T_{N2}$ only.

Previous reports established that, Tb ions play a direct and decisive role to lead to multiferroic properties with a critical canting angle of magnetic moments, unlike other well-known multiferroics. From temperature dependent neutron powder diffraction studies on $Tb_{2-x}Y_xBaNiO_5$, we get an insight into the critical canting angle for multiferroic behavior.

While multiferroic transition temperature decreases linearly with Y concentration, there is an abrupt drop of relative canting angle (of Tb and Ni magnetic moments) with respect to that in parent compound for an initial substitution of x= 0.5 in the multiferroic region, without any notable change thereafter. We therefore infer that this critical canting angle is made up of two components - cooperative (long-range) and local (short-range) contributions.

**Reference:** *Ram Kumar et al. phys. Stat. Solidi B (2023) 2300042 (DOI: 10.1002/pssb.202300042*

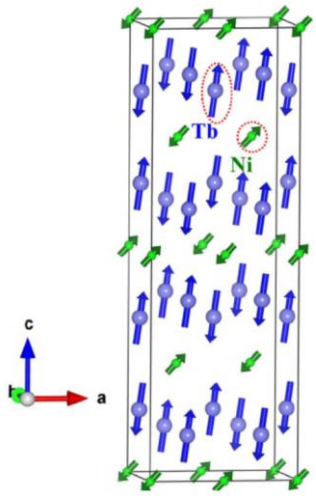



**Fig. 2**: *The magnetic structure of $Tb_{0.5}Y_{1.5}BaNiO_5$ at 2 K. The Tb and Ni moment highlighted in red dotted circle signifies the direction of the canting of the moments between c-axis and ab-plane. .*

## Lectures Delivered:

- **"*Studies on functional materials using neutrons as a probe*"** invited talk during National Conference on Functional Materials: Synthesis, Properties and Applications organized ONLINE by Department of Physics, Faculty of Science, Aligarh Muslim University, Aligarh during February 21 – 23, 2022.
- **"*Neutron diffraction under extreme conditions*"** during XIX School on Neutron as Probes of Condensed Matter (NPCM 2022) organized by UGC-DAE CSR Mumbai Centre and SSPD, BARC at TSH Anushaktinagar, Mumbai during November 14 – 19, 2022.
- **"*Rietveld Refinement Method Using FullProf for Crystallographic Structures using Powder Diffraction Data*"** series of two lectures and tutorials during online webinar organized by Department of Physics, PSMO College, Kerala during January 25 –26, 2023.
- **"*X-ray Diffraction: An Important Tool for Structural Characterization*"** during Refresher course organized by Department of Physics, Savitribai Phule Pune University, Pune on 18th November 2021.

# 4.3 Collaborative Research Scheme

## Antiferromagnetically coupled double perovskite as an efficient and robust catalyst for visible light driven water splitting at neutral pH (CRS/2021-22/03/564)

Dr. Avijit Kumar Paul, N.I.T. Kurukshetra

Green and sustainable energy production through renewable sources is an enormously exciting field of research. Herein, we report an A-site lanthanum doped oxygen excess ruthenate (predominantly $Ru^{5+}$-ions) double perovskite system, $CaLaScRuO_{6+\delta}$ (CLSR), as an excellent photocatalyst for water splitting. The well characterized polycrystalline compound shows canted antiferromagnetic (AFM) behavior due to the existence of disordered Ru-ions at the B-site. Based on density functional theory + U (Hubbard U) calculations, we have estimated various magnetic exchange interactions and found that the ground state is antiferromagnetic in nature which is in perfect agreement with our experimental results. Detailed analysis of the electronic structure further reveals that the present system belongs to the family of charge transfer semiconductors with an energy gap of B0.45 eV. Finally, the material is found to proficiently work for the oxygen evolution reaction (OER) via visible-light driven water splitting at neutral pH in an ecofriendly manner [Phys. Chem. Chem. Phys. **24**, 5083 (2022)]

## Magnetic and electrical transport studies of polycrystalline $Sr_{1-x}Bi_xFe_{12}O_{19}$ (x = 0, 0.01, and 0.02)

Dr. P.N.Vishwkarma, N.I.T. Rourkela

Bismuth-substituted strontium hexaferrites, $Sr_{1-x}Bi_xFe_{12}O_{19}$ for x = 0, 0.01 and 0.02, are studied via powder neutron diffraction (ND), magnetization (M) studies, Mössbauer spectroscopy, and electrical transport. ND results show an indication of increasing $Fe^{2+}$ at 12k crystallographic sites (which is supported by Mössbauer results), with increasing Bi in the sample. They also suggest an increase in strain due to Bi substitution for the polyhedral associated with 2a and 2b spin-up and 4f1 spin-down sites. The M measurements over a wide associated with 2a and 2b spin-up and 4f1 spin-down sites. The M measurements over a wide temperature range(3–823 K), shows irreversibility in ZFC and FC data right below the Curie temperature, along with the Hopkinson peak in the ZFC data. The T scan of saturated magnetization follows the Bloch relation but that of the coercive field shows unconventional behaviour. The coercive field data is fitted using an equation devised by taking into consideration of all the three anisotropies. The critical exponents at the temperatures for all the compounds shows the interplay of anisotropy magnetoresistance (AMR) and giant magnetoresistance (GMR). Low temperature data are dominated by GMR and gradual participation of AMR increases as room temperature is approached. [*M.R. Sahoo, J. Phys. D* ***55****, 265001 (2022)*]

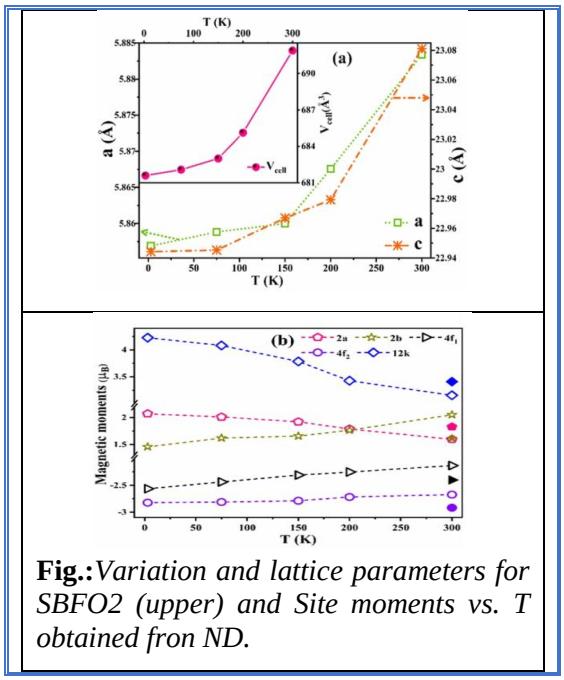



**Fig.:***Variation and lattice parameters for SBFO2 (upper) and Site moments vs. T obtained fron ND.*

## Magnetic and structural properties of Zn and Zr co-doped $BaFe_{12}O_{19}$ hexaferrites

Dr. Anupinder Singh, G. N. D. University, Amritsar

M-type hexaferrites with $BaZn_xZr_xFe_{12-2x}O_{19}$ (x = 0.1–0.7) were investigated for structural, microstructural and magnetic properties. The `c/*a*′ ratio was < 3.98, for all *x* confirming M-type hexaferrite structure. XRD results show simultaneous decrease in crystallite size (149–69 nm) and an increase in cell volume (699.1–711.0 $Å^3$) with increasing dopant concentration. FESEM micrographs reveal that the a) average grain size varies within 0.61–0.79 µm and b) sample porosity decreases with increasing concentration of $Zn^{2+}$-$Zr^{4+}$ dopants. M-H studies reveal that a) $M_S$ increases from 61.5 emu/g (at x = 0) to 72.9 emu/g (at x = 0.1) and decreases afterwards to 61.45 emu/g (at x = 0.7) and b) $H_C$ decreases continuously from 4118 Oe (at x = 0.0) to 319 Oe (at x = 0.7). The excellent magnetic properties of these hexaferrite samples make them useful in magnetic data storage devices, devices for microwave absorption and in spintronic devices. [*Swati Verma et al, J. Alloy. Compd.* ***930****, 167410 (2023)*]

## Fortified relaxor ferroelectricity of rare earth substituted 4-layered $BaBi_{3.9}RE_{0.1}Ti_4O_{15}$ (RE = La, Pr, Nd, and Sm) Aurivillius compounds

Dr. T. Patri, RGUKT, Andhra Pradesh

The effect of rare-earth ($RE^{3+}$) ion substitution on structural, microstructural, and electrical properties in BaBi4Ti4O15 (BBTO) Aurivillius ceramics has been investigated. The Rietveld refinements on X-ray diffraction (XRD) patterns confirm that all the samples have an orthorhombic ($A2_1am$) structure. Temperature dependent synchrotron XRD patterns reveal that the existence of dual phase in higher temperature region. The randomly oriented plate-like grains are experimentally confirmed the distinctive feature of BBTO ceramics. The broad band dielectric spectroscopic investigation signifies a shifting of ferroelectric phase transition ($T_m$) towards low temperature region with a decrease of the $RE^{3+}$-ionic radii in BBTO ceramics. The origin of diffuse ferroelectric phase transitions followed by stabilization of the relaxor ferroelectric nature at high frequency region is explained using suitable standard models. The temperature dependent ac and dc conductivity results indicate the presence of double ionized oxygen vacancies in BBTO ceramics, whereas the dominance of single ionized oxygen vacancies is observed in RE-substituted BBTO ceramics. The room temperature polarization vs. electric field (P–E) hysteresis loops are shown to be well-shaped symmetric for BBTO ceramics, whereas slim asymmetric ferroelectric characteristics developed at RE-substituted BBTO ceramics. [*T. Patri et al, Sci. Rep.* ***12****, 16508 (2022)*]

## Thermionic emission assisted charge conduction mechanisms across $LaMnO_3$/ $La_{0.7}Ca_{0.3}MnO$ interface of manganite thin film structure (CRS – M – 281)

Dr. P.S. Solanki, Department of Physics, Saurashtra University

Temperature dependence of resistive switching (RS) behavior across chemically grown $LaMnO_3$/$La_{0.7}Ca_{0.3}MnO_3$ (LMO/LCMO) interface have been discussed by employing various theoretical approaches and mechanisms. Temperature dependent RS behavior of LMO/LCMO interface highlights impactful switching between high resistance state (HRS) and low resistance state (LRS) under reverse bias mode through an active role of depletion region. Trapping–detrapping processes assisted charge conduction has been identified as a source of RS nature of LMO/LCMO interface. Thermionic emission model and space charge limited conduction (SCLC) mechanism is employed to understand charge conduction and charge transport across LMO/LCMO interface. Ag/LMO/LCMO/Ag has also been investigated for possible retention and endurance behaviors under different external parameters which verify stability, reliability, reproducibility, non–volatile nature and

applicability of LMO/LCMO interface. [H. Dadhich et al. Curr Appl Phys, 50]

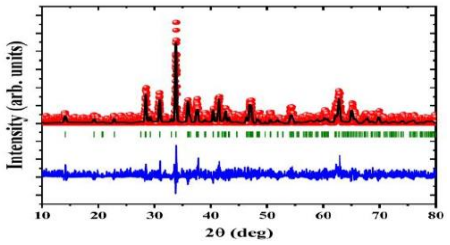
## Synthesis and Study of Rare Earth doped $GaFeO_3$ -$AlFeO_3$ Orthoferrites Solid Solution for Spin-lattice and Magneto-electric coupling (CRS/2021-22/03/578)

Dr. Basavaraj Angadi, Bangalore University, Bengaluru

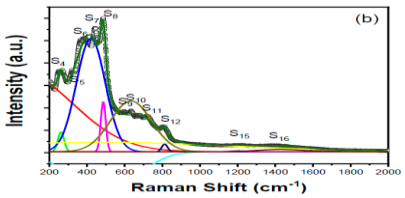
Pure $AlFeO_3$ multiferroic system was synthesized through conventional solid state reaction method. Figure 1 (a) shows Rietveld refined single phase XRD patterns of hand ground $AlFeO_3$ and sintered at 1400 0C/12hr. The hand ground $AlFeO_3$ shows pure phase compared to ball milled and it confirms orthorhombic structure with *Pna*$2_1$ space group.

Figure 1 (b) shows the room temperature Raman data of $AlFeO_3$ belonging to the orthorhombic Pna21 space group containing eight formula units, i.e., 40 atoms in a unit cell, resulting in 120 normal modes, namely, ΓFe = 6A1 + 6A2 + 6B1 + 6B2, ΓAl = 6A1 + 6A2 + 6B1 + 6B2, and Γo = 18A1 + 18A2 + 18B1 +18B2. Because the inversion symmetry is lacking, Raman modes are also infrared active. There are 117 Raman modes, while A1 + B1 + B2 are acoustic modes. Figure 1 (b) shows the Raman spectrum at 300 K, revealing 14 modes labelled as S4 to S18 in the spectral range of 200–2000 $cm^{-1}$.

**(a)**




**(b)**




## Magnetic field dependent neutron diffraction on reduced graphene oxide-$BiFeO_3$ nanocomposite CRS/2021-22/03/540

Dr. D. Bhattacharya, CSIR-CGCRI, Kolkata

Towards multiferroic application, many materials are being explored and $BiFeO_3$ is one of the prime material showing multiferroic properties at room temperature, but due leakage current, the applications have not been very effective. Several ways are being tried to cater this issue, the composition of $BiFeO_3$ with graphene is one approach. In this study, magnetic field dependent neutron powder diffraction (ND) study of reduced graphene oxide and $BiFeO_3$ nanocomposite (RGO/BFO) was carried out at PD-3 diffractometer at the wavelength of 1.48 Å. Rietveld refined fitted patterns for zero and 20kOe magnetic field are plotted in fig 1 and 2. The observed data of sample could be fitted with R3c space group and the magnetic structure was refined with Γ1 irreducible representations. From the magnetic field dependent neutron diffraction, the lattice volume found to decrease and then increase as shown in fig 3. This situation is different in case of pure $BiFeO_3$, which

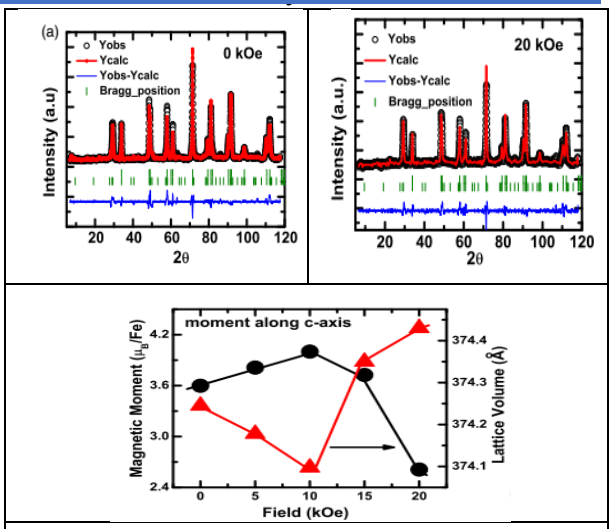



**Fig.1:** *Rietveld refined ND pattern of reduced graphene oxide-BiFeO3 in (a) zero (b) 20kOe magnetic field (c) Variation of lattice volume and magnetic moment along c-axis as a function of magnetic field.*

depicts negative magnetostriction and hence magnetoelectric coupling which results in decrease in ferroelectric polarization under magnetic field. This points out towards the possibility of switch from negative to positive magnetostriction, in which Fe-C bond may be playing significant role. The results were published in *Physica Status Solidi (*RRL)

## Enhanced magnetic and magnetoelectric behaviour in morphologically distinct BTFO and LSMO composites (CRS/2021-22/03/585)

……Dr. A. K. Singh, NIT Rourkela, Odisha

(1-x)BFTO-xLSMO (BFTO: $Bi_5Ti_3FeO_{15}$; LSMO: $La_{0.67}Sr_{0.33}MnO_3$) composited (x = 0, 0.1, 0.2, 0.3 and 0.4) composites were prepared by modified sol-gel technique to explore magnetic and magnetodielectric behaviour. The magnetic studies reveal that the saturation magnetization (Ms ~ 7.0 emu/g) and coercive field (Hc ~ 1660 Oe) increased by nearly-three and 66 times for 40 % LSMO contained composite. The enhanced magnetic behavior is due to the interaction between the multiple magnetic ordering (AFM/FM) present in the
prepared composites. The estimated values of squareness ratio (Mr/Ms) are lower than 0.5, illustrating the multidomain nature of the composites. The switching field distribution (SFD) plot indicates that strong exchange coupling exists in the x = 0.4 composite compared to others. The change in dielectric permittivity at different magnetic fields is due to the magnetodielectric (MD) coupling in the composites.

The field-dependent MD studies reveal that maximum MD strength (~0.34 %) and minimum magneto loss (ML) (~0.02 %) are observed in x = 0.2 and 0.1 composites at 100 kHz, respectively. It is due to the non-collinear alignment of magnetic Mn ions at RT, which leads to the inverse Dzyalonskii-Moriya interaction. Additionally, the maximum MD coupling strength γ (-16.87 (emu/g)2) is observed in the x = 0.2 composite. The observed MD response in the composites is due to the dominating grain capacitive effect rather than the resistive effect, which is ascertained by the frequency dependent magnetoresistance measurement. Hence, the composite's enhanced magnetic and magnetodielectric behaviour makes it a suitable candidate for multifunctional device applications.

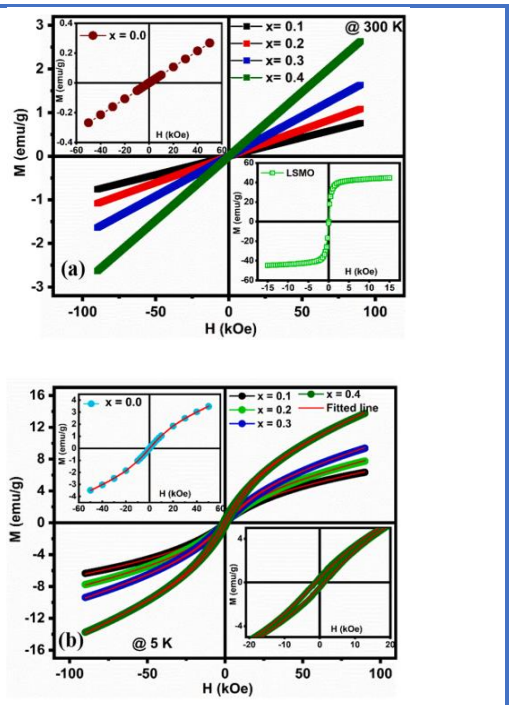



**Fig.1:** *The magnetic characterization for the composites at 300 K (top fig) and 5 (bottom fig) ascertain the magnetic behaviour of the composites under study*

[Ref: R. Jena et. al, JMMM 562, (2022) 169821].

# 5. Research Activities at Kalpakkam Node

**DR. N. V. CHANDRA SHEKAR**

**Scientist-In-Charge, Kalpakkam Node**

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The research activity, user statistics and the status of in house research scholars at Kalpkkam Node (KN) of UGC-DAE CSR are summarised below. The in-house research activities of the Node are carried out by four Scientists of the Node namely Dr. G. M. Bhalerao, Dr. Sujay Chakravarty, Dr. Shamima Hussain and Dr K Saravanan, along with the research scholars (JRF/SRF) of the Node. Notably, in last one year more than 80 faculties/research scholars from different Universities and research institutions have got benefitted from our facilities, enabled by the Scientists of KN . Two of the research scholars of KN , Mr. Siddhartha Dam and Mr. Abhishek Thakur as guided by Dr. Shamima Hussain have successfully defended their thesis and received the provisional Ph.D. degree from University of Madras. Another three of the research scholars of KN , Mr. Balaram Thakur, Mr. Deena Nath & Mr. Surakanti Srinivas Reddy have completed their research work and submitted their thesis to University of Madras.

Materials Science with Accelerator being the major thrust area of KN and several users have utilised the 200kV ion accelerator facility commissioned at the node. The accelerator research group at Kalpakkam Node led by Dr. Saravanan is focusing mainly on the importance of ion beam modifications of materials. Dr. Saravanan has also got two research project proposals sanctioned from DST-SERB, Govt. of India. Equipments procured from these projects will be utilized with the ion accelerator.

The focus of the research group led by Dr. Shamima Hussain has been on obtaining substrate-free films for device applications including PVDF that were synthesized and modulated using suitable fillers for tuning the properties while retaining the flexibility and the free-standing nature. A lab-based triboelectric Nano generator (TENG) operating in a vertical contact-separation configuration was fabricated using these composite films. Apart from the in house research activity the group led by Dr. Shamima has also helped thirty five researchers from other academic institutions with Raman spectroscopic studies.

The research group led by Dr. G. M. Bhalerao is mainly focussed on high pressure studies of core/shell carbon nanostructures based on the measurement of pressure drop across amorphous carbon shell. The high pressure behaviour of core/shell amorphous carbon (a-C) nanostructures (NSs) was studied using synchrotron XRD and Raman spectroscopy up to 25 GPa.

The research group led by Dr Sujay Chakravarty has primary research focus in tailoring the Microstructure, Magnetic & transport properties of carbon, graphene and other carbon based materials as well as conventionally nonmagnetic nitride and oxide thin films in order to understand d0 Magnetism for their potential application as magnetic semiconductor. In addition the group led by Dr. Sujay has also helped more than forty researchers from other academic institutions with magnetic studies using SQUID-VSM, characterization of surface morphology using Atomic Force Microscopy (AFM) as well as transport studies by measurement of resistivity, magnetoresistance & Hall at high magnetic field & low temperature.


## DR. G. M. BHALERAO

**Scientist - F**

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**Research Interest:**

Transmission Electron Microscopy, Nanomaterials, Crystal Growth

**Group Members:** (1) Surakanti Srinivas Reddy (SRF-submitted thesis) (2) Somesh Chandra (SRF)

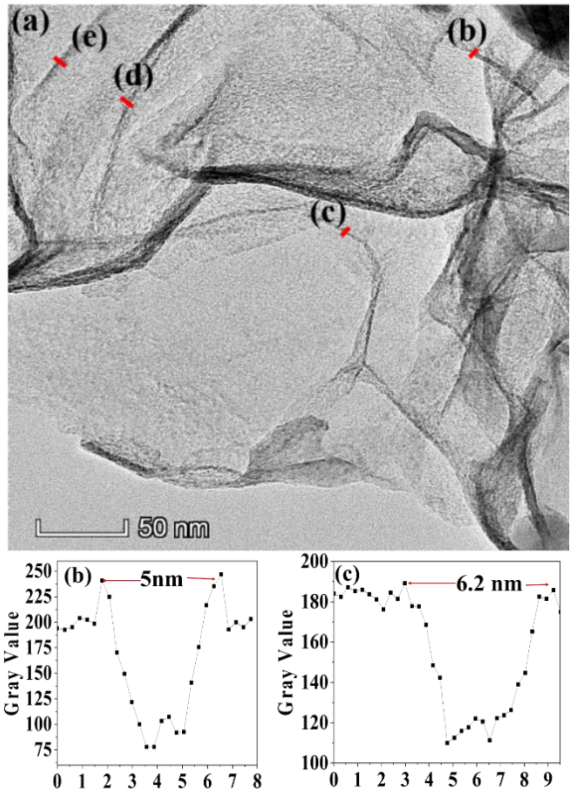
**Facilities:** (1) Transmission Electron Microscope (2) IR Optical Float Zone furnace for single Crystal Growth

## In-house Research Activity

### ➢ Synthesis of thin large Nanosheets

A virtual substrate method for large metal oxide nanosheets synthesis is discovered. Ashless filter paper was used as the novel virtual substrate and combustive oxidation. CuO/MgO with different proportion in the final produce were selected as model prototype materials to study synthesis kinetics. Aqueous soluble acetate precursors were utilized, and the products were characterized by powder x-ray diffraction (XRD), Raman spectroscopy, and transmission electron microscopy (TEM). The selection of these prototypes was based on their contrasting crystallographic properties and contrasting physico-chemical properties of the respective acetate precursors. This method yields polycrystalline (grain size tens of nm) nanosheets with a thickness of ~3 nm, which percolate to form centimeter-long freestanding structures. Our synthesis kinetics model establishs that in case of mixed precursor, the precursor with higher solubility/aqueous affinity get precedencein attaining sheet morphology. In the case of a single precursor, nanosheets were always formed. The growth kinetics for the metal oxide nanosheets is explored. Experiments using single and mixed precursors suggest that the precursor with higher aqueous solubility is preferred over the less solubility precursor for the formation of nanosheets, whereas the precursor with lower solubility yields nanoparticles. The present way of synthesis provided here can successfully be exploited for synthesizing other metal oxides in freestanding, porous Nanosheets to improve their functional activities.

[*Ref:- Somesh Chandra et al., Thin Solid Films* ***758*** *139726 (****2023****)*]



➢ **One pot synthesis of CdSe QDs by aqueous phase method**

One pot synthesis of CdSe QDs by aqueous phase method. The powder X-ray diffraction (XRD) pattern on the sample is shown in Fig. 1. Perhaps the hydrogen bonding among the citrate caps lead to the association and attributing overall glassy structure to the sample. The peaks riding over this glassy background are fitted faithfully in the Zinc blende (Cubic) structure of CdSe. The peaks positioned at various 2θ values and corresponding (h k l) values are recorded, which are attributed to the planes of the cubic structure of the CdSe (JCPDS-65-2891. The size of the particles was approximately less than 10 nm, calculated by using Scherrer equation. The spectrum showed that the peaks due to reacted selenium present at 80°C temperature were completely vanishes at 140°C.

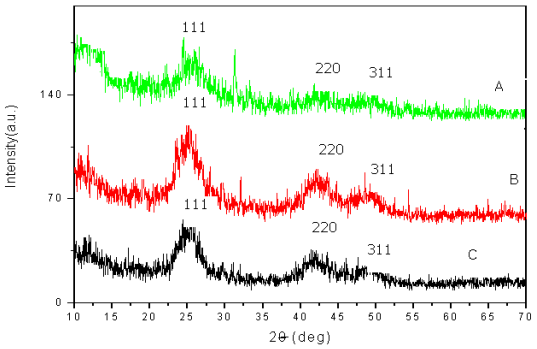



**Fig.1:** *XRD pattern of CdSe quantum dots refluxed at 80°C (A), 120°C (B), and 140°C (C)* .

## Lectures Delivered:

- Delivered Lecture entitled **"***Microscopic Flashlights for Atoms : A Brief Perspective on Techniques and Analyses***"** at Two Days Hands on Training Workshop on MICROSCOPY AND SPECTROSCOPY TECHNIQUES (HRTEM, SEM, AFM & ATOMIC ABSORPTION SPECTROMETER held at Anna University, Chennai on 22.11.2022.

- Delivered Lecture entitled **"***Modification of Defects in Carbon Nanostructures and it's Practical Aspects***"** in Two Days International webinar on ADVANCED NANOMATERIALS FOR EMERGING APPLICATIONS (IWANEA-2023) held online at Periyar University, Salem on 07.03.2023.

- Delivered Lecture entitled **"***Transmission Electron Microscopy in Nanomaterials and Macromolecular Research***"** at NATIONAL CONFERENCE ON MODERN FUNCTIONAL MATERIALS (NCMFM-2023) held at Sri Sai Ram Engineering College, Chennai on 23.03.2023.


## DR. SUJAY CHAKRAVARTY

**Scientist-F**

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**Research Interest:**
Tailoring the Microstructure, Magnetic & transport properties of graphene and other carbon based materials, $d^0$ Magnetism in conventional nonmagnetic materials; Magnetic semiconductor; Morphology and Size Dependent properties of magnetic nanoparticles & nanostructures; Defect & strain induced magnetism in thin film, Atomic diffusion at nanoscale & microstructural stability of nanomaterials.

**Group Members:** (1) Hari Singh, JRF, (2) Nisha Dhull, JRF

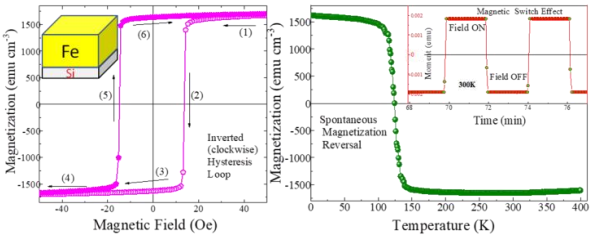
**Facilities:** (1) GIXRD, (2) SQUID-VSM magnetometer, (3) 15 Tesla cryogen free system with Resistivity and Hall measurement options, (4) Scanning probe microscope, (5) Magnetron Sputtering system, (6) Hot Isostatic Press, (7) High Vacuum annealing system for thin films.

## In-house Research Activity:

Primary research interest of my group is tailoring the Microstructure, Magnetic & transport properties of graphene and other carbon based materials as well as to understand $d^0$ Magnetism in conventionally nonmagnetic nitride and oxide thin films by manipulating its constituents and oxygen for application as magnetic semiconductor. Apart from that we are also interested in Morphology and Size dependent properties of magnetic nanoparticles & nanostructures. The key research outputs during the academic year 2022-23 are as follows:

- **Investigation of novel magnetization switching effect along with inverted hysteresis loop & spontaneous magnetization reversal observed in nanocrystalline iron thin film:-**

The origin of experimentally observed Novel magnetization switching effect along with Inverted Hysteresis Loop (IHL) & Spontaneous Magnetization Reversal (SMR) in the nanocrystalline iron thin film is investigated. The film deposited using ion beam sputtering is polycrystalline with preferred orientation along [110] and [211] directions, as confirmed from GIXRD and cross sectional TEM. The origin of IHL, SMR and novel magnetic switching effect is explained due to antiferromagnetic interaction between the oriented crystallite and surrounding amorphous matrix. Moreover, transformation of the non-IHL into IHL in the absence of large positive

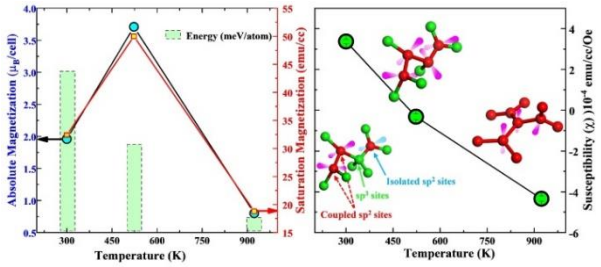



exchange bias is observed, which depends on the loop tracing field range (HR). The magnetic switching effect observed at room temperature is unique for iron film and can have potential application as functional material. [*Manuscript is under review*]

- **Thermal stability of the magnetic moment in amorphous carbon thin film- An experimental and ab-initio study:-**

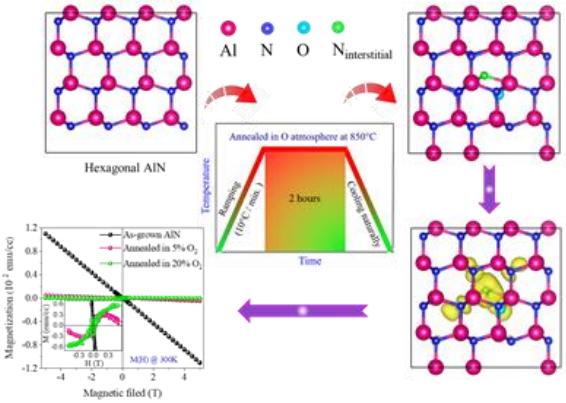
The effect of vacuum annealing on the microstructure and the thermal stability of magnetic moment in amorphous carbon (a-C) thin film is studied. In the as-deposited sample, an isolated $sp^2$ atom surrounded by $sp^3$ atom results in the paramagnetic contribution, and a $sp^2$-$sp^2$ atom with twisted π-orbitals results in weak ferromagnetic coupling. The saturation magnetization increases when the sample is annealed at 523 K and later

decreases when further annealed at 923 K. The ab-initio molecular dynamics calculation predicts that, the net magnetization of the system increases from 300 K to 523 K due to the increase in $sp^2$ fraction. Further annealing at 923 K enhances π-orbital overlapping, which leads to the annihilation of moments sites. The present study differentiates between the two structures that contribute to the magnetism in a-C in terms of their thermal stability




and indicates that the twisted π-orbitals structure is thermodynamically more stable than the structure where $sp^3$ surrounds $sp^2$ hybridized atom.
[*Ref:- B. Thakur et al., Diamond & Related Materials Vol. 127, Page 109200 (2022)*]

➢ **Influence of isothermal annealing in a controlled oxygen environment on the microstructure, chemical, and magnetic properties of crystalline Aluminium nitride thin films:-**

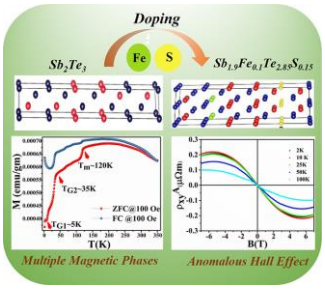



The crystalline AlN thin films were isothermally annealed at 850°C in a controlled oxygen environment. The AlN bonding at the film's surface was systematically reduced and finally vanishes when the film is annealed at 20% oxygen mixed with argon environment. During annealing, nitrogen in AlN is replaced by oxygen, and a fraction of replaced nitrogen is trapped at the interstitial sites in AlN. Magnetic measurement exhibits dilute ferromagnetism induced in as-grown AlN film after annealing. DFT calculation reveals interaction between N 2p orbitals of interstitial nitrogen and first neighbouring nitrogen atoms contributing to observed magnetic properties.
[*Manuscript is under review*]

## Collaborative Research Activity:

Apart from the in-house research, the key work related to the collaborative research activity during 2022-23 is highlighted below.

➢ **Multiple Magnetic Phases and Anomalous Hall Effect in $Sb_{1.9}Fe_{0.1}Te_{2.85}S_{0.15}$ Topological Insulators:-**
**(Principal Investigator:** *Dr. Sandip Chatterjee, IIT BHU***)**
$Sb_{1.9}Fe_{0.1}Te_{2.85}S_{0.15}$ where a unique combination of disordered glassy phases, competitive FM−AFM interactions, and nontrivial surface state coexisted at the same time is explored. The impact of those complicated magnetic phases upon the observed




AHE is discussed with magneto-transport studies. The comprehensive analysis verifies the slower dynamics and formation of a cluster spin glass state in the present system.
[*Ref:- Debarti Pal et al., J. Phys. Chem. C Vol. 127, Page 2508-2517 (2023)*]

## Lecture Delivered

Delivered oral talk entitled "*Exploring magnetism in amorphous carbon*" in INTERNATIONAL CONFERENCE IUMRS-ICA 2022 organized by MRSI at IIT Jodhpur on 20.12.2022.


## DR. SHAMIMA HUSSAIN

**Scientist-F**

sh@csr.res.in


**Research Interest:**

Condensed Matter Physics, Semiconductor physics, Thin films of Transition Metal Dichalcogenides, Polymers

**Group Members:** (1) Mandeep Jangra - SRF (2) Nisha M - JRF

**Ph.D. Completed:** 02 nos.

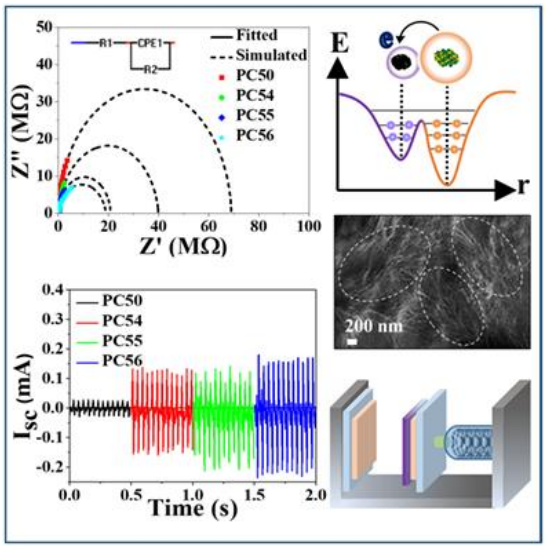
**Facilities:** (1) FESEM/EDX, (2) FIBSEM, (3) Raman spectrophotometer, (4) XPS, (5) High Energy Ball Mill, (6) e-beam evaporation system, (7) Chemical Synthesis laboratory, (8) Box Furnace

## In-house Research Activity

In this period, the focus of our group has been on obtaining substrate-free films for device applications.

➢ **Enhanced dielectric properties of composite films of polymers**

Towards this, freestanding films of PVDF were synthesized. For making them application friendly, their properties were modulated using suitable fillers. While the fillers helped tune the properties of the synthesized films, the challenge remained in retaining the flexibility and the free-standing nature. Studies were carried on films with cellulose , the natural fibre as fillers . It was found that addition of cellulose increased the hydrophobicity of the composite films. This was attributed to the fact that cellulose nanocrystals were embedded within the PVDF matrix. A confirmatory study was carried out through impedance spectroscopy. Temperature dependent impedance spectroscopy revealed a shift in the glass transition temperature of the polymer- the ac and the aa. Further, based on the properties of the films, a lab-based triboelectric nanogenerator (TENG) operating in a vertical contact-separation configuration was fabricated using these composite films. A maximum




output power density of ~6 μW/cm$^2$ was achieved from the fabricated TENG.

➢ **Ebeam evaporation of Thin films of binary TMDs**

Attempts were made towards synthesising thin films of $CoS_2$ through eBeam evaporation technique. While the films obtained were of high crystallinity, their stability posed a problem as they quickly changed to their oxide. The deposition conditions for the same are being optimised to obtain stable films of the compound.

[*Ref:- Mandeep Jangra et al. Journal of Polymer Science vol.61, Pages 334-345 (2022)*]

## Collaborative Research Activity:

➢ **Effect of ZnO nanoparticles on structure and magnetic properties of $Bi_2O_3$-$B_2O_3$:$Cr_2O_3$ glasses**

ZnO nanoparticles doped- $Bi_2O_3$–$B_2O_3$–$Cr_2O_3$ glass samples are synthesized by the melt-quenching. The XRD spectra confirm that the samples exhibit amorphous structure. The intensity and broadness of the two halos in the XRD spectra are observed to decrease, which confirm the homogeneous substitution of the ZnO nanoparticles in the composition by replacing the $Cr_2O_3$.The FTIR spectra depict the functional groups of the BBMZ glasses in terms of mainly, $[BO_4]$, $[BO_3]$, $[BiO_6]$ and $[ZnO_4]$ units. The EPR spectra of the BBC1 and BBCZ2 samples have shown two signals at $g \approx 4.7$ and $g \approx 1.98$ due to the existence of paramagnetic $Cr^{3+}$ ions in the glass matrix. Replacement of the $Cr_2O_3$ by ZnO nanoparticles in bismuth-borate glasses is responsible for i) improving oxidation of boron, ii) decreasing the $[O\text{-}H]^-$ absorption ability, and iii) declining the paramagnetic nature of BBCZ glasses. This is because of the ZnO nanoparticles improve the chemical durability and enhance the chemical reaction rate due to the increased surface to volume (S/V) ratio when comparing with the bulk state of ZnO. These glasses would catch hold of possible applications as optical elements, moisture sensors and magnetic sensors etc.

➢ **Studies on UV-A,B,C Emitting Persistent Luminescent Materials**

The recent developments on PersL materials especially those emitting UV radiation have found applications in photodynamic therapy, information storage, anticounterfeiting, photocatalysis, etc. To prepare UV-emitting materials, which can be divided into UV-A, UV-B and UV-C regions, one needs to follow smart techniques (calculations) rather than physical efforts. While VRBE gives us information about the exact location of rare earth ions in individual hosts, the options to prepare UV-emitting materials is limited as the transitions in lanthanoids are restricted because of their f–f nature (for $Ln^{3+}$ ions). However, if one considers the $Ln^{2+}$ ions, and an f–d transition, the emission can vary quite a lot. Only few of the rare earth ions, $Gd^{3+}$, $Ce^{3+}$ and $Pr^{3+}$, are capable of emitting in the UV-region. The $Gd^{3+}$ and $Pr^{3+}$ emission is independent of the host crystal field due to shielding of the outermost electrons. The most promising among all is $Ce^{3+}$ whose 5d shell is affected by the choice of host lattice and the emission can be tuned from UV to red region. Herein, we have summarized such materials and found it to be promising to work on these materials emitting UV–PersL

## Lectures Delivered:

- Delivered Lecture entitled "*Understanding X-ray Photoelectron Spectroscopy spectra through a few examples*" at SSN College of Engineering, Kalavakkam, on March 24,2023
- Delivered Lecture entitled "*Analysing XPS spectra: Few examples*" at FDP ON ANALYTICAL TOOLS FOR MATERIALS CHARACTERIZATION at VIT, Vellore on march 15,2023
- Delivered Lecture entitled *"Electron Microscopy an Overview"* in a training programme on NAOTECHNOLOGY IN AGRI-FOOD SYSTEM-REPLETE WITH OPPORTUNITIES at SKUAST-Shalimar, Kashmir on Feb 25, 2023.
- Delivered Lecture entitled *"Freestanding composite films of polymers for advanced applications"* at the Indo-Japan workshop, University of Tokyo, Tokyo on March 02,2023
- Delivered Lecture entitled "*Morphological Analysis of thin films grown by chemical route*" at the NIUS 19.1 on Jan 07,2023

## Sponsored Project:

- Core Research Grant-SERB

"Structural Characterization, Quantum Chemical, Molecular Docking and Antimicrobial Activity Studies on Cellulose/polyvinylidene fluoride nanocomposite Films"
Sanctioned amount: Rs. 486000/-

## Honours/ Recognitions/Awards:

- Delegate member – Indo - Japan delegation to University of Tokyo

## Foreign visits by faculty:

- Visited University of Tokyo, Tokyo, Japan as a delegate member for the Indo-Japan workshop sponsored by DST India and JSPS, Japan.


## DR. K. SARAVANAN

**Scientist-D**

sara@csr.res.in


**Research Interest:**

Ion accelerator based materials research. Ion beam synthesis/modification of materials, Ion beam analysis.

**Group Members:** (1) Ms. Chidambara Sharma (Project Assistant, SERB-DST project)

**Facilities:** (1) 200 kV Accelerator (2) NMR spectrometer (3) Arc melting (4) Melt spinning (5) Chemical depth profiler (6) 200 keV TEM

## In-house Research Activity:

We study the effect of ion beam irradiation and modification on electrical, optical and structural properties of various materials including oxides, metals and semiconducting materials.

➢ **Ion beam modification of Au-ZnO composites**

Ion irradiation have been performed on Au/ZnO composite films. It is observed that formation of Au islands on the surface aligned ZnO nanostructures.

The X-ray diffraction analysis revels that the formed ZnO nanostructures are hexagonal wurtzite and *c*-axis oriented crystallites. Raman spectra has shown enhanced intensity in the Au/ZnO sample which is due to the unique surface plasmon resonance property of Au nanostructures. The ion beam modified nanostructures exhibit interesting photoluminescence emission in the UV regions.

Ion irradiation technique can effectively be used for the modification of surface. Further the ion beam modified surface found to be suitable for many electronic optoelectronic devices. A review article, focusing the importance of ion beam modification of materials, has been published in Journal of Electronic Materials in 2022.
[*Ref: Saravanan et al. Journal of Electronic Materials Vol. 51Pg. 4169 (2022)*]

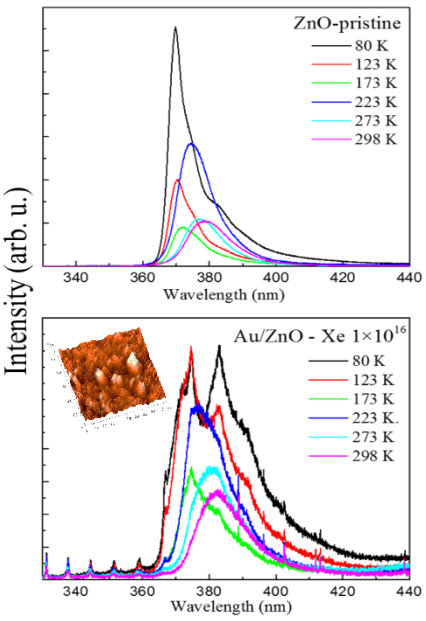



**Fig.1:** *Low temperature photoluminescence spectra of pristine ZnO and ion beam modified Au/ZnO nanostructures. The insert shows the AFM micrograph of ion beam modified Au/ZnO surface.*

## Collaborative Research Activity:

➢ **Heavy ion irradiation effect on the metal foils**

Several collaborative works with MSG/IGCAR have been initiated. These include:

1) The effect of 450 keV $Ar^{2+}$ ion irradiation on the metal foils
2) $N^+$ ion irradiation of AlN thin films
3) $He^+$ ion irradiation on Si diode sample

➢ **CRS project – CRS:2021-22/04/602**
The nanocrystalline diamond thin films have been irradiated with N, $N_2$, $N_3$ and $N_4$ molecular ion beams. It is observed from Raman studies that the diamond films acquire $sp^2$-content after ion-implantation. It is observed that the $N_4^+$ implanted BDD films possess the high electrical conductivity as compared to the other diamond sample.

## Lectures Delivered:

- Delivered Lecture entitled *"Surface modification by ion beam irradiation"* at AWARENESS MEET ORGANIZED BY UGC-DAE CSR KALPAKKAM NODE held at Kalpakkam Node on 19.07.2022.

## Sponsored Project:

- SRG/SERB-DST,
"Synthesis and modification of of wide bandgap oxide - metal nanostructures: Tuning of surface plasmon resonance for high efficiency plasmonic solar cell and related applications"
Sanctioned amount: Rs. 29,05,200/-

- EMEQ/SERB-DST,
"Ion beam synthesis, modification of nanostructures for field electron emission and sensor application"
Sanctioned amount: Rs. 49,56,120/-

## 5.3 Collaborative Research Schemes

### Study on the effects of co-assembly of peptide with G-quadruplex DNA (CRS Proj. No. : CRS/2021-22/04/634)

Dr. Jishu Naskar (PI), Univ. Of Kalyani

Herein, it is described that a synthetic dendron-like peptide, $C^{\delta 3}$–(YYEE)–E co-assembles with G4 DNA in aqueous buffer containing $Na^+$ ions. Various orthogonal biophysical studies have established the co-assembly phenomenon. *In silico*, molecular docking studies also corroborate the results obtained from biophysical experiments. Importantly, the co-assembly enhances the thermal stability of G4 DNA compared to free G4 DNA. The peptide inhibits the activity of telomerase enzyme which is found to be over-expressed in most of the cancer cells and also down-regulates the c-Myconcogenic expression. The study highlights the applicability of a synthetic bioactive peptide as a putative anticancer therapeutic agent.

