

ANNUAL REPORT

2023-24



नैनो एवं मृदु पदार्थ विज्ञान केंद्र

विज्ञान एवं प्रौद्योगिकी विभाग, भारत सरकार के अधीन एक स्वायत्त संस्था

**CENTRE FOR NANO AND
SOFT MATTER SCIENCES**

Autonomous Institute under the Dept. of Science and Technology, Govt. of India

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Foreword

I have great pleasure in presenting before you the CeNS annual report for the period 2023-2024.

I am proud of the sustained improvement in the Centre's academic achievements. For instance, extramural funding has been realized for as many as 23 projects, most of which are new proposals, and a few started a year or two ago. Academic output has also been outstanding, with 68 publications (at an average IF of 5.7), filing of 5 new invention disclosures, and granting of 6 patents applied previously. The long pending request for the affiliation of CeNS with AcSIR received approval this financial year. With this, the students can register for PhD at any of the three prestigious institutes, namely Mangalore University, MAHE, and AcSIR.

Regarding infrastructure development, we continue our unceasing efforts to make the already vibrant campus more liveable with 24/7 access to the research facilities, thanks to the on-campus accommodation options. Several new amenities have been added, including additional office space for students and interns, new toilet blocks near the Bay lab, and a revamped kitchen attached to the multipurpose hall.





The leadership and the administrations at CeNS and at DST, under the able guidance of our esteemed GC and RAB members, are steadfastly trying to improve life on the campus and usher in new initiatives to promote ease of doing science. Our parent department, DST, also saw a change of guard during the year, with Dr. Chandrasekhar Srivari relinquishing the office. We are happy to note and grateful that Prof. Abhay Karandikar, the new DST Secretary, takes much interest in the activities of the Centre and has been proactive in initiating measures for further development. The government of India has announced the creation of an apex body, the Anusandhan National Research Foundation (ANRF), to provide strategic direction for research, innovation, and entrepreneurship across all disciplines of science. The prime aim of ANRF is to create an enabling platform for fruitful interactions among the research-oriented academia, both universities and research institutions, industries, and government departments. The platform is expected to promote active participation and desirable contribution from industries as well as government bodies including ministries at both State and Central levels. We are determined to contribute with the best of our efforts to poise and position CeNS to take advantage of the programs being rolled out by ANRF and carry out impactful research that benefits all the stakeholders, and the society at large.

This annual report also contains details of notable events conducted on the campus, including the prestigious review meeting of SERB-SUPREME proposals, the in-house symposium, Prof. Chandrasekhar Memorial Lecture, and the Swachchatha and Hindi Pakhwada, among others. The Centre has been privileged to have hosted several prominent personalities who visited us on these occasions. I sincerely thank each of the associated CeNSians for their exemplary teamwork and for making these events a grand success.

Several of our colleagues received prestigious awards and honours, including fellowships to INYAS and NASI, membership to NASI, and the TMA Pai Endowment Chair of MAHE. As in the past, several research outcomes of the Centre received media attention as popular news articles, TV programs, etc. In its year-end review 2023, the Department of Science and Technology put on record highlighting key achievements of CeNS, such as the affordable energy-efficient smart window by employing metal mesh electrode and a revolutionary electrochromic energy storage (EES) device with high switching contrast, area capacitance, and long cycling life. We are also proud of many students who have done exceptionally well bringing laurels to CeNS by bagging the best oral and poster presentation awards at several conferences/workshops. The administrative team deserves compliments for the unrelenting help in various activities of the Centre.

As we enter into Amrit Kaal, the 25-year-long leadup to India@100 years of independence, our Honorable Prime Minister has given a clarion call to build India as the global centre of science and technology. On behalf of all CeNSians, I pledge that we will do our best to make an impactful contribution in this direction.

- Director



1. Introduction



Centre for Nano and Soft Matter Sciences (CeNS), an autonomous research institute under the Department of Science and Technology (DST), Government of India, is a registered scientific society in Karnataka. DST provides core support to the Centre in the form of a grant-in-aid for conducting basic and applied research in Nano and Soft matter sciences. The Centre exercises an open-minded approach to R&D in the broad area of nanoscience and technology interlaced with soft matter principles with a high emphasis on Intellectual Property and technology translational aspects.

The Centre is engaged in materials research at all relevant length scales. Specifically, the activities are focused on a variety of metal and semiconductor nanostructures, liquid crystals, gels, membranes, and hybrid materials. It has close interactions with many Institutions and Industries, in India and abroad.

The Centre previously known as the Centre for Liquid Crystal Research was established in 1991 by an eminent liquid crystal scientist, Prof. S. Chandrasekhar, FRS. In 1995, it became an autonomous institute under the Department of Electronics, Government of India, and in 2003, was brought under DST. Subsequently, in the year 2010, the name was changed to the Centre for Soft Matter Research. Recently in 2014, the Centre further widened the scope of research activities to embrace nanoscience and technology and is now known as the Centre for Nano and Soft Matter Sciences (CeNS). In 2021, the Centre permanently moved to the 14-acre sprawling campus, named as Arkavathi, located at Shivanapura, Bangalore North. The research infrastructure on the campus includes the state-of-the-art Materials Laboratory, Tata Steel Advanced Materials Research Centre (TSAMRC), Technology Business Incubator Project-Greenhouse, sophisticated synthesis laboratory, and faculty laboratories.



Materials Laboratory consists of Fabrication Lab, HRTEM/FESEM Lab, Energy Lab, Gas Sensor Lab, TSAMRC Lab, Micro/Spectroscopy Lab, and XRD/Thermo Lab. The labs are equipped with state-of-the-art research facilities that are available to researchers from other academic institutions and industries to carry out characterization, fabrication, and testing of nano/soft materials and devices. Central Research Facility (CRF) is an online platform and enables access to the research facilities housed in Materials Laboratory through an easy-to-follow registration process and the user can view and request the available booking slots at <https://crf.cens.res.in/>. The demonstrable prototype devices developed based on lab-level research findings are displayed in the gallery to set a meaningful interaction with the industries. It also showcases the Centre's expertise, uniquely encompassing both nano and soft matter sciences, an interactive version of the devices is available at Tech-Platform (<https://www.cens.res.in/tech-platform>). Tata Steel Advanced Materials Research Centre (TSAMRC) has set up an exclusive research lab at CeNS in 2016 to cater to the projects floated under the program which enables the researchers to explore the commercialization aspects of their research innovations under the supervision of Tata Steel.

The Centre offers Ph.D. programme to students who have cleared the Masters in Physics/Chemistry/Material Science/Nano Science and Technology and are qualified CSIR-NET(JRF)/GATE/JEST or hold Inspire fellowship. CeNS also offers industry-sponsored Ph.D. programs to candidates from recognized R&D organizations, academic institutions, government organizations, and industries. (<https://www.cens.res.in/en/academics/research-programmes>).



1. Governing Council

Chairman	Prof. K. N. Ganesh SERB National Science Chair Jawaharlal Nehru Centre for Advanced Scientific Research Jakkur P.O., Bengaluru- 560 064
Member (ex-officio)	Prof. Abhay Karandikar Secretary to Government of India Department of Science and Technology, Government of India Technology Bhavan, New Mehrauli Road, New Delhi 110 016
Member (ex-officio)	Shri Vishvajit Sahay Additional Secretary & Financial Adviser Department of Science and Technology Government of India, Technology Bhavan, New Mehrauli Road, New Delhi 110 016
Member	Prof. Pallab Banerji Professor and Former Head Materials Science Centre, Indian Institute of Technology, Kharagpur, Kharagpur 721 302
Member	Prof. Shreepad Karmalkar Director & Professor - School of Electrical Sciences Indian Institute of Technology, Bhubaneswar, Argul, Khordha- 752 050
Member	Shri Manoj Jain Director (R & D) Bharat Electronics Limited, Outer Ring Road, Nagawara, Bengaluru 560 045
Member	Prof. Ashok K. Ganguli Director & Professor Indian Institute of Science Education and Research (IISER), Berhampur 760 003
Member	Prof. K George Thomas Professor, School of Chemistry & J C Bose National Fellow, Indian Institute of Science Education and Research, Thiruvananthapuram (IISER-TVM) Thiruvananthapuram 695 551
Member	Prof. Umesh V. Waghmare Professor, Theoretical Sciences Unit, Jawaharlal Nehru Centre for Advanced Scientific Research, Jakkur, Bengaluru 560 064
Member- Secretary	Prof. Bhagavatula L. V. Prasad Director - Centre for Nano and Soft Matter Sciences Arkavathi, Survey No.7, Shivanapura, Dasanapura Hobli, Bengaluru 562 162



3. Research Advisory Board

Chairman	Prof. D. D. Sarma Solid-State and Structural Chemistry Unit, Indian Institute of Science, Bengaluru 560 012
Member	Dr. Ashish Lele Director - CSIR-National Chemical Laboratory, Dr. Homi Bhabha Road, Pune - 411 008
Member	Dr. Tata Narasinga Rao Director - International Advanced Research Centre for Powder Metallurgy & New Materials (ARCI), Balapur P.O, Hyderabad-500 005
Member	Prof. P. B. Sunil Kumar Professor - Department of Physics, Indian Institute of Technology Madras, Chennai -600 036
Member	Prof. Chandrabhas Narayana Director - Rajiv Gandhi Centre for Biotechnology Thiruvananthapuram, Kerala – 695 014
Member	Dr. Sumitesh Das Director - Tata Steel UK R&D Tata Steel Limited, Room No.154, Research and Development Division, Jamshedpur – 831 007
Convenor	Prof. Bhagavatula L. V. Prasad Director - Centre for Nano and Soft Matter Sciences Arkavathi, Survey No.7, Shivanapura Dasanapura Hobli, Bengaluru 562 162



4. Scientists & Admin Staff

Name	Designation
Prof. Bhagavatula L.V. Prasad	Director
Prof. G. U. Kulkarni	Adjunct Professor
Dr. D. S. Shankar Rao	Scientist F
Dr. C. V. Yelamaggad	Scientist F
Dr. S. Angappane	Scientist E
Dr. P. Viswanath	Scientist E
Dr. Neena Susan John	Scientist E
Dr. Pralay K. Santra	Scientist E
Dr. H. S. S. R. Matte	Scientist D
Dr. Ashutosh K. Singh	Scientist C
Dr. Kavita A. Pandey	Scientist C
Dr. Subash C. K.	Inspire Faculty
Dr. Goutam Ghosh	Ramanujan Faculty
Dr. S. Krishna Prasad	Distinguished Scientist
Dr. Geetha G Nair	Distinguished Scientist

Name	Designation
Mr. Subhod M. Gulvady	Administration and Finance Officer
Mr. Vivek Dubey	Accounts Officer
Ms. P. Nethravathi	Assistant Administrative Officer
Dr. Sanjay K. Varshney	Technical Officer -A
Ms. Sandhya D. Hombal	Technical Officer-A
Mr. M. Jayaram	Senior Administrative Assistant (Purchase)
Dr. Nayana J.	Senior Library cum Information Assistant
Mr. Jayaprakash V. K.	Support Staff



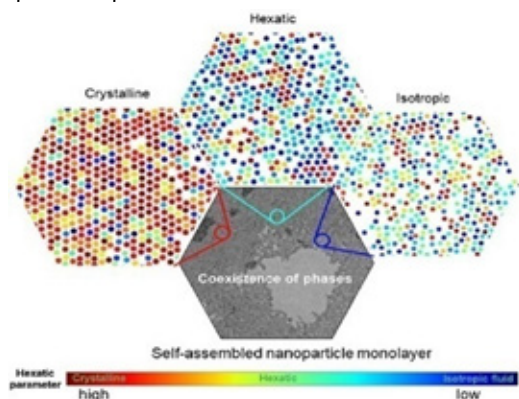


5. Research and Development Activities

5.1 Nanomaterials and composites

Topological phases in nanoparticle monolayers

Topological phases are stable configurations of matter in 2-dimensions (2D) that form via spontaneous symmetry breaking. These play a crucial role in determining the system's properties. CeNS researchers in collaboration with scientists of CSIR-NCL, have shown that in an evaporation-driven self-assembly process, the three topological phases, namely crystalline, hexatic, and isotropic-fluid phases, can coexist within the same nanoparticle monolayers. This coexistence is associated with the local variation in particle size, which can be described by a unique frequency parameter (p_{25}), quantifying the fraction of NPs that has size deviation greater than or equal to 25% of the mean size (where the deviation, ζ is defined as $\zeta = (|Size - mean|) / mean$). The p_{25} -values for the three phases are distinctly different: crystalline arrangement occurs when $p_{25} < -0.02$, while a hexatic phase exists for $0.02 \leq p_{25} \leq 0.1$. For $p_{25} \geq 0.1$, the isotropic-fluid phase occurs.



Coexistence of three different topological phases in a self-assembled nanoparticle monolayer

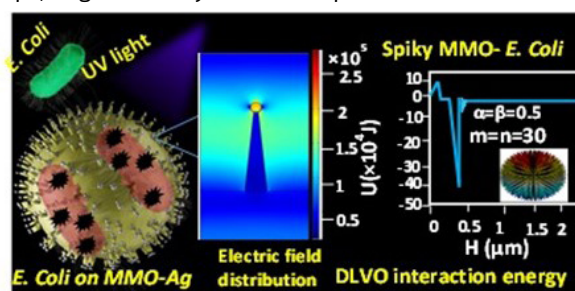
See: Topological phases in nanoparticle monolayers: can crystalline, hexatic, and isotropic-fluid phases coexist in the same monolayer? Bhattacharjee K, Vaidya S S, Pathak T, Shimpi J R & Prasad B L V, *Soft Matter*, 19, 7271-7280 (2023) doi:10.1039/d3sm00290j

Affiliations: Kaustav Bhattacharjee, Salil S. Vaidya, Tushar Pathak, Jayesh R. Shimpi (CSIR,NCL-Pune), and B L V Prasad (CeNS)

Antimicrobial coatings based on spiky metal oxides

Antimicrobial coatings are essential for controlling the pathogen spreading and their interface with the hosts. These may be applied to masks as additional security to the wearer over the pore filtration or applied to surfaces that are often hand-touched as the nanocoating can deactivate the virus irreversibly. An antimicrobial nano formulation containing mixed metal oxides (MMO) of TiO_2 , ZnO , SiO_2 , CuO with silver nanoparticles (MMO-Ag)

capped with a cationic surfactant by the hydrothermal route is developed. The developed nano formulation possesses a high specific surface area of $73.5 \text{ m}^2\text{g}^{-1}$. The nanoformulation exhibits excellent antimicrobial properties against gram-negative (*E. coli*), gram-positive (*S. aureus*) bacteria, and bacteriophage virus, superior to that of the spherical morphology. The enhanced antimicrobial properties of spiky nanoformulation are attributed to sharp nanometric tips that can physically puncture the cell membrane of the pathogen via a mechano-bactericidal effect. The developed nano formulation-coated fabric exhibits self-cleaning properties on exposure to UV light by facilitating complete degradation of the bacteria owing to the photocatalytic component present in the nanoformulation that gets enhanced due to electric field intensity near the tips, augmented by silver nanoparticles.



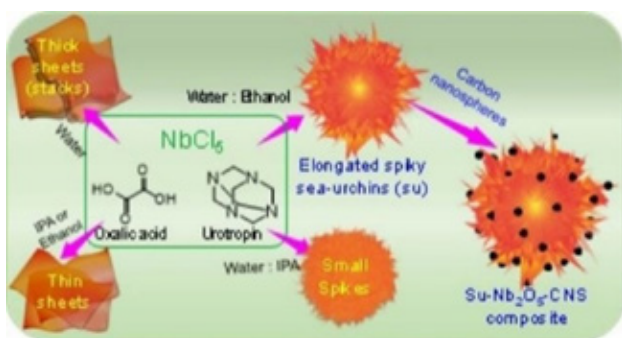
Spiky mixed metal oxides with silver nanoparticles as antimicrobial coatings

See: Self-cleaning formulations of mixed metal oxide-silver micro-nano structures with spiky coronae as antimicrobial coatings for fabrics and surfaces. B, R. P., Shenoy, B. M., Verma, M., Nayak, S., Hegde, G., & John, N. S., *Materials Advances*, 5, 4293-4310 (2024) doi:10.1039/D3MA00951C

Affiliations: Ramya Prabhu B., Manish Verma, Neena S. John (CeNS), Bhomy Maithry Shenoy (IISc, -Bengaluru) and Soumyashant Nayak (ISI-Bengaluru)

Synthesis of Nb_2O_5 nanomaterials with diverse morphologies and its composite with carbon nanospheres

A facile and efficient hydrothermal approach is devised for the controlled synthesis of diverse Nb_2O_5 nanostructures, including ultra-thin sheets, thick sheets or stacks, spiky, and elongated spiky sea urchin morphologies using urotropin as a growth-directing and hydrolyzing agent in various mixed, and pure solvents. The spiky Nb_2O_5 structures show a pseudohexagonal phase with less amount of urotropine content, while thin sheets are obtained with higher urotropine concentration and are primarily amorphous. A composite of elongated spiky sea urchin morphologies of Nb_2O_5 along with the carbon nanospheres has shown 8-fold higher specific capacitance than its constituents for energy storage applications.



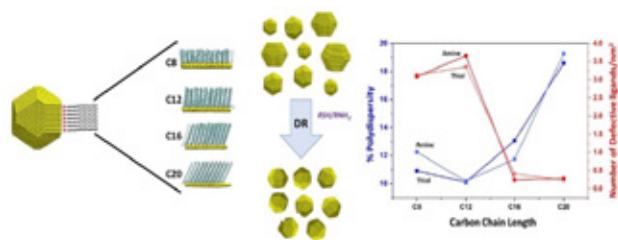
Diverse morphologies of Nb_2O_5 by solution synthesis

See: Diverse morphologies of Nb_2O_5 nanomaterials: A comparative study for the growth optimization of elongated spiky Nb_2O_5 and carbon nanosphere composite. Kommula, B., Prabhu B, R., Kopperi, H., Bhat, V. S., Hegde, G., & John, N. S., *Particle & Particle Systems Characterization*, 41, 2300118 (2024) doi:https://doi.org/10.1002/ppsc.202300118

Affiliations: Bramhaiah Kommula, Ramya Prabhu B., Harishankar Kopperi, Neena S. John (CeNS) and Bhat and, Gurumurthy Hegde (Christ (Deemed to be University), Bengaluru)

Influence of van der Waals interactions between the alkyl chains of surface ligands on the size and size distribution of nanocrystals prepared by the digestive ripening process

CeNS researchers along with scientists from CSIR-NCL have shown that while making monodispersed nanocrystals (NCs) by thermal heating of polydispersed NCs with surface active organic ligands the chain lengths of amine and thiol ligands, have a huge influence. They clearly show that ligands with C12 chain length result in the formation of NCs with narrow size distributions when compared to C8, C16, and C20 chain length ligands.



Digestive ripening with amines and thiols of different alkyl chain length. The correlation between % polydispersity and the defect density. The results suggest that molecules with more defects result in particles with more mono dispersity.

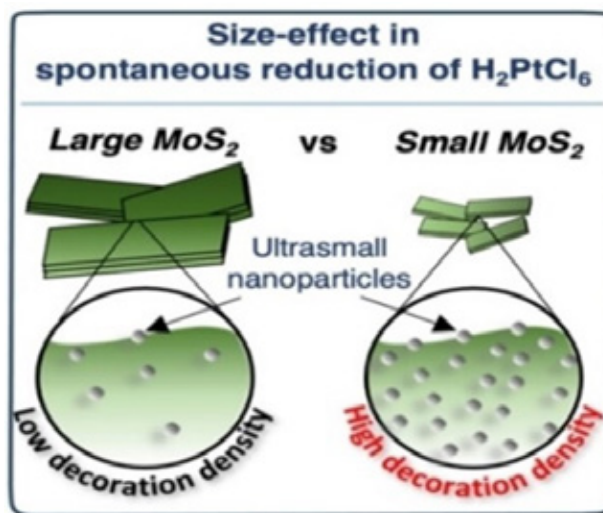
See: Influence of van der Waals interactions between the alkyl chains of surface ligands on the size and size distribution of nanocrystals prepared by the digestive ripening process. Shimpi, J. R., Thomas, R., Meena, S. K., & Prasad, B. L. V., *Langmuir* (2023) doi:10.1021/acs.langmuir.3c02316

Affiliations: Jayesh R. Shimpi, Rinto Thomas, Santosh Kumar Meena (CSIR-NCL, Pune) and B. L. V. Prasad (CeNS)

Spontaneous decoration of ultrasmall metal nanoparticles on size-separated MoS_2 nanosheets

Understanding size-dependent properties of 2D materials is crucial for their optimized performance when incorporated through solution routes. Towards this, the

chemical nature of MoS_2 as a function of nanosheet size is investigated through the spontaneous reduction of chloroauric acid. Microscopy studies suggest higher gold nanoparticle decoration density in smaller nanosheet sizes, resulting from a higher extent of reduction. Further corroboration through surface-enhanced Raman scattering using the gold-decorated MoS_2 nanosheets as substrates exhibited an enhancement factor of 1.55×10^6 for smaller nanosheets, which is 7-fold higher as compared to larger nanosheets. These plasmonic-semiconductor hybrids are utilized for photodetection, where Au decoration is found to impact the photo response of smaller nanosheets the most and is optimized to achieve responsivity of 367.5 mA W^{-1} and response times of $\sim 17 \text{ ms}$. The simplistic modification via solution routes and its impact on optoelectronic properties provide an enabling platform for 2D materials-based applications.



