ANNUAL REPORT
2019-20

Institute of Nano Science and Technology

An Autonomous Institute supported by
Department of Science and Technology, Government of India

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FROM THE DESK OF DIRECTOR

I feel privileged to get an opportunity for being part of the Institute of Nano Science and Technology (INST), Mohali (Punjab), which has been set up by Government of India with a vision to pursue excellence in nanoscience and nanotechnology to further translate technologies for the societal benefits.

INST has attracted bright and young researchers who lead vibrant research programs, pushing the frontiers of basic and applied sciences. Thus, the institute nurtures cutting-edge research in various directions of nanoscience with an interdisciplinary overlap. It's a matter of pride to inform you that being a relatively smaller institute comprising of 36 faculty members, the publications per faculty is increasing progressively. The institute encourages its scientists to publish their research in peer reviewed international high impact journals which is reflected in their recent publication record in reputed journals such as Energy and Environment Science, Nature Communication, Nano Letters, ACS Nano, JACS etc. The total no of publications along with average impact factors continue to take strides with 2019 endowing us 104 publication (average impact factor 4.9). Thus, we are glad to have ranked higher in nature index 2020 with overall rank of 39. With such pace, I am sure INST will feature soon in top 25 in the coming years.

Technology development is an integral part of INST's mandate; being a relatively newer institute with dynamic faculty members INST has associated itself with a number of industrial partners and I am sure such activities will increase further to develop indigenous technologies to India's benefit. Last seven years, INST has witnessed major breakthroughs in several areas of therapeutics and energy related technologies. Recently, INST has developed several technologies such as: a cost-efficient and scalable method for graphene based integrated on-chip micro supercapacitor, which is a miniaturized electrochemical storage device; a 'Nano-Spray Gel' that could be administered on-site for treatment of frostbite injuries and heal the wound; a novel low cost topical haemostatic device to address uncontrolled bleeding, purification devices for water and air respectively. An interesting example includes the development of low-cost electro-catalyst from fish gills to develop environmentally friendly rechargeable zinc-air batteries. The research direction in hotspot engineering has also met huge success for the development

of a hybrid SERS platform of MoS2 nanostructure. Extensive efforts have also been driven to discover novel nano therapy for retardation of several cancer progression. The scientists in INST also extend their hand to find out a solution for industrial friendly nanotechnology based low cost production method for anti-epileptic drug. We are also keen to address the societal issues to facilitate the quick and easy detection of nicotine in air by developing a metal-organic nanotube.

At the academic front also, the institute is progressing well. Our first batch of students have started graduating and many are being placed in reputed universities across the globe. The talent and the energy of our students need to be nurtured, shaped and channelled in the right directions. Our combined efforts would bring out not only the best in their careers, but the best in their lives too.

In a short span of seven years, INST has been truly instrumental in creating state-of-the-art facilities to support multi-faceted research activities to develop a strong platform for nanotechnology based innovation in the diverse domains of energy, environment, agriculture, nanotherapeutics, sensor, diagnostics and quantum materials etc.

I am happy that INST community has been successfully working towards establishing their role as a leading Research and Development Organization of the country that plays an important role in addressing the societal needs and contribute to the nation through providing nanotechnology based knowledge and solutions to the energy, environment and health sector.

The upcoming state-of-the-art campus covering 35 acres is almost ready and 1st phase of the shifting of various laboratories has already started.

Now, it is high time to thank all the employees for their cooperation and dedicated efforts in accomplishing the set targets and for their dedication for innovation. I would like to place on record the continuous support provided by DST and the key role played by the Board Of Governors (BoG), Research and Academic Advisory Council (RAAC), Finance Committee and especially members of Building Works Committee (BWC), who has put all their effort in making all the thing in one places for building a new campus, in providing the right policy support, encouragement and guidance. The contributions of various committee members in steering the R&D programmes in the right direction are noteworthy.

I am quite confident that the institute with its continued efforts will evolve as one of the leading research institutes in the area of nanoscience and nanotechnology recognized globally, where efforts in research will ultimately translate to society.

I wish my INST family all the very best.

Prof. Amitava Patra
Director

VISION, MISSION & OBJECTIVES

Vision

To emerge as a globally competitive India's foremost research institutions in Nano Science and Technology and to contribute to the society through applications of nanoscience and nanotechnology in the field of agriculture, medicine, energy and environment.

Core Objectives

- To advance knowledge and educate young minds in nano science and technology that will best serve the nation.
- Impart advanced training courses and laboratory techniques of nanotechnology at the highest level.
- Encouraging innovative and challenging technology/ product based scientific projects.
- Boosting translational research (from laboratory to industry) and foster interactions with industry
- Sensitizing public and media about the advantages and safeguards in Nano Science and Technology

Mission

To be a world class research institution by carrying out cutting-edge research through outstanding scientists from different branches of science and engineering, encouraging them to carry out their individual scientific research to be published in the best journals along with their mandate to jointly work on interdisciplinary projects to develop devices/technologies based on nano science and technology. To encourage all aspects of nanoscience and nanotechnology with major thrust on the following areas: agricultural nanotechnology, sensors, medical nanotechnology, nanotechnology based solutions for energy and environment. The ultimate goal is to make a difference to society through nanoscience and technology.

KEY COMMITTEES

BOARD OF GOVERNORS (BoG)

CHAIRPERSON	
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MEMBERS	
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PROF. BANSI DHAR MALHOTRA Department of Biotechnology Delhi Technological University, Shahbad Daulatpur, Main Bawana Road, Delhi-110042	**PROF. SHANTIKUMAR V. NAIR** **Director** Amrita Centre for Nanosciences and Molecular Medicine Amrita Institute of Medical Sciences and Research Centre, Elamakkara, Kochi-682026
PROF. K. S. NARAYAN Professor Jawaharlal Nehru Centre for Advanced Scientific Research Jakkur, Bangalore-560064. Karnataka	**DR. TATA NARASINGA RAO** Scientist 'G' & Associate Director International Advanced Research Centre for Powder Metallurgy & New Materials (ARCI) Balapur P.O. Hyderabad -500005
PROF. KISHORE M PAKNIKAR Director (officiating) Nanobioscience Agharkar Research Institute Gopal Ganesh Agharkar Road Pune-411004, Maharashtra	**SH. ALOK SHEKHAR, IAS** Principal Secretary to Govt. of Punjab Department of Science, Technology & Environment, Room No. 519, 5th Floor, Mini Secretariat, Kendriya Sadan, Sector 9, Chandigarh **(ex-officio)**
DR. JATINDER KAUR ARORA **Executive Director** Punjab State Council for Science & Technology MGSIPA Complex (2nd Floor), Sector –26 Chandigarh – 160 019 **(ex-officio)**	**PROF. J. GOWRISHANKAR** **Director** Indian Institute of Science Education & Research (IISER) Sector 81, SAS Nagar Mohali – 140 306 **(ex-officio)**
PROF. AMITAVA PATRA **Director** Institute of Nano Science and Technology Habitat Centre, Sector 64, Phase-X, Mohali-160062 **(ex-officio)**	**Chief Finance & Administrative Officer** Institute of Nano Science and Technology Habitat Centre, Sector 64, Phase-X Mohali-160062 **Member-Secretary (ex-officio)**

RESEARCH AND ACADEMIC ADVISORY COUNCIL (RAAC)

Chairperson

Prof. K. N. Ganesh
Director, IISER, Tirupati

Members:

1. **Prof. Vijaymohan K Pillai**
   Director, CSIR-CECRI, Karaikudi
2. **Prof. Anand K Bachhawat**
   IISER, Mohali
3. **Dr. P. S. Anil Kumar**
   IISc, Bangalore
4. **Prof. Umesh V. Waghmare**
   JNCASR, Bangalore
5. **Prof. Amitava Patra**
   Director, INST, Mohali
6. **Dr. Jatinder K Arora**
   Executive Director
   Punjab State Council for Science & Technology (PSCST)
7. **Dr. Prakash P. Neelakandan**
   Member-Secretary, INST, Mohali

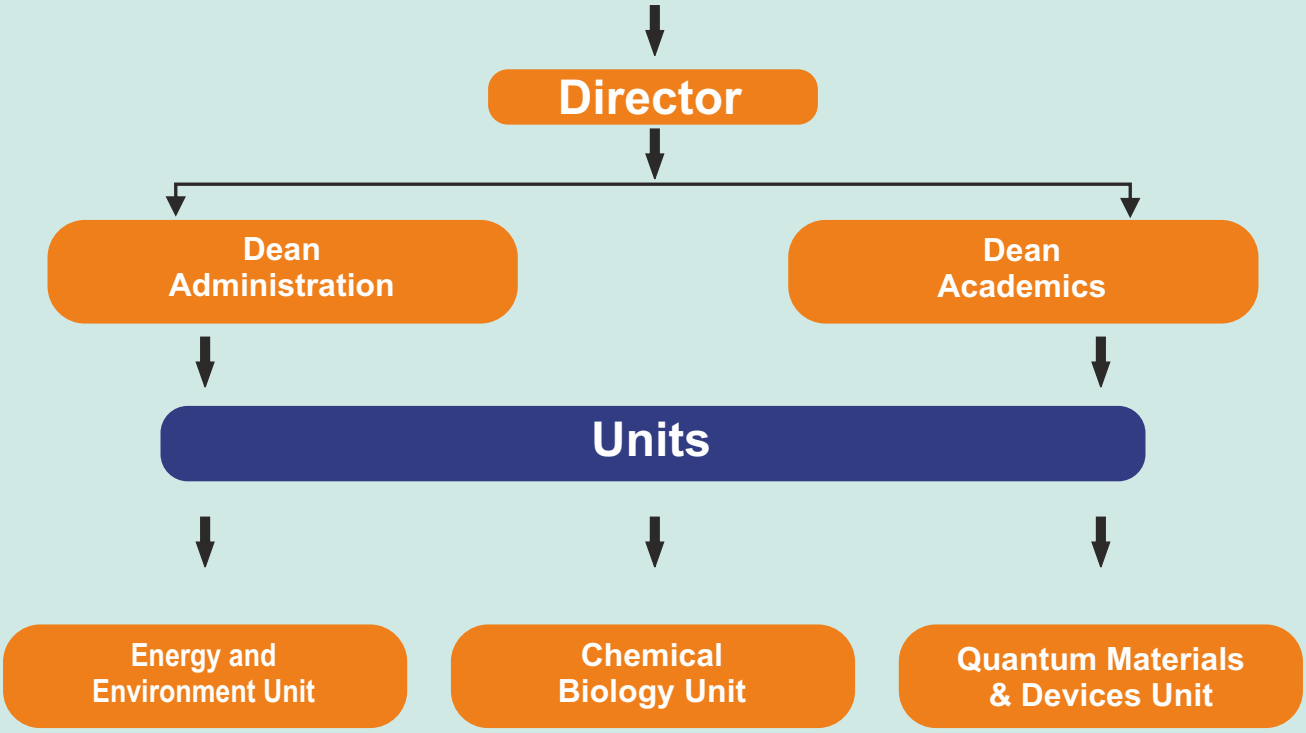
BUILDING WORKS COMMITTEE (BWC)	FINANCE COMMITTEE
Chairperson Prof Amitava Patra Director, INST, Mohali	**Chairperson** Prof. D. D. Sarma Professor IISc, Bangalore
Members:	**Members:**
1. Shri A. K. Jain Former Spl. DG, CPWD	**1. Prof. Amitava Patra** Director, INST, Mohali
2. Shri K N Rai Fmr Chief Executive, DRDO, New Delhi	**2. Finance Advisor** DST, New Delhi
3. Shri Sabyasachi Roy Senior Consultant, Projects & Construction, Delhi	**3. Chief Finance & Administrative Officer,** INST, Mohali
4. Head (AI Cell) DST or his/her nominee, New Delhi-110016	**4. Head (AI)** DST, New Delhi
5. Shri Madan Sharma Superintending Engineer, CSIO, Sector-30 Chandigarh	**5. Mrs. Vibha Mehta** Member - Secretary INST, Mohali
6. Chief Finance & Administrative Officer Institute of Nano Science & Technology	
7. Shri Niranjan Singh Member Secretary Consultant (Engineering) INST, Mohali	

नैनो विज्ञान एवं प्रौद्योगिकी संस्थान

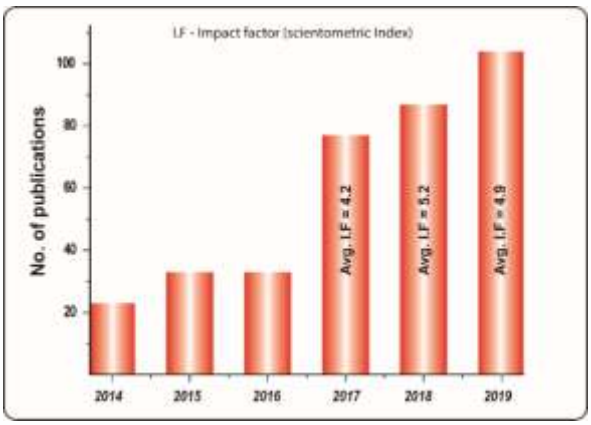
INST

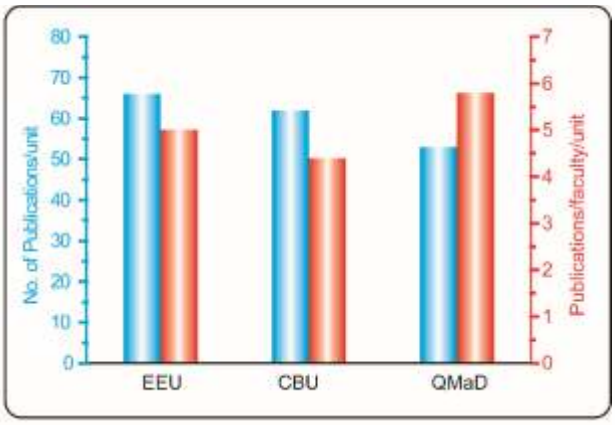
Institute of Nano Science and Technology

INST Organisational Chart

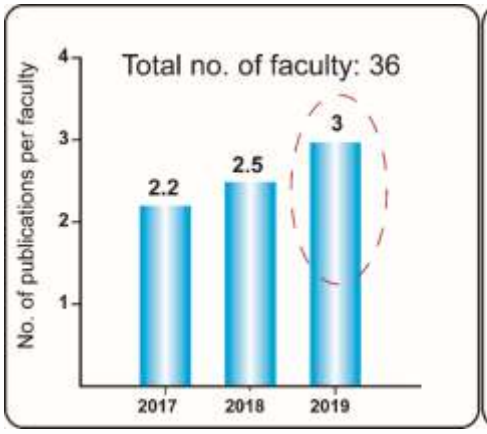


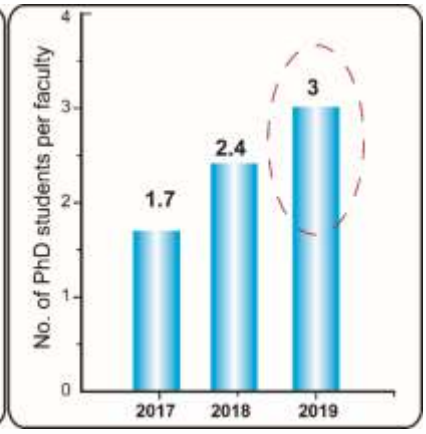
RESEARCH OUTPUT AT A GLANCE





- The quality of publications improve
- Number of publications/faculty is going up
- One student = 1 publication in last 3 years
- All units are performing excellent
- Significant amount of Intra-INST Collaborations
- EEU = Energy Environment Unit, CBU = Chemical Biology Unit, QMaD = Quantum Materials and Devices Unit





Source: https://www.natureindex.com/annual-tables/2020/institution/all/all

Prof. Amitava Patra
Director INST

Energy and Environment Unit

E E U

Dr. Debabrata Patra

Prof. Hirendra N. Ghosh

Dr. Jayamurugan Govindasamy

Prof. Kamalakannan Kailasham
Head of Unit

Dr. Menaka Jha

Dr. Monika Singh

Dr. Prakash P. Neelakandan

Dr. Ramendra Sundar Dey

Dr. Sanyasinaidu Boddu

Dr. Sonalika Vaidya

Dr. Tapasi Sen

Dr. Vivek Bagchi

Energy and Environment Unit, INST

Nanoporous organic frameworks

Metal Organic Frameworks (MOFs), Covalent Organic Frameworks (COFs), Porous Organic Frameworks (POFs) Covalent Triazine Frameworks (CTFs) and Heptazine-based microporous polymers (HMPs)

Nanostructured materials such as metal oxides, carbide, fluorides, phosphates, phosphides, transition metal chalcogenides, carbon nitrides; Nanocarbon-based hybrid materials

Photoresponsive soft nanomaterials, supramolecular polymers, Self-powered supramolecular assemblies, Emulsion based catalytic microcapsules; plasmonic nanostructures based on DNA origami; Polymer tagged nanoparticles

Functional Materials

Applications

Energy Conversion:

Hydrogen Evolution Reaction (HER), Oxygen Reduction Reaction (ORR), Oxygen Evolution Reaction (OER), PEMFC.

Energy Storage:

Renewable energy, hybrid supercapacitor with battery or biofuel cells, rechargeable metal-air batteries; Gas storage applications

Environmental Remediation:

Air/Water purification, Waste to Valuable Product; Recycling the electronic wastes into nanomaterials for various energy related applications.

Solar cell Applications:

Solar cell fabrication, Decay dynamics, energy and electron transfer in nanoparticles, clusters and QDs.

Catalysis:

Catalytic organic transformations; CO2 conversion to metal and organic carbonates.

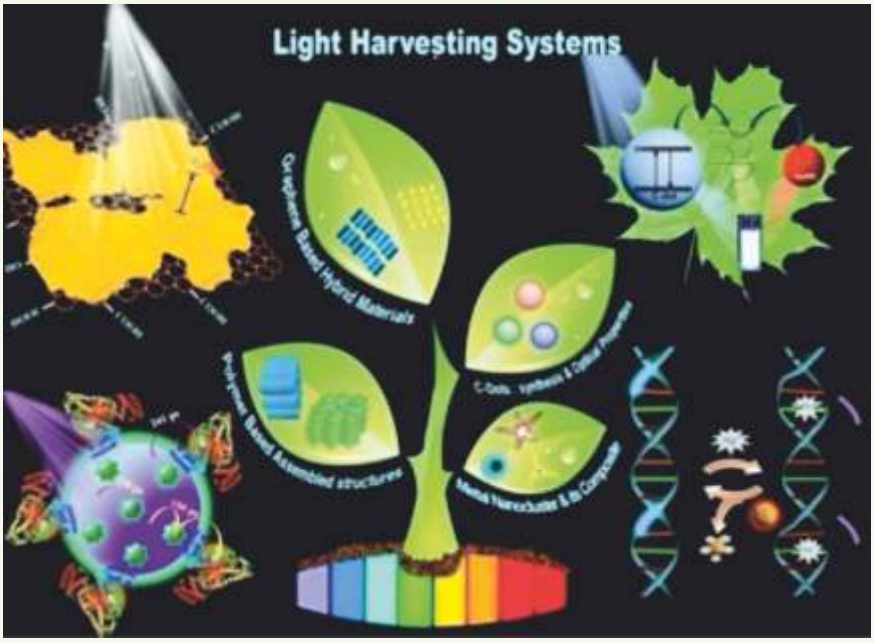
Sensing:

Applications in sensing, organic electronics, nanotherapeutics and chemical biology; single-molecule fluorescence spectroscopy

1. Prof. Amitava Patra, Director (On lien from IACS)

Research Activities/Highlights:

Our research focuses on Physical Chemistry and Chemical Spectroscopy of light harvesting nanomaterials, most especially in the subarea of carrier relaxation dynamics, energy transfer, electron transfer and charge transfer of quantum dots, Au nanoparticles, Au clusters, C-dots, semiconducting polymer, 2D materials and porphyrin-based luminescent nanoparticles, and up- and down- converted luminescent materials for photonics and biophotonics applications.



Significant Achievements:

Joined as Director, INST on 11th March, 2020.

Selected Publications: (from IACS-Kolkata)

1. Maity, S.; Bain, D.; Patra, A. An Overview on Current Understanding of Photophysical Properties of Metal Nanoclusters and their Potential Applications, *Nanoscale*, **2019**, *11*, 22685 – 22723 (Invited Review Article).
2. Ghosh, S.; Ghosh, A.; Jana, B.; Patra, A. Ultrafast Energy Flow Dynamics in Conjugated Polymer Based Host-Guest Light Harvesting System, *J. Phys. Chem. C* **2019**, *123*, 26727−26734.
3. Bera, R.; Chakraborty, S.; Nayak, S. K.; Jana, B.; Patra, A. Structural Insight and Ultrafast Dynamics of 2D-Porphyrin Nanostructures, *J. Phys. Chem. C* **2019**, *123*, 15815−15826.
4. Maity, S.; Bain, D.; Patra, A. Engineering Atomically Precise Copper Nanoclusters with Aggregation Induced Emission, *J. Phys. Chem. C* **2019**, *123*, 2506−2515.
5. Bain, D.; Maity, S.; Patra, A. Opportunities and Challenges in Energy and Electron Transfer of Nanoclusters based Hybrid Materials and their Sensing Applications, *Physical Chemistry Chemical Physics*, **2019**, *21*, 5863 – 5881 (Perspective, invited).

No of PhD/Postdoc/intern students (at IACS):

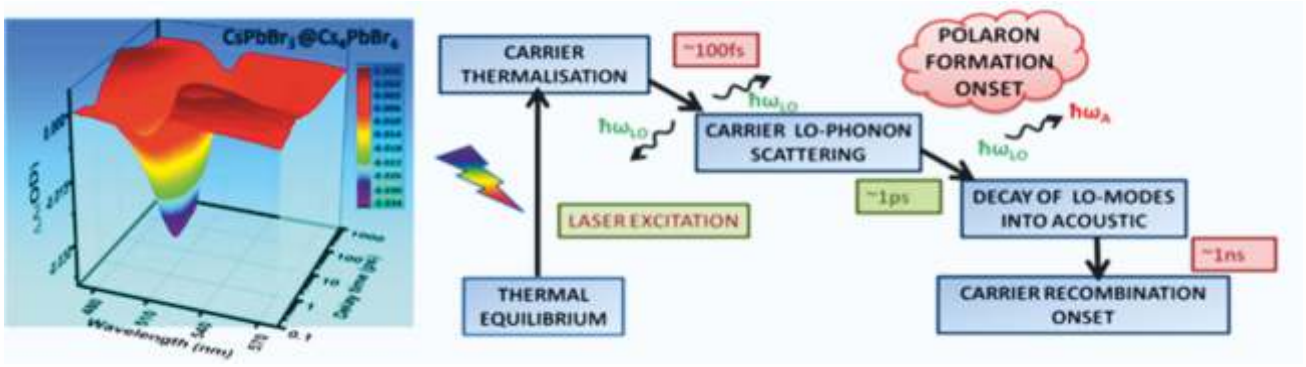
PhD Students - **10**, Post doc - **1**, Intern students – **1**

2. Prof. Hirendra Nath Ghosh, Scientist-G

Research Activities/Highlights:

Ultrafast Charge Carrier Dynamics of Solar Energy and Photodetector Materials which includes novel semiconductor quantum dots, metal and semiconductor plasmonic materials, 2D transition metal di-chalcogenides (TMD) and perovskite materials.

- Demonstrated deceleration of carrier cooling rate in CsPbBr3 NCs by providing a shell of Cs4PbBr6 over the core CsPbBr3 NCs due to the stimulation of the polaron formation process.
- Demonstrated longer charge carrier lifetime in Cu2CdSnS4 (CCTS) as compared to Cu2ZnSnS4 (CZTS) nanocrystal, establishing detail insights into enhancement of the photocurrent in Cd-substituted CZTS devices.
- Demonstrated hot carrier thermalization dynamics in near infrared active semiconductor (Cu2-xS) plasmonics nanocrystals and determined hole-phonon coupling constant.



2D contour plot of indicative polaron formation in 0d/3D $CsPbBr_3$@Cs_4PbBr_6 core-shell and schematic diagram of carrier relaxation dynamics coupled with growth and decay of longitudinal optical (LO) phonon.

Significant Achievements:

Polaron-mediated slow carrier cooling dynamics in CsPbBr3@Cs4PbBr6 core–shell perovskite system has been demonstrated.

- Ultrafast trion formation dynamics in 2D MoS_2 monolayer demonstrated for the first time.
- Heat generation of $Cu_{2-x}S$ plasmonic semiconductor NCs found to be one order less as compared to that of metallic system which can be used for efficient optoelectronic devices.

Selected Publications:

1. Goswami, T.; Rani, R.; Hazra, K. S.; and Ghosh, H. N. Ultrafast Carrier Dynamics of the Exciton and Trion in MoS_2 Monolayers Followed by Dissociation Dynamics in Au@MoS_2 2D Heterointerfaces. *J. Phys. Chem. Lett.* ***2019***, *10,* 3057.
2. Kaur,G.; Babu, K. J.; Ghorai,N.; Goswami, T.; Maiti, S. Ghosh, H. N. Polaron Mediated Slow Carrier Cooling in Type-1 3D/0D $CsPbBr_3$@Cs_4PbBr_6 Core-Shell Perovskite System. *J. Phys. Chem. Lett.* **2019***, 10*, 5302.
3. Debnath, T.*;* Ghosh, H. N. Ternary Metal Chalcogenides: into the Exciton and Bi-exciton Dynamics. *J. Phys. Chem. Lett. (Perspective)* ***2019***, *10,* 6227.

No of PhD/Postdoc/intern students:

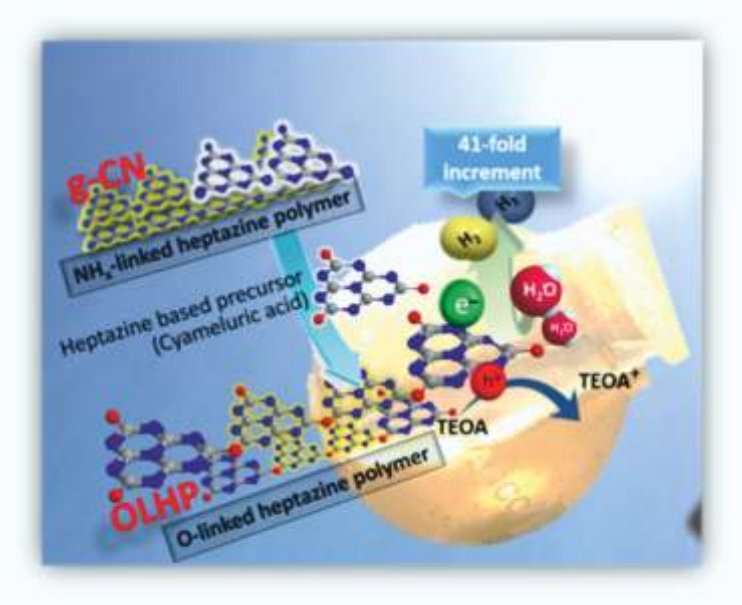
PhD Students - **7**, Post doc - **2**, Intern students – **2**

3. Prof. Kamalakannan Kailasam, Scientist-F/Professor

Research Activities/Highlights*:*

Advanced Functional Nanomaterials: Energy and Environmental Applications like Photocatalytic Water Splitting, Biomass Conversion to Fine Chemicals Production, Gas Storage & Conversion and Humidity & VOC sensing using Heptazine based Carbon Nitride Polymers and Metal Oxide Nanostructures.

- An oxygen linked Heptazine polymer (OLHP) was developed for the first time.
- Cyameluric acid was explored as polymer precursor for the first time
- Improved charge separation compared g-CN was observed.
- 41 times higher hydrogen evolution rate was observed compared to g-CN.



Significant Achievements:

- A true oxygen linked heptazine based carbon nitrides (OLHPs) were reported for the first time. The significance of the work is OLHPs are prepared from heptazine based single molecular precursor, which reduces the defects in the final carbon nitride polymer.
- Metal-free visible light photocatalytic carbon nitride quantum dots as efficient antibacterial agents were applied for the first time. The antibacterial activity is comparable to widely used Ag-nanoparticles.

Selected Publications:

1. Battula, V. R.; Jaryal, A.; Kailasam, K. Visible light-driven simultaneous H2 production by water splitting coupled with selective oxidation of HMF to DFF catalyzed by porous carbon nitride. *J. Mater. Chem. A* **2019**, *7*, 5643.
2. Battula, V. R.; Sunil Kumar, Chauhan, D. K.; Samanta, S.; Kailasam, K. A true oxygen-linked heptazine based polymer for efficient hydrogen evolution. *Applied Catalysis B: Environmental*, **2019**, *244*, 313.
3. Yadav, P.; Zhang, C.; Whittaker, A. K.; Kailasam, K.; Shanavas, A. Magnetic and photocatalytic curcumin bound carbon nitride nanohybrids for enhanced glioma cell death. *ACS Biomater. Sci. Eng.* **2019**, *5*, 6590.

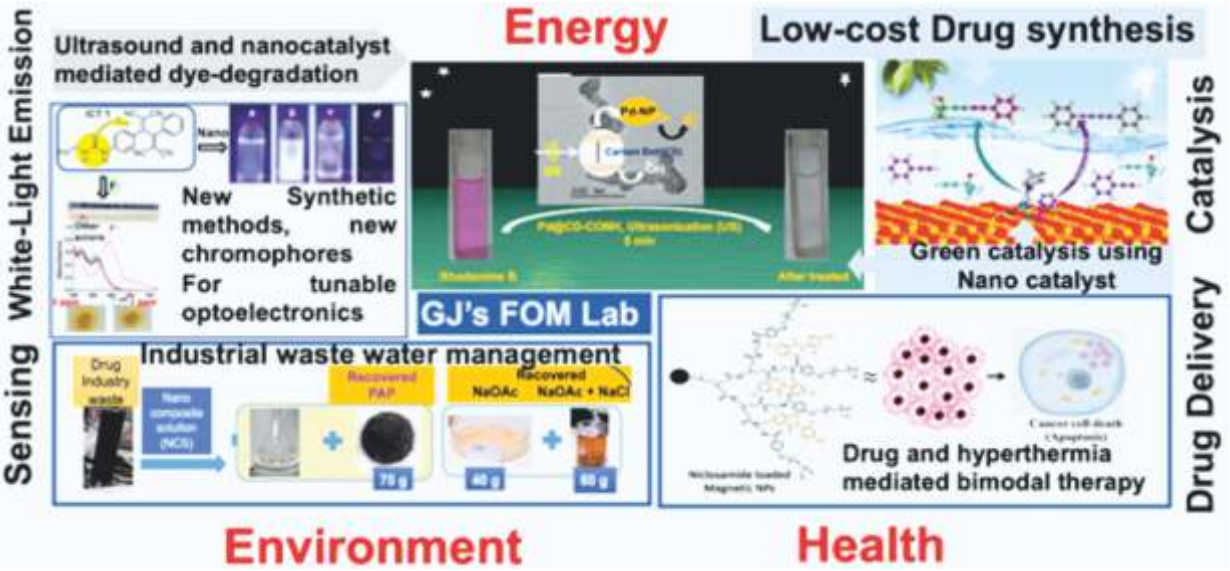
No of PhD/Postdoc/intern students:

PhD students - **6**; Project Fellows- **2** and Postdoc- **2**

4. Dr. Jayamurugan Govindasamy, Scientist-E/Associate Professor

Research Activities/Highlights:

- Polymer chemistry, Catalysis, Functional organic (nano) materials for optoelectronics, sensing, drug delivery, health and environmental applications.
- Highly efficient and selectivity tuneable green catalysts for Glaser and Click reactions.
- Customized nanocarriers for drug and pesticide delivery.
- Industrial friendly, low-cost, scalable process for the antiepileptic drug 'Rufinamide'
- Urea based push-pull chromophores for white-light emission and colorimetric sensing of biologically relevant fluoride ion



Significant Achievements:

- New push-pull chromophores and their role in remarkable white-light emission property
- A self-sustainable technology with zero waste for treatment of paracetamol industrial effluent.
- Polymer-coated Nano catalyst was developed for the production of rufinamide drug's intermediate, which is highly efficient, economical, scalable and eco-friendly.

Selected Publications:

1. Dar, A. H.; Gowri, V.; Gopal, A.; Muthukrishnan, A.; Bajaj, A.; Sartaliya, S.; Selim, A.; Ali, M. E.; Jayamurugan, G. Designing of Push-Pull Chromophores with Tunable Electronic and Luminescent Properties using Urea as Electron Donor. *J. Org. Chem.* **2019**, *84*, 8941.
2. Kaur, S.; Mukhopadhyay, A.; Selim, A.; Gowri, V.; Dar, A. H.; Neethu, K. M.; Sartalia, S.; Ali, M. E.; Jayamurugan, G. Tuning of the Cross-Glaser Products mediated by Substrate-Catalyst Backbone Interactions. *Chem. Commun.* **2020**, *56*, 2582.
3. Ahmad, A.; Gupta, A.; Ansari, M.; Vyawahare, A.; Jayamurugan, G,; Khan. R. Hyperbranched polymer-functionalized magnetic nanoparticles mediated hyperthermia and niclosamide bimodal therapy of Colorectal Cancer Cells. *ACS Biomat. Sci. Eng.* **2020**, *6*, 1102.

Patents: G. Jayamurugan, A. Selim, K. M. Neethu, V. Gowri, M. E. Ali, Thiol functionalized polymers bearing catalytic nanoparticles method of preparing the same and use thereof, Patent no. 201911042361.

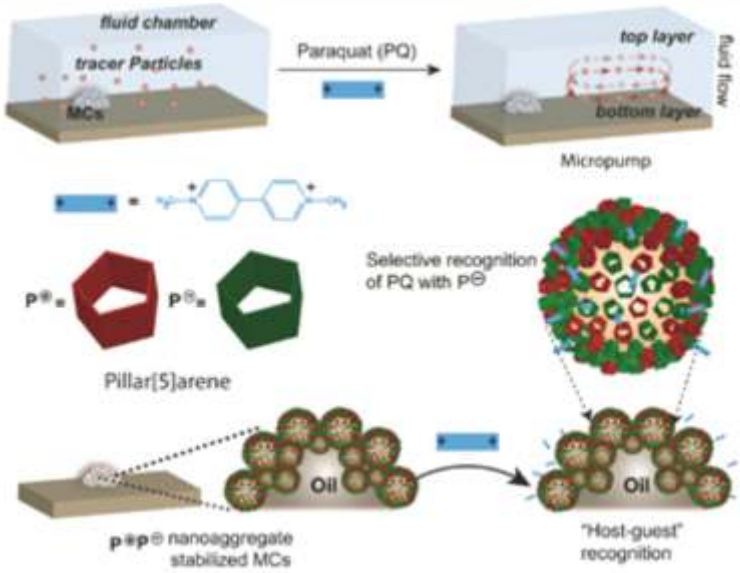
No of PhD/Postdoc/intern student:

PhD students - **4**; Project Fellows- **1** Post doc -**1,** Women Scientist (WOS-B) - **1** and Intern- **2**

5. Dr. Debabrata Patra, Scientist-E/Associate Professor

Research Activities/Highlights:

- Self-assembly of nanomaterials at liquid-liquid interface
- Fabrication of catalytic microcapsules using microfluidic device
- Self-powered micro engine using supramolecular system
- Macroscopic self-assembly of supramolecular systems
- Layer-by-layer assembly for protective coatings



Graphical representation of "host-guest" micropump. Pillar[5]arene stabilized nanoaggregate stabilized MCs inside the chamber turn on fluid flow in presence of paraquat.

Significant Achievements:

We fabricated Pillar[5]arene (P[5]A) stabilized microcapsules (MCs) via self-assmbly and crosslinking of P[5]A nanoaggregates at liquid-liquid interface. Thses MCs microengines turn on fluid flow in presence paraquat (PQ) due to "host-guest" molecular recognition. The microengines could be useful in designing non-mechanical micropumps, powerless microfluidics and diagnostic devices.