[*Ref:- Soumi Biswas et al., Chemistry Select Vol. 8 Pg. e202203563 (2023)*]

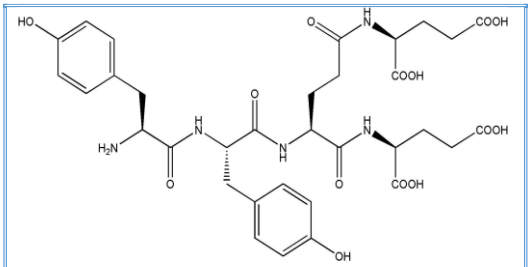
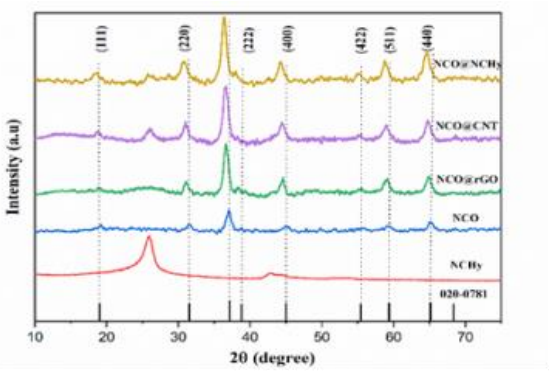



**Fig.1:** *Chemical structure of the peptide, $C^{\delta 3}$-(YYEE)-E*

### Bifunctional Ternary ThioSpinel Nano-forms@Carbon Nanostructures for Sustainable Energy Applications (CRS Proj. No. : 2021/CRS/18/07/16)

PI: Dr. K. K. Aruna (PI), Rathinam Technical Campus, Coimbatore-641004.

NiCo2O4@carbon nanostructures were synthesised by facile hydrothermal method with a molar ratio 1:2:4 (Ni:Co:O) on 10 wt.% carbon nanostructures (rGO, f-MWCNT and nanocarbon NCHy, which is a hybrid of 1:1 rGO and f-MWCNT). Synthesised sample were studied by X-Ray diffraction method. Catalyst ink was prepared by sonicating 3 mg of material in ethanol/water along with Nafion solution. Prepared catalysts inks were coated on L-type glassy carbon electrode (GCE- working electrode) and was analysed for the OER activities in a three electrode cell system, where, Graphite rod, Hg/HgO/1M KOH were used as counter electrode and reference respectively. X-ray diffraction pattern of NCHy, NCO, NCO@rGO, NCO@CNT, NCONCHy shows the peaks indexed to cubic $NiCo_2O_4$ with Space group: F*3. Furthermore, the peaks are showing red shift due to the incorporation of rGO and f-MWCNT and the rate of shift increases from NiCo2O4 to NiCo2O4@ f-MWCNT. The polarisation curve for




the as-synthesised samples NCHy, NCO, NCO@rGO, NCO@CNT, exhibited $\eta_{10}$ (overpotential at the current density 10 $mAcm^{-2}$) at 421 mV, 330 mV, 318 mV, 313 mV respectively, whereas NCO@NCHy attained 10 $mAcm^{-2}$ at $\eta$ = 287 mV. This is very clear indication of the support material enhancing the electrochemical activity toward OER. The stability of the catalyst was determined by ADT with high scan rate of 100

$mVs^{-1}$. The 1st and 5000th cycle of NCO@NCHy showed almost same current density, which substantiate the material stability. After ADT the stability of the catalyst material was determined by CA testing for duration of 6 hrs at a constant potential value of 600 mV vs. RHE for NCO@NCHy. The materials showed high degree of stability

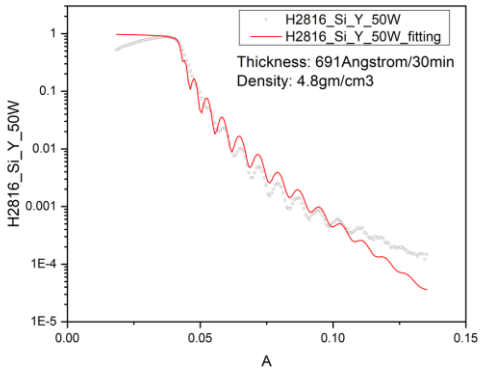
.

## Diffusion Dynamics of Yttrium and Yttrium oxide in Iron and ODS alloys

(CRS Proj. No. : 2021/CRS/24/59/173)

Dr K. Suresh Babu (PI), Pondicherry University, Puducherry – 605 014

Yttrium (Y) and Iron (Fe) were deposited on Silicon wafer (100) and glass substrates using sputter deposition technique for process optimization. The optimised process conditions are power, Ar gas flow (in SCCM), deposition pressure and substrate rotation. To estimate the thickness of the individual layers X-ray Reflectivity (XRR) was used. These films were annealed at different temperatures at 300, 400 and 500 °C in high vacuum annealing system for the diffusion study using SIMS. The diffusion of Yttrium is seen using SIMS and a change in the slope is observed. Further data analysis is under process to calculate of diffusion coefficients using the SIMS data.



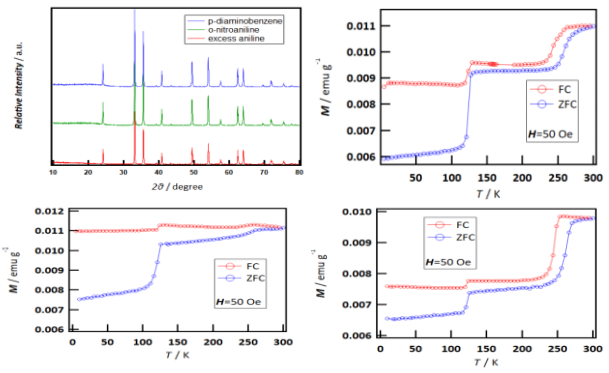

## Soft Molecular Chemistry approach for possible generating chiral ε-$Fe_2O_3$ phase

(CRS Proj. No. : 2021/CRS/24/39/253)

Dr. Prasanna S. Ghalsasi (PI), The M. S. University of Baroda, Vadodara 390 002

Synthesized $Fe_2O_3$ gel obtained after mixing Fe salt with different organic bases such as aniline, ortho-nitro aniline, and para-diamino benzene. This gel on drying results in the crystallization of organic salts and (partially hydrated) $Fe_2O_3$.

Iron oxide synthesized from above method was heated at 600°C to obtain crystalline product/phase, which was studied using powder x-ray diffraction technique. Powder x-ray diffraction observed after heating at 300°C showed a more amorphous nature. Magnetic measurement using SQUID magnetometer

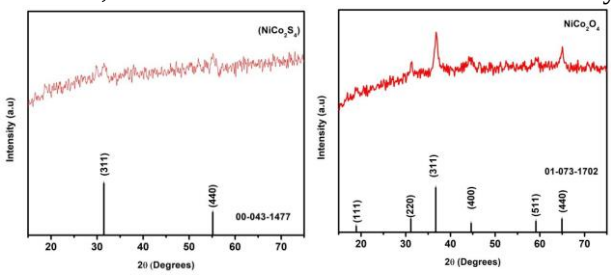



showed distinct different phases for the $Fe_2O_3$. Detailed correlation of the observed magnetic behaviour, powder x-ray and synthetic methodology is presently under investigation.

## Low Temperature Thermoelectric Performance of $NiCo_2S_4$ Spinel (CRS Proj. No. : 2021/CRS/35/44/645)

Dr. R. Navamathavan (PI), Vellore Institute of Technology, Chennai

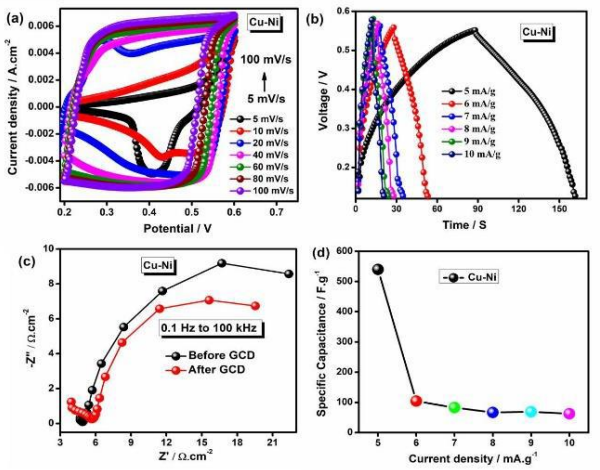
The synthesis of $NiCo_2S_4$ nanomaterial was carried out by Solvothermal method. The resultant nanostructure was formed. However, comparing the XRD data analysis for $NiCo_2S_4$ and $NiCo_2O_4$, it is identified that the $NiCo_2S_4$ did not form effectively. The formation of the $NiCo_2S_4$ nanostructure was not predominant due to the atmosphere effect. Hence, to obtain the stable formation of the $NiCo_2S_4$, the reaction should be performed under vacuum furnace, and then the sulfonation will efficiently take place.




## Development of High Voltage Solid-State Flexible Supercapacitors Using Graphene Based Electrode Materials and Gel-Electrolytes (CRS Proj. No. : 2021/CRS/52/21/156)

Dr. G. Murugadoss, Sathyabama Institute of Science and Technology, Chennai

High quality transition metal based electrode materials were synthesized, such as Cu and Ni as standalone electrodes materials and also a Cu-Ni nanocomposite electrode material focusing on their electrochemical performances. In the Cu-Ni Nanocomposite XRD spectrum the peaks clearly indicates the formation of both copper and nickel metals with the corresponding peak values. Deconvolution of high-resolution Ni 2p XPS spectra shows multiple split peaks of oxidized nickel along with a characteristic satellite peak. This shows that the surface of Ni gets oxidized and a broad oxygen peak (O 1s) confirms the formation of NiO. Cyclic Voltammetry curves of Cu-Ni metal nanocomposite electrode materials at the very low scan rate of 5 mV/s, there is a visible presence of redox peaks emerging from faradaic redox process. The increase in the cathodic and anodic peak separation during the increment of scan rate replicates the diffusion controlled redox process. The Distortion from the well-ordered EDLC curve suggests the nonlinear charge / discharge curves were resulted from the diffusion controlled process, that results in appearance of a plateau region in both CV and GCD curves, hence the energy storage mechanism is not capacitive in nature instead it is battery–type storage mechanism with nonlinear GCD behaviour. The GCD curves were monitored for various current densities from 5 mA/g to 20 mA/g and the calculated specific capacitance is of the order of 540 F/g at a current density of 5 mA/g. From the plot between specific capacitance and current density, it is clearly seen that when current density increases the specific capacitance gradually decreases which is as a consequence of scanty utilization of electro active material controlled diffusion which in turn inhibits the completion of complete redox transitions. The EIS measurement from 0.1 Hz to 100 kHz of Cu-Ni nanocomposites, even before and after GCD the internal resistance and the charge transfer resistance of the Cu-Ni nanocomposites are very low, suggesting a good capacitive behaviour and good diffusion rate of



ions. Current density versus specific capacitance graph shows high specific capacitance of 540 F/g at a current density of 5 mA/g. The overall performance of Ni-Cu nanocomposite were enhanced by its high porous structure with a uniform surface morphology followed by its unique battery like charge storage behaviour.

## Effect of ZnO nanoparticles on structure and magnetic properties of $Bi_2O_3$-$B_2O_3$: $Cr_2O_3$ glasses (CRS Proj. No. : CRS/2021-22/04/615)

Dr. L Srinivasa Rao (PI), VNR Vignana Jyothi Institute of Engineering and Technology, Hyderabad

ZnO nanoparticles doped $Bi_2O_3$–$B_2O_3$–$Cr_2O_3$ glass samples are synthesized by the melt-quenching. The XRD spectra confirm that the samples exhibit amorphous structure. The intensity and broadness of the two halos in the XRD spectra are observed to decrease, which confirm the homogeneous substitution of the ZnO nanoparticles in the composition by replacing the $Cr_2O_3$.The FTIR spectra depict the functional groups of the BBMZ glasses in terms of mainly, $[BO_4]$, $[BO_3]$, $[BiO_6]$ and $[ZnO_4]$ units. The EPR spectra of the BBC1 and BBCZ2 samples have shown two signals at $g \approx 4.7$ and $g \approx 1.98$ due to the existence of paramagnetic $Cr^{3+}$ ions in the glass matrix. Replacement of the $Cr_2O_3$ by ZnO nanoparticles in bismuth-borate glasses is responsible for i) improving oxidation of boron, ii) decreasing the $[O\text{-}H]^-$ absorption ability, and iii) declining the paramagnetic nature of BBCZ glasses. This is because of the ZnO nanoparticles improve the chemical durability and enhance the chemical reaction rate due to the increased surface to volume (S/V) ratio when comparing with the bulk state of ZnO. These glasses would catch hold of possible applications as optical elements, moisture sensors and magnetic sensors etc.

## Studies on UV-A, B, C Emitting Persistent Luminescent Materials ZnO (CRS Proj. No. : 2021/CRS/28/23/315)

Dr. Suchinder Sharma (PI), Amity University, Mohali

The recent developments on PersL materials especially those emitting UV radiation have found applications in photodynamic therapy, information storage, anticounterfeiting, photo catalysis, etc. To prepare UV-emitting materials, which can be divided into UV-A, UV-B and UV-C regions, one needs to follow smart techniques (calculations) rather than physical efforts. While VRBE gives us information about the exact location of rare earth ions in individual hosts, the options to prepare UV-emitting materials is limited as the transitions in lanthanides are restricted because of their f–f nature (for $Ln^{3+}$ ions). However, if one considers the $Ln^{2+}$ ions, and an f–d transition, the emission can vary quite a lot. Only few of the rare earth ions, $Gd^{3+}$, $Ce^{3+}$ and $Pr^{3+}$, are capable of emitting in the UV-region. The $Gd^{3+}$ and $Pr^{3+}$ emission is independent of the host crystal field due to shielding of the outermost electrons. The most promising among all is $Ce^{3+}$ whose 5d shell is affected by the choice of host lattice and the emission can be tuned from UV to red region.

## Nanostructured MXene as Alternate Anode for High capacity Lithium-ion and Sodium-ion Batteries: Probing Intercalation/Alloying Mechanisms (CRS Proj. No. : CRS/2021-22/04/596)

Prof. Perumal Elumalai (PI), Pondicherry University, Puducherry – 605 014

The lithium-ion and sodium-ion half-cell batteries were fabricated using the prepared delayered $Ti_3C_2$ MXene as anode material. The fabricated half-cells show excellent lithium and sodium storage

performances. The initial observation revealed that the fabricated half-cell delivers a stable high capacity of 295 mA h $g^{-1}$ for lithium-ion storage and 300 mA h $g^{-1}$ for sodium-ion storage. Further, the full-cell lithium-ion battery (MXene|1M LiPF6|LCO) and full-cell sodium-ion battery (MXene|1M NaClO4|NVP) in the form of CR-2032 coin cell and the practical pouch-type battery would be fabricated. The fabricated full-cell will be used for investigating the mechanism responsible for the lithium-ion and sodium-ion storage either by in operando XRD or post-mortem analysis (XRD, XPS and SEM) of the cycled cells. The aforementioned analysis will further confirm whether the enhanced storage and capacity is due to intercalation/DE intercalation or alloying/DE alloying mechanisms.

## **Design and development of nanomaterials for high-performance supercapacitors towards energy storage applications** (CRS Proj. No. : 2021/CRS/24/39/291)

Dr. S. Nehru (PI), University of Madras, Chennai

Making nanocomposites using carbon-based materials and pseudo capacitive bimetallic oxides is an efficient strategy to improve the electrochemical performance of supercapacitors. In this project, in-situ synthesis of nickel cobaltite on carbon nanosheets (CNS) with different ratios by facile hydrothermal method is reported. The size, morphology, defects, surface area and bonding states are identified by physiochemical methods like XRD, SEM, Raman, FT-IR, BET and XPS analyses are carried out. Electrochemical analyses of the electrode materials coated on nickel plate with fabricated by a three-electrode electrochemical system with a 3M Potassium hydroxide electrolyte. The electrode materials showed pseudo capacitive behaviour due to the fast faradaic redox properties between 0.0 to 0.5 V. Among the four different samples $NiCo_2O_4$@CNS (Y) (where, Y = 1.0, 2.0, 5.55 and 11.10 mmol) and the $NiCo_2O_4$@CNS (2.0) sample showed the high capacitance 736 F $g^{-1}$ and fabricated all symmetric and asymmetric supercapacitors by using 3M KOH electrolyte. The two-electrode system of the energy density is 25.9 W h $kg^{-1}$ at power density of 267 W $kg^{-1}$ for symmetric supercapacitors and 9.9 W h $kg^{-1}$ at power density of 465 W $kg^{-1}$ for asymmetric supercapacitors. The synergistic effect of both $NiCo_2O_4$ and CNS can improve the pseudo capacitor nature of the electrode materials

## **Redox functionalized MXenes for Designing High Energy Density Supercapacitor** (CRS Proj. No. : CRS/2021-22/04/611)

Dr. Senthilkumar S. (PI), Vellore Institute of Technology (VIT) Vellore – 632014

The structure of the synthesized $Ti_3C_2T_x$ MXene was investigated initially using pXRD in the 2θ ranging between 5 and 90°. Sharp diffraction peaks were observed indicative of the crystalline nature of the material. The morphology of synthesized $Ti_3C_2T_x$ MXene was characterized by FESEM, which clearly shows that the $Ti_3C_2T_x$ MXene exhibits microscale accordion-like morphology after etching with HF. Furthermore, EDX spectrum reveals the presence of Ti, C as well as terminal groups like -OH, -F in $Ti_3C_2T_x$. Further, the functionalization using carboxyl group was examined by recording the FTIR spectrum of $Ti_3C_2T_x$ MXene and COOH- $Ti_3C_2T_x$ MXene. In the FTIR spectrum, the stretching and bending vibration at 3432 $cm^{-1}$ and 1374 $cm^{-1}$ confirmed the strong hydrogen-bonded OH terminal group on the surfaces of $Ti_3C_2T_x$-MXene. In an anhydrous environment, these highly active -OH groups readily experienced ring opening followed by esterification reaction with succinic anhydride, which enabled the chemical introduction of

carboxylic acid (COOH) functional groups into the $Ti_3C_2T_x$ MXene surface to produce COOH-$Ti_3C_2T_x$ MXene.

The acid and alkali salts were used as etchants for the synthesis of $V_2CT_x$ MXene and the results were not satisfactory. HF is a harsh etchant that produces multi-layered (ML) $V_2CT_x$ MXene and flakes that are defective or of poor quality. In order to avoid this damage from high concentrated HF, a less harsh etchant for the synthesis of $V_2CT_x$ using a combination of HF and hydrochloric acid (HCl) was utilized. The synthesized ML-$V_2CT_x$ MXene was characterized by XRD, FESEM and EDX. In the XRD results, the (002) peak observed for $V_2AlC$ MAX phase shifted to 7.3° in the ML-$V_2CT_x$, which clearly witnesses the removal of Al from the MAX phase resulting in the formation of MXene. Moreover, the intensities of other diffraction peaks observed for ML-$V_2CT_x$ MXene was comparatively higher than that of the MAX phase, suggesting the more crystalline nature of $V_2CT_x$ MXene. The FESEM image displays opened multi-sliced Nano layers of ML-$V_2CT_x$ MXene. The elemental composition of ML-$V_2CT_x$ was tested by EDX and demonstrated the existence of (V, C, OH, F, Cl) in the ML-$V_2CT_x$ MXene.

## **The effect of molecular ion irradiation on diamond films** (CRS Proj. No. : CRS/2021-22/04/602)

Dr. K. J. Sankaran, CSIR-Institute of Minerals and Materials Technology, Bhubaneswar

The diamond films of various morphologies (microcrystalline diamond (MCD), ultrananocrystalline diamond (UNCD) and boron doped diamond (BDD)) were synthesized by varying the gas compositions of $CH_4$, $H_2$ and Ar and dopants. The obtained diamond films were implanted with nitrogen ions $N^+$, $N_2^+$, $N_3^+$, $N_4^+$, followed by annealing at 600C in $N_2$ atmosphere. The ion-implanted samples were characterized using FESEM and Raman spectroscopy. It is observed that the diamond films acquire $sp^2$-content after ion-implantation. The electrical properties of these ion implanted diamond films were carried out using Hall Effect measurements under van der Pauw configuration. It is observed that the $N_4^+$ implanted BDD films possess the high electrical conductivity as compared to the other diamond samples. The induction of the $sp^2$-phases in the BDD films due to nitrogen ion implantation could be the possible reason for the improvement in the electrical conductivity. Further characterization studies such as XPS, XANES and TEM studies are required to confirm this statement, are under progress.

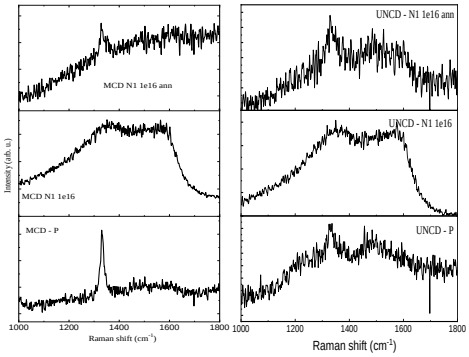



**Fig.1:** *Raman spectra of pristine, ion irradiated and annealed MCD and UNCD thin films.*

# 6. Reports on Conferences, Workshops and Seminars organised

## Awareness workshops (online mode) (6-15 September 2022)

UGC-DAE CSR organized six awareness workshops from 6$^{th}$September to 15$^{th}$September 2022 in online mode. The six workshops accommodated participants from Universities, colleges and institutes of northern region, eastern region, southern region, west and central region and north east regions of the country. Each workshop was coordinated by a CSR, Centre along with two local host universities from different geographical regions of the country:

**Photo:** A screen-shot of the Awareness workshop

| Date | Coordinator | Local host |
|---|---|---|
| 6-09-2022 | Kolkata | **Dr. Dambarudhar Mohanta, Dr. Moon Moon Devi**, Deptartment of Physics,Tezpur University, Tezpur<br>**Dr Mrityunjoy Mahato,** N.E.H University, Shillong |
| 7-09-2022 | Indore | **Dr. Farooq Hussain Bhat**, IUST, Awantipora, Kashmir<br>**Dr. Ram Prakash**,SMVD University, Katra |
| 9-09-2022 | Kolkata | **Dr. V. Rama Rao Medicherla**, SOAD University, Bhubaneswar<br>**Dr. Raj Kumar Nandi,** D.H.W University, Sarisha |
| 13-09-2022 | Kalpakkam | **Prof. C Venkateswaran**,University of Madras<br>**Dr. K. R. S. Preethi Meher**, Central University of Tamil Nadu Thiruvarur |
| 14-09-2022 | Indore | **Dr. Dhirendra Kumar,**G.J. College, Rambagh, Bihta, Patna<br>**Dr. Goverdhan Reddy,**Guru GhasidasUniv.,Koni, Bilaspur |
| 15-09-2022 | Mumbai | **Dr. Nikesh A. Shah,** Saurashtra University, Rajkot<br>**Dr. BasavarajAngadi,** Bangalore University |

The program commenced with welcome address by the local host/coordinators and Director/Centre Directors from UGC-DAE CSR followed by presentations on Synchrotron beamline facilities and in-house facilities by Indore Centre, Neutron scattering and other BARC facilities and in-house facilities by Mumbai Centre, Facilities at Variable Energy Cyclotron Centre and in-house facilities at Kolkata Centre and facilities at ion-beam accelerator and in-house facilities at the Kalpakkam node. The facilities at Indore Centre were introduced by Dr. Vasant Sathe, Dr.N.P. Lalla, Dr. V.R. Reddy, Dr. Mukul Gupta, Dr.Ramjanay Choudhary, and Dr. Dileep Gupta. The Facilities at Mumbai Centre were introduced by Dr. P.D. Babu, Dr.S. Rayaprol, Dr.S.D. Kaushik andDr. Sudip Mukherjee. BARC facilities were introduced by Drs. R. Acharya, BARC on some days and Dr. Anit K Gupta, BARC.. The Facilities at Kolkata Centre were introduced by Dr. S. Ghugre, Dr.J.M.B. Krishna, Dr. RajashriRaut, Dr. A .Chakraborty and Dr. S. Chatterjee. The Facilities at Kalpakkam node were introduced by Dr. N V Chandra Shekar, Dr. G.M. Bhalerao, Dr. Shamima Hussain, Dr. Sujoy Chakravarty and Dr. K Saravanan. The presentations were followed by a discussion session on each day wherein participants asked their queries related with the utilization of the facilities and CRS projects.

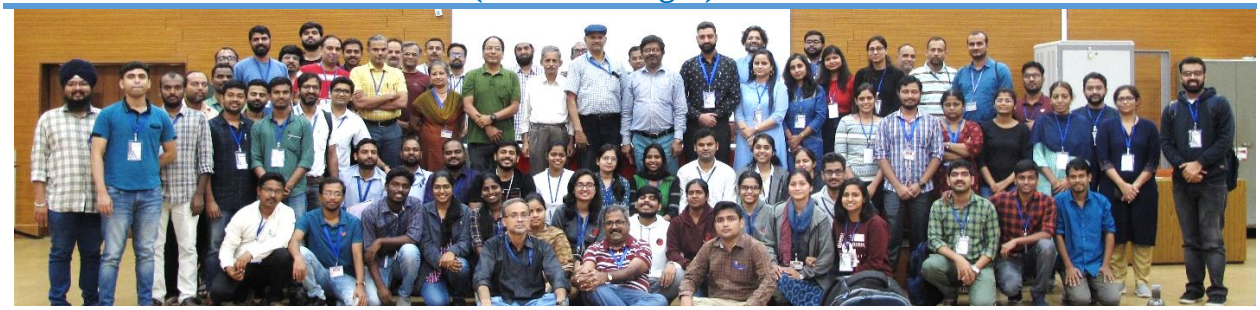
The event was attended by at least 80 to 120 participants each day. The response from the participants was encouraging and is expected to results in a pan India increase in the users of the facilities.

## Annual Science Day Celebrations (7 December 2022)

UGC-DAE Consortium for Scientific Research, Indore celebrated its Annual Science Day on 7th December, 2022. On this occasion, Chancellor, Homi Bhabha National Institute and Chaiman, GB, UGC-DAE CSR Dr. Anil Kakodkar, was the Chief Guest. The function started with the floral welcome to the chief guest by the Director, UGC-DAE CSR, Prof. Amlan J. Pal. Dr. V. Sathe, Centre Director, UGC-DAE CSR, Indore Centre, welcomed the Director, IIT Indore Prof. Suhas Joshi and Dr. S. Ghughare, Centre Director, UGC-DAE CSR, Kolkata Centre, welcomed Head of the Physics Department, DAVV Indore, Prof. A. Mishra. Dr. P.D. Babu, Centre Director, UGC-DAE CSR, Mumbai Centre welcomed Shri T.A. Puntambekar, Director, Electron Accelerator Group, RRCAT, Indore and Prof. R. Gupta, Head of the Instrumentation Department, DAVV Indore was welcomed by Dr. V. Sathe. This was followed by a brief address by the Director, UGC-DAE CSR, Prof. Amlan J. Pal, highlighting the role of Consortium in providing the access to the big science facilities of the country to the University researchers and the importance of collaborative research among different institutions. Director, IIT Indore Prof. Suhas Joshi also underlined the significance of a joint research efforts and ways to further enhance it. On this occasion, Shri T.A. Puntambekar from RRCAT, Indore briefed about the ongoing combined academic activities between UGC-DAE CSR, Indore and RRCAT, Indore along with other institutions, universities and colleges across India. Prof. A. Mishra of DAVV, Indore emphasized the importance of the UGC-DAE CSR, Indore in the academic activities of the Physics department of DAVV, Indore and other colleges. Dr. R.J. Choudhary introduced the Chief Guest to the gathering, highlighting his scientific achievements and recognitions. Dr. Anil Kakodkar on this occasion delivered an Annual Science Day Lecture. In his lecture he talked about the knowledge empowerment and its linkage with the economy, society and growth of a country. He stressed on developing the culture of innovation among students at the initial stage of school / colleges itself and develop a knowledge society. After the Chief Guest's address, Dr. V. Sathe proposed a vote of thanks. The function was attended by scientists and academicians from RRCAT, DAVV and other institutions and scientists and students of CSR.


*Dr. Anil Kakodkar, Chaiman, Governing Board, UGC-DAE CSR and Vice-Chancellor, Homi Bhabha National Institute addressing the gathering at Annual Science Day Celebration-2023.*

## XIX School on Neutrons as Probes of Condensed Matter (NPCM-2022)
## November 14 – 19, 2022
## Venue: TSH (Anushaktinagar) & Dhruva-BARC



UGC-DAE Consortium for Scientific Research (CSR), Mumbai centre and Solid-State Physics Division (SSPD) BARC in association with Neutron Scattering Society of India (NSSI) organized the XIX school on Neutrons as Probes of Condensed Matter (NPCM-2022) from November 14 – 19, 2022 at BARC Mumbai, highlighting the use of neutrons in condensed matter physics. This edition was nineteenth in the series and was coordinated by Dr. Sudhindra Rayaprol (UGC-DAE CSR, Mumbai Centre) and Dr. Mayanak K Gupta (SSPD, BARC).

The school was attended by 65 participants comprising of faculty members, research scholars and post-doctoral fellows from various Indian universities and research institutions from all over the country. For the first time, NPCM lectures were relayed simultaneously on an online platform (WebEx) for the benefit of those participants who could not be accommodated for in-person (offline) participation. 100 participants signed up for online lectures, and about 40 participants were always online during the lecture sessions.

The school comprised four days of lectures and tutorials, and two days of experiments at Dhruva reactor. Over four days, 19 lectures and 4 tutorials were conducted at Multipurpose Hall (MPH) at the Training School Hostel (TSH), Anushaktinagar, Mumbai. The lectures covered various aspects of neutron scattering and were delivered by experts. Four tutorials on the analysis of SANS and diffraction data including crystallographic and magnetic structure data, were also conducted. Experimental sessions were carried out at Dhruva reactor on fourth and fifth day of the school. During the Dhruva visit for experimental sessions on fourth and fifth day, two lectures one each on health physics and research reactors were delivered by the experts from health physics and reactor operations division, Dhruva reactor, BARC.

On 14th November 2022, the school after inauguration by the Chief Guest Prof. Amlan J. Pal, Director, UGC-DAE CSR. He emphasized the role of CSR in value-addition in the research endeavours of faculties and students from various universities and institutions from all over the country. He also encouraged students to have a balanced, but focused approach to life and research so that the doctorate in philosophy is justified. Dr. S. M. Yusuf, Director Physics Group, BARC gave the introductory lecture for the benefit of all participants. His long-standing association with the neutron schools and his support for the program was well received by the audience. All the participants were welcomed by Dr. P. D. Babu (Centre Director, UGC-DAE CSR Mumbai Centre), and he also briefed them about the mandate and activities of UGC-DAE CSR, especially Mumbai centre.

***Prof. A. J. Pal**, Director (UGC-DAE CSR) and Dr. S. M. Yusuf, Director, Physics Group, BARC, delivering their speeches during the inaugural ceremony of NPCM-2022.*

Dr. S. Rayaprol (UGC-DAE CSR) and Dr. M. K. Gupta (SSPD, BARC), Coordinators NPCM-2022 briefed the participants about the school and proposed vote of thanks, respectively.

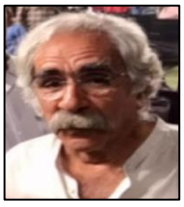
## IX$^{th}$ International Conference on Perspectives in Vibrational Spectroscopy (ICOPVS-2022)


*Unveiling of the abstract book of ICOPVS-22 by Prof. Siva Umapathy and Dr. S. V. Nakhe.*

The 9$^{th}$ International conference on perspectives in vibrational spectroscopy (ICOPVS2022), has been organized by UGC-DAE CSR, Indore Centre along with Devi Ahilya University, Indore from 13 to 17 December 2022. The conference was inaugurated by Dr. Shankar V. Nakhe, Director RRCAT Indore in the presence of patrons of the conference, Prof. Amlan J Pal, Director, UGC-DAE CSR, and Prof. Renu Jain, Vice Chancellor, Devi Ahilya University, Indore, keynote speaker Prof. Siva Umapathy, Director, IISER, Bhopal and Conference Chair Dr. Vasant Sathe, Centre Director, UGC-DAE CSR, Indore. In his inaugural remarks Dr. Vasant Sathe, Conference chair provided the scope of the conference in light of the current developments in vibrational spectroscopy.

In a keynote lecture, Prof. Siva Umapathy, Director, IISER, Bhopal presented his result on femtosecond time sensitivity and his patent on the in-depth analysis of materials hidden inside a box using Raman spectroscopy and its application in defence, forensic and security sectors. He also discussed the utility of vibrational spectroscopy in the early detection of kidney-related disease.

In the technical session, Dr. Vasant Sathe, UGC-DAE CSR, Indore presented his breakthrough research of measuring a very small (femtometer) atomic displacement inside a crystal lattice using polarised Raman spectroscopy and its usages in understanding multiferroicity, charge density waves, superconductivity etc. Prof. Ara Apkarian, University of California Irvine, USA, presented Surface Enhanced Raman Spectroscopy based technique to visualize the vibrations of atoms inside a molecule. Prof. Sebastian Schlucker, Germany presented his work on enhancing the sensitivity of Raman spectroscopy by choosing the size and gap between nano-particles, new way of preparation of nano-particles with homogeneous size and shape. The enhanced sensitivity is useful in detecting very small dose of viruses and therefore detection of infection like Corona at early stages.



**Prof. A. Apkarian**

**Prof. Siva Umapathy**

**Prof. S Schlucker**

**Prof. Mischa Bonn**

**Dr. V G Sathe**

*Plenary speakers delivering their talk at the conference.*

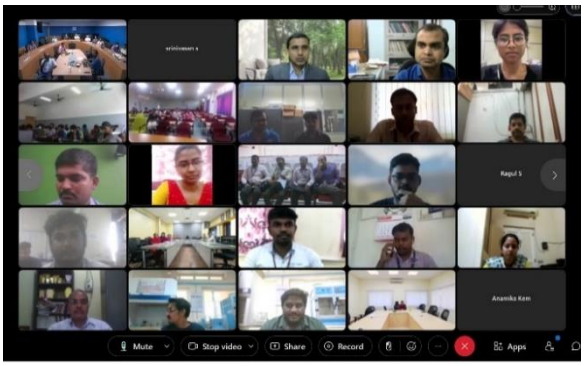
Prof. Mischa Bonn, from Germany was awarded with Dayawati Rastogi Award for his contribution in vibrational spectroscopy.

In an evening talk, Prof. Vasant Shinde of CSIR, Hyderabad, spoke about the Indian knowledge system and the discovery of Indian DNA from an excavated body belonging to the 4000 BC period in Rakhigari.

The conference was attended by nearly 250 participants including leading researchers in vibrational spectroscopy. There were 30 invited talks, 30 contributory talks and 150 poster presentations in various areas of vibrational spectroscopy like, decease diagnostic, theoretical/computational methods, vibrational spectroscopy in materials science, ultrafast spectroscopy. Eight young participants were awarded Dayawati Rastogi Awards for their excellent contributory talks and Poster presentations. The conference was financially supported by DST-SERB and BRNS, India.

## Awareness Meet on Materials Science with Ion Accelerator (Hybrid mode), 19 July 2022

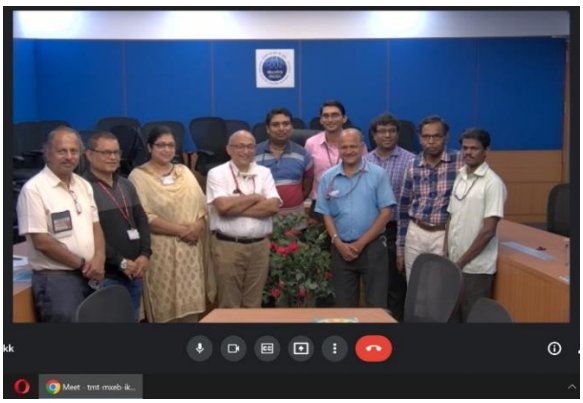
Awareness meet on Mterials science with Ion Accelerator was organized on 19th July 2022 on Hybrid mode at Kalpakkam Node. Local participant/speakers were attended in person and other participants and speakers were attended via online. The workshops were coordinated by different centres and local coordinators. Nearly 250 participants from 24 different academic institutions have been participated in this event and most of them are from southern part of India.




*Snapshots taken during the awareness meet.*

Dr. N. V. Chandra Shekar, Scientist in charge, Kalpakkam Node welcomed the dignitaries, invited speakers and the participants. He gave brief overview about the meet. Prof. Amlan J. Pal, Director UGC-DAE CSR delivered the presidential address. Dr. Vasant Sathe, Center Director, Indore Center gave brief introduction about UGC DAE CSR and its mandate to felicitate utilization of mega DAE facilities and other advanced facilities to University researchers. Dr. R. Divakar, Director MMG & MSG IGCAR, delivered the inaugural address. He emphasized on more scientific interaction between University researchers and IGCAR scientists through such meetings. After inaugural address one e-booklet about ion accelerators, various types of accelerator and its application, was released. After release of the booklet the first keynote lecture entitled "Ion accelerators and radiation research: the Indian perspective" was delivered by Dr. C. David, IGCAR. He gave the participants a glimpse about various ion accelerators available in India and abroad and the utilization of ion beams as a principal tool for ion beam analysis, studying radiation damage and societal applications. After keynote lecture, Dr. Sanjiv Kumar, Head, NCCCM/BARC, delivered the next talk entitled "Depth profiling by energetic ion beams: concepts and applications". Next speaker Dr. R. J. Choudhary, Scientist-G, UGC-DAE CSR Indore delivered the talk entitled "Probing the correlation between electronic and magnetic properties of transition metal oxides using Indus synchrotron source". He gave the participants an overview of Synchrotron facility at RRCAT and different beamlines available for various studies. The next speaker was Dr. K. J. Sankaran, Senior Scientist, CSIR-IMMT, Bhubaneswar, who gave a focused talk on "ion beam implantation in diamond thin films for electron emission applications". His The first speaker of the second session was Dr. S. Amirthapandian, Scientific Officer-G, ARDSS, MSG, IGCAR. He gave a talk entitled "Ion irradiation effects in materials science - Role of Electron microscopy". He gave an overview to the participants about the power of electron microscopy in understanding the ion irradiation effects such as ion beam mixing, ion beam synthesis, ion irradiation induced phase transformation,

amorphization etc. The next speaker was Dr. Mukul Gupta, Scientist-G, UGC-DAE CSR, Indore. He presented an overview of beamline BL-01 at Indus-2 in RRCAT for soft XAS & MCD experiments and important results obtained utilizing this facility. The next speaker was Dr. M. Vairavel, Postdoctoral Fellow, Uppsala University, Sweden. He gave a talk entitled "Novel applications of MeV ion beams: from battery research to forensic applications". He presented the application of ion beam in depth profiling of Li and O in $Li^+$ ion batteries. The next talk was delivered by Dr. B. Sundaravel, Scientific Officer-G, ARDSS/MSG, IGCAR, Kalpakkam. The title of his talk was "Ion beam analysis of Crystallinity and Defects". He gave a very nice presentation including basics of ion beam analysis in probing the defects in crystalline materials. The last talk of the 2nd session was delivered by Dr. K. Saravanan, Scientist-D, UGC-DAE CSR Kalpakkam Node. The title of his talk was "Surface modification by Ion beam irradiation". His talk is mainly focused on application of ion beam in modification of 2D materials, thin films and surfaces. The next session was feedback session. In feedback session the participants were encouraged to ask questions and give their suggestions. Most of the participants thanked the organizers for conducting this awareness meet and giving an overview about the facilities available at UGC DAE CSR in general and application of ion accelerators in material science research in particular. After the feedback session the meeting was concluded with a vote of thanks delivered by Dr. Shamima Hussain Scientist-F, UGC-DAE CSR Kalpakkam Node.



*Local organizing committee of the Awareness meet.*

## Teacher's Day 2022

UGC-DAE Consortium for Scientific Research, Indore Centre celebrated Teachers Day on 07 and 08 September 2022. The event included two special colloquia by eminent scientists. On day one, Prof. Sanjay Mathur, Chair Professor and Director, Institute of Inorganic and Materials Chemistry, University of Cologne, Germany delivered a special colloquium on "Chemically Processed Functional Ceramics for Energy and Health Applications". The event's second day included a special colloquium on "Ultrafast Polaron Dynamics in Perovskites Materials" by Professor Hirendra N. Ghosh, Bhabha Atomic Research Centre, Mumbai. Dr. Vasant G. Sathe, Centre-Director, Indore Centre, welcomed the guests. Prof. Amlan J. Pal, Director, UGC-DAE CSR spoke about the role of teachers in mentoring graduate and undergraduate students to take up academic research as a career path. Research scholars made cultural performances in honor of their teachers on both days of the event.

*(left to right) Floral welcome of Prof Sanjay Mathur and Prof. H N Ghosh by the Director and centre Director, respectively. Cultural performance by the research scholars of the Indore Centre.*

## Research Scholar days, 5-6 Jan 2023

The in-house research scholar workshop was conducted on "Research Scholar days" 5-6 Jan 2023 as a part of academic committee, Indore centre. The research scholars of the consortium delivered talk on their published research work. Special Colloquium and evening lectures were delivered by eminent scientists Prof. Sanjay Puri (JNU Delhi), Prof. Aditi Sen (HRI Prayagraj), Dr.K.K.Pant (RRCAT, Indore), and Prof. Surajit Dhara (University of Hyderabad). The external experts along with our in-house faculty members went through all the students presentation and gave valuable suggestion to improve their work further.

## Report on National Science Day 2023

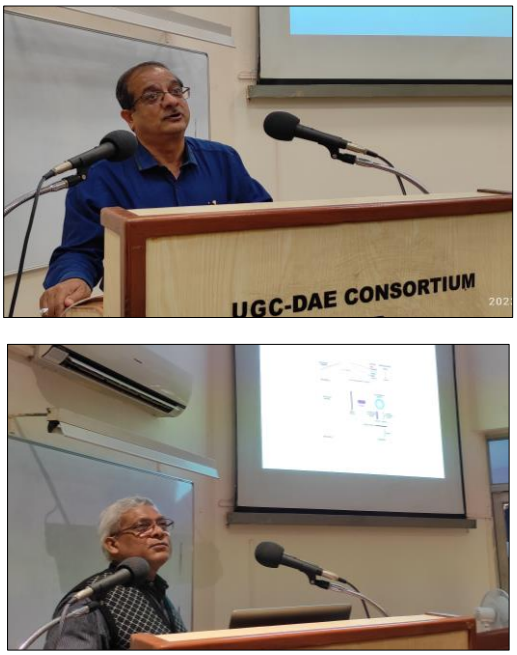



**Photo:** *(top) Address by the chief guest Prof. A. Mishra, HoD, SoP, D.A.V.V. (bottom) Opening remarks by Dr. N.P. Lalla, Scientist-H, UGC-DAE CSR Indore*

The National Science day, which marks the discovery of Raman effect was celebrated on February 28, 2023 in the Bhide hall of the Indore Centre. On this occasion, Dr. N.P. Lalla gave opening remarks and explained the basics of Raman effect. This was followed by a chief guest address by Prof. A. Mishra, HoD, School of Physics, D.A.V.V., who motivated the students to pursue a research career. The highlight of the event was scientific demonstrations by research scholars of our Indore centre. The event concluded with the presentation of vote of thanks

List of scientific demonstrations.

1. **Superconducting suspension effect (Magnetic Levitation)** by Satyendra Singh/Rajeev Dwivedi / Dr. Venkatesh
2. **Effect of Liquid Nitrogen on Materiala Properties** by Sushil Kumar/Mohan Gangrade/Dr. Venkatesh
3. **Shape Memory Alloy** by Mohan Gangrade/Dr. Venkatesh
4. **Spinning ball in Liquid Nitrogen** by Saranjeet Singh/Manisha Priyadarshini/Dr. D. Kumar
5. **Pressure Demo: Balloons in Liquid Nitrogen** by Saranjeet Singh/Manisha Priyadarshini/Dr. D. Kumar
6. **Tesla Effect for Transferring Power without Cable** by Pragati Sharma / Divya
7. **Drinking Bird** by Sishir Jana
8. **Light and Vision** by Nikita Choudhary/Akshaya A./Ashish Gupta

## Report on One-Day Meeting on "Applications of X-ray & Electron Diffractions in Condensed Matter Physics and Material Science

One day meeting on "Applications of X-ray & Electron diffractions in Condensed Matter Physics and Material Science " was organized on Friday, 24 March 2023. It is hosted by the Indore Centre of the UGC-DAE Consortium for scientific research (UGC-DAE CSR). This meeting aimed to bring some eminent scientists working in this area to discuss and share knowledge on the latest developments in this field with young researchers and students. On that occasion, we also facilitated Dr Niranjan Prasad Lalla for his immense scientific contribution to this field. Based on the vast experience and significant contribution in this area, we invited six eminent speakers from different places to deliver talks in their expertise.

Dr. Dileep Kumar welcomed all the participants/ speakers on behalf of the consortium. He thanked the Director, Prof. Amlan J. Pal and the Centre Director, Dr Vasant Sathe, for initiating the idea of conducting this meeting. Prof. Rajeev Ranjan from IISC Bangalore, Dr Archana Sagdev and Dr Himanshu Shrivastava from RRCAT, Indore, Dr Pankaj Sagdev from IIT Indore, Dr Shahid Anwar and Dr Sharmishtha Anwar from IMMT, Bhubaneswar delivered talks in different sessions of the meeting which were chaired by Dr V. Sathe, Dr R. Rawat and Dr V. R Reddy from UGC-DAE CSR Indore.

The facilitation function (the last session) was conducted by Dr Debalaya Sarker. She and the participants recalled their association with Dr Lalla. Dr. Lalla also talked about his journey as a researcher. At the end of the event, his students (ex as well as current), organizers and the Centre Director, Indore Centre facilitated Dr. Lalla by presenting a Shawl and a memento.

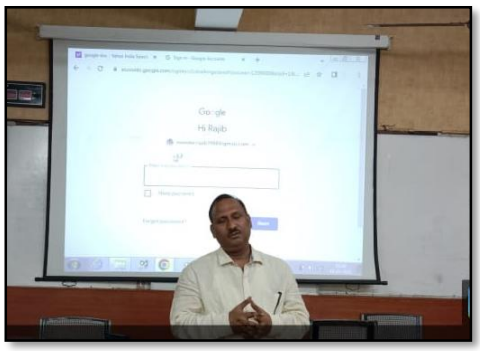
*Some photograph from the felicitation function of Dr. Lalla*

## (Online) Workshop on Presentation of Experimental Proposals for Campaign of the Digital INGA@VECC

Kolkata Centre organized a workshop during 4th to 6th January, 2023, in association with VECC and SINP. The proceedings consisted of presentations by researchers intending to use the digital INGA setup at VECC for their experiments on nuclear structure investigations. There were around twenty presentations and each was followed by discussions on the physics, the experimental conditions and the feasibility of the proposed experiment. The proposals included those led by users groups from different teaching and research institutions such as Visva Bharati, IIT-BHU, IIEST (Shibpur), University of Allahabad, BARC, University of Mumbai, UM-DAE CEBS (Mumbai), TIFR, SINP and VECC. The inauguration of the event was graced by the Director, UGC-DAE CSR and the Director, VECC and the Director, SINP. The Chairman of the Accelerator Users' Committee at VECC introduced the audience to the premises of the proposed campaign.