Size of liquid exfoliated MoS_2 nanosheets plays a crucial role in determining nanoparticle decoration densities in the spontaneous reduction of chloroplatinic acid into ultra-small Pt nanoparticles.

See: Spontaneous decoration of ultrasmall Pt nanoparticles on size-separated MoS_2 nanosheets. Lobo, K., Gangaiah, V. K., Chandraraj, A., John, N. S., & Matte, H. S. S. R., *Chemistry – A European Journal*, 29, e202301596 (2023) doi:https://doi.org/10.1002/chem.202301596

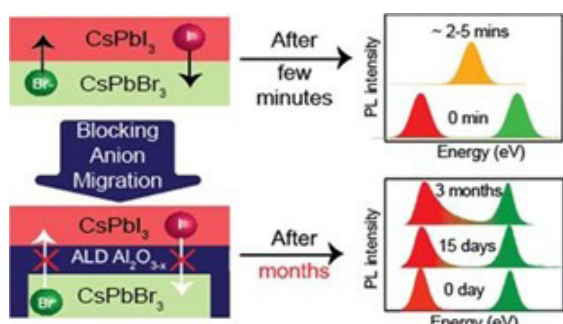
Affiliations: Kenneth Lobo, Vijaya Kumar Gangaiah, Chandraraj Alex, Neena S. John and H. S. S. Ramakrishna Matte (CeNS)

Restricting anion migrations in lead halide perovskites

Lead halide perovskite (LHP) nanocrystals (NCs) are promising for optoelectronic devices due to their adjustable band gap through anion exchanges. However, rapid anion migrations at layer interfaces hinder well-defined interfaces. CeNS researchers introduced an ultrathin alumina layer via atomic layer deposition (ALD) at the interface of $CsPbBr_3/CsPbI_3$ NC films. ALD alumina minimally affects structural or optical properties except for agglomeration. It temporally restrains anion migration, with the rate decreasing as alumina thickness increases, following first-order kinetics. Density



functional theory (DFT) calculations suggest iodide ion migration through oxygen vacancies in alumina with an activation energy of 1.54 eV. This approach offers insights for developing halide perovskite-based tandem optoelectronics.

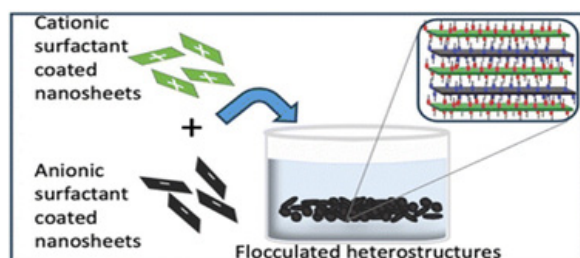


The bare interface between CsPbBr₃ and CsPbI₃ causes immediate anion exchange within 2-5 minutes, whereas an ultrathin alumina layer at the interface restricts the anion exchange for over months.

See: Restricting anion migrations by atomic layer-deposited alumina on perovskite nanocrystals while preserving structural and optical properties. Rathod, R., Kapse, S., Pal, D., Das, M. R., Thapa, R., & Santra, P. K., *Chemistry of Materials*, 36, 1719–1727 (2024) doi: 10.1021/acs.chemmater.3c03113

Affiliations: Radha Rathod, Dipayan Pal, Pralay K. Santra (CeNS), Samadhan Kapse, Ranjit Thapa (SRM University, Andhra Pradesh) and Manash R. Das (CSIR-NEIST, Assam).

Solution-based electrostatic self-assembly route for obtaining graphene-transition metal dichalcogenide heterostructures



Material design through heterostructures of 2D materials shows significantly enhanced performance in addition to the emanation of striking new physical phenomena such as superconductivity.

A protocol is demonstrated with capabilities to effectively produce electrostatically self-assembled heterostructures of 2D materials using surfactant-assisted liquid exfoliated nanosheets. The process provides good control through size selection via cascade centrifugation, allowing for effective interaction between the nanosheets when mixed in the liquid phase and resulting in the formation of heterostructures through self-assembly. This route could help the exploration of heterostructures of numerous 2D materials using a rather simple approach. The applicability of the heterostructures in field emission applications is evaluated where the turn-on and threshold field values observed suggest that these heterostructures are suitable emitters for large-area applications such as flat panel display devices and high current density single

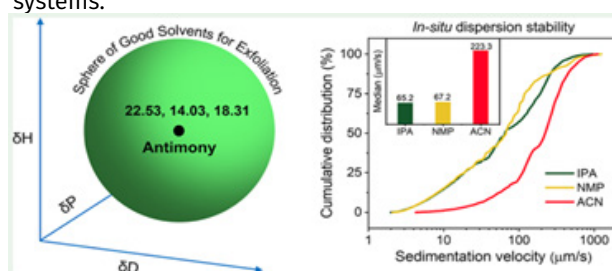
electron beam applications.

See: Solution-based electrostatic self-assembly route for obtaining graphene-transition metal dichalcogenide heterostructures. Lobo, K., Sumbe, P. R., More, M. A., Late, D. J., & H. S. S. Ramakrishna Matte. *Dalton Transactions*, 53, 3465 (2024) doi:10.1039/D3DT03749E

Affiliations: Kenneth Lobo, H. S. S. Ramakrishna. Matte (CeNS), Priyanka R. Sumbe, Mahendra A. More (Savitribai Phule Pune University, Pune) and Dattatray J. Late (Brane Enterprises Private Limited, Hyderabad)

Determination of Hansen solubility parameter and in situ visualization of dispersion stability of solution-processed antimonene

Antimony emerges as one of the interesting mono-elemental graphene analogues, having unique properties and a wide range of applications. Among the solution-processing routes, liquid-phase exfoliation (LPE) offers various advantages. However, the choice of solvent greatly influences the exfoliation efficiency. A detailed work has been carried out on the LPE of antimony and its dispersion stability. By employing the Hansen solubility sphere method, the Hansen solubility parameters of antimony are determined to be 22.53, 14.03, and 18.31 MPa^{1/2}, corresponding to the dispersion interactions, polar interactions, and hydrogen bonding interactions, respectively. To further understand the solute-solvent interactions, the stability of the dispersions is investigated both qualitatively and quantitatively using an accelerated centrifuge-based technique employing space-time-resolved extinction profiles (STEP). The sedimentation kinetics of the dispersions are studied using various metrics like instability index, integral extinction, and cumulative sedimentation velocity distribution. Among the solvents studied, isopropyl alcohol, ϵ -caprolactone, N-methyl pyrrolidone, dimethyl sulfoxide, and ethanol are found to have better dispersion stability. Interestingly, some of the solvents with high dispersion concentrations appear to be relatively less stable. Combining Hansen solubility parameters with stability analysis helped in identifying the efficient solvents for obtaining stable antimonene dispersions. Furthermore, antimonene nanosheets embedded in the carbon nanotube matrix are used as anode materials for lithium-ion battery applications. The excellent cyclic stability exhibited by antimonene indicates it to be a promising candidate for next-generation energy storage systems.



Liquid-phase exfoliation of antimony

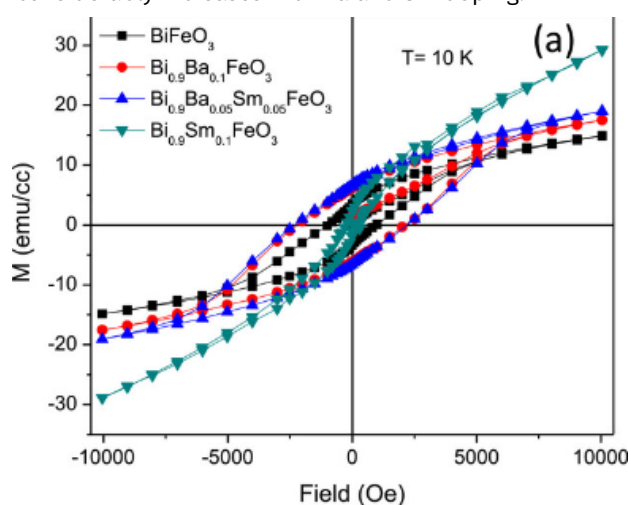


See: Determination of Hansen solubility parameter and in Situ visualization of dispersion stability of solution-processed antimonene. Sahoo, P., Sahoo, R. C., & Matte, H., *ACS Applied Nano Materials*, 6, 21957-21966 (2023) doi:10.1021/acsanm.3c04189

Affiliations: Priyabrata Sahoo, Ramesh Chandra Sahoo and H. S. S. Ramakrishna Matte (CeNS)

Structural, morphological, and magnetic properties of Ba, Sm doped, and Ba-Sm Co-doped BiFeO₃ nanocrystalline thin films deposited by a spin coating method

CeNS researchers have synthesized BiFeO₃, Bi_{0.9}Ba_{0.1}FeO₃, Bi_{0.9}Sm_{0.1}FeO₃, and Bi_{0.9}Ba_{0.05}Sm_{0.05}FeO₃ nanocrystalline thin films on Pt/TiO₂/SiO₂/Si (100) substrate using the spin coating method, and investigated the structural, morphological, and magnetic properties systematically. M-H measurements show that the magnetization considerably increases with Ba and Sm doping.



Magnetization as a function of magnetic field for Ba, Sm doped and Ba-Sm Co doped BiFeO₃ nanocrystalline thin films for 10 K.

See: Structural, morphological, and magnetic properties of Ba, Sm Doped and Ba-Sm Co-Doped BiFeO₃ nanocrystalline thin films deposited by a spin coating method. Kambhala, N., Angappane, S., & Akkera, H. S., *Crystal Research and Technology*, 58, 2200261 (2023) doi:10.1002/crat.202200261

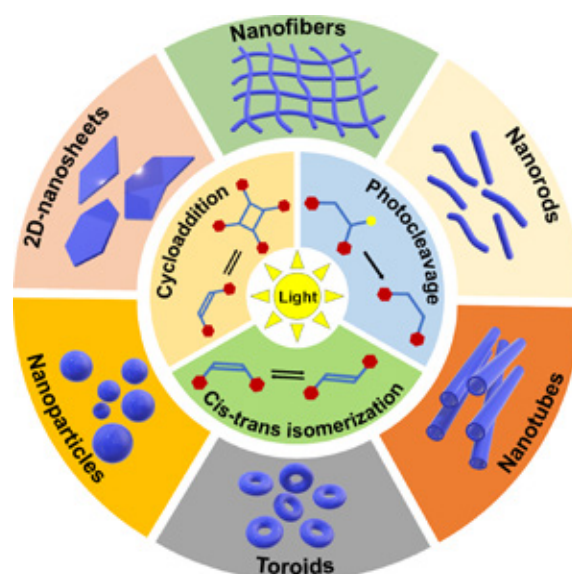
Affiliations: Nagaiah Kambhala (Jain University, Bengaluru) S. Angappane (CeNS) and Harish Sharma Akkera (Presidency University, Bengaluru).

5.2 SOFT MATERIALS AND COMPOSITES:

Light-regulated morphology control in supramolecular polymers

Stimuli-responsive materials have gained significant recent interest owing to their versatility and wide applications in fields ranging from materials science to biology. In the majority of examples, external stimuli, including light, act as a remote source of energy to depolymerize/deconstruct certain nanostructures or provide energy for exploring their functional features. However, there is little emphasis on the creation and precise control of these materials. Although significant progress has been made in the last few decades in understanding the pros and cons of various directional non-covalent interactions and their specific molecular

recognition ability, it is only in the recent past that the focus has shifted toward controlling the dimension, dispersity, and other macroscopic properties of supramolecular assemblies. Control over the morphology of supramolecular polymers is extremely crucial not only for material properties they manifest but also for effective interactions with biological systems for their potential application in the field of biomedicine. This could effectively be achieved using photoirradiation which has been demonstrated by some recent reports. The concept as such offers a broad scope for designing versatile stimuli-responsive supramolecular materials with precise structure-property control. However, there has not yet been a compilation that focuses on the present subject of employing light to impact and regulate the morphology of supramolecular polymers or categorize the functional motif for easy understanding. To overcome this, recent examples of how light irradiation can tune the morphology and nanostructures of supramolecular polymers have been collated and categorized based on their chemical transformation such as cis-trans isomerization, cycloaddition, and photocleavage. A direct correlation among the structures of the building blocks, mesoscopic properties, and functional behaviour of such materials has been established and future research directions have been suggested.



See: Light-regulated morphology control in supramolecular polymers. Mukherjee, A., & Ghosh, G., *Nanoscale*, 16, 2169-2184 (2024) doi:10.1039/D3NR04989B

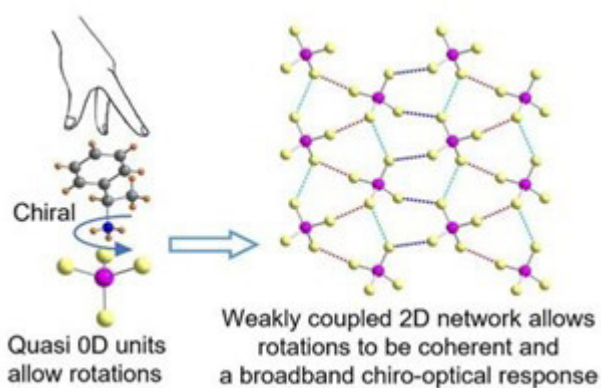
Affiliation: Anurag Mukherjee, (Westfälische Wilhelms University Münster, Germany) and Goutam Ghosh (CeNS)

Chiro-optical properties of 2D (R/S-MBAA)₂CuBr₄

The compound (R/S-MBA)₂CuBr₄, consisting of R/S- α -methyl benzylamine (R/S-MBA) connected to distorted CuBr₄ tetrahedral units in alternating layers, exhibits remarkable chiroptical properties. Recently through a collaborative effort, CeNS scientists, have shown that the



optical properties of these materials make them stand out in the orange-red part of the visible spectrum among other hybrid materials. This high chiral anisotropy factor is achieved through a transfer of chirality from the organic component to the inorganic layer, facilitated by an extensive network of asymmetric hydrogen bonds and electronic coupling. This results in the alignment of CuBr_4 tetrahedral units along a 21-screw axis.



See: Unique Chiro-optical Properties of the Weakly-2D (R-/S-MBA) 2CuBr_4 Hybrid Material. Das, R., Hossain, M., Mahata, A., Swain, D., De Angelis, F., Santra, P. K., & Sarma, D. D., *ACS Materials Letters*, 5, 1556-1564 (2023) doi:10.1021/acsmaterialslett.3c00268

Affiliations: Ranjan Das, D.D. Sarma (IISc-Bengaluru), Modasser Hossain, Pralay K. Santra (CeNS), Arup Mahata (IIT, Hyderabad), Diptikanta Swain (ICT, Bhubaneswar) and Filippo De Angelis (University of Perugia, Italy)

Pathway-dependent controlled supramolecular polymerization of peptides

Recently, pathway complexity in supramolecular self-assembly has gained great attention due to their ability to control the dimensions of the nanostructures. Although the self-assembly of a wide range of organic and π -chromophore-based compounds has been extensively explored in the context of pathway complexity, analogous investigations using peptides have received very little attention. An effort has been made to collate recent examples of control over nano- and secondary structures of self-assembled peptides through pathway-dependent approaches. Regulating the competing kinetic vs thermodynamic pathways would aid to create tunable nanostructures with definite sizes and shapes, which is very crucial for effective interactions with biological

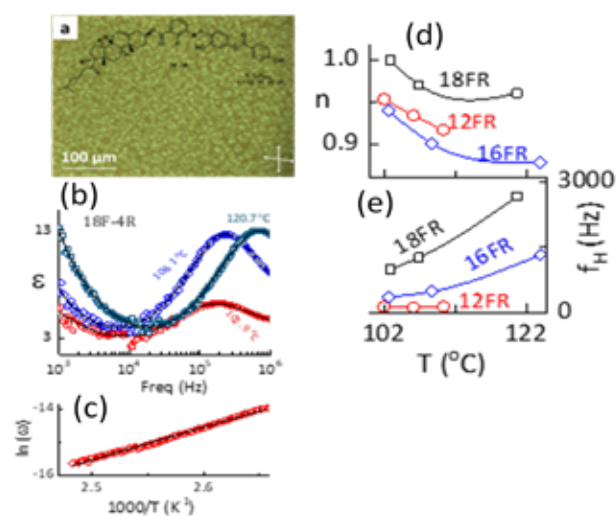


systems and a wide variety of applications in biomedicine. **See:** Pathway-dependent controlled supramolecular polymerization of peptides. Ghosh, G., *Giant*, 14, 100160 (2023) doi:https://doi.org/10.1016/j.giant.2023.100160

Affiliation: Goutam Ghosh (CeNS)

Mesomorphic and dielectric properties of strategically designed chiral bent-core liquid crystals

Chiral bent-core liquid crystals (LCs) are endowed with exceptional stability across a broad range of temperatures. In this context, CeNS researchers in collaboration with IISER Mohali have studied new fluorinated molecules with chirality as cholesterol. These molecules exhibit a chiral dark conglomerate (DC) phase over a broad temperature range of $\sim 85^\circ\text{C}$ in an enantiotropic manner. The study unveils the long-range DC phase, shows domains of opposing chirality, and belongs to the sponge-type DC phase. Notably, the enhancement of a specific chiral domain reveals the bias towards supramolecular chirality, attributable to molecular chirality as supported by circular dichroism measurements. This finding holds promise for chiral plasmonics, enantiomeric separation, and nano-templating applications.



(a) POM image along with molecular structure, (b) Variation of imaginary part of the complex permittivity e'' as a function of probing frequency (f) at several representative temperatures, (c) temperature dependence of relaxation frequencies for the representative material 18F-4R, (d) the variation of exponent, n , and (e) the hopping frequency, f_H , with respect to temperature for 12F-4R, 16F-4R, and 18F-4R.

See: Mesomorphic and dielectric properties of strategically designed chiral bent-core liquid crystals displaying wide temperature range dark conglomerate phase. Baghla, A., Punjani, V., Rao, D. S. S., Prasad, S. K., & Pal, S. K., *Journal of Materials Chemistry C*, 12, 3915-3923 (2024) doi:10.1039/d3tc04106a

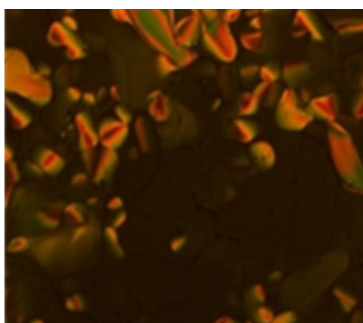
Affiliation: Anshika Baghla, Vidhika Punjani, Santanu Kumar Pal (IISER, Mohali) and D.S. Shankar Rao, S. Krishna Prasad (CeNS)

Tris(boranil) columnar liquid crystalline fluorophores: pseudo-triphenylene boron(III) complexes with peripheral N-B-O linkages

The first examples of tris (boranil) discotics have been



synthesized and characterized. All six tris(boranyl) discotics with nine peripheral *n*-alkoxy tails display columnar (Col) mesophase over a wide thermal range. XRD study evidences the stacking of the columns in either rectangular or oblique 2D lattices. The length of peripheral chains appears to affect the columnar behavior of the tris(boranyl)s. Three of the six materials with *n*-octyloxy, *n*-nonyloxy, and *n*-decyloxy are room temperature Col LCs while the others with *n*-hexyloxy, *n*-heptyloxy, and *n*-dodecyloxy freeze the Col phase in a glassy state close to room temperature. The solid-state (thin films), solution, and fluid columnar structure of the compounds emit light. CV profiles of these LCs exhibit an identical, irreversible oxidation behavior; they display two oxidative peaks inferring that they lose electrons readily in two oxidation steps at the electrode surface. Thus, the tris(boranyl) discotics realized in the present study can be regarded as potential functional materials for device applications as they show Col phase at room temperature, notable photophysical properties, and redox behavior.

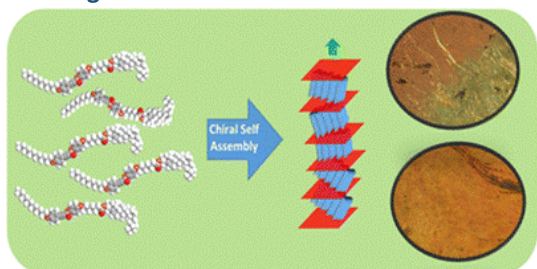


Photoluminescent tris(boranyl) discotics exhibit room temperature columnar mesomorphism, and redox behavior.

See: Tris(boranyl) Columnar Liquid Crystalline Fluorophores: pseudo-Triphenylene Boron(III) Complexes with Peripheral N-B-O Linkages. Veerabhadraswamy, B. N., Khatavi, S. Y., Rathod, A. S., Kanakala, M. B., Rao, D. S. S., & Yelamaggad, C. V., *Chemistry- A European Journal*, 29, 202202987 (2023) doi:10.1002/chem.202202987

Affiliations: Veerabhadraswamy, B. N., S. Y. Khatavi, A. S. Rathod, M. B. Kanakala, D. S. Shankar Rao and C. V. Yelamaggad (CeNS).