Selected Publications:

1. Varshney, R.; Kumar, S.; Ghosh, K.; Patra, D. "Fabrication of Dual Catalytic Microcapsules by Mesoporous Graphitic Carbon Nitride (mpg-C3N4) Nanoparticles-Enzyme Conjugates Stabilized Emulsions" *New J. Chem.,* **2020**,*44*, 3097-3102.
2. Gill, A. K.; Riyajuddin, S.; Alam, M.; Ghosh, K.; Patra, D. "Mussel-inspired UV protective organic coatings via layer-by-layer assembly" *Eur. Polym. J.* **2020**, *124*, 109455.
3. Varshney, R.; Sharma, S.; Prakash, B.; Laha, B. P.; Patra, D. "One-Step Fabrication of Enzyme-Immobilized Reusable Polymerized Microcapsules from Microfluidic Droplets" *ACS Omega*, **2019**, *4*, 13790-13794.

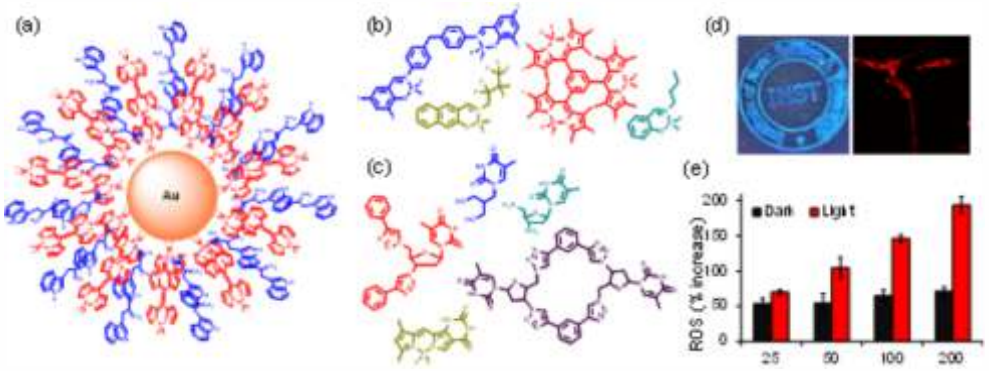
No of PhD/Postdoc/intern student:

PhD students - **4**

6. Dr. Prakash P. Neelakandan, Scientist-E/Associate Professor

Research Activities/Highlights:

- **Nanocomposites**: Nanocomposites containing BODIPY dyes and metal nanoparticles exhibiting plasmon-molecule coupling were developed for applications in photodynamic therapy and chemosensing.
- **Organoborons:** Boron containing organic molecules were synthesized and their photophysical and mechanical properties were tuned by varying the substituents. By following this approach, flexible single crystals, organogels and photosensitizers were successfully developed.
- **Nucleic Acid Analogues:** Analogues of thymidine incorporating the triazole moiety were synthesized through intramolecular 1,3-dipolar cycloaddition reactions. One of these nucleoside analogues was observed to exhibit dose dependent cytotoxicity against glioblastoma and breast cancer cells.



(a-c) Chemical composition of nanocomposites, organoborons and nucleoside analogues. (d) Luminescent marker and cell-imaging application of organoborons. (e) Cytotoxicity exhibited by the nanocomposites against C6 cells under dark and light irradiation.

Significant Achievements:

We have developed a sensitive method for the detection of biothiols. Our methodology utilizes a nanocomposite containing BODIPY, gold nanoparticles and tryptophan, and can detect picomolar concentrations of cysteine. Our system can function under a variety of conditions over a wide range of concentrations and does not require any hi-tech instrumentation for detecting the analyte.

Selected Publications:

1. Kumar, P. P. P.; Yadav, P.; Shanavas, A.; Neelakandan, P. P. Aggregation enhances luminescence and photosensitization properties of a hexaiodo-BODIPY, *Mater. Chem. Front*. **2020**, *4*, 965-972.
2. Marandi, P.; Kumar, P. P. P.; Venugopalan, P.; Neelakandan, P. P. Selective metal-ion detection and activatable photosensitization properties of a tetraphenylethylene based salicylideneimine, *ChemistrySelect*, **2019**, *4*, 5707-5713.
3. Kumar, P. P. P.; Yadav, P.; Shanavas, A.; Thurakkal, S.; Joseph, J.; Neelakandan P. P. A three-component supramolecular nanocomposite as a heavy-atom-free photosensitizer, *Chem. Commun*. **2019**, *55*, 5623-5626.

No. of PhD/Postdoc/intern students:

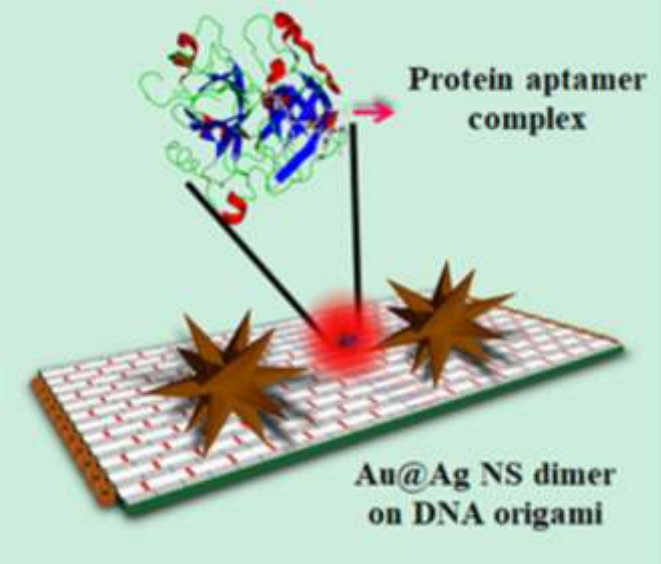
Ph. D. students - 4, project student -1, SERB-NPDF- 1 and Women Scientist (WOS-A) - 1.

7. Dr. Tapasi Sen, Scientist-D/Assistant Professor

Research Activities/Highlights:

- Fabrication of DNA origami directed self-assembled plasmonic nanostructures for single-molecule sensing and assays applications.
- Design of self-assembled hybrid nanostructures with unidirectional energy transfer for programming light harvesting efficiency.
- Studying nano-bio-interactions using single-molecule fluorescence spectroscopy.

Recently our group has designed Au@Ag nanostar dimer nanoantennas assembled on rectangular DNA origami with interparticle gap of 5 nm. Single thrombin protein was specifically placed in the plasmonic hotspot of dimer nanoantennas. We were able to detect single thrombin protein molecule on the designed nanoantennas as sensing platform through SERS technique.



Design of Plasmonic nanoantenna for single protein sensing

Significant Achievements:

- Bimetallic Au@Ag nanostar dimer nanoantennas on DNA origami with tunable interparticle gap were designed
- Such nanoantennas were found to act as broadband enhancer of Raman signals of three single dye molecules corresponding to different regions of the visible spectrum
- The designed plasmonic nanoantenna has the potential to be used as label free sensor for detection of single protein molecule.

Selected Publications:

1. Tanwar, S.; Sharma, B.; Kaur, V.; Sen, T. White light emission from a mixture of silicon quantum dots and gold nanoclusters and its utilities in sensing of mercury (II) ions and thiol containing amino acid. ***RSC Adv.*** **2019**, ***9*****,** 15997.
2. Haldar, K.K.; Tanwar, S.; Biswas, R.; Sen, T.; Lahtinen, J. Noble copper-silver-gold trimetallic nanobowls: an efficient catalyst. *J. Colloid Interface Sci.* **2019**, *556*, 140.
3. Dash, L.; Biswas, R.; Ghosh, R.; Kaur, V.; Banerjee, B.; Sen, T.; Patil, R.A.; Ma, Y-R.; Haldar, K. K. Fabrication of mesoporous titanium dioxide using Azadirachta indica leaves extract towards visible-light-driven photocatalytic dye degradation. *Journal of Photochem. Photobio. A: Chem.* **2020,** *400*, 112682**.**

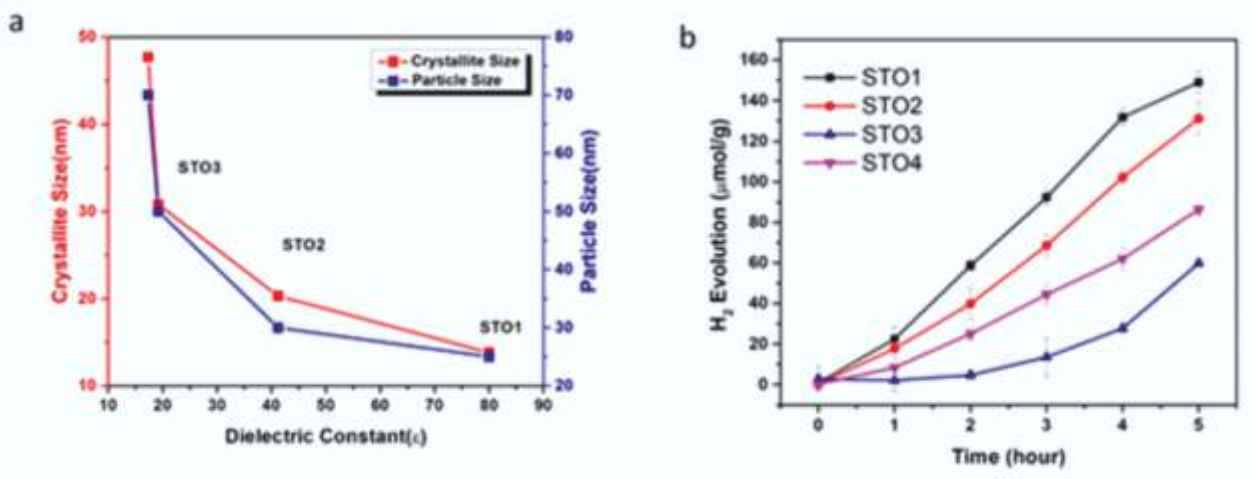
No. of PhD/Postdoc/intern students:

PhD students - **4**, Intern - **1**

8. Dr. Sonalika Vaidya, Scientist-D/Assistant Professor

Research Activities/Highlights:

- Our group is involved in designing different nanostructures for photocatalysis (organic pollutant degradation and water splitting). In this aspect we have synthesized SrTiO3 using different structure directing agents which also acted as solvent. We observed that there was correlation between the dielectric constant of the solvent and photocatalytic efficiencies of the catalyst towards both organic pollutant degradation and water splitting.
- Our group is also involved in understanding the formation of nanostructures using SAXS. In this aspect we are studying the effect of surfactants on size and shape of microemulsions.



Plot showing (a) variation of crystallite and particle size with the dielectric constant of solvents, (b) Hydrogen Evolution in presence of the catalyst (STO1, STO2, STO3 and STO4).

Significant Achievements:

- We have been able to control the size, shape and assembling behaviour of the oxides using different structure directing agent which also acted as solvents. Their role was showcased on their photocatalytic behaviour towards photocatalytic behaviour (organic pollutant degradation and water splitting). Apart from this we were able to understand the effect of different surfactants in governing the shape and size of reverse micelles using SAXS.

Selected Publications:

1. Vijay, A.; Mukhopadhyaya, A.; Shrivastava, V.; Bhardwaj, D.; Ganguli, A. K.; Ali, M. E.; Vaidya, S. Understanding the role of ionic flux on the polarity of the exposed surfaces of ZnO. *Phys. Chem. Chem. Phys.* **2020**, *22*, 15427-15436.

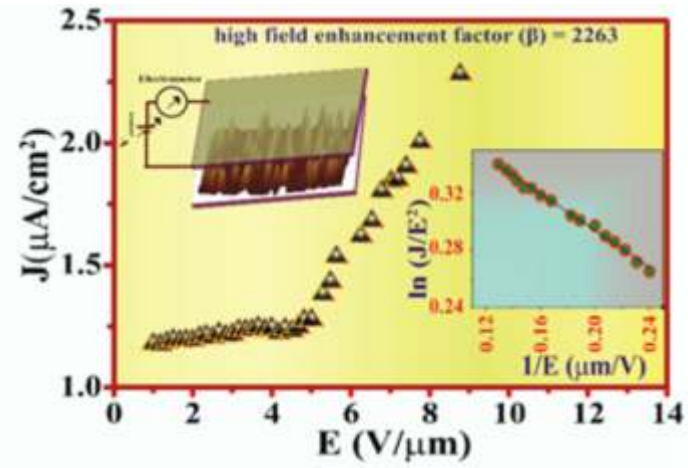
No. of PhD/Postdoc/intern students:

PhD students - **3**, Project Assistant - **1**

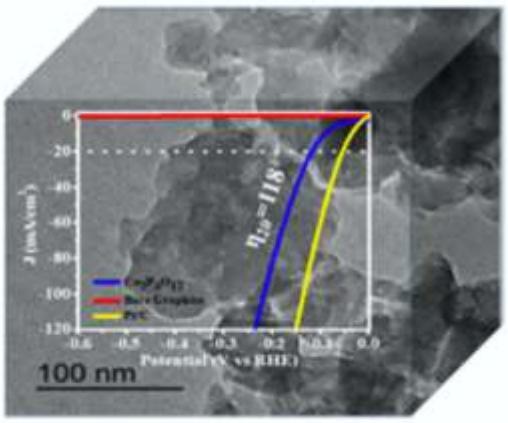
9. Dr. Menaka Jha, Scientist-C

Research Activities/Highlights:

- Anisotropic synthesis of Rare Earth Hexaboride (NdB_6, GdB_6, $La_xNd_{1-x}B_6$, $La_xGd_{1-x}B_6$)
- Extraction of transition metal from the waste magnetic material especially cobalt and Iron and their various utilization such as chlorine evolution reaction, oxygen evolution reaction and hydrogen evolution reaction
- Development of ultrathin transition metal cyclotetraphosphate and utilization as hydrogen evolution reaction
- Utilization of coir fibre for the synthesis of porous graphene oxide and used for the supercapacitor application



Vertically Aligned Nanorods of NdB_6 synthesized via Solid-State Borothermal Reduction



Utilization of cobalt cyclotetraphosphate as hydrogen evolution reaction

Significant Achievements:

Our research group have synthesised 1st time NdB6 anisotropic synthesis and utilized as a field emitter. Apart from that ultrathin transition metal cyclotetraphosphate has been also synthesised and showing very low over potential. Paper waste and ceramic industrial effluent have been also utilized for the extraction of the valuable end product.

Selected Publications:

1. Singh, H.; Sunaina; Yadav, KK.; Bajpai, VK.; Jha, M.; Tuning the bandgap of m-ZrO2 by incorporation of copper nanoparticles into the visible region for the treatment of organic pollutants. *Mater. Res. Bul.,* **2020**, *123*, 110698.
2. Nishanthi, ST.; Yadav, KK.; Baruah, A.; Vaghasiya, K.; Verma, RK.; Ganguli, AK.; Jha, M.; Nanostructured silver decorated hollow silica and their application in the treatment of microbial contaminated water at room temperature. *New J. Chem*. **2019**, *43*, 8993-9001.
3. Nishanthi, S.T., Baruah, A., Yadav, K.K., Sarker, D., Ghosh, S., Ganguli, A. K., Jha, M., New low temperature environmental friendly process for the synthesis of tetragonal MoO2 and its field emission properties. *Applied Surface Science*, **2019**, *467*, 148-1156.

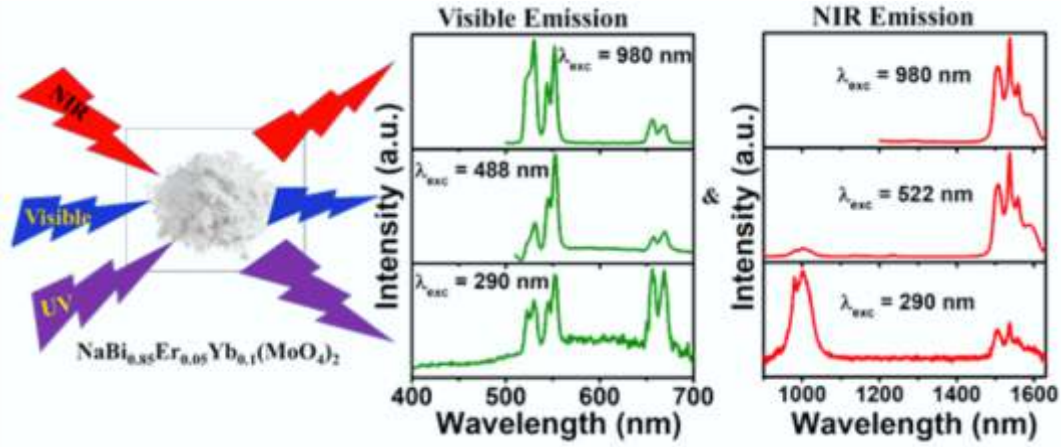
No of PhD/Postdoc/intern students: 7

PhD students – **7,** post doc – **1**

10. Dr. Sanyasinaidu Boddu, Scientist-C

Research Activities/Highlights:

- A simple co-precipitation method has been developed for the synthesis of undoped, lanthanide ions doped $NaBi(MoO_4)_2$ nanomaterials at room temperature. Highest quantum efficiency is observed in 10% Eu^{3+} doped $NaBi(MoO_4)_2$ nanomaterials.
- Solid solution has been observed at room temperature in complete range of composition between $NaBi(MoO_4)_2$ and $NaLa(MoO_4)_2$. The band gap of these solid solutions tuned from 3.36 to 4.4eV. Band gap of these materials plays crucial role in dependency of luminescence efficiency on excitation wavelength. Maximum quantum efficiency observed is 70%.
- Er^{3+},Yb^{3+}co-doped $NaBi(MoO_4)_2$ nanomaterials show excitation dependent photoluminescence properties in visible, NIR regions



Photoluminescence properties of $NaBi_{0.85}Er_{0.05}Yb_{0.1}(MoO_4)_2$ nanomaterials in visible and NIR regions at different excitation wavelengths.

Significant Achievements:

A suitable host materials for lanthanide doping has been synthesized at room temperature. Europium doped materials show excellent red emission with 70% quantum efficiency at 394 & 464nm excitation which is a suitable red component for white light emitting diodes. Er3+, Yb3+ doped materials exhibit excitation dependent luminescence properties in visible & NIR regions upon UV, Visible and NIR excitations which has applications in luminescence based unclonable anti-counterfeiting.

Selected Publications

1. Pushpendra; Kunchala, R.K; Achary, S.N; Tyagi, A.K; Naidu. B.S. Rapid, Room Temperature Synthesis of Eu^{3+} Doped $NaBi(MoO_4)_2$ Nanomaterials: Structural, Optical, and Photoluminescence Properties, *Cryst. Growth Des.*, **2019**, *19*, 3379-3388.
2. Pushpendra; Kunchala, R.K; Achary, S.N; Naidu. B.S. $NaBi_{0.9}Eu_{0.1}(MoO_4)_2$ Nanomaterials: Tailoring the Band Gap and Luminescence by La^{3+}Substitution for Light-Emitting Diodes, *ACS Appl. Nano Mater.*, **2019**, *2*, 5527-5537
3. Pushpendra, Kunchala, R.K; Kalia, R; Naidu, B.S. Excitation Dependent Visible and NIR Photoluminescence Properties of Er3+, Yb3+ Co-doped $NaBi(MoO_4)_2$ Nanomaterials, *RSC Adv.*, **2020**, *10*, 14525 – 14530

No. of PhD/Postdoc/intern students:

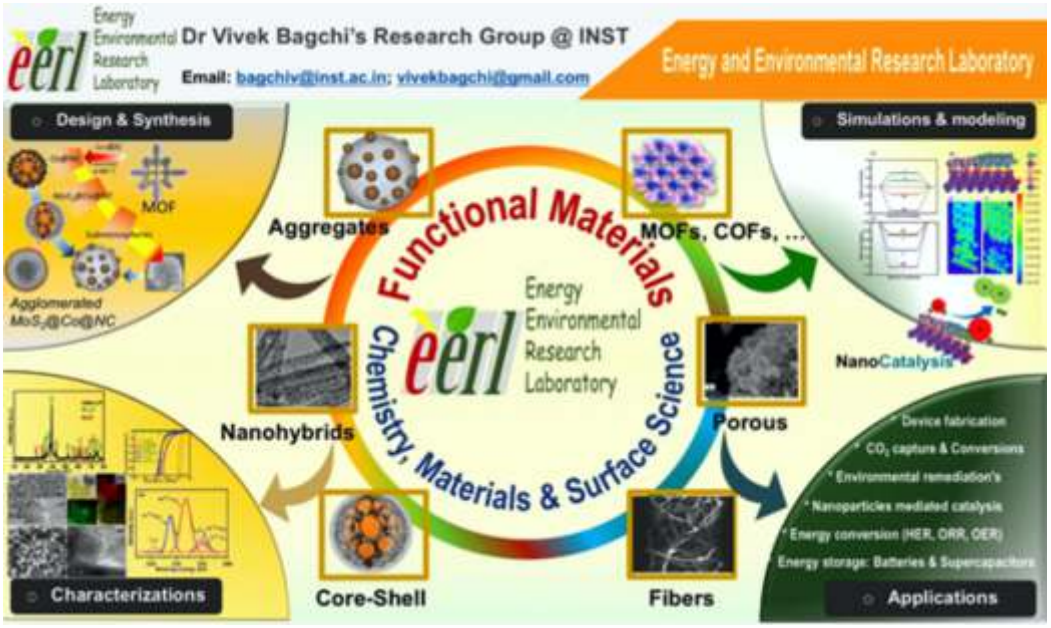
PhD students – **3**, Intern -**1**

11. Dr. Vivek Bagchi, Scientist-C

Research Activities/Highlights:

We design advanced functional materials for:

- Energy conversion for fuel cell and electrolysers; Energy Storage -Metal ion/air batteries and hybrid devices; Electrochemical carbon dioxide conversion; Nanomaterials mediated catalysis; Environmental pollutant Degradation; Air/ water remediation



First scheme (Clockwise) shows how an implementation of a strategy can improve ORR activity; Second scheme shows how copper nanoparticles lowers the over potential at high current density; Third scheme shows a synergistic effect in a hierarchically grown MoS_2 nano layers on N doped carbon warped cobalt nanoparticles; Fourth scheme shows microporous 3-D RGO aerogels for supercapacitor applications.

Significant Achievements:

An air purifier with unique features developed at INST.
Excellent Reviewer Award from Bulletin of Materials Science, Springer.

Selected Publications:

1. Kumar, R. Ahmed, Z.; Kaur,H.; Bera. C.; Bagchi, V. Probing into the effect of heterojunctions between Cu/Mo2C/Mo2N on HER performance. *Catalysis Science and Technology,* **2020,** *10,* 2213 – 2220.
2. Ahmed, Z.; Sachdeva, P. K.; Rai, R.; Kumar, R.; Maruyama, T.; Bera, C.; and Bagchi, V. Promoting electrocatalytic oxygen reduction in a model composite using selective metal ions. *ACS Applied Energy Materials,* **2020**, *3,* 3645 – 3652.
3. Ahmed, Z.; Rai, R.; Kumar, R.; Maruyama, T.; Bagchi, V. Hydrated FePO4 nanoparticles supported on P-doped RGO show enhanced ORR activity compared to their dehydrated form in an alkaline medium, *RSC Advances,* **2019,** *9,* 24654-24658.

No. of PhD/Postdoc/intern students:

Ph.D. students: **3**

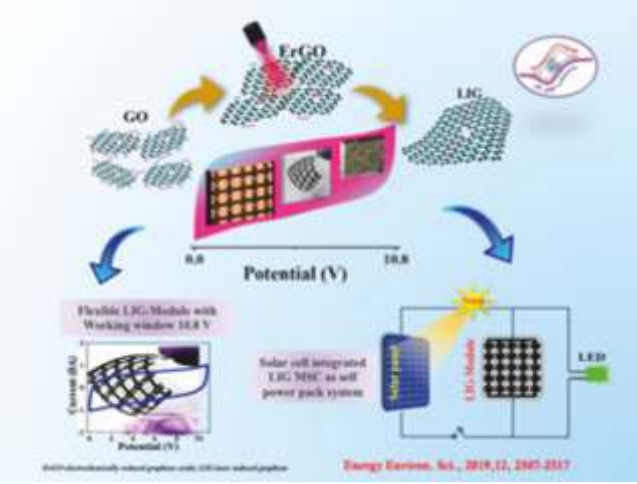
12. Dr. Ramendra Sundar Dey, Scientist-C

Research Activities/Highlights:

Dr. Dey persues research in the challenging problem of metal-free on-chip microsupercapacitor, metal-air batteries and generation of renewable fuel. His major research are:

- On-chip microsupercapacitors
- Rechargeable battery systems; metal-air batteries, hybrid supercapacitor-battery or paper-based biofuel cells
- Electrocatalytic N_2 (NRR), CO_2 (CRR) & O_2 (ORR) reduction reactions
- Catalysts development for water splitting (O_2 and H_2 evolution reaction)

Recently, transition metal doped graphitic carbon nitride & binary active (Fe-Mn) were utilised as low-cost electrocatalyst for efficient ORR and Zn-air battery application.



Schematic representation of laser-irradiated graphene based micro-supercapacitor and a hybrid cell to demonstrate the self-charging power unit

Significant Achievements:

Dr. Dey has recently solved a long-standing problem of microsupercapacitor by designing a new emerging material, highly conducting laser irradiated graphene to replace the conventional metals like copper, gold *etc*., which shows exceptional cycle life (100% C_{sp} retention after 100000 cycles). The array of MSC was integrated with a commercial solar cell module for hybrid energy harvesting and as storage device towards self-sustainable energy for future application.

Book: ***Carbonaceous Materials and Future Energy: Clean and Renewable Energy Sources****,* by Ramendra Sundar Dey, Taniya Purkait, Navpreet Kamboj, Manisha Das, CRC Press, Taylor & Francis Group, 2019, DOI:10.1201/9781351120784, ISBN: 978-0-8153-4788-0.

Selected Publications:

1. Kamboj, N.; Purkait, T.; Das, M.; Sarkar, S.; Hazra, K.S.; Dey, R. S. Ultralong cycle life and outstanding capacitive performance of 10.8 V metal-free micro-supercapacitor with highly conducting and robust laser-irradiated graphene for integrated storage device. *Energy Environ. Sci*. **2019**, *12*, 2507.
2. Purkait, T.; Dimple; Kamboj, N.; Das, M.; Sarkar, S.; De Sarkar, A.; Dey, R. S. Electrochemically customized assembly of hybrid xerogel material via combined covalent and non-covalent conjugation chemistry: An approach for boosting the cycling performance of pseudocapacitors. *J. Mater. Chem. A* **2020**, *8*, 6740.
3. Sarkar, S.; Kamboj, N.; Das, M.; Purkait, T.; Biswas, A.; Dey, R. S. Universal Approach for Electronically Tuned Transition-Metal-Doped Graphitic Carbon Nitride as a Conductive Electrode Material for Highly Efficient Oxygen Reduction Reaction. *Inorg. Chem.* **2020**, *59*, 1332.

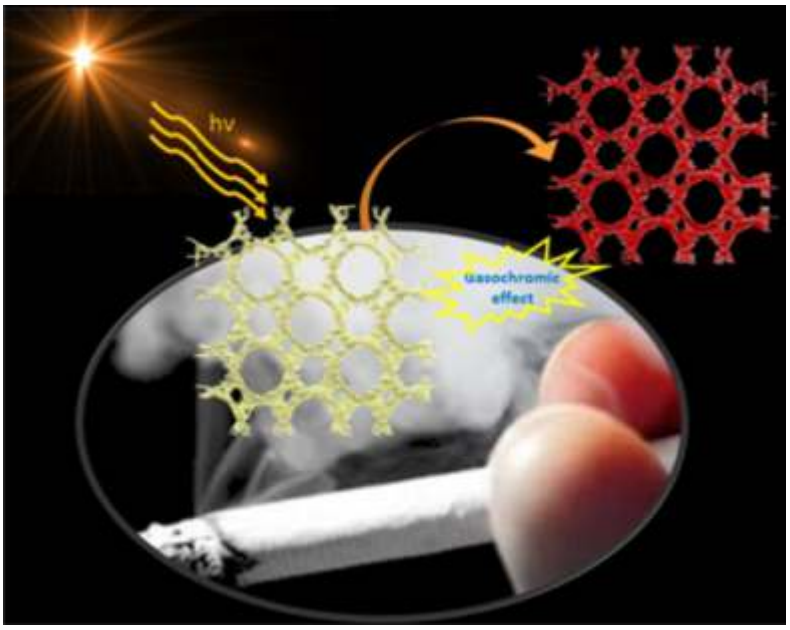
No. of PhD/Postdoc/intern students:

Ph.D. students: **5**, Project student: **1**

13. Dr. Monika Singh, Scientist-C

Research Activities/Highlights:

Nicotine, being a major constituent of second hand smoke (SHS) or cigarette smoke, is quite harmful for human health, because of its carcinogenic potential. Hence, its detection in air has become very significant. For the first time, a metal organic nanotube (MONT) has being used for the detection of nicotine from cigarette smoke at room temperature. MONT is a unique class of metal-organic framework (MOF) where independent one-dimensional tubular structures are formed. MONT, [Zn3(*btc*)2(μ3-OH)(DMF)]·H2O (*btc* = benzene tricarboxylic acid) possesses distinctive structural features, i.e., three differently shaped porous channels (circular, star, and oval), formed by periodic linkage of btc with Zn, giving rise to the formation of a highly porous framework structure. When exposed to cigarette smoke in the presence of sunlight, this MONT display a gasochromic effect, i.e., a significant color change from light yellow to dark pink within just 20 s. A high sensitivity with low detection limit of ~ 23.3 μM was witnessed



Significant Achievements:

The significance of the above work lies in the fast, easy, naked-eye, specific sensing of nicotine from cigarette smoke, which is first of its kind. The chemical and thermal stability of this MONT, and the quick and easy detection of nicotine, in air gives great prospects for this material as a sensor for practical environmental applications. Practically, this material could be further exploited for the detection of nicotine in nonsmoking public places.

Selected Publications:

1. Rani, D.; Bhasin, K. K.; Singh, M. Visible-Light-Assisted Gasochromic Sensing of Nicotine from Cigarette Smoke by Metal-Organic Nanotube*, ACS Materials Letters,* **2020***, 2,* 9.
2. Rani, D.; Kumar, R.; Kumar, V. Singh, M. High yield Cycloaddition of Carbon Dioxide to Epoxides Catalysed by Metal Organic Frameworks, *Mat Today Sustainability,* **2019**, *5,* 10021.

No. of PhD/Postdoc/intern students:

Phd students – **2** Intern -**1**

QUANTUM MATERIALS & DEVICES UNIT

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Prof. Abir De Sarkar

Dr. Suvankar Chakraverty

Dr. Md. Ehesan Ali

Dr. Dipankar Mandal

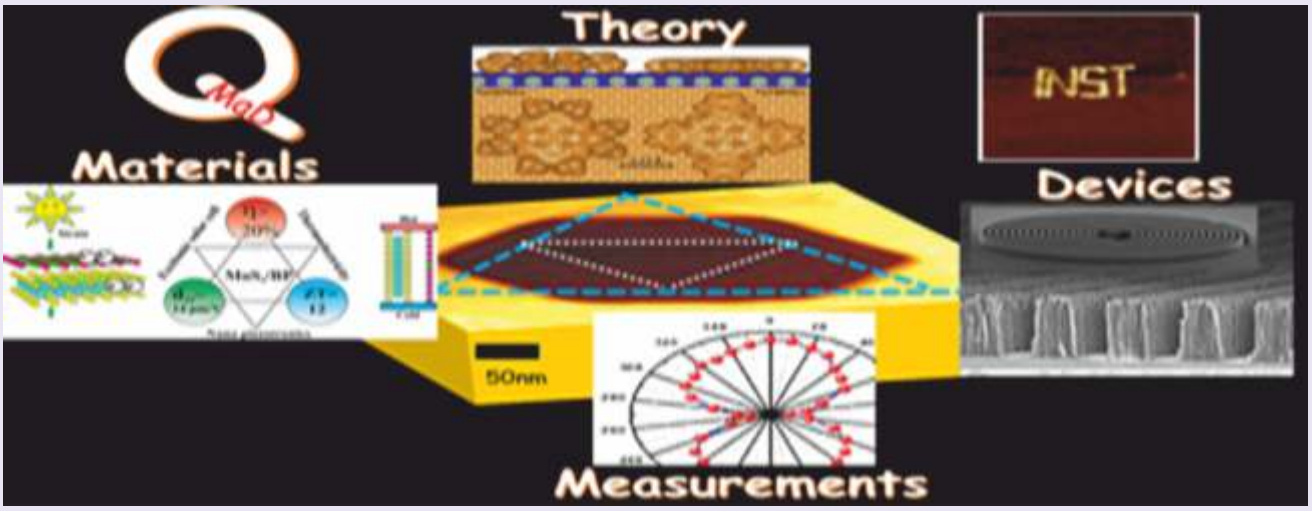
Dr. Indranil Sarkar

Dr. Kaushik Ghosh

Dr. Kiran Shankar Hazra

Dr. Chandan Bera

Shri Bhanu Prakash



QUANTAM MATERIALS AND DEVICES UNIT:

"Quantum materials", a class of materials which now trigger a major part of the global fundamental research, and drive a number of new technologies. The research on these materials are not only experiment-driven but a detail theoretical modelling is necessary to design and predict new materials that has relevance to the next generation integrated devices with emergent quantum properties.

The "Quantum Materials and Devices Unit" (QMDU) at Institute of Nano Science and Technology is devoted to cater the needs of future quantum technologies of India. An excellent team of scientists along with a large number of PhD students and postdoctoral fellows are working coherently to achieve not only in-depth understand of the fundamental aspects quantum materials at nano scale, but also to design advance devices for technological applications. This unit has a perfect blend of theoretical, experimental and device scientists, who are involved in developing technologies to artificially control the quantum states "electronic" and "spin" of the matter at nanoscale. The scientists at QMDU of INST Mohali, have taken keen interest to bolster the material resource with particular emphasis to cater the needs of quantum technologies of the country. Researchers at QMDU of INST have recently made several serendipitous fundamental discoveries in the field of Quantum Materials and Devices, and is devoted to do so in the future. The individual profile of Faculty members linked to this webpage may be browsed for details. Brief description is listed below

Theory:

- Design new materials in nanosize for energy conversion and next-generation electronics.
- Spin-associated properties of molecules and materials at Nanoscale: organic molecular magnets, spin-filter, molecular spintronics.
- Diagnostic and therapeutic aspects of Malaria.
- 2D nanostructure materials for efficient of thermoelectric and solid state spintronic devices.

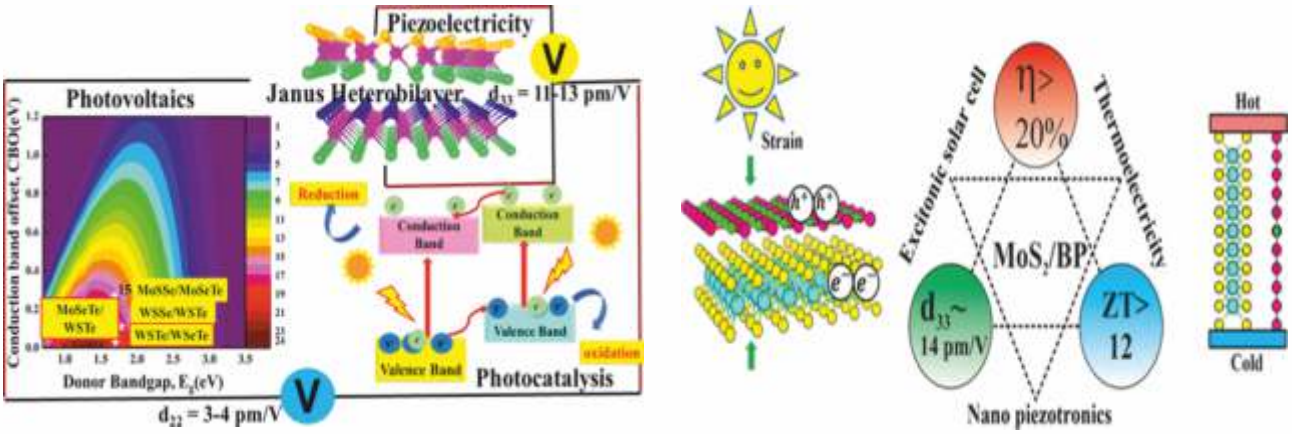
Experiment:

- 2D Semiconductors and heterostructures based Opto-electronic devices.
- Experimental microfluidics for micro-nano fabrication of devices for biomedical science.
- Oxide thin films, interface and superstructure for spin-electronics applications.
- Electronic structure and physical property correlation studies for quantum materials and device applications.