## Hindi Language Workshop

Kolkata Centre has organized a Hindi language workshop on 14th November 2022 where a special lecture was delivered by Shri Nirmal Kumar Dubey, Assistant Director (Implementation), Regional Implementation Office (East), Ministry of Home Affairs, Department of Official Language. After the workshop, Kolkata Centre has taken several steps towards implementation of Hindi in the daily functioning.



## Outreach Program

During this period UG & PG students from the Department of Electronics, D.M. College of Science, Dhanamanjuri University, Manipur; Department of Physics, Jhargram Raj College; Department of Physics, ADAMAS University; Department of Physics, Presidency University; Department of Physics, Jagomaya Devi College have visited the Kolkata Centre as a part of their curriculum. During their visit, presentations by, Prof. Umesh Garg (Senior Full Bright-Nehru Fellow), Dr. Ajit K. Sinha (Former Director UGC-DAE CSR), Tilak Kumar Ghosh (Scientific Officer-VECC), and Gayathri N. Banerjee (Scientific Officer- VECC) and the in-house faculties were organized which catered to a milieu for interaction of the young minds with senior practitioners in the research domain.


## Vigilance Awareness Week

Kolkata Centre has celebrated vigilance awareness week during October 31 to November 06, 2022. Shri Suresh Madhavan, Chief Vigilance Officer (CVO) of Metal Scrap Trading Corporation Limited (MSTC Ltd.) under the aegis of Ministry of Steel, Govt. of India, delivered a lecture at Kolkata Centre on the occasion of "Vigilance Awareness Week" on 31st Oct, 2022. Shri Madhavan mentioned that every Vigilance Awareness week has a theme. Shri Madhavan then discussed the different forms of corruption.

## Student Seminar

As part of improving speaking, presentation, and interaction skills, Kolkata Centre has organized its Ph.D. students to deliver seminar on a periodic basis. The first type of seminars involved a journal talk, involving a published manuscript related to their research topic. The other type of seminars involved a library talk, where the student has to prepare and deliver a talk based on a topic from a book borrowed from the institute library. It was observed that these presentations significantly improved the students' professional oratory skills.

## CSR Colloquiums organised at UGC DAE CSR Indore

1. **"Present scenario of understanding the charged particle and photon induced Inner Shell Ionization processes and their applications"** by Prof. Prof. Debasis Mitra, University of Kalyani, 11 April 2022. (online mode)
2. **"Rational design of functional materials: A chemist's approach"** by Prof. A K Tyagi, Director, Chemistry Group Bhabha Atomic Research Centre, 06 May 2022. 11 April 2022
3. **"Use of Raman spectroscopy in Physics, Chemistry and Biology fields"** by Prof. Chandrabhas Narayana, Director, Rajiv Gandhi Centre for Biotechnology, 19 May 2022.
4. **"Chemically Processed Functional Ceramics for Energy and Health Applications"** by Prof. Sanjay Mathur, Inorganic and Materials Chemistry, University of Cologne, Greinstrasse 6, D-50939 Cologne, Germany, 07 Sep 2022
5. **"Ultrafast Polaron Dynamics in Perovskites Materials"** by Prof. Hirendra N. Ghosh Bhabha Atomic Research Centre, 08 Sep 2022
6. **"The new emerging Physics of Metal-insulator Transition"** by Prof. Arup Kumar Raychaudhuri, SERB Distinguished Fellow, CSIR- Central Glass and Ceramic Research Institute, Kolkata, 17 Nov 2022
7. **"Post-collision interactions and photoelectron recapture upon atomic inner-shell photoionization. Angular correlations and ultrafast science"** Prof. Yoshiro AZUMA, Visiting Professor, IIT, Delhi, 17 Nov 2022
8. **"Buckling and Defects in Two – Dimensional Atomically Thin Monolayers"** by Prof. Ayan Datta, School of Chemical Sciences, IACS, Kolkata, 20 Jan 2023.
9. **"Spintronic and topological aspects of certain equiatomic Heusler alloys"** by Prof. K. G. Suresh, Department of Physics, Indian Institute of Technology Bombay, Mumbai, 10 March 2023.

# हिंदी पखवाड़ा व्याख्यान (2022)

प्रत्येक वर्ष की भंति हिंदी पखवाड़ा के अवसर पर इस वर्ष भी हिंदी व्याख्यान का आयोजन किया गया। व्याख्यान दिनांक 30.09.2022 को दोपहर 3.00 बजे इंदौर केंद्र के भिड़े लेक्चर हॉल में संपन्न हुआ। व्याख्यान इंदौर केंद्र की एक महिला वैज्ञानिक श्रीमती डॉ. देबलय सरकार ने दिया । व्याख्यान का शीर्षक और सार इस प्रकार है।

## "कार्यात्मक-पदार्थों की स्वायत्तशासी संगणकीय और प्रायोगिक खोज"

व्याख्याता: डॉ. देबालया सरकार

**व्याख्यान**- सारांश

विषम उत्प्रेरक के अलावा, ताप-विद्युतीक उपकरण वर्तमान युग के गिने-चुने टिकाऊ लेकिन व्यवहार्य ऊर्जा समाधानों में से हैं। एकल-परमाणु-मिश्र-उत्प्रेरक (एसएएसी) और ताप-विद्युतीक दोनों का यह पक्का वादा, वर्तमान में उपलब्ध सामग्री की तुलना में अतिरिक्त-उपलब्ध उच्च-दक्षता वाली सामग्री की पहचान तथा उसके डिजाइन पर निर्भर है। सामग्री से संबंधित उपलब्ध रासायनिक जानकारी-भंडार की विशालता के कारण हालांकि अभी तक केवल इसके छोटे अंश को ही प्रयोगात्मक और/या संगणकीय रूप से स्कैन किया जा सका है। एक सक्रिय-शिक्षण-ढांचे में संकुचित-संवेदन आधारित प्रतीकात्मक-प्रतिगमन को नियोजित करते हुए, हमने न केवल बेहतर SAAC/TE सामग्री की रचनाओं में एक प्रवृत्ति की पहचान की है, बल्कि कई अत्यंत उच्च प्रदर्शन करने वाली सामग्रियों की भविष्यवाणी को प्रयोगात्मक रूप से सत्यापित भी किया है। इनमें से, हमने AgCuGaTe को 827 K पर ~ 2.8 उच्च योग्यता का एक प्रयोगात्मक आंकड़ा रखने वाला ताप-विद्युतीक पाया, जो इस क्षेत्र में एक महत्त्वपूर्ण सफलता है। कई नए अनुमानित SAACs में, Ag (111) पर Mn और Zn (001) सतह पर Pt को न केवल सक्रिय होने की भविष्यवाणी की गई, बल्कि इनहे उत्प्रेरक हाइड्रोजनीकरण के लिए स्थिर उम्मीदवार भी पाया। हमारी कार्यप्रणाली पदार्थ-विज्ञान में भौतिक-सूचित-वर्णनकर्ताओं के महत्व और उनकि जबरदस्त क्षमता को प्रदर्शित करती है, विशेष रूप से अपेक्षाकृत छोटे डेटा सेट के लिए जो अच्छी तरह से नियंत्रित प्रयोगों से उपलब्ध हुआ है।

# 7. Appointments/ Superannuation

## Appointments

**Dr. Sanjoy Kr Mahatha** joined the Indore centre as Scientist-D on 1st August 2022. He has expertise in laboratory- and synchrotron-based photoemission and X-ray absorption spectroscopies. He received his PhD degree in 2013 from Saha Institute of Nuclear Physics (SINP, Calcutta University). Post PhD, he worked as a Postdoctoral Researcher at International Center for Theoretical Physics, Italy (2013-2014), Consiglio Nazionale delle Ricerche, Italy (2014-2016) and Aarhus University, Denmark (2016-2018) and as a Scientist at Deutsches Elektronen-Synchrotron DESY, Germany (2018-2021). Piror to joining Indore Centre, he was working as an Assistant Professor at Thapar Institute of Engineering and Technology, Patiala during 2021-2022.

**Dr. Sumanta Chattopadhyay** joined as a Scientist-D at the UGC-DAE CSR, Mumbai Centre on February 16, 2023. He has expertise in neutron diffraction, X-ray diffraction, and extreme condition magnetometry (high-field, mK regime) techniques. His research interest involves exploring the physics of various types of quantum materials such as quantum magnets, multiferroics, and topological systems. Dr. Chattopadhyay performed his doctoral research work at the Indian Association for the Cultivation of Science (IACS), Kolkata and awarded the Ph.D. degree from the University of Calcutta in 2013. As a post-doctoral fellow, he worked at the Laboratoire de Physique des Solides (LPS), Orsay, France (2013-15), CEA Grenoble & Institute Laue Langevin (ILL), Grenoble, France (2015-16), and Dresden High Magnetic Field Laboratory (HLD-EMFL), Dresden, Germany (2017-23).

**Dr. Souradyuti Ghosh** joined Kolkata Centre as Scientist-D on 12th May 2022. He has expertise in radiation biology, biomarker screening, and bioanalytical method development. He received his Ph.D. from Johns Hopkins University, Baltimore, USA (2015), where his research work focused on the synthesis and characterization of radiation induced DNA damages, especially involving DNA-DNA interstrand cross-link formation. He did his postdoc in Cornell University, Ithaca, NY (2015-16) where he probed UV-induced spatiotemporal release of electrophiles in cell and downstream signalling pathway. Prior to joining UGC-DAE CSR Kolkata Centre, he was employed as an assistant then associate professor at Bennett University (2016 – 2022) where his research focused on nucleic acid engineering and isothermal amplification based nucleic acid identification.

**Shri Sourav Sarkar** joined the Kolkata Centre on 27th June 2022 as Administrative Officer-I. Before joining the Kolkata Centre, Shri Sarkar had served as a Section Officer at the Mumbai Centre of the Consortium. He comes with a decade-long of experience in various administrative positions in different organizations.

**Shri Abhay Kumar Seth** joined the Kolkata Centre on 9th May 2022 as Personal Assistant to the Centre-Director. Prior to joining the Centre Shri Seth had served the legal fraternity.

**Mr. Ziaul Haque** joined Indore Centre as Junior Engineer-C on 25th May 2022

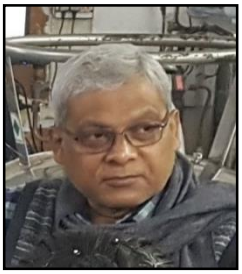
**Mr. Narian Kumar Lengay** joined Indore Centre as AO-I on 8th August 2022

**Mr. Lokesh Shrivas** joined Indore Centre as Assistant-1 on 10th August 2022

**Mr. Kumud Narayan** joined Indore Centre as PA to Centre Director on 22nd December 2022

## Superannuation

**Dr. N. V. Chandra Shekar** relieved the position of Scientist in-Charge of Kalpakkam Node on 31st March 2023. He took charge in 1st Nov 2018. During his tenure is a memorandum of understanding (MoU) between IGCAR and UGC-DAE CSR, Kalpakkam Node was signed by the Director , IGCAR , Dr. A. K. Bhaduri and the Director , UGC-DAE CSR, Dr. A .K. Sinha on March 11, 2020, renewing the existing MoU up to December 2023. One of the major achievement during this perioed is the inauguration of the 200kV accelerator at UGC-DAE CSR, Kalpakkam Node..



**Dr. N. P. Lalla,** Scientist-H superannuated from the Consortium on March 31st , 2023, after serving Indore centre as a scientist for more than 26 years. During his tenure he established TEM laboratory and LTHM-XRD facilities. LTHM-XRD facility is one of the unique x-ray diffraction facilities in the country. He has also made significant contributions in the field of crystallography by understanding several complex routes of structural ordering in various oxide perovskites.

**Shri Ram Prasad Chattopadhyay** was associated with the Kolkata Centre since November 1996, as an Administrative Officer-I in-charge of the Accounts Section. He superannuated from his position on 31st July 2022. Shri Chattopadhyay would be remembered for his contributions in sustaining awareness workshops and user activities carried out as a part of the mandate of the Consortium.

**Mr. Arjun Sanap**, PS to Director retired on 30th September 2022.

**Mr. Ambrose Joseph**, Caretaker, Indore Centre retired on 30th November 2022.

# 8. Awards/ Ph.D. Theses/ Projects

## 8.1 Awards

### Indore Centre (in-house)

1. **Dr. Ram Janey Choudhary**, Scientist-G, Indore Centre has received the **Materials Research Society of India (MRSI)'s Medals for 2022** at MRSI annual meeting held at IIT, Jodhpur.
2. **Dr. Vasant Sathe**, Centre Director, Indore Centre have received the **"Science Excellent Award"** for 2023 by Charotar Moti Sattavis Patidar Kelavani Mandal, Anand, Gujrat.
3. **Dr. Debalya Saker**, Scientist-D, Indore Centre received the Best Thesis Award 2017, IIT Delhi [August 2022].
4. **Mr. Bodhoday Mukherjee**, research scholar, Indore Centre received the best paper award in the National Conf. on Physics and Chemistry of Materials (NCPCM2023), Holkar Sci. College, Indore during 16 - 18 March, 2023.
5. **Ms. Najnin Bano,** research scholar, Indore Centre received **"Dayawati Rastogi best poster presentation Award"** in "International Conference on Perspective in Vibrational Spectroscopy**"** held during 13-17 December 2022 at Indore, India.
6. **Mr. Satyendra Singh Nirvan, r**esearch scholar, Indore Centre received the best poster award at "International e-Symposium on Materials Development and Scale-up for Membrane Separation, Sensing, Energy and Biological Applications (MDS-MSEB)" 24-25$^{th}$ Jan 2023 (Virtual Mode), organized by the Department of Chemical Engineering, SRM Institute of Science and Technology,Kattankulathur.
7. **Ms. Isha**, research scholar, Indore Centre received Max-Planck fellowship for MPI-Stuttgart visit during **January-March, 2023**.
8. **Mr. Koushik Chakraborty**, research scholar, Indore Centre received visiting research scholar Max-Planck fellowship to visit MPI-FKF, Stuttgart, Germany **May-June, 2023**.
9. **Dr. Arvind Yogi,** Scientist-D, Indore Centre received Bhabha-Newton funding for ISIS-UK experiments **June, 2023.**
10. **Dr. Mukul Gupta** Scientist-G, Indore Centre is mentoring a TARE project from SERB with Dr. Ghadai from SMIT, Majitar, Sikkim.
11. **Dr. Mukul Gupta,** Scientist-G, Indore Centre is serving as Advisory Editorial Board Member for Applied Surface Science Advances (Elsevier) and Associate Editor of Hybrid Advances (Elsevier).
12. **Dr. S. Rayaprol,** Scientist-G, Mumbai Centre Consultant for International Union of Crystallography (IUCr) – Commission on Magnetic Structure (CMS).

### (Under CRS)

13. **Ms Disha Harinkhere** received Young Scientist Award from MPCOST, Bhopal (2023)
14. **Dr. M. Maghimaa** (CRS project PI) received Young Scientist Award in 3rd Intl. Conf. on Applications of Natural compounds, Nanomaterials, Oncolytics in Cancer Biology and Biotechnology (ICANNO CB-22) of School of Life Sciences and ACER, B. S. Abdur Rahman Crescent Instt. Science & Technology, Chennai, India and Purdue University, USA on 27-28 October, 2022.
15. **Dr. M. Maghimaa** (CRS project PI) received the best young Researcher Award in the National Conf. on Recent Trends in Microbial Biotechnology, Bharthidasan University, Tiruchirappalli, Tamil Nadu on 24 February 2023.

## 8.2 Ph.D. Theses

### Indore Centre (in-house)

1. **Mohit Chandra** has been awarded Ph.D. degree from DAVV, Indore (May 2022) for the thesis titled, "*Investigation of structural, dielectric and magneto-dielectric properties of transition metal oxides*" under the supervision of Dr. R Rawat and Dr. Kiran Singh, May 2022.
2. **Mr. Akash Surampalli** has been awarded Ph.D. degree from DAVV, Indore (July 2022) for the thesis titled, *"Preparation and study of $BaTiO_3$ based electro-caloric materials"* under the supervision of Dr. V. Raghavendra Reddy.
3. **Mr. Manik Kuila** has been awarded Ph.D. degree from DAVV, Indore (Dec 2022) for the thesis titled, *"Preparation and study of $R_3Fe_5O_{12}$ garnet based magneto-optically active materials"* under the supervision of Dr. V. Raghavendra Reddy.
4. **Mr. Deepak Prajapat** has been awarded Ph.D. degree from DAVV, Indore (March 2023) for the thesis titled, *"Structural, Magnetic and Electrical Properties of Four Layer Aurivillius Compounds"* under the supervision of Dr. V. Raghavendra Reddy.
5. **Mr. Sumit Bera** has been awarded Ph.D. degree from DAVV, Indore ( Physics 2022) for the thesis titled, *"Morphological and physical properties of systems including materials of topological interest"* under the supervision of Dr. V. Ganesan and Co-supervision of Dr. R.Venkatesh.
6. **Mr. Prakash Behera** was awarded Ph.D. degree from DAVV, Indore ( Physics 2022) for the thesis titled, *"Electronic and Thermal Properties of Material Systems Including those Derived from Metal-Insulator Transitions*" under the supervision of Dr. V. Ganesan.
7. **Dr. Anup Kumar Bera** has been awarded Ph.D. degree from DAVV, Indore (March 2023) for the thesis titled *"In-situ growth and tuning the magnetic properties of ultrathin films by ion sculpting"* under the supervision of Dr. Dileep Gupta.

### Kolkata Centre (in-house)

8. **Mr. Sambhu Charan Das** has been awarded Ph.D. degree by University of Calcutta for the thesis titled, "**Magnetic Behaviour of Some Manganese Based Alloys Having First Order Structural Transition**" under the supervision of Dr. Souvik Chatterjee

### (under CRS)

9. **Mr. Pintu Singha** of University of Calcutta has been awarded Ph.D. degree by University of Calcutta for the thesis titled, "***Thermoelectric and Magnetransport Property Study of Bismuth Chalcogenides***" under the supervision of Dr. Aritra Banerjee

### Kalapakkam Node (in-house)

10. **Mr. Abhishek Thakur,** has been **awarded** Ph.D. (Physics) 2022 by University of Madras, Chennai for the thesis titled, *"Studies on freestanding PVDF thin films with some Nano-fillers"* under the supervisiton of Dr. Shamima Hussain.
11. **Mr.Siddhartha Dam,** has been **awarded** Ph.D. (Physics) 2022 by University of Madras, Chennai for the thesis title, *"Studies on thin films of transition metal dichalcogenides"* under the supervision of Dr. Shamima Hussain.

## 8.3 M.Sc./ M.Phil./ Summer projects

### Indore Centre

1. "Introduction to Resistivity measurements and Sample preperation by Arc melting Technique" Ms. Poonam Yadav from Amity University , Jaipur under the supervision of Dr. Archana Lakhani
2. "SERS based diagnostic applications using 2-D materials" Ms. Sachi Sharma, Devi Ahilya University, 30-04-2023, under the supervision of Dr. Praveen Kumar Velpula.
3. "Probing the stability and structural transitions of the perovskite functional materials at extreme conditions using the Raman spectroscopy" Ms. Urmi Deshmukh, Devi Ahilya University, 30-04-2023, under the supervision of Dr. Praveen Kumar Velpula.
4. Ms. Apurva, Ms. Nainshree, and Ms. Vaishali of DAVV, Indore.
5. Morphological and structural characterization of Tellurium Nanostructure synthesized by microwave assisted solvothermal process, Ms. Shivani Panchtilak, Holkar science college,Indore.
6. Morphological and structural characterization of Tellurium Nanostructure synthesized by microwave assisted solvothermal process, Ms. Neha viswakarma, Holkar science college,Indore.
7. Morphological and structural characterization of Tellurium Nanostructure synthesized by microwave assisted solvothermal process, Ms. Shakshi seshraoji charde, Holkar science college,Indore

### Kolkata Centre

8. **"Measurements for Characterization of Gamma-ray Detectors"** Sandip Paul and Souvik Maity, Panskura Banamali College, May, 2022, Dr. Rajarshi Raut.
9. **"Internship on Gamma-ray Detection"** Sufia Arshi and Joyshree Seal, ADAMAS University, September-October, 2022, Dr. Rajarshi Raut.
10. "**Schiff-base derivative for selective fluorescence sensing of $Al^{3+}$ ion.**" Asif Ikbal Nurani, Aliah University, Dr. Goutam Pramanik.
11. **"Sample preparation and study of the transition temperature of Ti doped $Mn_5Si_3$ alloy"** Animesh Ghanta, Panskura Banamali College, May, 2022, Dr. Souvik Chatterjee.
12. **"Study of structural properties by powder x-ray diffraction and mössbauer spectroscopic properties of pure iron"** Debabrata Patra and Sourav Rana, Panskura Banamali College, May, 2022, Dr. Rajib Mondal.

## 9.1 List of Publications

## Indore Centre

### In-house publications

1. **Electron-magnon scattering in an anisotropic half-metallic ferromagnetic Weyl semimetal Co3Sn2S2**
Shivam Rathod , Megha Malasi , Archana Lakhani , and Devendra Kumar**,** Phys. Rev. Materials **6** (2022) 084202 (https://doi.org/10.1103/PhysRevMaterials.6.084202).
2. **Evidence of surface delocalization in ultrathin films of topological insulator in presence of intersurface hybridization and disorder**
Megha Malasi, Shivam Rathod , Archana Lakhani, and Devendra Kumar, Appl. Phys. Lett. **121** (2022) 093101 (https://doi.org/10.1063/5.0101268)
3. **Quantum coherent transport and electron–electron interaction in BiSbTe single crystals**
Indu Rajput, Sonali Baral, Mukesh Kumar Dasoundhi, Devendra Kumar, Archana Lakhani, Materials Today Communications **33** (2022) 104537 (https://doi.org/10.1016/j.mtcomm.2022.104537)
4. **Growth of rare-earth monopnictide DySb single crystal by novel Self-flux method**
Mukesh Kumar Dasoundhi, **Archana Lakhani*,Journal of Crystal Growth 605, 127053 (2023).**DOI: https://doi.org/10.1016/j.jcrysgro.2022.127053
5. **Enhancing the limit of uniaxial magnetic anisotropy induced by ion beam erosion**
AK Bera, AS Dev, D Kumar,Appl. Phys. Lett. 122 (2023) 022405.
6. **Interface magnetism in Fe/Alq3 bilayer; interface resolved nuclear resonance scattering studies**
AG Khanderao, S Kaushik, AS Dev, VR Reddy, I Sergueev, HC Wille, ...Journal of Magnetism and Magnetic Materials 560, 169663 (2022).
7. **Growth of ultra-thin Cobalt on fullerene (C60) thin-film: in-situ investigation under UHV conditions**
S Kaushik, AG Khanderao, P Gupta, VR Reddy, D Kumar, Materials Science and Engineering: B 284, 115911 (2022).
8. **Kinetically-decoupled electrical and structural phase transitions in $VO_2$**
S. R. Sahu, S. S. Majid, A. Ahad, A. Tripathy, K. Dey, S. Pal , B. K. De, Wen-Pin Hsieh, R. Rawat, V. G. Sathe,, and D. K. Shukla, **Phys. Rev. B 107**, 134106 (2023). https://doi.org/10.1103/PhysRevB.107.134106.
9. **Raman mode softening in $SrMnO_3$ induced by optical excitation**
Arup Kumar Mandal, Aprajita Joshi, Surajit Saha, Binoy Krishna De, Sourav Chowdhury, V. G. Sathe, U. Deshpande, D. K. Shukla, Amandeep Kaur, D. M. Phase, and R. J. Choudhary, **Physical Review B 106**, 104104 (2022)**.** https://doi.org/10.1103/PhysRevB.106.104104.
10. **Monoclinic symmetry at the nanoscale in lead-free ferroelectric $BaZr_xTi_{1-x}O3$ ceramics**
K. Dey, A. Tripathy, S. R. Sahu, H. Srivastava, A. Sagdeo, J. Strempfer, and D. K. Shukla, Phys. Rev. B 105, 174202 (2022). https://doi.org/10.1103/PhysRevB.105.174202.
11. **Improved Thermoelectric Figure of Merit in Polyol Method-Prepared $Cu_{1-x}Bi_xS$ ($x \leq 0.06$) Nanosheets**
B. Mukherjee, **R. Chatterjee**, Tarachand, A. Lakhani, N. P. Lalla, S. Hussain, **Y.-K. Kuo**, G. S. Okram. **Cryst. Growth Des.** Published on 13 April (2023). DOI: 10.1021/acs.cgd.3c00 029
12. **Improved Thermoelectric Figure of Merit in Polyol Method Prepared $(Cu_7Te_4)_{1-x}(MnTe_2)_x$ ($x \leq 0.06$) Nanocomposites**
B. Mukherjee, C. Chotia, R. Venkatesh, **Y.-K. Kuo** and G. S. Okram**. J. Mater. Science: Mater. Electronics 34, 144 (1-8)** (2023). DOI: 10.1007/s10854-022-09591-x
13. **Electron–phonon interactions and superconductivity of β-Nb2N thin films**
S. Kalal, A. Tayal, S. Karmakar, R. Joshi, R. Rawat, M. Gupta, , Applied Physics Letters 122, 072602 (2023). DOI: https://doi.org/10.1063/5.0142370.
14. **Study of Fe-C phase formulations through Fe self-diffusion during thin film growth**
Prabhat Kumar, O. Leupold, I. Sergueev, H.-C.Wille, M. Gupta, , Applied Surface Science 597, 153611 (2022).DOI: https://doi.org/10.1016/j.apsusc.2022.153611
15. **Light-Controlled Magnetoelastic Effects in Ni/$BaTiO_3$ Heterostructures**
A. Bagri, A. Jana, G. Panchal, S. Chowdhury, R. Raj, M. Kumar, M. Gupta, V. R. Reddy, D. M. Phase, R.J. Choudhary, , ACS Applied Materials & Interfaces 15, 14, 18391–18401 (2023). DOI: https://doi.org/10.1021/acsami.2c21948.
16. **Structural and magnetic asymmetry at the interfaces of MgO/FeCoB/MgO trilayer: Precise study under x-ray standing wave conditions**

Md. S. Jamal, P. Gupta, R. Raj, M. Gupta, V. R. Reddy, D. Kumar, , Journal of Applied Physics 131, 235301 (2022). DOI: https://doi.org/10.1063/5.0092977

17. **Interface-resolved study of magnetism in MgO/FeCoB/MgO trilayers using x-ray standing wave techniques**
Md. S. Jamal, P. Gupta, I. Sergeev, O. Leupold, D. Kumar, , Physical Review B 107, 075416 (2023). DOI: https://doi.org/10.1103/PhysRevB.107.075416.
18. **Role of Local Structural Distortions on the Origin of *j* = 1/2 Pseudo-Spin State in Sodium Iridate**
P Yadav, S Sarkar, M Sharma, DM Phase, RJ Choudhary and Rajamani Raghunathan, ACS Applied Electronic Materials 5 (1), 418-428 (2023).
19. **Robust perpendicular magnetic anisotropy in Ce substituted yttrium iron garnet epitaxial thin films**
Manik Kuila, Archna Sagdeo[#], **Lanuakum A. Longchar**, R. J. Choudhary, **S. Srinath**, and V. Raghavendra Reddy,J. Appl. Phys. 131, 203901 (2022), https://doi.org/10.1063/5.0085572.
20. **Electrocaloric effect in Sn substituted BaTiO3 ceramics: covering a broad temperature range**
Akash Surampalli, Deepak Prajapat & V. Raghavendra Reddy, Ferroelectrics, 589, 64 (2022), https://doi.org/10.1080/00150193.2022.2061219.
21. **Effect of substrate and Fe/Rh stoichiometry on first order antiferromagnetic–ferromagnetic transition in FeRh thin films**
Pampi Saha, Seema, V.R. Reddy, Pooja Gupta[#], Mukul Gupta, R. Rawat,Journal of Magnetism and Magnetic Materials 551 (2022) 169095 https://doi.org/10.1016/j.jmmm.2022.169095.
22. **Morphology induced large magnetic anisotropy in obliquely grown nanostructured thin film on nanopatterned substrate**
Anup Kumar Bera, Arun Singh Dev, Manik Kuila, Mukesh Ranjan, Pallavi Pandit, Matthias Schwartzkopf, Stephan V. Roth, Varimalla R. Reddy, Dileep Kumar,Applied Surface Science 581 (2022) 152377, https://doi.org/10.1016/j.apsusc.2021.152377.
23. **Magnetism in four-layered Aurivillius Bi5FeTi3O15 at high pressures**
Deepak Prajapat, Akash Surampalli, Anjali Panchwanee, Carlo Meneghini, Ilya Sergeev, Olaf Leupold, Srihari Velaga, Binoy Krishna de, Marco Merlini, Konstantin Glazyrin, René Steinbrügge, Atefeh Jafari, Himashu Kumar Poswal, V.G. Sathe and V. Raghavendra Reddy,Journal of Magnetism and Magnetic Materials 562 (2022) 169783. https://doi.org/10.1016/j.jmmm.2022.169783.
24. **Screen-printed film deposited using quasi 2-dimensional Bi2Se3 nanostructures for desalination membrane filler application**
Kumar, Sushil, M. P. Saravanan, Dileep Kumar, and R. Venkatesh. *Journal of Environmental Chemical Engineering* 10, no. 2 (2022): 107128. DOI: 10.1016/j.jece.2022.107128.
25. **Two-Dimensional Weak Antilocalization Signatures Due to Quantum Coherent Transport in Nanocrystalline SnTe**
Singh, Satyendra, Hasan Afzal, Vinay Kaushik, Sushil Kumar, Prakash Behera, and R. Venkatesh, *Langmuir* 38, (2022) 3122. DOI: 10.1021/acs.langmuir.1c03091.
26. **Intricate interplay between superconductivity and topological surface states of c axis oriented $MoTe_2$**
Afzal, H., Patidar, M.M., Saravanan, M.P., Venkatesh, R. and Ganesan, V., 2022.. *Journal of Applied Physics*, *131*(19), p.193902. DOI: 10.1063/5.0087830.
27. **Reversible optical control of Fano resonance and domain configuration at room temperature in BaTiO3**
V Dwij**,** BK De**,** MK Gupta **#,** R Mittal #**,** NP Lalla, V Sathe Journal of Applied Physics **131 (5)** (2022) 053102.
28. **Temperature-Dependent Structural, Dielectric, and Raman Spectroscopy Studies on Magnetoelectric $Co_4Nb_2O_9$**
Satish Yadav, Mohit Chandra, R Rawat, Ashish Khandelwal, LS Sharath Chandra, RJ Choudhary, Vasant Sathe, AK Sinha, **Kiran Singh**The Journal of Physical Chemistry C **126 (35)** (2022) 14986-14994.
29. **Optical control of domain configuration through light polarization in ferroelectric**
Vivek Dwij, Binoy Krishna De**,** Sumesh Rana**,** Hemant Singh Kunwar**,** Satish Yadav**, h**ikha Rani Sahu**,** R Venkatesh, NP Lalla, DM Phase, DK Shukla, VG Sathe, Physical Review B **105 (13)** (2022) 134103.
30. **Imaging of strain driven magnetic domains and strong spin-phonon coupling in epitaxial thin films of $SrRuO_3$**
S Tyagi, VG Sathe, G Sharma, R Rawat,Applied Surface Science **589** (2022) 153024.

31. **Revisiting eigen displacements of tetragonal BaTiO3: Combined first principle and experimental investigation**
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38. **Complex magnetic behaviour in rare earth rich magnetocaloric materials–$R_3T$**Srikanta Goswami, P.D. Babu, R Rawat; *Acta Crystallogr. A ACTA CRYSTALLOGR A* **78**, a477-a478 (2023)
39. **CoFeVSb: A promising candidate for spin valve and thermoelectric applications**J. Nag, D. Rani, D. Singh, R. Venkatesh, B. Sahni, A. K. Yadav, S. N. Jha, D. Bhattacharya, P. D. Babu**,** K.G. Suresh and Aftab Alam, *Phys. Rev. B* **105**, 144409 (2022). [https://doi.org/10.1103/PhysRevB.105.144409].

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**T Patri, T Durga Rao**, K Chandra Sekhar, S Raghupathi Rao, S Rayaprol, and P. D. Babu; *Phys. Status Solidi B* 259 (11), 2200223 (2022). [https://doi.org/10.1002/pssb.202200223]
41. **Antiferromagnetically coupled double perovskite as an efficient and robust catalyst for visible light driven water splitting at neutral pH**
N. Kumar, T. Rom, B. Mallick, R. Kaushik, A. Ghosh, P.D. Babu, S.K. Panda, and A.K. Paul; *Phys. Chem. Chem. Phys.* **24**, 5083 (2022). [DOI https://doi.org/10.1039/D1CP04082K]
42. **Metamagnetic Transitions and Magnetocaloric Properties of $HoCr_{1-x}Fe_xO_3$ (x= 0.25 and 0.75) Compounds**
G. Kotnana, **P.D. Babu** and S.N. Jammalamadaka, *J. Supercond. Nov. Magn.*, 1-11 (2022). [https://doi.org/10.1007/s10948-022-06225-5]
43. **Neutron diffraction study and temperature variation of magnetic anisotropy in Bi substituted nickel ferrite**
**Vazeera Bhanu**, **P. V. Prakash Madduri**, **M. Harsita**, **T. Durga Rao**, K. Vinod#, S. Rayaprol, **A. K. Bhatnagar**, Awadhesh Mani#, **Bhumireddi Sattibabu,** Ceramics Int. 48 (2022) 23300. [DOI: https://doi.org/10.1016/j.ceramint.2022.04.316)]
44. **Impact of electric poling on structure, magnetism and ferroelectricity of $0.7(PbFe_{0.5}Nb_{0.5}O_3)$ – $0.3(BiFeO_3)$ multiferroic**
**Sunanda T. Dadami**, Sudhindra Rayaprol, Vasant Sathe and **Basavaraj Angadi,** Solid State Commun. **351** (2022) 114766. [DOI: doi.org/10.1016/j.ssc.2022.114766]

45. **Unraveling the effect of A-site Sr doping in double perovskites $Ca_{2-x}Sr_xScRuO_6$ ($x$ = 0 and 1): Structural interpretation and mechanistic investigations of trifunctional electrocatalytic effects**
**Nikhil Kumar**, **Tanmay Rom**, **Mukesh Kumar**, **Tharamani C. Nagaiah**, Eoyoon Lee, Hyung Chul Ham, Sun Hee Choi, Sudhindra Rayaprol, Vasudeva Siruguri, **Tapas Kumar Mandal**, Brendan J. Kennedy, and **Avijit Kumar Paul,** ACS Appl. Energy Mater. **5** (2022) 11632. [DOI: doi.org/10.1021/acsaem.2c02101]
46. **Temperature Dependent Crystal Structure of Nd2CuTiO6: An In Situ Low Temperature Powder Neutron Diffraction Study**
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**Korobi Konwar**, Niyorjyoti Sharma, Pranjali Pranjali, Anupam Guleria, Som Datta Kaushik, Anupam Dutta, Rupak Mukhopadhyay, Debasis Sen, Weibo Gao, **Pritam Deb,** Langmuir, 38, 11087 (2022). [https://doi.org/10.1021/acs.langmuir.2c01764]
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51. **Thermoresponsive phase behavior and nanoscale self-assembly generation in normal and reverse Pluronics®**
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54. **Broadband dielectric spectroscopy and small-angle neutron scattering investigations of chitosan-graphene-silver metacomposites**
**S. Somanathan**, V. K. Aswal#, **R. P. Ramasamy**, J. Mater. Sci.: Mater. Electron. **33**, 217 (2022). [DOI: 10.1007/s10854-021-07287-2]
55. **Formulation, Solubilization, and In Vitro Characterization of Quercetin-Incorporated Mixed Micelles of PEO-PPO-PEO Block Copolymers**
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58. **Heme Protein Binding of Sulfonamide Compounds: A Correlation Study by Spectroscopic, Calorimetric, and Computational Methods**,
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61. **Structural transitions in TPGS micelles induced by trehalose as a model cryoprotectant,**
S. Arya, R. Patidar, D. Ray#, V.K. Aswal#, N. Ranjan, **P. Bahadur** and S Tiwari, Colloids Surfaces A **642**, 128714 (2022). [https://doi.org/10.1016/j.colsurfa.2022.128714]
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63. **Unusual solubilization capacity of hydrophobic drug olanzapine in polysorbate micelles for improved sustained drug release,**
P. Singla, **S. Garg**, **S. Kaur**, **Navneet Kaur**, **N. Kaur**, V. K. Aswal#, E. Velliou, **H. Kaur**, M. Peeters, **R. K. Mahajan**, J. Mol. Liq. **359**, 119256 (2022) [https://doi.org/10.1016/j.molliq.2022.119256]
64. **Composition triggered Aggregation/Solubilization behaviour of mixed counter charged gemini Surfactants: A Multi-technique investigations,**
**B. Patel, Sneha Singh, K. Parikh, V. Chavda, D. Hirpara**, D. Ray#, V.K Aswal#, **Sanjeev Kumar**, J. Mol. Liq. 359, 119242 (2022). [https://doi.org/10.1016/j.molliq.2022.119242]
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71. **Effect of monovalent salts on molecular interactions of globular protein (BSA) above its isoelectric point,**
S. Pandit, S. Kundu and V. K Aswal#, Chem. Phys. Lett. **804**, 139916 (2022). [https://doi.org/10.1016/j.cplett.2022.139916]
72. **Probing the supramolecular assembly in solid, solution and gel phase in uriede based thiazole derivatives and its potential application as iodide ion sensor,**
A. M. Patel, D. Ray#, V. K. Aswal# and A.Ballabh, J. Mol. Liquids **362**, 119763 (2022). [https://doi.org/10.1016/j.molliq.2022.119763]
73. **Cholesterol Mediated Stable Vesicles: A Nano Drug Delivery Vehicle for Anti-cancer Drugs Curcumin and 5-Fluorourecil,**
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**B. Patel, S. Singh, K. Parikh, V. Chavda, D. Hirpara**, D. Ray#, V. K Aswal# and **Sanjeev Kumar**, J. Mol. Liquids **359**, 119242 (2022). [https://doi.org/10.1016/j.molliq.2022.119242]

76. **Altering of the Electric and Magnetic Dipole Transition Probability of $Eu^{3+}$ in YPO4 Lattice by Codoping of K+ Ion: Potential Materials for Imaging and Heating**
**Ramaswamy Sandeep Perala,** Manas Srivastava**#,** Bheeshma Pratap Singh**#,** V. N. K Putta**#**, R Acharya**#**, and R.S. Ningthoujam**#,** Industrial and Engineering Chemistry Research (ACS) 61, 9755 (2022). [https://doi.org/10.1021/acs.iecr.2c01463]

Following publications is common with Indore Centre

77. **Nontrivial Topological Features and Griffith's-Phase Behavior in CrFeVGa Probed by Experiment and Theory**
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## Kalpakkam Node

### In-house publications

1. **Study on High Pressure Behaviour of Spherical Carbon Black Nanoparticles With Core-Shell Structure**
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2. **High pressure studies on core/shell amorphous carbon nanostructures**
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4. **Enhanced dielectric properties of freestanding, flexible, hydrophobic cellulose/poly(vinylidene fluoride) composite films**
   Mandeep Jangra, Abhishek Thakur, Siddhartha Dam, Shamima Hussain, **J. Polym. Sci. 61** (2023) 334–345. https://doi.org/10.1002/pol.20220512.
5. **Investigating the Enhanced Photoresponse in MoS2/GaAs Heterojunction**
   Siddhartha Dam, Shamima Hussain, **Phys. Status Solidi Appl. Mater. Sci. 220** (2023). https://doi.org/10.1002/pssa.202200378.
6. **Effect of 200 keV H+ ion implantation on films of poly(vinylidene fluoride)**
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   Abhishek Thakur, Mandeep Jangra, Siddhartha Dam, Shamima Hussain, **J. Mater. Sci. Mater. Electron. 33** (2022) 18658–18672. https://doi.org/10.1007/s10854-022-08715-7.
8. **A Comprehensive Review on Ion Beam Reduced Graphene Oxide-Tailoring the Reduction with Optical, Electrical and Electronic Structural Properties**
   K. Saravanan, **G. Jayalakshmi**, B. Sundaravel#, N. V. Chandra Shekar#, **Journal of Electronic Materials 51** (2022) 4169. https://doi.org/10.1007/s11664-022-09702-8

### Following publications are common with Indore Centre, Kolkata Centre

9. **Thermal stability of the magnetic moment in amorphous carbon thin film - An experimental and ab-initio study**
   Balaram Thakur, Sharat Chandra#, Yogesh Kumar, Mukul Gupta, UP Deshpande, NV Chandra Shekar#, Sujay Chakravarty. Diamond and Related Materials **Volume 127** (2022) 109200. https://doi.org/10.1016/j.diamond.2022.109200
10. **Thermally-induced co-existence of superparamagnetism and spin-glass like behavior in undoped amorphous AlN thin film**
    Deena Nath, Sujay Chakravarty, K Saravanan, UP Deshpade, Arup Dasgupta#, AV Thanikai Arasu#, R Baskaran#, NV Chandra Shekar#. Materials Research Bulletin **Volume 153** (2022) 111876. https://doi.org/10.1016/j.materresbull.2022.111876
11. **Thickness-dependent structural and magnetic properties of Fe4N thin films**
    Akhil Tayal, Pooja Gupta#, Sujay Chakravarty, Mukul Gupta. Journal of Magnetism and Magnetic Materials **Volume 563** (2022) 169999. https://doi.org/10.1016/j.jmmm.2022.169999
12. **Enhanced dielectric properties of MoS2/ PVDF free-standing, flexible films for energy harvesting applications**
    Mandeep Jangra, Abhishek Thakur, Siddhartha Dam, Souvik Chatterjee, Shamima Hussain, **Mater. Today Commun. 34** (2023). https://doi.org/10.1016/j.mtcomm.2022.105109.
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## Collaborative Research (with authors from CSR**)

14. Variation of sulfur concentration on the effective deposition of solution processed ZnS thin films for buffer layer in thin film solar cells, **R Anne Sarah Christinal**, **I Prakash**, **A Alex Arunmozhi**, Sujay Chakravarty, **A Leo Rajesh,** Materials Today: Proceedings **68** (2022) 356-362. https://doi.org/10.1016/j.matpr.2022.05.569\
15. Spray pyrolysed Cu2ZnSnS4 thin film photovoltaic cell fabricated using cost effective materials. **R Anne Sarah Christinal**, **I Prakash**, Sujay Chakravarty, **A Leo Rajesh**. Physica B: Condensed Matter **637** (2022) 413911. https://doi.org/10.1016/j.physb.2022.413911
16. Tunable room temperature ferromagnetism in fullerene thin film induced by 1 MeV Proton microbeam irradiation. **Ram Kumar**, **Krishna Mohan**, **Amala Augusthy**, **Sandeep Bari**, **Anukul P Parhi**, **Aditya H Kelkar**, Sujay Chakravarty, **Neeraj Shukla**. Thin Solid Films Volume **755** (2022) 139350. https://doi.org/10.1016/j.tsf.2022.139350
17. Sulfurization free spray deposited kesterite Cu2ZnSnS4 absorber layer for photovoltaic applications. **R Anne Sarah Christinal**, **G Genifer Silvena**, Sujay Chakravarty, **A Leo Rajesh**. Journal of Materials Science: Materials in Electronics 33 (2022) pages22361–22373. https://doi.org/10.1007/s10854-022-09014-x
18. Enhancement of electron mobility and thermoelectric power factor of cobalt-doped n-type Bi2Te3. **P Singha**, **Subarna Das**, **VA Kulbashinskii**, **VG Kytin**, Sujay Chakravarty, **AK Deb**, **S Bandyopadhyay**, **Aritra Banerjee**. International Journal of Energy Research 46 (2022) 17029-17042. https://doi.org/10.1002/er.8366
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20. Multiple Magnetic Phases and Anomalous Hall Effect in Sb1.9Fe0.1Te2.85S0.15 Topological Insulators. **Debarati Pal**, **Abhineet Verma**, **Mohd Alam**, **Sambhab Dan**, Amit Kumar#, Seikh Mohammad Yusuf#, Soma Banik#, Sujay Chakravarty, **Satyen Saha**, **Swapnil Patil**, **Sandip Chatterjee**. The Journal of Physical Chemistry C **127** (2023) 5, 2508–2517. https://doi.org/10.1021/acs.jpcc.2c06655

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21. Giant exchange bias in antiferromagnetic Pr2CoFe0.5Mn0.5O6: a structural and magnetic properties study. **Khyati Anand, Arkadeb Pal, Amish G Joshi, Prabir Pal,** Rahul Singh#**, Peter Tsung-Wen Yen, SM Huang, Md Alam, Seema Kumari,** Vasant Sathe**,** Sujoy Chakravarty**, Anita Mohan, Sandip Chatterjee.** Journal of Physics D: Applied Physics **55** (2022) 365004. DOI 10.1088/1361-6463/ac79da
22. Effect of reentrant spinglass-like states on Schottky Anomaly and exchange bias in polycrystalline Sm0. 5Y0. 5Fe0. 58Mn0. 42O3. **Subhajit Raut**, S Chakravarty, **HS Mohanty**, **S Mahapatra**, S Bhardwaj, A M Awasthi, **B Kar**, **K Singh**, M Chandra, A Lakhani, **V Ganesan**, **M Mishra Patidar**, R K Sharma#, Velaga Srihari#, HK Poswal#, **S Mukherjee, S Giri**, **Simanchalo Panigrahi**. Journal of Magnetism and Magnetic Materials **Volume 563** (2022) 169950. https://doi.org/10.1016/j.jmmm.2022.169950
23. Effect of magnetic phase coexistence on spin-phonon coupling and magnetoelectric effect in polycrystalline Sm0. 5Y0. 5Fe0. 58Mn0. 42O3. **S Raut**, S Chakravarty, **HS Mohanty**, **S Mahapatra**, S Bhardwaj, A M Awasthi, **B Kar**, **K Singh**, M Chandra, **V Ganesan**, **M Mishra Patidar**, R K Sharma#, Velaga Srihari#, HK Poswal#, **S Mukherjee**, **S Giri**, **S Panigrahi**. Physica B: Condensed Matter Volume **651** (2023) 414593. https://doi.org/10.1016/j.physb.2022.414593