The interplay of chirality and restricted rotation: stabilization of chiral, frustrated mesophases over a wide thermal range



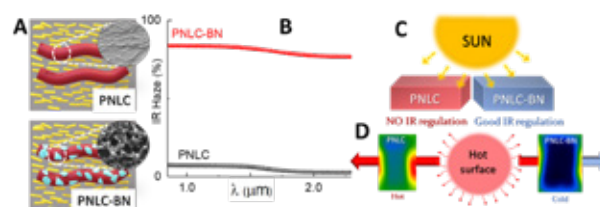
CeNS researchers have demonstrated that the incorporation of restricted rotation in chiral liquid crystal (LC) molecules, achieved through the insertion of the triple bond, facilitates the competition between the two

incompatible fluid structures yielding twist grain boundary (TGB) phases having chiral smectic C (SmC*) structure. Due to the restricted rotation caused by the triple bonded system, the novel optically active dimers incorporating cholesterol and phenyl 3-phenylpropionate segments interconnected by an *ω*-oxyalkanoxy spacer of varying lengths and parity, stabilized the TGBC* over a wide temperature range, in addition to blue phase-I/II, chiral nematic (N*), and smectic A (SmA) phases.

See: The interplay of chirality and restricted rotation: stabilization of chiral, frustrated mesophases over a wide thermal range. Bhat, S. A., & Yelamaggad, C. V., *Soft Matter*, 20, 3685-3694 (2024) doi:10.1039/d4sm00126e

Affiliations: Sachin A Bhat and C. V. Yelamaggad (CeNS)

Regulation of IR radiation through preferential placement of h-BN nanosheets in a polymer network liquid crystal



LC-polymer (PNLC) and LC-polymer-hBN (PNLC-BN) systems: (A) schematic diagram showing molecular architectures with polymer fibres (maroon) and the h-BN flakes (cyan) in the midst of LC molecules (yellow) with the insets presenting the SEM images of changed morphology, (B) hugely enhanced IR haze for PNLC-BN. (C) Schematic of IR regulation under solar illumination and (D) Thermal imaging and quantification of thermal regulation on exposure to a hot surface with IR camera images; the image is much cooler with the PNLC-BN device than with the PNLC device.

There has been a great deal of interest recently in devices which effectively shield near-infrared light with an additional feature of external field tunability, particularly for energy-saving applications. CeNS researchers have demonstrated an approach for fabricating a highly efficient near-infrared regulating device based on a polymer network liquid crystal reinforced with nanosheets of hexagonal-boron nitride (BN). The device achieves ~84% IR scattering capability over a wavelength range of 800 – 2300 nm, and can also be regulated by electric field. Interestingly, the observed high IR regulation is despite individual components of the composite being IR transparent, in stark contrast to earlier attempted incorporation of IR-absorbing/scattering particles. Detailed experimental characterization suggests that the preferential positioning of the BN nanosheets, a consequence of the photo-polymerization process, is responsible for the observed feature. The IR reflectivity/back scattering gets doubled upon incorporation of the nanosheets, which manifests in enhanced convective/radiative heat barrier capability seen by thermal imaging and significant (2°C) reduction in the ambient temperature upon one-Sun illumination. Numerical simulations are also found to be in good agreement with the observed enhanced



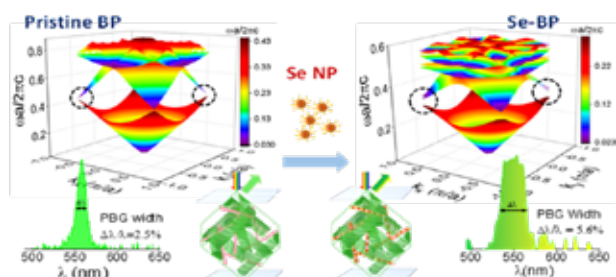
reflectance for the BN-incorporated case. The presence of BN augments the mechanical rigidity of the system by a factor of 6.8 without compromising on the device operating voltage. The protocol employed is quite general and thus advantageous with far-reaching applications in passive cooling of buildings and structures, in thermal camouflaging, and in overall energy management.

See: IR regulation through preferential placement of h-BN nanosheets in a polymer network liquid crystal. Pisharody, G. R., Sahoo, P., Rao, D. S. S., Matte, H., Sikdar, D., & Prasad, S. K., *Materials Horizons*, 11, 554-565 (2023) doi:10.1039/d3mh01467c

Affiliations: Gayathri R. Pisharody, Priyabrata Sahoo, D. S. Shankar Rao, H. S. S. Ramakrishna Matte, S. Krishna Prasad (CeNS) and Debabrata Sikdar (IIT, Guwahati)

Driving a liquid crystalline cubic blue phase towards a complete photonic bandgap with high index nanoparticle inclusions

Three-dimensional (3D) photonic crystals with complete photonic bandgap (PBG) are fascinating due to the possibility of controlling light in all directions. Realizing such photonic crystals is nontrivial due to symmetry requirements and associated fabrication challenges. Liquid crystalline cubic blue phases are soft 3D photonic crystals with an incomplete PBG due to the low refractive index contrast (<0.1). A simple approach of high refractive index nanoparticle doping is employed to drive a cubic blue phase towards a complete PBG. The photonic band diagrams and reflection spectra of the nanoparticle-doped blue phase simulated using the finite element method show an increased PBG width, a parameter that quantifies the complete PBG. Experimental studies of reflection spectroscopy give direct evidence of an increase in PBG width (by a factor of >2) for the nanoparticle-doped BP, validating the simulations. The findings are explained based on increased refractive index contrast (~ 1.4) due to the nanoparticles getting trapped in the cores of disclination lines of the blue phase lattice.



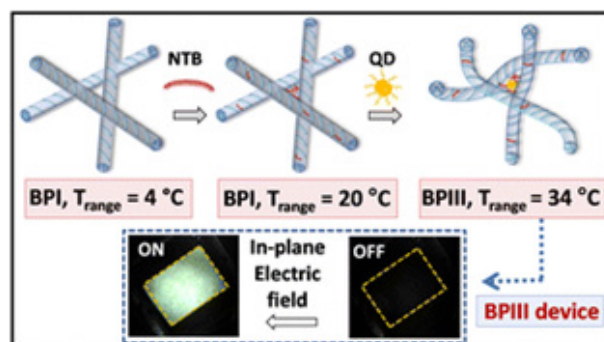
Reflection spectroscopic measurements supported by FEM simulations show that adding high-index nanoparticles increases the refractive index contrast of cubic blue phase driving it towards a complete PBG system.

See: Towards complete photonic band gap in a high refractive index nanoparticle-doped blue phase liquid crystal. Khatun, N., Sridurai, V., & Nair, G. G., *Nanoscale*, 15, 17808-17817 (2023) doi:10.1039/d3nr03366j

Affiliations: Nurjahan Khatun, Vimala Sridurai and Geetha G. Nair (CeNS)

A liquid crystalline amorphous blue phase with a wide thermal range and ultra-fast electro-optic response time for next generation LCD applications

Amorphous Blue phase, or BPIII, a mesophase exhibited by highly chiral liquid crystals, is increasingly being investigated for next-generation displays due to its attractive electro-optical properties, such as sub-millisecond response time, high contrast ratio and wide viewing angle. However, obtaining a fast-responding, thermally stable BPIII with commercial usability is still a challenge due to the frustrated nature of the phase. The thermal and electro-optic properties of BPIII exhibited by a low molecular weight liquid crystalline system prepared by a synergistic addition of a liquid crystalline dimer and quantum dots leads to a highly thermally stable BPIII. The dimer that exhibits a twist bend nematic phase with ultra-low bend elastic constant stabilizes the cubic blue phase, BPI, due to free energy considerations. The inclusion of surface-functionalized quantum dots to the mixture further reduces the free energy associated with the topological defects leading to the induction of BPIII that is stable over a wide thermal range of over 34°C spanning ambient and below/above ambient temperatures, as confirmed from polarizing optical microscopy, and electro-optical studies. The response time associated with the switching between achromatic dark and bright states ($\sim 200 \mu\text{s}$) is, faster than that reported for low molecular weight systems and on par with polymeric systems. A prototype device fabricated using the BPIII composite is found to be thermally, temporally, and electrically stable.



Addition of a liquid crystalline dimer with ultra-low bend elastic constant and surface-functionalized QDs leads to BPIII with a wide thermal range covering above/below ambient temperatures.

See: Topological defects stabilized by a soft twist-bend dimer and quantum dots lead to a wide thermal range and ultra-fast electro-optic response in a liquid crystalline amorphous blue phase. Khatun, N., Sridurai, V., Csorba, K. F., & Nair, G. G., *Journal of Materials Chemistry C*, 11, 9686-9694 (2023) doi:10.1039/d3tc00861d

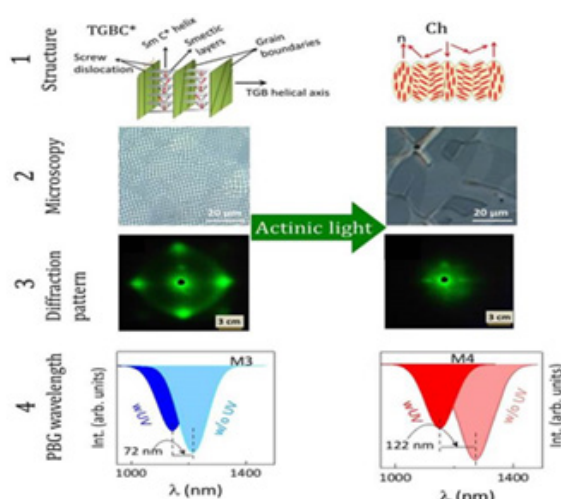
Affiliations: Nurjahan Khatun, Vimala Sridurai, Geetha G. Nair (CeNS) and Katalin F. Csorba (Academy of Sciences Budapest-Hungary)



5.3 PHASE TRANSITION:

Dimer-parity dependent odd-even effects in photoinduced transitions to cholesteric and twist grain boundary SmC* mesophases: PBG characteristics

The influence of flexible spacer parity of the guest photoactive liquid-crystalline dimer on the photonic bandgap (PBG) features of the cholesteric (Ch) and twist grain boundary smectic C* (TGBC*) phases of the host molecule has been investigated for the first time. Both the phases exhibit PBG structure, with the former having it in one and the latter in three dimensions respectively. The concentration of the photoactive dimer is very small in the host liquid crystal (HLC) system that exhibits isotropic (Iso) \rightarrow Ch \rightarrow TGBC* sequence. The photoisomerization experiment brings out the feature that the pitch of the Ch phase blue-shifts, with the magnitude being more for the even dimer system compared to the odd one. This effect is accompanied by a reduction in the width of the PBG, again the effect is more pronounced for the even parity mixture compared to the odd one. The two-dimensional periodicity of the SmC* helix identified with the grid pattern in the TGBC* phase shows the memory effect upon photoisomerization. X-ray diffraction measurements reveal that the odd dimer system shows a larger layer spacing than the even one. Upon UV illumination for one of the materials, layer spacing shows an increase. The investigations reveal that, apart from the actinic light, the spacer and parity of the photoactive dimer play a significant role in controlling the PBG properties in all three directions.



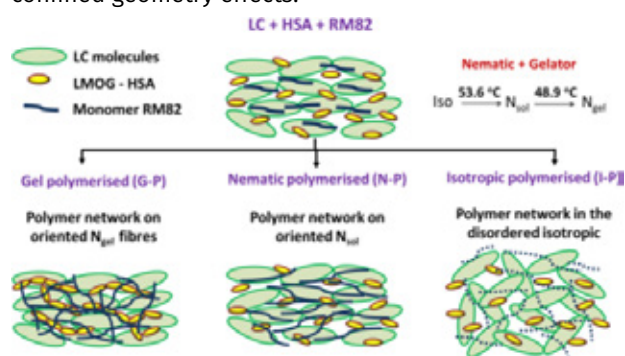
Structural arrangement (panel 1), polarizing optical microscopy images (panel 2), laser diffraction (panel 3) in the TGBC* and Ch phases. Panel 4 shows the photoinduced shift in 1D PBG for the odd and the even mixture.

See: Dimer-parity dependent odd-even effects in photoinduced transitions to cholesteric and twist grain boundary SmC* mesophases: PBG characteristics. Sahoo, R., Reshma, C., Rao, D. S. S., Yelamagad, C. V., & Prasad, S. K., *Journal of Molecular Liquids*, 393, 123443 (2024) doi:10.1016/j.molliq.2023.123443

Affiliations: Rajalaxmi Sahoo, C. Reshma, D.S. Shankar Rao, C.V. Yelamagad and S. Krishna Prasad (CeNS)

Anisotropic sol-gel transition and morphological aspects of a hierarchical network of nematic gel and a superimposed photopolymer

A liquid crystal confined in a hierarchical double network arising from the fibres of an organogelator and a photopolymer is investigated. The morphological characteristics and the gel point are seen to be strongly dependent on temperature, or more accurately on the thermodynamic phase in which the polymerization is carried out and also the concentration of the reactive monomer. The presence or absence of the anisotropy of the phase as well as the fluid or the gel character present architectures that are substantially different in complexity as quantified by the fractal dimension obtained from scanning electron microscopy images. The main aspect of this study, which includes dielectric as well as elastic constant measurements, is the attractive feature of hierarchical networks wherein the polymer and gel networks are caused by different chemical species providing a control to have one of them superimposed on the other leading to interesting confined geometry effects.



Schematic illustration of the scope of the network (right panel) and the morphology of the system as imaged through an electron microscope (left panel)

See: Anisotropic sol-gel transition and morphological aspects of a hierarchical network of nematic gel and a superimposed photopolymer. Varshini, G. V., Rao, D. S. S., & Prasad, S. K., *Journal of Materials Chemistry C*, 11, 7682-7696 (2023) doi:10.1039/d3tc00991b

Affiliations: G. V. Varshini, D. S. Shankar Rao and S. Krishna Prasad (CeNS)

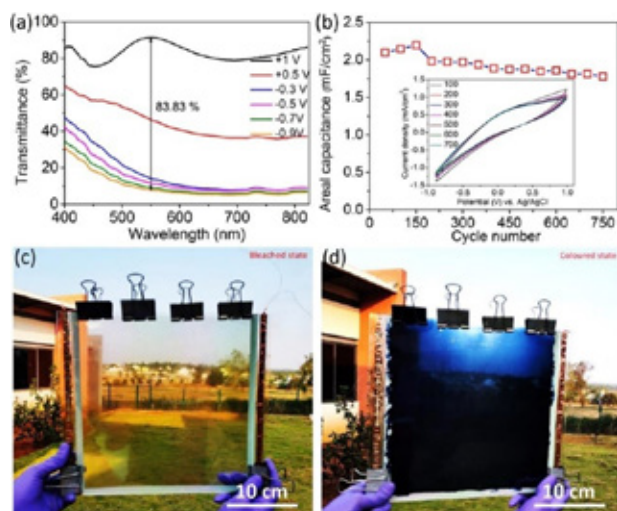
5.4 DEVICE FABRICATION

Affordable electrochromic smart windows

Researchers from CeNS have developed an affordable, energy-efficient glass window by reducing the cost of components used in electrochromic energy storage (EES) devices. They used a metal mesh electrode, thin WO₃ film, and Al³⁺ electrolytes to create a revolutionary EES device with high switching contrast, area capacitance, and long cycling life. The device has the potential for commercialization with minimal investment. Furthermore,



they achieved an ultra-high switching contrast of 90% by optimizing WO_3 sputtering on cost-effective Al-mesh overlaid with SnO_2 . The ECSWs demonstrated fast switching, good cyclic stability, and excellent coloration efficiency. They developed a large-area smart window operating at 2V, which powered a display.

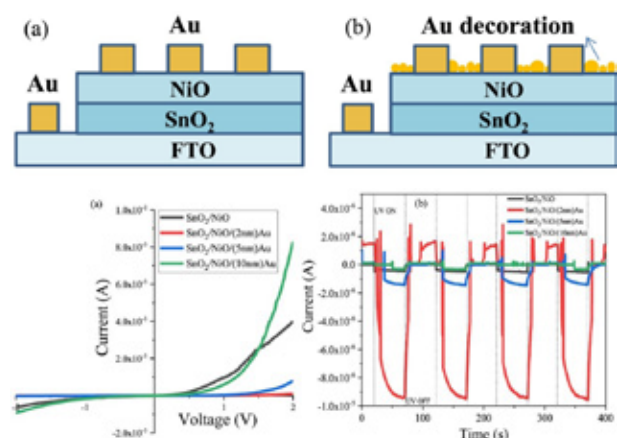


EES device based on hybrid transparent electrode (ITO/Al-mesh). (a) transmittance modulation by the optimized WO_3 film coated on the hybrid electrode at different applied voltages. (b) cyclic of the optimized WO_3 /ITO/Al-mesh active electrode at 100 mV/s scan rate. Insert showing its cyclic voltammograms at different cycle numbers. Photographs of a large area (900 cm²) dual functional EES device in (c) bleached (discharged) and (d) coloured (charged) state

See: Affordable smart windows with dual-functionality: Electrochromic color switching and charge storage. Mondal, I., Ganesha, M. K., Singh, A. K., & Kulkarni, G. U., *Advanced Materials Technologies*, 18, 2300651 (2023) doi:10.1002/admt.202300651

Affiliations: Mukhesh. K.G, Ashutosh K. Singh (CeNS) & Indrajit Mondal, G. U. Kulkarni (JNCASR - Bengaluru)

Enhanced photodetector performance of SnO_2/NiO heterojunction via Au incorporation



(a) SnO_2/NiO devices and Au decorated SnO_2/NiO devices (b) I-V characteristics of SnO_2/NiO devices without and with Au decoration, temporal response of the devices at zero bias, with 365 nm illumination.

CeNS researchers have modified SnO_2/NiO heterojunction by incorporating Au at the surface and interface of different devices. The 2 nm Au surface decorated $\text{SnO}_2/$

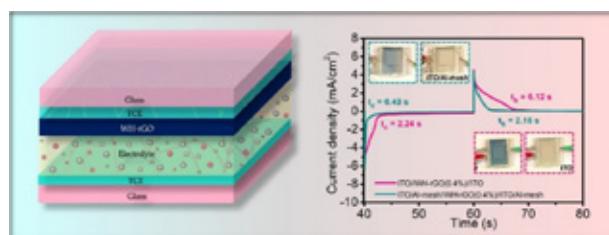
NiO diode showed 10.6 micro. A photocurrent generation. The responsivity, rise time, detectivity, and ON/Off ratio calculated for the device SnO_2/NiO with Au NPs at the interface were 3.1 mA W⁻¹, 1.6s, 1.8 × 10¹⁰ Jones, and 2.6 × 10³ respectively, best among all the devices.

See: Enhanced photodetector performance of SnO_2/NiO heterojunction via Au incorporation. M, Athira, Shafna K. K, F., & Angappane, S., *Semiconductor Science and Technology*, 38, 055014 (2023)

Affiliations: M. Athira, Fathima Shafna K. K. and S. Angappane (CeNS)

Low-cost hybrid transparent conducting electrodes

Scientists at CeNS have devised a cost-effective method to create smart windows that can change color using minimal power. Traditional electrochromic windows face hurdles like high production costs and limited performance. To tackle this, they developed a special ink made of $\text{WO}_3 \cdot \text{H}_2\text{O}$ nanoplates and rGO nanosheets. This ink, sprayed onto large surfaces, resulted in windows that change color in just seconds while also storing energy efficiently. By using this ink on new types of electrodes, they produced larger smart windows that change from blue to clear rapidly. These advancements promise cheaper, faster, and more versatile smart windows for cars and buildings.



(a) Electrochromic device configuration (b) Device performance in terms of switching time

See: Dual-Functional electrochromic smart window using $\text{WO}_3 \cdot \text{H}_2\text{O}$ -rGO nanocomposite ink spray-coated on a low-cost hybrid electrode. Dutta, P., Verma, M., Paliwal, M. S., Mondal, I., Ganesha, M. K., Gupta, R., Singh, A. K. & Kulkarni, G. U., *ACS Applied Materials & Interfaces*, 15, 57304 (2023) doi:10.1021/acami.3c11337

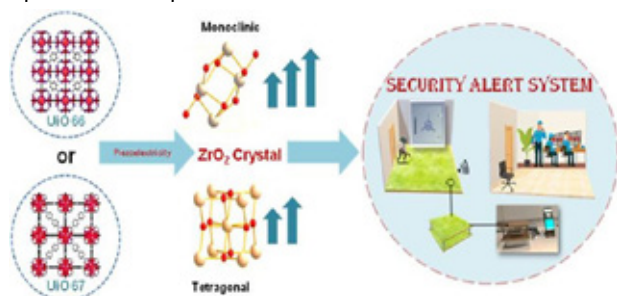
Affiliations: Pritha Dutta, Mukhesh K. G., Ashutosh K. Singh (CeNS), Mohit Verma, Mayank S. Paliwal, Ritu Gupta (IIT, Jodhpur) and Indrajit Mondal, G.U. Kulkarni (JNCASR, Bengaluru)

Polymer nanocomposites with UiO-derived zirconia fillers for energy generation and pressure-sensing devices: the role of crystal structure and surface characteristics

The influence of varying crystal structures of zirconia nanoparticles on mechanical to electrical energy conversion efficiency of zirconia-poly(vinylidene difluoride) (PVDF) composite is investigated. Two metal-organic frameworks, UiO-66 and UiO-67, were employed to synthesize four different types of zirconia nanoparticles with precise control of the monoclinic and tetragonal phases. It was hypothesized that the stable crystalline structure of the monoclinic phase might act as a better nucleating agent, and among monoclinic derivatives,



ZrO₂-66m was found to be more hydrophobic, enabling a better interaction with PVDF. The results validate that the PVDF-monoclinic ZrO₂ nanoparticle nanocomposites will be an excellent value addition for flexible, durable energy generation and pressure-sensing applications. A prototype of a wireless, Bluetooth-enabled security alert system supported by an Android application was developed using the polymer nanocomposite with an optimized composition.