1. Prof. Abir De Sarkar, Scientist – 'F'/ Professor & Dean (Academics)

Research Activities/Highlights:

Energy conversion in low dimensional materials and next-generation electronics. It includes nano-piezotronics, piezoelectricity, thermoelectricity, thermal conductivity, carrier mobility, low power memory device and data storage devices, band gap and edge engineering in nanomaterials, catalysis.



Nanomaterials for energy conversion and next-generation electronics

Significant Achievements:

In recent publications in leading International Journals, such as, *Nanoscale* **and *American Chemical Society - Applied Materials & Interfaces*, we** have demonstrated the occurrence of super high out-of-plane piezoelectricity via stacking one monolayer over the other in the 2D nanostructures. The out-of-plane piezoelectric coefficient in the computationally designed 2D materials reaches as high as 56 pm/V, which is exceedingly higher than that in the bulk materials, such as, α-quartz (2.27 pm/V), wurzite AlN (5.1 pm/V), wurzite GaN (3.1 pm/V), which are commonly used in industry.

Selected Publications:

1. Mohanta, M. K.; Sarkar A. D. Tweaking the physics of interfaces between monolayers of buckled cadmium sulfide for a superhigh piezoelectricity, excitonic solar cell efficiency and thermoelectricity. *ACS Appl. Mater. Interfaces* **2020**, *12*, 3114.
2. Mohanta, M.K.; Rawat, A.; Jena, N; Dimple; Ahammed, R.; Sarkar, A. D. Interfacing boron monophosphide with molybdenum disulphide for an ultrahigh performance in thermoelectrics, 2D excitonic solar cells and nanopiezotronics. *ACS Appl. Mater. Interfaces* **2020**, *12*, 3114.
3. Mohanta, M.K.; Rawat, A.; Dimple; Jena, N.; Ahammed, R.; Sarkar, A. D. Superhigh out-of-plane piezoelectricity, low thermal conductivity and photocatalytic abilities in ultrathin 2D van der Waals heterostructures of Boron Monophosphide and Gallium Nitride. *Nanoscale* **2019**, *11*, 21880.

No. of PhD/Postdoc/intern student:

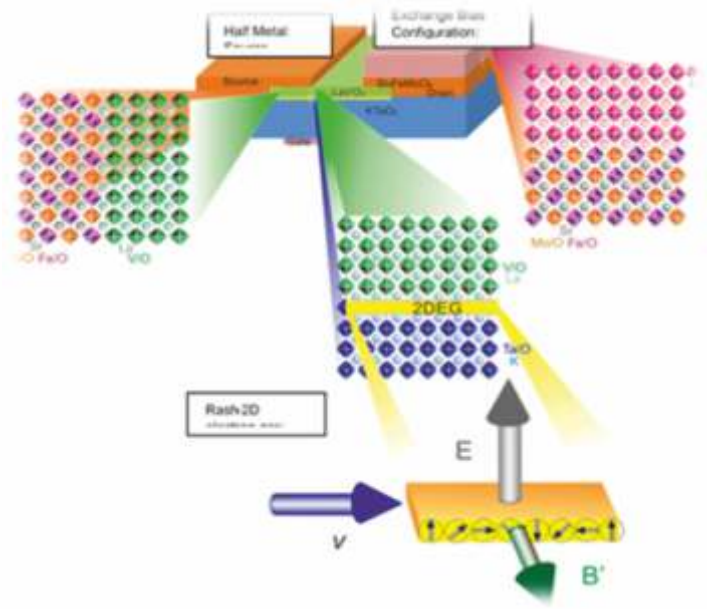
Ph.D. students – **7**, Project Fellow – **1**.

2. Dr. Suvankar Chakraverty, Scientist-E/Associate Professor

Research Activities/Highlights:

First realization of strong Rashba spin-splitted electronic state at the oxide interface.

- First observation of signature of non-trivial Berry's phase at oxide interface.
- Nano scale electrical domain writing on an oxide surface with strong spin orbit coupling.
- Realization of topological signature on the electronics state on the 2 dimensional electron gas (2DEG) formed at oxide interface similar to that observed in systems with Weyl fermions.



Schematic for a spin transistor based on Rashba effect

Significant Achievements:

We have realize 2DEG at a novel interface composed of $LaVO_3$ and $KTaO_3$, where strong spin-orbit coupling and relativistic nature of the electrons in the 2DEG result in "Rashba field", leading to anisotropic magnetoresistance and planar Hall effect similar to the behaviour previously observed in topological materials with possible Dirac or Weyl like fermions. This is the first observation of strong Rashba effect where the spin of the electron locked with its direction of motion, in an oxide interface. This finding has significant implication in the field of spin-electronics and quantum devices since this oxide superstructures could be integrated with relevant materials to achieve new or integrated physical properties.

Selected Publications:

1. Wadehra, N.; Tomar, R.; Gopal, R. K.; Singh, Y.; Dattagupta, S.; Chakraverty, S. Planar Hall effect and anisotropic magnetoresistance in a polar-polar interface of $LaVO_3$-$KTaO_3$ with strong spin-orbit coupling. *Nat. Commun.* **2020**, *11,* 8741.
2. Wadehra, N.; Kumar, N.; Mishra, S.; Tomar R.; Chakraverty, S. Nano-electrical domain writing for oxide electronics. *Appl. Surf. Sci.* **2020**, 509, 145214.
3. Wadehra, N.; *Chakraverty, S.* Electrostatic memory in $KTaO_3$. *Appl. Phys. Lett.* **2019**, *114,* 163103.

No. of PhD/Postdoc/intern student:

Ph.D. students – **6**

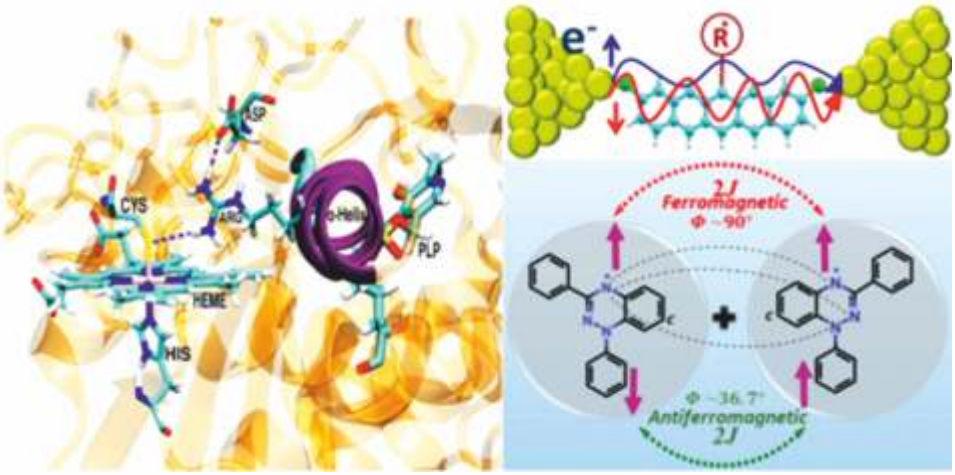
3. Dr. Md. Ehesan Ali; Scientist-E/Associate Professor

Research Activities:

Dr. Ali's research activities revolve around the *Quantum Mechanical Computations* of spin-associated properties of molecules and materials at Nanoscale. It encompasses,

- Designing organic molecular magnets
- Spin-filter/transport across the Nano-junctions
- Molecular spintronics
- Explorations of spin-resolved potential energy surfaces for catalytic reactions.

Dr. Ali's group is also quite passionate about structural simulations of proteins to decode protein dynamics and electron transfer processes in various biochemical activities for diagnostic and therapeutic applications.



Significant Achievements:

The electron transfer from the substrate to the ferromagnetic centre of Co-porphyrin molecule deposited on the Cu(111) substrate shows "*turning-off the exchange splitting*" in the Co-atom that provides a non-magnetic identity of the Co-atoms. This fundamental understanding explains the quenching of magnetic moments on Co (also observed in the XMCD) for CoP/Cu(111). We also proposed a "*zonal spin-alternation rule*" that enables us to predict the ground spin-state of the organic diradicals, whereas the famous "*spin-alternation*" rule fails for triazinyl based di-radicals.

Selected Publications:

1. Arruda, L.; Ali, Md. E.; Bernien, M.; Nickel, F.; Kopprasch, J.; Czekelius, C.; Oppeneer, P. M; Kuch, W. Modifying the Magnetic Anisotropy of an Iron Porphyrin Molecule by an on-Surface Ring-Closure Reaction. *J. Phys. Chem. C* **2019**, *123*, 14547.
2. Bajaj, A.; Ali, Md. E. First-Principle Design of Blatter's Diradicals with Strong Ferromagnetic Exchange Interactions. *J. Phys. Chem. C* **2019**, *123*, 15186.
3. Arruda, L. M. Ali, Md. E.; *et al.* Surface-orientation- and ligand-dependent quenching of the spin magnetic moment of Co porphyrins adsorbed on Cu substrates. *Phys. Chem. Chem. Phys.* **2020,** *22*, 12688.

Patents: Jayamurugan, G.; Selim, A.; Neethu, K. M.; Gowri, V.; Ali, Md. E. Thiol functionalized polymers bearing catalytic nanoparticles method of preparing the same and use thereof" *Indian Patent no.* 201911042361, **2019**.

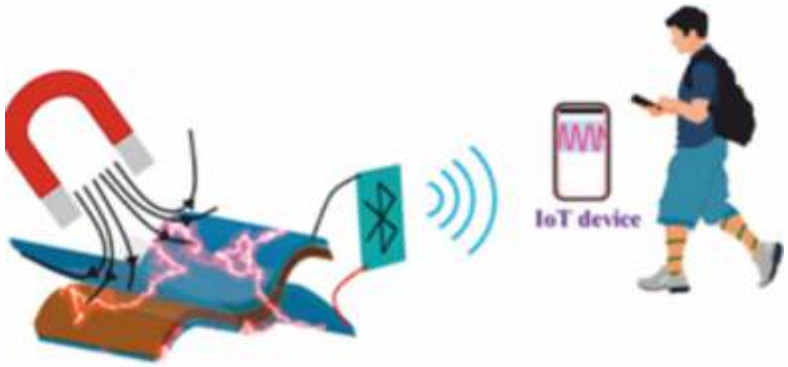
No. of PhD/Postdoc/intern student:

Ph.D. students – **6**

4. Dr. Dipankar Mandal, Scientist-E/Associate Professor

Research Activities/Highlights:

- Flexible and rollable magneto-mechano-electric nanogenerator (MMENG)-based wireless Internet of Things (IoT) sensor has been demonstrated as illustrated below.
- MMENG can enable to capture and utilize the environmental magnetic noise in the absence of a direct current magnetic field.



A schematic presentation of MMENG and wireless IoT sensor. MMENG showing its potential to harvest environmental magnetic noises in order to generate electric power.

- A simple yet highly efficient design strategy to enhance the output performance of an all-organic self-powered piezo-organic-e-skin sensor has been developed.
- It shows excellent mechanical to electrical energy conversion that enable to sense human finger touch (10 V under 10 kPa) with energy conversion efficiency of 53%.
- An efficient and convenient way of monitoring human-health status in hospital-free mode has been demonstrated.

Significant Achievements:

New type of triboelectric driven flexible self-charging triboelectric power cell (STPC) has been fabricated on a normal sheet of paper. It exhibits Pmax, Voc, and Isc of ~0.67 μW, ~3.82 V, and ~0.20 μA, respectively in 1 kPa impact. This work has been published in high impact journal (Nano Energy, 2019, 63, 103831) and highlighted in **Nature India** (Ref."A temperature and weight sensor made on paper. Can charge itself, could be useful in wearable devices", 26th June, 2010,https://www.natureasia.com/ en/nindia/article/10.1038/ nindia.2019.81).

Selected Publications:

1. Ghosh, S. K.; Roy, K.; Mishra, H. K.; Sahoo, M. R.; Mahanty, B; Vishwakarma, P. N.; Mandal, D. Rollable magnetoelectric energy harvester as wireless IoT sensor. *ACS Sustainable Chem. Eng.* **2020**, *8*, 864.
2. Karmakar, S.; Kumbhakar, P.; Maity, K.; Mandal, D.; Kumbhakar, P. Development of flexible self-charging triboelectric power cell on paper for temperature and weight sensing. *Nano Energy* **2019**, *63*, 103831.
3. Sultana, A.; Ghosh, S. K.; Alam, Md. M.; Sadhukhan, P.; Roy, K.; Xie, M.; Bowen, C. R.; Sarkar, S.; Das, S.; Middya, T. R.; Mandal, D. Methylammonium lead Iodide incorporated poly(vinylidene fluoride) nanofibers for flexible piezoelectric-pyroelectric nanogenerator. *ACS Appl. Mater. Interfaces* **2019**, *11*, 27279.

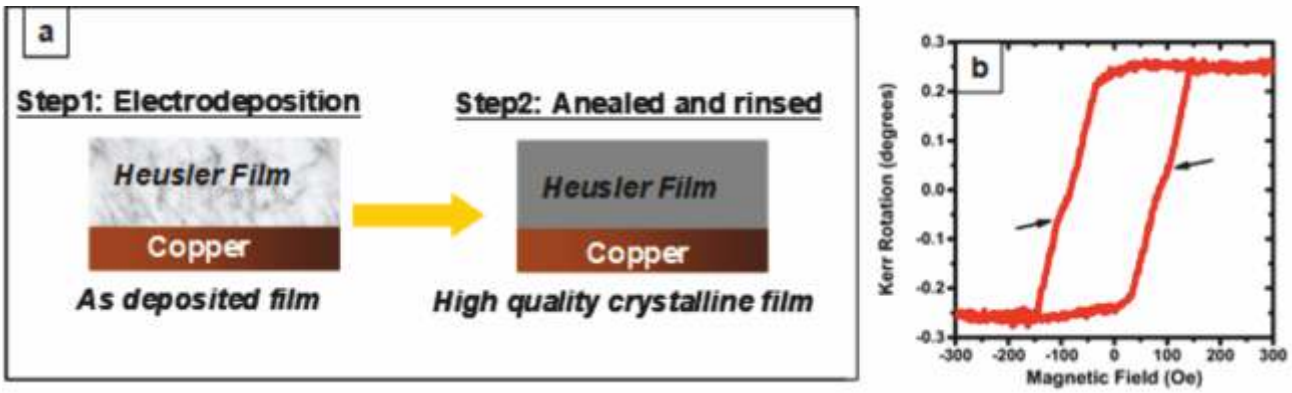
No of PhD/Postdoc/intern student:

PhD students - **5,** Project fellow – **1**, Intern student – **1**

5. Dr. Indranil Sarkar, Scientist-E/Associate Professor

Research Activities/Highlights:

- We have developed a novel scheme based on electrochemical method for growing thin films of a very important device material for spintronic application namely Heulser alloy
- This scheme developed provides a very cost effective and easy method of Heusler alloy film growth compared to conventional scheme of high vacuum evaporation method which is both expensive and complex.
- The electrodeposited Heulser alloy film on polycrystalline copper plates show high magnto optical response as revealed by detection of large kerr rotation
- We have demonstrated the possibility of all electrochemical growth of metal oxide/ Heulser alloy heterostructures.



(a) The figure shows schematic of novel electrochemical route for realizing high quality Heusler alloy film deposition. (b) The figure shows giant magneto optic response of electrodeposited film as evidenced by presence of large kerr rotation under application of magnetic field.

Significant Achievements:

Our results showed the possibility of using a simple and a cost effective method for growth realization of Heusler alloy/ oxide hetrostructure film.

Selected Publications:

1. Haque, A.; Banik, A.; Varma, R. M.; Sarkar, I.; Biswas, K.; Santra, P. K. Understanding the Chemical Nature of the Buried Nanostructures in Low Thermal Conductive Sb-Doped SnTe by Variable-Energy Photoelectron Spectroscopy. *J. Phys. Chem. C* **2019**, *123*, 1610272.
2. Pramanik, A.; Pandeya, R. P.; Ali, K.; Joshi, B.; Sarkar, I.; Moras, P.; Sheverdyaeva, P. M.; Kundu, A. K.; Carbone, C.; Thamizhavel, A.; Ramakrishnan, S.; Maiti, K. Depth-resolved core level spectroscopy of noncentrosymmetric solid BiPd. *Phys. Rev. B* **2020**, *101*, 035426.

No of PhD/Postdoc/intern student:

PhD student- **1**, Intern – **2**

6. Dr. Kaushik Ghosh, Scientist-E/Associate Professor

Research Activities/Highlights:

Electronics:

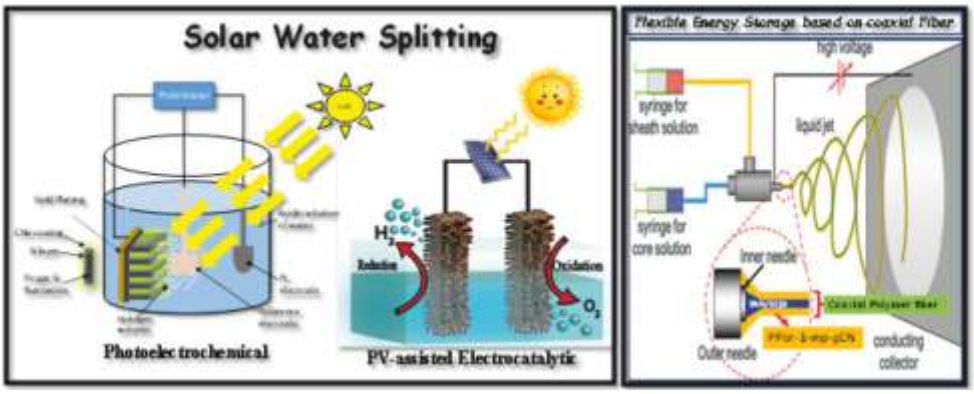
- CNT-Graphene based FED/FET device, 3DIC interconnect fabrication, characterization & reliability Study & Thermal Management.
- Carbon based piezoelectric device.

Energy:

- Advanced Material Synthesis for Solar Cell Application / Renewable Energy.
- Noncorrosive hydrophobic ARC coating for Solar glass.
- All Carbon based Transparent /Flexible micro-coil Supercapacitor.
- Novel Photo catalyst for PEC water splitting.
- Photo-Voltaic assisted electrochemical water splitting: Alternate to PEC.
- CO2 reduction: Photo, Thermal & Electrochemical

Sensor:

- Graphene-nanoribbon based NEMS detector.
- Novel Graphitic VACNT magnetic coils



Significant Achievements:

Dr. Kaushik Ghosh has received bilateral research project from India-Japan (DST-JSPS) Cooperative Science Programme (IJCSP)-2019 under "Materials and System Engineering: Man-Made Systems" category for implementation for the period of two years (2020-2022).

Selected Publications:

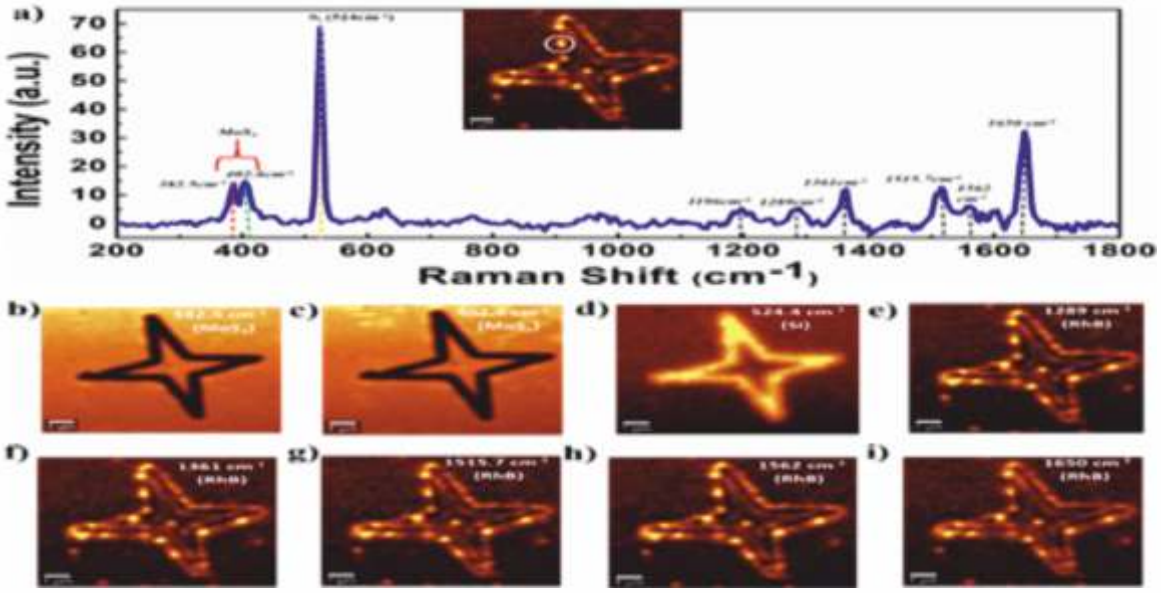
1. Kumar, S.; Aziz, T.; Kumar, S.; Riyajuddin, S.K.; Yaniv, G.; Meshi, L.; Nessim, G.L.; Ghosh, K. 3-Dimensional Graphene Decorated Copper-Phosphide (Cu3P@3DG) Heterostructure as Effective Electrode for Supercapacitor. *Frontiers in Materials, Energy Materials* **2020**, 7, 30.
2. Riyajuddin, S. K.; Kumar, S.; Gaur, S. P.; Sud, A.; Maruyama, T.; Ali, M. E.; Ghosh, K. Linear Piezoresistive Strain Sensor based on Graphene/g-C_3N_4/PDMS Heterostructure. *Nanotechnology* **2020**, *31,* 295501.
3. Riyajuddin, S. K.; Aziz, T.; Kumar, S.; Nessim, G. D.; Ghosh, K. 3D-Graphene Decorated with g-C_3N4/Cu_3P composite: A Noble Metal-free Bifunctional Electrocatalyst for overall water splitting. *ChemCatChem* ***2019,*** *12*, 1394.

No of PhD/Postdoc/intern students:

PhD students – **3,** Intern – **2,** Project fellow - **1**

7. Dr. Kiran Shankar Hazra, Scientist-D/Assistant Professor

Research Activities/Highlights:
Our group research activities have been focused on artificially nanostructuring of 2D semiconductors and exploring their optical and electronic response. We have demonstrated controlled formation of surface enhanced Raman hotspots by sculpting artificial edges in monolayer MoS2. We have also developed metal free SERS substrate on few layer black phosphorus by low power focused laser irradiation technique. In another report we have given insight on how vibrational and electronic properties of MoS2 gets affected by transverse and vertical gate electric field. We are also working of contact engineering of 2D hetero-structures and non-cryogenic bolometer sensors.



Significant Achievements:
Our research group has established a straightforward and unique route to fabricate precisely controlled nanostructures of desired geometry and location on 2D materials, which is a rapid one-step low power laser writing process. In this process, a focused laser beam of meagre power of a conventional Raman spectrometer is used to do nanostructuring on 2D flakes of desired feature size and geometry just by playing with the laser power and exposure time. Using this technique, we can achieve the minimum feature size of ~300nm, which is close to the diffraction limit of the laser used (i.e., 532nm laser line). This process does not require any photoresist coating and not go through the standard semiconducting multistep process flow.

Selected Publications:

1. Rani, R.; Jena, N.; Kundu, A.; Sarkar, A. D.; Hazra, K. S. Impact of transverse and vertical gate electric field on vibrational and electronic properties of MoS2, *J. Appl. Phys.* **2020**, *127,* 45101.
2. Kundu, A.; Rani, R.; Hazra, K. S. Controlled nanofabrication of metal-free SERS substrate on few layered black phosphorus by low power focused laser irradiation, *Nanoscale,* **2019**, *11,* 16245.
3. Rani, R.; Kundu, A.; Hazra, K. S. Spectral dependent white light reflection mapping of MoS2 flake for improving accuracy of conventional optical thickness profiling, *Opt. Mater.* **2019,** *90,* 46.

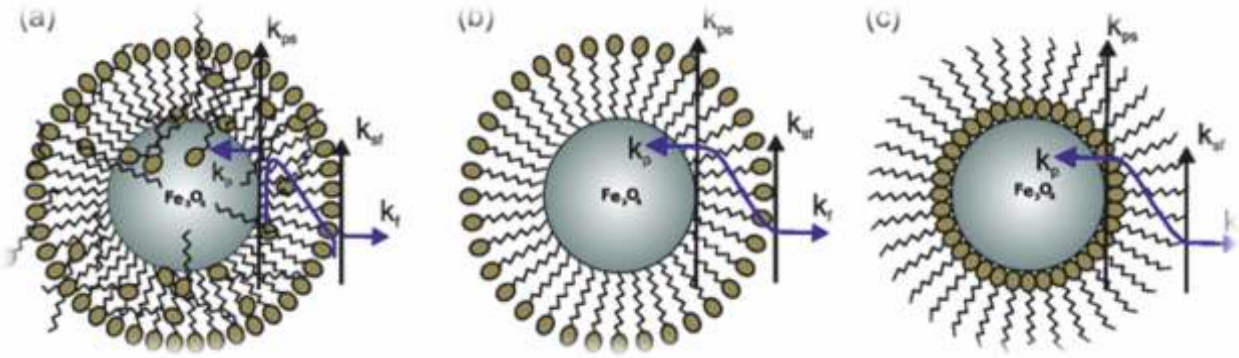
No of PhD/Postdoc/intern students:
PhD students – **4**

8. Dr. Chandan Bera, Scientist-D/Assistant Professor

Research Activities:

Dr. Bera's group is working on the thermal and electron transport mechanism in alloy materials and developing a simple predictive model for thermal and electron transport in 2D and nanostructured materials for the efficient design of the thermoelectric device. His group also interested in electron and spin transport properties in the heterostructure interface and working on the electronic and spintronic properties of the interface from the atomistic calculation based on density functional theory.

- Nanoscale phonon and electron transport
- Thermoelectric properties and energy conversion
- Nanomaterials, nanotechnology, Computational Nanoscience



Mechanistic insights of the surface contribution towards heat transfer in a nanofluid

Significant Achievements:

- Dr. Chandan Bera is selected for the thematic collection of Emerging Investigators of Physical Chemistry Chemical Physics.
- Dr. Chandan Bera and his Ph.D. student Ms. Sonali Kakkar visited TU Wien under the DST-OeaD exchange project.
- First Ph.D. student (Ms. Prabhjot Kaur) from Dr. Chandan Bera group awarded Ph.D. degree in December 2019.

Selected Publications:

1. Gupta, R.; Bera, C. Spin-orbit coupling effect on the thermopower and power factor of CoSbS, *Phys. Rev. B*, **2020, *101,*** 155206.
2. Gupta, R.; Kaur, B.; Carrete, J.; Bera, C. A theoretical model of the thermoelectric properties of SnSxSe1-xand how to further enhance its thermoelectric performance, *J. Appl. Phys.* **2019**, ***126,*** 225105.
3. Lenin, R.; A. Singh, A.; Bera, C. Role of nanoparticle interaction in magnetic heating. *MRS Communications*, **2019**, ***9,*** 1034.

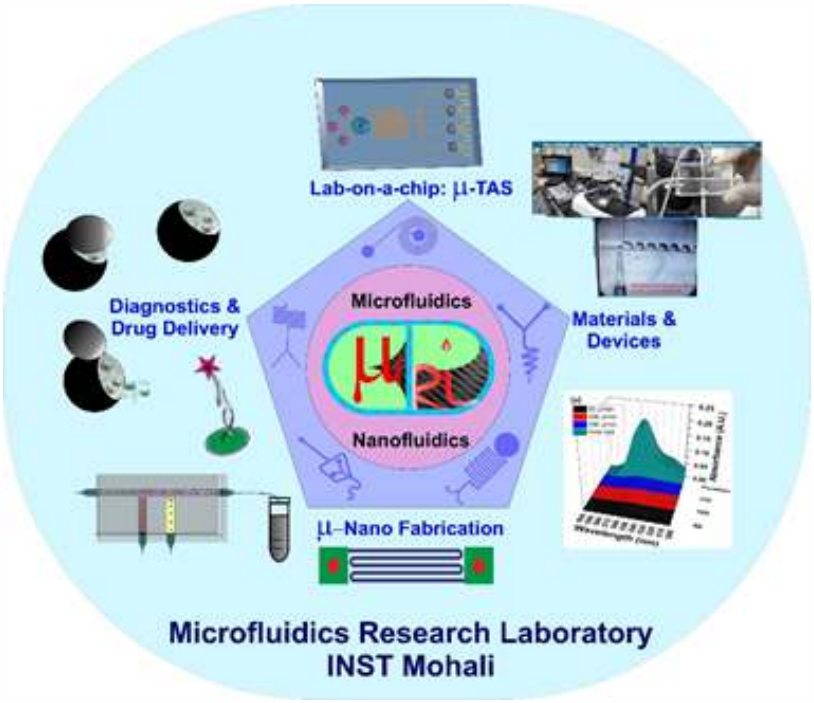
No of PhD/Postdoc/intern students:

PhD students: **6**, Postdoc: **1**

9. Shri Bhanu Prakash, Scientist-C

Research Activities:

- Experimental microfluidics and micro-nano fabrication for device applications.
- Synthesis of novel nanostructures using microfluidic route for inline photocatalytic and photovoltaic applications is ongoing work.
- To combine surface enhanced Raman spectroscopy (SERS) and plasmonics with microfluidics for different device based applications is also being explored.
- Designing new devices for energy conversion/harvesting and development of sensors for food safety, environmental safety and in particular homeland security applications.
- Apart from this, in collaboration, we are also working on synthesis of peptide nanostructures and development of devices for biomedical use.



Microfluidics for Sensing and Device Applications

Significant Achievements:

- Developed new platform for in-channel nanostructure synthesis and photocatalysis.
- Developed new microfluidic platform for continuous and droplet microfluidics via time effective and low cost routes avoiding the use of expensive lithographic setups.
- Microfluidic device for enrichment of live and motile spermatozoa of cattle with NDRI Karnal (Indian Patent: 202011008229).

Selected Publications:

1. Dube, T.; Kumar, N.; Kour, A.; Mishra, J.; Singh, M.; Prakash, B; Panda, J. J. Gold Nano-/Micro-Roses on Levodopa Microtubes for SERS-Based Sensing of Gliomas. *ACS Appl. Nano Mater*. **2019**, *2*, 5.
2. Varshney, R.; Sharma, S.; Prakash, B.; Laha, J.; Patra, D. One Step Fabrication of Enzyme Immobilized Reusable Polymerized Microcapsules from Microfluidic Droplets. *ACS Omega,* **2019,** *4*, 13790.

No of PhD/Postdoc/intern students:

Project Assistant – **1**, Intern -**1**

CHEMICAL BIOLOGY UNIT

CBU

Prof. Deepa Ghosh

Prof. Surajit Karmakar

Dr. Asish Pal

Dr. Sharmistha Sinha

Dr. Rahul Kumar Verma

Dr. P S Vijayakumar

Dr. Jiban Jyoti Panda

Dr. Subhasree Roy Choudhury

Dr. Sangita Roy

Dr. Manish Singh

Dr. Asifkhan

Dr. Deepika Sharma

Dr. Rehan Khan

Dr. Shyam Lal M

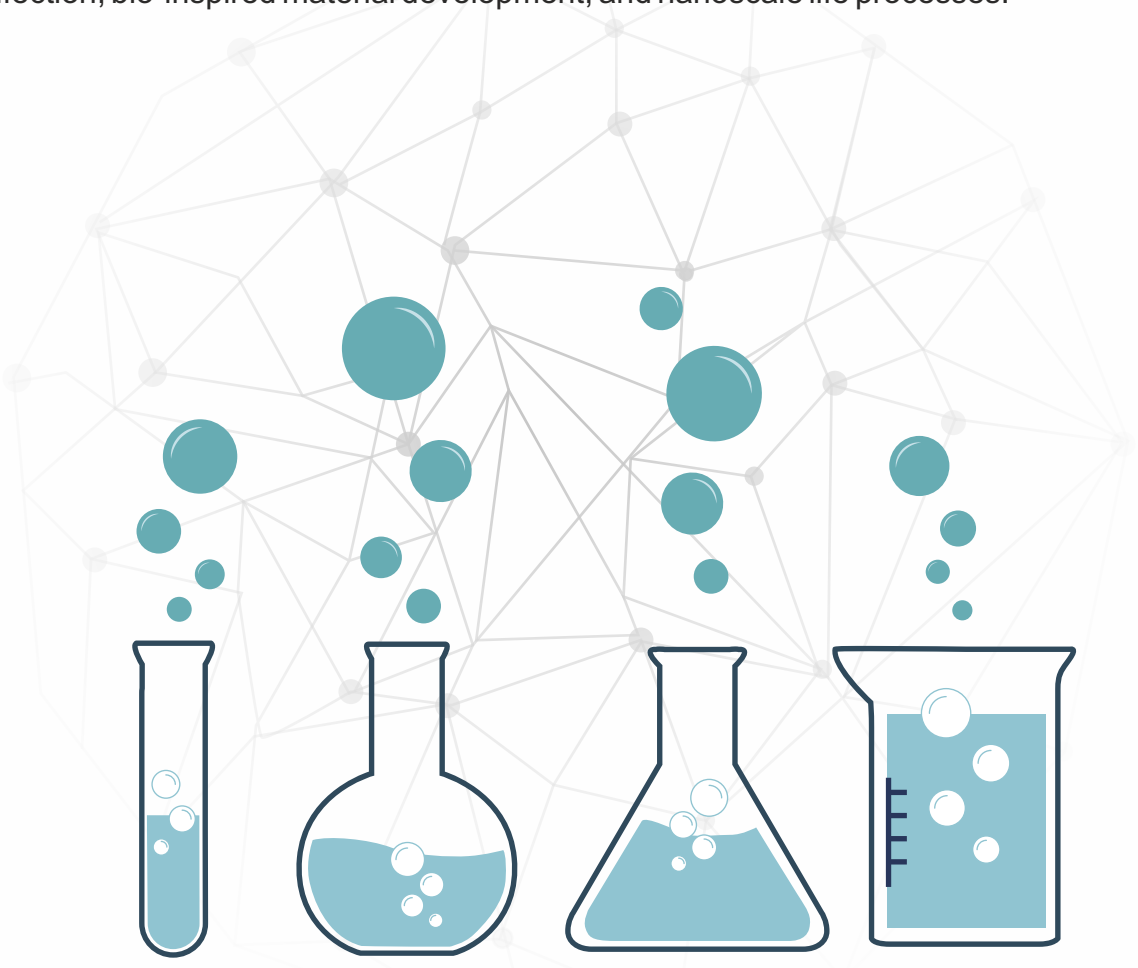
CHEMICAL BIOLOGY UNIT

The Chemical Biology Unit at INST is a centre for interdisciplinary work at the interface of biology and chemistry. CBU is one of the important thrust areas of the institute where fourteen research groups of chemists, biologists, pharmacologists, and agriculture scientists are working together to develop unique nanotechnological tools or protocols to explore and solve biological questions. The main emphasis of the unit is to address problems that surpass the common regime of chemistry and biology with the help of nanoscience and nanotechnology. Chemical biologists at INST probe molecular events that are relevant to humans, plants, animals, and microbes.

Following are the some of the major research area at the unit:

- Therapeutics, disease management and drug delivery in cancer
- Nanotherapeutic management of infectious diseases and microbes
- Tissue engineering and development of biological scaffolds
- Biomimetics
- Understanding biomolecular events at the nanoscale

CBU researchers contribute at the evolving interface of science and explore drug delivery, diagnostic and disease management principles, *in vivo* imaging ventures, microbial biology and infection, bio-inspired material development, and nanoscale life processes.