### Publications from Collaborative Research (without authors from CSR**.)

24. Co-Assembly of Peptide with G-Quadruplex DNA: A Strategic Approach to Develop Anticancer Therapeutics. **Soumi Biswas**, **Shubhanwita Basak**, **Satyabrata Samui**, **Sanjeev Pasadi, K. Muniyappa**, and **Jishu Naskar**, **ChemistrySelect 8** (2023) e202203563. https://doi.org/10.1002/slct.202203563
25. Role of Ni doping in magnetic dilution of Fe sublattice and in tailoring optical properties of CoFe2O4. **Gulzar Ahmad Lone**, **Mohd Ikram.** Journal of Alloys and Compounds **934** (2023) 167891. https://doi.org/10.1016/j.jallcom.2022.167891
26. Magnetocaloric effect and critical behaviour in zinc doped cobalt ferrite nanoparticles. **Sibasish Mandal**, **Samrat Mukherjee**. Journal of Solid State Chemistry **323** (2023) 124008. https://doi.org/10.1016/j.jssc.2023.124008

# Presentation in Conference & Symposium

## Indore Centre

1. **A comparative study of n-type and p-type $Sb_2Te_3$ single crystals**
   Indu Rajput and Archana Lakhani. International Conference on "Emergent Techniques and Functional Materials" (ICETFM-2022) held at MEDI-CAPS University, Indore, 12 -14 July 2022.
2. **Unusual carrier dynamics in Antimony crystal**
   Mukesh Kumar Dasoundhi and Archana Lakhani, International Conference on "Emergent Techniques and Functional Materials" (ICETFM- 2022) held at MEDI-CAPS University, Indore, 12 -14 July 2022."
3. **Structural characterization of Cr doped $Bi_2Te_3$ single crystal**
   Sonali Baral and Archana Lakhani. International Conference on "Emergent Techniques and Functional Materials" (ICETFM- 2022) held at MEDI-CAPS University, Indore, 12 -14 July 2022.
4. **Impact of crystalline defects on transport properties of $Sb_2Te_3$**
   Indu Rajput and Archana Lakhani, 66$^{th}$ DAE Solid State Physics Symposium -2022 held at BIT, Meshra, Ranchi, 18-22 December 2022.
5. **Structural and transport analysis on Cr doped $Bi_2Te_3$ single crystals**
   Sonali Baral and Archana Lakhani, 66$^{th}$ DAE Solid State Physics Symposium -2022 held at BIT, Meshra, Ranchi, 18-22 December 2022.
6. **The role of native defects in quantum coherent transport of $BiSbTe_3$ Single crystals**
   Indu Rajput and Archana Lakhani,38$^{th}$ MP Young Scientist Congress held at Samrat Ashok Technological Institute, Vidisha during 17-19 March 2023.
7. Mr Shivam Rahod presented the work titled **"Exploration of the anisotropy and half-metallicity of ferromagnetic Weyl semimetal $Co_3Sn_2S_2$ through electron-magnon scattering"** in 38th M.P. Young Scientist Congress (17-19 March 2023) at Samrat Ashok Technological Institute, Vidisha.
8. Ms Megha Malasi presented the work titled **"Inter-surface hybridization in topological insulator $Bi_2Se_3$ thin films: role of thickness and disorder"** in 38th M.P. Young Scientist Congress (17-19 March 2023) at Samrat Ashok Technological Institute, Vidisha.
9. **Plant mediated nanoparticles coated cotton fabrics for the antimicrobial and wound healing applications**
   M. Mathanmohun and G. S. Okram in 3$^{rd}$ International Conference on Applications of Natural compounds, Nanomaterials, Oncolytics in Cancer Biology and Biotechnology (ICANNOCB-22), School of Life Sciences and Association of Cancer Education and Research (ACER), B.S. Abdur Rahman Crescent Institute of Science & Technology, Chennai, India and Purdue University, USA on 27-28 October, 2022.
10. **Plant-mediated nanoparticle fabrics for antimicrobial and wound healing applications (OR49)**
    M. Mathanmohun and G. S. Okram in TNSCST sponsored National Conference on Recent Trends in Microbial Biotechnology (RTMBT-2023), Dept. of Marine Biotechnology, Bharathidasan University, Tiruchirappalli-24. Tamil Nadu. On 24$^{th}$ Feb 2023 Page No. 52
11. **Green synthesis of nanoparticles coated nanofabrics with antimicrobial potential.**
    M. Mathanmohun and G. S. Okram in 8th International Conference on Research Frontiers in Chalcogen Cycle Science and Technology, Department of Microbiology, University of Galway, Galway, Ireland on 17 & 18 Nov 2022. Page number 23.
12. **Antimicrobial and cytotoxic activates of green synthesized nanoparticles coated cotton fabrics.**
    M. Mathanmohun and G. S. Okram in National conference (Hybrid mode) on Current Trends in Medical Biotechnology: An Interdisciplinary Approaches for Healthy Life CTMB-IAHL-2022 & Annual meeting of Society for Biotechnologists (SBTI 2022) India, Department of Biotechnology (DBT)-New Delhi, Ministry of Science & Technology. Government of India, Centre for Applied Sciences (Biotechnology & Microbiology), Government Degree College (Men) Srikakulam. Andhra Pradesh on 17 – 19 Nov 2022. Page No77.
13. **Embedding green synthesized nanoparticles in cotton fabric to assess their antibacterial activities (OR43)**
    B. Elango, G. S. Okram and M. Mathanmohun in TNSCST, National Conference on Recent Trends in Microbial Biotechnology (RTMBT-2023), Dept. of Marine Biotechnology, Bharathidasan University, Tiruchirappalli-24. Tamil Nadu. On 24$^{th}$ Feb 2023 Page No. 46.
14. **Investigation of Spin-Phonon Coupling in Single Crystal $CoS_2$**
    Poster presentation by Suman Karmakar at ICOPVS-2022, organized by UGC-DAE Consortium for Scientific Research, Indore

15. **Study of Heat Capacity and Magnetocaloric Effect in Single Crystal $CoS_2$**
    Poster presentation by Suman Karmakar at 66th DAE Solid State Physics Symposium -2022 held at BIT, Meshra, Ranchi, 18-22 December 2022.
16. **The study of giant magnetocaloric effect and influence of martensitic transition in $FeRh_{0.8}Pd_{0.2}$**
    Poster presentation by Rajeev Joshi at ICMA held at Goa University, 2023
17. **Study of the Influence of Martensitic Phase on Near Room Temperature Giant Magnetoresistance in $Fe_{50}Rh_{40}Pd_{10}$**
    Poster presentation by Rajeev Joshi at 66th DAE Solid State Physics Symposium -2022 held at BIT, Meshra, Ranchi, 18-22 December 2022.
18. **An Investigation of Magnetic Transition in GdPdGe**
    Poster presentation by Priyanshi Tiwari at 66th DAE Solid State Physics Symposium -2022 held at BIT, Meshra, Ranchi, 18-22 December 2022.

## Kolkata Centre

19. **The Practice of Gamma-Ray Spectroscopy: Here and Now**
    R. Raut, Springer Proceedings in Physics **282** (2023) 3 **(https://doi.org/10.1007/978-3-031-19268-5_1)**

## Mumbai Centre

20. **Structural and Magnetic Properties of $Nd_2CuTiO_6$ at Low Temperature**,
    **Nitin Kumar**, S. D. Kaushik, K Sandeep Rao#,, S. N. Achary#, P.D. Babu, S.K. Deshpande, poster presented at the 66th DAE Solid State Physics Symposium, BIT Mesra, Ranchi, December 18-22, 2022.
21. **Structural, Magnetic and Dielectric Properties of $SrCaMnTiO_6$**
    *Smita Borole, Nilofar Kurawle, and Sudhindra Rayaprol,* Poster presentation (Poster # k0003) during DAE-Solid State Physics Symposium 2022, held at BITS Mesra, Ranchi during December 18 – 22, 2022
22. **Structural and Magnetic Properties of a New Ternary Ce Compound, $Ce_2Cu_3Al_8$**
    *Nilofar Kurawle, Smita Borole and Sudhindra Rayaprol,* Poster presentation (Poster # k0001) during DAE-Solid State Physics Symposium 2022, held at BITS Mesra, Ranchi during December 18 – 22, 2022
23. **Influencing Structure and Magnetism of $Mn_2O_3$ by Fe Substitution: A Neutron Diffraction Study**
    *R Nikam, N Kurawle, Smita Borole, R A P Ribeiro, S R Lazaro and S Rayaprol,* Poster presentation (Poster # k0007) during DAE-Solid State Physics Symposium 2022, held at BITS Mesra, Ranchi during December 18 – 22, 2022
24. **Magnetic anomalies in $AlB_2$-type hexagonal $Ho_2RhSi_3$ and $Er_2RhSi_3$**
    *Kartik K Iyer, K. Maiti, Sudhindra Rayaprol, Ram Kumar, S. Mattepanavar, S. Dodamani and E. V. Sampathkumaran,* Poster Presentation (k0006) during 66th DAE-Solid State Physics Symposium held at BITS Mesra during December 18-22, 2022
25. **Exploring the structural and physical properties of $Tb_2NiMnO_6$ through neutron diffraction**
    **R Athira, S D Kaushik,** *Presented in DAE-BRNS two-day theme meeting on strategic planning for enhancing research reactor utilization (RRU-2022) held at BARC Mumbai during May 2022*
26. **Neutron diffraction studies of pristine $HfO_2$ and Ta-doped $HfO_2$**
    S. Pathak., P. Das, M. Sahu and **S. D. Kaushik,** Presented in DAE-BRNS two-day theme meeting on strategic planning for enhancing research reactor utilization (RRU-2022) held at BARC Mumbai during May 2022
27. **Understanding the origin of magnetoelectric coupling in G-type antiferromagnetic $Fe_2TeO_6$ through neutron diffraction,**
    A. K. Singh **S. D. Kaushik**
    Presented in DAE-BRNS two-day theme meeting on strategic planning for enhancing research reactor utilization (RRU-2022) held at BARC Mumbai during May 2022
28. **A Room Temperature Polar and Weak-Ferromagnetic Oxide with Low Dielectric Loss**
    A. Manjon Sanz, Nagamalleswari Katragadda, Pranab Mandal, Premakumar Yanda, A Sundaresan, **S D Kaushik**, Weiguo Zhang, P Shiv Halasyamani, Foundations of Crystallography, 78 a48 (2022), Abstracts of the 2022 American Crystallographic Association Meeting, Portland, Oregon, USA, 29 July - 3 August 2022
29. **Structural and magnetic properties of $Pr_3Ni_2NbO_9$ double perovskite**
    *S. D. Kaushik:R. Athira and J. Saha.* Presented during 66th DAE- SSPS symposium held at BIT Mesra during 16-21 Dec 2022.

30. **Elemental analysis of Long Grain Size Fennel Seed samples using Instrumental Neutron Activation Analysis Technique**
    **Arpita Datta, A. N. Garg,** V. Sharma#, R. Acharya#, 15th Biennial DAE BRNS Symposium Nuclear and Radiochemistry (NUCAR-2021), Page. 188 (E-9), BARC, Mumbai, 2022.
31. **Quantification of Light Elements in Baby Food Samples Using PCF at Dhruva Research Reactor**
    **Arpita Datta, Sakshi Gupta,** V. Sharma#, R. Acharya# DAE-BRNS Theme Meeting on Strategic Planning for Enhanced Research Reactor Utilization (RRU-2020), INS Volume 53 (Issue 46), BARC, Mumbai, 2022 (https://inis.iaea.org/search/searchsinglerecord.aspx?recordsFor=SingleRecord&RN=53113498).
32. **Estimation of Essential Trace Elements of Baby Food Samples using PIXE and Comparison of Results with EDXRF: Possible Application of Food Forensics**
    **Reetta Sara George, Arpita Datta,** V. Sharma#, R. Acharya#, NUCAR-2023, BARC, Mumbai (accepted for presentation).
33. **Quantification of Micronutrients in the Baby Food Samples by INAA Arpita Datta, Reetta Sara George,** V. Sharma#, R. Acharya#, utilizing high flux reactor neutrons from Dhruva reactor, NUCAR-2023, BARC, Mumbai (accepted for presentation).

### Kalpakkam Node

34. **Exploring magnetism in amorphous carbon.**
    Sujay Chakravarty, Balaram Thakur, Uday P. Deshpande, Mukul Gupta, Sharat Chandra#, N. V. Chandra Shekar#. **INTERNATIONAL CONFERENCE IUMRS-ICA 2022** organized by MRSI at IIT Jodhpur during 19-23, December 2022.
35. **Effect of ZnO nanoparticles on structure and magnetic properties of Bi2O3-B2O3: Cr2O3 glasses**
    **Linganaboina Srinivasa Rao**, Shamima Hussain, **Adepu Navalika**, **K. Aruna Prabha**, 2nd INTERNATIONAL CONFERENCE On MULTIFUNCTIONAL MATERIALS (ICMM-22), organized by Geethanjali College of Engineering and Technology, Hyderabad, during 22-24, December 2022.

# 9.2 List of Collaborative Research Schemes (CRS)

## Indore centre

| S.No | CRS No | Principal Investigator | Title |
|---|---|---|---|
| 1. | CRS/2022-23/01/652 | Sanjeev Kumar<br>9286935563<br>skdubey@ddn.upes.ac.in<br>UPES | Development of Ferrite nanomaterials for photocatalytic production of Hydrogen and conversion of Carbon dioxide into hydrocarbon |
| 2. | CRS/2022-23/01/685 | Saurav Giri<br>9432488554<br>sspsg2@gmail.com<br>Indian Association for the Cultivation of Science | Exploring ferroelectric order and multicaloric effect in R2Ti2O7 and R2M/M//O6 series |
| 3. | CRS/2022-23/01/715 | Dr.N. Pavan Kumar<br>7702299587<br>pavanphysics@matrusri.edu.in<br>Matrusri Engineering College, Hyderabad | Development of Multiferroic Composites and Fabrication of a Proto-type Multiferroic Energy Harvester |
| 4. | CRS/2022-23/01/702 | Dr Mona Semalty<br>9193342275<br>monasemalty@gmail.com<br>HNB Garhwal University (A Central University) Srinagar Garhwal, Uttarakhand | Studying the crystalline nature of drug/drug excipient composites using ADXRD beamline (BL-12), Indus-2, and its effect on their biopharmaceutical properties |
| 5. | CRS/2022-23/01/680 | SAIKAT DUTTA<br>7652906714<br>sdutta2@amity.edu<br>Amity University Uttar Pradesh | X-ray absorption near edge structure (XANES) and extended X-ray absorption fine structure (EXAFS) spectroscopic analysis of electronically tuned flexible single-atom materials with maximized atomic efficiency |
| 6. | CRS/2022-23/01/675 | Sachin Pathak<br>9528042400<br>s.pathak@ddn.upes.ac.in<br>University of Petroleum and Energy Studies, Dehradun | Origin and modulation of interfacial magnetic anisotropy in HM/CeFeB/MgO heterostructure for magnetic memory application |
| 7. | CRS/2022-23/01/729 | Netram Kaurav<br>9425957755<br>netramkaurav@yahoo.co.uk<br>Department of Physics, Government Holkar (Model Autonomous) Science College | Exploring Frustration Effect in Low dimensional Spin Lattice Systems |
| 8. | CRS/2022-23/01/651 | JATIS KUMAR DASH<br>9440389975<br>jatis.d@srmap.edu.in<br>SRM University-AP, Andhra Pradesh | Engineering and surface functionalization of Janus two-dimensional (2D) materials for efficient sensors and flexible energy devices |

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| 9. | CRS/2022-23/01/683 | Dr. Shrikant S Maktedar<br>7051217672<br>shrikant@nitsri.ac.in<br>National Institute of Technology, Srinagar (J&K) | Carbon Nanoarchitectronics for Sustainable Energy Conversion and Storage |
| 10. | CRS/2022-23/01/655 | Dr. Neelabh Srivastava<br>6392192675<br>neelabh@mgcub.ac.in<br>Mahatma Gandhi Central University | Investigations on magnetism and spin-polarized magneto-transport behaviour in half-metallic oxide ferromagnets and Heusler alloys for spintronic applications |
| 11. | CRS/2022-23/01/665 | Yugeswaran Subramaniam<br>9486803042<br>yugesh.phy@pondiuni.edu.in<br>Pondicherry University | Facile synthesis of single-phase high entropy oxide nanoparticles in thermal plasma for radiation shielding application |
| 12. | CRS/2022-23/01/727 | Prof. Aloke Kanjilal<br>9958840640<br>aloke.kanjilal@snu.edu.in<br>Shiv Nadar Institution of Eminence, Delhi-NCR | |
| 13. | CRS/2022-23/01/723 | DIWAKAR SHENDE<br>9422390841<br>dzshende@che.vnit.ac.in<br>Visvesvaraya National Institute of Technology Nagpur | Formulation and Design of Cenosphere based Prosthetic rod, nail, screw, tooth, bone implants and artificial bone through Metal/Metal Oxides Coating and Sintering |
| 14. | CRS/2022-23/01/730 | S M Senthil Kumar<br>9442066076<br>senthilkumarsm@cecri.res.in<br>Central Electrochemical Research Institute | Design and development of hetero-atom doped porous carbon / metal oxide, metal nitrides composites as bi-functional (ORR / OER) oxygen electrocatalyst for energy conversion and storage applications |
| 15. | CRS/2022-23/01/710 | Dr. N. PRIYADHARSINI<br>9942460041<br>priyadharsinin@psgrkcw.ac.in<br>PSGR KRISHNAMMAL COLLEGE FOR WOMEN | MODELLING AND FABRICATION OF HIGH GAIN MICRO-STRIP PATCH ANTENNA USING POLYMER IMPREGNATED PEROVSKITE MANGANITE MATERIALS |
| 16. | CRS/2022-23/01/670 | Jayita Nayak<br>09641894840<br>jayitanayak@gmail.com<br>IIT Kanpur | Spectroscopic and magnetotransport investigation of magnetic topological materials |
| 17. | CRS/2022-23/01/700 | Dr. Tusharkanti Dey<br>9007841386<br>tushar@iitism.ac.in<br>IIT (ISM) Dhanbad | Single crystal growth and search for novel magnetic phases in 3d Co2+ frustrated compounds: A3CoTa2O9 (A=Ba, Sr, Ca) |

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|---|---|---|---|
| 18. | CRS/2022-23/01/698 | Dr. Alpa Dashora<br>9461503962<br>alpa.dashora-phy@msubaroda.ac.in<br>The M.S. University of Baroda | Synthesis, magnetic and transport properties of large half-metallic bandgap Heusler alloys Fe2-xCoxHfSi (x= 0, 0.5, 1, 1.5, 2) for applications in spintronics and spincaloritronics. |
| 19. | CRS/2022-23/01/660 | Dr. Bharat Kataria<br>9428015023<br>brkataria22@rediffmail.com<br>Department of Nanoscience and Advanced Materials, Saurashtra University, Rajkot | Exploring magneto-caloric and resistive switching properties of multifunctional GdMnO3 based nanostructured thin films. |
| 20. | CRS/2022-23/01/705 | Jagadish Chandra Mahato<br>09775941090<br>jagadishc.mahato@visva-bharati.ac.in<br>Department of Physics, Visva-Bharati | Structural and electronic property investigation of metallic ultrathin film on InAs(111) surfaces using STM and XPS |
| 21. | CRS/2022-23/01/704 | Dr Mrunal Deshpande<br>9444803240<br>mrunald@ssn.edu.in<br>Sri Sivasubramaniya Nadar College of Engineering | Development of black phase Formamidinium lead triiodide-based hybrid perovskite light absorber with improved thermal stability for solar cell applications |
| 22. | CRS/2022-23/01/687 | Saikiran Vadavalli<br>9908041411<br>svadaval@gitam.edu<br>GITAM Deemed to be University | Fabrication of bimetallic and multi-layered nanostructured thin films by magnetron sputtering for SERS applications |
| 23. | CRS/2022-23/01/671 | Abhinav Pratap Singh<br>9915240730<br>jaiswarsinghap@nitj.ac.in<br>Dr. B. R.Ambedkar National Institute of Technology, Jalandhar | Investigation of bipolar conductivity in strontium zincates |
| 24. | CRS/2022-23/01/695 | Ravi Kumar Shukla<br>7895151892<br>ravi.shukla@dituniversity.edu.in<br>DIT University, Dehradun, Uttarakhand | Photo-Dielectric Effect in Liquid Crystals (PDELC) |
| 25. | CRS/2022-23/01/678 | SHAHID ANWAR<br>9776968558<br>shahid@immt.res.in<br>CSIR IMMT Bhubaneswar | Development of TiAlSiN based nanocomposite coating for hardness application. |
| 26. | CRS/2022-23/01/694 | Dr. K. Suresh<br>9791670126<br>ksureshphy@buc.edu.in<br>Bharathiar University | Empirical metage for economical production of magnetic quantum dots by Micro discharge plasma method for Immunoprecipitation – Magnetic immunoassay |

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| 27. | CRS/2022-23/01/717 | Dr. Santhosh Kumar A<br>7767940529<br>asanthoshkumar_physics@cbit.ac.in<br>Chaitanya Bharathi Institute of Technology (Autonomous), Hyderabad | Exploring doped-MnNiGe ribbons for magnetocaloric, magnetoresistance and EMI shielding applications |
| 28. | CRS/2022-23/01/720 | Chivukula Ratna Prabha<br>9327201349<br>chivukula_r@yahoo.com<br>The M.S. University of Baroda | Development of biosensors for the detection of pathogens, hormones and cancer biomarkers |
| 29. | CRS/2022-23/01/725 | Gopala Krishna Podagatlapalli<br>08374311009<br>gpodagat@gitam.edu<br>GITAM deemed to be University | Fabrication of metal-doped Molybdenum di-sulfide quantum dots via ultrafast laser ablation for biological, surface-enhanced Raman spectroscopic applications |
| 30. | CRS/2022-23/01/726 | Virendra Kumar Verma<br>7893960185<br>vkvermaiitk@gmail.com<br>VIT-AP University | Study of interface effect on the magnetoelectric coupling in composite ferroelectric and ferromagnetic heterostructures |
| 31. | CRS/2022-23/01/728 | Bhaskar Chandra Mohanty<br>8437813908<br>bhaskar@thapar.edu<br>Thapar Institute of Engineering and Technology, Patiala | Growth and characterizations of CaZrS3 based chalcogenide perovskite thin films for photovoltaic applications |
| 32. | CRS/2022-23/01/684 | NALLAMUTHU S<br>9791889719<br>nallamuthu.s@vitap.ac.in<br>Department of Physics, School of Advanced Sciences, VIT-AP University, Near Vijayawada, 522 237 Andhra Pradesh | Investigation of quantum spin liquid in Rare-Earth Pyrochlores A2B2O7, where A3+ (La, Ce, Yb) and B4+ (Ti and Ru) for quantum computation applications |
| 33. | CRS/2022-23/01/706 | Dr.K.Saravanakumar<br>9043732005<br>dr.k.saravanakumar@gmail.com<br>Kongunadu Arts and Science College, Coimbatore | Study of thermal conduction and ZT in Ca3Co4O9 nanostructured thin films with Phonon-Glass-Electron-Crystal approach |
| 34. | CRS/2022-23/01/731 | ASHIS BHATTACHARJEE<br>9434142050<br>ashis.bhattacharjee@visva-bharati.ac.in<br>VISVA-BHARATI UNIVERSITY | Synthesis and Characterization of Iron Oxide Nanoparticles Through One-Step Thermal Protocol for Biomedical Applications |
| 35. | CRS/2022-23/01/668 | Prasun Banerjee<br>9113854549<br>pbanerje@gitam.edu<br>GITAM University | Investigations on High Capacitance Behavior of 2D MXene materials for Energy Storage Applications |

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| 36. | CRS/2022-23/01/666 | Y. Ashok Kumar Reddy<br>6302121030<br>akreddy@iiitdm.ac.in<br>Indian Institute of Information Technology, Design and Manufacturing, Kancheepuram | Metal oxide-based heterostructures for gas sensor devices |
| 37. | CRS/2022-23/01/659 | C. Ravikumar<br>7639461007<br>ravikumarc@che.vnit.ac.in<br>Department of Chemical Engineering, Visvesvaraya National Institute of Technology (VNIT) Nagpur | Morphology tuning of heterostructured palladium/magnetic nanoparticles for enhanced catalytic performance in electro-oxidation reactions |
| 38. | CRS/2022-23/01/686 | Dr. Sanjay Tiwari<br>7567503983<br>sanjay1.tiwari@niperraebareli.edu.in<br>National Institute of Pharmaceutical Education and Research (NIPER) - Raebareli | Improvement in phase characteristics and solid-state performance of quercetin via cocrystal development |
| 39. | CRS/2022-23/1107 | JAI SINGH<br>09424459805<br>jai.bhu12@gmail.com<br>Guru Ghasidas Vishwavidyalaya (A Central University), Bilaspur (C.G.), India 495009 | "Ternary nano-composite formation of bismuth telluride (Bi2Te3 ) with different amount of zinc oxide (ZnO) nanostructures and carbon nano-tubes (CNTs) to optimize the thermoelectric performance" |
| 40. | CRS/2022-23/01/708 | Jayaramulu Kolleboyina<br>9963768672<br>jayaramulu.kolleboyina@iitjammu.ac.in<br>Indian Institute of Technology Jammu | Nanoporous MXene Heteronanostructures for Gas Sensors: Temperature-dependent powder XRD and Raman Study |
| 41. | CRS/2022-23/01/699 | Anup Thakur<br>9417110095<br>dranupthakur@gmail.com<br>Punjabi University, Patiala | Developing broad red emitting Zn1-xSrxAl2O4 based nanophosphors through cationic site engineering |
| 42. | CRS/2022-23/01/661 | Dr. Gaurav Mahadev Lohar<br>9604695030<br>gauravlohar24@gmail.com<br>Lal Bahadur Shastri College of Arts, Science and Commerce, Satara | Synthesis of MXene for energy storage devices |
| 43. | CRS/2022-23/01/681 | Dr Jitumani Kalita<br>8638298471<br>jitumani.kalita@cottonuniversity.ac.in<br>Cotton University | Synthesis of multilayer inorganic and organic semiconductor thin films for fabrication of selective UV sensing device |
| 44. | CRS/2022-23/01/674 | Dr. P. Karuppasamy<br>9791552297<br>karuppasamyp@ssn.edu.in<br>Sri Sivasubramaniya Nadar College of Engineering | Growth of High-Quality Alkali Metal Halide Perovskite Single Crystals for High Energy Radiation Detector Applications |

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| 45. | CRS/2022-23/01/701 | Dr. Susanta Ghosh<br>8001782253<br>susanta.ghosh@visva-bharati.ac.in<br>Integrated Science Education & Research Center, Visva-Bharati (A Central University) | Development of low cost Bimetallic Phosphides (MnFeP) Electro-catalysts for the Water Splitting Reaction |
| 46. | CRS/2022-23/01/711 | Dr Mukesh Chandra<br>08800420903<br>mukeshdimri@yahoo.com<br>Jaypee University of Engineering and Technology, Guna, MP | Synthesis and studies of Garnet thin films for Magnon Spintronic Devices |
| 47. | CRS/2022-23/01/716 | Pravanjan Mallick<br>9437656274<br>pravanjanphy@gmail.com<br>Maharaja Sriram Chandra Bhanja Deo University | Interfacial Coupling Induced Emergence of Properties in NiO based Bimagnetic Nanocomposites for Spintronics Application |
| 48. | CRS/2022-23/01/653 | Dr Babasaheb R Sankapal<br>09637532624<br>brsankapal@phy.vnit.ac.in<br>Visvesvaraya National Institute of Technology (VNIT) Nagpur | Coin Cell Solid-State Supercapacitor from Dry Cell Battery Waste |
| 49. | CRS/2022-23/01/656 | AYAN MUKHERJEE<br>8372098447<br>ayanmukherjee88@gmail.com<br>COLLEGE OF COMMERCE,ARTS & SCIENCE | Biomaterial template derived metal doped NiCo2O4 nanostructure for improved supercapacitor electrode. |
| 50. | CRS/2022-23/01/669 | Dr. Umesh Prakash Gawai<br>7219554819<br>upgawai.phys@gmail.com<br>Department of Physics, DDSP Arts Commerce and Science College, Erandol | “Synthesis, magnetotransport property of ferromagnetic spin-chain structure of Na4MTeO6 (M=Co, Ni) tellurate compounds” |
| 51. | CRS/2022-23/01/663 | Dr K. RAVICHANDRAN<br>9444803218<br>ravi21068@unom.ac.in<br>Department of Nuclear Physics, University of Madras, | Investigation on Magnetic and Magnetoresistance Properties of Co2CrGe Heusler Alloy Thin Films for Spintronics Applications |
| 52. | CRS/2022-23/01/667 | Sanjit Sarkar<br>09735233424<br>snjtsarkar0@gmail.com<br>Dept. of Physics, Surendranath Evening College | Natural Sunlight Assisted Magnetically Separable Core-Shell Photo-catalysts for Industrial Waste Water Treatment |

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| 53. | CRS/2022-23/01/672 | Tarun Garg<br>7895016900<br>gargphy1981@gmail.com<br>VIT Vellore | Electric Field Modulated Magnetism in HfO2/Co Ultrathin Films based Magnetoelectric Heterostructure |
| 54. | CRS/2022-23/01/673 | Dr. Gunasekaran Venugopal<br>9894789648<br>pvsguna@gmail.com<br>Central University of Tamil Nadu | Examining the Electronic Structure of Carbon Quantum Dots composited with Rare-earth materials using Synchrotron Radiation Toward Clean Green Energy Production |
| 55. | CRS/2022-23/01/682 | Dr. Anjalu Ramchiary<br>8812871635<br>anjaluramchiary88@gmail.com<br>Bodoland University | Quantum dot-metal oxide (core-shell) heterojunction for photocatalytic applications |
| 56. | CRS/2022-23/01/691 | Sunku Sreedhar<br>9491988708<br>sreedhar.sunku@gmail.com<br>Madanapalle Institute of Technology and Science | Nanofabrication of ferroelectric multi-layered thin films based of BTO, BFO and Hf(Zr)O2 for integration into semiconductor electronic and photonic device applications |
| 57. | CRS/2022-23/01/697 | Kodam Ugendar<br>9940270209<br>ukodam@gitam.edu<br>GITAM School of Science, GITAM deemed to be University | Effect Of YFe1−xCrxO3 (0 < x < 1) Layer On YBCO Critical Temperature for Spintronic Devices |
| 58. | CRS/2022-23/01/658 | Dr. C. Karthik Kumar<br>9962878599<br>karthickumar.c.k@gmail.com<br>Vinayaka Missions Research Foundation | Investigation of Structural Phase Transitions of Perovskite Single Crystals by Using Synchrotron based Single Crystal X-ray Diffraction Studies |
| 59. | CRS/2022-23/01/707 | GUBBALA VENKATA RAMESH<br>8076909068<br>venkataramesh_chm@cbit.ac.in<br>Chaitanya Bharathi Institute of Technology | Alkali metal-doped g-C3N4 decorated with plasmonic nanostructures: A SERS based flexible sensor to detect pesticides in ppb level |
| 60. | CRS/2022-23/01/709 | Sulochana Deb<br>7002803341<br>debsulochana@gauhati.ac.in<br>Gauhati University | Study of Tunnel Magneto Resistance Ratio of Magnetic Tunneling Junction with Molybdenum Disulfide Tunnel Barrier for Spintronics Device |
| 61. | CRS/2022-23/01/657 | Dhrubojyoti Roy<br>09470524289<br>dhrubojyoti.roy@cgu-odisha.ac.in<br>C V Raman Global University | Study of semiconductor-ferroelectric interface and its application for the development of NC-FET device. |

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| 62. | CRS/2022-23/01/690 | Tirthankar Chakraborty<br>07866928269<br>tirtha255@gmail.com<br>School of Physics and Materials Science, Thapar Institute of Engineering and Technology | Exploration of topological quantum phenomena in oxide single crystals |
| 63. | CRS/2022-23/01/712 | Dr. S. Shanmukharao Samatham<br>9630680607<br>shanmukharao_physics@cbit.ac.in<br>Chaitanya Bharathi Institute of Technology (Autonomous), Hyderabad | Tailoring magneto-transport phenomena in magnetic skyrmion materials: Mn1-xCrxSi and MnSi1-xSnx |
| 64. | CRS/2022-23/01/713 | SUJIT DAS<br>8420000315<br>sujitdas@iisc.ac.in<br>Indian Institute of Science, Bangalore | Probing of magnetic skyrmions in perovskite oxide and ferroelectric control of metal-insulator transition in nitride heterostructures. |
| 65. | CRS/2022-23/01/696 | Kulvinder Singh<br>9788300085<br>kulvinderchem@gmail.com<br>DAV College, Sector 10, Chandigarh | SYNTHESIS, CHARACTERIZATION AND SUPERCAPACITIVE INVESTIGATION OF POROUS CARBON NITRIDE NANOSTRUCTURES |
| 66. | CRS/2022-23/01/719 | Dr. Gurudas Mandal<br>9051673657<br>gurudasmandal88@gmail.com<br>Kazi Nazrul University | Assessment of biodegradation behaviors of implant Mg alloys based on machine learning algorithms |
| 67. | CRS/2022-23/01/692 | Puja Dey<br>8910089756<br>puja.dey@knu.ac.in<br>Kazi Nazrul University | Fabrication and study of Hybrid Inorganic-Organic Dual Spin Valves for Multifunctional Spintronics Application |
| 68. | CRS/2022-23/01/732 | Charu Lata Dube<br>8264269023<br>dubecharu@gmail.com<br>Central University of Gujarat | Synthesis of tungsten oxide doped borosilicate glasses for NIR shielding application |
| 69. | CRS/2022-23/01/688 | Dr. Vijeth<br>9164223172<br>vijethhebri@gmail.com<br>Nagaland University | Fabrication and Characterization of Metal Chalcogenide Nanostructures for Flexible Supercapacitor Applications |
| 70. | CRS/2022-23/01/724 | Dr Suresh Pittala<br>9848868798<br>sureshp.ecc@gmail.com<br>Dayananda Sagar University | Multiferroicity in hexagonal Lu1-xAxFeO3 (A = Sr, Zr, La, Nd) ceramics |

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| 71. | CRS/2022-23/01/650 | Bimal Kumar Sarma<br>9854079070<br>bimal@gauhati.ac.in<br>Gauhati University | Ferromagnetism and tunable infrared plasmonics of transparent conducting oxide in the metallic regime |
| 72. | CRS/2022-23/01/703 | RANJITH RAMADURAI<br>09494424990<br>ranjith@msme.iith.ac.in<br>Indian Institute of Technology Hyderabad | Utilization of synchrotron studies to examine the local structure and associated distortions of high TC layered perovskite Nd2Ti2O7 for high temperature pyroelectric applications. |
| 73. | CRS/2022-23/01/662 | Dr.M.Amalanathan<br>9940347178<br>nathan.amalphysics@gmail.com<br>Nanjil Catholic College of Arts and Science | Synthesis of noble metal doped/transition metal oxide nanostructured composite for super capacitor electrode |
| 74. | CRS/2022-23/01/679 | Debajit Deb<br>07005786066<br>debajitdeb12pec018@gmail.com<br>Dept. of ECE, Koneru Lakshmaiah Education Foundation | Optimization of Organic Spin Valves for Room Temperature Magnetoresistance Applications |
| 75. | CRS/2022-23/01/722 | Charu Dwivedi<br>8630004042<br>charudwived@gmail.com<br>Department of Chemistry, School of Physical Sciences, Doon University, Dehradun-248001 | Development of tungsten oxide based nanostructures as near infrared shielding materials for smart window applications |
| 76. | CRS/2022-23/01/693 | Dr. P. Sakthivel<br>9952806070<br>sakthi1807@gmail.com<br>Karpagam Academy of Higher Education | Effective synthesis and investigation of structural, morphological, photoluminescence behaviors of CsPBXBr3 (X = Sn, Mn, Ni) Perovskite Quantum dots for Stretchable Light Emitting Diodes |
| 77. | | Dr. Firoz Badesab<br>7745034168<br>firoz@nio.org<br>CSIR-National Institute of Oceanography, Goa. | Multi-proxy characterization of biogenic magnetic particles at active marine cold-seep systems |
| 78. | CRS/2022-23/01/714 | S. Parthiban<br>8220929931<br>spn@psgias.ac.in<br>PSG Institute of Advanced Studies | Excimer Laser Irradiation of highly conducting and broadband transparent oxide thin-films for solar cells |
| 79. | CRS/2022-23/01/654 | Dr. Haritha Lakkaraju<br>9959001510<br>haritha25feb@gmail.com<br>Telangana University | Transparent conducting oxides for flexible optoelectronic devices |

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| 80. | CRS/2022-23/01/689 | Dr. Debasis De<br>08918409620<br>debasisd@rgipt.ac.in<br>Rajiv Gandhi Institute of Petroleum Technology | Development of catalyst-coupled photoelectrodes for renewable energy |
| 81. | CRS/2022-23/01/718 | Dr. G. Hema Chandra<br>7387153681<br>drghc@rediffmail.com<br>Visveswaraya National Institute of Technology, Nagpur | Fabrication of Ge- incorporated Cu2ZnSnSe4 thin film absorber based photovoltaic devices |
| 82. | CRS/2022-23/01/721 | Dr Abhay A Sagade<br>9834223272<br>abhaya@srmist.edu.in<br>SRM Institute of Science and Technology | Probing charge transport in 1D supramolecular nanowires by AC resistance measurements |
| 83. | CRS/2022-23/01/677 | Dr. Khalid Sultan<br>7006185276<br>khalidsultan@cukashmir.ac.in<br>Central University of Kashmir | Exploring the doping based enhancement in electrical and magnetic properties of R2NiMnO6 (R=rare earth) system |
| 84. | CRS/2022-23/01/676 | K.D. Mallikarjuna Rao<br>9632524294<br>saiskdmrao@iacs.res.in<br>Indian Association for the Cultivation of Science | Fabrication and development of Halide Perovskite/2D-MXene heterostructures for optoelectronic devices |
| 85. | CRS/2022-23/01/664 | Dr Sesha Vempati<br>06303704768<br>sesha@iitbhilai.ac.in<br>Indian Institute of Technology Bhilai | Addressing the origin of magnetism in monolayer Molybdenum disulfide |

# Kolkata Centre

| Sl.No | Name & Affiliation | Title of the project | Year of Sanction |
|---|---|---|---|
| 1 | Dr. Ritwika Chakraborty<br>Department of Physics<br>University of Mumbai | Spectroscopic investigation of neutron-rich nuclei around N =32 sub-shell closure | 2019 |
| 2 | Prof. R. Gowrishankar<br>Department of Physics<br>Satya Sai Institute of Higher Learning | Experimental investigations on the Level structures of doubly odd Ta isotopes | 2019 |
| 3 | Dr. Ajay Tyagi<br>Department of Physics<br>Benaras Hindu University | Validation of surrogate reaction technique for measuring (n,p) reaction cross sections and measurement for 51 Cr(n,p) cross sections | 2019 |
| 4 | Dr. Tarakeswar Trivedi<br>Guru Ghasidash Vishwavidyala | Investigation of stapler and chiral bands in transitional nuclei | 2019 |
| 5 | Prof. Bivash Ranjan Behera<br>Department of Physics<br>Punjab University | Examination of weak transfer channel in the fusion barrier distribution studies | 2019 |
| 6 | Dr. Sarla Rani<br>VES College of Arts, Science and Commerce, Mumbai | Fusion and break-up cross-section measurement of weakly bound nuclei on medium mass targets near barrier, sub-barrrier and deep sub-barrier region : | 2019 |
| 7 | Dr Suresh Kumar<br>Department of Physics and Astrophysics<br>University of Delhi | Search for large Octupole collectivity and high-spin isomers near N=126 shell closure : | 2019 |
| 8 | Dr. Rajnikant Jasbhai Makwana<br>Deaprtment of Physics<br>M.S. University of Baroda | Generation of nuclear data for reactor applications | 2019 |
| 9 | Prof. Manoj K. Sharma<br>School of Physics and Material Science<br>Thapar Institute Engineering and Technology, Patiala | Fission and competing nuclear dynamics governed via compound and non-compound nuclear channels | 2019 |
| 10 | Dr. Anagha Chakraborty<br>Department of Physics<br>VisvaBharati | Study of nuclear level density as a function of angular momentum, temperature and unveiling the role of collectivity and shell structure | 2019 |
| 11 | Dr Sinjinee Das Gupta<br>Department of Physics<br>Victoria Institution (College) Kolkata | Role of intruder orbitals for generation of high spin states in mass 190 region | 2019 |
| 12 | Dr. Subhendu Rajbansi<br>Department of Physics<br>Presidency University, Kolkata | Second order phase transition in atomic nuclei: E(5) symmetry breaking in $^{84}$Sr | 2019 |
| 13 | Dr. Dharmendra Singh<br>Department of Physics | Study of incomplete fusion dynamics and role of various entrance channel parameters at energy above the coulomb barrier | 2019 |

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| | Central University of Jharkhand, Ranchi | | |
| 14 | Dr. A. Chatterjee<br>Department of Chemistry<br>K L University | Development of optical biosensor for environmental monitoring: quantification of organochlorine pesticide residues in fruits and vegetables with quantum dots | 2019 |
| 15 | Prof. Subir Das<br>Department of Biochemistry,<br>College of Medicine & JNM Hospital | Elucidation of Protective Mechanisms of Grape Extracts from Different Cultivars against Radiation Induced DNA damage | 2019 |
| 16 | Prof. Swati De<br>Department of Chemistry<br>University of Kalyani | Gamma irradiation based synthesis of graphene based nanomaterials and their applicability in fluorescence sensing and catalysis | 2019 |
| 17 | Dr. C. Saha,<br>Department of Natural Science Maulana Abul Kalam Azad University of Technology | Radiation induced synthesis of protein nanoparticles for drug delivery and imaging in cancer treatment | 2019 |
| 18 | Prof. P. Das<br>Department of Chemical Engineering<br>Jadavpur University | Synthesis of reduced Graphene oxide using gamma irradiation and Detoxification of wastewater using reduced Graphene oxide based nano-coated composite in presence of Gamma/UV/photolytic radiation/irradiation technique | 2019 |
| 19 | Dr. K. Sen<br>Department of Chemistry,<br>University of Calcutta | Radiation induced synthesis and modification of metal nanoparticles for optical sensing of biomarkers | 2019 |
| 20 | Prof. N Kalarikkal<br>School of Pure and Applied Physics,<br>Mahatma Gandhi University | Heavy ion/gamma ray engineered vertically oriented graphene hybrid systems for environmental remediation | 2019 |
| 21 | Dr. R. Bhattacharjee<br>Amity Institute of Nanotechnology,<br>Amity University Kolkata | Effect of post-synthetic treatment on the efficiency of carbon quantum dots | 2019 |
| 22 | Dr. P. Chaudhuri<br>Department of Environmental Science<br>University of Calcutta | Studies on conjugation of PET/SPECT radioisotopes with environmentally benign nature resourced chemical reagents | 2019 |
| 23 | Prof. Saurabh Das<br>Department of Chemistry<br>Jadavpur University | To explore the possibility of transition metal complexes of anthracyclines and its simpler analogues to be effective radiosensitizers by targeting DNA and/or other macromolecules | 2019 |
| 24 | Dr. Raneesh. B<br>Department of Physics<br>Catholicate College | Development of metal oxide-Graphene/CNT hybrid materials using gamma irradiation technique for high performance Na- Ion battery electrodes | 2019 |
| 25 | Dr. Parvej Ahmad Alvi<br>Department of PhysicsBanasthaliVidyapith | Investigation of radiation effects on graphene based polymer nano composites | 2019 |

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| 26 | Dr. A. Semalty<br>Department of Pharmaceutical Sciences<br>HNB Garhwal University | Synthesis of polymeric cyclodextrin nanoparticles: Effect of radiation | 2019 |
| 27 | Dr. D. Mohanta<br>Department of Physics<br>Tezpur University | Effect of energetic γ-photons and ion beams on the structural, opto-electronic and rheological property of tungsten dichalcogenide-based composites | 2019 |
| 28 | Dr. A. Priyam<br>Department of Chemistry<br>Central University of South Bihar | Tunable magnetoplasmonic nanomaterials Radiation chemical synthesis and its applications in non-invasive theranostics for cancer | 2019 |
| 29 | Prof. Saratchandra M. Babu,<br>Department of Chemistry<br>GITAM University | Effect of gamma radiation on structure, vis-nir luminescence and cytotoxicity of lanthanide-based Metal-Organic Frameworks (MOFs) | 2019 |
| 30 | Dr. Umesh P. Gawai<br>C S P Mandal's Dadasaheb Digambar Shankar Patil Arts, Commerce and Science College | Doping effect of metal on local structure and magnetic property of GO and rGO incorporated Metal/Metal oxide nanomaterials | 2019 |
| 31 | Dr. Aritra Banerjee,<br>Department of Physics,<br>University of Calcutta | Magneto-transport property study of thermoelectric composites | 2019 |
| 32 | Dr. Jagadeesha Angadi V<br>Department of Physics<br>School of Engineering<br>Presidency University<br>Bengaluru | Electric field Induced tuning of Magnetism in Hexagonal magnetoelectricmultiferroic and their radiation stability | 2019 |
| 33 | Dr.Arindam Karmakar,<br>Surya Sen Mahavidyalaya,<br>Siliguri | Magnetoelectric properties of $ABaB_4O_7$ "114" oxides(A = Lanthanides/Y/Ca/Sr, B = Co/Fe/Mn) | 2019 |
| 34 | Dr.Tapanendu Kamilya,<br>Narajole Raj College<br>Midnapore | Synthesis of biocompatible magnetic nanoparticles and their applications in nanotherapy and prevention of environmental water pollution | 2019 |
| 35 | Dr.Sukanta De<br>Department of Physics<br>Presidency University,<br>Kolkata | Transition metal oxychloridenano-sheets based supercapacitor | 2019 |
| 36 | Dr.Ismayil<br>Department of Physics<br>Manipal Institute of Technology, Manipal | Study of correlations between free volume related microstructure and ionic conductivity in metal salt doped polymer electrolyte films | 2019 |
| 37 | Dr.Subhajit Sarkar<br>Department of Physics<br>West Bengal State University | Defect induced multiferroic properties in $BaTi_{1-x}Fe_xO_{3-\delta}$ systems in powder and film forms | 2019 |
| 38 | Dr. C.M.S. Negi<br>Department of Electronics<br>Banasthali Vidhyapith | Investigations of radiation effects in polymer solar cells | 2019 |