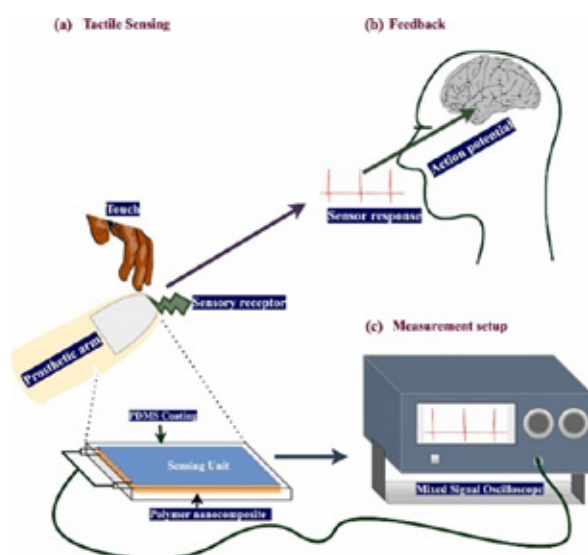


Schematic of nanofiller crystal structures and the role of Piezoelectric pavement in security alert system

See: Polymer nanocomposites with UiO-Derived zirconia fillers for energy generation and pressure-sensing devices: the role of crystal structure and surface characteristics. Mukherjee, G., Verma, A., Madhu, A. H., Prasad, B. L. V., & C. K., Subash, *ACS Applied Nano Materials*, 7, 5809-5818 (2024) doi:10.1021/acsanm.3c04730

Affiliation: Gargi Mukherjee, (CSIR-NCL, Pune) Ankur Verma, B LV Prasad, Subash C. K. (CeNS), and Arjun Hari Madhu (NIT, Calicut)

Optimization of PVDF nanocomposite-based flexible piezoelectric tactile sensors: a comparative investigation



Schematic of tactile sensing using the fabricated device and its testing

A comparative analysis of the performance enhancement of PVDF-based piezoelectric tactile sensors with the addition of different nanofillers such as zinc oxide, titanium dioxide, and nano-silica fillers to develop PVDF composite sensor films is carried out. The incorporation of nanofillers leads to faster crystallization and thereby promotes strong interfacial interactions leading into the formation of piezoelectric β -phase enriched PVDF

composites. Process flow involved in the fabrication, packaging, and characterization of the piezoelectric nanocomposite-based tactile sensors are investigated in detail. The sensor characterization results show that nanoparticle addition into the PVDF matrix improves the piezoelectric performance with a maximum observed sensitivity of 103 mV/N for zinc oxide-incorporated devices. The sensors developed with titanium dioxide and nanosilica particles also exhibited a similar improvement in sensitivity. Flexible, and self-powered tactile sensors realized using cost-effective fabrication mechanisms are targeted towards implementing in the large area portions of prosthetic devices.

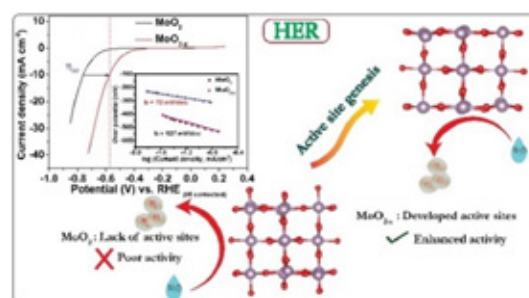
See: Optimization of PVDF nanocomposite based flexible piezoelectric tactile sensors: A comparative investigation. Hari, M. A., Karumuthil, Subash. C., & Rajan, L., *Sensors and Actuators A-Physical*, 353, 114215 (2023) doi:10.1016/j.sna.2023.114215

Affiliation: Arjun Hari M., Lintu Rajan (NIT, Calicut) and Subash C.K. (CeNS)

5.5 ENERGY AND ENVIRONMENT :

Probing active site evolution in MoO₂ under applied potentials during hydrogen evolution reaction

MoO₂ is an effective host and catalytic material for electrochemical hydrogen evolution reactions (HER), however, pristine MoO₂ as electrocatalysts is less known due to a lack of knowledge of the active sites and their development during HER. The active site evolution on applying a cathodic potential to pristine MoO₂ and the corresponding improvement in catalytic activity is correlated. Advanced X-ray spectroscopy has revealed the emergence of active sites in MoO₂ through a change of Mo-O coordination from octahedral (Oh) to coordinatively unsaturated distorted environment. The key thermodynamic and kinetic parameters, such as the change in Gibbs free energy for hydrogen adsorption on the catalyst surface are simulated.



Active site development in MoO₂ during electrochemical treatment for efficient HER kinetics

See: Probing the evolution of active sites in MoO₂ for hydrogen generation acidic medium. Alex, C., Jana, R., Ramakrishnan, V., Naduvil Kovilakath, M. S., Datta, A., John, N. S., & Tayal, A., *ACS Applied Energy Materials*, 6, 5342-5351 (2023) doi:10.1021/acsaem.3c00320.

Affiliations: Chandraraj Alex, Vivek Ramakrishnan, Muhammed Safer N.K., Neena S. John (CeNS), Rajkumar Jana, Ayan Datta (IACS, Kolkata) and Akhil Tayal (Deutsches Elektronen-Synchrotron DESY, Germany)



Rare earth nickelate for urea-assisted water electrolysis

For urea-assisted electrochemical hydrogen generation, the capability of the electrocatalyst to sustain the NiOOH active species is of paramount importance as it ensures the optimal engagement of the maximum pool of active Ni centers in the electrocatalytic process. The UOR prowess of a rare earth nickelate - NdNiO₃ is unveiled showcasing high urea electro oxidation reaction (UOR) activity with a reduced burden of Ni mass loading. From detailed cyclic voltammetry studies, in-situ X-ray absorption spectroscopy, and impedance analyses, it has been substantiated that NdNiO₃ triggers the UOR to proceed through the unconventional direct mechanism, which obviates the need for catalyst regeneration during UOR. The preferential direct mechanism of UOR, enhanced mass activity, and commendable resistance against CO_x poisons emanate from the more facile formation and effective stabilization of active - NiOOH species in NdNiO₃.



NdNiO₃, a rare earth nickelate stabilizes NiOOH active species to proceed with urea electro-oxidation through a direct mechanism.

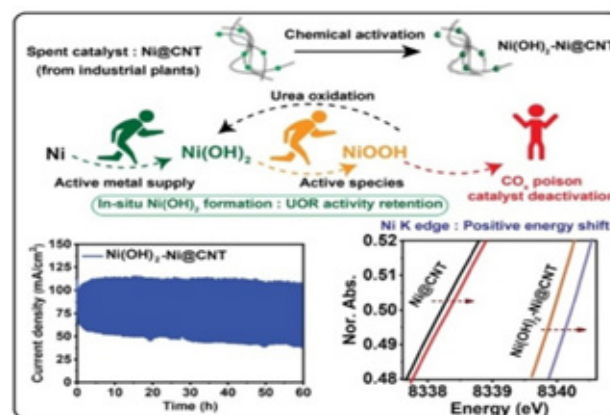
See: Evidence for exclusive direct mechanism of urea electro-oxidation driven by in situ-generated resilient active species on a rare-earth nickelate. Rao, N. N., Alex, C., Mukherjee, M., Roy, S., Tayal, A., Datta, A., & John, N. S., *ACS Catalysis*, 14, 981-993 (2024) doi:10.1021/acscatal.3c04967

Affiliations: Nikhil N. Rao, Chandraraj Alex, Subir Roy, Neena S. John (CeNS) Moumita Mukherjee, Ayan Datta (IACS, Kolkata) and Akhil Tayal (DeutschesElektronen-Synchrotron DESY, Germany)

In-situ generated Ni(OH)₂ on chemically activated spent catalyst for urea electrolysis

Electrochemical urea oxidation reaction (UOR) is an efficient way to produce cost-effective hydrogen from urea-based wastes. A chemical modification involving partial oxidation of the spent catalyst consisting of Ni@CNT, generated from industrial methane decomposition plants, is found to augment sustained UOR activity for a prolonged time in extensive alkaline conditions. The activated catalyst, Ni(OH)₂-Ni@CNT exhibits a TOF of 0.5

s⁻¹ and Tafel slope of 30mV/dec retaining UOR activity for 60 h at ~75mA/cm² in 1.6M urea and 6M KOH. In-situ X-ray absorption spectroscopy reveals that Ni in the activated spent catalyst possesses an average oxidation state of ~1.4 and Ni(OH)₂ content gets enhanced from 26 to 30% during UOR representing fresh Ni(OH)₂ formation. The activated Ni nanoparticles wrapped with carbon nanotubes provide excellent activity, CO_x removal, and turnover frequency, and favor the in-situ formation of fresh Ni(OH)₂ responsible for the activity retention.



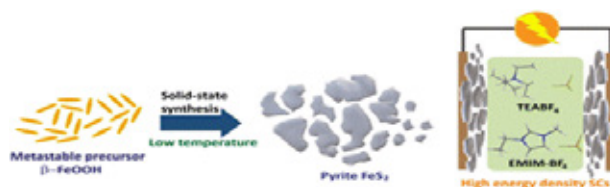
Chemically activated spent catalyst for electrocatalytic urea assisted hydrogen and hydrogen in highly alkaline medium with excellent activity retention.

See: In-situ generated Ni(OH)₂ on chemically activated spent catalyst sustains urea electro-oxidation in extensive alkaline conditions. Alex, C., Naduvil Kovilakath, M. S., Rao, N. N., Sathiskumar, C., Tayal, A., Meesala, L., Kumar, Pramod & John, N. S., *International Journal of Hydrogen Energy*, 59, 390-399 (2024) doi:https://doi.org/10.1016/j.ijhydene.2024.01.339

Affiliations: Chandraraj Alex, Muhammed Safer N.K., Nikhil N. Rao, C. Sathiskumar, Neena S. John (CeNS), Akhil Tayal, (DeutschesElektronen-Synchrotron DESY, Germany) and Lavanya, M., Pramod Kumar (HP Green R&D Centre, Bengaluru)

Low-temperature synthesis of crystalline pyrite FeS₂ for high energy density supercapacitors

Researchers from CeNS have developed a low-temperature synthesis of crystalline pyrite-FeS₂ through a solid-state annealing route, which was achieved using FeOOH, a metastable precursor, in the presence of H₂S gas. The as-synthesized pyrite FeS₂ was employed as an electrode for fabricating high-energy-density supercapacitors.



Schematic representation of FeS₂ synthesis and their applications in high energy density supercapacitors.

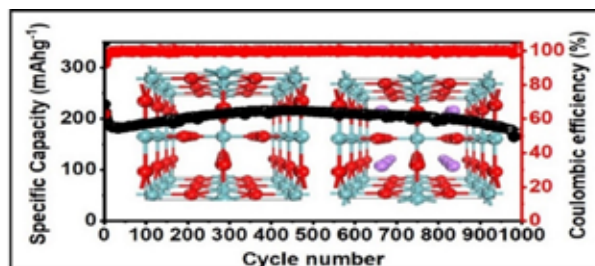
See: Low-temperature synthesis of crystalline pyrite FeS₂ for high energy density supercapacitors. Vishwanathan, S., & Matte, H. S. S. R., *Chemical Communications*, 59, 9263-9266 (2023) doi:10.1039/D3CC02153J

Affiliations: Savithri Vishwanathan and H. S. S. RamakrishnaMatte(CeNS)



NbO₂ a highly stable, ultrafast anode material for Li- and Na-ion batteries

Anode materials with fast charging capabilities and stability are critical for realizing next-generation Li-ion batteries (LIBs) and Na-ion batteries (SIBs). CeNS researchers along with scientists from JNCASR employed a simple synthetic strategy to obtain NbO₂ and studied its applications as an anode for LIB and SIB. In the case of the LIB, it exhibited a specific capacity of 344 mAh g⁻¹ at 100 mA g⁻¹. It also demonstrated remarkable stability over 1000 cycles, with 92% capacity retention. Additionally, it showed a unique fast charging capability, which takes 30s to reach a specific capacity of 83 mAh g⁻¹. For the SIB, NbO₂ exhibited a specific capacity of 244 mAh g⁻¹ at 50 mA g⁻¹ and showed 70% capacity retention after 500 cycles. Furthermore, detailed density functional theory reveals that various factors like bulk and surface charging processes, lower ion diffusion energy barriers, and superior electronic conductivity of NbO₂ are responsible for the observed battery performances.

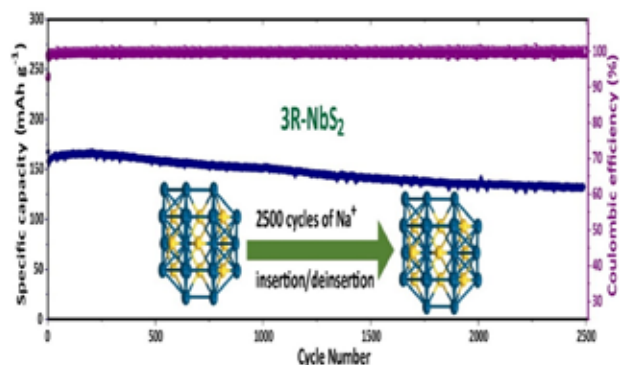


A highly stable and fast-charging anode for Li- and Na- ion batteries.

See: NbO₂ a highly stable, ultrafast anode material for Li- and Na-ion batteries. Chithaiah, P., Sahoo, R. C., Seok, J. H., Lee, S. U., Matte, H., & Rao, C. N. R., *ACS Applied Materials & Interfaces*, 15, 45868-45875 (2023) doi:10.1021/acsami.3c08694

Affiliations: Ramesh Chandra Sahoo, H. S. S. Ramakrishna Matte (CeNS), Jun Ho Seok, Sang Uck Lee (Sungkyunkwan University, South Korea) and P. Chithaiah, C. N. R. Rao (JNCASR, Bengaluru)

3R-NbS₂ as a highly stable anode for sodium-ion batteries



The rapid depletion of fossil fuel reserves and the resulting environmental repercussions have spurred extensive efforts to explore renewable and sustainable alternatives.

Anode materials for advanced sodium-ion batteries (SIBs) require major improvements with regard to their cycling stability, which is a crucial parameter for long-

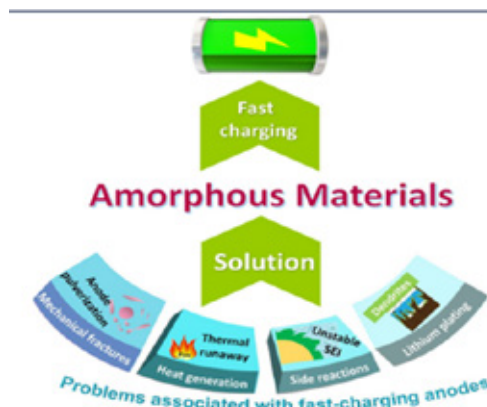
term battery operation. 3R-NbS₂, synthesised by a simple solid-state annealing route, as an anode for SIBs with remarkable cycling stability for 2500 cycles at 0.5 Ag⁻¹ is reported. The stable nature of the NbS₂ anode was attributed to its dominant capacitive behaviour.

See: 3R-NbS₂ as a highly stable anode for sodium-ion batteries. Vishwanathan, S., Chithaiah, P., Matte, H. S. S. R., & Rao, C. N. R., *Chemical Communications*, 60, 1309 (2024) doi:10.1039/D3CC05548E

Affiliations: Savithri Vishwanathan, H. S. S. Ramakrishna Matte (CeNS) and P. Chithaiah, C. N. R. Rao (JNCASR-Bengaluru)

Amorphous anode materials for fast-charging lithium-ion batteries

Fast-charging technology is set to revolutionize the field of lithium-ion batteries (LIBs), driving the creation of next-generation devices with the ability to get charged within a short span of time. From the anode perspective, it is of paramount importance to design materials that can withstand continuous Li⁺ insertion/de-insertion at high charging rates and still remain unaffected by factors such as mechanical fractures, electrolyte side reactions, polarisation, lithium plating, and heat generation. Herein, the recent advancements in the design of amorphous materials as anodes for fast-charging LIBs have been discussed. While the development of this particular class of materials for application in high-rate anodes has been paid limited attention in recent literature, it holds immense promise for improving fast-charging capabilities. This concept summarizes the recent strides made in this emerging field, outlining the strategies employed in the design of amorphous anodes and emphasizing the crucial role played by the amorphous nature in achieving fast-charging performance. Further, the successive initiatives that can be undertaken to drive the progress of amorphous materials for fast-charging LIBs have also been detailed, which could potentially improve their commercial viability.



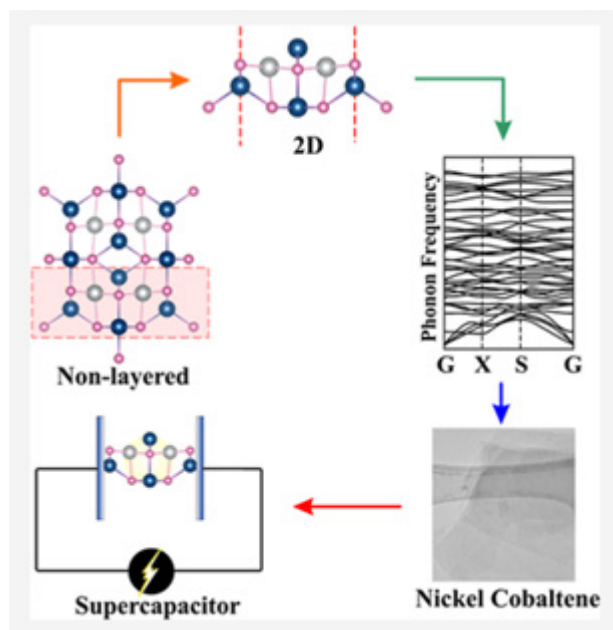
See: Amorphous anode materials for fast-charging lithium-ion batteries. Vishwanathan, S., Pandey, H., & Ramakrishna Matte, H. S. S., *Chemistry – A European Journal*, 30, e202303840 (2024) doi:https://doi.org/10.1002/chem.202303840

Affiliations: Savithri Vishwanathan, Harshit Pandey, and H. S. S. Ramakrishna Matte (CeNS)



Solution processing of spinel nickel cobaltite: exfoliation mechanism, dispersion stability, and applications

The exfoliation of non-layered materials to mono- or few-layers is of growing interest to realize their full potential for various applications. Nickel cobaltite (NiCo_2O_4), which has a spinel crystal structure, is one such nonlayered material with unique properties and has been utilized in a wide range of applications. Herein, NiCo_2O_4 is synthesized from NiCo_2 -Layered double hydroxides using a topochemical conversion technique. Subsequently, bulk NiCo_2O_4 is exfoliated into mono- or few-layer nickel cobaltene nanosheets using liquid-phase exfoliation in various low-boiling point solvents. An analytical centrifuge technique is also utilized to understand the solute-solvent interactions by determining their dispersion stability using parameters such as the instability index and sedimentation velocity. Among the studied solvents, water/isopropyl alcohol cosolvent is found to have better dispersion stability. In addition, density functional theory calculations are carried out to understand the exfoliation mechanism. It is found that the surface termination arising from the Co-O bond needs the least energy for exfoliation. Furthermore, the obtained nickel cobaltene nanosheets are utilized as an active material for supercapacitors without any conductive additives or binders. A solid-state symmetric supercapacitor delivers as specific capacitance of 10.2mFcm^{-2} with robust stability, retaining ~98% capacitance after 4000 cycles.



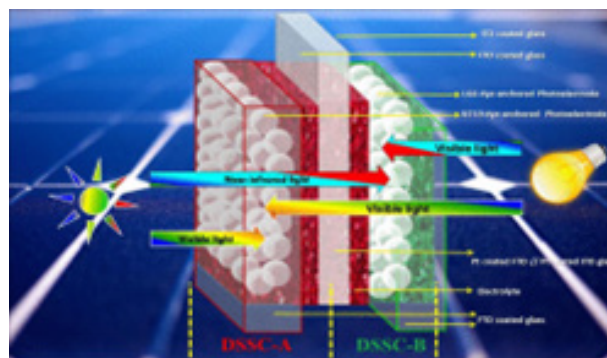
Liquid-phase exfoliation of nonlayered nickel cobaltite has been carried out in low-boiling point solvents to obtain dispersions of nickel cobaltine and DFT calculations further supported the experimental observations.