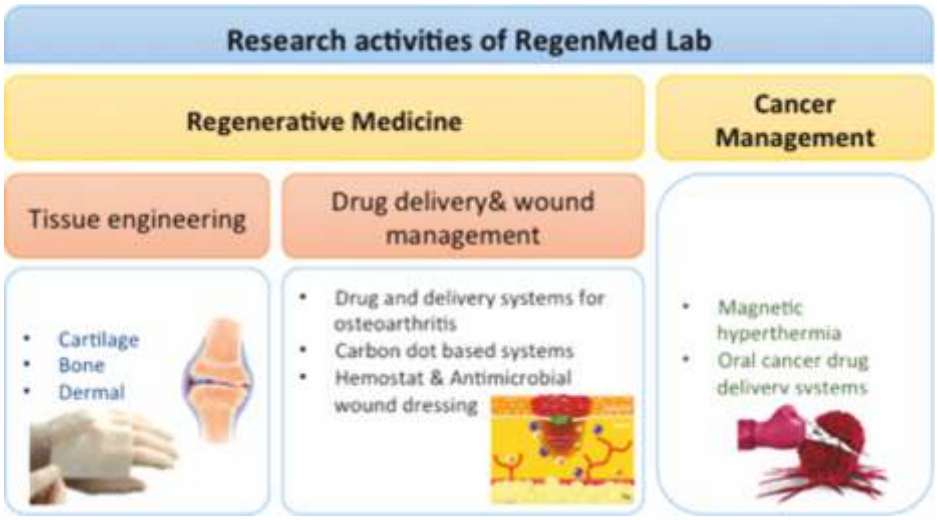


1. Prof. Deepa Ghosh, Scientist-F / Professor

Research Activities/Highlights:

Pre-clinical evaluation of a low-cost starch-based topical haemostat is developed. The patented product is under scale-up process and studies in larger animals are to be initiated.

- Drug and drug delivery platforms for addressing osteoarthritis and wound healing.
- Cartilage tissue engineering projects to address articular cartilage damage.
- Treatment of diabetic wound dressing using tissue engineering approaches using piezoelectric materials
- Collaborative project with Rajiv Gandhi Centre for Biotechnology in developing drug delivery platform for addressing oral cancer rebound after surgery.



Significant Achievements:

The group developed a low-cost haemostatic agent which is very efficient in comparison with marketed products. The patented product is under scale-up. We designed *in situ* magnetic nanoparticles inside a cancer cell can be utilised to treat cancer using magnetic hyperthermia. The results were promising and testing in relevant *in vivo* models is planned.

Selected Publications:

1. Kaushik, S., Thomas, J., Panwar, V., Ali, H., Chopra, V., Sharma, A., Tomar, R.; Ghosh, D. In situ biosynthesized Superparamagnetic Iron oxide Nanoparticles (SPIONS) induce efficient hyperthermia in cancer cells. *ACS Appl. Bio Mater.* **2020**, 3, 2, 779-788.
2. Panwar, V., Thomas, J., Sharma, A., Chopra, V., Kaushik, S., Kumar, A.; Ghosh, D. In-vitro and in-vivo evaluation of modified sodium starch glycolate for exploring its haemostatic potential. *Carbohydr. Polym.* **2020**, 235, 115975.
3. Panwar, V., Sharma, A., Thomas, J., Chopra, V., Kaushik, S., Kumar, A.; Ghosh, D. In-vitro and In-vivo evaluation of biocompatible and biodegradable calcium-modified carboxymethyl starch as a topical hemostat. *Materialia* **2019**, *7*, 100373.

Patents

- Ghosh, D.; Swati Kaushik, S. Magnetic nanoparticles for live-cell imaging and highly efficient hyperthermia. *Indian patent No.* TEMP/E-1/22628/2019-DEL.
- Ghosh, D.; Panwar, V.; Anjana Sharma, A.; Jijo Thomas, J.; Kaushik, S. Modified polysaccharide material having hemostatic properties. *Indian patent No.* TEMP/E-1/11313/2019-DEL.

No of PhD/Postdoc/intern students:

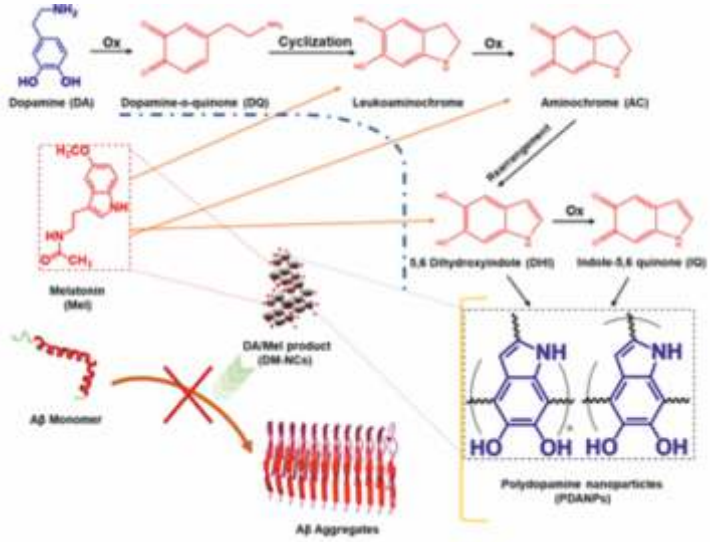
PhD Students - **4**, Post Doc: **2**, Project JRF: **1**

2. Prof. Surajit Karmakar, Scientist-F/Professor & Dean-Administration

Research Activities/Highlights:

Development of nano-therapeutics including screening of peptide and small molecule combinatorial therapy, siRNA delivery and peptide-mediated cancer therapy by targeting mitochondrial metabolism.

- Understanding the molecular mechanisms of diabetic retinopathy and their prevention by nanotherapy.
- Nanomaterials for tumour imaging and chemo-photo combination therapy. To overcome resistance to chemotherapy, target validation, signal transduction in membrane proteins and nanoparticles endocytotic cascade.
- Receptor and ion channel regulation on cell membrane organization, endosomal function and escape. Environment, Food and probiotic Nanobiotechnology.



Schematic illustrating the mechanism of DM-NCs evolution and its Aβ anti-aggregation/disaggregation activity

Significant Achievements:

We report a dopamine-melatonin nanocomposite (DM-NC), which possesses a synergistic near-infrared (NIR) responsive photothermal, pharmacological modality and can withstand variable pH and peroxide environment. NIR-activated melatonin release and photothermal effect collectively inhibit Aβ nucleation, self-seeding, and propagation and can also disrupt the preformed Aβ fibres examined using in vitro Aβ aggregation and Aβ-misfolding cyclic amplification assays.

Selected Publications:

1. Srivastava, A.K.; Choudhury, S.R.; Karmakar, S. Near-Infrared Responsive Dopamine/Melatonin-Derived Nanocomposites Abrogating in Situ Amyloid β Nucleation, Propagation, and Ameliorate Neuronal Functions. *ACS Appl. Mater. Interfaces* **2020**, 12, 5658.
2. Srivastava, A.K.; Roy Choudhury, S.R.; Karmakar S. Melatonin/Polydopamine Nanostructures for Collective Neuroprotection based Parkinson's disease Therapy. *Biomater. Sci.* **2020**, ***8***, 1345.
3. Sood, A.; Dev, A; Mohanbhai, S.J.; Shrimali, N.; Kapasiya, M.; Kushwaha, A.; Roy Choudhury, S.R.; Guchhait, P.; Karmakar S. Disulfide-Bridged Chitosan-Eudragit S-100 Nanoparticles for Colorectal Cancer. *ACS Appl. Nano Mater*. **2019**, *2*, 6409.

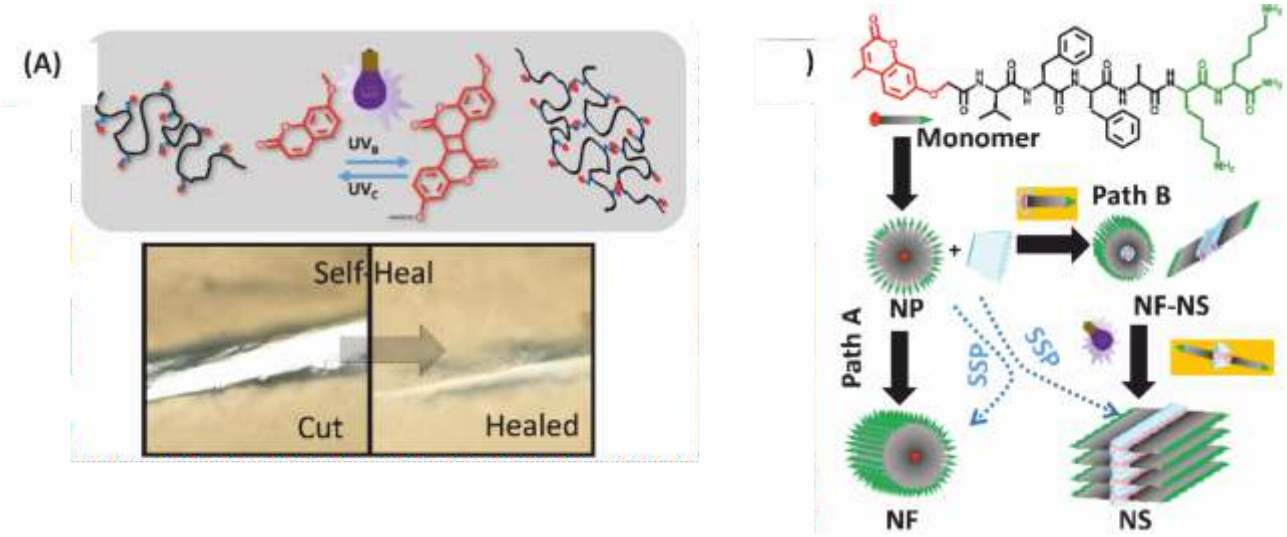
No of PhD/Postdoc/intern students:

PhD students – **3**, Post Doc -**1**, intern -**1**

3. Dr. Asish Pal, Scientist-E/Associate Professor

Research Activities:

- Stimuli-responsive collapse of single chain polymer to polymeric nanoparticles and their applications in self-healing coating, catalytic nanoreactors and drug delivery across blood brain barriers.
- Pathway complexity in self-assembly of peptide materials, strategies including living supramolecular polymerization, self-sorting to control shape and size of nanostructures in amyloid like peptide fibers.
- Peptide, polymer hydrogels and stimuli-responsive behavior for targeted drug delivery and 3-dimensional scaffold for tissue engineering.



(A) Photo-triggered self-healing system through the control of chain collapse in functional single chain polymers, (B) Pathway complexity of amyloid-inspired peptide amphiphiles mediated by photo-irradiation and host-guest complexation to result diverse nanostructures such as nanoparticles (NP), nanofibers (NF) and nanosheets (NS)

Significant Achievements:

Recently, our group has developed an excellent self-healing polymer material that is being explored for smart and corrosion resistant coating for photovoltaic solar cell.

Selected Publications:

1. Joseph, J. P.; Miglani, C.; Singh, A.; Gupta, D.; Pal, A. Photoresponsive Chain Collapse in Flexo-rigid Functional Copolymer to Modulate Self-healing Behavior. *Soft Matter* **2020**, *16*, 2506.
2. Joseph, J. P.; Singh, A.; Gupta, D.; Miglani, C.; Pal, A. Tandem Interplay of Host-guest Interaction and Photo-responsive Supramolecular Polymerization to 1D and 2D Functional Peptide Materials. *ACS. Appl. Mater. Interface* **2019**, *11*, 28213.
3. Sharma, K.; Joseph, J. P.; Sahu, A.; Yadav, N.; Tyagi, M.; Singh, A.; Pal, A.; Kartha, K. P. R. Supramolecular Gels from Sugar-linked Triazole Amphiphiles for Drug Entrapment and Release for Topical Application. *RSC. Adv*. **2019**, *9*, 19819.

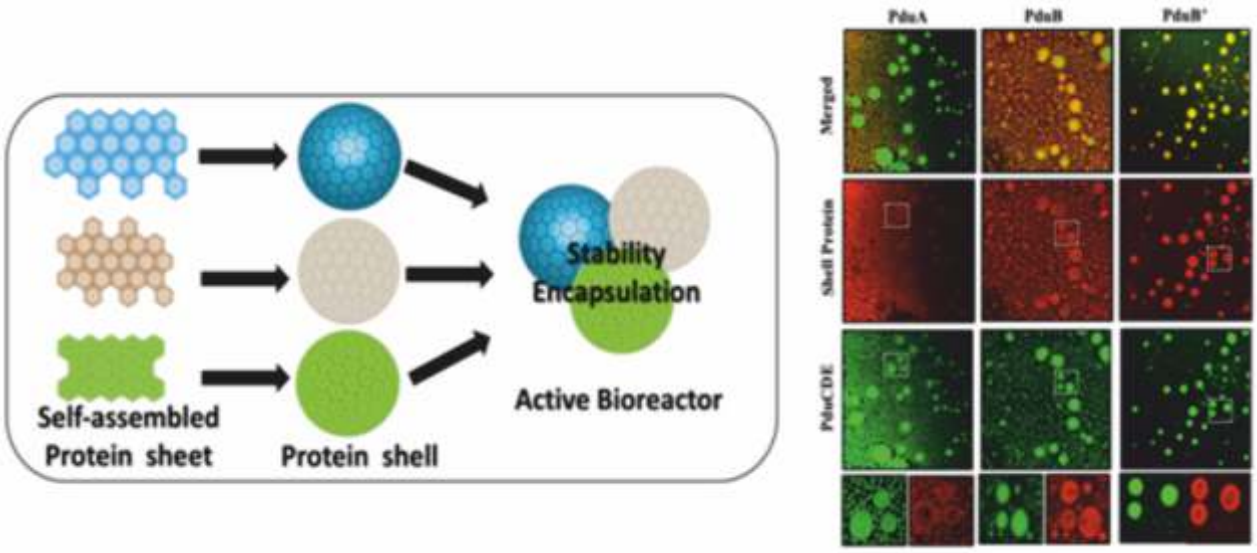
No of PhD/Postdoc/intern students:

PhD students - **4**, post doc – **1** and intern student - **3**

4. Dr. Sharmistha Sinha, Scientist-E / Associate Professor

Research Activities/Highlights:

- Genetic mutations that results in switching of one amino acid to different variants at the same codon in *p53 gene* show different cancer cell progression.
- The need of developing therapeutic strategies that consider the resultant mutant-variant as a target rather than mutation position.
- Development of nanocomponent protein shell for studying individual BMC shell proteins
- The shell proteins show similar behaviour towards native substrate but different behaviour for ectopic substrates.



Protein compartments for studying properties of individual proteins from heterogenic protein compartments

Significant Achievements:

- Our group has demonstrated successfully how to simplify the complex micro compartments into simple protein compartments for functional and structural assays. Further we have provided insights into the mechanism of biogenesis of bacterial micro-compartments.
- Dr. Sharmistha Sinha has received the prestigious Har Govind Khorana-Innovative Young Biotechnologist Award 2019.

Selected Publications:

1. Garg, A.; Hazra J. P.; Sannigrahi, M. K.; Rakshit, S.; Sinha S. Variable Mutations at the p53-R273 Oncogenic Hotspot Position Leads to Altered Properties. *Biophys. J*, **2019**, *118, 720-728*.
2. Bari, N. K.; Kumar, G.; Hazra J. P.; Kaur, S; Sinha S. Functional protein shells fabricated from the self-assembling protein sheets of prokaryotic organelles. *J. Mat. Chem. B*, **2020**, ***8***, *523-533*.

Patent: A Cellulose- Metallothionein Conjugate For Metal Binding (Applied: Temp-E-1/35136/2017-Del)

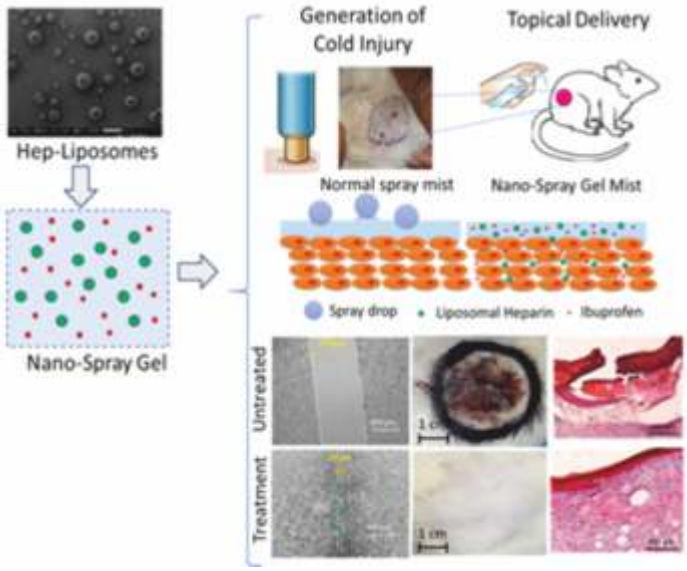
No of PhD/Postdoc/intern students:

PhD Students – **6** Intern student - **1**

5. Dr Rahul K. Verma, Scientist-D/Assistant Professor

Research Activities/Highlights:

- Development and evaluation of heparin encapsulated metered-dose topical "Nano-spray gel" liposomal formulation ensures rapid on-site management of frostbite injury.
- Developed and animal trials of dynamic inhalable particles for TB therapy.
- Elucidation of mechanism of bacterial killing by alginate Micro-Spheres.



Heparin encapsulated metered-dose topical "Nano-spray gel" liposomal formulation ensures rapid on-site management of frostbite injury by inflammatory cytokines scavenging

Significant Achievements:

Our work on heparin encapsulated metered-dose topical "Nano-spray gel" liposomal formulation for rapid on-site management of frostbite injury published in **ACS Biomaterials and Engineering Sciences** received one of the top attention score and considered important paper published in 2019 by American Chemical Society. This work was widely published by more than 41 international media houses (Eureka-alert, Medical dialogues, News medical life sciences Science daily, New Atlas, Physiological.org, Nanowerk, x-mol, Dailymail, tereko-helsinki *etc*.)

Selected Publications:

1. Sharma, A.; Vaghasiya, K.; Gupta, P.; Singh, A.K.; Gupta, U. D.; Verma, R. K. Dynamic mucus penetrating microspheres for efficient pulmonary delivery and enhanced efficacy of host defense peptide (HDP) in experimental tuberculosis. *J. Control. Release.* **2020,** *324*, 6617.
2. Sharma, A.; Vaghasiya, K.; Gupta, P.; Singh, A. K.; Gupta, U.D.; Verma, R.K. Targeted pulmonary delivery of Epigallocatechin gallate (EGCG), a green tea polyphenol controls the growth of *Mycobacterium tuberculosis* by enhancing the autophagy and supressing bacterial burden. *ACS Biomater. Sci. Eng.* **2020,** 8, *23*, 4357.
3. Vaghasiya, K.; Sharma, A.; Kumar. K.; Ray. E.; Katare. O. P.; Hota. S. K.; Verma, R. K. Heparin encapsulated metered-dose topical "Nano-spray gel" liposomal formulation ensures rapid on-site management of frostbite injury by inflammatory cytokines scavenging. *ACS Biomater. Sci. Eng.* **2019,** *5*, 6617.

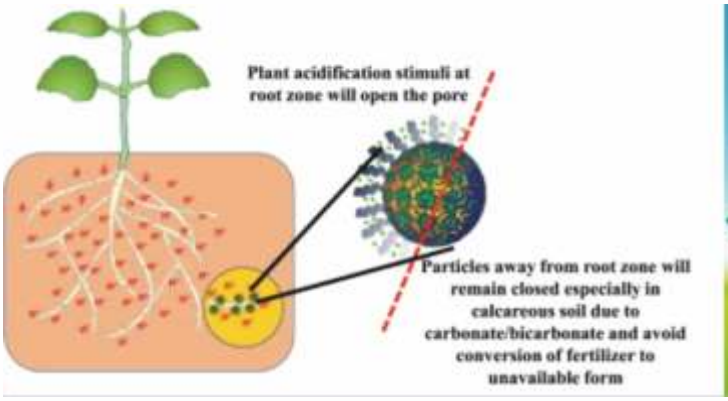
No of PhD/Postdoc/intern student:

PhD students - **4**, Intern student - **2**

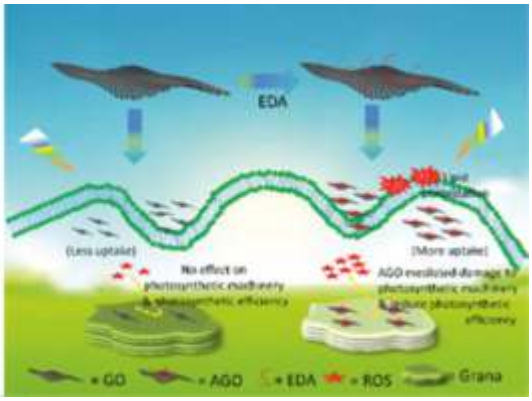
6. Dr. P. S. Vijaya Kumar, Scientist-D/Assistant Professor

Research Activities/Highlights:

- **Nano-hives for plant stimuli controlled targeted iron fertilizer application**: Synthesized, FeSO4 loaded mesoporous silica coated with chitosan FeSO4@MS@CH. FeSO4@MS@CH shows more iron release in pH 5 compared to pH 7. FeSO4@MS@CH applied tomato showed more root binding and express significantly less deficiency expression.
- **Effect of galvanotaxic graphene oxide on chloroplast activity**: Interaction quantified with Biolayer-Interferometry coupled confocal microscopy



Nano-hives for plant stimuli controlled targeted iron fertilizer application



Charge dependent binding of graphene oxide in the chloroplast.

Significant Achievements:

We developed eco-friendly targeted fertilizer application formulation and tested in the efficiency in the lab (published in reputed journal and appreciated with few poster awards). Adopting the technology to test in the large scale with modifications and initiated trial in the field scale.

Selected Publications:

1. Pulkit, Kaur, K.; Rawat, A.; Sarka, A. D.; Singh M.; Vijayakumar P. S**.** Nano-hives for plant stimuli controlled targeted iron fertilizer application,*Chemical engineering journal*, **2019**, *375*, 121995.
2. Sharma, S.; Sahu, B.; Srinivasan, S.; Singh, M.; Jayamurugan, G.; Vijayakumar P. S. Effect of galvanotaxic graphene oxide on chloroplast activity: Interaction quantified with Biolayer-Interferometry coupled confocal microscopy, *Carbon*, **2020**, *162*, 147.

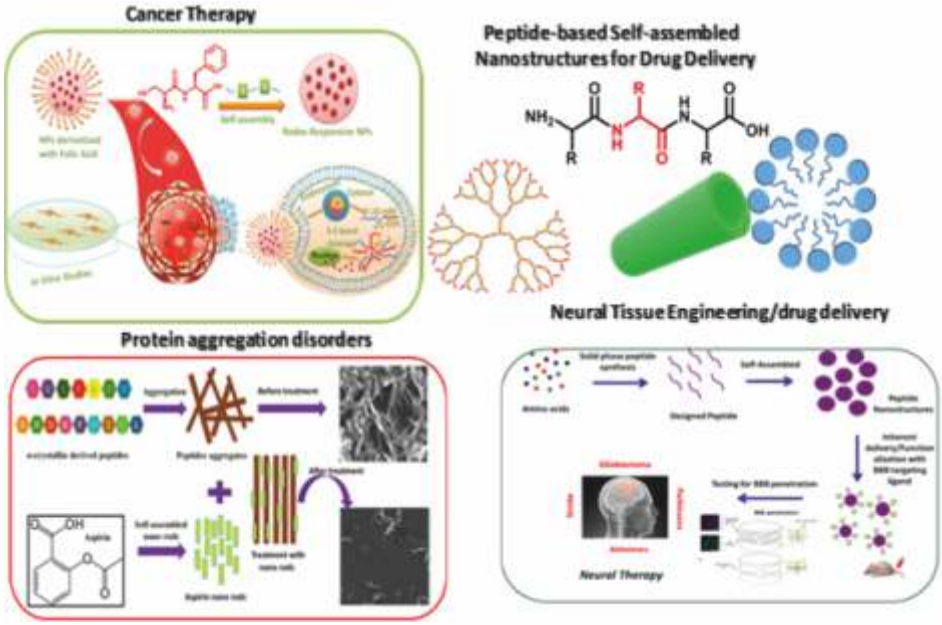
No of PhD/Postdoc/intern student:

PhD students - **4**, Intern students – **2**

7. Dr. Jiban Jyoti Panda, Scientist-D/Assistant Professor

Research Activities/Highlights:

- Design and synthesis of nanostructures for targeting different protein aggregation disorders. Recently, we established a peptide-based crystalline aggregation model with aspirin based nanorods as potential inhibitor towards the protein aggregation and non-invasive therapy for cataract disease.
- We developed cancer targeted and redox-responsive nanoparticles (NPs) from disulfide linked oxidized cysteine-phenylalanine (CFO). The NPs were conjugated with folic acid (FA) to specifically target cancer cells, and the presence of disulfide bonds would enable the disintegration of the particles in the presence of elevated levels of glutathione (GSH) in cancer cells for enhanced delivery and efficacy of the entrapped drug molecules.



Significant Achievements: Long Term ICMR-DHR international Fellowship for Young Biomedical Scientists 2019-20: Dr Jiban Jyoti Panda.

Selected Publications:

1. Chibh, S.; Kaur, A.; Yadav, N.; Kumar, P.; Yadav, P.; Chauhan, V. S.; Panda, J. J. Redox-Responsive Dipeptide Nanostructures toward Targeted Cancer Therapy. *ACS Omega.* **2020**, *5*, 3365-3375.
2. Gondil, V. S.; Dube, T.; Panda, J. J.; Yennamalli, R. M.; Harjai, K.; Chhibber, S. Comprehensive evaluation of chitosan nanoparticle based phage lysin delivery system; a novel approach to counter S. pneumoniae infections. *Int J Pharm*. **2020,** *5*, 573:118850
3. Bisht, A.; Sharma, M.; Sharma, S.; Ali, M. E.; Panda, J. J. Carrier-free self-built aspirin nanorods as anti-aggregation agents towards alpha-crystallin-derived peptide aggregates: potential implications in non-invasive cataract therapy. *J Mater Chem B.* **2019,** *28,* 6945-6954.

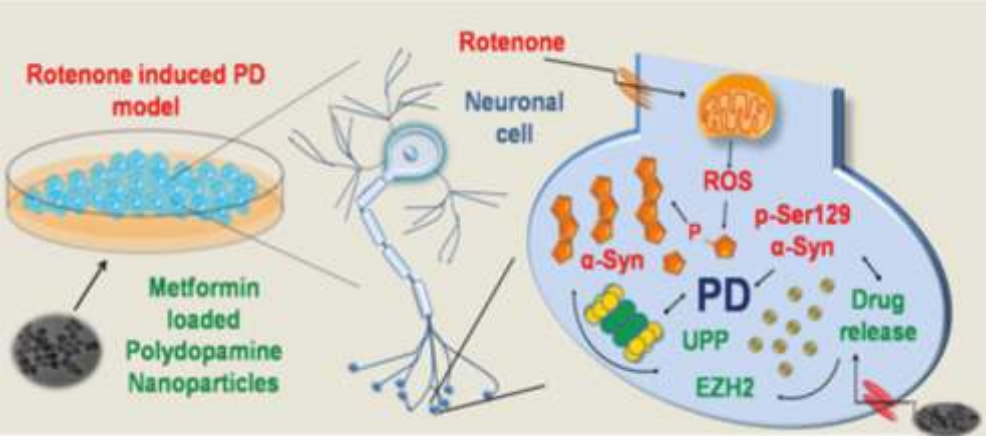
No of PhD/Postdoc/intern students:
PhD students – **4**, Interns - **2**, Project student: **1**

8. Dr. Subhasree Roy Choudhury, Scientist-C

Research Activities/Highlights:

Development of target specific Nano therapeutics for epigenetic regulation of cancer and neurodegenerative diseases in the following areas;

- Epigenetic regulation and nanotherapeutic intervention of Polycomb mediated proteasomal signalling in Acute Myeloid Leukaemia.
- Nano therapy controlling epigenetic transcriptional repression in neurodegenerative Parkinson's disease model.
- Epigenetic suppression of Polycomb by NIR responsive Photo-Chemo-Combination therapy for Glioblastoma.
- Regulation of PP2A mediated Epigenetic signalling for colorectal cancer and its control by Chemo-Photodynamic combinatorial nanotherapy.



Schematic illustrating recuperative Effect of Metformin loaded Polydopamine Nanoformulation promoting EZH2 mediated Proteasomal Degradation of phospho-α-Synuclein for Parkinson's disease prevention.

Significant Achievements:

We reported neuroprotection efficacy of bio-compatible polydopamine nanocarrier for metformin delivery by crossing blood brain barrier *in vitro*, 3D and *in vivo* experimental Parkinsons models. The neuroprotective potential was arbitrated by downregulation of phosphoserine 129 (pSer129) α-Syn, with reduction in oxidative stress, prevention of apoptosis and anti -inflammatory activities and proved novel interaction of epigenetic regulator EZH2 mediated ubiquitination and proteasomal degradation of aggregated pSer129 α-Syn for Parkinsons disease prevention.

Selected Publications:

1. Sardoiwala, M. N.; Srivastava, A.K.; Kaundal, B.; Karmakar, S.; Choudhury, , S. R. Recuperative effect of metformin loaded polydopamine nanoformulation promoting EZH2 mediated proteasomal degradation of phospho-α-synuclein in Parkinson's disease model. *Nanomed: Nanotech, Bio and Med* **2020**, 24, 102088.
2. Sardoiwala, M.N.; Kushwaha, A.C.; Dev, A.; Shrimali, N.; Guchhait, P.; Karmakar, S.; Choudhury, S. R. Hypericin-Loaded Transferrin Nanoparticles Induce PP2A-Regulated BMI1 Degradation in Colorectal Cancer-Specific Chemo-Photodynamic Therapy. *ACS Biomater. Sci. Eng.* **2020**, 6, 3139.
3. Kaundal, B.; Srivastava, A.; Dev, A.; Mohanbhai, S. J.; Karmakar, S.; Choudhury, S. R. Nanoformulation of EPZ011989 attenuates EZH2-c-Myb epigenetic interaction by proteasomal degradation in Acute Myeloid Leukemia. *Mol. Pharmaceutics* **2020**, 2, 604.

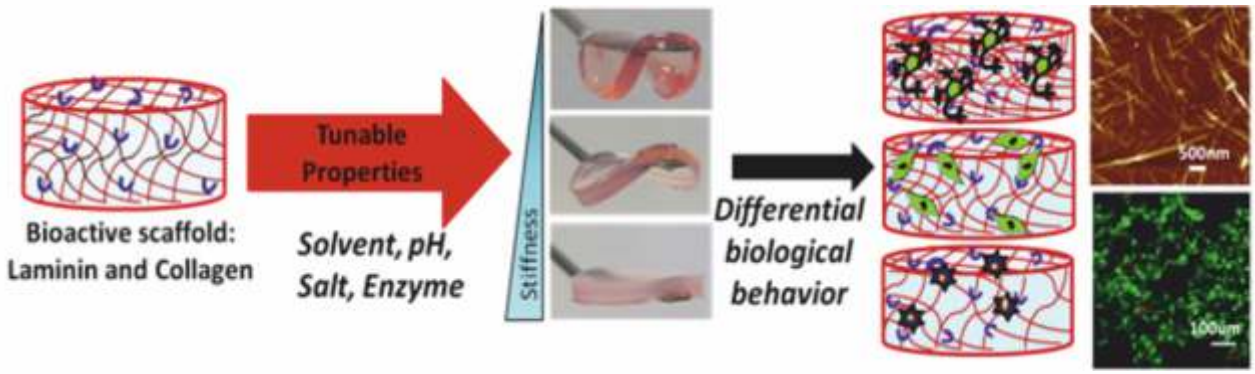
No of PhD/Postdoc/intern students:

Ph.D. students - **3**

9. Dr. Sangita Roy, Scientist-D/Assistant Professor

Research Activities/Highlights:

- Understanding design principle of peptide self-assembly to create organic-inorganic hybrid materials
- Exploration of minimalist peptide nanotechnology for development of novel biomimetic scaffolds as synthetic extracellular matrix (ECM)
- Designing the ultra-short peptide sequence to form hydrogel scaffolds based on structural and functional proteins of ECM, such as, Laminin, Collagen, Fibronectin etc.
- Studies on differential interactions of cells with these designer scaffolds
- Use of non-equilibrium self-assembly to control physicochemical properties of these bioactive scaffolds and create ideal microenvironment for cellular growth



Schematic representation of the development of designer bioactive peptide hydrogel scaffolds to provide biochemical and biophysical cues for controlling cellular behaviour

Significant Achievements:

- Our group explored a minimalistic approach to fabricate novel biomimetic functional scaffolds using self-assembling bioactive peptide sequences for designing an extracellular matrix (ECM) mimics for tissue engineering applications. We, for the first time, explored the library of structurally related pentapeptides derived from a natural extracellular matrix protein, Laminin, which plays crucial roles in cell adhesion, migration and proliferation.
- To construct a better mimic of natural ECM, we developed the conjugate gels from collagen and laminin mimetic peptides. The conjugate matrix offers an advantage of incorporating the properties of both structural as well as functional peptide segments of natural ECM.

Selected Publications:

1. Sharma, P.; Kaur, H.; Roy, S. Inducing Differential Self-Assembling Behaviour in Ultrashort Peptide Hydrogelators Using Simple Metal Salts, *Biomacromolecules* **2019**, *20,* 2610.
2. Pal, V. K.; Jain, R.; Roy, S. Tuning Supramolecular Structure and Function of Collagen Mimetic Ionic Complementary Peptides via Electrostatic Interactions. *Langmuir* **2020**, *36,* 1003.
3. Jain, R.; Roy, S. Controlling Neuronal Cell Growth through Composite Laminin Supramolecular Hydrogels, *ACS Biomater. Sci. Eng*. **2020**, *6,* 2832.

No of PhD/Postdoc/intern students:

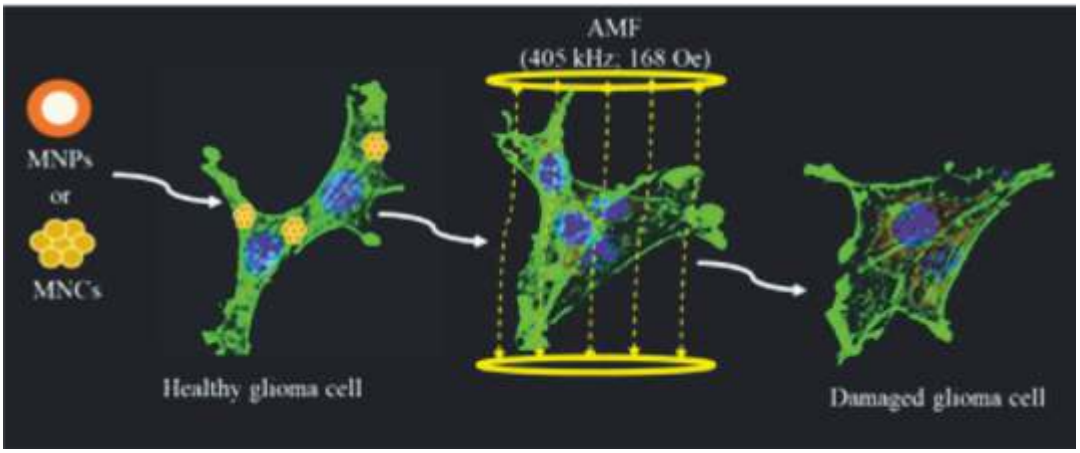
PhD students – **6**

10. Dr. Deepika Sharma, Scientist-C

Research Activities/Highlights:

The role of a natural bioactive – Stevioside, as a biosurfactant for magnetic nanoparticles was validated for application in magnetic hyperthermia-mediated glioblastoma cancer therapy.

- Different shapes (spherical and nanoclusters) are being investigated to enhance the hyperthermia output.
- The highest SAR value of ~600 W/g obtained for magnetic nanoclusters (MNCs), which was significantly higher than that obtained for spherical magnetic nanoparticles ~82 W/g (MNPs).
- Such a high SAR value of the nanoclusters further validates their potential as effective hyperthermia agents either alone or in conjugation with other theranostic therapies like photothermal therapy.
- Further, a remarkable increase in SAR values of modified STE molecule coated MNPs (209.25 W/g) when compared to unmodified STE coated MNP ~80 W/g was also observed.



Application of nano-magnets for magnetic hyperthermia-mediated glioblastoma therapy.

Significant Achievements:

- Surface modification of Stevioside molecules by replacing the free terminal primary hydroxyl groups with carboxymethyl group led to increased hydrophilicity of the molecule. This enhanced hydrophilicity of STE ultimately results in higher colloidal stability of (Carboxymethyl)STE-MNPs in solution phase. This further resulted in enhanced thermal response of MNPs when exposed to AMF. These (Carboxymethyl) STE-MNPs may prove potential candidates for MHCT based GBM therapy in future.
- A remarkable increase in SAR values of modified STE molecule coated MNPs (209.25 W/g) when compared to unmodified STE coated MNP ~80 W/g was observed.