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| 39 | Dr. Gobinda Gopal Khan<br>Department of Material Science and Engineering<br>Tripura University | Defect engineering of nanomaterials using ion beam irradiation for ecofriendly energy harvesting | 2019 |
| 40 | Prof. Sabu Thomas<br>Mahatma Gandhi University | Gamma ray assisted cross linked silicon rubber based EMI shielding material | 2019 |
| 41 | Dr Rajendra Prasad<br>Department of Biochemistry & Biotechnology ,<br>Annamalai University | Understanding the radioresistance mechanisms of Deinococcusradiodurans by targeting thioredoxinreductase antioxidant system | 2019 |
| 42 | Prof. Vivekananda Mandal<br>Department of Botany<br>University of GourBanga | Assessment of the effect of gamma radiation on viability, infestation, sporulation and morpho-metabolic changes of mycorrhizal species of Clerodendrumindicum (L.) O. Kuntze (Verbinaceae) | 2019 |
| 43 | Prof. Rama Rao Malla,<br>Department of Biochemistry & Bioinformatics, Institute of Science, GITAM University | Sensitization of drug resistant triple negative breast cancer cell lines by combination of radiation and cd151 inhibitor, 2-thio-6-azauridine : | 2019 |
| 44 | Prof. Sarmistha Raychowdhuri<br>Department of Biophysics & Molecular Biology<br>University of Calcutta | Comparative study of ionizing radiation and chemical elicitor induced expression of the genes induced in phytosterol biosynthesis and simultaneous accumulation of antidiabeticcomponent “charantin” in momordicacharantiaLinn : | 2019 |
| 45 | Prof. Nandan Bhattacharya ,<br>Panskura Banamali College | Study of the effect of radiation on a variant form of DNA polymerase beta gene expressed specifically in ovarian tumour : | 2019 |
| 46 | Prof. Tapas Kumar Bandopadhyay<br>Department of Molecular Biology.and Biotechnology<br>University of Kalyani | In vitro mutagenesis of Limonium Misty Blue to develop novel red color flower | 2019 |
| 47 | Dr Subarna Bhattacharya,<br>School of Environmental Studies<br>Jadavpur University | Inhibition of fungal biodeterioration of construction materials using low and high LET ionizing radiation | 2019 |
| 48 | Prof. Sanjit Dey<br>Department of Physiology<br>University of Calcutta | Augmentation of radiation induced oxidative stress in radiosensitive and radioresistant tumour cells by anthocyanins from coloured Phytochemicals : | 2019 |
| 49 | Dr. Debasish Datta<br>Department of Physics<br>Presidency University<br>Kolkata. | Synthesis and study of novel semiconductor materials through ion beam irradiation | 2019 |

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| 50 | Dr. Paramesh Gadige,<br>Department .of Physics<br>Sri Sathya Sai Institute of Higher Learning | Gamma-ray and ion beam irradiation studies on lead-free piezoelectric ceramics and their polymer composites | 2019 |
| 51 | Dr. Jatis Kumar Dash<br>Department of Physics<br>SRM University-AP, Amaravati | Ion beam modification of two-dimensional (2d) layered materials heterostructures: defect engineering and device performances | 2019 |
| 52 | Dr Tinku Basu<br>Amity Institute of Nanotechnology<br>Amity University, Noida | Development of $MnO_2$nano sheet wrapped porphyrin based metal organic frame work for room temperature oxidative degradation of antibiotics in effluent water from Pharmaceutical Industry using electrochemical technique : | 2019 |
| 53 | Dr Prafulla K. Jha<br>Department. of Physics<br>M.S. University of Baroda, | Ion irradiation-induced effects on 2D Transition metal dichalcogenidesnanostruc-tured materials: A combined experimental and theoretical studies : | 2019 |
| 54 | Dr. Pradip Kumar MandalDepartment of Physics University of North Bengal | Effect of irradiation on the display parameters of room temperature ferroelectric and antiferroelectric liquid crystal mixtures useful for display applications : | 2019 |
| 55 | Dr.Somnath Biswas,<br>Department of Physics,<br>LNM Institute of Information Technology<br>Jaipur | Magneto-transport studies of ZnO based magnetic tunnel junctions fabricated by ion implantation technique | 2019 |
| 56 | Dr.Raghavendra Rao Juluri<br>Physics Department, Dr. A P J Abdul Kalam IIIT- RGUKT Ongole | Growth of AgAu bimetallic endotaxial nanostructures on Si by ion implantation | 2019 |
| 57 | Dr .Narayana Kalkura<br>Crystal Growth Centre<br>Anna University | Negatively charged ions on grapheme-polymer-ceramic composite by low energy ions for biomedical applications : | 2019 |
| 58 | Prof. Ajay Gupta<br>Amity Center for Spintronics Materials<br>Amity University, Noida | Tailoring magnetic anisotropy in thin films using nanopatterning | 2019 |
| 59 | Dr. Jagadish Chandra Mahato<br>Department of Physics<br>Narendrapur Ramakrishna Mission | Investigation of Kr ion beam irradiation effects of the Pd/Fe or Co thin film on Si(100) | 2019 |
| 60 | Dr. N. Srividya<br>Department. of Food and Nutritional Sciences<br>Sri SathyaSai Institute of Higher Learning | XRF based profiling of essential minerals in native and bio-processed pigmented rice varieties | 2019 |

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| 61 | Dr. R. Sathyavathi<br>Department of Physics<br>K.L.University, Hyderabad | Mapping of trace element aluminium in human body fluid by busing PIXE technique and its linkage to Alzeiemers disease | 2019 |
| 62 | Prof. N.Srinivas<br>Department of Environmental Studies<br>GITAM | Applicationof electroremediation coupled with phytoremediation technique for the removal of trace elements from sewage sludge | 2019 |
| 63 | Prof. M.L. Garg<br><br>Department of Biophysics<br>Panjab University | Protective role of Zinc in case of Arsenic toxicity: A metal-protein interaction study | 2019 |
| 64 | Dr. Madhumita Manna,<br>Principal, WBSES,<br>Bidhannagar College | Assessment of trace element profiles of some medicinal plantsand mangroveswith respect to their Antileishmanial activities : | 2019 |
| 65 | Prof. Apurba Ratan Ghosh<br>Department of Environmental Science<br>University of Burdwan | Evaluation of available trace elements and methane emission from OCP at Raniganj-Asansol coal field areas, PaschimBardhaman | 2019 |
| 66 | Prof. Sajal Ray<br><br>Department of Zoology<br>University of Calcutta | Development of detection technology to trace early warning signal of metal contamination in the soil around Kolkata Leather Complex using earthworm as monitoring species : | 2019 |
| 67 | Dr. Raj Kumar Dutta,<br>Department of Chemistry,<br>Indian Institute of Technology Roorkee | Micro-XRF based elemental mapping and strategies for selective recovery of precious metals from waste printed circuit boards (WPCBs | 2019 |
| 68 | Dr. S. Santhosh Kumar<br>Department of Physics<br>KanchiMamunivar Centre for Post Graduate Studies,<br>Puducherry | Trace elemental analysis of herbal bhasma prepared in accordance to the traditional medicinal practice of ayurveda | 2019 |
| 69 | Dr. Abhijit Sarkar<br>Department of Botany<br>University of GourBanga | Analysesof elemental composition in total atmospheric deposits (TAD) and $PM_{10}$, $PM_{2.5}$ and $PM_1$ fractions of air borne particulate matter in Malda district, West Bengal & their effects on ecosystem | 2019 |
| 70 | Dr. Vivek Singh<br>School of Physics<br>Mata Vaishnodevi University<br>J&K | Heavy, toxic and trace elemental detection in biological samples, gallstones, kidney stones using EDXRF and PIXE spectroscopic techniques | 2019 |
| 71 | Dr. Sasmita Das<br>Department of Biotechnology<br>Academy of Management &Information Technology,<br>Khordha | Investigation of metal tolerant bacteria isolated from selected metal processing industries of Odisha | 2019 |

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| 72 | Dr. Srimoyee Banerjee<br>School of Biotechnology & Bioinformatics, D.Y. Patil Deemed to be University,<br>Navi Mumbai, | Development of sustainable heavy metal bioremediation system with microbes isolated from Mumbai mangroves | 2019 |
| 73 | Dr.Shaon Ray Chaudhuri<br>Department of Microbiology Tripura University | Validation of the efficacy of treated dairy effluent as biofertilizer for cultivation of economic crops | 2019 |
| 74 | Dr. S. Venkatesh,<br>Department of Biosciences<br>Sri SatyaSai Institute of Higher Learning | Metabolic reprogramming associated with different stages of glioma might drive resistance to ionizing radiations: Mechanisms, Biomarkers and Therapeutic targets | 2019 |
| 75 | Dr Rajesh Babu Dandamudi, Department of Chemistry<br>Sri SathyaSai Institute of Higher Learning | Effect of irradiation on afflotoxin content and nutritional parameters of groundnuts evaluated using UPLC-MS/MS analysis | 2019 |
| 76 | Dr. Parswajit Kalita, University of Petroleum and Energy Studies (UPES) | Designing piezoelectric mechanical energy harvesters based on polymer-biowaste hybrids for self-powered biomedical & next-generation electronics applications | 2022 |
| 77 | Dr Susmita Singh<br>Amity University, Kolkata | Development of irradiation-induced nano carbon allotrope supported novel plurimetallic electrocatalyst for Low Temperature Fuel Cell | 2022 |
| 78 | Prof Tarakdas Basu, University of Kalyani | Nano-formulation of phytochemicals of medicinal plant origin, characterization of the nanonized products and investigation on their radio-protective efficacy against ionizing radiation-induced damage in human skin cells | 2022 |
| 79 | Dr Madhumita Mukhopadhyay, Department of Chemistry, Amity University, Kolkata | Biocompatible Functionalized Nitrogen doped Graphene Nanosheets as Cell Radiosensitizers in Therapeutics. | 2022 |
| 80 | Dr Dipankar Halder Jadavpur University | Degradation of organic pollutants present in contaminated water employing noble metal nanocatalyst synthesized using eco-friendly pathway | 2022 |
| 81 | Dr Jasaswini Tripathy, School of Applied Sciences (Chemistry),KIIT Bhubaneswar | Development of fluorescent carbon dots and mesoporous silica-based nanohybrids for cancer theranostics | 2022 |

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| 82 | Dr Naidu Dhanpal Jayram Kalasalingam,<br>Academy of Research and Education | Ion beam irradiation of semiconductor thin films for Surface enhanced Raman spectroscopy application | 2022 |
| 83 | Prof. Narendra Nath Ghosh, Birla Institute of Technology and Science Pilani, K K birla Goa campus | Radioactive Ion Beam irradiation of a multifunctional nanocomposite composed of multiferroic BiFeO3 nanoparticle and semiconducting graphitic carbon, for tuning its electronic structure and properties and its application in the fabrication of high-performance mechanically flexible all-solid-state supercapacitor device and photo-catalyst for Industrial dye-containing wastewater treatment under natural sunlight and solar power generated simulated solar light | 2022 |
| 84 | Dr Kamesh Viswanathan, Baskaran Charotar University of Science & Technology | Development of one-time and multi-standard colour chart for detecting total Uranium in drinking water using digital camera approach | 2022 |
| 85 | Prof Amrita Chatterjee, BITS PILANI KK BIRLA GOA CAMPUS | Development of GO (or rGO) based smart functional materials for removal of Hg(II)/organic Hg and fluoride ions from aqueous media by magnetic solid phase extraction (MSPE) | 2022 |
| 86 | Dr Kakoli Banerjee,<br>Prabh Jagatbandhu College | Exploration of Novel Pyrochlores for Nuclear Waste Management: Probing with Long-lived Fission Products and Actinides | 2022 |
| 87 | Dr Santhy Ajish, Maharaja Institute of Technology Mysore | Study of effect of Gamma irradiation on the mechanical and electrical properties of Glass fiber reinforced Epoxy (GE) composites with a hybrid combination of Alumina and Silica nano fillers and Alumina Trihydrate micron filler | 2022 |
| 88 | Dr Santosh Kumar Department of Food Engineering and Technology, Central Institute of Technology Kokrajhar | “Chitosan-based nanocomposite as a sustainable solution for postharvest shelf-life extension of fruits and vegetables” | 2022 |
| 89 | Dr Alok Ghosh, University of Calcutta | Simultaneous biosorption of dyes and heavy metals from water by using the dry biomass of Bacillus cereus M1 16 (MTCC 5521 | 2022 |
| 90 | Prof Jyoti Prakash Maity, KIIT Deemed to be University | Studies on the γ-radiation-induced effects of successive plant generations (F1, F2, and F3) and yield production from food grain, and correlation with heavy metal (e.g., As, Cr, Ni, Pb, etc.) tolerance/stress response | 2022 |

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| 91 | Dr Shidharth Sankar Ram, AIPH University | Effect of gamma radiation on growth and lipid biosynthesis induction of microalgae for biodiesel production | 2022 |
| 92 | Dr Aryadeep Roy Choudhury, St. Xavier's College (Autonomous), Kolkata | Deciphering the effect of sub lethal dose of gamma radiation on cross adaptation of rice plants to arsenic and fluoride co-contamination | 2022 |
| 93 | Dr Sudeep Bose<br>Amity Institute of Biotechnology, AUUP, Noida | Nucleolin Targeting with Mesoporus Silicon Nanoparticle Conjugated Natural Products as a Radiosensitizer for Breast Cancer | 2022 |
| 94 | Dr Kishor Kumar, Ramakrishna Mission Vivekananda Educational and Research Institute | Ionizing radiation-induced mutagenesis and rapid identification of mutant genes for the improvement of traditional aromatic rice | 2022 |
| 95 | Dr Sankha Bhattacharya, School of Pharmacy & Technology Management, Shirpur, Maharashtra 425405 | Melatonin-loaded PLGA:D-Tocopheryl and Polysarcosine blend polymeric nanoparticles for glioblastoma multiform therapy | 2022 |
| 96 | Dr Neelima Sharma,<br>Birla Institute of Technology, Mesra, Ranchi | Synthesis of Reduced Graphene Oxide- metal nanoparticles for early detection of Hepatocellular Carcinoma through Surface Enhanced Raman Spectroscopy | 2022 |
| 97 | Dr Bhabatosh Banik,<br>Cotton University | Designing Platinum(IV)-based combination chemotherapeutics by conjugating glycolysis inhibitors to Cisplatin | 2022 |
| 98 | Prof Sanghamitra Sengupta, University of Calcutta | Delineating precise stages of breast cancer progression using molecular fingerprints generated by infrared vibrational spectroscopy | 2022 |
| 99 | Dr Anindita Ukil,<br>Department of Biochemistry, University of Calcutta | Deciphering the comprehensive mechanisms of anti-microbial peptides using leishmaniasis as model intra-macrophage parasitic infection: Implications for drug development against macrophage-associated diseases | 2022 |
| 100 | Prof Ansuman Chattopadhyay, Department of Zoology, Visva-Bharati, Santiniketan | Enhancement of radio-sensitivity in cancer cells by depleting intracellular Nrf2 level | 2022 |
| 101 | Prof Varsha Wasudeorao, Wankhade Savitribai Phule Pune University, Pune | Mechanism of oxidative stress caused by radiations in cardiomyocytes and possible ameliorative potential of leaf extracts of Ficus religiosa | 2022 |

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| 102 | Dr Sabyasachi Chakrabortty, Department of Chemistry, SRM University AP Andhra Pradesh | Synthesis of High Indexed Faceted, Near Infra-Red (NIR) Active Hybrid Nanomaterials for (Photo)Catalysis | 2022 |
| 103 | Dr Md Hedayetullah Mir, Aliah University | Photoresponsive Metal-Organic Frameworks (MOFs) for the Fabrication of Smart Photoactuating Materials | 2022 |
| 104 | Dr Rupam Mukherjee, Lovely Professional University, Punjab | Understanding percolation driven magneto-dielectric effect in composite systems | 2022 |
| 105 | Dr. Prajwal Chettri,<br>Salesian College | Investigation of structural modifications in graphene under extreme thermal gradients and its immediate impact on physiochemical properties | 2022 |
| 106 | Dr Goutam Kumar Kole, Department of Chemistry, SRM Institute of Science and Technology | Multi-functional Metal-Organic-Materials Derived from Trivalent Metals with Second Near Infra-red (NIR-II) Emission | 2022 |
| 107 | Dr Soumyaditya Sutradhar, Department of Physics, Amity University Kolkata Development of Magnetic | Hexaferrite Nanofillers Decorated-Poly(vinylidene fluoride) Heterojunction Laminated Composites as Radar Absorbing Materials | 2022 |
| 108 | Dr Yasir Hasan Siddique, Aligarh Muslim University, Aligarh, UP. | Effect of tangeretin silver nanocomposite on the Drosophila model of Alzheimer's disease | 2022 |
| 109 | Dr Shabeeba Nawab, University of Calicut | Development of High-Performance Supercapacitor Electrode Materials | 2022 |
| 110 | Dr Arunima Biswas, Department of Zoology, University of Kalyani | Repurposing PDE5 inhibitor encapsulated nanoparticles for the treatment of cervical cancer. | 2022 |
| 111 | Dr Soumabha Bag, Department of Industrial Chemistry, Mizoram University | Application of the high entropy materials as a shield for ionizing photon | 2022 |
| 112 | Dr Sinthiya Arokiaswamy, Department of Physics, St. Joseph's College Trichy 620002, Tamilnadu, India | Effect of ion fluency in Alkali Hydrogen Phthalate thin film, with histidine and lactic acid impurities, to enhance Second harmonic generation (SHG) | 2022 |
| 113 | Prof Gouranga Sundar Taki, Institute of Engineering and Management. Kolkata | Investigation of magnetic properties of ion beam irradiated graphene as potential spintronic material | 2022 |
| 114 | Dr Somnath Biswas, | Ion-implanted Heat Dissipation Channels in Microelectronics | 2022 |

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| | The LNM Institute of Information Technology | | |
| 115 | Prof Tinku Basu, Amity University, Uttar Pradesh | Inclusion of selective metal ions (Ni+2 and N) using low energy ion beam irradiation towards the development of surface enhanced bimetallic catalyst systems for degradation of antibiotics | 2022 |
| 116 | Dr N. Pushpa, JSS College of Arts, Commerce & Science | TCAD Modeling and Characterization of Hydrogen and Helium ion irradiated MOS and Bipolar Devices | 2022 |
| 117 | Prof Jiban Jyoti Das, Cotton University | Development of High Power Target for monochromatic Neutron Source | 2022 |
| 118 | Dr Ruma Basu, Jogamaya Devi College | Detection and removal of heavy-metal ions and living cells in wastewater using aptamer modified magnetic nanoparticles based multifunctional fluorometric and colorimetric sensors for combating industrial wastewater pollution. | 2022 |
| 119 | Dr Dasaradha Ramarao Seethiraju, VNR Vignana Jyothi Institute of Engineering and Technology | Tailoring electronic and magnetic properties of two-dimensional layered transition metal oxides for spintronics applications | 2022 |
| 120 | Dr Harkirat Singh, NIT Srinagar, J&K-190006 | 2D superconductivity in transition metal dichalcogenides. | 2022 |
| 121 | Dr Ankita Indra, Department of Physics, Srikrishna College, Bagula, Dist- Nadia, West Bengal, Pin-741502 | Tunning of magnetoelectric coupling with doping at R-site in green phase multiferroic $R_2BaCuO_5$ (R=rare earth) | 2022 |
| 122 | Dr K Ramesh Kumar, GITAM Institute of Science, GITAM | New Perspective in understanding the magnetic/spin contribution to the Seebeck coefficient in itinerant magnetic systems | 2022 |
| 123 | Dr Tapas Paramanik, Dept of Physics, School of Sciences, NIT Andhra Pradesh, Tadepalligudem, A.P.- 534101 | To study structural, electronic and magnetic properties of half- metallic spintronics materials: Fe-based quaternary Heusler alloys | 2022 |
| 124 | Dr Buddhadev Mukherjee, Visva-Bharati | Search of octupole collectivity in 62,64,66 Zn through α-induced measurements | 2022 |
| 125 | Dr Debajyoti Barooah, Department of Physics, Cotton University | Measurements of natural radioactivity and associated radiological hazards in rocks and soil from Kopili Fault Zone, Assam. | 2022 |
| 126 | Dr Rebecca Lalnuntluangi, Department of Physics, Banaras Hindu University | Measurement of particle induced reaction cross sections and theoretical study of nuclear data | 2022 |

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| 127 | Dr Nikit Deshmukh, AURO University, Surat | Critical energy measurement and dependence in Heavy–ion fusion. | 2022 |
| 128 | Dr Mridula Baro, Cotton University | Development of high flux Neutron Beam Shaping Assembly (BSA) for BNCT applications | 2022 |
| 129 | Dr Anagha Chakraborty, Department of Physics, Siksha Bhavana, Visva-Bharati | Investigating the controlling effects of shell closure and collectivity on nuclear level density at varying angular momentum and excitation | 2022 |
| 130 | Dr M. Hemalatha, University of Mumbai | Study of nuclear transmutation of long-lived fission fragments using protons | 2022 |
| 131 | Prof Samit Mandal, Department of Physics & Astrophysics, University of Delhi | Fission Time Scale Measurements around mass ~ 200 Region | 2022 |
| 132 | Dr Unnati Ainst, Amity University, Uttar Pradesh | A trace elemental analysis of fly ash-based ready to use building material obtained from Delhi-NCR Region | 2022 |
| 133 | Prof M.M. Musthafa, University of Calicut | Measurement of (n,γ) cross sections of long living radionuclides using surrogate ratio method | 2022 |
| 134 | Dr Kumar Raju Mukhi, GITAM Institute of Science, GITAM | Study of nuclear shapes in A ~ 40 region through low-energy Coulomb-excitation | 2022 |
| 135 | Dr Dharmendra Singh, Department of Physics, Central University of Jharkhand, Ranchi | Study of various entrance channel effects on the population of angular momentum values in incomplete fusion | 2022 |
| 136 | Dr Md. Harunar Rashid, Rajiv Gandhi University | Effect of surface modification and doping on structural, magnetic and electrical resistivity properties of $CuFe_2O_4$ nanoparticles | 2022 |
| 137 | Prof Sukhen Das, Jadavpur University | High-Temperature Sustainable Metal Oxide Semiconductor Quantum Dots (MOSQDs) implanted Reduced Graphene Oxide (rGO) hybrid nanosheet for Superior Electromagnetic Interference Shielding Performance and Radar Absorbing Coating for Stealth Technology. | 2022 |
| 138 | Dr Ibetombi Soibam, NIT Manipur | Study of multiferroic nanocomposites with Dy substituted Bismuth ferrite as one of its constituent phase | 2022 |
| 139 | Dr Manashi Chakraborty, The Neotia University | Studies on improving multiferroicity with RGO/GO/Graphene based nanocomposites | 2022 |
| 140 | Dr Manish Pal Chowdhury, Department of Physics, IIEST, Shibpur | Chemiresistive - magnetic hybrid gas sensor for $NH_3$ gas detection | 2022 |

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| 141 | Dr Sudipta Pal,<br>Department of Physics,<br>University of Kalyani | Magnetic, dielectric and magnetocaloric properties of nonmagnetic ions doped multiferroic $GdFeO_3$ | 2022 |
| 142 | Dr Moumita Patra,<br>Raghunathpur College,<br>Raghunathpur, Purulia-723133 | Fabrication and characterization of nanostructured perovskites with efficient thermoelectric as well as magnetodielectric properties. | 2022 |
| 143 | Prof Rupam Dinda,<br>NIT Rourkela | Study of novel magnetic behaviour of vanadium(IV) complexes: Potential molecular qubits and spin-frustrated systems' | 2022 |
| 144 | Dr Koushik Dey, Dept. of Physics(HOD), Santal Bidroha Sardha Satabarshiki Mahavidyalaya. PO + PS: Goaltore, Dist: Paschim Medinipur, PIN- 721128 | Investigation of magnetoelectric coupling and ferroelectricity in $RVO_4$ (R= Dy, Gd, Ho, Er and Yb) oxides. | 2022 |
| 145 | Dr.Tapanendu Kamilya<br>Narajole Raj College | Immobilization of α-Amylase on Biocompatible Magnetic Nanoparticles and Design of Reusable Nano-Biocatalyst for Starch Hydrolysis | 2022 |
| 146 | Dr Debajyoti De,<br>The Neotia University (Lien) and Sukumar Sengupta Mahavidyalaya | Studies on Exchange Bias effect in combination of 'core-shell' and 'inverted core-shell' structures | 2022 |

# Mumbai Centre

| Sr. No. | CRS ref | Principle Investigator | Title of the project | Year of sanction |
|---|---|---|---|---|
| 1. | 2020/301 | Dr. Sanjay Tiwari National Institute of Pharmaceutical Education and Research (NIPER), Raebareli UP | Tumor selective drug delivery using targeted micellar systems | 2020 |
| 2. | 2020/302 | Dr. Deepali Shrivastava Pillai College of Engineering, Panvel, Navi Mumbai | Study of Dielectric and Structural Properties of polyimide-nanocomposite films | 2020 |
| 3. | 2020/304 | Dr. Dharmesh Varade Ahmedabad University, Ahmedabad | Phase behavior and microstructures in aqueous solution of mixed surfactant systems, Micellar transition foaming and microemulsion | 2020 |
| 4. | 2020/306 | Dr. Atul Khanna Guru Nanak Dev University, Amritsar | Structural studies of conducting oxide and oxyhalide glasses and glassceramics for applications in solid- state batteries | 2020 |
| 5. | 2020/308 | Dr. M. S. Khatri NIT Uttarakhand | Fabrication and characterization of Co- based CoPt/Pt multilayered films by electrodeposition | 2020 |
| 6. | 2020/309 | Dr. R. Kalai Selvan Bharathiar University, Coimbatore | Investigations on the crystal structure of K0.7Mn1- yMyO2 (M=Fe,Cr & Co); y= 0.0 - 0.5) particles by neutron powder diffraction for K-ion batteries | 2020 |
| 7. | 2020/310 | Dr. C. R. MariappanNIT Kurukshetra, Haryana Transferred now to NIT, Puducherry | Development of lithium stuffed garnet-type solid electrolytes with high ionic conductivities for all solid-state lithiuum ion batteries | 2020 |
| 8. | 2020/311 | Dr. Ashwin Mohan Institute of Chemical Technology, Mumbai | Investigating geometric ferroelectricity in Ruddleson- Popper A3B2O7 phases | 2020 |
| 9. | 2020/312 | Dr. P. P. Jana IIT Kharagpur, Kharagpur | Use of neutron powder diffraction for crystal structure determination of copper based intermetallic alloys in the Cu-Zn-M (M=Sb,Sn,In) system | 2020 |
| 10. | 2020/313 | Dr. T. Durga Rao GITAM University, Vizag | Structural and magnetic properties of R2NilrO6 iridates (R = La, Ce, Pr, Nd, Tb, Ho, Y and Lu) | 2020 |
| 11. | 2020/314 | Dr. A. N. Prabhu Manipal Institute of Technology, Manipal | Synthesis and characterization of novel chalcogenide thermoelectric materials for Peltier cooling applications | 2020 |
| 12. | 2020/315 | Dr. B. V. Rajendra Manipal Institute of Technology, Manipal | Synthesis and Characterization of Lanthanum doped zinc oxide thin films | 2020 |
| 13. | 2020/316 | Dr. S. Chattopadhyay Manipal University, Jaipur | Effect of lithium and europium co-doping on the opto- electronic and magnetic properties of transition metal ion doped ZnO nanostructures | 2020 |

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| 14. | 2020/317 | Dr. Vijaykumar Patel<br>J. N. M. Patel Science College, Bharthana, Surat | Tuning the self-assembly and growth of stimuli responsive polymer muicelles by hydrophobic additives | 2020 |
| 15. | 2020/318 | Dr. Sidhartha Jena NIT Rourkela, Odisha | Probing the structure and dynamics of differently cross-linked gellan gum hydrogels | 2020 |
| 16. | 2020/319 | Dr. Sonal I. Thakore<br>M. S. University, Baroda | Investigating self-assembly behavior of polysaccharide based nano vesicles developed for drug delivery application | 2020 |
| 17. | 2020/321 | Dr. Soumya Jyoti Ray IIT Patna, Bihar | Polarized neutron reflectivity measurements of thin film heterostructures for spin-triplet superconducting state generation | 2020 |
| 18. | 2020/324 | Dr. Aabid Hussain Shaik<br>VIT-Vellore, Tamilnadu | Mechanical investigation of the effect of washing of stabilizers in Cu nanofluids for heat transfer applications using small angle neutron scattering | 2020 |
| 19. | 2020/325 | Dr. B. Shivamurthy<br>Manipal University, Manipal | Electrical, Magnetic and Structural properties of multi-layered metal coated carbon fabric polymer composites | 2020 |
| 20. | 2020/326 | Dr. Arpita Dutta<br>Amity Institute of Nuclear Science and Technology (AINST), Noida | Quality assurance and Forensic Studies on Indian Spices using Nuclear Analytical Techniques | 2020 |
| 21. | 2020/327 | Dr. Pushpinder Bhatia Guru Nanak Dev College, Mumbai | Synthesis and characterization of Fe-based mineral magnetic oxides in bulk and nano formulations | 2020 |
| 22. | CRS/2021-22/03/540 | Dipten Bhattacharya<br>Senior Principal Scientist<br>CSIR-Central Glass and Ceramic Research Institute | Mapping of Ferroelectric Polarization with Magnetic Field across ±50 kOe at Room Temperature by using Powder Neutron Diffraction in Nanoscale BiFeO3 and BiFeO3-Reduced Graphene Oxide Nanocomposite | 2021 |
| 23. | CRS/2021-22/03/541 | Prof. Subit Kumar Saha<br>Professor<br>Birla Institute of Technology & Science (BITS) Pilani, Hyderabad Campus, Jawahar Nagar, Kapra Mandal, Medchal District-500078, Telangana | Investigation of Compaction of DNA by Some Potential Surfactants in the presence of Nanoparticles and Decompaction Induced by Cyclodextrins using Fluorescence Spectroscopy and Small-Angle Neutron Scattering Techniques | 2021 |
| 24. | CRS/2021-22/03/542 | RADHA PERUMAL RAMASAMY<br>ASSISTANT PROFESSOR<br>ANNA UNIVERSITY | Investigation of Solid Polymer Electrolytes Using Neutron and Dielectric Relaxation Spectroscopy | 2021 |
| 25. | CRS/2021-22/03/543 | Gurpreet Kaur<br>ASSISTANT PROFESSOR<br>PANJAB UNIVERSITY | Biocompatible metallosomes: fabrication, characterization and their interactional behavior with biomolecules | 2021 |
| 26. | CRS/2021-22/03/544 | Tathamay Basu<br>Assistant Professor<br>Rajiv Gandhi Institute of Petroleum Technology (RGIPT), Jais | Investigation of magnetic structure and magnetoelectric coupling of designed 4d/5d - 4f coupled strongly correlated systems | 2021 |
| 27. | CRS/2021-22/03/545 | Dr. Sanjeev Kumar<br>Associate Professor | Mixed Surfactant Morphologies: SANS and DLS Studies | 2021 |

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| | | Applied Chemistry Department, Faculty of Technology and Engineering, The Maharaja Sayajirao University of Baroda, Vadodara, Gujarat | | |
| 28. | CRS/2021-22/03/546 | Dr. Shweta Dilip Jagtap<br>Assistant Professor<br>Savitribai Phule Pune University | Neutron diffraction studies on undoped and doped WS2/WSe2 nanocomposites for gas sensing application | 2021 |
| 29. | CRS/2021-22/03/547 | Atul Khanna<br>Professor<br>Guru Nanak Dev University | Structure-property correlation studies in chemically strengthened aluminosilicate and alumnioborosilicate glasses by high-Q neutron diffraction | 2021 |
| 30. | CRS/2021-22/03/548 | Dr. Mohammad Muzammil<br>Assistant professor and Institute Research and Devlopment Coordinator<br>Swarrnim Startup & Innovation University | A novel biocompatible, self-healable and injectable vesicle hydrogels for pancreatic cancer models. | 2021 |
| 31. | CRS/2021-22/03/549 | Amitava Bhattacharyya<br>Assistant Professor<br>Department of Physics, Ramakrishna Mission Vivekananda Educational and Research Institute | Understanding Honeycomb Layered Oxides' Unconventional Magnetism | 2021 |
| 32. | CRS/2021-22/03/550 | Dipanshu Bansal<br>Assistant Professor<br>IIT Bombay | Thermodynamics of paramagnetic metal - antiferromagnetic insulator transition in RNiO3 (R = Nd, Pr) | 2021 |
| 33. | CRS/2021-22/03/551 | Puyam Sobhindro Singh<br>Senior Principal Scientist & Professor<br>CSIR Central Salt & Marine Chemicals Research Institute | Structure mapping of mixed matrix membranes at the nanometer-length-scale | 2021 |
| 34. | CRS/2021-22/03/552 | Prof. Balaprasad Ankamwar<br>Professor<br>Savitribai Phule Pune University (Formerly, University of Pune), Ganeshkhind, Pune- 411 007, India. | Biosynthesis of iron oxide nanoparticles and study on their magnetic and bioactive properties | 2021 |
| 35. | CRS/2021-22/03/553 | Saket Asthana<br>Professor<br>Indian Institute of Technology Hyderabad | Investigation of the structure-property relationship in lead free relaxor ferroelectric to optimize recoverable energy storage density | 2021 |
| 36. | CRS/2021-22/03/554 | Sudhir Cherukulappurath<br>Assistant Professor<br>Goa University | Evolution of structural and optical properties of multifunctional magnetic-plasmonic-graphene oxide nanocomposites due to photothermal effects. | 2021 |
| 37. | CRS/2021-22/03/555 | Dr. Debakanta Samal<br>Reader-F<br>Institute of Physics, Bhubaneswar | Exploration of magnetism in 4d Pyrochlore Bi2Ru2O7 upon Nd doping | 2021 |
| 38. | CRS/2021-22/03/556 | Bholanath Pahari<br>Assistant Professor<br>Goa University | Designing polymer-in-ceramic composite electrolytes for high-performance sodium-ion batteries | 2021 |

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| 39. | CRS/2021-22/03/557 | Dr Bhumireddi sattibabu<br>Assistant professor<br>GITAM DEEMED TOBE UNIVERSITY | Investigation of structural and multicaloric properties in doped double perovskite La2NiMnO6 | 2021 |
| 40. | CRS/2021-22/03/558 | Dr. Ghanshyam Das Varma<br>Professor<br>Indian Institute of Technology Roorkee | Growth and study of structural, superconducting and magnetic properties of Iron-based topological superconductors | 2021 |
| 41. | CRS/2021-22/03/559 | Dr. Shailesh Narain Sharma<br>Senior Principal Scientist (Sc. F), Professor (AcSIR )<br>Advanced Materials and Devices Metrology Division, CSIR- National Physical Laboratory(NPL) | Synthesis and Characterization of Novel Magnetic Nano-Zeolite Composites: An Efficient Heavy Metal (Cd, Pb, Cr, As, Hg) and Radionuclides (U, Eu, Pu) Adsorbent | 2021 |
| 42. | CRS/2021-22/03/560 | Dr. R.N. Bhowmik<br>Associate Professor<br>DEPARTMENT OF PHYSICS, PONDICHERRY UNIVERSITY, R. VENKATARAMAN NAGAR, KALAPET, PONDICHERRY, Pin Code-605014 | Understanding of the Magnetic Field induced Spin Order in metal doped Hematite (α-Fe2O3) system using Neutron diffraction and Magnetization Measurements | 2021 |
| 43. | CRS/2021-22/03/561 | Dr. Reshma Raut Dessai<br>Assistant Professor<br>Goa University | Investigation of application-based properties of Aerogels | 2021 |
| 44. | CRS/2021-22/03/562 | Dr Pranab Mandal<br>Assistant Professor<br>SRM University AP | Neutron diffraction studies on novel magnetoelectric oxides at the morphotropic phase boundary | 2021 |
| 45. | CRS/2021-22/03/563 | Dharamashibhai V Rabari<br>Assistant Professor<br>Ahmedabad University | Self-aggregation Behavior of Surfactants in Novel Synthesized Deep Eutectic Solvents. | 2021 |
| 46. | CRS/2021-22/03/564 | Avijit Kumar Paul<br>Assistant Professor<br>National Institute of Technology Kurukshetra | New Perovskite Oxides for Application in Energy Generation and Storage Purpose | 2021 |
| 47. | CRS/2021-22/03/565 | Shubhankar Roy<br>Assistant Professor<br>Vidyasagar Metropolitan College | Functionality of Half-Metallicity in Half-Heusler Full-Heusler Composite: Impact on structural and Thermoelectric Power Generation. | 2021 |
| 48. | CRS/2021-22/03/566 | Dr. Sushma P. Ijardar<br>Assistant Professor<br>Veer Narmad South Gujarat University | Exploring selective separation of sodium salts using aqueous two phase system composed of temperature sensitive polymer. | 2021 |
| 49. | CRS/2021-22/03/567 | Dr. Deep Shikha<br>Assistant Professor<br>Sri Guru Teg Bahadur Khalsa College, Sri Anandpur Sahib, Punjab | Studies on agricultural soil quality for improvement in crop products utilizing Nuclear Analytical Techniques: A comparison between chemical and bio fertilizers | 2021 |
| 50. | CRS/2021-22/03/568 | Ajit Kumar Patra<br>Associate Professor<br>Department of Physics, Central University of Rajasthan | Exploring the Functionalities of Novel Heusler Alloys by Employing Neutron Diffraction | 2021 |

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| 51. | CRS/2021-22/03/569 | Dr. Sanjaykumar H Panjabi<br>Assistant Professor<br>CHAROTAR UNIVERSITY OF SCIENCE AND TECHNOLOGY | Surface Active Ionic Liquids with Aromatic Counter Ions: Synthesis, Characterization and its Applications | 2021 |
| 52. | CRS/2021-22/03/570 | Dr Vikas L Mathe<br>Professor<br>Savitribai Phule Pune University, Pune | Neutron diffraction analysis of thermal plasma synthesized Fe-Mn alloys. | 2021 |
| 53. | CRS/2021-22/03/571 | Amritendu Roy<br>Assistant Professor<br>School of Minerals, Metallurgical and Materials Engineering , IIT Bhubaneswar | An investigation into the local structure vis-à-vis correlations with functionalities in multicomponent AlCuFeMn based alloys | 2021 |
| 54. | CRS/2021-22/03/572 | Anupinder Singh<br>ASSISTANT PROFESSOR<br>PHYSICS DEPARTMENT, GURU NANAK DEV UNIVERSITY, AMRITSAR | To study the multiferroic properties in bulk and flexible thin sheets of Polymer/multiferroic ceramics composites | 2021 |
| 55. | CRS/2021-22/03/573 | Saroj L Samal<br>Assistant Professor<br>National Institute of Technology, Rourkela | Investigation of the Magnetic Structure and Properties of Fe2SnS4 Related Inverse Thiospinels and MxNbSe2 (M = Cr, Fe, Ni) layered dichalcogenides. | 2021 |
| 56. | CRS/2021-22/03/574 | Pavan Venu Prakash Madduri<br>Assistant Professor<br>Indian Institute of Information Technology Design and Manufacturing, Kurnool | Synthesis of high-Tc and small-sized-skyrmion/antiskyrmion host bulk materials and to study their exotic magnetic properties. | 2021 |
| 57. | CRS/2021-22/03/575 | Kedar Singh<br>Professor<br>School of Physical Sciences, Jawaharlal Nehru University, New Delhi | Investigation of local structures and magnetic ordering in diluted magneticsemiconductor quantum dots | 2021 |
| 58. | CRS/2021-22/03/576 | Dr. Ashim Kumar Pramanik<br>Assistant Professor<br>Jawaharlal Nehru University | Temperature dependent Neutron diffraction measurements for Sr2NiMo1-xMxO6 (M = W, Te) double perovskites | 2021 |
| 59. | CRS/2021-22/03/577 | Dr. Jayanta Hazarika<br>Assistant Professor<br>Pandu College, Guwahati | Studies of structural, electrical transport, dielectric relaxation and magnetic properties of conducting polymers-ferrites nanostructures. | 2021 |
| 60. | CRS/2021-22/03/578 | Basavaraj Angadi<br>Associate Professor<br>Department of Physics, Bangalore University, Bangalore | Synthesis and study of rare earth doped GaFeO3 -AlFeO3 orthoferrites solid solution for Spin-lattice and Magneto-electric coupling | 2021 |
| 61. | CRS/2021-22/03/579 | Dr. Pareshkumar Yogeshbhai Parekh<br>Assistant Professor<br>Veer Narmad South Gujarat University | SANS Characterization of Core-Shell Micelles from novel polyvinyl caprolactam–polyvinyl acetate–polyethylene glycol graft copolymer. | 2021 |

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| 62. | CRS/2021-22/03/580 | Dr. ROHIT L. VEKARIYA<br>Assistant Professor<br>Institute of Science and Technology for Advanced Studies and Research (ISTAR), CVM University, Vallabh Vidyanagar - 388 120, Anand, Gujarat, INDIA. | Dissimilar self-assembly of Fluro and hydro-carbon based di-block copolymers in solution | 2021 |
| 63. | CRS/2021-22/03/581 | JASHASHREE RAY<br>Assistant Professor I<br>Kalinga Institute of Industrial Technology, Bhubaneswar | Investigation of antisite disorder of B-cations in R2CoMnO6, R2NiMnO6 (R: Rare Earth) double Perovskites (A2BB'O6). | 2021 |
| 64. | CRS/2021-22/03/582 | Dr. Kiran Singh<br>Assistant Professor<br>Department of Physics, Dr B R Ambedkar National Institute of Technology, Jalandhar | Investigation on the effect of substitution on the magnetic structure and spin-lattice coupling in A4B2O9 family (A=Mn, Co, Ni, Fe and B=Nb and Ta) | 2021 |
| 65. | CRS/2021-22/03/583 | Dr Neena Bedi<br>Assistant Professor<br>Department of Pharmaceutical Sciences, GND University Amritsar | Optimization and Development of Shikonin and its Derivatives loaded Microsponges based Nanofibres and Assessment of its Modulatory effect on MMP-9 in Diabetic Wounds | 2021 |
| 66. | CRS/2021-22/03/584 | Dr.Jyoti Prasad Borah<br>Assistant Professor<br>NIT Nagaland | Enhancement of magneto crystalline anisotropy of non-rare earth substitution M type hexaferrite for permanent magnet | 2021 |
| 67. | CRS/2021-22/03/585 | ANIL KUMAR SINGH<br>Associate Professor<br>NATIONAL INSTITUTE OF TECHNOLOGY ROURKELA | Understanding low magnetic field control of ferroelectric polarization and its microscopic origin in Y-type hexaferrites | 2021 |
| 68. | CRS/2021-22/03/586 | Sanjeev Kumar<br>Professor<br>Punjab Engineering College Chandigarh | Investigations on structural, dielectric and magnetic properties of transition metal doped sodium bismuth titanate (Na0.5Bi0.5TiO3) composites | 2021 |
| 69. | CRS/2021-22/03/587 | Dr Shidaling Matteppanavar<br>Assistant Professor<br>KLES Basavaprabhu Kore Arts Science and Commerce College Chikodi | Synthesis and Studies on Spin Lattice, Spin Phonon and Magnetoelectric Coupling in High-Temperature Thermoelectric PrFeO3 and NdFeO3 | 2021 |
| 70. | CRS/2021-22/03/588 | Dr. Bradha Madhavan<br>Associate Professor<br>Rathinam Technical Campus | Neutron diffraction, magnetism and dielectric studies of LaTi0.5B0.5O3-δ (B= Mn, Co, Fe) | 2021 |
| 71. | CRS/2021-22/03/589 | Dr. M. Mahendran<br>Professor and Head<br>Thiagarajar College of Engineering, Madurai | Thermoelectric Performance of Ta Doped Half-Heusler Alloys. | 2021 |
| 72. | CRS/2021-22/03/590 | Dr Nishad Gopal Deshpande<br>Assistant Professor<br>Indian Institute of Information Technology, Surat | Shape anisotropic nanostructures designed by core-shell FexOx+1@Ag/SiO2 (x = 2, 3) for magnetic hyperthermia and magneto-mechanical nano-actuators in low frequency rotating magnetic field. | 2021 |

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| 73. | CRS/2021-22/03/591 | RASHMI ACHARYA<br>Professor<br>Department of Chemistry, I.T.E.R, SOA Deemed to be University, Bhubaneswar | Adsorptive remediation of Cr (VI) by magnetite based composite nanomaterials and concentration determination by Instrumental Neutron Activation Analysis (INAA) and Particle Induced X-ray Emission (PIXE) techniques. | 2021 |
| 74. | CRS/2021-22/03/592 | Prateek Bhojane<br>Assistant Professor<br>Department of Physics, University of Petroleum and Energy Studies | Prediction of Hydrogen Atom Position in Metal Carbonate Hydroxide Hydrate Based Materials, using Neutron Diffraction for Energy Storage Applications. | 2021 |
| 75. | CRS/2021-22/03/593 | Dr. Davuluri Srikala<br>Assistant Professor<br>Department of Physics, Hansraj College, University of Delhi | Study of magnetic exchange paths leading to magnetic frustration in GeMxCo2-xO4 (M = Ni/Mg) spinel compounds and exploring their energy bandgap. | 2021 |
| 76. | CRS/2021-22/03/594 | Prof. Pritam Deb<br>Professor<br>Tezpur University | Spin dynamic investigation and structural co-relation of the ensembles of two dimensional primary nanosystem | 2021 |
| 77. | CRS/2021-22/03/595 | Dr. MANORANJAN KAR<br>Associate Professor<br>Indian Institute of Technology Patna | Crystal and Magnetic Structure study on co-doped SrFe12O19 and its Magneto-Electric Properties | 2021 |