See: Solution processing of spinel nickel cobaltite: exfoliation mechanism, dispersion stability, and applications. Sahoo, R. C., Sahoo, P., Mohanta, M. K., Jena, P., & Matte, H., *Inorganic Chemistry*, 63, 7838-7847 (2024) doi:10.1021/acs.inorgchem.4c00430

Affiliations: Ramesh Chandra Sahoo, Priyabrata Sahoo, H. S. S. RamakrishnaMatte (CeNS) and Manish Mohanta, Puru Jena (Virginia Commonwealth University, United States)

Unveiling a new frontier in efficient solar power conversion with a pioneering bifacial tandem dye-sensitized solar cell

CeNS researchers, in collaboration with Yogi Vemana University, have developed a bifacial tandem dye-sensitized solar cell (DSSC-DSSC), which exhibits a high solar power conversion efficiency (PCE) of 12.76% with a current density of 27.61mA/cm^2 . The present work demonstrates the integration of an LG6 dye sensitizer for near-infrared light utilization and an N_{719} dye sensitizer for effective visible light capture in the bifacial tandem cell design. The developed bifacial tandem cell with LG6 and N_{719} dyes exhibited better incident photon-to-current conversion efficiency. A stable performance was detected up to 814h. The developed mini-module exhibited a maximum point power density output of 1.41mW/cm^2



A bifacial tandem DSSC

See: Unveiling a new frontier in efficient solar power conversion with a pioneering bifacial tandem dye-sensitized solar cell. Mounika, P. M., Ambapuram, M., Maddala, G., Kalvapalli, S., Ganesha, M. K., Singh, A. K., Thota, N., Rajesh, M., Giribabu, L., Venkateswarlu, K. & Mitty, R., *ACS Applied Electronic Materials*, 5, 5661-5667 (2023) doi:10.1021/acsaem.3c01000

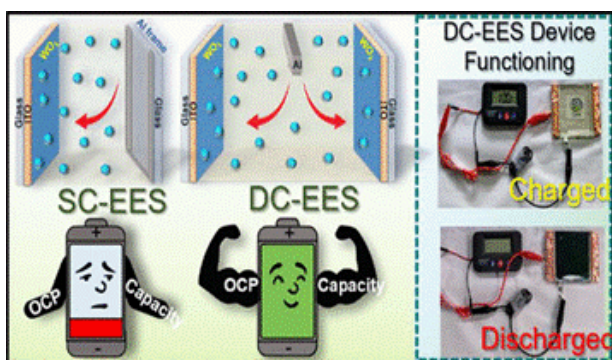
Affiliations: P M Mounika, Meenakshamma A, Gurulakshmi M, Susmitha K, L. Giribabu, Katta VenkateswarluRaghavender Mitty (Yogi Vemana University, Kadapa) Mukhesh K. G., Ashutosh K. Singh (CeNS), Narayana Thota (NIT, Tadepalligudem) and M Naga Rajesh (IIT, Hyderabad)

Aqueous-based electrochromic batteries

Aqueous-based electrochromic batteries have significant potential for use in color indicator energy storage, including energy-efficient buildings and wearable devices with visible energy level performance. While many materials have the ability to change color upon ion intercalation, they often have low optical contrasts and capacities. To address these issues, multivalent ions can provide a solution by providing multiple electrons, resulting in a higher optical contrast and capacity. Herein, an Al-ion electrochromic battery with a unique design, utilizing WO_3 as the cathode material, Al metal as the anode, and AlCl_3 as the aqueous electrolyte is proposed.



Ex situ X-ray diffraction results reveal that the peak position and interlayer spacing of the optimized WO_3 porous thin film (~170 nm) change during Al-ion intercalation and deintercalation, indicating the high structural stability of the optimized WO_3 electrode. A double cathode-electrochromic battery (DC-EES) device consisting of two cathodes on either side of an Al metal film anode was fabricated and it demonstrated superior electrochemical performance due to its increased active surface area and open circuit potential. The device exhibited an open circuit potential of ~1.2 V and a capacity of ~155 mAh/m² at 0.5 A/m², which are sufficient values for powering an electronic device. Additionally, the device exhibited excellent electrochromic behavior upon discharge with an optical contrast of 68% (transparent and blue). These results show the great potential of Al-ion electrochromic batteries as a cost-effective and high-safety material for applications in smart windows and energy storage displays in modern infrastructures.



Al-ion electrochromic battery

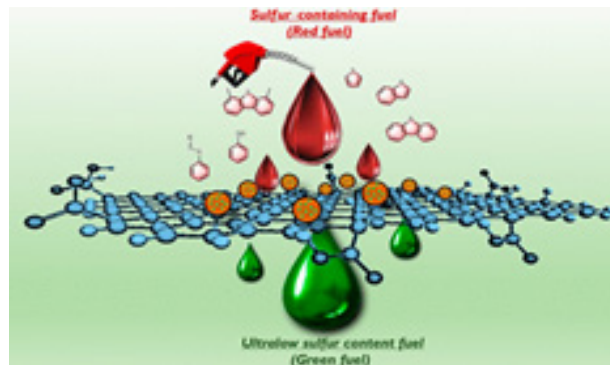
See: High-performance aqueous electrochromic battery for smart window application: mechanistic insights of Al-ion (De) intercalation kinetics in thickness-optimized WO_3 . Roy, R., Ganesh, M. K., Dutta, P., Pal, D., & Singh, A. K., *ACS Applied Energy Materials*, 6, 11683 (2023) doi:10.1021/acsaem.3c02237

Affiliations: Rahuldeb Roy, Mukhesh K.G., Pritha Dutta, Dipayan Pal, and Ashutosh K. Singh (CeNS)

Green synthesis of $\text{Ni}/\text{Fe}_3\text{O}_4/\text{rGO}$ nanocomposites for desulfurization of fuel

The growing need for clean air is gaining a lot of attention, and therefore, the removal of organosulfur compounds from fuel with a concentration of less than 15 ppm is becoming the need of the hour. To fulfill this expectation, CeNS researchers in collaboration with researchers from Aligarh Muslim University have developed magnetic hybrid nanomaterials ($\text{Fe}_3\text{O}_4/\text{rGO}$ and $\text{Ni}/\text{Fe}_3\text{O}_4/\text{rGO}$) through a sol-gel-assisted green synthetic technique that shows remarkable adsorptive desulfurization of dibenzothiophene (DBT). Further, doping with various concentrations of Ni enhances its magnetization, thereby making the recovery of nanocomposites easy, eco-friendly, and inexpensive with the help of an external magnet. Ni-doped $\text{Fe}_3\text{O}_4/\text{rGO}$ shows enhanced desulfurization with an effective removal efficiency of

73% as compared with a pristine nanocomposite (45%). As the doping concentration of Ni metal was increased, active Lewis acid sites were also remarkably increased promoting strong S-Ni bonding or π -complexation. With regard to academic, industrial, and environmental considerations, $\text{Ni}/\text{Fe}_3\text{O}_4/\text{rGO}$ is found to be a promising adsorbent due to its relatively high adsorption capacity, improved magnetization, and simple magnetic separation efficiency.

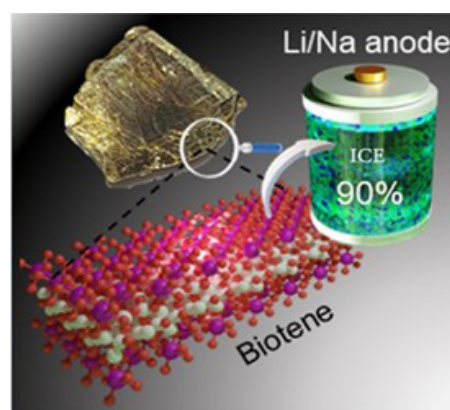


$\text{Ni}/\text{Fe}_3\text{O}_4/\text{rGO}$ as efficient adsorbent for organosulfur compounds with magnetic separation capability

See: Green Synthesis of $\text{Ni}/\text{Fe}_3\text{O}_4/\text{rGO}$ Nanocomposites for Desulfurization of Fuel. Rashid, T., Raza, A., Saleh, H. A. M., Khan, S., Rahaman, S., Pandey, K., Aldamen, M. A., Sama, F., Ahmad, A. Shahid, M. & Ahmad, S.A., *ACS Applied Nano Materials*, 6, 18905-18917 (2023) doi:10.1021/acsaem.3c03270.

Affiliations: Taiba Rashid, Azam Raza, Hatem A. M. Saleh, Shabnam Khan, Farasha Sama, Absar Ahmad, M. Shahid, Syed Afzal Ahmad (Aligarh Muslim University, Aligarh), SabiarRahaman, Kavita Pandey (CeNS) and Murad A. Aldamen (University of Jordan, Jordan).

Earth-abundant 2D material as sustainable anode for Li/Na-ion battery



Earth-abundant 2D Material, biotene as sustainable anode for energy storage devices

CeNS researchers in collaboration with scientists from Rice University have successfully harnessed the potential of naturally abundant Biotite, a van der Waals mineral, for advanced energy storage. Through bulk exfoliation, ultrathin 2D layers of Biotene were obtained, showcasing exceptional anode properties for both Li- and Na-ion batteries. Biotene demonstrated a remarkable first-cycle specific charge capacity of 302 mAh g⁻¹ for Li-ion and 141 mAh g⁻¹ for Na-ion, with ~90% initial Coulombic efficiency.



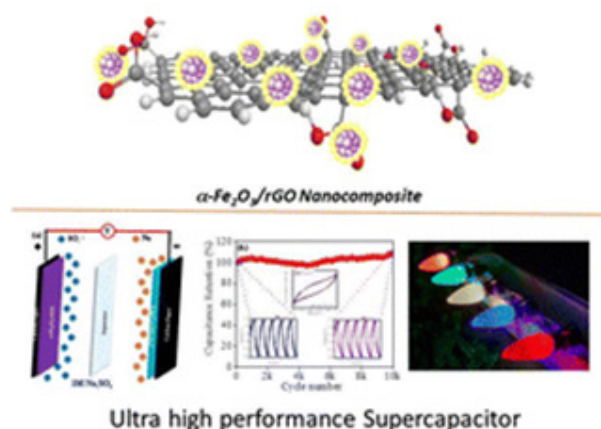
Impressively, the electrode displayed prolonged cycling stability, retaining ~75% capacity after 4000 cycles, even under higher current densities (500-2000 mA g⁻¹), marking a significant step towards the next generation of metal-ion battery anodes.

See: Biotene: earth-abundant 2D material as sustainable anode for Li/Na-ion battery. Pramanik, A., Mahapatra, P. L., Tromer, R., Xu, J., Costin, G., Li, Chenxi., Saju, Sreehari., Alhashim, Salma., Pandey, Kavita., Srivastava, Anchal., Vajtai, Robert., Galvao, Douglas S., Tiwary, Chandra Sekhar & Ajayan, P. M., *ACS Applied Materials & Interfaces*, 16, 2417-2427 (2024) doi:10.1021/acsami.3c15664

Affiliation: Atin Pramanik, Jianan Xu, Gelu Costin, Chenxi Li, Sreehari Saju, Salma Alhashim, Anchal Srivastava, Robert Vajtai, Pulickel M. Ajayan (Rice University, Texas), Preeti Lata Mahapatra, Chandra Sekhar Tiwary (IIT, Kharajpur), Raphael Tromer, Douglas S. Galvao (State University of Campinas, Brazil) and Kavita Pandey (CeNS).

Development of high capacity and highly stable supercapacitor devices: Eco-friendly synthesis of an α -Fe₂O₃/rGO nanocomposite and its application in high-performance asymmetric supercapacitors

This study introduces an eco-friendly method for synthesizing α -Fe₂O₃ nanoparticles using albumin, which acts as a reducing and stabilizing agent. The researchers also created α -Fe₂O₃/reduced graphene oxide nanocomposites. Various techniques confirmed the formation of these nanomaterials, including X-ray diffraction, infrared spectroscopy, and electron microscopy. Electrochemical tests demonstrated that the α -Fe₂O₃/rGO nanocomposites have excellent capacitance and stability, even after 10,000 cycles. A practical supercapacitor device was also developed, showing a high potential window of 2V and impressive cycling stability, highlighting its promise for advanced energy storage applications.

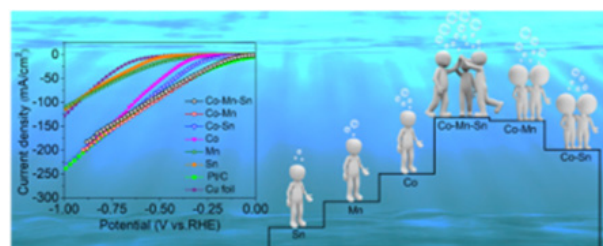


See: Eco-friendly synthesis of an α -Fe₂O₃/rGO nanocomposite and its application in high-performance asymmetric supercapacitors. Rahaman, S., Raza, A., Lone, A. R., Muaz, M., Zaidi, S. M. H., Adeb, M. A., Sama, F., Pandey, Kavita & Ahmad, A., *Physical Chemistry Chemical Physics*, 26, 16273-16286 (2024) doi:10.1039/D4CP00592A

Affiliations: Sabiar Rahaman, Adil Rashid Lone, Kavita Pandey (CeNS) and Azam Raza, Mohammad Muaz, SM Hasan Zaidi, Mohammad Asif Adeb, Farasha Sama, Absar Ahmad (Aligarh Muslim University -Aligarh)

Electrodeposited Co-Mn-Sn multicomponent alloy as an efficient electrocatalyst for hydrogen evolution reaction

CeNS researchers report the synthesis of a highly porous and fibrous nanostructured alloy of Co-Mn-Sn via a controlled electrodeposition process. This ternary Co-Mn-Sn alloy displayed enhanced activity with the lowest overpotential of 136 mV, a Tafel slope of 111 mV dec⁻¹, and a very low charge transfer resistance, making it superior to the binary alloys (Co-Mn and Co-Sn), or the single metal catalysts (Co, Mn and Sn). The ternary alloy also displayed high electrochemical and structural stability, making it a potential replacement for a conventional expensive Pt/C commercial catalyst for sustainable hydrogen.

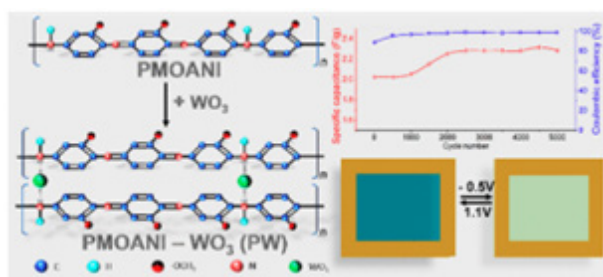


Co-Mn-Sn multi-component alloys were synthesized using an electrodeposition process and is efficient for hydrogen generation than the commercial one with higher stability.

See: Electrodeposited Co-Mn-Sn multicomponent alloy as an efficient electrocatalyst for hydrogen evolution reaction. M, Athira. C., Cherumannilkarumuthil, S., Singh, A. K., & Prasad, B. L. V., *International Journal of Hydrogen Energy*, 49, 658-667 (2024) doi:10.1016/j.ijhydene.2023.07.064

Affiliations: Athira Chandran M., Subash C.K., Ashutosh K. Singh and B. L.V. Prasad (CeNS)

Highly stable poly(o-methoxy aniline)/(o methoxy aniline)/WO₃ nanoflower composite-based electrochromic supercapacitors with real-time charge indication



Polymer-based electrochromic supercapacitors (ECSCs) have been developed that can visually convey stored energy status in real time. The electrochemical instability of the polymers utilized in such devices limits their practical application due to the difficulties in solution processability and short charge-discharge cyclic life. In this work, a simple and cost-effective chemical oxidative polymerization method was used to develop a highly



stable and electrochemically active nanocomposite poly (o-methoxy aniline) (PMOANI) and WO_3 nanoflowers. The multi-functionality of the nanocomposite is demonstrated by developing an ECS device, which shows an energy density of 370 mWh/kg and a power density of 4 W/kg with stable and prolonged charge-discharge cycles (>5000). Further, the ECS device is utilized to power a timer display (1.2 V) for >20 min using the energy stored in the charged state (blue color), which changes its color during discharge, demonstrating its capability as a power source with a real-time energy level indicator. It is expected that the polymer/metal oxide nanocomposite will certainly be a promising candidate to replace traditional polymers in ECS technologies to achieve prolonged stability for their application in modern electronic gadgets and infrastructures.

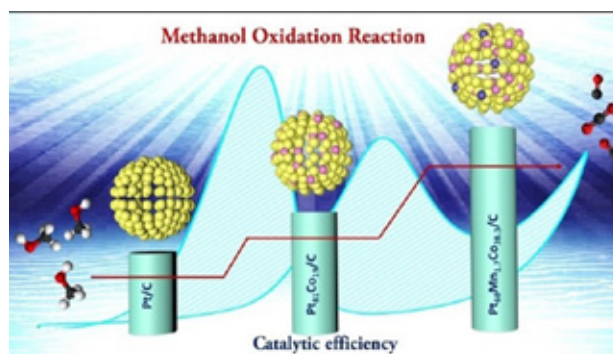
See: Highly stable Poly(o-methoxy aniline)/ WO_3 -nanoflower composite-based electrochromic supercapacitors with real-time charge indication. Dutta, P., Karumuthil, S. C., Roy, R., & Singh, A. K., ACS Applied Polymer Materials, 5, 4088-4099 (2023) doi:10.1021/acsapm.3c00311

Affiliations: Pritha Dutta, Subash C. K., Rahuldeb Roy and Ashutosh K. Singh (CeNS)

Alloying with Mn enhances the activity and durability of the CoPt catalyst toward the methanol oxidation reaction

Alloying Pt with other transition metals such as Ru, Co, Ni, and Fe is considered an effective approach to improve the catalytic performance and durability of Pt catalysts

used for the methanol oxidation reaction (MOR) in direct methanol fuel cells. In a recently published work, researchers from CeNS and CSIR-NCL, Pune successfully synthesized trimetallic $\text{Pt}_{100-x}(\text{MnCo})_x$ ($16 < x < 41$) catalysts. The electrocatalytic performance of the synthesized trimetallic catalysts was superior as compared to bimetallic PtCo alloys and commercially available Pt/C (comm. Pt/C) catalysts and they were more durable also.



Trimetallic PtMnCo catalysts with a composition of $\text{Pt}_{60}\text{Mn}_{1.7}\text{Co}_{38.3}$ displayed superior methanol oxidation reaction activity as well as better durability as compared to bimetallic PtCo alloy and commercially available Pt/C catalysts.

See: Alloying with Mn enhances the activity and durability of the CoPt Catalyst toward the Methanol Oxidation Reaction. Deshpande, P., & Prasad, B. L. V., ACS Applied Materials & Interfaces, 15, 26554-26562 (2023) doi:10.1021/acsami.3c01140

Affiliations: Pooja Deshpande (CSIR-NCL, Pune) and B.L. V. Prasad (CeNS).



6. Publications

The total number of publications in

Referred Journals	Conference Proceedings	Chapters in books
68	1	1

Average Impact Factor:

5.70

Details are provided in Annexure A

ACS Applied Electronic Materials	3
ACS Applied Energy Materials	2
ACS Applied Materials & Interface	5
ACS Applied Nano Materials	3
ACS Applied Polymer Materials	1
ACS Catalysis	1
ACS Materials Letters	1
ACS Sustainable Chemistry & Engineering	1
Advanced Materials Technologies	1
Asian Journal of Organic Chemistry	1
Cellulose	1
Chemical Communications	4
Chemistry - A European Journal	5
Chemistry of Materials	2
Chemistry - An Asian Journal	2
Chemistryselect	1
Crystal Research and Technology	1
Dalton Transactions	1
Dyes and Pigments	1
Giant	1
Inorganic Chemistry Communications	1
International Journal of Hydrogen Energy	4

Journal of Alloys and Compounds	1
Journal of Materials Chemistry A	1
Journal of Materials Chemistry C	3
Journal of Molecular Liquids	2
Journal of the American Chemical Society	1
Langmuir	1
Liquid Crystals	1
Materials Advances	1
Materials Chemistry and Physics	1
Materials Horizons	1
Molecules	1
Nanoscale	2
Particle & Particle Systems Characterization	1
Physica Scripta	1
Physical Review E	1
Small	1
Soft Materials	1
Soft Matter	3
Sustainable Energy & Fuels	1



7. Patents

Sl. No	Title	Inventors	Patent No. / Application No.	Filed/Granted
1	A composite of polymer network liquid crystals and hexagonal boron nitride; method and device thereof	D. S. Shankar Rao, H. S. S. Ramakrishna Matte, S. Krishna Prasad, Gayathri R. Pisharody & Priyabrata Sahoo.	IN202341034523 17/5/2023	Filed
2	Hybrid electrocatalyst of Nickel oxyhydroxide and metal nickelate for direct urea oxidation reaction	Neena S. John, Nikhil N. Rao, Alex C & Avani Anil Kumar	IN202341036166. 25/5/2023	Filed
3	A bendable piezoelectric soi-mosfet based touch sensor fabricated on an ultra-thin silicon diaphragm and a method of preparing the same	Arjun Hari M., Lintu Rajan, Soney Varghese, Subash C. K., Sabiha Sultana & Goutam P.	IN 202341039733 09/06/2023	Filed by NIT Calicut
4	A synaptic device and method of fabrication thereof	G.U. Kulkarni & Bharath B.	IN 202041032038 27.07.2020	Indian patent granted on 7/8/2023with Patent No. 443270
5	A strain sensor and method thereof	G.U. Kulkarni,K.D. Mallikharjuna Rao, K. Srivastava & Ritu Gupta	IN201641013578 PCT Application No.PCT/IB2017/052183	Indian Patent granted on 30/8/2023 with Patent No.448489
6	Ammonia Gas sensor	G. U. Kulkarni & Suman Kundu	IN202041057138 30/12/2020	Indian Patent granted on 4/9/2023 with Patent No.449351
7	A micro supercapacitor and Method Thereof	G.U.Kulkarni, Suman Kundu & Umesha Mogera	IN201841008669 9/3/2018	Indian Patent granted on 8/9/2023 with Patent No. 448489
8	Semiconductor junction for photo-generated electrons and method thereof	G. U. Kulkarni, Bharath B.,K.D.M. Rao & Harish K.N.	IN201741022128 23/6/2017	Indian Patent granted on 13/10/2023 with Patent No. 458931
9	A nanocomposite as piezo-electric energy generator and method thereof	Subhash C.K.,Ankur Verma & Arjun Hari M.	IN 202341071356 19/10/2023	Filed
10	Solar cell and method thereof	G.U.Kulkarni,Nikita Gupta & K.D.M. Rao	IN 201741003497 31/1/2017	Indian Patent granted on 29/11/2023 with Patent No. 474649
11	Electrochromic device and a method of fabrication thereof	Ashutosh K. Singh, Mukhesh K. Ganesha & Hafis H.	IN 202341083805 08/12/2023	Filed