Selected Publications:

1. Gupta, R.; Sharma, D. Manganese-Doped Magnetic Nanoclusters for Hyperthermia and Photothermal Glioblastoma Therapy. *ACS Appl. Nano Mater.*, **2020**, *3*, 2026.
2. Gupta, R.; Sharma, D. Evolution of Magnetic Hyperthermia for Glioblastoma Multiforme Therapy. Gupta Ruby, Sharma Deepika. *ACS Chem. Neurosci.*, **2019**, *10*, 1157.

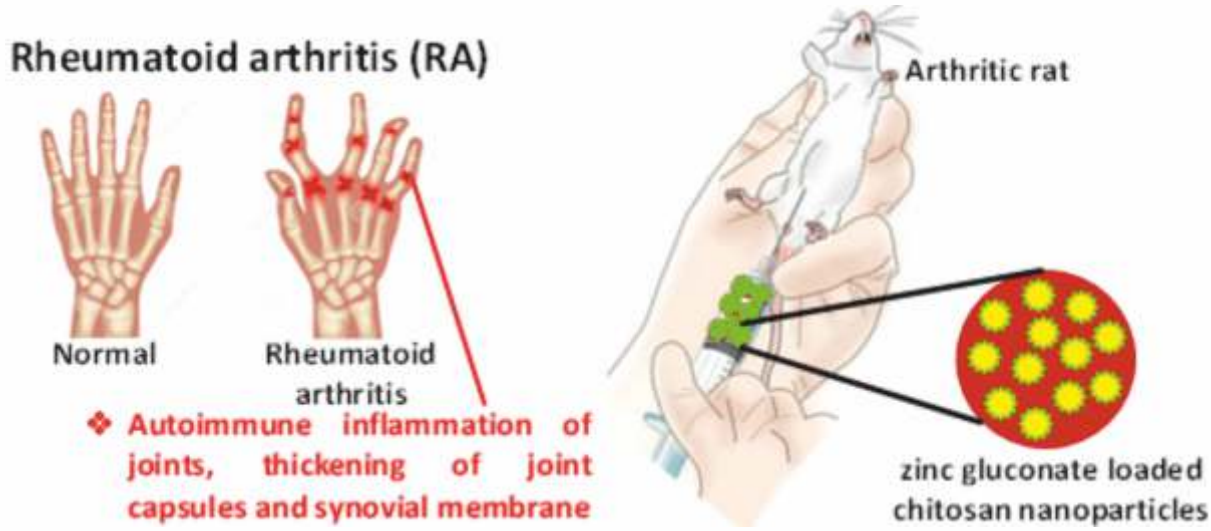
No of PhD/Postdoc/intern students:

PhD Students: **3** Intern -**1** Project -**1**

11. Dr. Rehan Khan, Scientist-C

Research Activities/Highlights:

- Chitosan based nanoformulation for Zinc gluconate to supplement zinc as it is crucial for the bone homeostasis and reported low zinc levels in arthritis. In our study, we found that chitosan based Zinc gluconate nanoformulation reduced the severity of Rheumatoid arthritis in rat model.
- Hyperbranched polymer-functionalized magnetic nanoparticles for the encapsulation of niclosamide drug and further with aim to retain superparamagnetic character to exploit for hyperthermia.
- Hyperbranched polymer-functionalized magnetic nanoparticles mediated combined therapy of hyperthermia and niclosamide drug exhibited enhanced killing of colorectal cancer cells as compared to single therapy.



Schematic Representation of chitosan based Zinc gluconate Nano formulation for the therapy of Rheumatoid Arthritis.

Significant Achievements:

In the year 2019, our research group published 4 papers and 1 book chapter. We have established new field of research in our group related to Surface-enhanced Raman Scattering (SERS)-mediated detection of bio-makers for sepsis and septic shock.

Selected Publications:

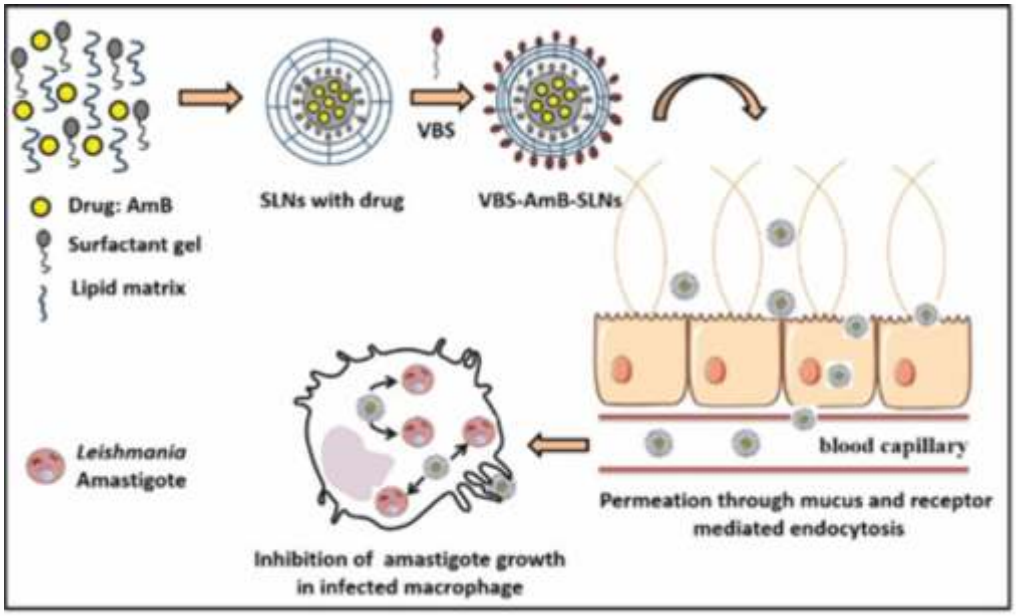
1. Ahmad, A.; Gupta, A.; Ansari, M. M.; Jayamurugan, G.; Khan, R. Hyperbranched polymer-functionalized magnetic nanoparticles mediated hyperthermia and niclosamide bimodal therapy of Colorectal Cancer Cells. *ACS Biomater. Sci. Eng.*, **2020**, 6, 2, 1102.
2. Ansari, M.M.; Ahmad, A; Mishra, R.K.; Raza, S.S.; Khan, R. Zinc gluconate-loaded chitosan nanoparticles reduce severity of collagen-induced arthritis in Wistar rats. *ACS Biomater. Sci. Eng.* **2019**, 5, 3380.
3. Ahmad, A; Khan, F; Mishra, R. K; Khan, R. Precision cancer Nano therapy: evolving role of multifunctional nanoparticles for cancer active targeting. *J. Med. Chem.* **2019**, 62, 10475.

No of PhD/Postdoc/intern students:

PhD Students: **3**, Intern Student: **1**

12. Dr. Shyam Lal M, Scientist-C

Research Activities/Highlights:
Our research thrusts is to engineering delivery systems for poorly water soluble drugs towards therapeutic clinical applications primarily, against neglected infectious diseases (Visceral Leishmaniasis). We focus on the development of nanomedicines based on biological nanomaterials with considerable priority on interface between *in vitro* and *in vivo* studies and how logically-designed and engineered drug delivery systems can be translated into clinically-effective therapeutics.



Vitamin B12-Stearic acid coated SLNs targeting Leishmaniasis

Significant Achievements:
Two of the developed formulations (solid lipid nanoparticles based combinatorial drug delivery system) have shown escalating improvement against visceral leishmaniasis in animal model. Further, extensive studies on the mechanistic insights are under process for the two developed formulations.

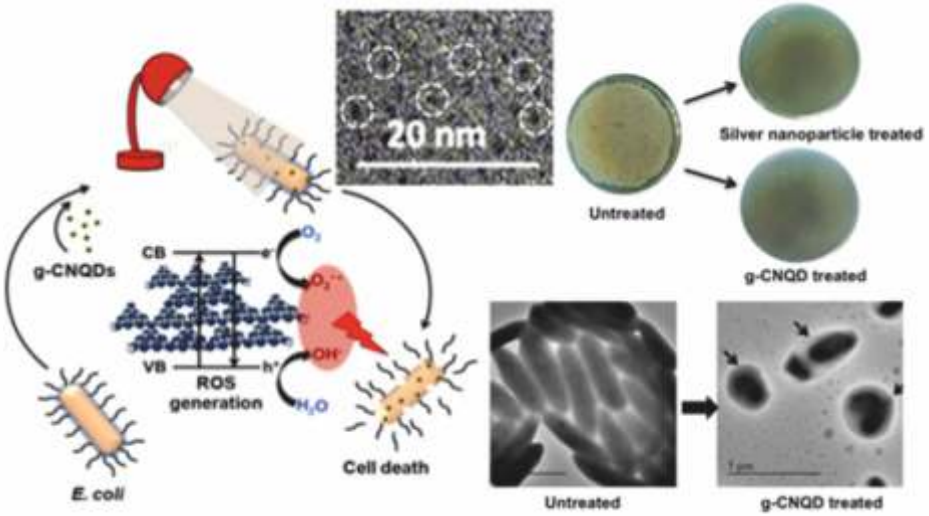
Selected Publications:
1. Singh, O.P.; Gedda M.R.; Mudavath S.L.; Srivastava, O.N.; Sundar, S. Envisioning the innovations in nanomedicine to combat visceral leishmaniasis: for future theranostic application. *Nanomedicine*., **2019**, *14*, 1911-1927.

No of PhD/Postdoc/intern students:
PhD students - **3**, Interns – **1**

13. Dr. Asifkhan Shanavas, Scientist-C

Research Activities/Highlights:

- **Targeted combinatorial nanomedicines:** Cancer patients undergo vigorous combination chemotherapeutic protocols. Combination nanomedicines offer vehicle uniformity, ratiometric drug loading with temporal site-specific release of the drugs. Our group investigates organo-inorganic nanoparticles for compartmentalization and sequential release of two or more chemotherapeutics.
- **Organo-Inorganic Biomaterials for Theranostics:** Multifunctional biomaterials offer a 'One for All' approach towards precise in vivo detection and subsequent treatment of solid tumors. Our group investigates organo-inorganic composite biomaterials for simultaneous therapy and imaging of cancerous tissues.
- **Plasmonic nanomaterials for Photothermal Therapy**: Gold based anisotropic nanostructures such as nanoshells have shown a huge success in combating drug resistant tumors. Our group explores asymmetric plasmonic nanoparticles for photothermal therapy to manage undruggable advanced cancers.



Significant Achievements:

We developed low cost metal free nanomaterials towards designing protective garment, that was highlighted by DST Media cell and was also included in the COVID-19 bulletin on 30 April 2020, covered by India Science

Selected Publications:

1. Kaur, N.; Mathur, P.; Yadav, P; Chakraborty, S.; Shanavas, A. Glycol chitosan in situ coating on PLGA nanoparticle curtails extraneous paclitaxel precipitates and imparts protein corona independent hemocompatibility. *Carbohydr. Polym* **2020**, *237*, 116170.
2. Yadav, P.; Zhang, C.; Whittaker, A.; Kailasam, K.; Shanavas, A. Magnetic and photocatalytic curcumin bound carbon nitride nanohybrids for enhanced glioma cell death. *ACS Biomater. Sci. Eng.* **2019**, *5*, 6590.
3. Shanavas, A.; Jain, N.; Kaur, N.; Thummuri, D.; Prasanna, M.; Prasad, R.; Naidu, V.; Bahadur, D.; Srivastava, R. A. polymeric core-shell combinatorial nanomedicine for synergistic anticancer therapy. *ACS Omega*, **2019**, *4*, 19614.

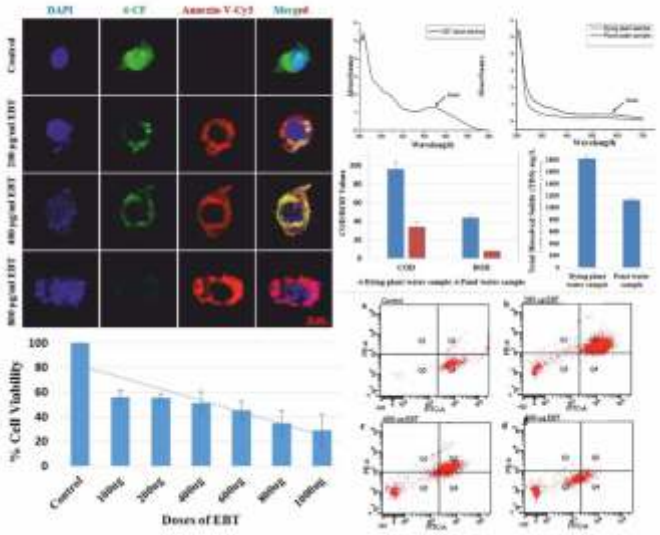
No. of Ph.D/Post Doc/intern students:

PhD students – 4, Project students - 2

14. Dr Manish Singh, Scientist-C

Research Activities/Highlights:

In-vitro toxicology assessment of Eriochrome black-t (EBT): an industrial dye: EBT is an azo dye which is used in carpet and textile industries for shades of dark blue colour. Bhadohi is popularly known as “the carpet city” due to the presence of large number of carpet manufacturing industries. These industries dispose of their dyes and chemicals containing effluents into nearby surroundings such as ponds or rivers. In the present study, water samples were collected from a Carpet dyeing plant and the adjoining pond of the city called Mullah Talab and tested for the presence of EBT by UV-Vis. We found high levels of COD, BOD and TDS in the water samples. MTT assay showed reduced Cell viability with the increasing doses of EBT. FACS and Confocal analysis also showed the increased levels of apoptosis with the increasing doses indicating the toxic effects of EBT on NIH 3T3 cells. Results show gradual accumulation of the toxic compounds like EBT is a potential cause of pollution and a serious environmental hazard.



In-vitro toxicology assessment of Eriochrome black-t (EBT): an industrial dye

Significant Achievements:

My student Indranil De received the inspire fellowship

Recent Publications:

1. Sharma, S.; Sahu, B.; Srinivasan, S.; Singh, M.; Govindasamy, J.; Shanmugam, V. Effect of galvanotaxic graphene oxide on chloroplast activity: Interaction quantified with Biolayer-Interferometry coupled confocal microscopy. *Carbon* **2020**, *162*, 147.
2. Dube, T.; Kumar, N.; Kour, A.; Mishra, J.; Singh, M.; Prakash, B.; Panda, J. J. Gold Nano-/Microroses on Levodopa Microtubes for SERS-Based Sensing of Gliomas. *ACS Appl. Nano Mater.* **2019**, *2*, 2663.

No. of Ph.D/Post Doc/intern students:

PhD students – 2, Project students – 1, Intern Students: **1**

Science & Technology Services

IPR, Projects Administration Cell

Shri Mukesh Raja, Scientist- C (Coordinator)

Administration and Coordination Cell of INST undertakes all science and technology related Matters as follows:

- Coordinator for Intellectual Properties Rights (IPR) Cell of INST and for Technology Licence/Transfer
- Extra & Intra mural R&D projects.
- Coordinator of the Inst-Industry Cell.
- Preparation of different Scientific and techno-feasibility reports and their submission to different funding agencies like DST, DBT & CSIR and other grantee institutions. Follow up action for INST activities.
- Publications of different report as per-line of INST
- Creating/organising Science Awareness programme by means of workshop/innovative Lecture/Outreach and other public lecture.
- Signing of MoUs as per mandate and objectives of INST.
- Nodal officer and single contact point for CRIKC domain and with Punjab State Council for Science and Technology.

INSTITUTE-INDUSTRY ACTIVITIES

INST has a dedicated IPR Cell (Members: Dr. Vivek Bagchi, Dr. Menaka Jha, Dr. R S Dey and Shri Mukesh Raja): A platform for encouraging filing of IPRs and patenting the products/technologies for the benefit of the Institute and thereby to the society at large.

- **Industry Collaborations and Funding:**
  Technology development is an integral part of INST's mandate; being a relatively newer institute with dynamic faculty members, INST has associated itself with a number of industrial partners also. INST has collaboration with the several sectors, like; 1) NTPC Energy Technology Research Alliance, 2) Indian Oil corporation Limited, 3) SRF Limited, 4) C. S. Zircon Pvt. Ltd. *etc*.
- A total of 9 industrial/consultancy projects have been sanctioned with a total funding of ~1.25 Crores.
- Collaborative Industrial programmes has been initiated with Tata Steel for execution of two projects:
  Design of process to convert iron ore slime into goethite and their nano-composites by Dr. Menaka Jha, Sci-C and Nanoporous Carbon Nitride based Organic polymers for CO_2 Activation and Conversion to Organic Carbonates by Dr. Kamalakannan Kailasam, Sci-E.
- Collaborative programmes has also been established for a project with NTPC Energy Technology Research Alliance on conversion of gaseous effluents released from power plants to materials with high commercial value.

Patents Filed: 5

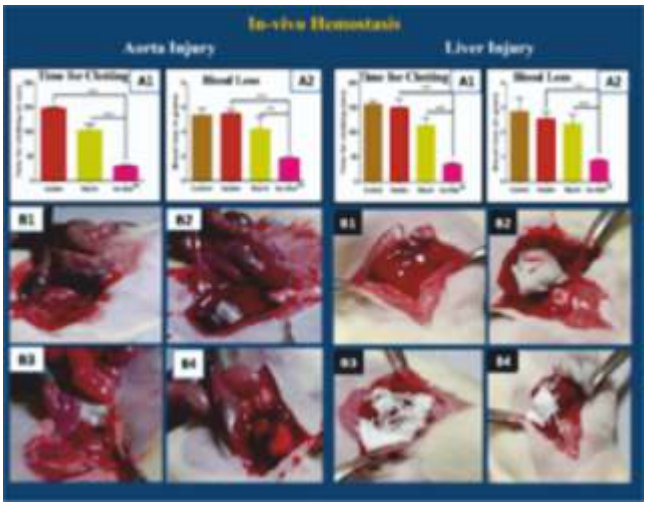
- Menaka Jha *et al*. A nano adsorbent for removal of lanthanide ions from water and associated methods, Patent no. 201711016720, 2017
- P. S. Vijaykumar *et al*. Efficient fertilizer delivery through mesoporous silica. Patent no 201811001751, 2017
- Sharmistha Sinha *et al*. Cellulose metallothionein conjugate for metal binding. Patent TEMP/E1/35136/2017-DEL, 2018
- Deepa Ghosh *et al*. Modified natural polysaccharide having improved hemostatic properties. Patent No. 201911010706. 2019
- Deepa Ghosh *et al*. Magnetic nanoparticles for live cell imaging and highly efficient hyperthermia. Patent No: 201911021448, 2019

Technologies developed:

INST has already developed several technologies as follows:

- A product from INST, sponsored by Technology Development and Transfer Program (DST/TDT/DDP-04/2017), Department of Science and Technology (DST), Government of India.

- INST has made low-cost Cartridges for purification of industrial and domestic waste water. INST has plans to test this modified adsorbent on real waste water contaminated with arsenic collected from rural area.



- A novel low cost haemostatic device has been developed to address moderate-heavy bleeding. The patented process has been tested in pre-clinical studies.

- Dr. Rahul Verma and his group developed a convenient, cold-stable spray gel that could be administered on-site for the immediate treatment of frostbite injuries, helping wounds heal.

RESEARCH PUBLICATIONS IN PEER REVIEWED JOURNALS

Sr	Publications
	2020
1	Tweaking the physics of interfaces between monolayers of buckled cadmium sulfide for a superhigh piezoelectricity, excitonic solar cell efficiency and thermoelectricity, M K Mohanta, A De Sarkar*. *ACS Applied Materials & Interfaces,* **2020,** *12,* 18123-18137.
2	Promoting electrocatalytic oxygen reduction in a model composite using selective metal ions, Z Ahmed, Parrydeep K Sachdeva, R Rai, R Kumar, Takahiro Maruyama, C Bera , V Bagchi. *ACS Applied Energy Materials,* **2020** *3,* 3645.
3	Dopamine functionalized CuO nanoparticles, A high valued "turn on" colorimetric biosensor for detecting cysteine in human serum and urine samples, D Rohilla, S Chaudhary, N Kaur, A Shanavas. *Materials Science and Engineering, C,* **2020,** *110,* 110724.
4	Glycol chitosan in situ coating on PLGA nanoparticle curtails extraneous paclitaxel precipitates and imparts protein corona independent hemocompatibility, N Kaur, P Mathur, P Yadav, S Chakraborty, A Shanavas. *Carbohydrate Polymers,* **2020,** *237,* 116170.
5	Impact of transverse and vertical gate electric field on vibrational and electronic properties of MoS2, R Rani, N Jena, A Kundu, A De Sarkar*, K S Hazra*. *Journal of Applied Physics,* **2020,** *127,* 145101.
6	Unravelling the Role of Fe–Mn Binary Active Sites Electrocatalyst for Efficient Oxygen Reduction Reaction and Rechargeable Zn-Air Batteries, S Sarkar, A Biswas, T Purkait, M Das, N Kamboj, R S Dey*. *Inorganic Chemistry,* **2020,** *59,* 5194–5205.
7	High yield Cycloaddition of Carbon Dioxide to Epoxides Catalysed by Metal Organic Frameworks, D Rani, R Kumar, V Kumar and M Singh. *Materials Today Sustainability,* **2020,** *5,* 100021.
8	Visible-Light-Assisted Gasochromic Sensing of Nicotine from Cigarette Smoke by Metal-Organic Nanotube, D Rani, K K Bhasin and M Singh. *ACS Materials Lett.,* **2020** *2,* 9-14.
9	**9.** In-vitro and in-vivo evaluation of modified sodium starch glycolate for exploring its haemostatic potential, V Panwara, J Thomasa, A Sharmaa, V Chopraa, S Kaushika, A Kumarb and D Ghosha*. *Carbohydrate Polymers,* **2020,** *235,* 115975.
10	**10.** Electrochemically customized assembly of a hybrid xerogel material via combined covalent and non-covalent conjugation chemistry, an approach for boosting the cycling performance of pseudocapa, T Purkait, Dimple, N Kamboj, M Das, S Sarkar, A De Sarkar, R S Dey*. *Journal of Materials Chemistry A,* **2020** *8,* 6740-6756.
11	Photoresponsive Chain Collapse in Flexo-rigid Functional Copolymer to Modulate Self-healing Behavior, Jojo P. Joseph, C Miglani, A Singh, D Gupta, A Pal. *Soft Matter,* **2020,** *16,* 2506-2515.
12	Ultra-low lattice thermal conductivity and giant phonon-electric field coupling in hafnium dichalcogenide monolayers, Dimple, M K Mohanta, A Rawat, N Jena, R Ahammed, A De Sarkar*. *Journal of Physics, Condensed Matter,* **2020,** *16,* 2506-2515.
13	Controlling Neuronal Cell Growth through Composite Laminin Supramolecular Hydrogels, R. Jain, S. Roy. *ACS Biomater. Sci. Eng.,* **2020,** *6(5),* 2832–2846.
14	Silymarin encapsulated nanoliquid crystals for improved activity against beta amyloid induced cytotoxicity, Singh A, Kumar A, Verma RK, Shukla R. *International Journal of Biological Macromolecules,* **2020,** *7;149,* 1198-1206 (IF,4.8).
15	Fe-porphyrin on Co (001) and Cu (001), A Comparative Dispersion-augmented Density Functional Theory Study, I Azuri, Md. E Ali, K Tarafder, Peter M. Oppeneer, L Kronik. *Israel Journal of Chemistry,* **2020,** *60,* 1-7.
16	Planar Hall effect and anisotropic magnetoresistance in a polar-polar interface of LaVO3-KTaO3 with strong spin-orbit coupling, N. Wadehra, R. Tomar, R. K. Gopal, Y. Singh, S. Dattagupta, S. Chakraverty. *Nature communication,* **2020,** *11,* 874(1-7).
17	Proton Triggered Fluorescence Switching in Self-Exfoliated Ionic Covalent Organic Nanosheets for Applications in Selective Detection of Anions, A Singh, M Devi, N Jena, M M Iqbal, Y Nailwal, A De Sarkar*, S K Pal*. *ACS Applied Materials & Interfaces,* **2020,** *12,* 13248-13255.
18	Aggregation Enhances Luminescence and Photosensitization Properties of a Hexaiodo-BODIPY, PPP Kumar, P Yadav, A Shanavas, and PP Neelakandan*. *Mater. Chem. Front.,* **2020,** *4,* 965-972.
19	Impact of one step alloying on the carrier relaxation and charge separation dynamics of CdxZn1-xSe graded nanocrystals, H N. Ghosh, P Maity, N Ghorai, J Dana. *Journal of Photochemistry and Photobiology A, Chemistry,* **2020,** *388,* 112131.
20	3-Dimensional Graphene Decorated Copper-Phosphide (Cu3P@3DG) Heterostructure as Effective Electrode for Supercapacitor, S Kumar , S. K. Tarik Aziz , S Kumar, Sk Riyajuddin , G Yaniv , L Meshi, Gilbert D. Nessim and K Ghosh *. *Frontiers in Materials, section Energy Materials,* **2020,** *7,* 112131.
21	Fabrication of dual catalytic microcapsules by mesoporous graphitic carbon nitride (mpg-C3N4) nanoparticle–enzyme conjugate stabilized emulsions, R Varshney, S Kumar, K Ghosh*, D Patra*. *New J. Chem.,* **2020**, *44,* 3097.

22	In Situ Biosynthesized Superparamagnetic Iron Oxide Nanoparticles (SPIONS) Induce Efficient Hyperthermia in Cancer Cells, S Kaushik, J Thomas, V Panwar, H Ali, V Chopra, A Sharma, R Tomar, D Ghosh. *ACS Appl. Bio Mater,* **2020,** *3,* 779-788.
23	The role of exfoliating solvents for control synthesis of few-layer graphene-like nanosheets in energy storage applications, Theoretical and experimental investigation, T Purkait, R Ahammad, A De Sarkar, R S Dey*. *Applied Surface Science,* **2020,** *509,* 145375.
24	Nano-electrical domain writing for oxide electronics, N. Wadehra, N. Kumar,S. Mishra, R. Tomar, S. Chakraverty. *Applied Surface Science,* **2020,** *509,* 145214.
25	Electronic, quantum transport and optical properties analysis of doped phosphorene sheet, S Singh, A De Sarkar, I Kaur. *International Journal of Environmental Analytical Chemistry,* **2020**, *509,* 145214.
26	Universal Approach for Electronically Tuned Transition-Metal-Doped Graphitic Carbon Nitride as a Conductive Electrode Material for Highly Efficient Oxygen Reduction Reaction, S Sarkar, N Kamboj, M Das, T Purkait, A Biswas, R S Dey*. *Inorganic Chemistry,* **2020,** *59,* 1332-1339.
27	Tuning the gelation behavior of short laminin derived peptides via solvent mediated self-assembly, R. Jain, S Roy. *Mater. Sci. Eng C,* **2020,** *108,* 110483.
28	Directed in situ shaping of complex nano- and microstructures during chemical synthesis, Georg R J Artus, S Olveira ,D Patra, S Seeger*. *Macromol. Rapid Commun,* **2020,** *38,* 4.
29	Manganese-Doped Magnetic Nanoclusters for Hyperthermia and Photothermal Glioblastoma Therapy., R Gupta and D Sharma. *ACS Applied Nano Materials,* **2020,** *3,* 2026-2037.
30	ZrS3/MS2 and ZrS3/MXY (MMo, W; X, YS, Se, Te; X≠Y) type-II van der Waals hetero-bilayers, Prospective candidates in 2D excitonic solar cells, R Ahammed, A Rawat, N Jena, Dimple, M K Mohanta, A De Sarkar*. *Applied Surface Science,* **2020,** *499,* 143894.
31	Inhalation delivery of host defence peptides (HDP) using nano-formulation strategies, A pragmatic approach for therapy of pulmonary ailments., S Adlakha, A Sharma, K Vaghasiya, E Ray, RK Verma. *Current Protein & Peptide Science,* **2020,** *21,* 369 – 378.
32	Self-Powered Human-Health Monitoring through Aligned PVDF Nanofibers Interfaced Skin-Interactive Piezoelectric Sensor, K Maity, S Garain, K Henkel, D Schmeißer, D Mandal*. *ACS Appl. Polym. Mater.,* **2020** *2,* 862-878.
33	Probing into the effect of heterojunctions between Cu/Mo2C/Mo2N on HER performance, R Kumar, Z Ahmed, H Kaur, C Bera, V Bagchi. *Catalysis Science and Technology,* **2020,** *10,* 2213 - 2220.
34	Tuning of the Cross-Glaser Products mediated by Substrate-Catalyst's Polymeric Backbone Interactions, S. Kuar, A. Mukhopadhyaya, A. Selim, V. Gowri, K. M. Neethu, A. H. Dar,S. Sartaliya, M. E. Ali*, G. Jayamurugan*. *Chem. Commun.,* **2020,** *56,* 2582-2585.
2019	
35	Hyperbranched polymer-functionalized magnetic nanoparticles mediated hyperthermia and niclosamide bimodal therapy of Colorectal Cancer Cells., A Ahmad, A Gupta, MM Ansari, A Vyawahare, G Jayamurugan, R. Khan*. *ACS Biomater. Sci. Eng.,* **2019,** *6,* 1102-1111.
36	NIR-responsive Indocyanine green-GenisteinNanoformulation controlling Polycomb epigenetic machinery for efficient Photo-Chemo-Combotherapy of Glioblastoma., Kaundal B, Srivastava AK, Sardoiwala N Md, Karmakar S, Roy Choudhury S*. *Nanoscale Advances,* **2019,** *1,* 2188-2207.
37	Nanostructure Endows Neurotherapeutic Potential in Optogenetics, Current Development and Future Prospects, M N Sardoiwala, A K. Srivastava, S Karmakar*, S Roy Choudhury*. *ACS Chem. Neurosci,* **2019,** *10, 8,* 3375-3385.
38	Disulfide-Bridged Chitosan-Eudragit S-100 Nanoparticles for Colorectal Cancer., Sood A, Dev A, Mohanbhai SJ, Shrimali N, Kapasiya M, Kushwaha A, Roy Choudhury S, Guchhait P, Karmakar S*.. *ACS Appl. Nano Mater,* **2019,** *2, 10,* 6409-6417.
39	Mussel-inspired UV protective organic coatings via layer-by-layer assembly, A K Gill, Sk.Riyajuddin, M Alam, K Ghosh, D Patra*. *Eur. Polym. J.,* **2019,** *124,* 109455.
40	**40.** Tuning supramolecular structure and function of collagen mimetic ionic complementary peptides via electrostatic interactions, VK Pal, R. Jain, S. Roy. *Langmuir,* **2019,** *36 (4),* 1003-1013.
41	3D-Graphene Decorated with g-C3N4/Cu3P composite, A Noble Metal-free Bifunctional Electrocatalyst for overall water splitting, Sk Riyajuddin, T Aziz, S Kumar, Gilbert D Nessim, K Ghosh. *ChemCatChem,* **2019,** *12,* 1394-1402.
42	In-vitro and In-vivo evaluation of biocompatible and biodegradable calcium-modified carboxymethyl starch as a topical hemostat, V Panwara, A Sharmaa, J Thomasa, V Chopraa, S Kaushika, A Kumar, D Ghosh. *Materialia,* **2019,** *2,* 103373.

43	POP-Pd (ii) catalyzed easy and safe in situ carbonylation towards the synthesis of α-ketoamides from secondary cyclic amines utilizing CHCl 3 as a carbon monoxide surrogate, Sk Safikul Islam, Sk Riyajuddin, R A Molla, N Yasmin, K Ghosh, Sk Manirul Islam. *New Journal of Chemistry,* **2019,** *44,* 1979-1987.
44	Evolution of Magnetic Hyperthermia for Glioblastoma Multiforme Therapy, R Gupta, D Sharma. *ACS Chemical Neuroscience,* **2019,** *10(3),* 1157-1172.
45	Design of process for stabilization of La2NiMnO6 nanorods and their magnetic properties, V. M. Gaikwad, K. K. Yadav, Sunain, S. Chakraverty, S. E. Lofland, K.V. Ramanujachary, S. T. Nishanthi, A. K. Ganguli, M Jha. *Journal of Magnetism and Magnetic Materials,* **2019,** *492,* 165652.
46	A theoretical model of the thermoelectric properties of SnSxSe1−x and how to further enhance its thermoelectric performance, R Gupta, B Kaur, J Carrete, C Bera. *Journal of Applied Physics,* **2019,** *126,* 225105.
47	Variable Mutations at the p53-R273 Oncogenic Hotspot Position Leads to Altered Properties, A Garg ,J P Hazra , M K Sannigrahi, S Rakshit, S Sinha. *Biophysical Journal,* **2019,***118 (3),* 720-728.
48	Functional protein shells fabricated from the self-assembling protein sheets of prokaryotic organelles, Naimat K. Bari, G Kumar, J P. Hazra, S Kaur, S Sinha. *Journal of Materials Chemistry B,* **2019**, *8,* 523-533.
49	Rollable Magnetoelectric Energy Harvester as Wireless IoT Sensor, S. K. Ghosh, K. Roy HK Mishra, MR Sahoo, B Mahanty, PN Vishwakarma, D Mandal*. *ACS Sustainable Chem. Eng.,* **2019,** *8,* 864–873.
50	Interfacing boron monophosphide with molybdenum disulphide for an ultrahigh performance in thermoelectrics, 2D excitonic solar cells and nanopiezotronics, M K Mohanta, A Rawat, N Jena, Dimple, R Ahammed, A De Sarkar*. *ACS Applied Materials & Interfaces,* **2019,** *12,* 3114-3126.
51	Nanomolar Detection of Biothiols via Turn-ON Fluorescent Indicator Displacement, PPP Kumar, N Kaur, A Shanavas, and PP Neelakandan*. *Analyst,* **2019,** *145,* 851-857.
52	S,N-GQD Enzyme Mimicked Electrochemical Sensor to Detect the Hazardous level of Monocrotophos in water, A. Jayalatha, N. Sharma, N. Nesakumar, K. Kailasam and J. B. B. Rayappan. *Electroanalysis,* **2019,** *32,* 1-8.
53	Heparin encapsulated metered-dose topical “Nano-spray gel” liposomal formulation ensures rapid on-site management of frostbite injury by inflammatory cytokines scavenging, Vaghasiya K, Sharma A, Kumar K, Ray E, Adhlakha S, Katare OP, Hota S,Verma RK*. *ACS Biomaterials Science & Engineering,* **2019,** *5,* 6617-6631
54	Polycaprolactone based nano-carrier for co-administration of moxifloxacin and rutin and its in-vitro evaluation for sepsis, Handa M, Sharma A, Verma RK, Shukla R. *Journal of Drug Delivery Science and Technology,* **2019,** *56,* 101286.
55	Zn (ii)@ TFP-DAQ COF, an efficient mesoporous catalyst for the synthesis of N-methylated amine and carbamate through chemical fixation of CO 2, P Sarkar, A H Chowdhury, Sk Riyajuddin, S Biswas, K Ghosh, Sk Manirul Islam. *New Journal of Chemistry,* **2019,** *44,* 744-752.
56	Silver nanoparticles architectured HMP as a recyclable catalyst for tetramic acid and propiolic acid synthesis through CO2 capture at atmospheric pressure, S Ghosh, A Ghosh, Sk Riyajuddin, S Sarkar, A H Chowdhury, K Ghosh, Sk Manirul Islam. *ChemCatChem,* **2019,** *12,* 1055-1067.
57	Pd NPs Decorated on POPs as Recyclable Catalysts for the Synthesis of 2-Oxazolidinones from Propargylic Amines via Atmospheric Cyclizative CO2 Incorporation, S Ghosh, S k Riyajuddin, S Sarkar, K Ghosh, Sk Manirul Islam. *ChemNanoMat,* **2019,** *6,* 160-172.
58	Synergistic Effect of Noble Metal free Ni(OH)2 co-catalyst and Ternary ZnIn2S4/g-C3N4 Heterojunction for Enhanced Visible Light Photocatalytic Hydrogen Evolution, L. R. Nagappagari, S. Samanta, N. Sharma,V. R. Battula, K. Kailasam. *Sustainable Energy & Fuels,* **2019,** *4,* 750-759.
59	Magnetic and photocatalytic curcumin bound carbon nitride nanohybrids for enhanced glioma cell death, Yadav, Pranjali; Zhang, Cheng; Whittaker, Andrew; K Kailasam. *ACS Biomaterials Sciences and Engineering,* **2019,** *5,* 6590.
60	Neuroprotective Strategies for Neurological Disorders by Natural Products, An update, Muneeb U Rehman, F Adil Wali, A Ahmad, S Shakeel, S Rasool, R Ali, S M Rashid, H M Ganaie, M Ahmad, R Khan. *Current Neuropharmacology,* **2019,** *17,* 247-267.
61	Ultrafast Plasmon Dynamics and Hole–Phonon Coupling in NIR Active Nonstoichiometric Semiconductor Plasmonic Cu2–xS Nanocrystals, N Ghorai, H N. Ghosh. *The Journal of Physical Chemistry C,* **2019** *123,* 28401-28410.
62	Chitosan-Graphene Oxide Hydrogels with Embedded Magnetic Iron Oxide Nanoparticles for Dye Removal, N Singh, Sk Riyajuddin, K Ghosh, S K Mehta, A Dan. *ACS Applied Nano Materials,* **2019,** *2,* 7379–7392.
63	Reduction of carbon dioxide with mesoporous SnO 2 nanoparticles as active photocatalysts under visible light in water, A H Chowdhury, A Das, Sk Riyajuddin, K Ghosh, Sk Manirul Islam. *Catalysis Science & Technology,* **2019,** *9,* 6566-6569.