## Kalpakkam Node

| S. No | Project No. | Principal Investigator/ Affiliation | Title of the project |
|---|---|---|---|
| 1. | CRS/2021-22/04/596 | Prof. Perumal Elumalai Pondicherry University, Pondicherry | Nanostructured MXene as Alternate Anode for High-capacity Lithium ion and Sodium-ion Batteries: Probing Intercalation/Alloying Mechanisms |
| 2. | CRS/2021-22/04/598 | Dr.Shyju T.S, Sathyabama Institute of Science and Technology | Development of Novel Quaternary Metal Chacogenides for Energy Harvesting Applications |
| 3. | CRS/2021-22/04/603 | Dr.Asim Guchhait, Prabhat Kumar College, Contaii | Self-powered flexible photo sensor based on 2D organometallic halide perovskite materials under indoor light. |
| 4. | CRS/2021-22/04/612 | Dr.Anuradha M.AshokPSG Institute of Advanced Studies, Coimbatore | ZnA2O4 spinel composites for intermediate temperature thermoelectric applications |
| 5. | CRS/2021-22/04/615 | Dr.Srinivasa Rao Linganabonia, VNR Vignana Jyothi Institute of Engineering and Technology (JNTUH), Hyderabad | Development of ZrO2 Nanoparticles doped - Bi203-B203: Cr203 glass-ceramic phosphors |
| 6. | CRS/2021-22/04/617 | Dr.Subhenjit Hazra, Sathyabama Institute of Science and Technology | Magnetically Retrievable Porous Nano hybrids: A Smart Material towards Sensing, Separation of Uranyl Ions present in Radioactive Waste |
| 7. | CRS/2021-22/04/621 | Dr.Ramesh Babu R, Bharathidasan University | Optimization and fabrication of Lead-free Stable bi-metallic based organic inorganic halide perovskite solar devices |
| 8. | CRS/2021-22/04/639 | Dr.Diptasikha Das, ADAMAS University | Half-Heusler And Heusler Nanocomposite: Impact of Mid -Temperature Thermoelectric power Generation. |
| 9. | CRS/2021-22/04/599 | Dr.Koteswara Rao Peta, University of Delhi | Development and characterization of monolayer MoS2 quantum dots field effect transistors (QDFET) for detection of DNA nucleobases and unlabelled DNA |
| 10. | CRS/2021-22/04/605 | Dr.Sreekala M S, SREE SANKARA COLLEGE, KALADY | Development of bio-reinforced polymer membranes for novel applications |
| 11. | CRS/2021-22/04/609 | Dr.Navneethan.M, Nanotechnology Research Center, SRM Institute of Science and Technology | Development of Nanostructured Materials for Fabrication of Wearable Thermoelectric Generator |
| 12. | CRS/2021-22/04/611 | Dr.Senthilkumar S, Vellore Institute of Technology (VIT), Vellore | Redox functionalized MXene for Designing High Energy Density Supercapacitor |
| 13. | CRS/2021-22/04/614 | Dr.R.Ananthakumar, Laboratory for Advanced Research in Polymeric Materials | Development of High-Performance Flexible Thin Film Supercapacitors Based on Transition Metal Nitrides |

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| | | (LARPM), Central Institute of Petrochemicals Engineering & Technology, Bhubaneswar | |
| 14. | CRS/2021-22/04/616 | Dr.Suchinder Sharma, Amity University, Mohali | Development of novel UV-emitting Long Persistent Perovskites materials and correlating the underlying mechanism with different morphologies |
| 15. | CRS/2021-22/04/620 | Dr.Sreenivasa Rao Amaraneni, Dayananda Sagar University | Synthesis and characterisation of hybrid ceramic membrane materials and design of photocatalytic reactor for drinking water purification from multiple pesticides: An evaluating the performance study |
| 16. | CRS/2021-22/04/622 | Dr.Swagat k.Mohapatra Institute of Chemical Technology Mumbai (Indian Oil Campus Odisha) | Synthesis of organic hydrides for n-doping of organic semiconductors |
| 17. | CRS/2021-22/04/623 | Dr.Gnana Kumar C, Madurai Kamaraj University, Madurai-625021 | Fabrication of wearable and self-powered multiplex sensors with flexible biofuel cells |
| 18. | CRS/2021-22/04/624 | Dr.Manjula M Muthurathinam, Sathyabama Institute of Science and Technology | Fabrication of efficiency enhanced thermoelectric materials from 2D MoS2/Polymer |
| 19. | CRS/2021-22/04/628 | Dr.Mubarak Ali, Chikkaiah naicker college, Erode-638004 | Fabrication of efficient visible light driven polypyrrole/Bi2O3/rGO ternary nanocomposite for the degradation of real industrial waste water |
| 20. | CRS/2021-22/04/629 | Dr.Nehru Selvan, UNIVERSITY OF MADRAS | Design and development of nanomaterials for High-performance supercapacitors towards energy storage applications |
| 21. | CRS/2021-22/04/631 | Prof. Mainak Banerjee, BITS Goa Campus | Mechanochemical synthesis of magnetic graphene oxide based reusable solid acid catalysts, their use in the synthesis of bioactive quinoxlines and further exploration towards green synthesis of influenza drug, Favipiravir |
| 22. | CRS/2021-22/04/632 | Dr.Lija K Joy, BISHOP MOORE COLLEGE, MAVELIKARA | Tailoring the Multiferroic and High Performance Energy Storage Properties of CoFe2O4 through Y3+ and Zr4+ ion Substitution. |
| 23. | CRS/2021-22/04/636 | Dr. Basil Kuriachen, National Institute of Technology Calicut | Development of novel methodology to deposit Micro/Nano secondary phases (Composite coatings) through Electrical Discharge to improve the surface tribology of Ti6Al4V |
| 24. | CRS/2021-22/04/637 | Dr.Sivaraj Paramasivam, Annamalai University | Investigations on material flow behaviour, mechanical properties and microstructural characteristics of friction stir welded nuclear grade materials |
| 25. | CRS/2021-22/04/640 | Dr.Jayamurugan P, Sri Ramakrishna Mission Vidyalaya College of Arts and Science | Fabrication and characterization of Conducting Nano-Polypyrrole (PPy)/LiMn2PO4 Cathode for Coil Cell Battery Applications. |

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| 26. | CRS/2021-22/04/643 | Dr.Arunmetha S<br>Koneru Lakshmaiah Education Foundation | Develop Nanostructured materials for Efficient Solar Energy Conversion Application |
| 27. | CRS/2021-22/04/601 | Dr. Daniel T. Thangadurai<br>Sri Ramakrishna Engineering College, Coimbatore, Tamilnadu | Development of Low-cost prototype device based on Graphene Quantum Dot composites for rapid online monitoring of Uranium (IV/VI) and Thorium (IV) in Acidic condition |
| 28. | CRS/2021-22/04/634 | Dr. Jishu Naskar<br>University of Kalyani,<br>Kalyani, Nadia, West Bengal | Modified amino acid based hybrid peptide: synthesis, conformational analysis and its application to target G-quadruplex nucleic acid structure for development of new anticancer tactic |
| 29. | CRS/2021-22/04/613 | Dr. Kalainathan Sivaperuman<br>Vellore Institute of Technology,<br>Vellore, Tamilnadu | Growth and characterization of organic single crystal for fast neutron scintillator detector device |
| 30. | CRS/2021-22/04/626 | Dr. Rajakumar Selvarajan<br>Annamalai University,<br>Annamalai Nagar, Tamilnadu | A Comparative Evaluation of Joint Characteristics of 304HCu Austenitic Stainless Steel Tubes Welded<br>by Keyhole Plasma Arc welding (KPAW) and Gas Tungsten Arc Welding (GTAW) Processes |
| 31. | CRS/2021-22/04/604 | Dr. Sasikala Ganapathy<br>Crystal Growth Centre,<br>Anna University, Chennai,<br>Tamilnadu | Fabrication of Excitonic Solar cells with improved efficiency utilizing Graphene: CdSe/CdS core-shell quantum dots |
| 32. | CRS/2021-22/04/600 | Dr. Shubra Singh<br>Crystal Growth Centre,<br>Anna University, Chennai,<br>Tamilnadu | Development of single crystalline and ceramic form of GarnettypeLi7-xGaxLa3Zr2-yTayO12(Cubic phase) for next generation battery applications |
| 33. | CRS/2021-22/04/627 | Dr. Sivakumar N.<br>Sairam Engineering College,<br>Chennai, Tamilnadu | Investigation of novel ABC ternary polycrystalline materials for microwave dielectric applications |
| 34. | CRS/2021-22/04/638 | Dr. Vinitha G<br>Vellore Institute of Technology-Chennai,<br>Chennai, Tamilnadu | Energy transfer in binary dye doped polymer for enhancing efficiency in nonlinear optical device applications |
| 35. | 2021/CRS/40/45/65 | Dr. Jagadeesh Sure,<br>Asst. Prof.<br>Vellore Institute of Technology ,<br>Vellore | The Effect of Molybdenum Addition on the Bioactivity and Tribocorrosion Properties of High-entropy Alloys for Medical Implant Applications |
| 36. | 2021/CRS/41/41/683 | S. Kavitha,<br>Asst. Prof.<br>Annamalai university, Annamalai Nagar - 608002. | Fabrication of High-Performance Piezoelectric Nano Energy Harvester for Sensors in Atomic Power Station Application |

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|---|---|---|---|
| 37. | 2021/CRS/14 /00/299 | Dr. K. J. Sankaran, CSIR-Institute of Minerals and Materials Technology Bhubaneswar-751013 Odisha | The effect of Microstructural on the Enhancement of Electrical Properties of Diamond Films by N and P co-ion Implantation for Electron Emission Displays |
| 38. | 2021/CRS/29 /29/477 | Prof. Shikha Wadhwa, Department of Chemistry University of Petroleum & Energy studies, Energy Acres, Bidholi campus, Dehradun-248007 | Investigation of interaction of hydrogen with Pd-Ag and Pd-GO alloy thin films for hydrogen sensing and storage applications |
| 39. | 2021/CRS/41 /26/189 | Dr. V. Madhu, Department of Applied Chemistry Karunya Institute of Technology and Sciences Coimbatore-641114 | Synthesis and Characterization of Organic–Inorganic Hybrid Perovskite Materials for Photodetector Applications |
| 40. | 2021/CRS/20 /47/92 | Prof. S. Mariyappan, Hindustan Institute of Technology and Science, #1, IT Expressway, Bay Range Campus, Padur, Chennai–603103 | Ion Irradiation Enabled Defects Mediated Charge Transport in 2D-Layered Van der Waals Heterostructures for Photovoltaics Applications |
| 41. | 2021/CRS/14 /50/377 | Dr. Atul Bandyopadhyay Asst. Prof. University of Gour Banga Malda-732101 | A comprehensive study on transition (3d) and rare earth (4f) ions doped nano-crystalline ferrites |
| 42. | 2021/CRS/05 /02/265 | Dr. Harinath Aireddy Assistant Professor Department of Electronics and Communication Engineering, Alliance College of Engineering and Design, Alliance University, Bangalore-562106 | Investigation of electric field controlled magnetization in ferromagnetic based field effect transistors for spintronic applications. |
| 43. | 2021/CRS/24 /59/173 | Dr K Suresh Babu Associate Professor Centre for Nanoscience and Technology, Pondicherry University | Thermal and radiation induced diffusion of Y in Fe and ODS alloys |
| 44. | 2021/CRS/52 /21/156 | Dr. G. Murugadoss Scientist-E Centre for Nanoscience and Nanotechnology Sathyabama Institute of Science and Technology, Chennai-600119 | Development of High Voltage Solid-State Flexible Supercapacitors Using Graphene Based Electrode Materials and Gel-Electrolytes |
| 45. | 2021/CRS/44 /17/648 | Dr. Monalisa Mukherjee Professor and Head Amity Institute of Click Chemistry Research and Studies Amity University, NOIDA- 201303 | SuFEx Click Chemistry for Functionalization of Graphene Quantum Dots: Application for Targeted Therapeutics. |
| 46. | 2021/CRS/18 /07/16 | Dr. K. K. Aruna Associate Professor Rathinam Technical Campus (RTC), Coimbatore - 641021 | Bifunctional Ternary ThioSpinel Nano forms@Carbon Nanostructures for Sustainable Energy Applications |

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|---|---|---|---|
| 47. | 2021/CRS/24 /39/253 | Dr. Prasanna S. Ghalsasi<br>Professor<br>The M. S. University of Baroda, Vadodara 390 002 | Soft Molecular Chemistry approach for possible generating chiral ε-Fe2O3 phase |
| 48. | 2021/CRS/35 /44/645 | Dr. R. Navamathavan<br>Associate Professor<br>Vellore Institute of Technology, Chennai -600127 | : Low Temperature Thermoelectric Performance of NiCo2S4 Spinel |

# 9.3 User Lists

## Indore Centre

**9T PPMS system for Resistivity, MR and Hall measurements**

| S. No | Name of the User | University/College/Institute |
|---|---|---|
| 1 | Mr. Paresh Sidhhpur,<br>C/o Prof. Bharat Katariya | Saurashtra University, Rajkot, Gujrat |
| 2 | Ms. Archana Verma,<br>C/o Prof Balak Das | Lucknow University , Lucknow |
| 3 | Dr. Ashish Chainani | National Synchrotron Radiation Research Centre, Taiwan |
| 4 | Dr.Shanmukh Rao | CBIT, Hyderabad |
| 5 | Mr. Apurba Pal | Kazi Nazrul University, AsanSol |
| 6 | Dr. Pooja Dey | Kazi Nazrul University, AsanSol |
| 7 | Dr. Sanjay Singh | IIT BHU, Varanasi |
| 8 | Prof. K.G Suresh | IIT , Bombay |
| 9 | Mr. Mainur Rahman<br>C/o Prof S. Shrinath | University Of Hyderabad |

**16 T PPMS for resistivity and magnetoresistance measurements**

| | | |
|---|---|---|
| **10** | Ms. Swetha Kalakuntla/Dr. Kalyana Lakshmi Yanapu | University College of Science, Osmania University, Hyderabad |
| 11 | Ms. Reena Rani/Dr. Ravi Bhatia | Guru Jambheshwar University of Science and Technology, Hisar |
| 12 | Mr. Chiranjit Karmakar/Mr. Rakeshkumar KKaneriya | Space Application Centre (ISRO), Gandhinagar |

**Piezoelectric coefficient (d33) and dielectric measurements)**

| | | |
|---|---|---|
| 13 | Prof. Neeraj Kumar Gaur C/o Prof. Neeraj Kumar Gaur | Barkatullah University, Bhopal (Formarly University of Bhopal)) |
| 14 | Ms. Deva Sucharitha CC/o Dr. Madhavaprasad Dasari | GITAM Deemed to be University |
| 15 | Dr. MD Kashif Shamim C/o Dr. Seema Sharma | A N College, Patna |
| 16 | Mr. Yogendar Singh C/o Dr. Pawan KumarKulriya | Jawaharlal Nehru University, New Delhi |
| 17 | Mr. Lickmichand M Goyal C/o Dr. Tarun Garg | Vellore Institute of Technology, Vellore |
| 18 | Mr. Shekhar Kumar C/o Dr. Seema Sharma | A N College |
| 19 | Ms. Mehroosh Fatema C/o Prof. Shahid Husain | Department of Physics, Aligarh Muslim University, Aligarh |
| 20 | Dr. Subodh SrivastavaC/o Dr. Subodh Srivastava | Vivekananda Global University, Jaipur Rajasthan |

**Home developed resistivity and thermopower measurements**

| | | |
|---|---|---|
| 21 | Dr. Preeti A Bhobe | IIT Indore |
| 22 | Ms. Chitralekha Kain C/o Dr. S. Shankar Subramanian | Atma Ram Sanatan Dharma College, University of Delhi |
| 23 | Ms. Sushmitha P RaoC/o Dr. Vijaylakshmi Dayal | Maharaja Institute of Technology Mysore |
| 24 | Dr. Abida Bashir Makdhoomi | GovT Degree College for Women, Anantnag Kashmir |
| 25 | Dr. Soma Banik | RRCAT, Indore |

**Thermopower Setup (5-325 K)**

| | | |
|---|---|---|
| 26 | Ajay Kumar Saw | Maharaja Institute of Technology, Mysore |

| | | |
|---|---|---|
| 27 | Prof. Asok Rao | MIT, Manipal |
| 28 | Shubha Dubey | Barkatullah Univ. Bhopal |
| 29 | Siva Krishna Prakash | University of Calicut, Kerala |
| 30 | Lijin Rajan | University of Calicut, Kerala |
| 31 | Dr. Shantanu | IIT Madras |
| 32 | Dr. Ranu Bhatt | BARC Mumbai |
| 33 | Shuvankar Gupta | SINP, Kolkata |

**Soft XAS Beamline BL01, Indus-2**

| | **User Name** | **Affiliation** |
|---|---|---|
| 34 | Dr. D Manikandan | IISC Bengelure |
| 35 | Dr. Seema Sharma | AN College, Patna |
| 36 | Dr. K J Sankaran | IMMT, BBSR |
| 37 | Dr. T. N. Bhat | Mangalore University |
| 38 | Dr. Sahi Dani | IIT, Ropar-Roopnagar |
| 39 | Ms. Aishwarya Madhuri | NIT, Manipur |
| 40 | Dr. Mukesh Ranjan | IPR Gandhinagar |
| 41 | Dr. Mandar M.S | Pune University |
| 42 | Mr . Manglanand | RRCAT |
| 43 | Mr. Rahul Tiwari | SOI, DAVV Indore |
| 44 | Dr. Sangita Bhomick | IIT, Bombay |
| 45 | Dr. Ashitosh Anand | GGSIP University Delhi |
| 46 | Mr. Dharmendar | Central University Panjab |
| 47 | Mr. Atanu Samanta | Shiv Nadar University |
| 48 | Mr. Sanjeev Goutam | Panjab University |
| 49 | Prof. N. K. Gaur | Barkatullah University |
| 50 | Prof Alok Kanjilal | Shiv Nadar University |
| 51 | Mr.Bisweswar Santra | Shiv Nadar University |
| 52 | Dr. VRR Madicheri | SOA University |
| 53 | Mr. Jaspreet Singh | BARC, Mumbai |
| 54 | Dr. A K Sinha | UPC Dheradhun |
| 55 | Mr. Sangeet K | SOI,DAVV Indore |
| 56 | Dr. Vijay Rai Singh | Central university, Gaya |
| 57 | Dr. Srinibas Satapathy | RRCAT |
| 58 | Mr. Binoy Kr Sahoo | NISER, BBSR |
| 59 | Ms Priti Vishwakarma | PVC- Mumbai University |
| 60 | Dr. Sujit Das | IISC, Bangalore |
| 61 | Dr K J Sankaran | CSIR-IMMT |
| 62 | Md Asif Khan | GDCWA, Kashmir |
| 63 | Dr. Asha A. S | CUST, Kerala |
| 64 | Dr. Ashish Biswas | IISER, Bhopal |
| 65 | Mr. Amit Verma | IET, DAVV Indore |
| 66 | Mr. Dhanveer Rana | IISER Bhopal |
| 67 | Prof S Murugavel | University Of Delhi |
| 68 | Ms. Shreeylakshmi | IGCAR Kalpakkam |
| 69 | Dr. Vijaylakshmi Dalal | MIT, Mysore |
| 70 | Ms. Manju | Panjab University |
| 71 | MS. Pooja Narwat | IPS Academy, Indore |
| 72 | Mr. Yksh gupta | SOP, Davv indore |
| 73 | Dr. Savan Katba | RK University |
| 74 | Mr. Kiran Barik | RRCAT |
| 75 | Mr. Narayan Prasad | IIT, Bhilai |
| 76 | Prof Ratnesh Gupta | SOI-DAVV Indore |
| 77 | Mr. Ashwini | IIT, Kanpur |

| | | |
|---|---|---|
| 78 | Prof Ajay Gupta | UPES, Dehradoon |
| 79 | Mr. Mandeep Singh | UPES, Dehradoon |
| 80 | Mr. Kuldeep Rawal | UPES, Dehradoon |
| 81 | Dr. Rajan Kumar Ghadai | ManiPal University |
| 82 | Mr.Hrishikeshp | NMSSVN |
| 83 | Ms. Manupriya | IIT, Indore |
| 84 | Ms. Aishwarya Madhuri | NIT, Manipur |
| 85 | Ms. Manish | University Of Dheli |
| 86 | Mr. Surendra Singh | BARC |
| 87 | Mr. B. Sarwan Kumar | IIT, Bombay |
| 88 | Mr. Jayprakash Sahoo | IISER, Bhopal |
| 89 | Ms. Sanketa Jana | NIT, Manipur |
| 90 | Mr. Prateek Gupta | Jaypee Institute, Noida |
| 91 | Mr. Urjit Sinh I Rathod | Panjab University |
| 92 | Ms. Akshaya A | SOI-DAVV Indore |
| 93 | Mr. Harsh Bhatt | SSPD-BARC, Mumbai |
| 94 | Dr. Kulvir Singh | Thapar Institute Patiala |
| 95 | Dr. Parasmani Rajput | RRCAT, Indore |
| 96 | Dr. Rajashri Urhude | BARC, Mumbai |
| 97 | Dr. Nidhi Pandey | JNSCR |
| 98 | Ms. Sankita Jana | NIT, Manipur |

**Magnetron Sputtering (2 inch)**

| | | |
|---|---|---|
| 99 | Dr. Pooja Gupta | RRCAT, Indore |
| 100 | Dr. Pooja Gupta | RRCAT, Indore |
| 101 | Dr. Kuntal Roy | (IISER) Bhopal |
| 102 | Prof. Venkata Rama Rao Medicherla | SOA Deemed to be University |
| 103 | Mr. Harsh Vardhan<br>C/o Dr. Gagan Sharma | Amity University |
| 104 | Ms. AVANTIKA CHAUHAN<br>C/o Dr. Amit KChawla | University of petroleum and energy studies |
| 105 | Prof. Aloke Kanjilal | Shiv Nadar University |
| 106 | Dr. YADAGIRI K | NIT WARANGAL |
| 107 | Ms. SANKETA JENA<br>C/o Dr. Bibhu PrasadSwain | NIT Manipur |
| 108 | Mr. Visheshvar Verma<br>C/o Dr. ARUN SINGH | Guru Ghasidas Vishwavidyalaya,Bilaspur-495009, |
| 109 | Dr. Pooja Gupta | RRCAT, Indore |
| 110 | Dr. YADAGIRI K | NIT WARANGAL |

**Magnetron Sputtering (3 inch)**

| | | |
|---|---|---|
| 111 | Dr. Pooja Gupta | RRCAT, Indore |
| 112 | Ms. Shamantha M S<br>C/o Dr. Vijaylakshmi Dayal | Maharaja Institute of Technology Mysore |
| 113 | Ms. Maria Pavithra<br>C/o Dr. Vijaylakshmi Dayal | Maharaja Institute of Technology Mysore |
| 114 | Ms. Preeti Negi<br>C/o Dr. Hardeep Kumar | NIT Uttarakhand |
| 115 | Dr. Kuntal Roy<br>C/o Dr. Kuntal Roy | (IISER) Bhopal |
| 116 | Dr. Kuntal Roy<br>C/o Dr. Kuntal Roy | (IISER) Bhopal |
| 117 | Mr. Amit Kumar Verma<br>C/o Dr. Rachana Gupta | IET DAVV Indore |

| | | |
|---|---|---|
| 118 | Dr. Rachana Gupta<br>C/o Dr. Rachana Gupta | Institute of Engineering and Technology, DAVV |
| 119 | Ms. Aishwarya Madhuri<br>C/o Dr. Bibhu PrasadSwain | NIT Manipur |
| 120 | Mr. Amit Kumar Verma<br>C/o Dr. Rachana Gupta | IET DAVV Indore |
| 121 | Mr. Amit Kumar Verma<br>C/o Dr. Rachana Gupta | IET DAVV Indore |

**XRD**

| | | |
|---|---|---|
| 122 | Ms. Aparna Ashok<br>C/o Dr. Neeru Bhagat | Symbiosis Institute of Technology, (Deemed) University |
| 123 | Dr. A Murugadoss Muruga | University of Madras, |
| 124 | Prof. SRINIVAS N. Mangalampalli | , The Maharaja Sayajirao University of Baroda, Vadodara |
| 125 | Dr. Aruna P. Maharolkar<br>C/o Dr. Aruna P.Maharolkar | Marathwada Institute of Technology Aurangabad |
| 126 | Ms. Shraddha C H<br>C/o Dr. Thirumaleshwara | Marathwada Institute of Technology Aurangabad |
| 127 | Ms. Preeti Burvey<br>C/o Dr. Dr. Preeti Jain | Medi-Caps University |
| 128 | Mr. Hardepinder Singh<br>C/o Dr. Hardeep Kumar | National Institute of Technology Uttarakhand |
| 129 | Ms. Shailaja Rakibe<br>C/o Dr. Dr. Preeti Jain | Medi-Caps University |
| 130 | Dr. AYANA BHADURI<br>C/o Dr. AYANA BHADURI | Amity University Haryana |
| 131 | Ms. Chitralekha kain C\o<br>Dr.S.Shankar Subramanian | MAHE Manipal |
| 132 | Dr. Mamatha D Daivajna | MAHE Manipal |
| 133 | Dr. Mamatha D Daivajna | MAHE Manipal |
| 134 | Dr. Vijaylakshmi Dayal | Maharaja Institute of Technology Mysore |
| 135 | Ms. Maria Pavithra<br>C/o Dr. Vijaylakshmi Dayal | Maharaja Institute of Technology Mysore |
| 136 | Ms. SANKETA JENA<br>C/o Dr. Bibhu PrasadSwain | NIT Manipur |
| 137 | Mr. BHUPENDRA SINGH<br>C/o Dr. AJAY SEMALTY | H.N.B. GARHWAL UNIVERSITY SRINAGAR GARHWAL |
| 138 | Mr. Mukesh Pandey<br>C/o Dr. MONA SEMALTY | H N B Garhwal University Srinagar Garhwal |
| 139 | Dr. Mamatha D Daivajna | MAHE Manipal |
| 140 | Ms. Deva Sucharitha C\o<br>Dr.Madhavaprasad Dasari | GITAM Deemed to be University |
| 141 | Prof. Brijlata Sharma | Bhilai Institute of Technology,Durg |
| 142 | Prof. Neeraj Kumar Gaur | Barkatullah University, Bhopal |
| 143 | Dr.Uday Kumar Khanapuram | National Institute of Technology Warangal |
| 144 | Mr. Urjitsinh I. Rathod<br>C/o Dr. Ashish B.Ravalia | Saurashtra University, Rajkot |
| 145 | Dr. Ketan P Gattu | Dr. Babasaheb Ambedkar University Aurangabad |
| 146 | Mr. Dharmendra kumar | Central University of Punjab |
| 147 | Mr. Prabhav Joshi<br>C/o Dr. Ashutosh Mishra | Devi Ahilya Vishwavidhyalaya |

| | | |
|---|---|---|
| 148 | Mr. Hardepinder Singh<br>C/o Dr. Hardeep Kumar | National Institute of Technology Uttarakhand |
| 149 | Dr. Nitish Gupta | SGSITS Indore |
| 150 | Ms. Shailaja Rakibe<br>C/o Dr. Preeti Jain | Medi-Caps University |
| 151 | Ms. Jyoti Shukla<br>C/o Dr. Ashutosh Mishra | School of Physics, Devi Ahilya University Indore |
| 152 | Ms. Mala Mangwani<br>C/o Dr. Ashutosh Mishra | davv University, Indore |
| 153 | Ms. SRIKANTH BACHU<br>C/o Dr.Sreenath ReddyMarri | DEPARTMENT OF PHYSSICS, OU |
| 154 | Dr. A Murugadoss Muruga | University of Madras, Chennai |
| 155 | Ms. Pallavi Soni<br>C/o Dr. Pragya Ojha | SGSITS,Indore |
| 156 | Ms. Shailaja Rakibe<br>C/o Dr. Dr. Preeti Jain | Medi-Caps University |
| 157 | Dr. Mamatha D Daivajna | MAHE Manipal |
| 158 | Mr. Mintu Debnath<br>C/o Dr. sudipta pal | University of Kalyani |
| 159 | Dr. Vijaylakshmi Dayal | Maharaja Institute of Technology Mysore |
| 160 | Mr. NILESHKUMAR GOVINDBHAI PARMAR<br>C/o Dr. Mitesh Sarkar | THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA |
| 161 | Ms. SRIKANTH BACHU<br>C/o Prof. Gopal Reddy Ch. | DEPARTMENT OF PHYSSICS, OU |
| 162 | Ms. Nausheen Noor<br>C/o Dr. Ashutosh Mishra | SOP DAVV |
| 163 | Ms. Shruti Jain<br>C/o Prof. Shubha Jain | Vikram University Ujjain |
| 164 | Mr. Prabhav Joshi<br>C/o Dr. Ashutosh Mishra | Devi Ahilya Vishwavidhyalaya |
| 165 | Ms. Pallavi Soni<br>C/o Dr. Pragya Ojha | SGSITS,Indore |
| 166 | Prof. Venkata Rama Rao Medicherla | SOA Deemed to be University |
| 167 | Mr. Mahendra Patel C/o<br>Dr. Masheer AhmedKhan | DAVV, Indore |
| 168 | Dr. A Murugadoss Muruga | University of Madras, Chennai- |
| 169 | Ms. Arpna Indurkhya C/o Dr. Masheer AhmedKhan | DAVV, Indore |
| 170 | Mr. Ambikesh Soni<br>C/o Dr. Gagan KantTripathi | RAJIV GANDHI TECHNICAL UNIVERSITY, BHOPAL |
| 171 | Ms. Preeti Negi<br>C/o Dr. Hardeep Kumar | NIT Uttarakhand |
| 172 | Mr. Vijay kumar thakur C/o Dr. Simant Kumar Srivastav | L N Mithila University Darbhanga Bihar,846008 |
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| 174 | Dr. Bhasker Soni | Maharaja Sayajirao University |
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| 176 | Ms. CHITRALEKHA KAIN C/o Dr. S. Shankar Subramanian | Amity University Rajasthan Jaipur |
| 177 | Dr. Muhammad Shahid Anwar | institute of Minerals and materials Techonology Bhubaneswar |

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| 178 | Ms. SRIKANTH BACHU<br>C/o Dr.Sreenath ReddyMarri | DEPARTMENT OF PHYSSICS, OU |
| 179 | Ms. Poonam Yadav C/o Dr.<br>DEEPSHIKHA RATHORE | Amity University Rajasthan Jaipur |
| 180 | Ms. Sayma Parveen<br>C/o Dr. Anubha Pandya | Devi Ahilya Vishwavidyalaya Indore (M.P.) |
| 181 | Ms. Deepika Pathak<br>C/o Dr. Arpan Bhardwaj | Govt. Madhav science P.G. college, ujjain (M.P) |
| 182 | Mr. Ramesh Avala<br>C/o Dr. Sukanti Behera | MANIT-BHOPAL |
| 183 | Ms. CHITRALEKHA KAIN C/o Dr.<br>S. Shankar Subramanian | Amity University Rajasthan Jaipur |
| 184 | Prof. Neeraj Kumar Gaur<br>C/o Prof. Neeraj KumarGaur | Barkatullah University, Bhopal (Formarly University of Bhopal)) |
| 185 | Ms. Monika Yadav<br>C/o Dr. Harendra Pratap SinghChauhan | School of Chemical Sciences, DAVV |
| 186 | Dr. Venkatesan Jayakumar Srinivasan | Shri Vaishnav Vidyapeeth Vishwavidyalaya |
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| 192 | Ms. CHITRALEKHA KAIN<br>/Dr.S.Shankar Subramanian | Amity University Rajasthan Jaipur |
| 193 | Dr. Rashmi Yadav | MANIT Bhopal |
| 194 | Mr. Sachin Dev<br>C/o Prof. Man Singh | Central University of Gujarat |
| 195 | Dr. Hema Chandra Gali | VNIT, Nagpur |
| 196 | Dr. Abida Bashir Makdhoomi | Govt Degree College for Women Anantnag Kashmir |
| 197 | Dr. Vijaylakshmi Dayal | Maharaja Institute of Technology Mysore |
| 198 | Dr. Mamatha D Daivajna | MAHE Manipal |
| 199 | Dr. Samay Singh Meena | Jai Narain Vyas University Jodhpur |
| 200 | Mr. Ramprasad Bharat C/o Prof.<br>Babasaheb N.Dole | Dr. Babasaheb Ambedkar University Aurangabad |
| 201 | Dr. Mamatha D Daivajna | MAHE Manipal |
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| 203 | Mr. Kuldeep Singha C/o Dr. Sandeep<br>KumarSrivastava | Central Institute of Technology Kokrajhar, Assam |
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| 208 | Mr. omnarayan agrawal<br>C/o Dr. Monalisa Mukherjee | AMITY UNIVERSITY NOIDA |
| 209 | Mr. Pramod R Nadig<br>C/o Dr. Mamatha Daivajna | Manipal Institute of Technology |

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| 217 | Dr. Umesh Prakash Gawai | DDSP Arts Commerce and Science College, Erandol Dist-Jalgaon |
| 218 | Dr. Hema Chandra Gali | VNIT, Nagpur |
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| 226 | Dr. Avirup Das | VIT Bhopal University |
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| 230 | Mr. Sachin Dev C/o Prof. Man Singh | Central University of Gujarat |
| 231 | Ms. Vaidehi Vinodrao Deshmukh C/o Dr. Kiran | Dr. B. R. Ambedkar National Institute of Technology Jalandhar |
| 232 | Mr. Prabhav Joshi C/o Dr. Ashutosh Mishra | Devi Ahilya Vishwavidhyalaya |
| 233 | Mr. Krishan Kumar C/o Prof. Man Singh | CENTRAL UNIVERSITY OF GUJARAT |
| 234 | Dr. AYANA BHADURI | Amity University Haryana |
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| 242 | Mr. Aadish Kumar Jain C/o Dr. Pradeep KumarSharma | School of Physics DAVV Indore |
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| 246 | Mr. shashank dubey C/o Dr. Pradeep KumarSharma | davv indore |
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| 250 | Ms.Rehila Karolin Blesstina C/o Dr. Mathavan T | NMS SVN College (Affiliated to Madurai Kamaraj University) |
| 251 | Mr. JOEL T C/o Dr. Mathavan T | NMSSVN College (Affiliated to Madurai Kamaraj University)) |
| 252 | Dr. YADAGIRI K | NIT WARANGAL |
| 253 | Mr. Krishan Kumar C/o Prof. Man Singh | CENTRAL UNIVERSITY OF GUJARAT |
| 254 | Dr. Sanjay Tiwari | National Institute of Pharmaceutical Education and Research -Raebareli |
| 255 | Mr. Tahir Yaqoob C/o Dr. Mandira Banerjee | Devi Ahilya University Indore |
| 256 | Ms. Ramya Shri C/o Dr. Mamatha Daivajna | Manipal Institute of Technology, MAHE Manipal |
| 257 | Ms. Aishwarya Madhuri C/o Dr. Bibhu PrasadSwain | NIT Manipur |
| 258 | Mr. Ramesh Avala C/o Dr. Sukanti Behera | MANIT-BHOPAL |
| 259 | Mr. Amit Kumar Verma C/o Dr. Rachana Gupta | IET DAVV Indore |
| 260 | Mr. Amit Kumar Verma C/o Dr. Rachana Gupta | IET DAVV Indore |
| 261 | Mr. Amit Kumar Verma C/o Dr. Rachana Gupta | IET DAVV Indore |
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| 263 | Ms. Shailaja Rakibe C/o Dr. Dr. Preeti Jain | Medi-Caps University |
| 264 | Ms. Aishwarya Madhuri C/o Dr. Bibhu PrasadSwain | NIT Manipur |
| 265 | Mr. Prakhar Mishra C/o Dr. Narendra Kumar Singh | University of Lucknow |
| 266 | Mr. Dharam singh C/o Prof. Pratibha Sharma | SCHOOL OF CHEMICAL SCIENCES DAVV INDORE |
| 267 | Ms. Aishwarya Madhuri C/o Dr. Bibhu PrasadSwain | NIT Manipur |
| 268 | Prof. ONKARNATH verma | CSVTU, Bhilai |
| 269 | Dr. Sandeep Kumar Verma | SAGE University, Indore |
| 270 | Ms. Yamini Patel C/o Prof. Pratibha Sharma | DAVV |

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|---|---|---|
| 271 | Ms. Nausheen Noor<br>C/o Dr. Ashutosh Mishra | SOP DAVV |
| 272 | Mr. BASILIO JOSE C/o Dr. Mahenda DevidasShinde | SANDIP UNIVERSITY |
| 273 | Ms. SANKETA JENA<br>C/o Dr. Bibhu PrasadSwain | NIT Manipur |
| 274 | Prof. Ramphal Brajiram Sharma | Department of Physics I I S Jaipur |
| 275 | Ms. Aarti Nagar<br>C/o Prof. Shubha Jain | , Vikram University, Ujjain |
| 276 | Ms. Prachi Joshi<br>C/o Dr. Ashutosh Mishra | School of Physics, DAVV |
| 277 | Mr. Prabhav Joshi<br>C/o Dr. Ashutosh Mishra | Devi Ahilya Vishwavidhyalaya |
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| 283 | Dr. Archana Chaudhary | Medi-Caps University Indore |
| 284 | Mr. Hardepinder Singh<br>C/o Dr. Hardeep Kumar | National Institute of Technology Uttarakhand |
| 285 | Mr. Tarun Choudhary C/o Dr. Manju KChattopadhyay | School of Electronics, Devi Ahilya University |
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| 289 | Ms. Akanksha Malik<br>C/o Dr. Richa Saini | Gurukul Kangri University |
| 290 | Ms. Shilpa Chauhan<br>C/o Dr. Richa Saini | Gurukul Kangri University |
| 291 | Mr. Dharmendra kumar<br>C/o Dr. Avirup Das | Vellore institute of technology bhopal |
| 292 | Mr. Hardepinder Singh<br>C/o Dr. Hardeep Kumar | National Institute of Technology Uttarakhand |
| 293 | Ms. ROWEENA AGNES C/o Dr. Preethi Meher KRS | central university |

**High Vacuum Thermmal Annealing**

| | | |
|---|---|---|
| 294 | Ms. Preeti Negi<br>C/o Dr. Hardeep Kumar | NIT Uttarakhand |
| 295 | Mr. Shubham Kumar<br>C/o Dr. Kavita Sharma | Amity university Noida |
| 296 | Mr. HRISHIKESH P<br>C/o Dr. Mathavan T | NMSSVN College (Affiliated to Madurai Kamaraj University) |

**Ion Beam Sputtering**

| | | |
|---|---|---|
| 297 | Dr. Sarathlal K V<br>C/o Dr. Sarathlal K V | University of Petroleum and Energy Studies Dehradun |

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|---|---|---|
| 298 | Dr. Subhadeep Datta<br>C/o Dr. Subhadeep Datta | Indian Association for the Cultivation of Science |
| 299 | Dr. Subhadeep Datta<br>C/o Dr. Subhadeep Datta | Indian Association for the Cultivation of Science |
| 300 | Dr. Subhadeep Datta<br>C/o Dr. Subhadeep Datta | Indian Association for the Cultivation of Science |
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| 302 | Ms. SANKETA JENA<br>C/o Dr. Bibhu PrasadSwain | NIT Manipur |
| 303 | Mr. Abhishek Kumar<br>C/o Dr. R P Aloysius | CSIR- National Physical Laboratory, New Delhi |
| 304 | Prof. Subharata Dhar<br>C/o Prof. Subharata Dhar | IIT- b |
| 305 | Prof. Ajay Gupta<br>C/o Prof. Ajay Gupta | University of Petroleum and Energy Studies, Dehradun |
| 306 | Dr. Manoj Kumar Tiwari<br>C/o Dr. Manoj KumarTiwari | Raja Ramanna Centre for Advanced Technology |
| 307 | Dr. Hema Chandra Gali<br>C/o Dr. Hema ChandraGali | VNIT, Nagpur |
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| 310 | Prof. Ajay Gupta | Upes Dehradun |
| 311 | Ms. Bhawna Yadav<br>C/o Dr. Mayur Vaidya | IIT, Hyderabad |
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| 313 | Mr. Krishna Chaitanya Nuli<br>C/o Dr. Mayur Vaidya | IIT HYDERABAD |
| 314 | Dr. Arup Samanta<br>C/o Dr. Arup Samanta | IIT Roorkee |
| 315 | Mr. Shubham Kumar<br>C/o Dr. Kavita Sharma | Amity university Noida |

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| 316 | Mr. Hardepinder Singh<br>C/o Dr. Hardeep Kumar | National Institute of Technology Uttarakhand |
| 317 | Ms. Preeti Negi<br>C/o Dr. Hardeep Kumar | NIT Uttarakhand |
| 318 | Mr. Shubham Kumar<br>C/o Dr. Kavita Sharma | Amity university Noida |
| 319 | Mr. Harsh Vardhan<br>C/o Dr. Gagan Sharma | Amity University |
| 320 | Ms. Komal Shekhawat C/o Dr.<br>Srinivasa Rao Nelamarri | MNIT Jaipur |
| 321 | Mr. Amit Kumar Verma<br>C/o Dr. Rachana Gupta | IET DAVV Indore |

**Laser Scanning Confocal Microscopy**

| **Sr. No.** | **Name of the student/scientist** | **University/College/Institute** |
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| 322 | Ms. Nishkala K.R./<br>Dr. Mamatha D Daivajna | Manipal Academy of Higher Education, Manipal |
| 323 | Ms. Aditi Kumawat | Devi Ahilya University, Indore |
| 324 | Ms. Sneha Nair/ Prof. Vipul Keerti Sharma | Government Holkar Science College, Indore |
| 325 | Dr. Srishti Jain/ Dr. Sandhya Jain | Madhya Pradesh Medical Science University, |

**Thin film x-ray diffractometer (HRRD)**

| Sr. No. | Name of the student/scientist | University/College/Institute |
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| 326 | Dr. Kavita Sharma | Amity Noida |
| 327 | Prof.Avradeep Pal | IIT Mumbai |
| 328 | Ms.Susmita | IET Indore |
| 329 | Dr. Nagaraju | CMIR Hyderabad |
| 330 | Dr.Umesh Gawai | DDSP College Jalgaon |
| 331 | Ms.Riya Dawn | Central Univ.. of Bihar, Gaya |
| 332 | Ms.Aradhana Kumari | Central Univ.. of Bihar, Gaya |
| 333 | Mr.Rahul | SOI, DAVV, Indore |
| 334 | Ms.Shraddha .C | SRM Univ., Chennai |
| 335 | Dr. Gagan sharma | Amity University Noida |
| 336 | Dr.Kashif | AN college Patna |
| 337 | Dr Sarathlala K.V | UPES Dehradun |
| 338 | Mr.V.Nagender | Osmania University |
| 339 | Ms.Sanketa Jena | NIT Manipur |
| 340 | Ms.Leelawati | SRM IST, Chennai |
| 341 | Ms.Swati Nagar | SOP DAVV Indore |
| 342 | Mr. Harpinder Singh | NIT Uttarakhand |
| 343 | Mr.Mandeep | UPES Dehradun |
| 344 | Ms.Akansha Maheto | Barkatullah Univ., Bhopal |
| 345 | Ms.Ayusha Biswal | SOA Odisha |
| 346 | Mr.Pratik Gupta | J.P.Inst &Tech Noida |
| 347 | Ms.Shephalika | SOA Odisha |
| 348 | Mr.Mohanlal | IISER Bhopal |
| 349 | Dr.Ratnesh Gupta | DAVV Indore |
| 350 | Mr.Pankaj Bhardaj | NIT Hamirpur |
| 351 | Mrs.Brijlata Sharma | CSVU , Bhilai |
| 352 | Dr.Usha Singh | IPS Academy Indore |
| 353 | Dr.Shilpam Sharma | RRCAT Indore |
| 354 | Mr.Shrikanth | Osmania university |
| 355 | Ms.Preeti Negi | Nit Uttarakhand |
| 356 | Mr.D.Rajkumar | CMRI Hyderabad |
| 357 | Dr.Ashwatha Prabhu | Manipal University |
| 358 | Ms.Awantika Chouhan | UPES Dehradun |
| 359 | Ms.Rimpi Seni | Delhi University |
| 360 | Mr. Prerit | IIIT Jabalpur |
| 361 | Ms. Harapriya | SOA Odisha |
| 362 | Mr. Tarek Sbera | SOA odisha |
| 363 | Ms.Pooja | IIT Kanpur |
| 364 | Mr. Anadhi Krsihna | MGCU Bihar |
| 365 | Ms. Astha Sharma | VNIT Nagpur |
| 366 | Ms.Abilasha | NPL Delhi |
| 367 | Mr.Bharat Kumar | Anna University TN |

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| 368 | Dr.Yadagiri | NIT Warangal |
| 369 | Mr.Shashi Ranjan | SOI DAVV |
| 370 | Mr.Kuldeep | UPES Dehradun |
| 371 | Mr. Amit Verma | IET DAVV Indore |
| 372 | Mr.Visheshwar | GGV Bilaspur |
| 373 | Mr.Rishikesh | Annamalai Univ., TN |
| 374 | Mr. Atul Kumar | MGCU Bihar |
| 375 | Mr.Rahul Tiwari | SOI DAVV Indore |
| 376 | Mr.Abinash Paride | NIT Warangal |
| 377 | Ms.Rucha Joshi | Shri Vaishnav Univ., Indore |
| 378 | Ms.Rajnandini | IIT BHU |
| 379 | Ms. Roweena | Central University of Tamil Nadu |
| 380 | Mr. Pratik Kumar | J.P.University Noida |
| 381 | Mr.Shekar | AN college Patna |
| 382 | Dr. Aloke Kanjilal | Shiv Nadar University |
| 383 | Mr.Yaksh Gupta | SOI DAVV Indore |
| 384 | Dr. A. Pandian | IGCAR Kalpakkam |
| 385 | Ms.Abilasha | NPL Delhi |
| 386 | Dr.Neha Sharma | RRCAT Indore |
| 387 | Ms. Sanketa Jana | NIT Manipur |
| 388 | Mr. Rahul Kumar | VIT Nagpur |
| 389 | Mr.Mainur Rehman | HCU Hyderabad |
| 390 | Ms.Amiya Ranjan Sahoo | VIT Nagpur |
| 391 | Ms.Archana | VIT Nagpur |
| 392 | Mr.Kapil Dev | Delhi University |
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**Mossbauer spectroscopy**