Sl. No	Title	Inventors	Patent No. / Application No.	Filed/Granted
12	An electrochromic device, an anode, and processes thereof	G. U. Kulkarni, Ashutosh K. Singh, Ganesh Krishna, Mukhesh K.G., & Chirag S.	IN202341090016 29/12/2023	Filed
13	A synergistic mixture of water and isopropyl alcohol and application thereof	G. U. Kulkarni, K. D. M. Rao & Rajashekhar. N. Pujar	IN 201641012112 6/4/2016 PCT Application no: PCT/IB2017/051934	Indian Patent Granted on 28/12/2023 with Patent No.491237
14	A method for fabrication of liquid crystal device with unidirectional alignment of liquid crystals	S. Krishna Prasad, H.S.S.Ramakrishna Matte, D. S. Shankar Rao, Gayathri R. Pisharody & Priyabrata Sahoo	IN202141029054 29.06.2021	Indian Patent granted on 18/01/2024 Patent No.500901
15	Antimicrobial nanoformulation and synthesis method thereof	Neena S. John & Ramya Prabhu B.	IN202141025077 05/06/2021	Indian Patent granted on 23/01/2024 with Patent No. 502408
16	Metal and flexible polymer composite as radially self-expandable axially flexible tubular structure	G. Kumara Swamy, Prateek Jain, Nishant Kumar & B.L.V. Prasad	2463/DEL/2015	Indian Patent granted on 02/02/2024 with Patent No. 506643
17	A hybrid transparent conducting electrode and method thereof	G. U. Kulkarni, Indrajit Mondal & Ashutosh K. Singh	IN 202041016742 18/4/2020 PCT Application No.PCT/IB2021/052083filed on 12.03.2021	Indian Patent granted on16/2/2024 with Patent No.511707
18	A nematic liquid crystal composite with enhanced photoluminescence and method thereof	Geetha G. Nair, V. M. Vaisakh, A. S. Achal Kumar, Balaram Pradhan, & C. V. Yelamaggad	IN201741029031 16/8/2017	Indian Patent granted on 01/03/2024 with Patent No.518090
19	Exfoliation of Graphene: Composition and Method of Preparation	H.S.S. Ramakrishna Matte, Vijaya Kumar Gangaiah, Amit Kumar Gupta, Kenneth Lobo, Rashmi Chandrabhan Shende, Chandrani Pramanik & Mriganshu Guha	IN 202431023370 25/3/2024	Filed



DST media cell covered the following innovative findings from CeNS

New low-cost substrates can enhance sensitivity of analytical tools for detecting toxic pollutants

<https://dst.gov.in/new-low-cost-substrates-can-enhance-sensitivity-analytical-tools-detecting-toxic-pollutants>

<https://blog.forumias.com/surface-enhanced-raman-spectroscopy-sers-new-low-cost-substrates-can-enhance-sensitivity-of-analytical-tools-for-detecting-toxic-pollutant/>

A new photonic memory developed with multilevel capability for optoelectronic data storage applications

<https://dst.gov.in/new-photonic-memory-developed-multilevel-capability-optoelectronic-data-storage-applications>

<https://government.economictimes.indiatimes.com/news/technology/new-photonic-memory-developed-with-multilevel-capability-for-optoelectronic-data-storage-applications/100199455>

Scalable Novel polymeric metal-ligand could help develop robust, flexible Micro-supercapacitors

<https://dst.gov.in/scalable-novel-polymeric-metal-ligand-could-help-develop-robust-flexible-micro-supercapacitors>

Researchers develop a high-performance anode for next-generation lithium-ion batteries

<https://dst.gov.in/researchers-develop-high-performance-anode-next-generation-lithium-ion-batteries>

<https://timesofindia.indiatimes.com/city/bengaluru/researchers-build-high-performancedevice-for-next-gen-li-ion-batteries/articleshow/101378792.cms?from=mdr>

<https://www.thehindu.com/news/national/karnataka/cens-researchers-develop-high-capacity-anode-for-next-gen-lithium-ion-batteries/article67026928.ece>

Low-energy-consuming switchable smart windows developed based on novel architecture for confining liquid crystals

<https://dst.gov.in/low-energy-consuming-switchable-smart-windows-developed-based-novel-architecture-confining-liquid>

Newspaper

<https://government.economictimes.indiatimes.com/news/technology/low-energy-consuming-switchable-smart-windows-developed-using-novel-architecture-by-bengaluru-scientists/101751550#:~:text=2%20min%20read,Low%20energy%20consuming%20switchable%20smart%20windows%20developed%20using%20novel%20architecture,on%2Ddemand%20switchable%20smart%20windows.>

https://www.business-standard.com/india-news/prototype-for-low-energy-consuming-switchable-smart-windows-developed-123071300914_1.html

Cobalt- Platinum alloy spiced with manganese is an effective catalyst for methanol oxidation reaction of methanol fuel cells

<https://dst.gov.in/cobalt-platinum-alloy-spiced-manganese-effective-catalyst-methanol-oxidation-reaction-methanol-fuel>

Researchers synthesize highly crystalline pyrite at low temperatures useful for fabricating high energy density supercapacitors

<https://dst.gov.in/researchers-synthesize-highly-crystalline-pyrite-low-temperatures-useful-fabricating-high-energy>

<https://www.deccanherald.com/technology/synthesised-pyrite-promises-applications-in-supercapacitors-2716528#lnsf0hj371doev5k5ew>

<https://www.thehindubusinessline.com/business-tech/synthesised-pyrite-for-supercapacitors/article67423512.ece>

A new multi-component alloy-based catalyst designed for efficient production of Green Hydrogen

<https://dst.gov.in/new-multi-component-alloy-based-catalyst-designed-efficient-production-green-hydrogen>

<https://www.deccanherald.com/science/new-alloy-catalyst-for-producing-green-hydrogen-2750791>

A simple and elegant pathway to attain a soft tunable 3D photonic crystal with complete photonic band gap

<https://dst.gov.in/simple-and-elegant-pathway-attain-soft-tunable-3d-photonic-crystal-complete-photonic-band-gap>

<https://government.economictimes.indiatimes.com/news/technology/cens-bengaluru-researchers-unveil-simple-new-pathway-to-attain-soft-tunable-3d-photonic-crystal/106085060>



Tuning optical properties of liquid crystals with a type of photoactive organic molecule can give novel optical devices

<https://dst.gov.in/tuning-optical-properties-liquid-crystals-type-photoactive-organic-molecule-can-give-novel-optical>

Transforming ordinary glass windows into affordable energy-storing smart glass with adaptive transparency

<https://dst.gov.in/transforming-ordinary-glass-windows-affordable-energy-storing-smart-glass-adaptive-transparency>

<https://www.thehindu.com/sci-tech/technology/bengaluru-based-cens-researchers-develop-technology-to-transform-glass-windows-into-energy-storing-device/article67835351.ece>

<https://timesofindia.indiatimes.com/city/bengaluru/transparent-battery-for-smart-glass-bluru-experts/articleshow/107540184.cms>

New catalyst can facilitate urea-assisted water splitting - a new strategy for energy-efficient hydrogen production

<https://dst.gov.in/new-catalyst-can-facilitate-urea-assisted-water-splitting-new-strategy-energy-efficient-hydrogen>

<https://www.thehindubusinessline.com/business-tech/urea-assisted-h2-production/article67961529.ece>

<https://dst.gov.in/new-catalyst-can-facilitate-urea-assisted-water-splitting-new-strategy-energy-efficient-hydrogen>

8. Entrepreneurship and Sponsored/ Collaborative Research Projects

CeNS had interaction with various industries for technology-oriented projects.

- A joint project with Saint-Gobain Research India is ongoing for the design and development of Smart windows.
- CeNS operates technology-oriented projects with Tata Steel Pvt. Ltd. enabled by Tata Steel Advanced Material Research Centre (TSAMRC@CeNS).
- Scientific Research Programme between JNCASR, CeNS, ICMCB, CNRS, UBx, and Bordeaux INP
- CeNS signed a MoU with the Institute of Wood Science and Technology (IWST) for joint investigations
- CeNS signed a MoU with the Milman Thin Films Pvt. Ltd.
- MoU between CeNS, MAPL & CONCOR for the development and distribution of atmospheric water generators.
- CeNS established collaboration with Max Planck Institute for Solid State Research in Stuttgart, Germany; Virginia Commonwealth University (VCU), USA; DESY, Hamburg, Germany.
- Collaborations are established with IIT Kanpur, IACS, Kolkata, BMSIT&M, Yelahanka, Bengaluru, BMS College of Engineering, Bengaluru, and Southeast University, Nanjing, , IIT Guwahati, NIT Calicut, IISC Bangalore, Jain University Bangalore, JNCASR Bangalore, and Vidhyasagar University West Bengal



CeNS-Milman Thin Films Systems Pvt. Ltd.



CeNS-IWST



9. New Teaching Programs/Materials Developed

SESSION	COURSE TITLE	CREDIT
Aug	Research Methodology	4 credits
Aug	Research Publication and Ethics	2 credits
Aug	Composite materials	3 credits
Aug	Lab1: Advanced Materials Characterization	3 credits
Aug	Supramolecular Chemistry	3 credits
Jan	Basics of Nano and Soft Matter	2 credits
Jan	Advanced Organic Chemistry	2 credits
Jan	Energy Materials and Devices	3 credits
Jan	Lab2: Synthesis, characterization, and device studies of nano and soft materials	3 credits
Jan	Nanofabrication	3 credits
As per AcSIR guidelines	Societal Program	4 credits

10. Complete/Ongoing Projects during the year

A. Completed

Sl. No.	Title of the project and sanctioned number	Sponsoring agency	Duration (from to)	Budget Sanction (₹in lakhs, excl. GST)
1	Material methods and devices for Futuristic Technologies (MDFT-2023)-SERB	SERB	Jul2023 - Oct 2023	4
2	Effect of nanoparticles on the liquid crystal analogue of the abrikosov phase at atmospheric and elevated pressures	SERB	Jan 2020- Aug 2023	17.82
3	Development of Mxene-based highly sensitive photoelectrochemical biosenso	Ksteps - Govt of Karnataka	Jul2023 - Oct 2024	3.0
4	Role of molecular interactions in solution-processed layered pnictogens	SERB	Jan 2020-Aug 2023	20.35
5	Second meeting of support for upgradation, preventive repair, & maintenance of equipment(SUPREME)	DST	Nov 2023- Jan 2024	8.3
6	Development of 3D nanostructured systems for flexible energy storage devices	SIRE	Sep 2023- Mar 2024	17.2
7	Designing coatings for the aluminium fins to improve the water harvesting efficiency of AWG	MAPL	Mar 2022- Feb2024	6.75
8	Transparency switching glasses (Phase-3)	Saint Gobain India	Feb 2023 - Dec 2023	13.65



B. Ongoing

Sl. No.	Title of the project and sanctioned number	Sponsoring agency	Duration (from to)	Budget Sanction (₹in lakhs, excl. GST)
1	Rational design, synthesis, and characterization of optically active monomers and dimmer phases	SERB	Dec 2020-Apr 2024	30.27
2	Disordered and soft Systems: Recent trends (DSSR)		Mar2024 - May 2024	3.00
3	Perovskite single crystalline solar cells	IFCPAR/ CEFIPRA	Nov 2023- Nov 2025	5.09
4	Rechargeable aqueous zn-ion-battery	Tata Steel Ltd.	May 2024-May 2025	14.86
5	Tuning of active sites in transition metal oxides towards cost-effective and durable electrocatalysts for PEM water electrolyzers	Gail India Limited	Jun 2023- Jun 2025	38.26
6	Fabrication and detection of single photon sources using thin films and nanoparticles of zinc oxide and hexagonal boron nitride	DST	Nov 2023- Nov 2025	46.98
7	Scalable coating of metal oxides on hybrid transparent electrodes and fabrication of smart window devices	DST	Mar 2022- Mar 2025	102
8	The research collaboration agreement between CeNS and Saint Gobain India Pvt Ltd.	Saint Gobain India Pvt Ltd.	May 2023- May 2025	90.51
9	Direct synthesis of gram scale-infra-red emitting colloidal quantum dot inks	DST	Oct 2023-Oct 2025	47.64
10	Karnataka Science and Technology Promotion Society (KSTePS)	KSTePS - Govt of Karnataka	Feb 2023- Feb 2025	29.5
11	Indigenization of scalable synthetic methods of electro-catalyst and their applications for polymer electrolyte membrane fuel cells.	Gail India Limited	May 2023- Mar 2025	87.55
12	Graphene as nano-additive in lubricant oils with enhanced stability and tribological properties	Tata Steel Ltd.	Jun 2022- Mar 2025	22.97
13	Development and understanding of Multi-component Alloy M-PtCo (M=Mn, Ni) and M-CoMn (M=Sn, Pd) growth mechanism and their electrocatalytic activity	SERB	Jan 2023- Jan 2026	48.09
14	High-active and tolerant catalysts based on high valent Ni-oxide for urea electrolysis with suppression of overoxidation.	SERB	Jan 2023- Jan 2026	23.36
15	Flexible, ultra-lightweight self-charging wearable healthcare devices.	SERB	Jan 2023- Jan 2026	23.68
16	Fabrication of oxide heterostructures of hybrid spin valve-resistive switching memory devices for artificial intelligence	SERB	Jan 2023- Jan 2026	16.45



Sl. No.	Title of the project and sanctioned number	Sponsoring agency	Duration (from to)	Budget Sanction (₹in lakhs, excl. GST)
17	Novel high -power density micro-supercapacitors for powering internet of things	SERB	Aug 2023- Aug 2026	37.37
18	Development of electrochemical sensor for water contaminants in the North-Eastern region of India	DRDO	May 2023- May 2026	42.86
19	Development of a mechanistic picture of in-situ cation exchange to synthesize ternary chalcogenide nanocrystals.	SERB	Mar 2024- Mar 2027	43.03
20	Photo-assisted electrochromic smart window for all weather conditions: from fundamental aspects to building prototypes.	CEFIPRA	Feb 2024- Feb 2027	13.99
21	Solution processing of non-layered materials: Role of bonding anisotropy and its impact on dimensionality	SERB	Jan 2024- Jan 2027	56.84
22	Materials for wearable, self-powered energy-generating and pressure-sensing devices	DST- INSPIRE	Oct 2021- Oct 2026	112.22



11. New research facilities created/major equipment acquired

Sl. No.	New Facilities created
01	Electrochemical Workstations
02	A custom-made mechanical tapping machine with a dynamic force measurement unit for piezoelectric measurements.
03	MACRO-CH, UV-Vis-NIR macro cuvette cell holder, attachment for Horiba Xplora Confocal Raman Microscope for acquiring Raman spectra of liquids and colloids
04	In-situ spectro-electrochemical module as an attachment for Perkin Elmer FT-IR spectrometer for in-situ monitoring of a reaction

12. Outreach Programme

12.1 V4: विज्ञान-विद्यार्थिविचारविनिमय

The novel science outreach program V4 is aimed at students studying at the high school/+2 level to stimulate and nurture scientific curiosity in young minds. During the year 2020 to 2024, 3,614 students benefitted from this program.

Under this program, the visiting school children listen to an interesting lecture of general interest by CeNS faculty followed by hands-on experience of the scientific demonstrations an important component of the Centre's flourishing science outreach program. The V4 program is held outside CeNS as well.

Details are given in Annexure B





12.2 Research Outreach Initiative (ROI)

The ROI program provides first-hand experience in front-line research to highly motivated students pursuing a post-graduate course in Physics/Chemistry/Materials Science. The following students were involved in the internship program at CeNS.

Sl. No.	Name of ROI student	Name of the Parent Institute	Project title	Duration	Research Mentor
1	Gayathri S.	Amrita Vishwa Vidyapeetham, Kerala	Synthesis of Ni-coordinator complexes as electro-catalysts for Urea- assisted water electrolysis.	16-01-2024 to 28-05-2024	Dr.Neena S.John
2	Fuad Seneen K.	Department of Chemistry, University of Calicut, Kerala	Liquid Crystal trimers showing ES IPT	17-04-2023 to 03-07-2023	Dr.C.V.Yelamaggad
3	Thejas M. N.	Christ(Deemed to be University), Bengaluru	Synthesis and characterization of TiO ₂ B phase	01-05-2023 to 01-08-2023	Dr. H.S.S. Ramakrishna Matte
4	Shikha Agarwal	University of Lucknow	Study of Liquid Crystals	22-05-2023 to 21-07-2023	Dr. P. Viswanath
5	Abdul Basith	Delhi Technological University, Delhi	Synthesis and characterization of WO ₃	01-06-2023 to 04-08-2023	Dr. Ashutosh. K. Singh
6	Pooja Shetty	St. Aloysius College, Mangalore	Synthesis and Characterization of mesoporous based nanomaterials	08-06-2023 to 28-06-2023	Dr. Subash C. K.
7	Prajna	St.Aloysius College, Mangalore	Synthesis and Characterization of amine-functionalized mesoporous-based nanomaterials	08-06-2023 to 28-06-2023	Prof. B.L.V. Prasad
8	Shreya Rao	Manipal Academy of Higher Education, Manipal	Incorporation of inorganic nanomaterials in liquid crystals as a triboelectric layer	19-06-2023 to 15-09-2023	Dr. S.Krishna Prasad
9	Archana K.	Bangalore University, Bengaluru	Design, synthesis, and characterization of liquid crystals and drives from cholesterol	27-07-2023 to 25-01-2024	Dr. C.V. Yelamaggad
10	Sudeshna Sahoo	IIT, Guwahati	Medium and high entropy alloys as electrocatalysts for hydrogen and oxygen evolution reactions	14-08-2023 to 13-11-2023	Dr.Ashutosh K. Singh



13. Ph.D.& Technical training

Ph.D. Programme

The Centre is recognized by Mangalore University and Manipal Academy of Higher Education (MAHE) and AcSIR(Academy of Scientific and Innovative Research). The students who enroll for the Ph.D. programme at the Centre, obtain their degree awarded by Mangalore University/MAHE and AcSIR (Academy of Scientific and Innovative Research)

Sponsored Candidates

The Centre also encourages motivated candidates from recognized R&D organizations, academic institutions, and government organizations as well as from industries to join the Ph.D. programme at the Centre on a full-time basis. He / She must be a regular employee of the sponsoring organization and need not necessarily be qualified in any National Eligibility Test.

CeNS regularly invites applications for short-term Research Associate and R&D/ Technical/Project Assistant posts and also encourages visiting students from the various institutes through Summer Research Internships and by providing technical training.

Skill Development Program @CeNS (SDPC)

CeNS recently initiated the SDPC program to share scientific skills and capabilities to carry out meaningful science for the benefit of our country and contribute to social scientific responsibilities. To enhance the job opportunities for students with a science background, CeNS offers certificate courses to provide hands-on training in the effective uses of various sophisticated instruments such as 3D printers, electron microscopes, surface stylus profilometers, etc.

Ph.Ds. Produced

Name of the student	Ph. D awarded date
Rajalaxmi Sahoo	01/04/2023
Athira M.	04/04/2023
Varshini G. V.	15/04/2023
Amit Bhardwaj	25/05/2023
Trupthi Devaiah C.	30/05/2023
Kenneth Lobo	26/08/2023
Suchithra P.	21/02/2024
Swathi S. P.	12/03/2024



Research Associate

Benedict Christopher	Thulasi Radhakrishnan Nair
Marilyn Esclance Dmello (N-PDF)	Paresh Kumar Behera
Maruthapandian V.	Santosh Y. Khatavi
Mathew K.Francis	Vijaya Kumar
Neha Verma	

Senior Research Fellow

Abhishek Kumar	Nurjahan Khatun
Abhishek Roy	Palash Jyoti Gogoi
Arya K.	Pritha Dutta
Athira Chandran M	Priyabrata Sahoo
Gayathri R. Pisharody	Radha Jitendra Rathod
Himani	Ramesh Chandra Sahoo
Jil Rose Perutil	Rahul M.
Kaiffee Sayeed	Rahul Singh
Manish Verma	Rahuldeb Roy
Mouli Das	Rohit Thakur
Modasser Hossain	SabiarRahaman
Muhammed Safeer N. K.	Savithri Vishwanathan
Mukhesh K. G.	Vigneshraaj A. S.
Nikhil N. Rao	Vishnu G. Nath

Junior Research Fellow

Adil Rashi Lone	Harshit Pandey
Abhijit Paul	Irin Mary Joseph
Abhishek Thakur	Moram Veera Manikanta Tatayya Naidu
Amir Soheli	Muskan
Amaljith P.	Kavya Bodhi T. K.
Anusha D'Souza	Keya Mondal
Anand Eswara Rao Aryasomayajula	Kumar Shubham
Aparna R	Prakriti Mishra
Bhagyalakshmi K	Rohit Kumar Sharma
Dev Sankar Choudhuri	Rupam Ghosh
Fathima Shafna K K	Sourav Moyra
Ganesh Mahendra	ThejaSajan K T



Gauri Sharma	Ushita Roy
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Industry Sponsored PhD Students

Himani	Rahul M.
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R&D/Technical/Project Assistants

Ankur	Meghana S.
Anagha Mohan	Mithun N.
Anupama T. S. A.	Praveena R.
Archana K.	Rajaganesh S. S.
Alex C	Rajesh P.R.
Basharat Ramzan	Rajendra M.
Deeksha G .	Reetu K.
Deepali Shankar Shivade	Reshma C.
Deepak Kumar Tamudia	Dr. Rajalakshmi R
Fuad Seneen K	Siddarth Madichetti
Geethanjali	Sondip Deka
Hafiz Hakeem	Suchetana Manna
Harshitha R.	Sumana S.
Harshitha M.	Surya B.
Jaisas Jeny Prasly Chandran	Tathagata Bhattacharjya
S SInchal	Vaibhavi G.K.
Manjula P.	Varshini R.J.
Mayank Jaiswal	

Administration

S Deepak	Roopa N
Tharaknath K.	Indresh S
Venkatesh K.	Abhilash Ganesh Suryavamshi
Vathsala K.N.	Ramya Shree R
Girish C.	Ashitha K.P.
Shruthi S.K.	Akash V
Usha S.R.	Ranjita Bhat
Khanu	Jyothi U V
Dr. Archana M L V	Narayan M G



Visiting Students

Name	Affiliation	Period
Umasharan Sahu	CSIR-NCL, Pune	12.06.2023 - 12.07.2023
Deepraj Pandit	IIT, Palakkad	15.06.2023 - 30.06.2023
Abhijna B	MAHE	03.07.2023 - 02.01.2024
Sonali K	MAHE	12.12.2023 - 26.12.2023
Dr Rajashekhar Pujar	TSL, Jamshedpur	19.12.2023 - 31.07.2024
Biswajit Mohanty	MAHE	15.03.2024 - 15.06.2024
Pooja M	MAHE	19.02.2024 - 18.07.2024

14. Events at CeNS

Planting of 400 Saplings

On 25 April 2023, around 400 saplings were planted by Faculty, Researchers, Administrative staff and supporting staff of the Centre. The saplings, which



comprise trees and flowering plants, were planted throughout the Campus.