64	Multiple helimagnetic phases in triclinic CuSeO3, R Tomar, S Kakkar, S Goyal, M. M Devi, C Bera, S. Chakraverty. *Journal of Magnetism and Magnetic Materials,* **2019,** *497,* 165945.
65	Conducting LaVO3/SrTiO3 Interface, Is Cationic Stoichiometry Mandatory?, R. Tomar, R. M. Varma, N. Kumar, D. D. Sarma, D. Maryenko, S. Chakraverty. *Advaned Material Interfaces,* **2019,** *497,* 1900941(1-6).
66	Strategies for extending charge separation in colloidal nanostructured quantum dot materials, P Maity, H N. Ghosh. *Physical Chemistry Chemical Physics,* **2019,** *21,* 23283-23300.
67	Gold Nano-/Microroses on Levodopa Microtubes for SERS-Based Sensing of Gliomas, T Dube, N Kumar, A Kour, J Mishra, M Singh, B Prakash, JJ Panda. *ACS Applied Nano Materials,* **2019,** *2 (5),,* 2663-2678.
68	Role of nanoparticle interaction in magnetic heating, R. Lenin, A. Singh, C Bera. *MRS Communications,* **2019,** *9(3),* 1034.
69	Facile one step synthesis of Cu-g-C3N4 electrocatalyst realized oxygen reduction reaction with excellent methanol crossover impact and durability, S Sarkar, S.S. Sumukh, K Roy, N Kamboj, T Purkait, M Das, R S Dey*. *Journal of Colloid And Interface Science,* **2019,** *558,* 182–189.
70	Ternary Metal Chalcogenides, Into the Exciton and Biexciton Dynamics, T Debnath, H N. Ghosh. *The journal of physical chemistry letters,* **2019,** *10,* 6227-6238.
71	Thymoquinone (2-Isopropyl-5-methyl-1, 4-benzoquinone) as a chemopreventive/anticancer agent, Chemistry and biological effects, A Ahmad, R K Mishra, A Vyawahare, A Kumar, M U. Rehman, W Qamar, A Q Khan, R Khan. *Saudi Pharmaceutical Journal,* **2019,** *27,* 1113-1126.
72	Single-phase Ni5P4-Copper foam superhydrophilic and aerophobiccore-shell nanostructures for efficient hydrogen evolution reaction, M Das, N Jena, T Purkait, N Kamboj, A De Sarkar, R S Dey*. *Journal of Materials Chemistry A,* **2019,** *10.1039/C9TA06729A,* 1113-1126.
73	Efficient Photosensitizing Capabilities and Ultrafast Carrier Dynamics of Doped Carbon Dots, S Mandal, A Yucknovsky, K Akulov, N Ghorai, T Schwartz, H N Ghosh, N Amdursky. *Journal of the American Chemical Society,* **2019,** *141,* 15413-15422.
74	One-Step Fabrication of Enzyme-Immobilized Reusable Polymerized Microcapsules from Microfluidic Droplets, R Varshney, S Sharma, B Prakash, J K Laha, D Patra*. *ACS Omega,* **2019,** *4,* 13790.
75	Catalytic synthesis of benzimidazoles and organic carbamates using a polymer supported zinc catalyst through CO 2 fixation, I H Biswas, S Biswas, Md Sarikul Islam, Sk Riyajuddin, P Sarkar, K Ghosh, Sk Manirul Islam. *New Journal of Chemistry,* **2019,** *43,* 14643-14652. DOI, doi.org/10.1039/C9NJ03015H
76	Controlled nanofabrication of metal-free SERS substrate on few layered black phosphorus by low power focused laser irradiation, A Kundu, R Rani, K S Hazra*. *Nanoscale,* **2019,** *11,* 16245-16252.
77	Tandem Interplay of Host-guest Interaction and Photo-responsive Supramolecular Polymerization to 1D and 2D Functional Peptide Materials, Jojo P Joseph, A Singh, D Gupta, C Miglani, A Pal. *ACS Applied Mater Interface,* **2019,** *11,* 28213-28220.
78	Zinc (II) incorporated porous organic polymeric material (POPs), A mild and efficient catalyst for synthesis of dicoumarols and carboxylative cyclization of propargyl alcohols and CO2 in ambi, Sk Safikul Islam, N Salam, R Ali Molla, Sk Riyajuddin, N Yasmin, D Das, K Ghosh, Sk Manirul Islam. *Molecular Catalysis,* **2019,** *477,* 110541.
79	Interaction of Carbon Dots with Endothelial Cells, Implications for Biomedical Applications, A Sharma, V Panwar, V Chopra, J Thomas, S Kaushik, D Ghosh. *ACS Applied Nano Materials,* **2019,** *1,* 08.
80	Precision Cancer Nanotherapy, Evolving Role of Multifunctional Nanoparticles for Cancer Active Targeting, A Ahmad, F Khan, R K Mishra, R Khan. *J. Med. Chem.,* **2019,** *62,* 10475-10496.
81	Defects, conductivity and photoconductivity in KTaO3, R. Tomar, N. Wadehra, S. Kumar, A. Venkatesan, D. D. Sarma, D. Maryenko, S. Chakraverty*. *Journal of Applied Physics,* **2019,** *126,* 35303.
82	Hydrogen bond assisted photoinduced intramolecular electron transfer and proton coupled electron transfer in an ultrafast time domain using a ruthenium-anthraquinone dyad, A Dey, J Dana, S Aute, A Das, H N. Ghosh. *Photochemical & Photobiological Sciences,* **2019,** *18,* 2430-2441.
83	Envisioning the innovations in nanomedicine to combat visceral leishmaniasis, for future theranostic application, O P Singh, M Rao Gedda, Shyam L M, O N Srivastava, S Sundar, *Nanomedicine,* **2019** *, 14,* 1911-1927.
84	Correlating Charge-Carrier Dynamics with Efficiency in Quantum-Dot Solar Cells, Can Excitonics Lead to Highly Efficient Devices?, S Maiti, J Dana, H N. Ghosh. *Chemistry–A European Journal,* **2019,** *25,* 692-702.
85	Study of field emission properties of pure graphene-CNT heterostructures connected via seamless interface, Sk Riyajuddin, S Kumar, K Soni, S P Gaur, D Badhwar, K Ghosh. *Nanotechnology,* **2019,** *30,* 385702.

86	Alginate Micro-Spheres elicit innate Th1-inflammatory response in macrophages leading to bacillary killing, Vaghasiya K, Eram A, Sharma A, Ray E, Adlakha S, Verma RK*. *AAPS PharmSciTech,* **2019,** *20(6),* 241 (IF,2.82).
87	Designing of Push-Pull Chromophores with Tunable Electronic and Luminescent Properties using Urea as Electron Donor, A. H. Dar, V. Gowri, A. Gopal, A. Muthukrishnan, A. Bajaj, S. Sartaliya, A. Selim, M. E. Ali, G. Jayamjurugan*. *The Journal of Organic Chemistry,* **2019,** *84,* 8941 - 8947.
88	A polymeric core-shell combinatorial nanomedicine for synergistic anticancer therapy, S Asifkhan; Jain, Nishant; Kaur, Navneet; Thummuri, Dinesh; Prasanna, Maruthi; Prasad, Rajendra; Naidu, Vegi; Bahadur, Dhirendra; Srivastava, Rohit. *ACS Omega,* **2019,** 4,19614-19622 Just accepted manuscript.
89	Vertically Aligned Few-Layered Graphene-Based Non-Cryogenic Bolometer, Anil K Yadav, S M Khan, A Kundu, R Rani, N Soin, J McLaughlin, D S Misra, K S Hazra*. *C—Journal of Carbon Research,* **2019,** *5,* 23.
90	Ultralong cycle life and outstanding capacitive performance of 10.8 V metal-free micro-supercapacitor with highly conducting and robust laser-irradiated graphene for integrated storage device, N Kamboj, T Purkait, M Das, S Sarkar, K S Hazra, R S Dey*. *Energy & Environmental Science,* **2019,** *12,* 2507-2517.
91	Supramolecular Gels from Sugar-linked Triazole Amphiphiles for Drug Entrapment and Release for Topical Application, K Sharma, Jojo P. Joseph, A Sahu, N Yadav, M Tyagi, A Singh, A Pal, K. P. R. Kartha. *RSC Advances,* **2019,** *9,* 19819 - 19827.
92	Temperature/pH triggered PNIPAM based Smart nanogel system loaded with Anastrozole delivery for application in cancer chemotherapy AAPS PharmScitech, Handa M, Sharma A, Verma RK, Shukla R. *AAPS PharmSciTech,* **2019,** *20(5),* 213.
93	Structure, dielectric, and optical properties of PbTi(1−x)(V0.50Fe0.50)xO3 perovskite ceramics, A K Yadav, A Verma, S Kumar, Sk Riyajuddin, K Ghosh, S Biring, S Sen. *Applied Physics A,* **2019,** *125,* 418.
94	Structural, opto-electronics and magnetic study of Fe/Si doped ZnO, G Bajpai, Sk Riyajuddin, K Ghosh, S Bajpai, Dharma R Basaula, S Bhatt, M Khan, Shun-Wei Liu, S Biring, S Sen. *Journal of Materials Science, Materials in Electronics,* **2019,** *30,* 9344-9355.
95	Three-dimensional for electrochemical detection of Cadmium in Klebsiella study the influence of Cadmium uptake in rice plant, S Mitra, T Purkait, K Pramanik, T K Maiti,* R S Dey*. *Materials Science & Engineering C,* **2019,** *103,* 109802.
96	Zinc Gluconate-Loaded Chitosan Nanoparticles Reduce Severity of Collagen-Induced Arthritis in Wistar Rats, Md. M Ansari, A Ahmad, R K Mishra, S S Raza, R Khan. *ACS Biomater. Sci. Eng.,* **2019,** 5, 3380
97	Modifying the Magnetic Anisotropy of an Iron Porphyrin Molecule by an On-Surface Ring-Closure Reaction, Lucas M Arruda, Md. E Ali, M Bernien, F Nickel, J Kopprasch, C Czekelius, Peter M Oppeneer, W Kuch. *The Journal of Physical Chemistry C,* **2019,** *123,* 14547-14555.
98	Ultrafast Carrier Dynamics of the Exciton and Trion in MoS2 Monolayers Followed by Dissociation Dynamics in Au@MoS2 2D Heterointerfaces, T Goswami, R Rani, K S Hazra, H N Ghosh*. *The journal of physical chemistry letters,* **2019,** *10,* 3057-3063.
99	Selective Metal-ion Detection and Activatable Photosensitization Properties of a Tetraphenylethylene based Salicylideneimine, P Marandi, PPP Kumar, P Venugopalan, and PP Neelakandan*. *ChemistrySelect,* **2019,** *4,* 5707-5713.
100	Polymer-incarcerated palladium-catalyzed facile in situ carbonylation for the synthesis of aryl aldehydes and diaryl ketones using CO surrogates under ambient conditions, T K Dey, P Basu, Sk Riyajuddin, A Ghosh, K Ghosh, Sk Manirul Islam. *New Journal of Chemistry,* **2019,** *43,* 9802-9814
101	First Principle Designing of Blatter's Diradicals with Strong Ferromagnetic Exchange Interactions, A Bajaj, Md. E Ali. *The Journal of Physical Chemistry C,* **2019,** *123,* 15186-15194.
102	Nanostructured silver decorated hollow silica and their application in treatment of microbial contaminated water at room temperature, Baruah A, Vaghasiya K, Ganguli AK, Verma RK, Jha M. *New Journal of Chemistry,* **2019,** *458(1),* 84-89.
103	Electrostatic memory in KTaO3, N. Wadehra, S. Chakraverty. *Applied Physics Letters,* **2019,** *114,* 163103(1-5).
104	Recent Progress of Electron Storage Mn Center in Doped Nanocrystals, T Debnath, H N. Ghosh. *The Journal of Physical Chemistry C,* **2019,** *123,* 10703−10719.
105	A Three-Component Supramolecular Nanocomposite as a Heavy-Atom-Free Photosensitizer, PPP Kumar, P Yadav, A Shanavas, S Thurakkal, J Joseph, and PP Neelakandan*. *Chem. Commun.,* **2019,** *55,* 5623-5626.
106	Role of Li+ and Fe3+ in modified ZnO, Structural, vibrational, opto-electronic, mechanical and magnetic properties, G Bajpai, Igamcha Moirangthem, S Sarkar, S Roy Barman, CP Vinod, S Bajpai, Sk Riyajuddin, K Ghosh, D R Basaula, M Khan, Shun-Wei Liu, Sajal Biring, S Sen. *Ceramics International,* **2019,** *45,* 7232-7243.
107	Polysaccharide-Based Hybrid Self-Healing Hydrogel Supports the Paracrine Response of Mesenchymal Stem Cells., J Thomas, A Sharma, V Panwar, V Chopra, and D Ghosh*. *ACS Applied Biomaterials,* **2019,** *45,* 7232-7243.

108	Thermoelectric figure of merit and thermal conductivity of Type-I clathrate alloy nanowires, P Kaur, Gerog K. H. Madsen, C Bera. *MRS Communications,* **2019,** *9,* 370.
109	Spectral dependent white light reflection mapping of MoS2 flake for improving accuracy of conventional optical thickness profiling, R Rani, A Kundu, K S Hazra*. *Optical Materials,* **2019,** *90,* 46-50.
110	Conversion of waste tin containers to highly efficient photocatalyst based on SnO2-Fe3O4 heterostructures, M Manolata Devi, H Singh, K Kaur, A Gupta, A K Ganguli, M Jha. *Waste Management,* **2019,** *87,* 719.
111	Efficient charge transport in surface engineered TiO2 nanoparticulate photoanodes leading to improved performance in quantum dot sensitized solar cells, S Maiti, F. Azlan, Y. Jadhav,J. Dana,P. Anand,S. K. Haram,G. R. Dey, H N. Ghosh. *Solar Energy,* **2019,** *181,* 195-202.
112	Mycobactericidal activity of some micro-encapsulated synthetic Host Defense peptides (HDP) by expediting the permeation of antibiotic, A new paradigm of drug delivery for tuberculosis, Sharma A, Vaghasiya K, Gupta P, Gupta UD, Verma RK*. *International Journal of Pharmaceutics,* **2019,** *10;558,* 231-241.
113	Hot Charge Carriers in QuantumDots, Generation, Relaxation, Extraction, and Applications, P Singhal, H N. Ghosh. *Chem Nano Mat,* **2019,** *5,* 985 –999.
114	Superhigh out-of-plane piezoelectricity, low thermal conductivity and photocatalytic abilities in ultrathin 2D van der Waals heterostructures of Boron Monophosphide and Gallium Nitride, M K Mohanta, A Rawat, Dimple, N Jena, R Ahammed, A De Sarkar*. *Nanoscale,* **2019,** *11,* 21880-21890.
115	Modified Graphene Oxide Based Zinc Composite, an Efficient Catalyst for N-formylation and Carbamate Formation Reactions Through CO2 Fixation, R Khatun, S Biswas, S Islam, I H Biswas, Sk Riyajuddin, K Ghosh, Sk Manirul Islam. *ChemCatChem,* **2019,** *11,* 1303-1312.
116	Room-Temperature Synthesis of Germanium Oxide Nanofilaments and Their Potential Use as Luminescent Self-Cleaning Surfaces, N H Saddiqi, D Patra, S Seeger* ChemPhysChem, 2019, 20, 538.
117	Impact of FRET between Molecular Aggregates and Quantum Dots, P Maity, T. Gayathri, J Dana, S. P. Singh, H N. Ghosh. *Chemistry–An Asian Journal,* **2019,***14,* 597-605.
118	Valley drift and valley current modulation in a strained monolayer MoS2, N Jena, Dimple, R Ahammed, A Rawat, M K Mohanta, A De Sarkar. *Physical Review B,* **2019,** *110,* 165413.
119	One Step Fabrication of Enzyme Immobilized Reusable Polymerized Microcapsules from Microfluidic Droplets, R Varshney, S Sharma, B Prakash, J Laha , D Patra. *ACS Omega,* **2019,** *110,* - Just Accepted.
120	Gold Nano-/Micro-Roses on Levodopa Microtubes for SERS-Based Sensing of Gliomas, T Dube, N Kumar, A Kour, J Mishra, M Singh, B Prakash, J J Panda. *ACS Appl. Nano Mater,* **2019,** *2,5,* 2663.
121	Metal-free visible light photocatalytic carbon nitride quantum dots as efficient antibacterial agents, An insight study, P Yadav, N S Thangaraj, B Purohit, A Shanavas, K Kailasam. *Carbon,* **2019,** *152,* 587.
122	Polymer immobilized [Mg@PS-anthra] complex, An efficient recyclable heterogeneous catalyst for the incorporation of carbon dioxide into oxiranes at atmospheric pressure and Knoevenagel conden, R K Mondal, Sk Riyajuddin, A Ghosh, S Ghosh, K Ghosh, Sk Manirul Islam. *Journal of Organometallic Chemistry,* **2019,** *880,* 322-332.
123	Solar Energy Harvesting in Type II van der Waals Heterostructures of Semiconducting Group III Monochalcogenide Monolayers, A Rawat, R Ahammed, D Sharma, N Jena, M KMohanta, A De Sarkar*. *Journal of Physical Chemistry C,* **2019,** *123,* 12666-12675.
124	Biofunctionalization of magnetite nanoparticles with stevioside, effect on the size and thermal behaviour for use in hyperthermia applications, R Gupta. *International Journal of Hyperthermia,* **2019,** *36(1),* 302-312.
125	The limit to realize an isolated magnetic single skyrmionic state, M. M. Devi,W. Koshibae, G. Sharma, R. Tomar, V. M. Gaikwad, R. M. Varma, M. N. Nair, M. Jha, D. D. Sarma, R. Chatterjee, A. K. Ganguli, S. Chakraverty. *Journal of Materials Chemistry C,* **2019,** *36(1),* 302-312.
126	Synthesis and characterizations of luminescent copper oxide nanoparticles, Toxicological profiling and sensing applications, S Chaudhary, D Rohilla, A Umar, N Kaur, A Shanavas. *Ceramics International,* **2019,** *45, 12,,* 15025.
127	Improving the Power Conversion Efficiency through alloying in Common Anion CdZnX (X=S, Se) Nanocrystal Sensitized Solar Cells, S Maiti, P Anand, F Azlan, J Dana, H N. Ghosh. *Chem Phys Chem,* **2019,** *20,* 2662– 2667.

EXTRAMURAL FUNDING DURING F.Y.-2019-20

Sr. No.	Title of Project	Name of the P.I	Duration of Project	Total Cost of Project	Funding Agency
1	Multilayer-Structured High-Energy-Density Dielectric Polymer Nanocomposite Capacitors for Pulse Power Applications	**Dr. Dipankar Mandal**	3 years	44,22,450	DST
2	Addressing Diabetic Foot Ulcers by using a Tissue Engineering Approach	**Dr. Deepa Ghosh**	36 months	55,76,440	SERB
3	Development of Nucleic Acid Analogues containing Metallo Base Pairs	**Dr. Nidhi Naithani (Women Scientist)**	3 years	32,43,000	DST-KIRAN Division
4	Realization of a prototype spin valve based on perovskite oxide superlattice Sr2FeMoO6LaBO3(B Fe)	**Dr. Suvankar Chakraverty**	3 years	25,44,100	DAE-BRNS
5	Drug-hydrogel prototypes for in situ containment of oral cancer	**Dr. Deepa Ghosh**		10,00,000 for first year	RGCB
6	JC Bose Fellowship to Prof. Hirendra Nath Ghosh	**Dr. H. N. Ghosh**	5 years	95,00,000	SERB
7	Teacher Associateship for Research Excellence (TARE)	**Dr. Praneet Kaur (P.I) & Dr. Deepa Ghosh (Mentor)**	36 Months	18,30,000	SERB-TARE
8	Self-titrating inflammation-responsive injectable smart nano-formulations for repetitive delivery of DMARDs and corticosteroids against Rheumatoid Arthritis	**Dr. Rahul Kumar Verma**	36 months	40,52,120	SERB-CRG
9	Ultrafast Charge Carrier Dynamics of Solar Energy Conversion Materials	**Prof. H. N. Ghosh**	36 months	42,77,040	SERB
10	Fabrication of low cost real time gas sensor for early crop pest monitoring and Management	**Dr. P. S. VihayaKumar**	36 months	33,01,853	SERB-CRG
11	DNA origami based optical nanoantennas for single molecule biosensing and imaging	**Dr. Tapasi Sen**	36 months	73,65,600	SERB-CRG
12	First Principle Designing of Single Molecules and Grafting on the Substrates to Quench the Quantum Tunneling of Magnetizations	**Dr. Md. Ehesan Ali**	36 months	37,37,059	SERB
13	Enzyme-Responsive hydrogel for site-specific drug delivery as potential therapy for Colitis	**Dr. Rehan Khan**	36 months	43,22,120	SERB-CRG
14.	Understanding the Forces Involved in the Packing of Enzymes Insise the Bacterial Microcompatments for the Development of Novel Encapsulated Bio-Systems	**Dr. Sharmistha Sinha**	3 years	58,57,120	DBT

DETAILS OF FOREIGN VISITS

Name of the Scientists	Country visited	Period of visit	Purpose of Visit
Dr. Chandan Bera	Austria	Mar. 28-29, 2019	Visited as a part of Bilateral Indo-Austrian joint project entitled "Study of Phase Stability and thermal Transport in 2D Sulfide Materials under Strain" *DST project no* INT/AUSTRIA/BMWF/P-02/2018
Dr. Dipankar Mandal	USA	Apr. 22-26, 2019	To attend 2019 MRS Spring meeting in Phoenix, Arizona, USA
Dr. Jayamurugan	Switzerland	Jun. 3-5, 2019	Attended François Diederich Farewell Symposium at the Honggerberg Campus, ETH-Zurich, Switzerland
Dr. Md. Ehesan Ali	Sweden	Jun. 1 to Jul. 28, 2019	Attended carry out the research work as part of the ongoing Indo-Swedish bilateral project jointly funded by the DST and Vetenskapsradet (Swedish Research Council)
Dr. Kaushik Ghosh	Singapore	Jun. 23–28, 2019	Attended "The International Conference on Materials for Advanced Technologies" (ICMAT)
Dr. Rahul Kumar Verma	Netherlands	Aug. 25 – 27, 2019	Attended 5th Inhaled Therapies for Tuberculosis and Other Infectious Diseases, conference in Groningen, The Netherlands
Dr. Rehan Khan	South Korea	Aug. 30 to Sept. 1, 2019	Attended 24th congress of APBMT 2019 in conjunction with the ICBMT 2019 (APBMT & ICBMT 2019)
Prof H. N. Ghosh	Germany	Sept. 25-27, 2019	Participated in a joint conference for Indian and German Scientists, which was organized at the University of Duisburg-Essen, Germany
	China	Nov. 10-15, 2019	Invited speaker at Journal of Physical Chemistry Letters Forum Workshop, by College of Chemistry in Jilin University in Changchun, China and delivered a lecture on Polaron Mediated Cooling Dynamics in Perovskite Materials: Effect of Temperature
Prof Kamalakannan Kailasam	Singapore	Nov. 21-23, 2019	Attended 10th Trilateral Conference on Nanoscience, Energy, Water & Healthcare organized by Materials Research Society of Singapore (MRS-S) at NTU Singapore
Prof. Abir De Sarkar	Singapore	June 23-28, 2019	Delivered a talk on "Atomic-Scale Insights into Energy Conversion in Transition Metal Dichalcogenide Monolayers in 10th International Conference on Materials for Advanced Technologies, ICMAT 2019
Dr. Indranil Sarkar	Japan	Feb 29 to Mar. 7, 2020	Conducted experiments at the synchrotron light source of the Photon Factory, Tsukuba Japan

AWARDS AND RECOGNITIONS

A) ENERGY AND ENVIRONEMENT UNIT

Prof. H. N. Ghosh: Sir J. C. Bose Fellowship from Department of Science and Technology, Govt of India.

- ✓ Gurpreet Kaur received best poster award at DAE-BRNS Theme Meeting on Ultrafast Sciences 2019, held at IIT Bombay, Mumbai.
- ✓ Nandan Ghorai received best poster award at International Conference on Nano Science and Technology (ICONSAT 2020), held at S. N. B. N. C. B. S, Kolkata.

Dr. Jayamurugan Govindaswamy

- ✓ Ms. Shaifali has received best poster award by ACS Applied Polymeric Materials in 25th CRSI National Symposium in Chemistry held on July 19-21, 2019 jointly organized by ACS and CRSI at IIT-Kanpur.
- ✓ Dr. Ritu Mahajan has received the 2nd best poster award in NANO INDIA 2019 organized by DST at Mahatma Gandhi University, Kerala.

Dr. Prakash Neelakandan

- ✓ Dr. Nidhi Naithani, Women Scientist (WOS-A) has received the best oral presentation award in "National Conference on Recent Advances in Physical Sciences (NCRAPS-2019)" held on 19-20 December, 2019 at Malviya National Institute of Technology (MNIT), Jaipur.

Dr. Monika Singh

- ✓ PhD student, Arti Joshi got ACS Best Poster Prize in 6th International Conference on Advanced Nanomaterials & Nanotechnology held at IIT Guwahati during 18-21 December 2019.
- ✓ PhD student, Deepika Rani won RSC Best Poster Prize in International Conference on Nano Science and Technology held at S N Bose National Centre during 5-7 March 2020.

Dr. Menaka Jha

- ✓ Dr. Sujeet got the best poster award at 11th Bengaluru India Nano held in Banglore during 2nd -4th March 2020.

Dr. Vivek Bagchi: Excellent Reviewer Award from Bulletin of Materials Science, Springer.

Dr. Ramendra Sundar Dey: selected for *Journal of Materials Chemistry A* Emerging Investigator 2019.

- ✓ Ms. Navpreet has received the best poster award in the '1st CRIKC Chemistry symposium' held on 2-3rd November 2019 at IISER Mohali.

B) QUANTUM MATERIALS AND DEVICE UNIT

Prof. Abir De Sarkar:

- ✓ Ms. Ashima Rawat received the Best Poster Award at the ACS sponsored 6th International Conference on Advanced Nanomaterials and Nanotechnology (ICANN 2019) held at IIT, Guwahati in 18-21 December, 2019.
- ✓ Ms. Ashima Rawat participated upon invitation in "Computational School on Electronic Excitations in Novel Materials Using the Yambo Code" held in the Abdus Salam International Centre for Theoretical Physics, Trieste, Italy between 27th and 31st January, 2020.
- ✓ Mr. Nityasagar Jena received prestigious Postdoc position funded by the European Union's Graphene Flagship project, Horizon 2020, between Germany, France and Belgium
- ✓ Mr. Dimple completed his Ph.D. on 11th November, 2019 and has been working as a **CNRS Postdoctoral Fellow** at Nancy, France since 20th November, 2020.

- ✓ **Dr. Suvankar Chakraverty:**
- ✓ Ms. Neha Wadehara, Ph.D student has been awarded Best presentation award, INST-inhouse symposium 2019.
- ✓ Ms. Ruchi Tomar, Ph.D student Nano-India 2019, has been awarded best poster presentation award.

Dr. Md Ehesan Ali:

- ✓ Aritra Mukhopadhyaya received best poster prize in International conference on "Current Trends in Functional Materials" January 15 – 17, 2020, NITK-Surathkal.

Dr. Dipankar Mandal

- ✓ Young Carrier Award (DST) (2019)
- ✓ INDIA Top Cited Author Award 2019 (from IOP Publishing)
- ✓ ITS SERB

Dr. Kiran S. Hazra

- ✓ Anirban Kundu received Best Poster Award – ICAN 2019 (IIT Guwahati)

C) CHEMICAL BIOLOGY UNIT:

Prof. Deepa Ghosh:

- ✓ Dr Swati Kaushik, of the group, has been awarded the best poster award in Nanobioteck 2019

Dr. Asish Pal:

- ✓ Ms. Deepika Gupta bagged CRSI-ACS best poster award at 26th CRSI conference at VIT, Tamil Nadu on February 6-8, 2019.

Dr. Sharmistha Sinha

- ✓ Dr. Sharmistha Sinha has received the prestigious Har Govind Khorana-Innovative Young Biotechnologist Award 2019

Dr. P.S. Vijayakumar:

- ✓ Mr. Pulkit received best poster award in Nano for agri, in Global bio India, Delhi 21st and 22nd Nov., 2019.

Dr. Sangita Roy:

- ✓ Ms. Pooja Sharma received best poster award in Fifth international conference on nanotechnology for better living (NBL-2019), jointly organized by NIT-Srinagar and IIT-Kharagpur; held during April 7 – 11, 2019 at SKUAST, Shalimar Srinagar, Jammu and Kashmir, India.
- ✓ Ms. Pooja Sharma received ACS travel award for best oral presentation International conference on Smart materials for sustainable technology (SMST 2020) organized by Society for Interdisciplinary Research on Materials and Biology, supported by ACS, held during 22-25 February 2020 in Goa.

- ✓ Ms. Harsimran Kaur received ACS travel award for best oral presentation International conference on Smart materials for sustainable technology (SMST2020) organized by Society for Interdisciplinary Research on Materials and Biology, supported by ACS, held during 22-25 February 2020 in Goa.
- ✓ Mr. Vijay Kumar Pal received best poster presentation award at International Conference on Nano Science and Technology (ICONSAT 2020), organized by S. N. B. N. C. B. S, Kolkata, held during March 5-7, 2020 in Kolkata.

Dr Rehan Khan:

- ✓ Mr Anas Ahmad got "Best Oral Presentation Award" in 4th In-house Symposium, held on 9-10 Dec 2019 at INST, Mohali.

CONFERENCES/EVENTS ORGANIZED

National Technology Day:

INST, Mohali in association with National Agri-Food Biotechnology Institute (NABI), Mohali have celebrated the Technology Day on Saturday, 11th May, 2019 at NABI auditorium, Sector-81, SAS Nagar.On this occasion, Padma Shri Prof. Srikumar Banerjee, Chancellor, Homi Bhaba National Institute (deemed to be University) and Ex-Chairman, Atomic Energy Commission of India, delivered a special lecture entitled "*Complementarity between Solar and Nuclear Energy*".

Prof. S. Banerjee delivering lecture on Technology day (left); Participants in INST In-house symposium (right)

INST In-House Symposium:

INST organized 4th 'In-House symposium' on 9th and 10th December, 2019. Plenary lectures were delivered by Prof. A. K. Tyagi (Chemistry Division, Bhabha Atomic Research Centre, Mumbai), Prof. Prashant Mishra (Department of Biochemical Engineering and Biotechnology, Indian Institute of Technology Delhi) and Prof. Satish Chandra B. Ogale (Department of Physics and Centre for Energy Science, Indian Institute of Science Education and Research, Pune). All the final year Ph. D. students of INST presented their research work during the symposium.

DST-ACS Publishing Workshop:

INST organized a skill-building workshop for early career researchers and M. Sc. / Ph. D. students in association with American Chemical Society, Department of Science and Technology and Vigyan Prasar on 20th November, 2019. The workshop focused on scholarly publishing, peer review, ethics, plagiarism, science communication, careers and was attended by ~300 students and early career researchers. Prof. Nikhil R. Jana (Indian Association for the Cultivation of Science, Kolkata), Prof. Abhishek Dey (Indian Association for the Cultivation of Science, Kolkata) and Mr. Gururaja Kulkarni (Institute of Product Leadership, Bengaluru) gave lectures about various aspects of publishing and career development.

Participants in DST-ACS workshop (left); Prof. Anders Hagfeldt delivering lecture in MTE program (right)

RSC Meet the Editor (MTE) programs:

INST organized RSC Meet the Editor (MTE) programs on 28th November 2019 with an aim to provide the researchers and the students with a platform to interact and engage with the RSC's journal Editors having International and Indian board members. Prof. Anders Hagfeldt, Editor-in-Chief, *Journal of Materials Chemistry A* and Prof Goutam De, Associate Editor, *Journal of Materials Chemistry A* shared their research and provided Editors' perspective on how to write research papers for maximum impact and shared details of RSC's peer review process. More than 170 participants attended the program.

Winter School on Advanced Techniques in Nano Science and Technology (ATNST 2019) for ST researchers:

INST Mohali has organized a Winter School for the purpose of raising the awareness of M.Sc/M.Tech and Ph.D students belonging to the ST-category in Advanced Techniques in Nano Science and Technology (ATNST) during 02nd to 07th December 2019.

The program schedule includes special plenary talks, invited expert lectures and practical demonstrations of advanced techniques in Nano Science and Technology. Participants came from different universities, institutions such as Osmania University, Panjab University, Central University of Rajasthan, University of Madras, University of Jammu, Mizoram University, CSIR-Central Food Technological Research Institute, Rani Channamma University, Tezpur University, NIPER Mohali and other institutes across India. Participants are young faculty members, Ph.D. students and M.Sc / M.Tech students were working in the field of nano science & technology.

Prof. H. N. Ghosh falicitating Prof. Pushan Ayyub (left); Participants in the interactive workshop (right)

Lecture were delivered by eminent speakers like Prof. Alok Kumar Mukherjee (Jadavpur University), Dr. Aasheesh Srivastava (IISER Bhopal), Prof. Pushan Ayyub (TIFR), Prof. Nikhil K. Singha (IIT Kharagpur), Dr. Ashish (CSIR-IMTech) and Dr. Sanyog Jain (NIPER Mohali), and Dr. Sanyog Jain (NIPER Mohali), Prof. Suman Chakroborty (IIT Kharagpur), Prof. A.C. Bhasikuttan (BARC), Dr. Mrinmoy De (IISc), Dr. Sarit Agasti (JNCASR), Dr. Murali Banavoth (University of Hyderabad), and Dr. Manjula Kalia (RCB-Faridabad) and Dr. Amilan Jose Devadoss (NIT Kurukshetra).

Lectures were followed by practical demonstration of various advanced instruments used in Nano Science and Technology on like TEM, SEM, AFM, UV-Vis Spectroscopy, Photoluminescence Spectroscopy, FTIR, XRD, Electro Spinning, Raman Spectroscopy, Confocal Laser Scanning Microscopy and Flow Cytometry. Overall, it provided an ample scope and opportunities for effective interactions that enabled the participants to pursue research using advanced scientific techniques.