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| 394 | Mr. Nagender | Osmania Univ., Hyderabad |
| 395 | Ms. Moditma | Delhi Univ., New Delhi |
| 396 | Dr. Kalyana Lakshmi | Osmania univ., Hyderabad |
| 397 | Prof. S. N. Kane | DAVV, Indore |
| 398 | Ms. Saphelika | SOA, Bhubaneswar |
| 399 | Ms. H. Leelawati | SRM Univ., Chennai |
| 400 | Miss Prajyoti P. Gauns Dessai | Goa Univ., Goa |
| 401 | Dr. Hysen Thomas | CUSAT, Cochin |
| 402 | Dr. Kavita Sharma | Amity Univ., Noida |
| 403 | Dr. Sanjay Singh Meena | Jodhpur Univ., Jodhpur |
| 404 | Dr. M. Sreenath Reddy | Osmania Univ., Hyderabad |
| 405 | Dr. Gulzhar Ahmad | NIT, Srinagar |
| 406 | Dr. Prabhu | ARCI, Chennai |
| 407 | Prof. Sevi Murugavel | Delhi Univ., Delhi |
| 408 | Prof. Ashish Bhattacharay | Visva-Bharati University, Shantiniketan |
| 409 | Dr. Kirandeep Singh | NCL, Pune |
| 410 | Ms. Subha Dubey | Barkatullah Univ., Bhopal |
| 411 | Prof. P. Murugavel | IIT Madras |
| 412 | Dr. Vijay Sharma | Korba, Chattishgarh |
| 413 | Md. Hannuar Rashid | Rajiv Gandhi Univ., Doimukh |
| 414 | Dr. Vijay Kumar Thakur | L. N. Mithila Univ., Bihar |

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| 415 | Dr. Sanjay Kumar Upadhyay | Hemvati Nandan Bahuguna Garhwal University |
| 416 | Prof. Bijay | IIT Delhi |
| 417 | Prof. Manoharan | Annamalai Univ., Chennai |
| 418 | Dr. K. Yadagiri | NIT, Warangal |
| 419 | Mr. T. Devender Reddy | Osmania Univ., Hyderabad |
| 420 | Prof. Ratnesh Gupta | DAVV, Indore |
| 421 | Mr. Uday Suriyan | Anna University |
| 422 | Prof. S. Srinath | Hyderabad Central University, Hyderabad |
| 423 | Mr. Dipannita Saha | IIT Mumbai |
| 424 | Dr. Sumit K Sonar | MNIT, Jaipur |
| 425 | Mr. Sujeet Kumar | NIT, Srinagar |
| 426 | Mr. Deep Chandrani | R. K. University, Rajkot |
| 427 | Ms. K. R. Nishikala | MIT, Manipal |
| 428 | Dr. Indrajit Ghosh | CSIR-Indian Institute of Petroleum, Dehradun, |
| 429 | Dr. T. Govardhan Reddy | Bilaspur Central Univ., Bilaspur |

**Magneto-optical Kerr effect (MOKE) : magnetometer and microscopy**

| Sr. No. | Name of the student/scientist | University/College/Institute |
|---|---|---|
| 430 | Mr. Kapil Dev / Prof. Annapoorni | Delhi Univ., New Delhi |
| 431 | Prof. Ajay Gupta | University of Petroleum and Energy Studies Dehradun |
| 432 | Dr. K. V. Saratlal | University of Petroleum and Energy Studies Dehradun |
| 433 | Dr. Hardeep Kumar | NIT Uttarakhand |
| 434 | Mr. Shubam / Dr. Kavita Sharma | Amity Univ., Noida |
| 435 | Prof. S. Srinath | Hyderabad Central Univ., Hyderabad |
| 436 | Ms. Swati Nagar / Prof. M. Banerjee | DAVV, SOP, Indore |
| 437 | Prof. Bhowmik | Pondicherry Univ., Pondicherry |
| 438 | Mr. Mohanlal | IISER, Bhopal |
| 439 | Mr. Amit Patel | BHU, Varanasi |
| 440 | Mr. A. K. Atul | MG Central Univ., Bihar |
| 441 | Dr. Pooja Gupta | RRCAT, Indore |
| 442 | Dr. Amaresh Chandra Mishra | IIT DM, Jabalpur |

**Ferroelectric (P-E) loop tracer**

| Sr. No. | Name of the student/scientist | University/College/Institute |
|---|---|---|
| 445. | Mr. D. Nagender | Osmania University, Hyderabad |
| 446. | Mr. Naeen Kumar | MANIT, Bhopal |
| 447. | Ms. Shubha Dubey | Barkatullah Univ., Bhopal |
| 448. | Ms. Manish Badole | IIT Indore |
| 449. | Dr. Oroosa Subohi | NIT, Nagpur |
| 450. | Ms. Dev Sucharitha | GITAM Univ., Vizag |
| 451. | Dr. Pragya Ojha | GSITS, Indore |
| 452. | Ms. Priyanka Mitra | BITS, Hyderabad |
| 453. | Mr. Ashutosh Anand | AMU, Aligarh |
| 454. | Mr. Tarun Garg | VIT, Vellore |

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|---|---|---|
| 455. | Dr. Kashif Shanin | AN college, Patna |
| 456. | Mr. Rayees Ahmad Parry | Barkatullah Univ., Bhopal |
| 457. | Mr. Devender Reddy | Osmania Univ., Hyderabad |
| 458. | Ms. Mehroosh Fatema | AMU, Aligarh |
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| 961. | Ms. Isha Songara / Dr. Nitu Katariya | Shri Vaishnav Vidhyapeeth Vishwavidyalaya |
| 962. | Mr. Suresh | IIT Indore |
| 963. | Dr. Bhubesh Chander Joshi /Mr. Prateek Gupta | Jaypee Institute of Technology |
| 964. | Ms. Mahima Jain | Medicaps University |
| 965. | Ms. Uma Rajput / Dr. S. N. Kane | Devi Ahilya Vishwavidyalaya |
| 966. | Mr. Rajkumar Dasi / Dr.Nagaraju Pothukanuri | CMR Technical Campus |
| 967. | Ms. Shailaja Rakibe / Dr. Preeti Jain | Medicaps University |
| 968. | Prof. Venkata Rama Rao /Ms. Harapriya Nayak | SOA Deemed to be University |
| 969. | Ms. Aditi Jain / Dr. Jitendra Tripathi | IPS Academy |
| 970. | Dr. Yadagiri | NIT |
| 971. | Ms. Harapriya Nayak | SOA Deemed to be University |
| 972. | Ms. Sanketa Jena / Dr. Bibhu Prasad Swain | National Institute of Technology |
| 973. | Ms. Deva Sucharita /Dr. Madhava Prashad Dasari | GITAM University |
| 974. | Mr. Harishikesh | MKU |
| 975. | Ms. Archana Bhatt | Devi Ahilya Vishwavidyalaya |
| 976. | Ms. Lakisha chaudhary | Devi Ahilya Vishwavidyalaya |
| 977. | Ms. Nandini Solanki | Devi Ahilya Vishwavidyalaya |
| 978. | Mr. Krishna Pratap Singh | Devi Ahilya Vishwavidyalaya |
| 979. | Ms. Shruti Kushwaha | Devi Ahilya Vishwavidyalaya |
| 980. | Ms. Jyoti Shukla / Dr. Ashutosh Mishra | Devi Ahilya Vishwavidyalaya |
| 981. | Ms. Roweena Agnes / Dr. Preethi Meher KRS | Central University Of Tamil Nadu |

**16T-VSM**

| Sr. No. | Name of the student/scientist | University/College/Institute |
|---|---|---|
| 982. | Prof. Anil Kumar | IISC Banglore |
| 983. | Dr. Madhava Prasad Dasari | Gitam University Visakhapatnam |
| 984. | Dr. Surjeet Singh | IISER Pune |
| 985. | Dr. Sharvanan Kumar Reddy | Osmania University Hyderabad |
| 986. | Dr. Soumyajyoti Ray | IIT Patna |
| 987. | Dr. Sanjay Singh | IIT-BHU |
| 988. | Dr. Nisha Kumari | ANC Patna |
| 989. | Dr. Preeti Bhobe | IIT Indore |
| 990. | Dr. Upendra Prashad | IPR Gandhinagar |
| 991. | Dr. Mamatha Daivajana | MIT Manipal |
| 992. | Dr. Md. Motin Seikh | Viswa Bharati Universiy |
| 993. | Dr. Shantilata | Viswa Bharati University |

| | | |
|---|---|---|
| 994. | Dr. Ashish Ravali | Saurashtra University |
| 995. | Dr. Ashish Parmanik | JNU New Delhi |
| 996. | Dr. Soma Banik | RRCAT Indore |
| 997. | Dr. Mintu Debnath | Kalyani University |
| 998. | Dr. Shravan Kumar Reddy | Osmania University |
| 999. | Dr. Harunar Rashid | Rajiv Gandhi University Arunanchal Pradesh |
| 1000. | Dr. Sovik Chatarjee | UGC DAE CSR, Kalpakkam |
| 1001. | Dr. Shravan Kumar Reddy | Osmania University |
| 1002. | Dr. M Srinath Reddy | Osmania University |
| 1003. | Dr. Mamatha Daivajana | MIT Manipal |
| 1004. | Dr. Rashi Nathawat | Manipal University Jaipur |
| 1005. | Dr. Dipak Mazumdar | IIT, Knpur |
| 1006. | Dr. Sarath Chandra | RRCAT, Indore |
| 1007. | Dr. M Srinath Reddy | Osmania University |
| 1008. | Dr. Mamatha Daivajna | MIT Manipal |
| 1009. | Dr. Santanu De | IIT Madras |
| 1010. | Dr. Neeru Bhagat | SIU Pune |
| 1011. | Dr. K. Yadgiri | NIT Warangal |
| 1012. | Dr. Indranil Das | SINP Kolkotta |

**7T-MPMS3-XL**

| Sr. No. | Name of the student/scientist | University/College/Institute |
|---|---|---|
| 1013. | Dr. Preeti Negi/ Dr. Hardeep Kumar | NIT Uttarakhand |
| 1014. | Dr. Apurva Pal | KNU, WB |
| 1015. | Dr. Saroj Kumar | Viswa Bharati University |
| 1016. | Dr. Sankar Rao Yadam | CVR College of Engineering |
| 1017. | Mr. Sangeeth/ Prof. Ratnesh Gupta | DAVV Indore |
| 1018. | Dr. Chanchal Sow | IIT, Kanpur |
| 1019. | Dr. Mamatha Daivajana | MIT Manipal |
| 1020. | Dr. D SathiRaja | IIT Indore |
| 1021. | Dr. Neeru Bhagat | SIU Pune |
| 1022. | Dr. Oroosa Subohi | NIT Nagpur |
| 1023. | Dr. Neeru Bhagat | SIU Pune |
| 1024. | Dr. Mamatha Daivajna | MIT Manipal |
| 1025. | Dr. Soma Banik | RRCAT, Indore |
| 1026. | Dr. P C Mandal | IIT Kanpur |
| 1027. | Dr. Saurav Marik | Thapar Universiy |
| 1028. | Prof. Avradeep Pal | IIT Bombay |

**9T-PPMS**

| Sr. No. | Name of the student/scientist | University/College/Institute |
|---|---|---|
| 1029. | Mr. Pramod R Nadig / Dr. Mamata Daivajna | MIT, Manipur |
| 1030. | Ms. Ayusha / Dr. Rama Rao | SOA University, BBSR |
| 1031. | Ms. Dibyata/ Dr. Surjit Singh | IISER, Pune |
| 1032. | Ms. Nisha Shahi / Dr. Sanjay Singh | IIT-BHU, Varanasi |
| 1033. | Mr. Anupam Singh / Dr. Sanjay Singh | IIT BHU, Varanasi |
| 1034. | Ms. Preeti Negi/Dr. Hardeep Kumar | NIT, Srinagar, Uttarakhand |
| 1035. | Mr. Mintu Debnath/ Dr. Sudipta Pal | Kalyani University |

| | | |
|---|---|---|
| 1036. | Mr. Ajay K Saw/ Dr. Vijaylakshmi Dayal | MIT, Mysore |
| 1037. | Prof. I. Das | SINP, Kolkata |
| 1038. | Ms. Susmita Choudhury/ Dr. Rachna Gupta | IET, DAVV, Indore |
| 1039. | Dr. Bindu R. | IIT, Mandi |
| 1040. | Ms. Papiya Saha/ Dr. Rabindra Nath | IGCAR, Kalapakkam |
| 1041. | Mr. Anandi Krishna Atul/ Prof. Neelabh Srivastava | MGU Bihar |
| 1042. | Aparna Ashok/ Dr. Neeru Bhagat | Symbosis International University, Pune |
| 1043. | Dr. Rachna Gupta | IET, DAVV, Indore |
| 1044. | Abhilasha | NPL |
| 1045. | Mr. Lozil Denzil Mendonca / Dr. Mamata Daivajna | MIT, Manipur |
| 1046. | Mr. Santanu De / Prof. Santhosh P Nagappan Nair | IIT Madras |
| 1047. | Mr. Mainur Rahman/ Prof. S Srinath | University of Hyderabad |

**Arc-melting**

| **Sr. No.** | **Name of the student/scientist** | **University/College/Institute** |
|---|---|---|
| 1048 | Ms. Aparna Ashok / Dr. Neeru Bhagat | Symbiosis Institute of Technology, Symbiosis International (Deemed) University |
| 1049 | Prof. Mayukh Majumder | Shiv Nadar University, Noida |
| 1050 | Mr. Anadi Krishna Atul / Dr. Neelabh Srivastava | Mahatma Gandhi Central University, Motihari, Bihar |

**Dielectric Measurements**

| **Sr. No.** | **Name of the student/scientist** | **University/College/Institute** |
|---|---|---|
| 1051 | Prof. N K Gaur | Barkatullah University, Bhopal |
| 1052 | Ms. Sangeeta/Dr. Kiran Singh | NIT, Jalandhar |
| 1053 | Ms. Vaidhi/Dr. Kiran Sigh | NIT, Jalandhar |

## Kolkatta centre

**X-ray powder diffractometer:-**

| Sr. No. | Name of the student/scientist | University/College/Institute |
|---|---|---|
| 1 | Dr Umesh Prakash Gawai | DDSP Arts Commerce and Science College, Jalgaon |
| 2 | Dr Debjyoti De | The Neotia University & Sukumar Sengupta Mahavidyalaya |
| 3 | Prof Papita Das | Jadavpur University |
| 4 | Dr Goutam Biswas | Cooch Behar Panchanan Barma University |
| 5 | Dr Moumita Patra | Raghunathpur College, Purulia |
| 6 | Dr Rina RaniRay | Maulana Abul Kalam Azad University, West Bengal |
| 7 | Dr Dibyarupa Pal | JIS University |
| 8 | Dr Abu Jahid Akhtar | Diamond Harbour Womens University |
| 9 | Dr Subhajit Sarkar | West Bengal State University |
| 10 | Dr Swarup Kumar Neogi | Adamas University |
| 11 | Dr. Ankita Indra | Srikrishna College |
| 12 | Dr Ashok Kumar Jha | Tilka Manjhi Bhagalpur University Bhagalpur |
| 13 | Dr Manoj Kumar | Central Univeristy of Jharkhand |
| 14 | Dr Arindam Karmakar | Surya Sen Mahavidyalaya |
| 15 | Dr Apurba Kanti Deb | Raiganj University |
| 16 | Dr Soumya Mukherjee | Kazi Nazrul University |

**4 K CCR (for zero-field resistivity/dielectric/ferroelectric measurements):-**

| | | |
|---|---|---|
| 17 | Dhananjay Mondal<br>C/o Prof Sukhen Das | Jadavpur University |
| 18 | Ms. Simrandeep Kour<br>C/o Dr. Rupam Mukherjee | Lovely Professional University |
| 19 | Ms. Rinku Sarkar<br>C/o Dr. Sudipta Pal | Kalyani University |
| 20 | Mr. Mandeep Jhangra<br>C/o Dr. Shamima Hussain | UGC DAE CSR, Kalpakkam Node |
| 21 | Mr. Souradeep Bhattacharya<br>C/o Dr. Kiran Singh | NIT Jalandhar |
| 22 | Dr Moumita Patra | Raghunathpur College |
| 23 | Dr. Gouranga SundarTaki | Institute of Engineering and Management |
| 24 | Dr Samrat Mukherjee | NIT Patna |
| 25 | Dr Sk Anirban | Government General Degree College, Salboni |
| 26 | Ms. Jhilik Roy<br>C/o Dr. Ruma Basu | Jogamaya Devi College |
| 27 | Mr. Sujay Munshi<br>C/o Dr Apurba Kanti Deb | Raiganj University |
| 28 | Mr. Subrata Mandal<br>Prof. Sanatan Chattopadhayay | University of Calcutta |
| 29 | Mr. Pradip Manna<br>C/o Dr. Sudipta Bandyopadhyay | University of Calcutta |
| 30 | Mr. Ashok Das<br>C/o Dr. Sudipta Bandyopadhyay | University of Calcutta |
| 31 | Ms. Shipra Das<br>C/o Prof. P. N. Santosh | IIT Madras |
| 32 | Mr. Biswarup<br>C/o Dr. Arnab Ghosh | UEM Kolkata |

**Cryogenic make 15 Tesla system:-**

| Sr. No. | Name of the student/scientist | University/College/Institute |
|---|---|---|
| 33 | Dr Siddhartha Ghosh | SRM University |
| 34 | Dr Samrat Mukherjee | NIT Patna |
| 35 | Mijanul Islam<br>C/o Dr. Arindam Karmakar | Surya Sen Mahavidyalaya, Siliguri |
| 36 | Dr. Harunar Rashid | Rajiv Gandhi University |
| 37 | Prof Goutam Biswas | Cooch Behar Panchanan Barma University |

**Resistive furnace (Box furnace, Tube furnace, Vacuum annealing furnace):-**

| | | |
|---|---|---|
| 38 | Mijanul Islam<br>C/o Dr. Arindam Karmakar | Surya Sen Mahavidyalaya, Siliguri |
| 39 | Dr Prasanta Karmakar | VECC Kolkata |
| 40 | Dr. Anupam Banerjee | Burdwan University |
| 41 | Ms. Rinku Sarkar<br>C/o Dr. Sudipta Pal | Kalyani University |
| 42 | Dr. Lakshman Dhal | Dum Dum Motijheel College |
| 43 | Mr. Mintu Debnath<br>C/o Dr. sudipta pal | Kalyani University |
| 44 | Mr. Rakesh Sen<br>C/o Dr. Ankita Indra | Srikrishna College |
| 45 | Mr. Sanand Kumar Pradhan<br>C/o Dr. Pradip Das | Guru Ghasidas Vishwavidyalaya |
| 46 | Ms. Shreya Nag<br>C/o Prof. Runu Banerjee Roy | Jadavpur University |

**Arc furnace:-**

| | | |
|---|---|---|
| 47 | Mr. Suman Mahakal<br>C/o Dr. Kartick Malik | Vidyasagar Metropolitan College |
| 48 | Dr. Aritra Banerjee | University of Calcutta |

**Pelletizer:-**

| | | |
|---|---|---|
| 49 | Mijanul Islam<br>C/o Dr Arindam Karmakar | Surya Sen Mahavidyalaya, Siliguri |
| 50 | Mr. Rakesh Sen<br>C/o Dr. Ankita Indra | Srikrishna College |
| 51 | Mr. Sujay Munshi<br>C/o Dr. Apurba Kanti Deb | Raiganj University |
| 52 | Dr. Arindam Midya<br>C/o Dr. Moumita Patra | Raghunathpur College |

**Mössbauer Spectrometer: -**

| Sr. No. | Name of the student/scientist | University/College/Institute |
|---|---|---|
| 53 | Dr. Sunil Chauhan | Sharda University |

**Planetary ball mill: -**

| Sr. No. | Name of the student/scientist | University/College/Institute |
|---|---|---|
| 54 | Prof. Papita Das | Jadavpur University |
| 55 | Dr. Subhajit Sarkar | West Bengal State University |
| 56 | Dr. Abhik Banerjee | TCG CREST, Kolkata |

**Fourier Transform Infrared Spectrometer:-**

| Sr. No. | Name of the student/scientist | University/College/Institute |
|---|---|---|
| 57 | Ms. Malabika Ghosh,<br>C/o Dr. Rama Ranjan Bhattacharjee | Amity University Kolkata |
| 58 | Dr. Umesh Prakash Gawai | DDSP Arts Commerce and Science College, Erandol Dist-Jalgaon |
| 59 | Dr. Ayana Bhaduri<br>C/o Dr. Ayana Bhaduri | Amity University Haryana |
| 60 | Dr. Gouranga Sundar Taki | Institute of Engineering and Management |
| 61 | Dr. Abirami Natarajan | SRMIST |
| 62 | Ms. Sayantani Mitra<br>C/o Prof. Susanta Lahiri | University of Calcutta |
| 63 | Dr. Debashree Das<br>C/o Dr. Kamalika Sen | University of Calcutta |
| 64 | Mr. Pritam Singh<br>C/o Dr. Kamalika Sen | University of Calcutta |
| 65 | Ms. Shalmali Basu<br>C/o Dr. Kamalika Sen | University of Calcutta |
| 66 | Dr. Sandipan Chatterjee | CSIR-Central Leather Research Institute |
| 67 | Dr. Dibyarupa Pal | JIS university |
| 68 | Dr. Rina Rani Ray | Maulana Abul Kalam Azad University of Technology, W.B. |
| 69 | Mr. Lokesh Adhikari<br>C/o Dr. Ajay Semalty | Dept. of Pharmaceutical Sciences, HNB Garhwal University |
| 70 | Mr. Sujay Munshi<br>C/o Dr. Apurba KantiDeb | Raiganj University |
| 71 | Mr. Bapan Bairy<br>C/o Dr. Moni Baskey (Sen) | The University of Burdwan |
| 72 | Dr. Moupriya Nag | University of Engineering & Management Kolkata |
| 73 | Dr. Goutam Kumar Kole | SRM Institute of Science and Technology |
| 74 | Dr. Susmita Singh | Amity University, Kolkata |
| 75 | Dr. Subarna Bhattacharyya | School of Environmental Studies, Jadavpur University |
| 76 | Dr. Sabyasachi Chakrabortty | SRM University AP - Andhra Pradesh |
| 77 | Ms. Suhasini Mallick<br>C/o Dr. Rina Rani Ray | Maulana Abul Kalam Azad University of Technology |
| 78 | Dr. Abu Jahid Akhtar | Diamond Harbour Women's University |
| 79 | Mr. Anirban Chaudhuri<br>C/o Dr. Subarna Bhattacharyya | School of Environmental Studies, Jadavpur University |
| 80 | Dr. Kaushik Banerjee | Variable Energy Cyclotron Centre |
| 81 | Ms. Sreejita Ghosh<br>C/o Dr. Rina Rani Ray | Maulana Abul Kalam Azad University of Technology, West Bengal |
| 82 | Mr. Somnath Das<br>C/o Dr. Dipankar Ghosh | JIS UNIVERSITY |
| 83 | Dr. Devastotra Poddar | Belda College, Vidyasagar University |
| 84 | Mr. Asif Seikh<br>C/o Dr. Kamalika Sen | University of Calcutta |
| 85 | Prof. Urmi Chatterji | University of Calcutta |
| 86 | Mr. Tamil Selvan Kannan<br>C/o Dr. Goutam Kumar Kole | SRM IST |
| 87 | Ms. Tiyasa Ray<br>C/o Dr. Kamalika Sen | University of Calcutta |

| | | |
|---|---|---|
| 88 | Dr. Sudip Kumar Saha | Diamond Harbour Women's University |
| 89 | Ms. Iti Diwan<br>C/o Dr. Purnima Swarup Khare | Rajiv Gandhi Proudyogiki vishwavidyalaya Bhopal. |
| 90 | Prof. Zahed Hossain | University of Kalyani |
| 91 | Prof. Jyoti Prakash Maity | KIIT Deemed to be University |
| 92 | Ms. Jyoti Shukla<br>C/o Dr. Ashutosh Mishra | School of Physics, Devi Ahilya University Indore |
| 93 | Ms. Riashree Mondal<br>C/o Dr. Subarna Bhattacharyya | Jadavpur University |
| 94 | Dr. Shabeeba Nawab Pilathottathil | University of Calicut |
| 95 | Dr. Rama Ranjan Bhattacharjee | Amity University |
| 96 | Ms. Bandita Dutta<br>C/o Dr. Rina Rani Ray | Maulana Abul Kalam Azad University of Technology, West Bengal |
| 97 | Mr. Tanmoy Chakraborty<br>C/o Dr. Soumyaditya Sutradhar | Jadavpur University |
| 98 | Dr. Chabita Saha | Maulana Abul Kalam Azad University of Technology, Kolkata |

**Laser Raman Spectrometer:-**

| Sr. No. | Name of the student/scientist | University/College/Institute |
|---|---|---|
| 99 | Dr. Umesh Prakash Gawai | DDSP Arts Commerce and Science College, Erandol Dist-Jalgaon |
| 100 | Mr. Sachin Damodar Rajadhyax<br>C/o Prof. Sangita Gajanan Dahotre | Dr. Babasaheb Ambedkar Technological University, Lonere |
| 101 | Ms. Ishaleena Choudhury<br>C/o Dr. Chabita Saha | Maulana Abul Kalam Azad University of Technology, Kolkata |
| 102 | Dr. Goutam Kumar Kole | SRM Institute of Science and Technology |
| 103 | Dr. Swati De | Kalyani University |

**Luminescence Spectrometer:-**

| Sr. No. | Name of the student/scientist | University/College/Institute |
|---|---|---|
| 104 | Dr. Debashree Das<br>C/o Dr. Kamalika Sen | University of Calcutta |
| 105 | Dr. Prasanta Karmakar | VECC, Kolkata |
| 106 | Dr. Gobinda Gopal Khan | Tripura University (A Central University) |
| 107 | Dr. Debashree Manna | Maulana Abul Kalam Azad University of Technology |
| 108 | Prof. Papita Das | Jadavpur University |
| 109 | Ms. Reetika Sarkar<br>C/o Dr. Debashree Manna | Maulana Abul Kalam Azad University of Technology |
| 110 | Ms. Ayantika Dan<br>C/o Dr. Debashree Manna | Maulana Abul Kalam Azad University of Technology |
| 111 | Dr. Suvadra Das | University of Engineering and Management Kolkata |
| 112 | Ms. Shalmali Basu<br>C/o Dr. Kamalika Sen | University of Calcutta |
| 113 | Dr. Chabita Saha | Maulana Abul Kalam Azad University of Technology, Kolkata |
| 114 | Dr. Ayana Bhaduri | Amity University Haryana |
| 115 | Mr. Aakash Hossain<br>C/o Prof. Papita Das | Jadavpur University |
| 116 | Mr. Sujay Munshi<br>C/o Dr. Apurba Kanti Deb | Raiganj University |
| 117 | Dr. Goutam Kumar Kole | SRM Institute of Science and Technology |
| 118 | Prof. Taposi Chatterjee | Techno International, New Town |

| | | |
|---|---|---|
| 119 | Dr. Vijaylakshmi Dayal | Maharaja Institute of Technology, Mysore |
| 120 | Prof. Md. Akhtarul Alam | Aliah University |
| 121 | Dr. Subhajit Sarkar | West Bengal State University |
| 122 | Mr. Tamil Selvan Kannan<br>C/o Dr. Goutam Kumar Kole | SRM IST |
| 123 | Ms. Iti Diwan<br>C/o Dr. Purnima SwarupKhare | Rajiv Gandhi Proudyogiki vishwavidyalaya Bhopal. |
| 124 | Dr. Pijus Kanti Samanta | P. K. College Contai |
| 125 | Dr. Madhumita Mukhopadhyay | Maulana Abul Kalam Azad University of Technology |
| 126 | Mr. Sumit Sarkar<br>C/o Dr. Madhumita Mukhopadhyay | Maulana Abul Kalam Azad University of Technology |
| 127 | Dr. Shabeeba Nawab Pilathottathil | University of Calicut |
| 128 | Dr. Tanay Pramanik | University of Engineering and Management Kolkata |

**Dynamic Light Scattering:-**

| Sr. No. | Name of the student/scientist | University/College/Institute |
|---|---|---|
| 129 | Dr. Indrajit Saha | Ramakrishna Mission Residential College (Autonomous) |
| 130 | Mr. Pritam Singh<br>C/o Dr. Kamalika Sen | University of Calcutta |
| 131 | Dr. Chabita Saha | Maulana Abul Kalam Azad University of Technology |
| 132 | Ms. Shalmali Basu<br>C/o Dr. Kamalika Sen | University of Calcutta |
| 133 | Prof. Anima Sunil Dadhich | GITAM (deemed to be University) |
| 134 | Dr. Sandipan Chatterjee | CSIR-Central Leather Research Institute |
| 135 | Dr. Debashree Das<br>C/o Dr. Kamalika Sen | University of Calcutta |
| 136 | Dr. Rina Rani Ray | Maulana Abul Kalam Azad University of Technology |
| 137 | Dr. Asmita Samadder | University of Kalyani |
| 138 | Ms. Malabika Ghosh<br>C/o Dr. Rama Ranjan Bhattacharjee | Amity University Kolkata |
| 139 | Ms. Nandita Ghosh<br>C/o Dr. Sudipta Mondal | NIT Durgapur |
| 140 | Dr. SUSMITA SINGH | Amity University, Kolkata |
| 141 | Mr. Nayan Sarkar | CSIR-Central Leather Research Institute |
| 142 | Ms. Suhasini Mallick<br>C/o Dr. Rina Rani Ray | Maulana Abul Kalam Azad University of Technology |
| 143 | Dr. Chabita Saha | Maulana Abul Kalam Azad University of Technology, Kolkata |
| 144 | Dr. Rama Ranjan Bhattacharjee | Amity University |
| 145 | Mr. Tridib Banerjee<br>C/o Dr. Kamalika Sen | University of Calcutta |
| 146 | Ms. Iti Diwan<br>C/o Dr. Purnima Swarup Khare | Rajiv Gandhi Proudyogiki vishwavidyalaya Bhopal. |
| 147 | Prof. Zahed Hossain | University of Kalyani |
| 148 | Ms. Ishaleena Choudhury<br>C/O Dr. Chabita Saha | Maulana Abul Kalam Azad University of Technology, Kolkata |
| 149 | Dr. Susmita Das | Amity University Kolkata |
| 150 | Prof. Jyoti Prakash Maity | KIIT Deemed to be University |
| 151 | Dr. Indrajit Saha | Ramakrishna Mission Residential College (Autonomous) |
| 152 | Dr. Shabeeba Nawab Pilathottathil | University of Calicut |

**Time Correlated Single Photon Counting (TCSPC):-**

| Sr. No. | Name of the student/scientist | University/College/Institute |
|---|---|---|
| 153 | Dr. Chabita Saha | Maulana Abul Kalam Azad University of Technology, Kolkata |
| 154 | Ms. Reetika Sarkar<br>C/o Dr. Debashree Manna | Maulana Abul Kalam Azad University of Technology |
| 155 | Ms. Ayantika Dan<br>C/o Dr. Debashree Manna | Maulana Abul Kalam Azad University of Technology |
| 156 | Dr. Debashree Das<br>C/o Dr. Kamalika Sen | University of Calcutta |
| 157 | Ms. Debatri Shit<br>C/o Dr. Smritimoy Pramanik | University of Calcutta |
| 158 | Ms. Ishaleena Choudhury<br>C/O Dr. Chabita Saha | Maulana Abul Kalam Azad University of Technology, Kolkata |
| 159 | Dr. Sudip Kumar Saha | Diamond Harbour Women's University |
| 160 | Dr. Indrajit Saha | Ramakrishna Mission Residential College (Autonomous) |
| 161 | Dr. Goutam Kumar Kole | SRM Institute of Science and Technology |
| 162 | Mr. Tamil Selvan Kannan<br>C/o Dr. Goutam Kumar Kole | SRM IST |
| 163 | Dr. Sudipta Bhowmik | University of Calcutta |
| 164 | Dr. Tanay Pramanik | University of Engineering and Management Kolkata |

**UV-Vis NIR Absorption Spectrophotometer:-**

| Sr. No. | Name of the student/scientist | University/College/Institute |
|---|---|---|
| 165 | Dr. Umesh Prakash Gawai | DDSP Arts Commerce and Science College, Erandol Dist-Jalgaon |
| 166 | Ms. Sayantani Mitra<br>C/o Prof. Susanta Lahiri | University of Calcutta |
| 167 | Dr. Subhajit Sarkar | West Bengal State University |
| 168 | Dr. Chabita Saha | Maulana Abul Kalam Azad University of Technology |
| 169 | Dr. Kamesh Viswanathan Baskaran | Charotar University of Science & Technology |
| 170 | Dr. Goutam Kumar Kole | SRM Institute of Science and Technology |
| 171 | Ms. Ishaleena Choudhury<br>C/O Dr. Chabita Saha | Maulana Abul Kalam Azad University of Technology, Kolkata |
| 172 | Dr. Ayana Bhaduri | Amity University Haryana |
| 173 | Dr. Md Hedayetullah Mir | Aliah University |
| 174 | Dr. Dipankar Halder | Jadavpur University |
| 175 | Ms. Sanchita Maity<br>C/o Dr. Dipankar Halder | Jadavpur University |
| 176 | Mr. Tamil Selvan Kannan<br>C/o Dr. Goutam Kumar Kole | SRM IST |
| 177 | Ms. Iti Diwan<br>C/o Dr. Purnima Swarup Khare | Rajiv Gandhi Proudyogiki Vishwavidyalaya, Bhopal. |
| 178 | Prof. Zahed Hossain | University of Kalyani |
| 179 | Ms. Jyoti Shukla<br>C/o Dr. Ashutosh Mishra | Devi Ahilya University, Indore |
| 180 | Dr. Shabeeba Nawab Pilathottathil | University of Calicut |
| 181 | Dr. Tanay Pramanik | University of Engineering and Management Kolkata |

**Isothermal Titration Calorimeter:-**

| Sr. No. | Name of the student/scientist | University/College/Institute |
|---|---|---|

| | | |
|---|---|---|
| 182 | Dr. Chabita Saha | Maulana Abul Kalam Azad University of Technology |
| 183 | Dr. Subhabrata Majumder | Saha Institute of Nuclear Physics |
| 184 | Dr. Sudipta Bhowmik | Calcutta University |
| 185 | Ms. Ishaleena Choudhury<br>C/O Dr. Chabita Saha | Maulana Abul Kalam Azad University of Technology |

**Flow Cytometer:-**

| Sr. No. | Name of the student/scientist | University/College/Institute |
|---|---|---|
| 186 | Sulagna Dutta | West Bengal State University |
| 187 | Souvik Sarkar | Sister Nivedita University |
| 188 | Riya Kulkheri | Bennet University |
| 189 | Garima Gupta | Bennet University |

**UV-Visible Spectrophotometer:-**

| Sr. No. | Name of the student/scientist | University/College/Institute |
|---|---|---|
| 190 | Garima Gupta | Bennet University |
| 191 | Sulagna Dutta | West Bengal State University |
| 192 | Souvik Sarkar | Sister Nivedita University |
| 193 | Riya Kulkheri | Bennet University |
| 194 | Tanusree Panigrahi | GITAM Univeristy |
| 195 | G S Taki | IEM Kolkata |
| 196 | B.S.Sarangi | KIIT Bhubaneswar |

**Cell Culture Facilities:-**

| Sr. No. | Name of the student/scientist | University/College/Institute |
|---|---|---|
| 197 | Riya Kulkheri | Bennet University |
| 198 | Garima Gupta | Bennet University |
| 199 | Sulagna Dutta | West Bengal State University |
| 200 | Souvik Sarkar | Sister Nivedita University |
| 201 | Partha S Mondal | BIT-Meshra |
| 202 | B.S.Sarangi | KIIT Bhubaneswar |

**IUCPIX Software Package:-**

| Sr. No. | Name of the student/scientist | University/College/Institute |
|---|---|---|
| 203 | S. Basu/ Dr. G. Mukherjee | VECC, Kolkata |
| 204 | S. Basak/ Dr. T. Bhattacharjee | VECC, Kolkata |
| 205 | A. Karmakar/ Prof. S. Chattopadhyay & Dr. P. Datta | SINP & Ananda Mohan College, Kolkata |
| 206 | N. Susshma/ Dr. R. Gowrishankar | SSSIHL, Andhra Pradesh |
| 207 | P. Pallav/ Dr. S. Das Gupta | Victoria Institution (College), Kolkata |
| 208 | A.K. Mondal/ Dr. A. Chakraborty | Visva Bharati, West Bengal |

**Software for Nuclear Level Lifetime Analysis:-**

| Sr. No. | Name of the student/scientist | University/College/Institute |
|---|---|---|
| 209 | K. Katre/ Dr. R. P. Singh | IUAC, New Delhi |
| 210 | A. Sharma/ Prof. S. K. Dhiman | Himachal University |

**In-house HPGe Detector:-**

| Sr. No. | Name of the student/scientist | University/College/Institute |
|---|---|---|
| 211 | P. Gogoi/Dr. D. Barooah | Cotton University, Guwahati |

**EDXRF**

| Sr. No. | Name of the student/scientist | University/College/Institute |
|---|---|---|
| 212 | Aleti Jaya Sree<br>C/o Prof A Durga Prasada Rao | Andhra University, Visakhapatnam. |
| 213 | Tanushree Panigrahi<br>C/o Dr. Anima S Dadhich | GITAM University, Visakhapatnam |
| 214 | Amit Kr Dey<br>C/o Prof Dr. Apurba Ratan Ghosh | Burdwan University, WB |
| 215 | MD Imran Hasan<br>C/o Dr Alok Ghosh | Ballygunge Sc College, Kolkata |
| 216 | Pranjal Gogoi | Cotton University, Guwahati, Assam |
| 217 | Reetta Sara George<br>C/o Dr Arpita Datta | AMITY University Kolkata |
| 218 | Sinthia Saha<br>C/o Dr. Susmita Singh | AMITY University Kolkata |
| 219 | Mainak Bose<br>C/o Dr Susmita Singh | AMITY University Kolkata |
| 220 | Tammanna Parida<br>C/o Prof Dr. Namacluri Srinivas | GITAM University, Visakhapatnam |
| 221 | Bhabau Sankar Sarangi<br>C/o Dr J P Maity | KIIT Deemed University - Bhubaneswar |
| 222 | Sulagna Datta<br>C/o Dr Madhumita Manna | Bidhannagar College, Kolkata |
| 223 | Suhasini Mallick<br>C/o Dr. Rina Roy | MAKAUT, Kolkata |

**Micro EDXRF:-**

| Sr. No. | Name of the student/scientist | University/College/Institute |
|---|---|---|
| 224 | Tanushree Panigrahi<br>C/o Dr. Anima S Dadhich | GITAM University, Visakhapatnam |
| 225 | MD Imran Hasan<br>C/o Dr Alok Ghosh | Ballygunge Sc College, Kolkata |
| 226 | Suhasini Mallick<br>C/o Dr. Rina Roy | MAKAUT, Kolkata |
| 227 | Susmita Manna<br>C/o Prof Dr. Sajal Roy | Calcutta University, Kolkata |
| 228 | Abhisheak Roy<br>C/o Prof Dr. Sajal Roy | Calcutta University, Kolkata |
| 229 | Dr. Susmita Singh | AMITY University Kolkata |
| 230 | Monisha Nayak<br>C/o Dr. Sudip Kr Saha | Diamond Harbour Womens' University |
| 231 | Anirban Chaudhuri<br>C/o Dr. Subarna Bhattachargge | Jadavpur University, Kolkata |
| 232 | Prof Pradeep Kr Behera | Sambalpur University, Odisha |

## Mumbai centre

**14T PPMS (VSM, HC, Resistance, MR, Hall)**

| Sr.No. | Name of the Scientist/Student | University/College/Institute |
|---|---|---|
| 1 | Dr. Tirupathi Pathri | RGKUT, Kadapa, A.P. |
| 2 | Prof. A.K Bhatnagar | Univ. of Hyderabad |
| 3 | Prof. Subhashis Ghosh | JNU, New Delhi |
| 4 | Dr. Jyoti Ranjan Sahu | North Orissa University, Baripada |
| 5 | Dr. Indrajit Naik | North Orissa University, Baripada |
| 6 | Dr. Pritam Deb | Tezpur University, Assam |
| 7 | Dr. Y. Sundarayya | Nagaland University, Lumami |
| 8 | Prof. Ravinder D | Telangana University, Nizamabad |
| 9 | Prof. S. Srinath | Univ. of Hyderabad |
| 10 | Mr. Saarthak D | Univ. of Hyderabad |
| 11 | Prof. K.J Thomas | University of Kerala |
| 12 | Dr. S. Savitha Pillai | Univ. Kerala |
| 13 | Prof. R. N. Bhowmik | Pondicherry Univ. |
| 14 | Prof. Subhasis Ghosh | JNU, New Delhi |
| 15 | Dr. Debajyoti De | The Neotia University, Kolkata |
| 16 | Dr. Kalyanshis De | The Neotia University, Kolkata |
| 17 | Dr. Hari Sankar Mohanty | GIET University, Gunupur |
| 18 | Dr. Meenakshi Sunder | Sri Paramakalyani College, Alwarkurichi, Tirunelveli. |
| 19 | Dr. Pravanjan Mallick | North Orissa Univ. Baripada |
| 20 | Dr. S. Srinath Reddy | Osmania Univ. |
| 21 | Dr. Anil M Palve | Mahatma Phule Arts Science and Commerce College, Panvel |
| 22 | Dr. Umesh P Gawai | Dadasaheb Digambar Shankar Patil Arts, Commerce&Science College,Erandol, Jalgaon |
| 23 | Dr. Anil Kumar Singh | NIT Rourkela |
| 24 | Dr. P.N. Vishwakarma | NIT Rourkela |
| 25 | Dr. Manvendra Singh Khatri | NIT Uttarakhand |
| 26 | Dr. Sandipan Chatterjee | Regional Centre for Extension & development, CLRI Kolkata |
| 27 | Dr. Madhu Chennabasappa | Siddaganga Institute of Technology Tumkur |
| 28 | Dr.Anupinder Singh | Guru Nanak Dev Univ. Amritsar |
| 29 | Mr. Sachin D Rajadhyax | Govt. Polytechnic, Malvan & BATU, Lonere |
| 30 | Ms. Dasari Swati | ISBM Univ. Chattisgarh |
| 31 | Prof. Saneep Chatterjee | IIT-BHU |
| 32 | Dr. S.Shankukharao | CBIT, Hyderabad |
| 33 | Chiranjit Karmakar | Space Application Centre, ISRO, Ahmedabad |
| 34 | Saikat Chattopadhyay | Manipal university, Jaipur |
| 35 | Dr. Avijit Paul | IIT Kurkshetra |
| 36 | Prof. G.D. Varma | IIT Roorkee |
| 37 | Dr. Anil K Singh | NIT Rourkela |
| 38 | Dr. G. A. Basheed | NPL, New Delhi |
| 39 | Mr. Pradip Yadav | NPL, New Delhi |
| 40 | Ms. Lalita | NPL, New Delhi |
| 41 | Dr. V. Srinivas | IIT Madras |
| 42 | Dr. Debashis Patra | IIT Madras |
| 43 | Prof. N. Harish Kumar | IIT Madras |
| 44 | Mr. Harikrishnan | IIT Madras |
| 45 | Prof. P.N. Santosh | IIT Madras |
| 46 | Prof. A.V. Mahajan | IIT Bombay |
| 47 | Dr. Dhanasekaran | IIT Bombay |
| 48 | Prof. K.G. Suresh | IIT Bombay |
| 49 | Mr. Jadupati Nag | IIT Bombay |

| | | |
|---|---|---|
| 50 | Ms Parul | IIT Bombay |
| 51 | Ms. Surbhi Gupta | IIT Bombay |
| 52 | Mr. Aditya | IIT Bombay |
| 53 | Dr. Deepanshu Bansal | IIT Bombay |
| 54 | Dr. Avradeep Pal | IIT Bombay |
| 55 | Dr. R. S. Dhaka | IIT Delhi |
| 56 | Dr. Amritendu Roy | IIT Bhubaneswar |
| 57 | Mamatha Daivajna | Manipal Inst. Technology, Manipal |
| 58 | Ashwathnath N Prabh | |
| 59 | Mandeep Singh | Guru Nanak Dev Univ. Amritsar |
| 60 | Prof. P.S. Anil Kumar | IISc Bangalore |
| 61 | Mr. Mithun Ghosh | IISc Bangalore |
| 62 | Mr. Santosh Kumar Khetan | IISc Bangalore |
| 63 | Dr. Soumay Mahapatra | Sri Sri University, Odisha |

**Dielectric Spectrometer(Impedance Analyzer)**

| | | |
|---|---|---|
| 64 | Dr.S.N.Achary | BARC |
| 65 | Dr.Subhash Thota | IIT Guwahati |
| 66 | Dr.Mamatha Daivajna | Manipal Institute of Technology |
| 67 | Dr. Vineeta Grover | BARC |
| 68 | Dr. Rakesh Shukla | BARC |

**X-ray Diffractometer (Bruker Benchtop D2 Phaser)**

| | | |
|---|---|---|
| 69. | Dr. Ajay Semalty | H.N.B. Garhwal University, Srinagar Garhwal-246174, Uttarakhand |
| 70. | Dr. Anil M Palve | Mahatma Phule Arts, Science and Commerce College, Panvel |
| 71. | Dr. Ramphal B Sharma | Dr B. A. Marathwada University, Aurangabad |
| 72. | Dr. S. N. Achary | Chemistry Division, BARC |
| 73. | Dr. Kalyanashish De | Neotia University, West Bengal |
| 74. | Dr. Sandipan Chatterjee | CLRI, West Bengal |
| 75. | Dr. Sneha Vishwasgir Buwa | SPPU, Pune |
| 76. | Dr. Stephen Rajkumar Inbanathan | The American College, Madurai, Tamil Nadu |
| 77. | Dr. Mamatha Daivajna | MIT, MAHE, Manipal |
| 78. | Dr. P. Saha | RPED, BARC |
| 79. | Kartik Iyer | TIFR, Mumbai |
| 80. | Dr. Shidaling Mattepanavar | KLE College, Chikodi, Karnataka |
| 81. | Dr. Mukesh Keshvani | Marwari University, Rajkot |