Special Health Scheme

On 25 April 2023, a Special Health Scheme was announced to benefit all the CeNSians. The Centre has entered into agreements with leading hospitals and Diagnostic Centres for better healthcare facilities at discounted rates

International Yoga Day

On the occasion of International Yoga Day -2023, on the theme of Vasudhaiva Kutumbakam, a lecture was organised on "Lifestyle disorder in modern lifestyle" by Mr Ramegowda B K, Medical Yoga Therapist,



followed by a demo session on different postures which are helpful for day-to-day lifestyles, especially for researchers who work for extended hours.

77th Independence Day Celebration @ CeNS

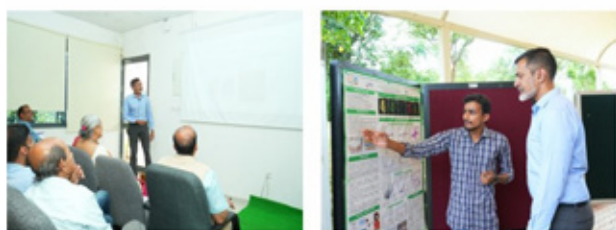
On the occasion of the 77th Independence Day, as a part of Amrit Mahotsav, CeNS planted around 75 saplings in the Government High School, Ravuthanahalli and conducted the Unveiling of Silaphalakam by Padma Shri Prof. K. N. Ganesh at Dasanapura Panchayat Office under the Campaign of "Meri Maati MeraDesh".





Founder's Day

The 16th Prof. S. Chandrasekhar Memorial Lecture was held on Aug 07, 2023. Prof. Vinodhan N. Manoharan, Wagner Family Professor of Chemical Engineering and Physics, Harvard University, Cambridge, USA delivered the lecture on "The self-assembly of simple RNA Viruses". In the talk, he discussed the self-assembly of a simpler, yet still interesting structure -- a single virus. The simplest viruses consist of RNA and coat proteins that form an icosahedral shell (called a capsid) that protects the RNA. These viruses were the first systems to be called "self-assembled," He also discussed various experimental results of his research work with a lively interaction /session.



Release of Coffee Table Book



Azadi Ka Amrit Mahotsav (AKAM) was initiated by Govt. of India to celebrate & commemorate 75 years of progressive Independent India. CeNS conducted 75 events starting from 12 March 2021 till the iconic event on 15 August 2022. To commemorate the achievement CeNS brought out the Coffee Table Book depicting the events that have been carried out. The Coffee table book was released by Padma Shri Prof. K N Ganesh on 5 September 2023.

MDFT (Materials Methods and Devices for Futuristic Technologies)

A conference programme and outreach event were organised at Karnataka State Higher Education Academy (KSHEA), Dharwad, between 29-30 September 2023. In this event, lecture sessions by eminent Scientists and poster presentations were organised.

Vigilance Awareness Week

Centre observed Vigilance Awareness Week from 30 October to 5 November 2023. Banners carrying information about the observation of the event and the contact details of the Centre's Vigilance Office were prominently displayed at the Centre. The special lecture was organised in association with RRI and the Indian Academy of Sciences. The lecture was on "Fall in Social Values and its Consequences" by N. Santosh Hegde, Retd. Judge, Supreme Court of India on 3 November 2023. The verbal pledging was held on 31 October 2023.



Rashtriya Ekta Diwas

Pledge for Rashtriya Ekta Diwas in observance of the birth anniversary of Sardar Vallabhbhai Patel was arranged on 31 October 2023.

Swachchtha Abhiyan 3.0

Department of Science and Technology launched the Special Campaign 3.0 (implementation phase) from 2 October to 31 October 2023 with special impetus on disposal of pendency, better space management and



making the environment and government infrastructures clean and green. Accordingly, CeNS conducted cleaning at its campus including the laboratory, corridor, office area, lawns, gardens, and walking path and as a part of the Swachchtha Abhiyan 3.0 pledge and mass cleaning was conducted on 31 October 2023.

Ayurvedic Medical Camp



CeNS organised an “Ayurvedic Medical Camp” to celebrate the 8th Ayurveda Day on November 9, 2023; Dr Annapoorna Bhat B.A.M.S, M.D., MSCP, D.Y.T., Medical practitioner and her team from Sampoonn Healthcare conducted the Medical Camp. Researchers, faculty & staff actively participated in the camp and benefited.

In-House Symposium

An in-house symposium was organised on 30 November and 1 December 2023. On the first day, the event began with Prof. B L V Prasad, (Director, CeNS) addressing the gathering. Followed by a Plenary talk on “v-gap engineering for enhancing the performance of 2D Materials for energy storage” by Prof. Vijayamohan Pillai, IISER Tirupati. As a part of the Symposium, the researchers Ms. Radha Rathod, Ms. Savithri Viswanathan and Mr. Modasser Hossain gave a presentation on their research topics. The lectures were followed by poster presentations by the researchers. The event was concluded with a lecture by Padmashri Shri Kiran Kumar, Former Chairman, of ISRO on the “Indian Space Programme” Shri Kiran Kumar shared his experience and insights into the

projects that were carried out during his tenure. The lecture was marked with lively interactive question & answers.



The second day started with a presentation by the faculty, Dr. Goutam Ghosh and Dr. Subash C K on their research topics followed by Flash Talks by researchers on select topics presented during poster session. The symposium ended with cultural event: an impressive performance by Ventriloquy Indushree Raveendra and a puppet show by Putthali Kalaranga headed by Shri Dattatreya Aralikatte on the act of Kumara Sambhava.

Sports Day

Sports day was organised on the second week of December 2023. The entire CeNS community participated in the various games like Chess, Carom, Shuttle Badminton, Cricket, Throw ball, Table tennis enthusiastically.



IISF 2023

The India International Science Festival (IISF), a collaborative endeavour between the Ministry of Science and Technology, the Ministry of Earth Sciences, the Department of Space and the Department of Atomic Energy in partnership with Vijnana Bharati - a science movement spearheaded by scientists of the nation with swadeshi spirit, was organised at DBT THSTI - RCB Campus NCR Biotech Science Cluster 3rd Milestone, Faridabad from 17 to 20 January 2024.



CeNS participated in the IIFS-2023, by showcasing its research highlights and demonstrable prototypes based on recent lab-level inventions. A large number of school students, parents, teachers, entrepreneurs and scientists visited CeNS stall. Prof. Abhay Karandikar, Secretary to Govt., DST paid a visit and appreciated CeNS research efforts. Other prominent visitors to the stall included Prof. G.U. Kulkarni President, JNCASR, scientists and officials from other DST institutions.

Republic Day



75th Republic Day was celebrated on 26th Jan 2024 with flag hoisting followed by a 5km Walkathon by CeNSians.

Navyadhara lecture series

Three lectures under Navyadhara series were organised during the academic year. First lecture of the series was by Prof. R. Vaidhyanathan, FRSC, IISER-Pune, who spoke on "Covalent Organic Frameworks and Metal Organic Frameworks- Demand, Promise and Challenges" The second lecture "The new (really old!) field of plasmonics" was given by Prof. Murali Sastry of Monash University, Australia. The series ended with the lecture on Nanoscale MOFs for Energy Harvesting,

Storage and Conversion by Prof. Tapas Kumar Maji, JNCASR.



National Science Day

The National Science Day was organised with a special V4 program with the theme "Indigenous Technologies for Viksit Bharat" to emphasise the importance of home grown innovations in India's scientific progress. The students from RNS PU College and Thiagarajan Central School participated in this program held on February 28. Prof. B L V Prasad and Prof. K A Suresh, formerly Director gave lectures on "Success in Scientific Research" & "Transformation to Viksit Bharat: What is our role" respectively. This was followed by science demonstrations & quizzes.



Women's Day celebration



On the occasion of International Women's Day held on 7 March 2024, a medical camp was organized for Women employees and families. Healthcare specialists on OBG & Oncology, General medicine,



Orthopaedic, Ophthalmology & ENT conducted medical check-ups. The event was supported by Ramaiah Memorial Hospital & Rotary Club. A Special lecture on “Astronomy from Ground & Space” by Prof. Annapurni Subramaniam, Director, IIA, Bengaluru, along with a special interactive session with women Scientists, researchers & admin staff heralded the event.

DSSR Conference

Disordered & Soft Systems: Recent Trends (DSSR) 2-day conference was organised on 27-28th Mar 2024 at CeNS. The sessions saw invited lectures on experimental and theoretical studies of soft and disordered systems, including liquid crystals, polymers, colloids, low-dimensional systems, nano-soft composites, and bio-related materials by



speakers from different institutes across the India. A session on student poster presentations was part of the conference. Dr D S Shankar who superannuated was honoured and felicitated during the conference.

15. Honours and Awards

Centre for Nano and Soft Matter Sciences appeared under the year-end review 2023 of the Department of Science and Technology for its key achievements. CeNS achievement in developing an affordable, energy-efficient smart window by employing metal mesh electrode, thin WO_3 film, and Al^{3+} electrolytes to create a revolutionary electrochromic energy storage (EES) device with high switching contrast, area capacitance, and long cycling life were highlighted.

Prof. B. L. V. Prasad, Director, CeNS have been elected as a Fellow of the National Academy of Sciences, India (NASI) for the year 2023, for his major contributions in the field of synthesis of metal nanoparticles and their assemblies and applications of soft and nano-materials.

Dr. C. V. Yelamaggad has been selected as Dr T M A Pai Endowment Chair in Advance Functional Materials. This is a prestigious academic appointment in Manipal Academy of Higher Education created in memory of the founder Dr. T M A Pai to promote excellence in teaching and research.

Dr. H. S. S. Ramakrishna Matte got elected as a Member of the National Academy of Sciences (NASI), India.

Dr. S. Krishna Prasad was honoured with Prof. Sivaramakrishna Chandrasekhar Memorial Lecture Award by the Indian Liquid Crystal Society in honour of his decades of academic accomplishments and

pioneering research contributions to the field of liquid crystals at the 30th National Conference on Liquid Crystals (NCLC-2023) held at Department of Physics, Andhra University, Visakhapatnam, 2- 4 November 2023



Prof. B. L. V. Prasad, Director, CeNS received the MRSI-CNR Rao Prize Lecture Award during the Annual General Meeting of MRSI at IIT(BHU) Varanasi during 12-15 December 2023.

Dr Neena S. John is honoured with the CRS Silver medal by Chiranthan Rasayan Sanstha for her excellent achievements in Research and Innovation, The award was presented during One-Day Symposium: Science beyond Boundary: Invention, Discovery, Innovation and Society “Rasayan 18” at Christ University, Bengaluru on 29-30 January 2024.



Dr. Neena S. John has been honoured with the IAAM Scientist Medal by International Association for Advanced Materials (IAAM), Sweden in recognition of her contribution to “Electrocatalysis” in August 2023.

Dr. Ashutosh K. Singh was selected as the best reviewer for the year 2022 by the Editorial Board, the Bulletin of Materials Science Journal.

Dr H. S. S. Ramakrishna Matte was selected under Scientific high-level visiting fellowships for the Short Research Trip to France (SRTF) programme organized by The French Institute in India (IFI) 2023.

Dr Kavita Pandey is selected to participate in Grand Challenges India, Biotechnology Industry Research Assistance Council (BIRAC), and Women Lift Health’s inaugural Women Leadership in STEM (WLS) cohort, a leadership development programme designed to elevate the power and influence of mid-career women in STEM fields in India by equipping them with essential tools, structured mentorship, coaching, peer support, and leadership skills for high impact.

Students Awards



Mr Nikhil N. Rao received a Poster presentation award for the poster titled “Direct mechanism of urea

electro-oxidation driven by resilient and CO_x poison tolerant active species generated on NdNiO₃” from Materials Horizons, Royal Society of Chemistry at MDFT - 2023, Dharwad, India, 29-30 September 2023.

Ms. Radha Rathod received the Best Oral Presentation award in In-house symposium at the Centre for Nano and Soft Matter Sciences organized from 30 November - 1 December 2023.

Mukhesh K. G. received the “Best Oral Presentation” award at the conference “Condensed Matter Physics and Application (CMPS-2023)” held at MAHE, Mangalore from 14-15 December 2023.

Pritha Dutta received the “Best Poster Presentation” award at the conference “International Conference on Functional Materials (ICFM-2024)” held at IIT Kharagpur from 9-11 January 2024.



Ms. Gayathri R. Pisharody won the best poster presentation award at “Disordered soft systems: Recent trends (DSSR)”, a conference organized by the Centre for Nano and Soft Matter Sciences (CeNS), Bangalore from 26 – 27 March 2024

Mr Priyabrata Sahoo Nominated for the LUM Young Scientist Award by LUM GmbH, Berlin, Germany (2024)



16. Reservation

The Centre follows the national policies on Reservation and Official Language as per the rules and orders issued by the Government of India from time to time. The Centre has one SC/ST employee working under Group C.

17. Official Language

Hindi Pakhwada

The Hindi Pakhwada was celebrated from 14 - 30 September 2023. Hindi Rajbhasha Committee organized various programs such as Kavita Smaran, Hindi compositions, Tongue Twister, Music Competition, quick sentence formation, essay, and seminars. The members of the Centre enthusiastically participated in the competition.

18. Miscellaneous

18.1 In-House Colloquia / Seminars

Research Fellows

Thesis Colloquia

Title	Speaker	Date
Metal oxide-based resistive memory devices for multifunctional applications	Swathi S. P.	07.06.2023
Investigations of two-dimensional materials for electrochemical applications	Ramesh Chandra Sahoo	07.09.2023
Nanostructure- assisted blue phase liquid crystals for photonic and electro-optic application	Nurjahan Khatun	25.09.2023
Solutions processing of layered materials and their applications	Priyabrata Sahoo	27.09.2023
Transition metal oxide-based materials for electrocatalytic energy conversion.	Muhammed Safeer N. K.	18.10.2023
Synergistic influence of soft-nano mesophases formed by incorporated nanostructures	Gayathri R.Pisharody	18.01.2024

Thematic Seminars

Title	Speaker	Date
Acoustic metamaterials: near-perfect sound absorbers	Nurjahan Khatun	28.04.2023
Combating cancer with 2D materials	Priyabrata Sahoo	12.05.2023
Molecular transport through capillaries: fabrication, characterization, and applications.	Ramesh Chandra Sahoo	09.06.2023
Water desalination by capacitive deionisation	Savithri Vishwanathan	06.10.2023
Transferring chirality from ligands to nanocrystals	Radha Jitendra Rathod	02.02.2024
Artificial intelligence for materials science	Modasser Hossian	09.02.2024



Journal Article-Based Seminar

Title	Speaker	Date
Thermodynamics of organic electrochemical transistors	Rohit Thakur	21.04.2023
Humidity-tolerant moisture-driven energy generator with mxene aerogel-Organohydrogel Bilayer.	Pritha Dutta	21.04.2023
Large piezoelectric response in a Jahn-Teller distorted molecular metal halide	Rahuldeb Roy	19.05.2023
Potential-driven restructuring of Cu Single atoms to nanoparticles for boosting the electrochemical reduction of nitrate to ammonia	Kaifee Sayeed	19.05.2023
Natural sunlight photocatalytic synthesis of benzoxazole-bridged covalent organic framework for photocatalysis	Abhishek Kumar	26.05.2023
Recycling urine for bio electrochemical hydrogen production using a MoS ₂ nano carbon coated electrode in a microbial electrolysis cell	Vigneshraaj A.S.	26 .05.2023
A general strategy for synthesizing biomacromolecular ionogel membranes via solvent-induced self-assembly	Manish Verma	02.06.2023
Synthesis of stable single-crystalline carbon dioxide clathrate powder by pressure swing crystallization	Palash Jyoti Gogoi	23.06.2023
Multi-functional graphene/leather for versatile wearable electronics	Arya K.	30.06.2023
Synthesis of liquid gallium at reduced graphene oxide core-shell nanoparticles with enhanced photoacoustic and photothermal performance	Abhishek Roy	30.06.2023
Oxygen-deficient tungsten oxide (WO _x) nanobelts with pH-sensitive degradation for enhanced sonodynamic therapy of cancer	Nikhil N. Rao	07.07.2023
Dual-mode porous polymeric films with coral-like hierarchical structure for all-day radiative cooling and heating	Jil Rose Perutil	14.07.2023
Broadband acoustoelectric conversion based on oriented polyacrylonitrile nanofibers and slit electrodes for generating power from airborne noise	Rahul M.	21.07.2023
Selective transport of water molecules through interlayer spaces in graphite	Sabiar Rahaman	28.07.2023
An adaptive multispectral mechano-optical system for multipurpose applications	Vishnu G. Nath	04.08.2023
Grooved electrodes for high-power-density fuel cells	Athira Chandran M.	11.08.2023
Taming the dichalcogenides: Isolation, characterization, and reactivity of elusive per selenide, persulfide, thioselenide, and selenosulfide anions	Mouli Das	11.08.2023
Versatile CO ₂ responsive sponges decorated with ZIF 8 for bidirectional separation of oil/water and controllable removal of dyes	Himani	18.08.2023
Unraveling the liquid gliding on vibrating solid-liquid interfaces with dynamic nano slip enactment	Moram Veera ManikantaTatayya Naidu	15.12.2023
Construction of angstrom-scale ion channels with versatile pore configurations and sizes by metal-organic frameworks	Dev Sankar Choudhuri	05.01.2024
Porous NiMoO ₄ nanosheet films and a device with ultra-large optical modulation for electrochromic energy-storage applications	Ganesh Mahendra	19.01.2024
De Novo green fluorescent protein chromophore-based probes for capturing latent fingerprints using a portable system	Harshit Pandey	01.03.2024
Laser-guided lightning	Aryasomayajula Anand Eswar Rao	15.03.2024



18.2 Colloquia/ Seminars by visitors

Scientific talks

Sl. No	Title of the Talk	Name of the Speaker	Affiliation	On Occasion	Date
1	Differentiating conformationally distinct alzheimer's amyloid- β oligomers using liquid crystals	Dr. Santanu Kumar Pal	IISER, Mohali	Invited talk	18.05. 2023
2	Nanocrystalline diamond for energy harvesting	Dr. Kalpataru Panda	Dept. Physics, Technische Universität Ilmenau, Germany	Special lecture	08.06.2023
3	Hydrogen production: H ₂ O vs H ₂ S Electrolysis-better for tomorrow?	Dr. Tharamani C. Nagaiah	Dept. of Chemistry, IIT Ropar	Special lecture	08.06.2023
4	Towards electro-tunable nanophotonic smart windows	Dr. Debabrata Sikdar	Dept. of Electronics and Electrical Engineering, IIT, Guwahati	Special lecture	04.07.2023
5	Vanadium dioxide: synthesis to applications	Dr. Amit Verma	IIT,Kanpur	Special lecture	06.07.2023
6	The self-assembly of simple RNA Viruses	Prof. Vinothan Manoharan	Harvard University, USA	Founders Day	07.08.2023
7	Self-healing in Hybrid Halide Perovskite Photovoltaic Devices	Prof. Shaibal K. Sarkar,	Department of Energy Science & Engineering, IIT-Bombay	Special lecture	01.09.2023
8	Renewables for sustainability: advanced functional nanomaterials from plant metabolites	Prof. Braja Gopal Bag	Vidyasagar University, West Bengal	Special lecture	13.10.2023
9	Direction-dependent dynamics in 2d colloidal fluids and the role of pinning in colloidal epitaxy	Prof. Chandan Mishra	IIT, Gandhinagar	Special lecture	13 .12.2023
10	Atomic-scale processing using selective atomic layer deposition and etching	Prof. Adrie Mackus	Eindhoven University of Technology, Eindhoven, The Netherlands	Special lecture	26.12.2023

Navyadhara lecture series

Title of the Talk	Name of the Speaker	Affiliation	Date
Covalent organic frameworks and metal-organic frameworks- demand, promise and challenges	Prof. R. Vaidhyanathan FRSC	IISER-Pune	28.06. 2023
The new (really old!) field of plasmonics	Prof. Murali Sastry	Monash University, Australia	27.12. 2023
Nanoscale MOFs for energy harvesting, storage, and conversion	Prof. Tapas Kumar Maji	JNCASR-Bengaluru	25 .01.2024



18.3 Other Events

Awareness talks

Title of the Talk	Name of the Speaker	On Occasion	Date
Vasudhaiva Kutumbakam	Mr. Ramegowda B K, Medical Yoga Therapist	International Yoga Day	21.06.2023
Ayurvedic Camp	Dr. Annapoorna Bhat, Sampooran Healthcare	8th Ayurveda Day	09.11.2023
An Introduction to ACS	Mr. Rajesh Parishwad, Senior Associate Director, ACS	Special lecture	08.06.2023
Blood donation camp	Rotary Bangalore Cubbon Park		16.02.2024
Materials Science, Physics, Chemistry at Wiley: Journal trends & editorial insights	Dr. Sujeet Dutta, Deputy Editor, Physical Sciences, Wiley APAC-LLP	Special lecture	27.02.2024
Self-healing in Hybrid Halide Perovskite Photovoltaic Devices	Prof. Shaibal K. Sarkar,	Special lecture	01.09.2023
Renewables for sustainability: advanced functional nanomaterials from plant metabolites	Prof. Braja Gopal Bag	Special lecture	13.10.2023
Direction-dependent dynamics in 2d colloidal fluids and the role of pinning in colloidal epitaxy	Prof. Chandan Mishra	Special lecture	13.12.2023
Atomic-scale processing using selective atomic layer deposition and etching	Prof. Adrie Mackus	Special lecture	26.12.2023
Astronomy from ground and space	Prof. Annapurni Subramaniam, Director	Women's day	08.03.2024

Conference/symposia/seminars/workshops organized

CeNS organized Materials, Methods & Devices for Futuristic Technologies (MDFT-2024) at KSHEA Hubli/Dharwad on 29 September to 1 October 2023 in collaboration with JNCASR and IIT Delhi

Prof. B L V Prasad conducted a workshop entitled "Emerging Trends in Materials Sciences" at NIT-Warangal Telangana on 7 October 2023.