LECTURES

A) Delivered by INST Faculty

Sr.	Event (National/International)	Title of the Talk	Date
	PROF. H N GHOSH		
1.	Indo-German Meeting 2019, University of Duisburg-Essen, Germany	Ultrafast Exciton, Bi-Exciton and Trion Dissociation Dynamics in Metal@Semiconductor Hetero-Structure Interface	25-27 Sept. 2019
2.	Ultra-Fast Sciences 2019 (UFS-2019), IIT, Mumbai, India	Exciton, Bi-Exciton, Trion and Polaron Dissociation Dynamics in Nano-Structured Hetero Interface: Implication in Solar Devices	7-9 Nov. 2019
3.	Journal of Physical Chemistry Letters Forum Workshop, Jilin University, 2699 Qianjin Street, Changchun 130012, China.	Polaron Mediated Cooling Dynamics in Perovskite Materials: Effect of Temperature	10-15 Nov. 2019
4.	6th International Conference on Advanced Nanomaterials and Nanotechnology (ICANN2019), on, in Guwahati-Assam	Ultrafast Exciton, Bi-Exciton, and Trion Dissociation Dynamics in Metal-Semiconductor Hetero Interface	18-21 Dec. 2019
5.	International Conference on Nanomaterials for Energy, Environment and Sustainability, Siksha 'O' Anusandhan, Bhubaneswar, Odisha	Exciton, Bi-Exciton and Trion Dissociation Dynamics in Hetero-Structure Interface	20-22 Dec. 2019
6.	15th DAE - BRNS Trombay Symposium on Radiation & Photochemistry Venue: DAE Convention Centre, Anushaktinagar, Mumbai, India	Ultrafast Exciton, Bi-exciton, Trion and Polaron formation and dissociation dynamics in Nano-hetero interface.	5-9 Jan. 2020
7.	Science Academies' Lecture Workshop on Materials Engineering for Sustainable Environment and Energy (MESES-2020) CSIO, Chandigarh	Ultrafast Exciton and Trion Dynamics on Au@2D MoS_2 Heterostructure	09-10 Jan. 2020
8.	Green & Sustainability in Polymers and Functional Materials: Opportunity & Challenges (GSPFM 2020), IIT Kharagpur, WB.	Exciton, Bi-exciton and Trion Dissociation Dynamics in 2D and 3D Nanostructure Materials	7-8 Feb. 2020
9.	2nd Materials Conclave and 31st AGM of MRSI CGCRI, Jadavpur, Kolkata, India	Polaron Dynamics in 0D/3D Perovskite Nanostructure Materials	11-14 Feb.20
10.	Frontier Problems in Nanoscience and Nanotechnology FPNN- 2020, IIT Gandhinagar, Gujarat	Exciton, Bi-Exciton, Trion and Polaron Dissociation Dynamics in 2D and 3D Nanostructure Materials	14-15 Feb. 2020
	PROF. ABIR DE SARKAR		
	10th International Conference on Materials for Advanced Technologies (ICMAT 2019), **Singapore**	*Atomic-Scale Insights into Energy Conversion in Transition Metal Dichalcogenide Monolayers"*	June 23-28, 2019
	DR. DIPANKAR MANDAL		
1	MRS Spring Meeting 2019, Phoenix, Arizona, USA	Human Skin Interactive Bio-e-skin for Self-powered Health Care Monitoring (Contributory talk)	22-26 Apr, 19
2	MRS Spring Meeting 2019, Phoenix, Arizona, USA	All Organic Piezoelectric E-Skin Sensor for Self-Powered Wearable Electronics Human Physiological Signal Monitoring (Contributory talk)	22-26 April, 2019
3	All India Workshop on Nanotechnology and Smart Materials, Chandigarh University	Nanopiezotronics Research Area for Self-Powered Electronics (Invited talk),	15-16 May, 19
4	TEQIP-III Sponsored Faculty Development Programme (FDP) on Futuristic Electronics Devices and Applications, Kurukshetra University, Haryana,	Self-Powered Electronics: Emerging Futuristic Forthcoming Technology (Expert Lecture 2) and Pyroelectric Nanogenerator as a Thermal Energy Harvester and IR-Sensor	26-31 August, 2019
5	TEQIP-III Sponsored Faculty Development Programme (FDP) on Futuristic Electronics Devices and Applications, Kurukshetra University, Haryana	Pyroelectric Nanogenerator as a Thermal Energy Harvester and IR-Sensor (Expert Lecture)	26-31 Aug. 2019
6	International Conference on Functional Materials (ICFM 2020), IIT Kharagpur	Magneto-Mechano-Electric Nanogenerator: A Possibilities of Harvesting Parasitic Magnetic Noises	6-8 Jan. 2020
7	National Science Day-2020, PEC, Chandigarh	Nanogenerator: A Newly Developed Energy Harvesting Device (Guest/expert lecture)	12 Mar. 2020
	DR. KAUSHIK GHOSH		
1	The International Conference on Materials for Advanced Technologies (ICMAT) Singapore	Delivered an invited talk	23-28 June, 2019
2	CNSNT, PU, Chandigarh	Delivered an Invited talk in National Seminar On Recent Trends in Nanoscience and Nanotechnology	30 Jan. 2020
3	ICONSAT 2020, Biswa Bangla Convention Centre, New Town, Kolkata	Delivered an invited talk hosted by S. N. Bose National Centre for Basic Sciences, Kolkata.	5-7 Mar. 2020
	PROF. KAMALAKANNAN KAILASAM		
1	Society for Promotion of Science & Technology in India" at Department of Physics, Panjab University, Sector-14, Chandigarh	Nanomaterials for Energy and Environment	17 Aug. 2019
2	International Workshop on Energy Technologies (iWET-2019)" at Manonmaniam Sundaranar University, Tirunelveli	Polymeric carbon nitride as visible light photocatalysts for generation of hydrogen and fine chemicals	24-26 Sept. 2019

3	one week Short Term Course on "Advanced Nanomaterials for Energy Storage Devices (ANESD-2019) on 23rd October, 2019 at Department of Physics, NIT Kurukshetra	Porous organic polymers for photocatalytic water splitting and biomass to H2 energy generation and fine chemicals	19-23 Oct. 2019.
4	1st CRIKC Chemistry Symposium (CCS2019)" held in IISER Mohali	Organic semiconductors for photocatalytic water splitting and biomass conversion	1-2 Nov. 2019
5	Curie Club, IISER Mohali" as part of the 8th Chemistry Week at IISER Mohali	Organic semiconductors for photocatalytic water splitting and biomass conversion	11 Nov. 2019
6	National Conference on Advanced Functional Materials-2019 (NCAFM-2019)" organized by Jamia Millia Islamia, New Delhi	Functional Porous Polymeric Networks as Visible light Photocatalysts for generation of Hydrogen and Fine Chemicals	20-21 Nov. 2019
7	10th Trilateral Conference on Nanoscience: Energy, Water & Healthcare" at the Nanyang Technological University (NTU), Singapore, organized by the Materials Research Society of Singapore (MRS-S)	Artificial Photosynthesis: Porous Organic Polymers for H2 generation and Biomass conversion	21-23 Nov. 2019
8	International conference on Nanomaterials for energy, environment and sustainability (ICNEES-2019)" organized by Centre for Nanoscience and Nanotechnology, ITER, SOA, Deemed to be University, Bhubaneswar, Odisha	Porous polymeric networks as heterogeneous photo catalyst for hydrogen generation and organic conversion in visible light	20-22 Dec. 2019.
9	IIT Goa	Advanced Functional Materials at Nano and Atomic Scale"	10-28 Feb. 2020
10	SERB School	Polymeric Carbon Nitrides, g-CN (so called g-C3N4)	14 Feb. 2020
	DR. JAYAMURUGAN GOVINDASWAMY		
1	Exhibition in technology day celebration organized by INST at NABI, Mohali	Demonstrated technology exhibition in technology day celebration	11 May, 2019
2	Participated in debate forum organized by Uttarakhand Department of Science and Technology in Destination Uttarakhand -2019	A mega exhibition & Business summit	18-20 July, 2019
3	international symposium on SUPRA and Nano Chemistry of Bioactive molecules (SANCBAM-2019) at Christian College, Kattakada	Supramolecular Interactions Mediated Functional Organic Nanomaterials	19 Aug. 2019.
4	School of chemical Sciences, IISER-TVM	Functional Organic Nanomaterials for Catalysis applications	21 Aug. 2019
5	international conference on Innovations in Bioprocess Technology (IBT-2019) at CIAB, Mohali	Nanotechnology: A perfect Companion to the Chemo-Processing of Biomass for the Controlled Delivery of Pesticides/Drugs and Green Catalysis	11-13 Dec. 2019
	DR. DEBABRATA PATRA		
1	Alumni Confluence @ IIT Bombay	Designing Functional Nanomaterials via Noncovalent Interaction	22 June, 2019
	DR. PRAKASH NEELAKANDAN		
1	1st CRIKC Chemistry Symposium (CCS-2019), IISER Mohali	Fine-tuning Photochemical Properties of Nanocomposites through Directed Self-assembly	2-3 Nov. 2019
	DR. VIVEK BAGCHI		
1	Electrochemical Techniques for Energy, Sensor and Corrosion Applications, 2019, organized by CSIO, Chandigarh	Hybrid nanomaterials for electrocatalytic applications	17-19 Nov. 2019
2	107th Indian Science Congress at University of Agricultural Sciences Bangalore	Synergistically enhanced HER activity in mesoporous Mo2C/MoO2 nanocomposite	3-7 Jan. 2020
	DR. R S DEY		
1	One Week FDP on "Futuristic Electronics Materials, Devices and Applications" Kurukshetra University, Kurukshetra, Haryana.	'Electroanalytical techniques: Basics and applications for energy storage and conversion	26-31 Aug. 2019
2	One Week FDP On "Futuristic Electronics Materials, Devices and Applications" at Kurukshetra University, Kurukshetra, Haryana	Carbonaceous materials for energy storage and hybrid storage systems'	26-31 Aug. 2019
3	Advanced Nanomaterials for Energy Storage Devices	Towards the Development of Fully Renewable Hybrid	19-23 Oct.
	(ANESD-2019)" at Department of Physics, N.I.T Kurukshetra.	Energy Technology: Role of Electroanalytical Chemistry'	2019
4	2nd International Conference on Nanoscience and Nanotechnology (ICNAN'19)' at Vellore Institute of Technology (VIT), Vellore	The role of electrode material for renewable and self-powered hybrid energy systems'	29 Nov.- 1 Dec. 2019
5	Indo-UK Newton-Bhabha Workshop on " Electrochemical Technologies for Sustainable Fuels, Chemicals and Industrial Processes " at IISER Pune, Pune	Towards the Development of Metal-free Supercapacitor for Hybrid Energy Storage System	2-5 Dec. 2019

SHRI BHANU PRAKASH			
1	Emerging Trends and Future Challenges in Chemical Sciences (ETFC-2020) at Conference Centre, University of Delhi.	Microfluidics: applications in nanotechnology and nano-biomedical science	10-11 May, 2020
DR. ASISH PAL			
1	CEP workshop on Nanomaterials and life at DRDO-INMAS, Delhi	Bottom-up Self-assembly to Tailored Soft Nanostructures	19 Aug, 2019
2	APSRT interactional conference at IIT-Kharagpur	Supramolecular Polymer to Functional Covalent Polymer for Designing Tailored and Precise Nanostructures	25 Sept, 2019
3	SPARC workshop at Panjab University	Self-assembly of Minimalistic Peptide Building Blocks as ECM Mimick and Catalysis	31 Oct, 2019
4	International Conference on Emerging techniques in drug discovery and drug delivery: current challenges and future prospects at CGC, Landran	Mimicking extracellular matrices in bottom-up self-assembly for biomedical applications	11 Feb, 2020
DR. DEEPA GHOSH			
1	NANOBIOTECK – 2019, New Delhi	The Interaction of Carbon dots with Endothelial cells: an Important Aspect for Biomedical Applications	21-23 Nov, 2019
2	SBCI-2019, BARC, Mumbai	Carbon dots and its role in angiogenesis. Advances at the Interface of Biology and Chemistry	31 Oct-3 Nov, 2019
3	8th Indian Chitin Chitosan Society Symposium 2019, Institute of Chemical Technology, Mumbai.	Chitosan based Hydrogels for Tissue Engineering Applications	19-20 Sept, 2019
DR. SURAJIT KARMAKAR			
1	INST In-house Symposium	Developing Nano-therapies and deciphering the role of epigenetic regulators in the treatment and management of malignant solid tumours	9-10 Dec, 2019
2	Group Monitoring Workshop (GMW), BITS Hyderabad	A High Performance Nanodelivery System For Inflammatory Bowel Disease (IBD) Therapy	14-15 Feb, 2020
DR. SUVANKAR CHAKRAVERTY			
1	National Conference on Thin film and Heterostructure of Quantum Materials, Toshali Sands, Puri	Emergent phenomena at the conducting interface of insulating oxides with strong spin orbit coupling	17-19 Feb, 2020
2	11-th APCTP-IACS-IITB Joint Conference on Emergent Phenomena in Novel Oxide Materials and Low Dimensional Systems, IITB	2DEG at the interface of perovskite oxides with strong spin orbit coupling	28–30 Nov, 2019
DR. RAHUL K VERMA			
1	5th Inhaled Therapies for Tuberculosis and Other Infectious Diseases Conference. in Groningen, the Netherlands.	Dynamic mucus-penetrating inhalable Micro-Particulate systems containing Host Defence peptides: New therapeutic opportunity for Pulmonary TB	25-27 Aug, 2019
DR. JIBAN JYOTI PANDA			
1	International Brain Research Society Meeting on Blood Brain Barrier; Punjab University.	BBB Traversing Peptide/Amino Acid Based Nanotherapeutics for Combating Neural Disorders	Nov, 2019
DR. P S VIJAYA KUMAR			
1	11th Bengaluru India nano 2020	Future forms :dream to come true with nano	2-3 March, 2020
2	Pharmacy Council of India, Chandigarh Group of College	Targeted cargo delivery with the assistance of nano. Emerging techniques in drug discovery drug delivery: current challenges ad future prospects	10-11 Feb, 2020
3	DBT- Global Bio Indi, TERI, Delhi	Ways in Nanotechnology for targeted and controlled preservation	21-22 Nov, 2019.
4	Panjab Engineering College, Chandigarh	Nanotechnology assisted advanced medicine and agriculture	22nd Oct., 2019
DR. DEEPIKA SHARMA			
1	11th Biennial Conference Indian Association of Hyperthermia Oncology & Medicine at Nanavati Super Specialty Hospital	Evolution of Magnetic Hyperthermia for Cancer Therapy: Past, Present and Future Perspective	15-16 Feb, 2020.
DR. REHAN KHAN			
1	National Conference on Nanomaterials in Biology (NCNB 2019), Jaipur, Rajasthan	Nanocarrier Composed of Magnetite Core Coated with Three Polymeric Shells Mediates LCS-1 Delivery for	9-12 Oct, 2019
		Synthetic Lethal Therapy of BLM-Defective Colorectal Cancer Cells	
2	In Sync with Next Generation Biosciecnes (INGB)-2019, Goa	Nanoparticle mediated LCS-1 delivery for the targeted therapy of BLM-defective colorectal cancer cells	6-8 Nov 2019
DR. MENAKA JHA			
1	Indian Institute of Technology Kanpur, India	Fourth International Conference on Nanotechnology for Better	6-7 April, 2019
2	6 th World Congress on Nanomedical Sciences ISNSCON-2018 and Chemistry Biology Interface Synergistic in New Frontiers.at Vigyan Bhawan, Delhi	New approach of conversion of waste to nanoproducts	7-10 Jan, 2019

DR. SONALIKA VAIDYA			
1	7th International Conference on Advancements and Futuristic Trends in Mechanical and Materials Engineering Indian Institute of Technology Ropar, Roopnagar, India	Self-assembly nanostructured materials: Design and Mechanism of formation	5-7 Dec, 2019

B) Invited Lectures at INST, Mohali:

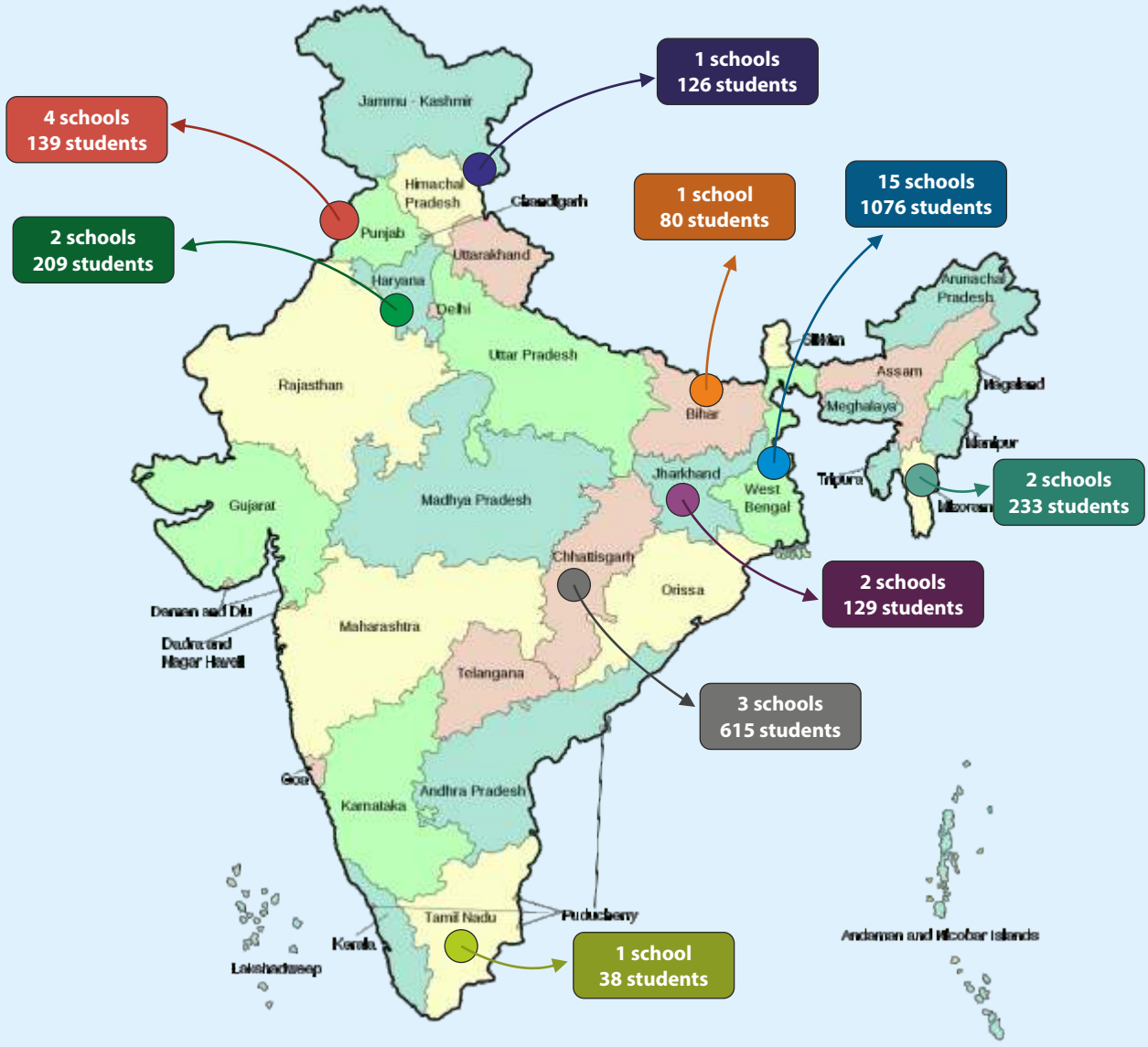
Sr.	Date	Title	Delivered By
1	02.04.19	Understanding 2D-3D junctions for solar cell and hermos-electric device	Dr. B. R. Mehta, IIT Delhi
2	10.04.19	Nanomechanical bending of water by light by photons momentum	Dr. K. P. Singh, IISER Mohali
3	07.05.2019	Designing Functional Materials by Molecular Self-assembly.	Dr. A. Ajayaghosh, NIIST, Thiruvananthapuram
4	17.05.2019	Manipulating and/or creating magnetism by architecture and interface	Dr. S. Bedanta, NISER, Bhubaneswar
5	28.05.2019	Ultrafast Spectroscopic Perspective of Molecules and Materials.	Prof. Anindya Dutta, IIT Bombay
6	24.06.2019	LASER, BUTTERFLY EFFECT and SECURE COMMUNICATION	Dr. D. Biswas, BARC
7	01.07.2019	Novel nano-based advanced technologies for the removal of hazardous radionuclides & heavy metal ions from groundwater	Dr. Shruti Mishra, IIT Kanpur
8	17.07.2019	Smart Materials: Capabilities and Applications.	Dr. Soumitra Satapathi, IIT Roorkee.
9	18.07.2019	Polymer-Based Nanomaterials: Structural Diversity and Applications.	Prof. Tushar Jana, University of Hyderabad.
10	26.07.2019	Soft Phonon and Thermal Transport in Chalcogenide Thermoelectric Materials.	Dr. Ajay Soni, IIT Mandi.
11	23.08.2019	Resistive switching devices for high-density memory and artificial synapse applications	Dr. Ajeet Kumar, NPL, Delhi.
12	04.10.2019	Nanoparticle decorated Multi Walled Carbon Nanotubes and Nanocomposites: Next generation high intensity electron source	Dr. Santanu Ghosh, Dept. of Physics, IIT Delhi
13	06.11.2019	Squaraine Based Dyes for Dye-Sensitized Solar Cells	Dr. J. Nithyanandhan, NCL Pune
14	25.11.2019	Supramolecular Chemistry of {Cr7M} Heterometallic Wheels.	Dr. Deepak Asthana, The University of Manchester, UK
15	29.11.2019	The Curious Case of Au (III) reduction by Phenylalanine 17Amphiphiles: Implications in Bio18medical applications.	Dr. Aasheesh Srivastava, IISER Bhopal
16	13.12.2019	Macroscopic Properties as Manifestations of Molecular Fluctuations	Dr. Chirodeep Bakli, , IIT Kharagpur
17	21.01.2020	Nanostructured Thermoelectric Energy Conversion	Dr. Kanishka Biswas, JNCASR, Bangalore.

Societal Outreach Activities in FY 2019-2020

Under its flagship outreach program, INST has started special initiatives like:

1. Organizing interactive sessions of school/college students with skilled persons/scientists, especially in rural schools and colleges.
2. Inter-zonal interactions, problem-solving sessions (zone-wise) for the students, so that they can think of solving local problems through science and technology.
3. Arranging field trips for the students to give a better understanding of the real world.
4. Organizing an annual open day for school/college students
5. Awards for students (region wise) to motivate them to do good work in their regular school/college curriculum

In FY 2019-2020, INST outreach cell has focused its attention in the backward ST-dominated districts of Chattisgarh, West Bengal, Jharkhand, Mizoram, Himachal *etc*. Total of **2715 Students (1374 ST students, 51%) of 29 Schools/Colleges** from April, 2019 to March, 2020 have been brought under the ambit of INST-outreach program.



Outstation Outreach Details:

S. No.	School Name and address	Number of students benefitted					District, State	Date of lecture
		Total	ST	SC	OBC	Girls		
1	**Badnagra MGD School, Gazole, Malda, West Bengal**	145	97	18	16	70	Gazole, Malda, WB	20/04/2019
2	**Kironmayee Pry School, Sahapur, Malda, West Bengal**	187	45	125	11	100	Sahapur, Malda, WB	20/04/2019
3	**Infant Jesus Convent School, Sector 65**	139	-	-	-	76	Mohali, Punjab	22/04/2019
4	**Ramakrishna Mission Hindi High School, Jamshedpur, JH**	35	25	05	05	0	Jamshedpur, JH	05/06/2019
5	**Vidya Bharti English School, Hata, Jharkhand**	94	33	12	07	36	Hata, JH	06/06/2019
6	**GSSS, Sundernagar**	126	1	27	11	68	Sundernagar, HP	15/06/2019
7	**Bairgachi High School, Bairgachi, Malda, West Bengal**	202	10	54	138	112	Gazole, Malda, WB	26/08/2019
8	**Chitkole R. K. Sikshaniketan, Rajadighi, Malda, West Bengal**	213	43	170	-	118	Gazole, Malda, WB	26/08/2019
9	**R. K. Mission Vidyamandir, Katihar, Bihar**	80	0	0	-	0	Katihar, Bihar	27/08/2019
10	**GSSS Mandhana, Morni, Haryana**	172	0	15	-	85	Morni, Haryana	06/09/2019
11	**GSSS Thapli, Morni, Haryana**	37	0	-	-	13	Morni, Haryana	06/09/2019
12	**Government higher secondary School, Gorhi**	306	278	16	14	150	Korba, Chattisgarh	06/09/2019
13	**Government girls high school, Balconagar, Chattisgarh**	137	80	21	36	137	Korba, Chattisgarh	09/09/2019
14	**Government higher secondary school boys, Balconagar, Chattisgarh**	172	98	-	-	71	Korba, Chattisgarh	12/09/2019
15	**Asok Vidyapeeth, Jhargram**	71	23	28	9	33	Jhargram, WB	23/09/2019
16	**Jhargram Banitirtha High School**	46	14	9	7	18	Jhargram, WB	23/09/2019
17	**Rani Benode Manjari Govt. Girls' School, Jhargram**	76	12	10	20	76	Jhargram, WB	23/09/2019
18	**Pachhunga University College**	120	110	05	05	55	Aizawl, Mizoram	14/12/2019
19	**Home Mission School, Zemabawk**	113	111	02	05	50	Aizawl, Mizoram	16/12/2019
20	**Kumalan Kuttai Govt. H. S. School**	38	1	17	-	21	Erode, Tamil Nadu	24/12/2019
21	**Madhabnagar Badalmoni High School, Mokdumpur**	10	-	-	-	0	Malda, WB	14/03/2020
22	**Malda Model Madrasah, B T College Road**	8	-	-	2	3	Malda, WB	14/03/2020
23	**Sahapur High School, Nageswarpur**	20	-	10	6	12	Malda, WB	14/03/2020
24	**Barlow Girls' High School, Mokdumpur,**	23	-	5	3	23	Malda, WB	14/03/2020
25	**Ramkinkar balika Vidyalaya, Mokdumpur**	15	-	-	-	15	Malda, WB	14/03/2020
26	**Malda Girls' High School, Women's college Road,**	10	-	2	1	10	Malda, WB	14/03/2020
27	**Bachamari G. K. High School, Old Malda**	18	-	4	-	10	Malda, WB	14/03/2020
28	**Malda College, Rabindra Avenue**	32	1	14	08	12	Malda, WB	14/03/2020
	Total = 28 Schools	**2645**	**982**	**569**	**304**	**1374**		

Outreach/Open day at INST, Mohali:

S.No.	School/College Name and address	Number of students benefitted					District, State	Date of visit
		Total	ST	SC	OBC	Girls		
1	**Infant Jesus Convent School, Sector 65**	25	-	-	-	13	Mohali, Punjab	11/05/2019
2	**Pt. Dean Dayal Upadhyaya Pashu Chikitsa Vigyan Vishwavidhalaya Go Anusandhan Sansthan**	47	-	-	-	11	Mathura, UP	Nov, 2019
3	**Chandigarh College of Pharmacy, Landran**	45	-	-	-	12	Mohali, Punjab	Nov, 2019
4	**University Institute of Pharmaceutical Sciences**	20	-	-	-	6	Chandigarh	Nov, 2019
5	**Madras Christian College**	50	-	-	-	26	Tambaram, Chennai	Jan, 2020
	Total = 5 Schools/colleges	**187**				**68**		

Participant at Vidya Bharti English School, Hata, Jharkhand (Left); Outreach workshop at GSSS, Sundernagar, Himachal Pradesh (Right)

Students and teachers of Bairgachi High School, Malda, West Bengal (left); Particpnats at GSSS, Mandhana attending the outreach workshop, Haryana (right)

Outreach workshop at Govt Girls' High School, Korba, Chattisgarh (left); students at Home Mission School, Aizawl (right)

Manpower@INST

Prof Amitava Patra - DIRECTOR					
SCIENTI STS					
2	Prof. H. N. Ghosh	Scientist G	**20**	Dr. P.S. Vijayakumar	Scientist D
3	Dr. Deepa Ghosh	Scientist F	**21**	Dr. Sangita Roy	Scientist D
4	Dr. Abir De Sarkar	Scientist F	**22**	Dr. Sonalika Vaidya	Scientist D
5	Dr. Surajit Karmakar	Scientist F	**23**	Dr. Tapasi Sen	Scientist D
6	Dr. Kamalakannan K	Scientist F	**24**	Dr. Asifkhan Shanavas	Scientist C
7	Dr. Prakash Neelakandan	Scientist E	**25**	Mr. Bhanu Prakash	Scientist C
8	Dr. Debabrata Patra	Scientist E	**26**	Dr. Chandan Bera	Scientist D
9	Dr. Asish Pal	Scientist E	**27**	Dr. Manish Singh	Scientist C
10	Dr. Md. Ehesan Ali	Scientist E	**28**	Dr. Monika Singh	Scientist C
11	Dr. Sharmistha Sinha	Scientist E	**29**	Dr. Menaka Jha	Scientist C
12	Dr. S. Chakraverty	Scientist E	**30**	Mr. Mukesh Raja	Scientist C
13	Dr. Kaushik Ghosh	Scientist E	**31**	Dr. Subhasree R.C.	Scientist C
14	Dr. Jayamurugan G.	Scientist E	**32**	Dr. Vivek Bagchi	Scientist C
15	Dr. Dipankar Mondal	Scientist E	**33**	Dr. Deepika Sharma	Scientist C
16	Dr. Indranil Sarkar	Scientist E	**34**	Dr. Rehan Khan	Scientist C
17	Dr. Rahul K. Verma	Scientist D	**35**	Dr. Shyam Lal M	Scientist C
18	Dr. Jiban Jyoti Panda	Scientist D	**36**	Dr. B.S. Naidu	Scientist C
19	Dr. Kiran S. Hazra	Scientist D	**37**	Dr. R. S.Dey	Scientist C

ADMINISTRATION					
1	Shri U. C Prasad	CFAO	3	Mrs. Sweta Belwal	Stenographer
2	Mrs Vibha Mehta	Finance Officer	4	Mr. Rajpreet Singh	Stenographer

CONTRACTUAL POSITIONS		
1	Dr. Goutam De	Visiting Scientist
2	Mr. Rattan Lal Sharma	Consultant (Admin)
3	Shri Niranjan Singh	Consultant (Engineering)
4	Mr. J. N. Ahuja	Consultant (S&M)
5	Dr. Ravinder Kaur	Store and Purchase Officer
6	Mr. Varender Singh	Assistant Engineer (Civil)
7	Baljinder Kaur	Technical Assistant (TEM)
8	Ashwinder Singh	Technical Assistant (Confocal)

THROUGH OUTSOURCING AGENCY		
1	Security Supervisor-cum-Caretaker	02
2	Office Assistants	11
3	Junior Engineer (Elec)	01
4	System Administrator	01
5	Security Guards	10

GOYAL PARUL & COMPANY

Head Office: # 54, Meedo Complex, 2nd Floor, Saharanpur Road,
Near Saharanpur Chowk, Dehradun-248001, Uttarakhand
Mobile: 09592888878 **Email:** k_vijaygupta@yahoo.com

AUDITORS' REPORT

The Director,
Institute of Nano Science and Technology Mohali, Punjab

We have examined the attached Balance Sheet of Institute of Nano Science and Technology, Mohali, Punjab as at March 31, 2020, Income and Expenditure Account and Receipt and Payment Account for the year ended March 31, 2020.

These Financial statements are the responsibility of the Institute's Management. This responsibility includes design, implementation and maintenance of internal control relevant to the preparation of financial statements that are free from material misstatement, whether due to fraud or error. It also includes the maintenance of adequate accounting records in accordance with the relevant Act for safeguarding of the assets of the organisation and for preventing and detecting the frauds and irregularities, Our responsibility is to express an opinion on these financial statements based on our audit.

We conducted our audit in accordance with Auditing Standards generally accepted in India. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether the financial statements are free of material misstatements. An audit includes examining on a test basis, evidence supporting the amounts and disclosures in financial statements. An audit also includes assessing the accounting principles used and significant estimates made by the management, as well as evaluating the overall financial statements presentation. We believe that our audit provides a reasonable basis for our opinion.

We further report that subject to following observations and subject to the fact that due to existing Covid 19 pandemic, the audit was conducted only on the basis of accounting data viz ledger received online:

On rental payments being made to Laboratories, TDS is not being deducted on the grounds of those being registered u/s 35(1) (ii) of the Income Tax Act. It is advised to obtain “Certificate of non deduction of TDS”, as is issued by income tax department, from all such laboratories to avoid any sort of litigation in future;

we have obtained all the information and explanations which to the best our knowledge and belief were necessary for the purpose of our audit;

a) In our opinion proper books of accounts, as required by law, have been kept by the institute so far as appears from our examination of those books;
b) The Balance Sheet, Income and Expenditure Account and Receipt and Payment Account of the institute are in agreement with the books of account;
c) In our opinion and to the best of our information and according to the explanations given to us, the said accounts read together with and subject to the Significant accounting Policies and Notes to Accounts thereon, give the information in the manner so required, and present a true and fair view in conformity with the accounting principles generally accepted in India;

1. In so far as it relates to Balance Sheet, of the state of affairs of the institute as at March 31, 2020.
2. In so far as it relates to the Income and Expenditure Account of the Excess of Expenditure over Income of the Institute for the period ended on that date.

As per our report of even date.

For Goyal Parul & Co.
Chartered Accountants
Place : Chandigarh
Date : 21.07.2020
UDIN: 20506042AAAACK3687

For Goyal Parul & Co.
Chartered Accountants

Place: Chandigarh
Date:-21.07.2020

(CA Vijay Kumar)
Partner

FINANCIAL STATEMENT
INSTITUTE OF NANO SCIENCE AND TECHNOLOGY
HABITAT CENTRE SECTOR-64 PHASE-X MOHALI PUNJAB

Schedule-15 Significant Accounting Policies

1. Accounting concepts & Basis of preparation of Financial Statements
   The financial statements have been prepared under the historical cost convention in accordance with the generally accepted accounting principles. The institute generally follows the accrual system of accounting and recognizes significant items of income & Expenditure on accrual basis unless otherwise stated.

2. Grants
   Grants are recognized on receipt, Grants received from Department of Science & Technology (DST) for Creation of Capital Assets (plan) is treated as corpus of the centre. Grants received for General (Plan), General (ST), Salaries (Plan) and Salaries - SC (Plan) are treated as of revenue nature and shown under Income & Expenditure Account.

3. Fixed Assets and Depreciation
   No depreciation on the Building has been charged during the year as these assets are not put to use upto 31.03.2020 as certified by the management of the Institute. Depreciation on assets has been charged at the rates applicable under Income Tax Act. Depreciation, on assets used for less than 180 days, is restricted to 50% of the prescribed rates. Cost of Fixed assets includes Custom Duty, Clearing & Forwarding Charges and Freight relating to such assets.

Vibha Mehta
Finance officer

Prof. Amitava Patra
Director

MUKESH RAJA
Scientist 'C' & Head of Office
Institute of Nano Science & Technology
Habitat Centre, Sector-64, Phase-10, Mohali

Mukesh Raja
Head of Office

As per our report of even date.

For Goyal Parul & Co.
Chartered Accountants
Place : Chandigarh
Date : 21.07.2020
UDIN: 20506042AAAACK3687

For Goyal Parul & Co.
Chartered Accountants

Place: Chandigarh
Date:-21.07.2020

FINANCIAL STATEMENT
INSTITUTE OF NANO SCIENCE AND TECHNOLOGY
HABITAT CENTRE SECTOR-64 PHASE-X MOHALI PUNJAB
BALANCE SHEET AS AT MARCH 31, 2020

Amount in (Rs.)

CORPUS/CAPITAL FUND AND LIABILITES	**Schedules**	**Current Year**	**Previous Year**
CORPUS/CAPITAL FUND	1	2398329146.56	1582342442.62
RESERVE AND SURPLUS	2	-2007960.51	-15535337.60
WELFARE FUND	3A	603928.00	606549.00
PROJECT ACCOUNT	3B	276877432.23	316405864.85
CURRENT LIABILITIES & PROVISIONS	4	63982446.98	62548048.04
TOTAL		**2737784993.25**	**1946367566.92**
ASSETS			
FIXED ASSETS-INST	5	2050010059.22	942496796.28
Fixed Assets-Project	5	167077595.01	156547321.77
Fixed Assets-Consultancy	5	891776.83	763628.33
CURRENT ASSETS, LOANS AND ADVANCES	6	519805562.20	846559820.54
MISCELLANEOUS EXPENDITURE (to the extent not written off or adjusted)		0.00	0.00
TOTAL		**2737784993.25**	**1946367566.92**
SIGNIFICANT ACCOUNTING POLICIES	15		
NOTES ON ACCOUNTS	16		

For INSTITUTE OF NANO SCIENCE AND TECHNOLOGY
As per our report of even date.