**Powder neutron diffractometer**

| **Sr. No.** | **Name of the student/scientist** | **University/College/Institute** |
|---|---|---|
| 82. | Dr. G. A. Basheed | NPL, Delhi |
| 83. | Prof. A. V. Mahajan | IIT Bombay, Mumbai |
| 84. | Dr. Saroj L. Samal | NIT Rourkela |
| 85. | Dr. D. Sajan | Bishop Moore College, Kallumala, Kerla |
| 86. | Dr. V. Sharma | BARC, Mumbai |
| 87. | Dr. M. Chennabassappa | Siddhganga Institute of Technology, Tumkuru |
| 88. | Prof. A. K. Bhatnagar | Hyderabad Central University |
| 89. | Dr. U. Gawai | DDSP college Erandol, Jalgaon |
| 90. | Dr. Jagdeesh Angadi | Presidency University, Bengaluru |
| 91. | Dr. Mintu Mondal | IACS, Kolkata |
| 92. | Dr. A. K. Bera | BARC, Mumbai |
| 93. | Dr. A. Yogi | UGC-DAE CSR Indore |
| 94. | Dr. S. Middey | IISc Bengaluru |

| | | |
|---|---|---|
| 95. | Dr. Yogesh Kumar | BARC, Mumbai |
| 96. | Dr. A. Angadi | Bangalore University |
| 97. | Dr. I. Naik | North Odisha University |
| 98. | Dr. Surbhi Gupta | IIT Bombay, Mumbai |
| 99. | Dr. K. G. Suresh | IIT Bombay, Mumbai |
| 100. | Dr. K. B. Modi | Saurashtra University, Rajkot, Gujrat |
| 101. | Dr. Vinayak Kamble | IISER Trivendrem |
| 102. | Dr. I. Soibam | NIT Manipur |
| 103. | Dr. Ram kumar | TIFR, Mumbai |
| 104. | Dr. Hanuma Kumar | IOP, Bhubaneshwar |
| 105. | Dr. Anupinder Singh | GNDU, Amritsar |
| 106. | Dr. Mala N. Rao | BARC, Mumbai |
| 107. | Dr. R. N. Singh | BARC, Mumbai |
| 108. | Dr. Amritendu Roy | IIT Bhubaneshwar |
| 109. | Dr. V. Mariappam | Pondicherry University |
| 110. | Dr. Buddhdeb Karnar | BARC, Mumbai |
| 111. | Dr. R. N. Bhowmik | Pondicherry University |
| 112. | Dr. S. Elizabeth | IISc, Bengaluru |
| 113. | Dr. Soumyajyoti Ray | IIT Patna |
| 114. | Dr. R. N. Mehto | JNU, New Delhi |
| 115. | Dr. N. G. Deshpande | IIIT Surat, Gujrat |
| 116. | Dr. Rabia Pandit | Punjab Technical University, Punjab |
| 117. | Dr. Tathamay Basu | RG Institute of Petroleum Technology, Amethi, UP |
| 118. | Dr. Apu Sarkar | BARC, Mumbai |
| 119. | Dr. Pranab Mandal | SRM University, Amravati, Andhra Pradesh |
| 120. | Prof. Harish Kumar | IIT Chennai, Tamil Nadu |
| 121. | Dr. S. R. Mahapatra | Sri Sri University, Odisha |
| 122. | Prof. V. Subramaniam | IIT Madras, Chennai |
| 123. | Dr. P. N. Vishwkarma | NIT Rourkela |
| 124. | Dr. T. Patri | RGUKT Andhra Pradesh |
| 125. | Dr. D. Bhattacharya | CSIR-CGCRI, Kolkata |
| 126. | Dr. P. P. Jana | IIT Kharagpur |
| 127. | Dr. A. K. Singh | NIT Rourkela |
| 128. | Dr. V. Ganesan | Medicaps University, Indore |

**Material synthesis lab**

| | | |
|---|---|---|
| 129. | Dr. S. N. Achary | Chemistry Division, BARC, Mumbai |
| 130. | Dr. Bala ji Mandal | Chemistry Division, BARC, Mumbai |
| 131. | Dr. I. Naik | North Odisha University, Baripada |
| 132. | Dr. Prasenjit Saha, | BARC, Mumbai |
| 133. | Dr. Yogesh Kumar | SSPD, BARC, Mumbai |

# Kalpakkam Node

## SQUID-VSM MPMS

| Sr. No. | User Name | Affialliation |
|---|---|---|
| **1.** | Dr. Pravanjan Mallick | Maharaja Sriram ChandraBhanja Deo University, Orissa |
| **2.** | Dr. Tarun Garg | VIT Vellore |
| **3.** | Mr. Alok Kumar Sahoo<br>C/o Dr. SuryanarayanDash | National Institute ofTechnology, Rourkela |
| **4.** | Dr. Shrawan Kumar Mishra | Indian Institute of Technology(BHU), Varanasi |
| **5.** | Ms. Simrandeep Kour | Lovely Professional University, Chandigarh |
| **6.** | Dr. A MurugadossMuruga | Department of InorganicChemistry, University of Madras,Chennai |
| **7.** | Dr. Savitha PillaiS | University of Kerala |
| **8.** | Mr. Arnab Kar<br>C/o Dr. Suja Elizabeth | Indian Institute of Science, Bangalore |
| **9.** | Dr. Murugesan Ganesan | VelTech Rangarajan Dr.Sagunthala R & D Institute of Science and Technology, Chennai |
| **10.** | Ms. Nazima Nazir<br>C/o Prof. Mohd. Ikram | NIT Srinagar |
| **11.** | Mr. NileshKumarGovindbhai Parmar<br>C/o Dr. Mitesh Sarkar | The Maharaja SayajiraoUniversity of Baroda |
| **12.** | Dr. Samrat Mukherjee | NIT Patna |
| **13.** | Mr. Vedant Pramode Khadse<br>C/o Prof. Subhash Thota | IIT Guwahati |
| **14.** | Dr. Harunar Rashid | Rajiv Gandhi University, Arunachal Pradesh |
| **15.** | Mr. Amitava Ghosh<br>C/o Dr. Chanchal Sow | Indian Institute of TechnologyKanpur |
| **16.** | Dr. Debajyoti De | The Neotia University (LIEN);Sukumar Sengupta Mahavidylaya, Midnapore, West Bengal |
| **17.** | Mr. Naveen Kumar R<br>C/o Dr. Senthur Pandi | Vellore University ofTechnology, Vellore |
| **18.** | Dr. Murugeswari A | Anna University, Chennai |
| **19.** | Dr. Hari SankarMohanty | GIET University, Gunupur, Odisha |
| **20.** | Ms. Divya Sherin GT<br>C/o Dr. Rabindra Nath Bhowmik | Pondicherry CentralUniversity |
| **21.** | Prof. Neeraj KumarGaur | Barkatullah University, Bhopal (Formarly Universityof Bhopal) |
| **22.** | Mr. Subrata Das<br>C/o Dr. Suja Elizabeth | Indian Institute of Science, Bangalore |
| **23.** | Mr. Manoj Mohan<br>C/o Dr. Hysen Thomas | Christian College,Chengannur, University ofKerala |
| **24.** | Dr. Ganesan Rajamanickam | Department of Physics, Indian Institute of Science, Bangalore |
| **25.** | Mr. Shohaib Abass<br>C/o Dr. Khalid Sultan | Department of Physics,Central University of Kashmir |
| **26.** | Dr. Ashim KumarPramanik | Jawaharlal Nehru University, Delhi |
| **27.** | Ms. Pujashree PriyadarshiniSethy<br>C/o Dr. Bibekananda Sundaray | Ravenshaw University,Cuttack |
| **28.** | Mr. Nayan Sarkar<br>C/o Dr. Sandipan Chatterjee | CSIR-Central LeatherResearch Institute, Kolkata |

## 15T Cryogenics Hall-MR MS

| | | |
|---|---|---|
| **29.** | Mr. Nabakumar Rana<br>C/o Dr. Aritra Banerjee | University of Calcutta |

| | | |
|---|---|---|
| **30.** | Mr. Sambhab Dan<br>C/o Dr. Swapnil ShashikantPatil | IIT BHU, Varanasi |
| **31.** | Mr. Vedant Pramode Khadse<br>C/o Prof. Subhash Thota | IIT Guwahati |
| **32.** | Dr. Murugeswari A | Anna University, Chennai |
| **33.** | Dr. Priyanka Tiwari<br>C/o Prof. Subhash Thota | IIT Guwahati |
| **34.** | Mr. Shohaib Abass<br>C/o Dr. Khalid Sultan | Department of Physics,Central University of Kashmir |

### AFM

| | | |
|---|---|---|
| **35.** | Dr. Bismita Nayak | NIT Rourkela |
| **36.** | Ms. Akanksha Mehto<br>C/o Dr. Jyotsna Chauhan | Rajiv Gandhi ProudyogikiVishwavidyalaya, Bhopal, Madhya Pradesh |
| **37.** | Dr. Varsha Rani Mehto<br>C/o Dr. Jyotsna Chauhan | Rajiv Gandhi TechnicalUniversity, Bhopal, Madhya Pradesh |
| **38.** | Ms. Supriya Vaish | Central University of Gujarat |

### 200 kV Accelerator

| | | |
|---|---|---|
| **39.** | Dr. R. Venkatesh<br>C/o Dr. R. Venkatesh | UGC-DAE CSR Indore |
| **40.** | Dr. B. Sundaravel<br>C/o Dr. B. Sundaravel | DDSS/MSG,<br>Indira Gandhi Centre for Atomic Research |
| **41.** | Dr. Gomathi<br>C/o Dr. Gomathi | SSSD/MSG,<br>Indira Gandhi Centre for Atomic Research |
| **42.** | Mr. Venkatesh<br>C/o Dr. Tribura Sundari | SSSD/MSG,<br>Indira Gandhi Centre for Atomic Research |
| **43.** | Mr. Venkatesh<br>C/o Dr. Tribura Sundari | SSSD/MSG,<br>Indira Gandhi Centre for Atomic Research |
| **44.** | Mr. Venkatesh<br>C/o Dr. Tribura Sundari | SSSD/MSG,<br>Indira Gandhi Centre for Atomic Research |
| **45.** | Ms. Prajisha<br>C/o Dr. K. J. Sankaran | CSIR-IMMT, Bhubaneswar |
| **46.** | Ms. Prajisha<br>C/o Dr. K. J. Sankaran | CSIR-IMMT, Bhubaneswar |
| **47.** | Dr. Ragavendra Reddy<br>C/o Dr. Ragavendra Reddy | UGC-DAE CSR Indore |
| **48.** | Mr. Venkatesh<br>C/o Dr. Tribura Sundari | SSSD/MSG,<br>Indira Gandhi Centre for Atomic Research |
| **49.** | Dr. Dhanya<br>C/o Dr. S. Dhara | SSSD/MSG,<br>Indira Gandhi Centre for Atomic Research |
| **50.** | Dr. K. Ganesan<br>C/o Dr. K. Ganesan | SSSD/MSG,<br>Indira Gandhi Centre for Atomic Research |
| **51.** | Dr. B. Sundaravel<br>C/o Dr. B. Sundaravel | DDSS/MSG,<br>Indira Gandhi Centre for Atomic Research |
| **52.** | Dr. Gomathi<br>C/o Dr. Gomathi | SSSD/MSG,<br>Indira Gandhi Centre for Atomic Research |
| **53.** | Dr. C. David<br>C/o Dr. C. David | DDSS/MSG,<br>Indira Gandhi Centre for Atomic Research |
| **54.** | Dr. C. David<br>C/o Dr. C. David | DDSS/MSG,<br>Indira Gandhi Centre for Atomic Research |

### NMR spectrometer

| | | |
|---|---|---|
| **55.** | Dr. Harunar Rashid<br>C/o Dr. Harunar Rashid | Department of Chemistry, Rajiv Gandhi University, Arunachal Pradesh |

### Arc melting unit

| | | |
|---|---|---|
| **56.** | Mr. Rasik Ahmad Parray<br>C/o Dr. Kuppan Ravichandran | University of Madras, Chennai |

### FESEM, EDS

| | | |
|---|---|---|
| **57.** | Dr. Stephen RajkumarInbanathan | The American College, Madurai |
| **58.** | Dr. Ayana Bhaduri | Amity University |

### Raman

| | | |
|---|---|---|
| **59.** | Dr. Hari SankarMohanty | Amet University, Chennai |
| **60.** | Dr. Pravanjan Mallick | UGC-DAE CSR Indore |
| **61.** | Ms. Lin Sunil<br>C/o Dr. AnitaRaghunadhanWarrier | VNR JNTU Hyderabad |
| **62.** | Ms. Nivetha Rajakumari S<br>C/o Dr. Baby SuneethaR | Amet University, Chennai |
| **63.** | Dr. Samrat Mukherjee | |
| **64.** | Ms. Navalika Adepu<br>C/o Dr. Srinivasa RaoLinganaboina | B R Ambedkar National Institute of Technology, Jalandhar |
| **65.** | Ms. Ekta Kushwaha<br>C/o Dr. Tathamay Basu | NIT Patna |
| **66.** | Prof. Pushpam S | *VNR JNTU,* Hyderabad |
| **67.** | Ms. Anju Subhash C/o<br>Dr. Anita Warrier | Rajiv Gandhi Institute of Petroleum Technology |
| **68.** | Dr. Venkatesh | NMSSVN College, Madurai, Tamil Nadu |
| **69.** | Dr. Srinivasa Rao L | Archeological Survey of India |
| **70.** | Mr Lin Sunil | NIT Warangal |
| **71.** | S. Nivetha Rajkumari | Pondicherry University,Pondicherry |
| **72.** | Dr. P. Mallick | Bishop Moore College , Kerala |
| **73.** | Dr. Samrat Mukherjee | Bishop Moore College, Kerala |
| **74.** | Ms. Navalika Adepu<br>C/o Dr. Srinivasa Rao<br>Linganaboina | Bishop Moore College, Kerala |
| **75.** | Ms. Ekta Kushwaha<br>C/o Dr. Tathamay Basu | Bishop Moore College, Kerala |
| **76.** | Prof. Pushpam S. | Bishop Moore College, Kerala |
| **77.** | Dr. Shanti Pappu | AISHW Coimbatore |
| **78.** | Dr. K. Yadagiri | ASI, Chennai |
| **79.** | Mr. Sujith Krishnan C/o Prof. P Elumalai | RSED, IGCAR |
| **80.** | Prof Sajan | Acharya Nagarjuna University |

### Crystal Growth facility

| | | |
|---|---|---|
| **81.** | Prof. S. Kalainathan | Vellore Institute of Technology |

## 9.4 General Information on Staff Position (as on March 31, 2023)

| Sl. No. | Designation | A | B | C |
|---|---|---|---|---|
| 01 | Director of the Consortium | 1 | 1 | I (1) |
| 02 | Centre-Director | 3 | 3 | I (1), M (1), K (1), |
| 03 | Scientist | 35 | 33 | I (19), K (6), M (4), KN (4) |
| 04 | Engineer | 6 | 6 | I (4), K (1), M (1) |
| 05 | Junior Engineer / Scientific Assistant / Technician | 44 | 43 | I (24), K (14), M (5) |
| 06 | AO – II | 1 | 1 | I (1) |
| 07 | AO – I | 7 | 5 | I (3), K (1), M (1) |
| 08 | Section Officer | 1 | - | M (-) |
| 09 | PS (to Director) | 1 | - | I (-) |
| 10 | PA (to Centre-Director) | 3 | 3 | I (1), K (1), M (1) |
| 11 | Assistant -II | 1 | 1 | I (1) |
| 12 | Assistant; Grade-I | 3 | 3 | I (2), K (1) |
| 13 | Typist/Steno-Typist/ Typist-cum-Clark/ Clerk-Typist | 7 | 3 | I (2), K (-), M (1) |
| 14 | Scientific Assistant (Library) | 2 | 2 | I (1), K (1) |
| 15 | Caretaker | 1 | - | I (-) |
| 16 | Guest House Attendant | 1 | 1 | K (1) |
| 17 | Driver-cum-Aux. Staff | 2 | 2 | I (2) |
| 18 | Driver | 4 | 3 | I (1), K (1), M (1) |
| 19 | Attendant-cum-Auxiliary Staff | 2 | 2 | M (1), I (1) |
| 20 | Helper / Lab. Attendant / Aux. Staff / Attendant | 12 | 12 | I (8), K (4) |
| **TOTAL** | | **137** | **124** | |

**A** : Approved.

**B** : Filled-up as on 31-March-2023.

**C** : Present posting at Indore (I), Mumbai (M), Kolkata (K), Kalpakkam (KN).

# List of staff at UGC-DAE CSR (AS ON 31.03.2023)

| Sl. No. | Dr./Mr./Ms. | Name | Designation |
|---|---|---|---|
| **1.** | Prof. | Amlan J. Pal | Director |
| **2.** | Dr. | Vasant Sathe | Centre-Director |
| **3.** | Dr. | P. D. Babu | Centre-Director |
| **4.** | Dr. | S. S. Ghugre | Centre-Director |
| **5.** | Dr. | N. P. Lalla | Scientist - H |
| **6.** | Dr. | S.R. Barman | Scientist – H |
| **7.** | Dr. | S. K. Deshpande | Scientist – H |
| **8.** | Mr. | P. Saravanan | Engineer –G |
| **9.** | Mr. | Tapas Kumar Mishra | Engineer –G |
| **10.** | Dr. | Rajeev Rawat | Scientist –H |
| **11.** | Dr. | V. R. Reddy | Scientist –H |
| **12.** | Dr. | A. Chakraborty | Scientist – G |
| **13.** | Dr. | G. S. Okram | Engineer-G / Scientist-G |
| **14.** | Dr. | Gautam Ghosh | Scientist – G |
| **15.** | Mr. | Sanjay Singh Thakur | Engineer –G |
| **16.** | Dr. | R. J. Choudhary | Scientist – G |
| **17.** | Dr. | Mukul Gupta | Scientist – G |
| **18.** | Dr. | S. Rayaprol | Scientist – G |
| **19.** | Dr. | Archana Lakhani | Scientist – G |
| **20.** | Dr. | Dileep Kumar Gupta | Scientist –F |
| **21.** | Dr. | Som Dutta Kaushik | Engineer –F |
| **22.** | Dr. | G. M. Bhalerao | Scientist - F |
| **23.** | Dr. | Sujoy Chakravorty | Scientist- F |
| **24.** | Dr. | Shamima Hussain | Scientist- F |
| **25.** | Dr. | Devendra Kumar | Scientist- F |
| **26.** | Dr. | Rajarshi Raut | Scientist- F |
| **27.** | Dr. | Souvik Chatterjee | Scientist- F |

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| **28.** | Dr. | Sudip Mukherjee | Scientist- F |
| **29.** | Dr. | Dinesh Kumar Shukla | Scientist- F |
| **30.** | Dr. | R. Venkatesh | Scientist- E |
| **31.** | Mr. | U. P. Deshpande | Scientist- F |
| **32.** | Mr. | Bhushan Jain | Engineer- E |
| **33.** | Dr. | Rajamani Raghunathan | Scientist- E |
| **34.** | Dr. | Goutam Pramanik | Scientist-D |
| **35.** | Dr. | Rajib Mondal | Scientist-D |
| **36.** | Dr. | Arvind Kumar Yogi | Scientist-D |
| **37.** | Dr. | K. Saravanan | Scientist-D |
| **38.** | Dr. | Praveen Kumar Velpula | Scientist-D |
| **39.** | Dr. | Debalaya Sarker | Scientist-D |
| **40.** | Dr. | Rajib Batabyal | Scientist-D |
| **41.** | Dr. | Souradyuti Ghosh | Scientist-D |
| **42.** | Dr. | Sanjoy Mahatha | Scientist-D |
| **43.** | Dr. | Sumanta Chattopadhyay | Scientist-D |
| **44.** | Mr. | J.B.M. Krishna | SA-F/JE-F |
| **45.** | Mr. | Suresh Bhardwaj | SA-F/JE- F |
| **46.** | Mr. | J.V. Joshi | SA-F/JE- F |
| **47.** | Mr. | S.C.Das | SA-F/JE- F |
| **48.** | Mr. | Nandkishore L. Ghodke | SA-F/JE-F |
| **49.** | Mr. | Avinash Wadikar | SA-F/JE-F |
| **50.** | Mr. | Satish R. Potdar | SA-F/JE-F |
| **51.** | Mr. | B. R. Mendole | Scientific Assistant-F |
| **52.** | Mr. | P. V. Rajesh | SA-F/JE-F |
| **53.** | Mr. | Pinaki Das | SA-F/JE-F |
| **54.** | Mr. | M. K. Verma | SA-F/JE-F |
| **55.** | Mr. | N. Vijayakumar | Junior Engineer-F |
| **56.** | Ms. | Aparna Datta/Basu | Scientific Assistant-F |

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|---|---|---|---|
| **57.** | Mr. | S. Selvaraj | Scientific Assistant-F |
| **58.** | Mr. | Kranti Kumar Sharma | Junior Engineer-F |
| **59.** | Mr. | Vinay K. Ahire | Junior Engineer-F |
| **60.** | Mr. | Mohd. Imran | Junior Engineer-F |
| **61.** | Mr. | Munshi Venugopal | Junior Engineer-F |
| **62.** | Mr. | Kaushik Basu | Scientific Assistant-F |
| **63.** | Mr. | Mohan Kumar Gangrade | Scientific Assistant-F |
| **64.** | Mr. | Mukesh Kumar | Scientific Assistant-F |
| **65.** | Mr. | A. K. Rathore | Scientific Assistant-F |
| **66.** | Ms. | Preeti Mahajan/ Bhradwaj | Junior Engineer-F |
| **67.** | Mr. | Anil Gome | Junior Engineer-F |
| **68.** | Ms. | Mahua Kar (Ghosh) | Scientific Assistant-F (Library) |
| **69.** | Mr. | Vinod Savaner | Scientific Assistant-E |
| **70.** | Mr. | Jaganmoy Biswas | Scientific Assistant-E |
| **71.** | Mr. | Rakesh Kumar Sah | Scientific Assistant-E |
| **72.** | Mr. | Layanta Behera | Scientific Assistant-E |
| **73.** | Smt. | Madhulika Sinha | Scientific Assistant-D (Library) |
| **74.** | Mr. | S. Thilakaraj Kumar | Scientific Assistant-E |
| **75.** | Mr. | C. K. Modak | Junior Engineer-E |
| **76.** | Mr. | Sachin Kumar | Junior Engineer-F |
| **77.** | Mr. | Manoj Kumar | Junior Engineer-F |
| **78.** | Mr. | B. K. Behera | Junior Engineer-E |
| **79.** | Mr. | Sharad Karwal | Junior Engineer-D |
| **80.** | Mr. | Ashish K. Deshmukh | Junior Engineer-D |
| **81.** | Mr. | Md. Ziaul Haque | Junior Engineer-C |
| **82.** | Mr. | Ms. M. Pal | Technician- K |
| **83.** | Mr. | K. Dey | Technician –K |
| **84.** | Mr. | Nitin Patil | Technician –K |
| **85.** | Mr. | D.H. Raju | Technician – H |

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|---|---|---|---|
| **86.** | Mr. | Prabir Kumar Das | Technician – J |
| **87.** | Mr. | Sanjay Srivastava | Technician – J |
| **88.** | Mr. | Ravindra P. Bhimgade | Technician-F |
| **89.** | Dr. | Ashish Upadhayaya | Administrative Officer –II |
| **90.** | Mr. | Rajeev Bhagwat | Administrative Officer –I |
| **91.** | Mr. | Devendra Singh | Administrative Officer –I |
| **92.** | Mr. | Pawan Kumar | Administrative Officer –I |
| **93.** | Mr. | Sourav Sarkar | Administrative Officer –I |
| **94.** | Mr. | Nariyan Kumar Lengay | Administrative Officer –I |
| **95.** | Mr. | Abhay Kumar Seth | PA (to Centre-Director) |
| **96.** | Ms. | Rupali Sahu | PA (to Centre-Director) |
| **97.** | Mr. | Kumud Narayan | PA (to Centre-Director) |
| **98.** | Mr. | Utpal Sarkar | Assistant-II |
| **99.** | Mr. | C.L. Dwivedi | Assistant –I |
| **100.** | Mr. | S.C. Chaudhury | Assistant –I |
| **101.** | Mr. | Lokesh Srivas | Assistant –I |
| **102.** | Mr. | Vishnu Kaushal | Clerk-Typist |
| **103.** | Ms. | Meenakshi Gupta | Clerk-Typist |
| **104.** | Ms. | Pranita Anant Bandarkar | Clerk-Typist |
| **105.** | Mr. | Bireswar Pradhan | Guest House Attendent |
| **106.** | Mr. | Arun Yadav | Driver |
| **107.** | Mr. | Joyanta Dhar | Driver |
| **108.** | Mr. | Dilip Kaushal | Driver-cum-Aux. Staff |
| **109.** | Mr. | Anil Rao Jadhav | Driver-cum-Aux. Staff |
| **110.** | Mr. | Namdev Suryavanshi | Driver |
| **111.** | Mr. | T. B. Thapa | Helper |
| **112.** | Mr. | Iqbal Hussain | Lab Attendent |
| **113.** | Mr. | Ram Chandra Baniya | Lab Attendent |
| **114.** | Mr. | Kapil Nayak | Lab Attendent |

| | | | |
|---|---|---|---|
| **115.** | Mr. | N.K. Reddy | Lab Attendent |
| **116.** | Mr. | Ram Chandra Maity | Lab Attendent |
| **117.** | Mr. | Prafulla Chandra Das | Aux. Staff |
| **118.** | Mr. | Nitin J. Patil | Attendent/Aux.Staff |
| **119.** | Mr. | B. R. Behra | Attendent |
| **120.** | Mr. | Manoj Kumar Sarwan | Attendent |
| **121.** | Mr. | Sushil Kumar Sharma | Attendent |
| **122.** | Mr. | Prakash Shinde | Attendent |
| **123.** | Mr. | Kamlesh Verma | Attendant/Aux.Staff |
| **124.** | Smt. | Shobha Yadav | Auxiliary Staff |

## 10.1 GOVERNING COUNCIL COMMITTEE (AS ON 31-MARCH-2023)

| S. NO. | POSITION | NAME | DESIGNATION |
|---|---|---|---|
| 1. | PRESIDENT CHAIRPERSON, UGC. | **Prof. M. Jagadesh Kumar** | Chairman, UGC, New Delhi |
| 2. | VICE-CHAIRPERSON, UGC. | **Prof. Deepak Kumar Srivastava** | Vice-Chairman, UGC, New Delhi. |
| 3. | CHAIRPERSON GOVERNING BOARD, UGC-DAE CSR. | **Dr. Anil Kakodkar** | Chairman, Rajiv Gandhi Science & Technology Commission Former Chairman, Atomic Energy Commission |
| 4. | SCERETARY, UGC. | **Prof. Manish R. Joshi** | Secretary, UGC, New Delhi |
| 5. | SECRETARY, DAE OR **NOMINEE**. | **Shri K. N. Vyas** | Chairman AEC & Secretary DAE, Mumbai. |
| 6. | VICE-CHANCELLOR, DA UNIVERSITY. | **Dr. Renu Jain** | Vice-Chancellor, DAVV, Indore. |
| 7. | DIRECTOR, BARC OR HIS **NOMINEE**. | **Dr. Ajit Kumar Mohanty** | Director, BARC, Mumbai. |
| 8. | DIRECTOR, CAT | **Dr. Shankar V. Nakhe** | Director, RRCAT, Indore. |
| 9. | DIRECTOR, VECC. | **Dr. Sumit Som** | Director, VECC, Kolkata. |
| 10. | ADVISOR (T), MHRD OR HIS NOMINEE. | **Shri Rakesh Ranjan** | IAS, Additional Secretary New Delhi. |
| 11. | SECRETARY, DST OR **NOMINEE**. | | |

| | | | |
|---|---|---|---|
| **12.** | DIRECTOR GENERAL, CSIR OR **NOMINEE.** | | |
| **13.** | DIRECTOR GENERAL, ICMR OR **NOMINEE**. | | |
| **14.** | DIRECTOR GENERAL, ICAR OR NOMINEE. | | |
| **15.** | CHAIRMAN, SAC, UGC-DAE CSR. | **Prof. S. Ramakrishnan** | Director, Tata Institute of Fundamental Research, Mumbai |
| **16.** | MEMBER SECRETARY, DIRECTOR, UGC-DAE CSR. | **Prof. Amlan J. Pal** | Director, UGC-DAE CSR, Indore. |
| **17.** | BUREAU HEAD (IUC), UGC. | **Dr. Jitendra Kumar Tripathi** | Joint Secretary & Bureau Head ( IUC) UGC, New Delhi. |
| **18.** | VICE CHANCELLOR OF UNIVERSITY OR DIRECTOR OF INSTITUTE OF HIGHER LEARNING & RESEARCH: NOMINATED BY PRESIDENT OF THE COUNCIL. | **Prof. Avinash C. Pandey** | Director, IUAC, New Delhi. |
| **19.** | VICE CHANCELLOR OF UNIVERSITY OR DIRECTOR OF INSTITUTE OF HIGHER LEARNING & RESEARCH: NOMINATED BY PRESIDENT OF THE COUNCIL. | **Prof. (Dr.) Arun Kumar Sarma** | Director General, NECTAR, New Delhi. |
| **20.** | DIRECTOR OF 1 IIT NOMINATED BY PRESIDENT OF COUNCIL. | **Prof. Abhay Karandikar** | Director<br>IIT, Kanpur. |
| **21.** | EMINENT SCIENTIST OF PHYSICAL SCIENCE NOMINATED BY PRESIDENT OF COUNCIL. | **Prof. Ratnesh Gupta** | Head, School of Instrumentation, DAVV, Indore. |
| **22.** | EMINENT SCIENTIST OF PHYSICAL SCIENCE NOMINATED BY PRESIDENT OF COUNCIL. | **Prof. Vir Singh** | Dept. of Physics, IIT, Roorkee.<br>- |

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|---|---|---|---|
| **23.** | AGRICULTURE SCIENTIST NOMINATED BY PRESIDENT OF THE COUNCIL. | **Dr. Anil Kumar Singh** | Former Deputy Director General, Indian Council of Agriculture Research, (ICAR) & Vice-Chancellor, Rajmata Vijayaraje Scindia Krishi Vishwavidyalaya, Gwalior. |
| **24.** | MEDICAL SCIENTIST NOMINATED BY PRESIDENT OF THE COUNCIL. | **Dr. Ulka Shrivastava** | Director, Medical Education, Govt. of M.P., Bhopal. |
| **25.** | SCIENTIST NOMINATED BY MHRD, GOI. | *Vacant* | - |
| **26.** | MEMBER OF UGC NOMINATED BY CHAIRPERSON OF UGC. | **Dr. Shivaraj** | Professor of Chemistry, Dean, Faculty of Science and Development & UGC Affairs, Osmania University. |
| **27.** | EMINENT SCIENTIST NOMINATED BY UGC. | **Dr. Rajendra Dobhal** | Director General, Uttarakhand State Council for Science and Technology & Scientific Advisor, Govt. of Uttarakhand, Dehradun. |
| **28.** | EMINENT SCIENTIST NOMINATED BY UGC. | **Prof. Shri Singh** | Distinguished Professor, Department of Physics, Banaras Hindu University, Varanasi. |

## 10.2 GOVERNING BOARD COMMITTEE (as on 31-MARCH-2023)

| S. NO. | POSITION | NAME | DESIGNATION |
|---|---|---|---|
| 1 | Chairperson appointed by President of Council. | **Dr. Anil Kakodkar** | Chairman, Rajiv Gandhi Science & Technology Commission, Former Chairman, Atomic Energy Commission. |
| **EX-OFFICIO MEMBERS:** | | | |
| 2 | SCERETARY, UGC. | **Prof. Manish R. Joshi** | Secretary, UGC, New Delhi |
| 3 | SECRETARY, DAE OR **NOMINEE**. | **Shri K. N. Vyas** | Chairman AEC & Secretary DAE, Mumbai. |
| 4 | VICE-CHANCELLOR, DA UNIVERSITY. | **Dr. Renu Jain** | Vice-Chancellor, DAVV, Indore. |
| 5 | DIRECTOR, BARC OR HIS **NOMINEE**. | **Dr. Ajit Kumar Mohanty** | Director, BARC, Mumbai. |
| 6 | DIRECTOR, CAT | **Dr. Shankar V. Nakhe** | Director, RRCAT, Indore. |
| 7 | DIRECTOR, VECC. | **Dr. Sumit Som** | Director, VECC, Kolkata. |
| 8 | ADVISOR (T), MHRD or his nominee; Jt Sec (Tech Education) {Deptt of Sec & Higher Edu. MHRD} | **Shri Rakesh Ranjan** | IAS, Additional Secretary New Delhi. |
| 9 | Chairman, SAC, UGC-DAE CSR | **Prof. S. Ramakrishnan** | Director, Tata Institute of Fundamental Research, Mumbai. |
| 10 | Member Secretary Director, UGC-DAE CSR. | **Prof. Amlan J. Pal** | Director, UGC-DAE CSR, Indore. |
| 11 | BUREAU HEAD (IUC), UGC. | **Dr. Jitendra Kumar Tripathi** | Joint Secretary & Bureau Head ( IUC) UGC, New Delhi. |
| **NOMINATED MEMBERS:** | | | |

| | | | |
|---|---|---|---|
| **12** | Member of UGC, nominated by Chairperson, UGC | **Dr. Shivaraj** | Professor of Chemistry Dean, Faculty of Science and Development & UGC Affairs Osmania University. |
| **13** | VICE CHANCELLOR OF UNIVERSITY OR DIRECTOR OF INSTITUTE OF HIGHER LEARNING & RESEARCH: NOMINATED BY PRESIDENT OF THE COUNCIL. | **Prof. Avinash C. Pandey** | Director, IUAC. |
| **14** | VICE CHANCELLOR OF UNIVERSITY OR DIRECTOR OF INSTITUTE OF HIGHER LEARNING & RESEARCH: NOMINATED BY PRESIDENT OF THE COUNCIL. | **Prof. (Dr.) Arun Kumar Sarma** | Director General, NECTAR, New Delhi. |
| **15** | DIRECTOR OF 1 IIT NOMINATED BY PRESIDENT OF COUNCIL. | **Prof. Abhay Karandikar** | Director IIT, Kanpur. |
| **16** | EMINENT SCIENTIST OF PHYSICAL SCIENCE NOMINATED BY PRESIDENT OF COUNCIL. | **Prof. Ratnesh Gupta** | Head, School of Instrumentation, DAVV, Indore. |
| **17** | EMINENT SCIENTIST OF PHYSICAL SCIENCE NOMINATED BY PRESIDENT OF COUNCIL. | **Prof. Vir Singh** | Department of Physics, IIT, Roorkee. |
| **18** | AGRICULTURE SCIENTIST NOMINATED BY PRESIDENT OF THE COUNCIL. | **Dr. Anil Kumar Singh** | Former Deputy Director General, ICAR & Vice-Chancellor, Rajmata Vijayaraje Scindia KrishiVishwavidyalaya, Gwalior. |
| **19** | MEDICAL SCIENTIST NOMINATED BY PRESIDENT OF THE COUNCIL. | **Dr. Ulka Shrivastava** | Director, Medical Education, Government of Madhya Pradesh, Bhopal. |
| **20** | SCIENTIST NOMINATED BY MHRD, GOI. | *Vacant* | - |

## 10.3 Finance Committee (as on 31-March-2023)

| Sl No. | Position | Name | Designation |
|---|---|---|---|
| **EX-OFFICIO and NOMINATED MEMBERS:-** | | | |
| 1 | Chairperson of Governing Board | **Dr. Anil Kakodkar** | Chairman, Rajiv Gandhi Science & Technology Commission Former Chairman, Atomic Energy Commission |
| 2 | Secretary, UGC | **Prof. Manish R. Joshi** | Secretary, UGC, New Delhi |
| 3 | Financial Advisor, UGC | **Shri P. K. Thakur** | Financial Advisor, UGC |
| 4 | Director, UGC-DAE CSR | **Prof. Amlan J. Pal** | Director, UGC-DAE CSR, Indore. |
| 5 | Bureau Head, PLAN Budget, UGC | **Dr. Jitendra Kumar Tripathi** | Joint Secretary & Bureau Head (IUC) UGC, New Delhi. |
| 6 | External Member **NOMINATED** by UGC | **Prof. V. K. Jain** | Vice-Chancellor, Tezpur University, Assam. |
| 7 | Member of GB, **NOMINATED** by Chairperson, GB | | |
| 8 | Centre-Director, Indore Centre of UGC-DAE CSR. | **Dr. Vasant Sathe** | C-D, Indore Centre of UGC-DAE CSR. |
| 9 | Centre-Director, Mumbai Centre of UGC-DAE CSR. | **Dr. P. D. Babu** | C-D, Mumbai Centre of UGC-DAE CSR. |
| 10 | Centre-Director, Kolkata Centre of UGC-DAE CSR. | **Dr. S. S. Ghugre** | C-D, Kolkata Centre of UGC-DAE CSR. |
| 11 | Bureau Head (IUC), UGC. | **Dr. Jitendra Kumar Tripathi** | Joint Secretary & Bureau Head (IUC) UGC, New Delhi. |
| 12 | A.O. of the Consortium, **NOMINATED** by the Director as non-member Secretary. | **Dr. Ashish Upadhayaya** | A.O.-II, UGC-DAE CSR |

## 10.4 Scientific Advisory Committee (as on 31-March-2023)

**Chairman:**
Prof. S. Ramakrishnan
Director, Tata Institute of Fundamental Research, Mumbai.

**Nominated Members:**

(i) Dr. Karuna Kar Nanda
Director, Institute of Physics, Bhubaneswar

(ii) Dr. R. Divakar
Group Director, Materials Science Group and Metallurgy & Materials Group,
IGCAR, Kalpakkam

(iii) Prof. Satyajit Saha
DAE Raja Ramanna Fellow
Saha Institute of Nuclear Physics, Kolkata

(iv) Prof. S.V. Chiplunkar
Former Director, ACTREC, Tata Memorial Centre, Kharghar, Navi Mumbai

(v) Prof. D. Narayana Rao
DAE Raja Ramanna Fellow and UGC BSR Faculty Fellow,
School of Physical Sciences, Central University of Hyderabad, Hyderabad

(vi) Prof. K. G. Suresh
Department of Physics, IIT Bombay, Mumbai

**Ex-officio members:**
Director BARC, Mumbai
Director, RRCAT, Indore
Director, VECC, Kolkata
Centre Director, Indore Centre
Centre Director, Mumbai Centre
Centre Director, Kolkata Centre

**Invited member:** Scientist-in-Change, Kalpakkam Node

**Ex-officio Member Secretary:** Director, UGC-DAE CSR

# 10.5 Users' Committees

## Indore Centre

| | | |
|---|---|---|
| 1. | Director, UGC-DAE CSR | **Chairman** |
| 2. | Centre Director, UGC-DAE CSR Indore Centre | **Convener** |
| 3. | Dr. Tarun K. Sharma<br>Scientific Officer-H, Head Materials Science Section<br>RRCAT, Indore | Member |
| 4. | Dr. Mukesh P. Joshi<br>Scientific Officer-H,<br>Head Photonics Nanomaterials lab<br>RRCAT, Indore | Member |
| 5. | Prof. Ashutosh Mishra<br>School of Physics<br>Devi Ahilya Vishwavidyalaya, Indore | Member |
| 6. | Prof. Prabhat Mandal<br>Condensed Matter Physics Division<br>Saha Institute of Nuclear Physics<br>Salt Lake, Kolkata 700064 | Member |
| 7. | Prof. Subham Majumdar<br>School of Physical Sciences<br>Indian Association for the Cultivation of Science<br>Kolkata 700032 | Member |
| 8. | Prof. Sanjay Daga Dhole<br>Department of Physics<br>S.P. Pune University, Pune | Member |

## Kolkata Centre

| | | |
|---|---|---|
| 1. | Director, UGC-DAE CSR | **Chairman** |
| 2. | Centre Director, UGC-DAE CSR Kolkata Centre | **Convener** |
| 3. | Dr. Paramita Mukherjee<br>Head, Radiation Damage Studies Section &<br>Material Science Studies Division<br>VECC Kolkata | Member |
| 4. | Dr. Vaishali Naik<br>Head, Radioactive Ion Beam Facilities Group<br>VECC Kolkata | Member |
| 5. | Prof. Mitali Chatterjee<br>Department of Pharmacology<br>Institute of Postgraduate Medical Education &<br>Research (IPGMER), Kolkata | Member |
| 6. | Prof. Syamal Roy<br>Indian Institute of Chemical Biology<br>Kolkata | Member |
| 7. | Prof. Tarakdas Basu<br>Department of Biochemistry & Biophysics<br>University of Kalyani | Member |
| 8. | Prof. Saurav Giri<br>School of Physical Sciences<br>Indian Association for the Cultivation of Science<br>Kolkata 700032 | Member |

## Mumbai Centre

| | | |
|---|---|---|
| 1. | Director, UGC-DAE CSR | **Chairman** |
| 2. | Centre Director, UGC-DAE CSR Mumbai Centre | **Convener** |
| 3. | Dr. V. K. Aswal<br>SO/H, Head, Mesoscopic & Small Angle Scattering Section<br>Solid State Physics Division, Bhabha Atomic Research Centre | Member |
| 4. | Shri P. S. R. Krishna<br>SO/H<br>Solid State Physics Division, Bhabha Atomic Research Centre | Member |
| 5. | Prof. Satyabrata Patnaik<br>School of Physical Sciences<br>Jawaharlal Nehru University, New Delhi | Member |
| 6. | Prof. A.V. Mahajan<br>Department of Physics<br>IIT Bombay, Mumbai | Member |
| 7. | Prof. K.R.S. Priolkar<br>School of Physical and Applied Sciences<br>Goa University, Goa | Member |
| 8. | Prof. Kaloboran Maiti<br>Department of Condensed Matter Physics & Materials Science<br>Tata Institute of Fundamental Research<br>Mumbai 400005 | Member |

## 11. Balance Sheet

### UGC-DAE CORSORTIUM FOR SCIENTIFIC RESEARCH, INDORE
### BALANCE SHEET AS ON 31-3-2023

| Source of Funds | Schedule | Current Year | Previous Year |
|---|---|---|---|
| Capital Fund | 1 | 1,36,64,72,600.51 | 1,36,86,51,922.85 |
| Designated/Earmarked Fund | 2 | 5,32,54,686.30 | 5,08,81,566.99 |
| Current Liabilities & Provisions | 3 | 25,58,00,483.11 | 25,21,77,478.35 |
| **Total** | | **1,67,55,27,769.92** | **1,67,17,10,968.19** |
| **Application of Funds** | | | |
| Fixed Assets | 4 | | |
| Tangible Assets | | 1,04,39,42,299.54 | 1,10,07,78,457.24 |
| Intangible Assets | | 1,82,11,794.07 | 1,61,78,384.97 |
| Capital Work-in-progress | | 27,09,40,000.00 | 22,42,74,032.00 |
| Investments from Earmarked/ Endowement Funds | 5 | | |
| Long Term | | 5,23,12,358.00 | 5,01,91,474.00 |
| Short Term | | - | - |
| Investments - Others | 6 | 24,42,33,507.43 | 24,34,44,699.24 |
| Current Assets | 7 | 4,58,87,810.88 | 3,68,43,920.74 |
| Loans, Advances & Deposits | | | |
| **Total** | | **1,67,55,27,769.92** | **1,67,17,10,968.19** |
| Notes on Accounts | 20 | | |

As per our report of even date attached
For V K Dafaria & Co.
Chartered Accountants
FRN 000021C

27/6/2023

Administrative Officer-II
UGC-DAE CSR University Campus
Khandwa Road, INDORE

Director
UGC-DAE CSR University Campus
khandwa Road, INDORE (M.P.)

(CA Sohit Kotadia)
Partner
M.No.425132
UDIN: 23425132BGYUYI9420

## UGC-DAE CONSORTIUM FOR SCIENTIFIC RESEARCH, INDORE
### INCOME AND EXPENDITURE ACCOUNTS FOR THE YEAR ENDED 31-03-2023

| Particulars | Schedule | CURRENT YEAR | | | Previous year Total |
|---|---|---|---|---|---|
| | | CAPITAL HEAD | REVENUE HEAD | TOTAL | |
| **Income** | | | | | |
| Grants/Subsidies | 8 | 6,07,86,271.18 | 37,78,60,929.59 | 43,86,47,200.77 | 42,29,34,625.32 |
| Income from Investments | 9 | 1,102.00 | - | 1,102.00 | - |
| Interest Earned | 10 | - | - | - | - |
| Other Income | 11 | - | - | - | - |
| Prior Period Income | 12 | - | - | - | - |
| **Total (A)** | | **6,07,87,373.18** | **37,78,60,929.59** | **43,86,48,302.77** | **42,29,34,625.32** |
| **Expenditure** | | | | | |
| Staff Payments & Benefits | 13 | - | 35,26,83,686.00 | 35,26,83,686.00 | 26,54,28,100.00 |
| Academic Expenses | 14 | - | 73,10,873.92 | 73,10,873.92 | 84,23,458.72 |
| Administrative and General Expenses | 15 | - | 4,92,74,726.52 | 4,92,74,726.52 | 4,79,40,532.32 |
| Transportation Expenses | 16 | - | 11,39,990.00 | 11,39,990.00 | 11,01,024.00 |
| Repairs & Maintenance | 17 | - | 3,14,80,747.15 | 3,14,80,747.15 | 1,98,31,848.16 |
| Depreciation | 4 | 9,23,46,129.89 | 13,32,402.91 | 9,36,78,532.80 | 9,77,58,162.62 |
| Other Expenses | 18 | 6,12,23,291.65 | 1,90,379.71 | 6,14,13,671.36 | 7,57,60,013.12 |
| Prior Period Expenses | 19 | 91,376.28 | - | 91,376.28 | - |
| **Total (B)** | | **15,36,60,797.82** | **44,34,12,806.21** | **59,70,73,604.03** | **51,62,43,138.94** |
| Balance being excess of Income over Expenditure (A-B) | | (9,28,73,424.64) | (6,55,51,876.62) | (15,84,25,301.26) | (9,33,08,513.62) |
| Transfer to/from Designated fund | | | | | |
| a) CRS Fund | | - | - | - | - |
| b) Capital Fund | | - | - | - | - |
| c) Building Fund | | - | - | - | - |
| d) Others (General Fund) | | (6,058.66) | (6,41,66,896.86) | (6,41,72,954.92) | 42,98,646.43 |
| e) Corpus Standing Fund | | - | - | - | - |
| **Balance being surplus (Deficit) Carried to Capital Fund** | | **(9,28,67,366.58)** | **(13,84,979.76)** | **(9,42,52,346.34)** | **(9,76,07,160.05)** |
| Notes on Accounts | 20 | | | | |

Administrative Officer-II
UGC-DAE CSR University Campus
Khandwa Road, INDORE

Director
UGC-DAE CSR University Campus
Khandwa Road, INDORE (M.P.)

For V K Dafaria & Co.
Chartered Accountants
FRN 000021C

(CA Sohit Kotadiya)
Partner
M.No.425124
UDIN: 23425132BGXUY16420

# सीएसआर उपयोगकर्ताओं के भौगोलिक वितरण का मानचित्र



**संकलनकर्ता:**

डॉ. राजीव रावत, डॉ. सौविक चटर्जी, डॉ. सुजय चक्रवर्ती, डॉ. एस डी कौशिक, डॉ. आर वेंकटेश

**Compiled by:**

Dr . Rajeev Rawat, Sr. Souvik Chatterjee, Dr. Sujay Chakravarty, Dr. S. D. Kaushik, Dr. R. Venkatesh