विभा मेहता/ Vibha MEHTA वित्त अधिकारी/ Finance Officer नैनो विज्ञान एवं प्रौद्योगिकी संस्थान Institute of Nano Science & Technology (विज्ञान एवं प्रौद्योगिकी विभाग, भारत सरकार) (Deptt. of Science & Technology, Govt. of India) मोहाली, पंजाब-160 062 / Mohali, Punjab-160 062	प्रो. अमितावा पात्रा / Prof. Amitava Patra निदेशक / Director नैनो विज्ञान एवं प्रौद्योगिकी संस्थान Institute of Nano Science & Technology (विज्ञान एवं प्रौद्योगिकी विभाग, भारत सरकार का एक स्वायत्त संस्थान) (An Autonomous Institute of DST, Govt. of India) मोहाली, पंजाब / Mohali, Punjab	MUKESH RAJA Scientist 'D' & Head of Office Institute of Nano Science & Technology Habitat Centre, Sector-64, Phase-10, Mohali	As per our report of even date. For Goyal Parul & Co. Chartered Accountants Place : Chandigarh Date : 21.07.2020 UDIN: 20506042AAAACK3687
Vibha Mehta Finance officer	**Prof. Amitava Patra** Director	**Mukesh Raja** Head of Office	**For Goyal Parul & Co.** Chartered Accountants

FINANCIAL STATEMENT
INSTITUTE OF NANO SCIENCE AND TECHNOLOGY
HABITAT CENTRE SECTOR-64 PHASE-X MOHALI PUNJAB
INCOME AND EXPENDITURE FOR THE YEAR ENDED ON MARCH 31, 2020

Amount in (Rs.)

	INCOME	**Schedules**	**Current Year**	**Previous Year**
1	Income from Sales and Services	7	2148534.50	1791630.33
2	Grants/subsides	8	204204000.00	157297000.00
3	Fees/subscriptions	9	420710.00	666337.95
4	Interest refundable to GOI	10	32771561.89	32317857.95
5	Other Misc Income/Receipts	11	3510981.00	1783015.00
	TOTAL (A)		**243055787.39**	**193855841.23**
	EXPENDITURE			
1	Establishment Expenses	12	144968712.00	124595679.00
2	Other Expenses	13	84559698.31	78116956.95
	TOTAL (B)		**229528410.31**	**202712635.95**
	Balance being excess/(shortfall) of income over Expenditure (A-B) carried forward to General Reserve		13527377.08	-8856794.73
	Depreciation being adjusted from Capital Grant		50709296.07	49804069.10
	Surplus/Deficit after Depreciation		**-37181918.98**	**-58660863.82**

For INSTITUTE OF NANO SCIENCE AND TECHNOLOGY
As per our report of even date.

Vibha Mehta
Finance officer

Prof. Amitava Patra
Director

MUKESH RAJA
Scientist 'C' & Head of Office
Institute of Nano Science & Technology
Habitat Centre, Sector-64, Phase-10, Mohali

Mukesh Raja
Head of Office

As per our report of even date

For Goyal Parul & Co.
Chartered Accountants
Place : Chandigarh
Date : 21.07.2020
UDIN: 20506042AAAACK3687

For Goyal Parul & Co.
Chartered Accountants

Place: Chandigarh
Date:-21.07.2020

FINANCIAL STATEMENT
INSTITUTE OF NANO SCIENCE AND TECHNOLOGY
HABITAT CENTRE SECTOR-64 PHASE-X MOHALI PUNJAB
RECEIPT & PAYMENT FOR THE PERIOD 01-04-2019 TO 31-03-2020

RECEIPT & PAYMENT FOR THE PERIOD 01 04 2019 TO 31 03 2020					
RECEIPT	**Current Year**	**Previous Year**	**PAYMENT**	**Current Year**	**Previous Year**
Opening Balances			**Revenue Expenses**		
a) Cash in hand	0.00	0.00	Establishment		
			As per Schedule 12	144968712.00	124595679.00
b) With Canara Bank			Other Expenses		
In Current Account	5561469.08	10927.08	As per Schedule 13	84559698.31	78116956.95
In Deposit Account	816923294.09	995952463.93	Project Expenses		
Cheque Pending Realisation	24317.00	217126.00	As per Schedule 14	39702695.86	44495994.96
Cheque Pending Realisation-Project	3477.00	0.00			
Employees Benevolent Account	103006.00	76546.00			
Grants Received			**Capital Expenditure on Fixed Assets**		
Corpus/Capital Fund (As per Schedule-1)	866696000.00	514578000.00	As per Schedule	1197317584.00	717996205.00
Revenue Fund (As per Schedule-8)	204204000.00	157297000.00	**Other Payments/Advances**		
Projects Grant (As per Schedule 3B)	25258738.00	65785961.00	(At the end of the year)		
Interest on F.D. from Projects Grants	5700948.00	10281303.00	Advance to Parties	2624211.00	15227891.00
Welfare Fund	-2621.00	482756.00	Advance to Staff	4829938.00	5034915.00
Interest Received			Advance Projects	122719.00	344013.00
Interest from Bank Deposits	32771561.89	32317857.95	T.D.S. Recoverable	1551563.37	1692757.37
As per Schedule 10			Security fee deposited	1554688.00	1554681.00
			Grant/ fellowship recievable	0.00	90000.00
			Fellowship recoverable from externally funded PhD. students	3829072.00	0.0
Fees Subscriptions Received	420710.00	666337.95	Security deducted-Consultancy	130000.00	0.0
As per Schedule 9			**Any Other Receipts**		
			(At the beginning of the year)		
Other Income (specify)	5839542.00	3677983.00	Cheques Pending Encashment	33184.34	3997414.34
As per Schedule			Expenses Payable	49869240.70	59099600.16
			Security/EMD Deposits	15174469.00	3105565.00

Other Payments/Advances			Conference Receipts	0.00	0.00
(At the beginning of the year)			**Closing Balances**		
Advance to Parties	15227891.00	28731592.00	a) Cash in Hand	0.00	0.00
Advance to Staff	5034915.00	580323.00			
T.D.S. Recoverable	1692757.37	621460.00	**b) With Canara Bank**		
Security Fee	1554681.00	1421088.00	In Current Account	2460533.85	5561469.08
Advance (projects)	344013.00	101617.00	In Deposit Account	502592266.98	816923294.09
Grant Receivable	90000.00	90000.00	In Employees Benevolent Account	110570.00	103006.00
			Cheque Pending Realisation	0.00	24317.00
Security/EMD Deposits Received	12785863.00	15174469.00	Cheque Pending Realisation-Project	0.00	3477.00
Any Other Receipts					
(At the end of the year)					
Cheques Pending Encashment-INST	1345949.00	0.00			
Cheques Pending Encashment-Projects	21500.34	33184.34			
Cheques Pending Encashment-Consultancy	1275.00				
Expenses Payable	49827859.64	49869240.70			
	2051431146.41	1877967235.95		2051431146.41	1877967235.95

For INSTITUTE OF NANO SCIENCE AND TECHNOLOGY
As per our report of even date.

Vibha Mehta
Finance officer

Prof. Amitava Patra
Director

MUKESH RAJA
Scientist 'C' & Head of Office
Institute of Nano Science & Technology
Habitat Centre, Sector-64, Phase-10, Mohali

Mukesh Raja
Head of Office

As per our report of even date.

For Goyal Parul & Co.
Chartered Accountants
Place : Chandigarh
Date : 21.07.2020
UDIN: 20506042AAAACK3687

For Goyal Parul & Co.
Chartered Accountants

Place: Chandigarh
Date:-21.07.2020

		(Amount in Rs)
		SCHEDULE NO. -1
	CURRENT YEAR	PREVIOUS YEAR
CORPUS/CAPITAL FUND		
Contribution towards creation of corpus fund		
Balance at the beginning of the year	1582342442.62	1117568511.72
Add: Addition during the year (DST)	**866696000.00**	**514578000.00**
Capital	66696000.00	64578000.00
Construction of INST Campus	800000000.00	450000000.00
Less: Depreciation on fixed Assets	50709296.07	49804069.10
BALANCE AT THE YEAR END	**2398329146.56**	**1582342442.62**

		Amount in Rs)
		SCHEDULE NO. -2
	CURRENT YEAR	PREVIOUS YEAR
RESERVE AND SURPLUS		
General Reserve		
Balance at the beginning of the year	-15535337.60	-6678542.87
Add: Addition during the year - transfer from Income & Expenditure Account	13527377.08	-8856794.73
Less : Deduction during the year - Transfer from Income & Expenditure Account	0.00	0.00
BALANCE AT THE YEAR END	**-2007960.51**	**-15535337.60**

		(Amount in Rs)
		SCHEDULE NO. -3A
	CURRENT YEAR	PREVIOUS YEAR
WELFARE FUND		
Benevolent Fund		
Opening Balance	103006.00	76546.00
Employees Benvolent Fund	23000.00	23500.00
Interest on Employees Benvolent Fund	3664.00	2960.00
TOTAL	**129670.00**	**103006.00**
Employee Welfare Benevolent Fund from OHs of Consultancy Projects	53745.00	61050.00
INST Overheads Fund from Consultancy Projects	190521.00	206341.00
IPR Cell Fund from Ohs of Consultancy Projects	90829.00	90829.00
Outreach Programme Fund from Ohs of Consultancy Projects	49160.00	55320.00
Scientist PDA Share Fund from Ohs of Consultancy Projects	90003.00	90003.00
Total	**474258.00**	**503543.00**
Gross Total	**603928.00**	**606549.00**

		Amount in Rs)
		SCHEDULE NO. -3B
	CURRENT YEAR	PREVIOUS YEAR
PROJECT ACCOUNT		
Grant from CSIR	268583.00	268583.00
DBT Project	30762672.00	28618476.00
Grant from DAE	956650.00	0.00
Grant from DIHAR	1920545.00	1920545.00
SERB Project	114996068.00	90518853.00
Hindu college Delhi (Project sponsored by DST)	1569590.00	1569590.00
Grant from JNCASR	1264300.00	1264300.00
Grant Inspire Faculty	3228846.00	2528846.00
DST Project	239828303.00	250297752.00
Grant UGC-DAE	133428.00	133428.00
	394928985.00	**377120373.00**
Grant from DST received in Saving Bank		
DST	20144764.00	18923764.00
RCCB, Trivendrum	1000000.00	0.00
SERB Project	2700280.00	0.00
Interest on F.D. from Projects Grants	34397503.75	28971803.75
Interest on Bank Account		
Interest on Saving Account	1030352.00	755104.00
TOTAL	**454201884.75**	**425771044.75**
Less: Expenditure from Project Grants (Schedule 14) + Expense upto 31.03.2019)	177324452.52	109365179.90
Net Grants	**276877432.23**	**316405864.85**

		(Amount in Rs)
		SCHEDULE NO. -4
	CURRENT YEAR	PREVIOUS YEAR
CURRENT LIABILITIES AND PROVISIONS		
A. CURRENT LIABILITIES		
2. Cheques Pending Encashment- INST	1345949.00	0.00
Cheque Pending Ecashment-Consultancy	1275.00	0.00
3. Cheques Pending Encashment- Projects	21500.34	33184.34
4. GIS Payable	120.00	120.00
7. Salary Payable - INST	4851415.00	4639786.00
9. Security/Earnest Money Deposits	12785863.00	15174469.00
10. NPS Subscription	430071.00	872818.00
11. Benevolent Fund	21050.00	1950.00
Audit Fee Payable	0.00	29500.00
12.NPS-Employer Contribution	430071.00	0.00
14. GPF	80000.00	17740.00
15. EMD Deposit	7875173.75	6721670.75
16. GST	1349.00	2880.00
17. Consultancy Fee IND-02	0.00	167000.00
18. Grant received for NPDF Fellows	1530780.00	1678281.00
19. Grant INSPIRE FACULTY		
20. Grant Nano Mission School	-164538.00	-66335.00
21. TDS Under GST @ 2%	460504.00	922902.00
22. Professional Tax	15600.00	8000.00
TDS under GST-Projects	0.00	26224.00
TDS-Contractors-Projects	34.00	0.00
TDS Payable-INST	1131232.00	0.00
Labour Cess Payable	221008.00	0.00
SERB Travel Grant refundabvle To Prof. H.N. Ghosh	6721.00	0.00
PBG for Equipment	35700.00	0.00
Grant from ICMR Project	130007.00	0.00
Interest Received during FY on GIA from DST Refundable to DST	32771561.89	32317857.95
TOTAL (A)	**63982446.98**	**62548048.04**
B. PROVISIONS		
1. Other	0.00	0.00
TOTAL (B)	0.00	0.00
TOTAL (A+B)	**63982446.98**	**62548048.04**

(Amount in Rs)

SCHEDULE FORMING A PART OF BALANCE SHEET FOR THE YEAR 2019-20

SCHEDULE NO. -5

		GROSS BLOCK					DEPRECIATION			NET BLOCK	
ASSETS	RATE (%)	COST AS AT 01.04.2019	ADDITION USED FOR 180 DAYS OR MORE	ADDITION USED FOR LESS THAN 180 DAYS	SALE	COST AS ON 31.03.2020	AS ON 01.04.2019	DURING THE YEAR (Adjustment)	AS ON 31.03.2020	WDV AS ON 31.03.2019	WDV AS ON 31.03.2020
Fixed Assets-INST											
Airconditioners	15.00	3,698,058.00	115,070.00	-		3,813,128.00	1,845,890.91	295,085.56	2,140,976.48	1,852,167.09	1,672,151.52
Computer & Peripherils	40.00	11,424,232.00	333,848.00	671,549.00	-	12,429,629.00	9,892,001.11	880,741.36	10,772,742.47	1,532,230.89	1,656,886.53
Computer-IND 04	40.00	146,000.00				146,000.00	84,680.00	24,528.00	109,208.00	61,320.00	36,792.00
Electric items	15.00	4,609,505.00	302,805.00	106,449.00	-	5,018,759.00	1,782,111.46	477,513.46	2,259,624.91	2,827,393.54	2,759,134.09
Office Equipments	15.00	15,613,437.00	1023267	86687.00		16,723,391.00	6,367,680.52	1,546,855.05	7,914,535.57	9,245,756.48	8,808,855.43
Office Equipment-IND 02	15.00	23,600.00				23,600.00	5,044.50	2,783.33	7,827.83	18,555.50	15,772.18
Furniture & Fixtures	10.00	23,366,694.00	144,070.00	208,672.00		23,719,436.00	7,987,069.02	1,562,803.10	9,549,872.12	15,379,624.98	14,169,563.88
Library Books	15.00	3,418,452.00		11,942.00		3,430,394.00	1,807,060.12	242,604.43	2,049,664.55	1,611,391.88	1,380,729.45
Building (under construction)	0.00	636,514,544.00	539,646,882.00	564,104,702.00		1,740,266,128.00	-	-	-	636,514,544.00	1,740,266,128.00
Lab Equipments	15.00	417,033,602.00	10,644,184.00	40,822,432.00	-	468,500,218.00	143,579,790.08	45,676,381.79	189,256,171.86	273,453,811.92	279,244,046.14
Total-INST		**1,115,848,124.00**	**552,210,126.00**	**606,012,433.00**	**-**	**2,274,070,683**	**173,351,327.72**	**50,709,296.07**	**224,060,623.78**	**942,496,796.28**	**2,050,010,059.22**
Fixed Assets-Projects											
Computer & Peripherils	40.00	3,249,333.00	106,266.00	46,894.00		3,402,493.00	1,306,131.41	829,165.84	2,135,297.24	1,943,201.59	1,267,195.76
Furniture & Fixtures	10.00	28,047.00				28,047.00	3,140.99	2,490.60	5,631.59	24,906.02	22,415.41
Office Equipments	15.00	400,891.00	12,499.00	47,600.00	-	460,990.00	41,440.20	59,362.47	100,802.67	359,450.80	360,187.33
Lab Equipments	15.00	189,455,139.00	17,860,987.00	20,712,604.00		228,028,730.00	35,235,375.64	27,365,557.85	62,600,933.49	154,219,763.36	165,427,796.51
Total-Projects		**193,133,410.00**	**17,979,752.00**	**20,807,098.00**	**-**	**231,920,260.00**	**36,586,088.23**	**28,256,576.76**	**64,842,664.99**	**156,547,321.77**	**167,077,595.01**
Fixed Assets-Consultancy											
Computer & Peripherils	40.00	96,280.00	-	-		96,280.00	19,256.00	30,809.60	50,065.60	77,024.00	46,214.40
Lab Equipments	15.00	746,011.00	308,175.00	-		1,054,186.00	82,231.05	145,793.24	228,024.29	663,779.95	826,161.71
Lab Equipments	15.00	24,675.00		-		24,675.00	1,850.63	3,423.66	5,274.28	22,824.38	19,400.72
Total-Consultancy		**866,966.00**	**308,175.00**	**-**	**-**	**1,175,141.00**	**103,337.68**	**180,026.50**	**283,364.17**	**763,628.33**	**891,776.83**
Grand Total		**1,309,848,500.00**	**570,498,053.00**	**626,819,531.00**	**-**	**2,507,166,084.00**	**210,040,753.62**	**79,145,899.33**	**289,186,652.95**	**1,099,807,746.38**	**2,217,979,431.05**

						Amount in Rs)
					SCHEDULE NO. -6	
			CURRENT YEAR		PREVIOUS YEAR	
		CURRENT ASSETS, LOANS & ADVANCES				
A.		**CURRENT ASSETS**				
	1	Cash in Hand		0.00		0.00
	2	Bank Balances				
		Canara Bank				
		a) Current Account No. 2452201001102-INST	202456.76		5182.13	
		b) Auto Sweep/F.D. Accounts-INST	418205049.37		687857527.48	
		c) Current Account No.2919201000578-Projects	2169.09		100947.95	
		d) Auto Sweep/F.D. Accounts-Projects	76987070.61		115015408.61	
		e) Current Account No. -Consultancy	2255908.00		671052.00	
		f) Saving Account No. - 2919101003285	7400147.00		4784287.00	
		g) Auto Sweep A/c TD 2919307000065	0.00		14050358.00	
		h) Benevolent Account No. 2919101002412	110570.00	505163370.83	103006.00	822587769.17
	3	Cheque Pending Realization-INST		0.00		24317.00
	4	Cheque Pending Realization-Project		0.00		3477.00
		TOTAL: (A)		505163370.83		822615563.17
B		**LOANS, ADVANCES/DEPOSITS AND OTHER ASSETS ETC.**				
		Advance to parties	2217514.00		16497.00	
		INSA visiting scientist felowship receivable	0.00		90000.00	
		Secured Advance for Building	406697.00		15211394.00	
		Advance to Staff	4829938.00		5034915.00	
		Advance to staff (INST Projects)	122719.00		344013.00	
		Tax Deducted at Source-INST	484602.00		861217.00	
		Tax Deducted at Source-Project	784591.37		689020.37	
		Tax Deducted at Source-Consultancy	241650.00		101800.00	
		Tax Deducted at Source-GST-Consultancy	40720.00		40720.00	
		SECURITY DEPOSIT	1554688.00		1554681.00	
		INST Consultancy	0.00			
		Fellowship paid to externally funded PhD. students recoverable from them	3829072.00		0.00	
		Security deducted-Consultancy	130000.00		0.00	
		TOTAL (B)		14642191.37		23944257.37
		TOTAL (A+B)		519805562.20		846559820.54

SCHEDULE FORMING A PART OF INCOME AND EXPENDITURE FOR THE YEAR 2019-20				
				(Amount in Rs)
				SCHEDULE NO. -7
			Current Year	Previous Year
		INCOME FROM SALES & SERVICES		
	1	Receipts from Consultancy/Industrial Projects	3998500.00	4431994.00
	2	Less: Expenditure as per Schedule-15	1849965.50	2640363.68
		TOTAL	**2148534.50**	**1791630.33**

SCHEDULE FORMING A PART OF INCOME AND EXPENDITURE FOR THE YEAR 2019-20				
				(Amount in Rs)
				SCHEDULE NO. -8
			Current Year	Previous Year
		GRANTS/SUBSIDIES		
	1	Grant in Aid General (Plan)	76015000.00	31015000.00
	2	Grant in Aid Salaries (Plan)	128189000.00	113782000.00
	3	Grant in Aid General (ST)	0.00	12500000.00
		TOTAL	**204204000.00**	**157297000.00**

SCHEDULE FORMING A PART OF INCOME AND EXPENDITURE FOR THE YEAR 2019-20				
				Amount in Rs)
				SCHEDULE NO. -9
			Current Year	Previous Year
		FEES/SUBSCRIPTIONS		
	1	Application Fee	149000.00	277002.95
	2	RTI Fee	30.00	0.00
	3	Tender Fee	36680.00	157090.00
	4	Admission Fee	235000.00	232245.00
		TOTAL	**420710.00**	**666337.95**

SCHEDULE FORMING A PART OF INCOME AND EXPENDITURE FOR THE YEAR 2019-20			
			(Amount in Rs)
			SCHEDULE NO. -10
		Current Year	Previous Year
	INTEREST EARNED		
1	On Term Deposits		
	1. INST Main	32771561.89	32317857.95
	TOTAL	**32771561.89**	**32317857.95**

SCHEDULE FORMING A PART OF INCOME AND EXPENDITURE FOR THE YEAR 2019-20			
			(Amount in Rs)
			SCHEDULE NO. -11
		Current Year	Previous Year
	OTHER MISCELLANEOUS INCOME/RECEIPTS		
1	Guest House Receipts	92900.00	105500.00
2	Guest House Receipts-Projects	6000.00	2000.00
3	Overhead receipt	3187950.00	1180201.00
4	Penal Interest- INST	1139.00	2380.00
5	Penal Interest- Projects	0.00	471.00
6	Miscellaneous Receipts-INST	24372.00	353228.00
7	Miscellaneous Receipts-Projects	0.00	21532.00
8	Sample testing	192975.00	117703.00
9	Interest on TDS Refund	5645.00	0.00
	TOTAL	**3510981.00**	**1783015.00**

SCHEDULE FORMING A PART OF INCOME AND EXPENDITURE FOR THE YEAR 2019-20

			(Amount in Rs.)
			SCHEDULE NO. -12
		Current Year	Previous Year
	ESTABLISHMENT EXPENSES		
1	Pay and Allowances	69367010.00	65443513.00
2	Composite Transfer Grant	0.00	189415.00
3	Salary and Wages	16362139.00	14383077.00
4	Salary consultants & contractual staff	4246524.00	2220021.00
5	Salary INST Project	0.00	675000.00
6	Salary & Contingency of Post DOC	2864858.00	1718621.00
7	Salary/Stipend & Contingency of Ph.D Students	43892040.00	32198824.00
8	Salary Dr. Ehsan Student	0.00	145834.00
9	Children Education Allowance	546750.00	110250.00
10	LTC	3620771.00	3162860.00
11	Leave Salary & Encashment	1157297.00	762419.00
12	Medical Reimbursement Expenses	2024335.00	1885469.00
13	Pension Contribution	493408.00	1370808.00
14	Telephone	393580.00	329568.00
	TOTAL	**144968712.00**	**124595679.00**

SCHEDULE FORMING A PART OF INCOME AND EXPENDITURE FOR THE YEAR 2019-20

		(Amount in Rs)	
		SCHEDULE NO. -13	
		Current Year	Previous Year
	OTHER EXPENSES		
1	Accommodation Expenses	40381.00	67221.00
	Advertisement and Publicity	878808.00	538147.00
2	Annual Maintenance Expenses	168085.00	0.00
3	Freight and Cartage	14858.00	439659.00
4	Electricity/Power Supply Charges	8333056.00	7124799.00
5	Rent to GMADA, CIAB & NABI	17672399.00	13649458.00
6	POS machine rent	7080.00	7080.00
7	Repair and Maintenance	402998.00	930912.00
8	Guest House Expenses	42000.00	17570.00
9	Audit Fee	0.00	29500.00
10	Printing and Stationery	568485.00	665116.00
11	Conveyance	2228812.00	2266342.00
12	Interest on GST Deposit	16760.00	0.00
13	Postage and Stamps	164861.00	328385.00
14	Miscellaneous Expenses	16529.00	11838.01
15	Bank Charges	95684.42	247525.79
16	Legal, Professional Charges	120426.00	140020.00
17	Honorarium Paid	410395.00	432429.00
18	Horticulture, Gardening & Plantation	11306.00	17178.00
19	Labour and Processing Expenses	1320.00	34439.00
20	Meeting Expenses	140468.00	307761.00
21	Office Expenses	0.00	81926.00
22	Telephone Expenses	164514.00	127851.00
23	Computer Repair and Maintenance	124936.00	172684.00
24	Conference Expenses	165000.00	174365.20
25	Consumable Stores	563091.00	330484.00
26	Diesel for Generator Set	302750.00	488558.00
27	Exhibition Booking Charges	335933.00	405920.00
28	Internet Expenses	308239.00	382930.00
29	Newspapers and Periodicals	81765.00	64997.00
30	Patent Filling	134050.00	0.00
31	Registration Fee	84264.00	35039.00
32	Web Hosting	19247.00	80742.00
33	Foundation Day Award	0.00	55248.00
34	Outreach Programme Expenses	0.00	196794.00
35	Staff Welfare	74186.00	141077.00
36	Lab Chemicals	6000001.00	8092707.00
37	Canteen account	174823.00	181231.00
38	Caution Money	4000.00	12000.00

39	Overhead expense	2924271.00	866354.00
40	Sports Expenses	24890.00	78033.00
41	PDA Expense to Faculty	31675.00	33923.00
42	TA/DA	2365682.00	2603805.00
43	Water charge	18615.00	22390.00
44	INST project 03 Lab Chemicals	0.00	62185.00
45	In-house Symposium Expenses	0.00	27935.00
46	Retainer ship fees	210456.00	174456.00
47	Road Show	0.00	390027.00
48	Sample Testing	61238.00	89462.00
49	Swachhta Hi Sewa Mission	0.00	34250.00
50	Workshops	329213.00	0.00
51	Research Contingency of faculty	96205.00	91131.00
52	Training Fees	0.00	15340.00
53	Gandhi Anniversary Expenses	0.00	227704.00
54	Hindi Pakhwada	33183.00	9800.00
55	Expenditure from General ST Grant	5821198.00	2776071.00
56	Interest on GIA received from DST refundable to DST	32771561.89	32317857.95
57	Contingency-INST-03	0.00	16300.00
	TOTAL	**84559698.31**	**78116956.95**

			Amount in Rs)
			SCHEDULE NO. -14
		Current Year	**Previous Year**
	PROJECT ACCOUNT-EXPENDITURE		
1	Advertisement and Publicity	61334.00	151023.00
2	Bank Charges	131261.86	185616.96
3	Canteen	17385.00	21452.00
4	Contingency	1524780.00	1734223.00
5	JCB Fellowship	43333.00	0.00
6	Lab Chemicals	13556230.00	14571856.00
7	Miscellaneous expense	94694.00	24780.00
8	Overhead Expenses	3187950.00	922979.00
9	Salary- Project	12065698.00	12476789.00
10	T.A./ D.A.	1584605.00	1571726.00
11	Custom Charges	10674.00	2596.00
12	Fellowship- RP42 Indo Australian Project	0.00	654835.00
13	Honorarium RP-41	141000.00	23000.00
14	Rent POS Machine	7788.00	7788.00
15	Other Cost Fabrication RP-52	86648.00	133700.00
16	Accommodation RP-65	0.00	84370.00
17	Bank Interest earned on Grants refunded through Bharat Kosh	7189315.00	11929261.00
18	Depreciation on Project Assets	28256576.76	24023772.00
	TOTAL	**67959272.62**	**68519766.96**

			Amount in Rs)
			SCHEDULE NO. -15
		Current Year	Previous Year
	INDUSTRIAL AND CONSULTANCY PROJECTS-EXPENDITURE		
1	Bank Charges	1203.00	395.00
2	Contingency	155097.00	39718.00
3	Lab Chemicals	320988.00	727227.00
4	Salary	1117360.00	588571.00
5	T.A./ D.A.	75291.00	123418.00
6	Administration Share	0.00	82579.00
7	CO-PI -Share	0.00	381488.00
8	Mentor Share	0.00	18720.00
9	PI Share	0.00	102960.00
10	Distribution of Overheads	0.00	471950.00
11	Depreciation on Project Assets	180026.50	103337.68
	TOTAL	**1849965.50**	**2640363.68**

LIST OF ADVANCE TO PARTIES AS ON 31.03.2020		
		(Amount in Rs.)
	Current Year	**Previous Year**
M/s Parkash Freight Movers	16497.00	16497.00
Current Science Association for books	7000.00	0.00
M/s Airport Handling	2185000.00	0.00
Indian Academy of Science	1000.00	0.00
M/s India Today	4369.00	0.00
NISC	600.00	0.00
Outlook Publishing India (P) Ltd.	3048.00	0.00
Secured Advance to Sand Grouse for Building	406697.00	0.00
Secured Advance for Building	0.00	15211394.00
TOTAL	**2624211.00**	**15227891.00**

LIST OF ADVANCE TO STAFF AS ON 31.03.2020		
		(Amount in Rs.)
	Current Year	**Previous Year**
Dr. Asish Pal	60000.00	28000.00
Dr. Abir De	4838.00	0.00
Dr. Jayamurugan	0.00	226015.00
Sh. Bhanu	99900.00	0.00
Dr. Kaushik Ghosh	35000.00	0.00
Dr. Monika	16000.00	0.00
Dr. Suvankar	22407.00	0.00
Dr. P.S. Vijaya Kumar	5193.00	0.00
Dr. Rahul Verma	15000.00	0.00
Dr. Sangita	112100.00	0.00
Dr. Sanyasinaidu Boddu	30000.00	0.00
Dr. Shyam Lal	0.00	126000.00
Dr. Surajit Karmakar	0.00	0.00
Dr. Subhashree HBA Advance	2109500.00	2273900.00
Dr. Surajit HBA Advance	2177000.00	2381000.00
Dr. Debabrta Patra	76500.00	0.00
Dr. Dipankar Mandal	30000.00	0.00
Dr. Kiran	1500.00	0.00
Sh. Dhanjit Singh	15000.00	0.00
Sh. J.N. Ahuja	10000.00	0.00
Sh. Surinder Singh	10000.00	0.00
TOTAL	**4829938.00**	**5034915.00**

LIST OF ADVANCE TO STAFF AS ON 31.03.2020 of Project Account		
		(Amount in Rs.)
	Current Year	**Previous Year**
Dr.Deepa Ghosh	10000.00	0.00
Dr. Chandan Bera	14000.00	80000.00
Dr. Kiran	15000.00	0.00
Dr. Kamalkammam Kailasam	47200.00	0.00
Dr. Kaushik Ghosh	0.00	55744.00
Dr. Sanyasi Naidu	0.00	13000.00
Dr. Subhasree	22369.00	22369.00
Dr. Rahul Verma	14150.00	0.00
Sh. Shyam Lal	0.00	52900.00
TOTAL-Projects	**122719.00**	**224013.00**
INST-Saving-Dr. Chandan Bera	**0.00**	**120000.00**

FINANCIAL STATEMENT
INSTITUTE OF NANO SCIENCE AND TECHNOLOGY
HABITAT CENTRE SECTOR-64 PHASE-X MOHALI PUNJAB

Schedule-15 Significant Accounting Policies

4. Accounting concepts & Basis of preparation of Financial Statements

The financial statements have been prepared under the historical cost convention in accordance with the generally accepted accounting principles. The institute generally follows the accrual system of accounting and recognizes significant items of income & Expenditure on accrual basis unless otherwise stated.

5. Grants

Grants are recognized on receipt, Grants received from Department of Science & Technology (DST) for Creation of Capital Assets (plan) is treated as corpus of the centre. Grants received for General (Plan), General (ST), Salaries (Plan) and Salaries - SC (Plan) are treated as of revenue nature and shown under Income & Expenditure Account.

6. Fixed Assets and Depreciation

No depreciation on the Building has been charged during the year as these assets are not put to use upto 31.03.2020 as certified by the management of the Institute. Depreciation on assets has been charged at the rates applicable under Income Tax Act. Depreciation, on assets used for less than 180 days, is restricted to 50% of the prescribed rates. Cost of Fixed assets includes Custom Duty, Clearing & Forwarding Charges and Freight relating to such assets.

Schedules- 16 Notes to the Accounts

1. Department of Science and Technology (DST) Sanctioned and Released during the 2018-19, total Grant of Rs.6718.75 Lakhs. During the previous year 2019-20, Rs.10709.00 Lakhs were received as per following detail:

	Rs. In Lakhs
-Grant in Aid Creation of Capital Assets (Plan)	666.96
-Grant in Aid Construction of INST Campus	8000.00
-Grant in Aid General (Plan)	760.15
-Grant in Aid Salaries (Plan)	1281.89
	10709.00

As certified by the management of the Institute, the Grant in Aid Creation of Capital Assets (Plan) & Construction of INST Campus of Rs.8666.96 Lakhs has been shown as Corpus/Capital Fund and all the remaining Grants amounting of Rs.2042.04 Lakhs has been shown as of revenue nature under Income & Expenditure Account. As certified by the management of the Institute, the entire Grant in aid of Rs.8666.96 Lakhs released under the Nano Mission Grants has been utilized for creation of Capital Assets and hence capitalized in the Balance Sheet.

During the year Rs.23,000.00 has been contributed as Benevolent Fund by the employees of the Institute which has been incorporated in the final accounts of the Institute.

2. The financial statements have been prepared under the historical cost convention in accordance with the generally accepted accounting principles. The Institute generally follows accrual system of accounting and recognizes significant items of Income & Expenditure on accrual basis unless otherwise stated as certified by the management of the Institute.
3. In the opinion of the management the current assets, loans and advances are approximately of the value stated, if realized in the ordinary course of business. The provision of all the known liabilities is adequate and not excess of the amount considered reasonable and necessary.
4. No depreciation on the Building has been charged during the year as these assets are not put to use up to 31.03.2020 as certified by the management of the Institute. Depreciation on assets has been charged at the rates applicable under Income Tax Act. Depreciation, on assets used for less than 180 days, is restricted to 50% of the prescribed rates. Cost of Fixed Assets includes Custom Duty, Clearing & Forwarding charges and Freight relating to such assets.
5. As certified by the management of the Institute that the cost of all Laboratory Chemicals of Rs. 19556231.00 purchased during the year 2019-20 has been issued to laboratory and the same has been consumed up to 31.03.2020. Hence total cost of Rs. 19556231.00 has been charged to Income & Expenditure Account.
6. Bank Balances and Fixed Deposit Balances as on 31.03.2020 shown in the Balance Sheet are as certified by the management of the Institute and are subject to confirmation.
7. The Interest earned and accrued during the year shown as Income in the Income & Expenditure Account is as certified by the management of the Institute.
8. The provisions of various Acts like TDS, GST, GST-TDS, Labour Cess, Punjab Development Tax etc. have been complied with by the Institute, however it has been observed that TDS has not been deducted in two cases and GST has also not been charged on some minor receipts. The Institute is advised to ensure the strict compliance in future.
9. The depreciation has been charged to Capital fund instead of Income & Expenditure Account
10. Previous year figures have been regrouped/rearranged where ever considered necessary.
11. All Schedules form an integral part of the Balance Sheet and Income& Expenditure Account and have been duly authenticated by the management of the Institute.
12. All interests and other earning against Grant in aid or advances returned to DST as per their instructions.

Vibha Mehta
Finance officer

Prof. Amitava Patra
Director

Mukesh Raja
Head of Office

As per our report of even date.

For Goyal Parul & Co.
Chartered Accountants
Place : Chandigarh
Date : 21.07.2020
UDIN: 20506042AAAACK3687

Place: Chandigarh
Date:-21.07.2020

For Goyal Parul & Co.
Chartered Accountants

नैनो विज्ञान एवं प्रौद्योगिकी संस्थान

INST

Institute of Nano Science and Technology

INSTITUTE OF NANO SCIENCE AND TECHNOLOGY

(An Autonomous Research Institute of Dept. of Science & Technology, Govt. of India)

KNOWLEDGE OF NANO SCIENCE FOR THE NATION

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