Prof. B L V Prasad organized the workshop "Physics, Chemistry, and Materials Science: Emerging Trends" sponsored by Indian Science Academies at PB Siddhardha College Vijayawada on the 20 and 21 of March 2024.

Prof. B L V Prasad (Convener) and Dr. S Krishna Prasad, (Co-Convenor) organized a two-day conference titled "Disordered and Soft Systems: Recent Trends" (DSSR Conference) held at the Centre for Nano and Soft Matter Sciences on 27 and 28 March 2024.



18.4 Faculty Visits

Prof. B. L. V. Prasad

Place and period of visit	Purpose of visit	Title of the talk
JSS Science and Technology University, Mysore 4 April 2023	SATHI Site Visit	
Expert Committee Meeting 4-6 April JNCASR	SATHI	
International Advisory Committee FCASI-2023 at the University of Rajasthan, Jaipur April 20-21, 2023	Lecture	
NEHU, Shillong 26-28 April, 2023	SERB- SIRE Meeting	
SATHI, Guwahati 3 May 2023	Site visit	
Tata Steel Jamshedpur 11 May 2023	Material NEXT Competition	
IIT- Kanpur 3-4 July 2023	Guest- Honor for the Convocation of Material Science program	
TIFR, Hyderabad 5 July 2023	Talk	Designing retrosynthetic strategies for the preparation of metal, metal sulfide, and bimetallic sulfide nanocrystals
National Institute of Technology, Tiruchirappalli, Tamil Nadu. 30 July 2023	SATHI Site Visit	
IIT, Hyderabad 1-3 August 2023	SERB-NPDF, Review Meeting	
NIT-Warangal 7 October 2023.	Conducted workshop	Emerging Trends in Materials Sciences
SAIS Symposium 1- 2March 2024		
Indian Science Academies at PB Siddhardha College- Vijayawada 20 -21 March 2024.	Organized workshop	Physics, Chemistry, and Materials Science: Emerging Trends
Centre for Nano and Soft Matter Sciences 27-28 March 2024	Organized two-day conference	Disordered and Soft Systems: Recent Trends

Dr. D S Shankar Rao

Place and period of visit	Purpose of visit	Title of the talk
Department of Physics, Andhra University. Visakhapatnam 02- 04 November 2023.	Invited talk at 30 National Conference on Liquid Crystals (NCLC-2023) held at the Dept. of Physics, Andhra University, Visakhapatnam	Influence of sample thickness on sol-gel transition and morphology of a hierarchical network of nematic gel and a superimposed photopolymer



Dr. C.V. Yelamaggad

Place and period of visit	Purpose of visit	Title of the talk
Department of Chemistry MAHE, Manipal 08 April 2023	Invited Talk	Hybrid functional materials: design, synthesis and characterization
Bangalore Institute of Technology, Bangalore 19 May 2023	International Conference on Advanced Materials for Engineering and Management Applications	Functional hybrid materials for energy and invisibility
JNCASR, Bengaluru 23 May 2023	Presented a lecture Project Oriented Chemistry Education(POCE) Unique states of matter	Liquid Crystals: Life, science, and fundamentals
JNCASR, Bengaluru 29 May 2023	Presented a lecture Project Oriented Chemistry Education(POCE)	Liquid crystals: science and technology
KLE Technological University Institute, Hubli 10 August 2023	Invited Lecture	Research methodology and IPR aspects
H. S. Kotambri Science Institute Hubli 11 August 2023	Invited Lecture	How can one be invisible
P. C. Jabin Science College Hubli 11 August 2023	Invited Lecture	Research ethics
Department of Chemistry, University of York 20 October 2023	Invited Lecture	Soft-nanocomposites exhibiting mesomorphism, plasmon resonance, and ENZ property
KLS Gogte Institute of Technology, Belagavi. 19 January 2024	Invited Lecture Symposium on Nanotechnology: applications, challenges and prospects	Soft-nano composites for fundamental science and advanced applications
Vijayanagara Sri Krishnadevaraya University, Bellary 22 February 2024	Invited Lecture One-Day Symposium	Recent trends in spectroscopy and applications
Sri Vijayanagara Sri Krishnadevaraya University, Bellary 22 February 2024	One-day symposium Recent trends in spectroscopy and its applications	UV-Vis and IR spectroscopic techniques for structural Elucidation of organic compounds
Dayananda Sagar College of Engineering, Bengaluru 23 February 2024	Invited Lecture FDP program recent innovations in green and sustainable energy	Liquid crystals decorated gold nanoparticles: synthesis and characterization
BGS National Public School Hulimavu 28 February 2024	Invited Lecture National Science Celebration	Liquid Crystals: Life, Science, and Technology
MAHE, Manipal 29 February 2024	International conference on nanoscience and nanotechnology	Soft nano composites: synthesis and characterization
Mount Carmel College, Bengaluru 01 March 2024	Invited Lecture National Conference on "Advances in material sciences and applications"	How Can Objects be Invisible
CeNS 28 March 2024	Invited talk Disordered and soft systems: recent trends	Stereospecific synthesis of dipeptides with high enantiomeric excess and their self-assembly into ferroelectrically switchable columnar structure



Dr. Angappane S

Place and period of visit	Purpose of visit	Title of the talk
Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR). 7-9 December 2023	Attended the Conference on Recent Advances in Materials (RAM-90)	--
Ravenshaw University, Cuttack 18 December 2023	E PhD viva-voce Examiner	--
SJB Institute of Technology, Bangalore 18 March 2024	Invited talk Workshop on The recent advances in display technology, sensors and computation	Recent advances in gas sensors

Dr. Neena S. John

Place and period of visit	Purpose of visit	Title of the talk
Stockholm, Sweden 28 - 31 August 2023	55th Assembly of advanced materials congress, Baltic Conference Series organized by the International Association for Advanced Materials (IAAM)	Electrocatalysts for energy-efficient hydrogen generation from urea electrolysis
Karnataka Higher Education Academy, Dharwad, Karnataka 29-30 September 2023	Materials, methods, and futuristic technologies	Probing the active sites of metal ions in electrocatalytic reactions
Centre for Manufacturing Technology, Bengaluru 15 March 2024	International Women's Day Role of Women in Science, Technology, and Society conducted on the occasion	Engineering Materials for Applications

Dr. H S S Ramakrishna Matte

Place and period of visit	Purpose of visit	Title of the talk
SDM College, Dharamasthala 06 June 2023	Talk at as part of INYAS outreach activity	Basics of Electrochemical Energy Storage Systems
University of Manchester, UK 27 June 2023	Graphene 2023, University of Manchester, United Kingdom, 27-30 June 2023	
ARCI Hyderabad, 17-18 August 2023	Invited lecture on electrochemical sensors organized by ECSI	Enhancing the performance of electrochemical devices through materials engineering
IIT-ISM Dhanbad 15-17 September 2023	Attended Mid-Year Meeting of INYAS	-
Mangalore University 21-23 September 2023	Invited talk ICPN-2023	Solution-processed layered materials and their applications
IIT Guwahati 29 November-1 December 2023	Invited talk ICANN-2023	Solution processing of low-dimensional materials and their applications



Place and period of visit	Purpose of visit	Title of the talk
BARC Mumbai 3-6 December 2023	Attended AGM of NASI,	Solution processing of low-dimensional materials and their applications
The Lalit Ashoka, Bengaluru 20-23 November 2023	Invited talk at Recent Progress in Graphene and two-dimensional Materials RPGR-2023	Solution processing of low-dimensional materials and their applications
JNCASR Bengaluru, 7-9 December 2023	Invited talk at RAM-90	Solution processing of low-dimensional materials and their applications
IIT Chennai 18-20 December 2023	Invited talk at ComFlu-2023	Solution processing of low-dimensional materials and their applications
INSA-New Delhi 16-18 February 2024	INYS-INSA GBM	-
BMS Institute of Technology & Management, Bengaluru 11 March 2024	Invited talk Faculty development program on Innovations in Material Science and Analytical Techniques	Solution processing of inorganic materials and their applications

Dr. Ashutosh K. Singh

Place and period of visit	Purpose of visit	Title of the talk
Dept. of Physics, IIT Kanpur 30 June 2023	Invited Lecture	Effort towards the development of affordable and energy-efficient smart windows
Dept. of Physics, Acharya Institute of Graduate Studies, Bangalore 3 July 2023	Invited Lecture	Alternatives to conventional glass windows
Gothenburg Sweden 8-14 October 2023	Attending Conference Electrochemical Society Meeting -2023" at	Powering smart windows: unveiling crystal structure and al-ion storage correlation in wo_3 electrode via XRD for aqueous al-ion battery with real-time energy-level indication
MAHE, Manipal 14 December 2023	Attending conference CMPA-2023 conference	Energy-efficient smart windows
IIT, Kharagpur 11 January 2024	Attending conference ICFM 2024	Energy-efficient electrochromic smart window

Dr. Kavita Pandey

Place and period of visit	Purpose of visit	Title of the talk
University of Cambridge, UK 24 April - 28 May 2024	Collaborative work	



Dr. Subash C K

Place and period of visit	Purpose of visit	Title of the talk
SIAS Research Forum and PSMO College, Tirurangadi, Kerala (Online event) 26 April - 01 May 2023	Webinar as part of the Hands-on Training on Elemental Analysis	Scanning electron microscopy and elemental analysis techniques for material characterization
In-House Symposium 01 December 2023	Invited Talk	Polymer nanocomposites for pressure sensing and energy harvesting applications
DBT THSTI - RCB Campus NCR Biotech Science Cluster 3rd Milestone, Faridabad 17-20 January 2024	9th edition of the India International Science Festival (IISF 2023),	Exhibition (Prototype demonstration)

Dr. Goutam Ghosh

Place and period of visit	Purpose of visit	Title of the talk
INST, Mohali 05 -08 November 2023	Conference	Controlling nano- and secondary structures of self-assembled peptide
In-House Symposium 01 December.2023	Invited talk	Controlled supramolecular polymerization of π -systems and peptides through pathway complexity
IIT Guwahati 10 -13 December 23	Conference	Control over nano- and secondary structures in peptide self-assembly
Mahatma Gandhi University 12- 14 January 24	Conference	Controlled supramolecular polymerization of π -systems and peptides through pathway complexity

Dr. S Krishna Prasad

Place and period of visit	Purpose of visit	Title of the talk
Department of Physics, Andhra University. Visakhapatnam 2-4 November 2023.	Chandrasekhar Memorial Talk at the 30th National Conference on Liquid Crystals (NCLC-2023) held at Department of Physics, Andhra University, Visakhapatnam.	Influence of sample thickness on sol-gel transition and morphology of a hierarchical network of nematic gel and a superimposed photopolymer
CeNS 27 Mar 2024	Invited talk Disordered and soft systems: Recent trends	Behaviour of liquid crystal and plastic phases in confined geometries

Dr. Geetha G Nair

Place and period of visit	Purpose of visit	Title of the talk
European Synchrotron Radiation Facility (ESRF), Grenoble, France, 9-12 June 2023	To carry out Synchrotron Ultra-small angle X-ray diffraction experiments at ID02, ESRF	Effect of chirality on the structural and topological features of quantum dot-doped blue phase liquid crystal (SC-5393)



18.5 Scientists/Academic Visitors to CeNS

Sl. No.	Name & Affiliation	Within the country/abroad	Purpose of Visit	Duration of visit
1	Mr. Deepraj Pandit, IIT Palakkad	India	Research Collaboration	15.06.2023 to 30.06.2023
2	Dr. Debabrata Sikdar, IIT Guwahati	India	Research Collaboration	04.07.2023
3	Dr. Amit Verma, IIT Kanpur	India	Research Collaboration	06.07.2023
4	Dr. Chandan K. Mishra, IIT Gandhinagar	India	Research Collaboration	13.12.2023
5	Prof. Braja Gopal Bag, Vidyasagar University, India	India	Collaboration	05.10.2023 to 20.10.2023

18.6 Academic activities by research students and postdoctoral fellows

Sl. No.	Date	Name & Designation	Name of Conference attended	Mode of Presentation and Title
1	12.04.2023	Priyabrata Sahoo SRF	Manipal Research Colloquium (MRC), Manipal Academy of Higher Education, Manipal,	Poster Presentation Solution processing of layered materials and their applications
2	12.04.2023	Savithri Vishwanathan SRF	Manipal Research Colloquium (MRC), Manipal Academy of Higher Education, Manipal,	Poster Presentation Strategies to enhance the fast-charging performance of conversion anodes for lithium-ion batteries
3	25.04.2023	Priyabrata Sahoo SRF	“Advances in Polymer Materials (APM)”, G.B.Pant University of Agriculture & Technology, Pantnagar,	Poster Presentation Nanomechanical study of aqueous-processed-bn reinforced pva composites
4	26-30.06.2023	Swathi S.P. SRF	International Conference on Materials for Advanced Technologies (ICMAT) Singapore	Oral presentation Tailoring the multilevel resistive switching characteristics of hafnium oxide-based memory devices by differential work function engineering
5	27.06.2023	Priyabrata Sahoo SRF	Graphene 2023, University of Manchester, United Kingdom,	Poster Presentation Understanding the role of the molecular structure of the solvents in liquid phase exfoliation of 2D materials
6	5-7.07.2023	Swathi S.P. SRF	Nano Korea 2023 at Kintex, Seoul, South Korea	Oral presentation, Tin oxide nanorod array-based photonic memristor with multiple resistance states driven by optoelectronic stimuli
7	2-5.08.2023	Muhammed Safer N. K. SRF	Materials Today conference, Singapore.	Poster presentation Importance of high valent nickel for sustainable electrochemical urea oxidation
8	27.08.2023	Ramesh Chandra Sahoo SRF	Graphene 2023, University of Manchester, United Kingdom	Poster Presentation Enhanced charge storage capacity and high rate capabilities of Ni ₂ Co layered double hydroxides/expanded graphite composites as an anode for Li-ion batteries



Sl. No.	Date	Name & Designation	Name of Conference attended	Mode of Presentation and Title
9	27.08.2023	Savithri Vishwanathan SRF	Graphene 2023, University of Manchester, United Kingdom	Poster Presentation Strategies to enhance the fast-charging performance of conversion anodes for lithium-ion batteries
10	22-26.09.2023	Nikhil N Rao SRF	Performed in-situ XAS measurements at DESY beamline, Hamburg, Germany, supported by the India-DESY programme	
11	22-26.09.2023	Muhammed Safeer N K. SRF	Performed in-situ XAS measurements at DESY beamline, Hamburg, Germany, supported by the India-DESY programme	
12	29.09-01.10.2023	Mukhesh K.G. SRF	Materials, Methods and Devices for Futuristic Technologies (MDFT-2023) Karnataka State Higher Education Academy (KSHEA), Dharwad	Poster presentation Affordable smart windows with dual-functionality: electrochromic color switching and charge storage
13	29.09-01.10.2023	Vishnu G. Nath SRF	Materials, Methods and Devices for Futuristic Technologies (MDFT-2023), Karnataka State Higher Education Academy (KSHEA), Dharwad	Poster presentation, High-performance NO _x sensor based on ZnFe ₂ O ₄ in mixed spinel structure: a paradigm for developing a ultrasensitive and selective room temperature gas sensor.
14	29.09-01.10.2023	Pritha Dutta SRF	Materials, Methods and Devices for Futuristic Technologies (MDFT-2023) Karnataka State Higher Education Academy (KSHEA), Dharwad	Poster presentation Highly-stable poly(o-methoxyaniline)/wo ₃ -nanoflower composite-based electrochromic supercapacitors with real-time charge indication
15	29.09-01.10.2023	Athira Chandran M SRF	Materials, Methods and Devices for Futuristic Technologies (MDFT-2023) Karnataka State Higher Education Academy (KSHEA), Dharwad	Poster presentation Electrodeposited Co-Mn-Sn multicomponent alloy as an efficient electrocatalyst for hydrogen evolution reaction Supercapacitors with Real-Time Charge Indication
16	29.09-01.10.2023	Rahuldeb Roy SRF	Recent progress in Graphene and 2D Materials Research (RPGR-2023), IISC Bengaluru	Poster presentation Interlayer Water of Tungsten Oxide Unlocks the Jahn-Teller Distortion to Boost the Performance of Aqueous Electrochromic Battery
17	9-10.10.2023	Abhishek Kumar	Science Beyond Boundary: Invention, Discovery, Innovation and Society (Rasayan 17) held at Jain University, Bangalore	Attended
18	02-04.11.2023	Abhishek Kumar	30th National Conference on Liquid Crystals (NCLC-2023) held at Andhra University at Visakhapatnam	Poster presentation Highly frustrated twist grain boundary phase of liquid crystal A-B-A type trimers exhibiting ESIPT dual-fluorescence: The first examples
19	02-04.11.2023	Moram Veera Manikanta Tatayya Naidu JRF	30th National conference on liquid crystals (NCLC-2023) held at Andhra University at Visakhapatnam	Poster presentation-Influence of pH on the phase behaviour of cholesteric acid at the interfaces



Sl. No.	Date	Name & Designation	Name of Conference attended	Mode of Presentation and Title
20	02-04.11.2023	Gayathri R.Pisharody	30th National Conference on Liquid Crystals (NCLC-2023) held at Andhra University at Visakhapatnam	Poster presentation Remarkable IR regulation through preferential placement of h-BN nanosheets in a polymer network liquid crystal
21	02-04.11.2023	Jaisas Jeni Chandran	30th National Conference on Liquid Crystals (NCLC-2023) held at Andhra University at Visakhapatnam	Poster presentation Liquid crystals as green energy harvesters: Orientation-controlled aspects
22	02-04.11.2023	S. Sumana	30th National Conference on Liquid Crystals (NCLC-2023) held at Andhra University at Visakhapatnam	Oral presentation Hydrophobic interactions: a basis for elation of functionalized silica nanoparticle/nematic composites
23	02-04.11.2023	A. Anand Eswara Rao JRF	30th National Conference on Liquid Crystals (NCLC-2023) held at Andhra University at Visakhapatnam	Poster presentation, Surface patterning of gold using colloidal lithography approach for refractive index sensing
24	20-23.11.2023	Pritha Dutta SRF	Recent progress in Graphene and 2D Materials Research (RPGR-2023) at IISc, Bengaluru	Poster presentation- Highly-Stable Poly(o-methoxyaniline)/WO ₃ -nanoflower composite-based electrochromic supercapacitors with real-time charge indication
25	20-23.11.2023	Rahuldeb Roy SRF	Materials, Methods and Devices for Futuristic Technologies (MDFT-2023)	Poster presentation-Interlayer Water of Tungsten Oxide unlocks the jahn-teller distortion to boost the performance of aqueous electrochromic battery
26	20-23.11. 2023	Rohit Thakur SRF	Recent Progress in Graphene and 2D Materials Research, IISc, Bengaluru	Poster Presentation Solution-processed 2D materials on paper substrates for photodetection and photomechanical applications
27	30.11.2023	Rohit Thakur SRF	In-House-Symposium (IHS 2023), CeNS	Poster Presentation Insights into solution processing of Indium Selenide
28	30.11-01.12.2023	Rahuldeb Roy SRF	In-House-Symposium (IHS 2023), CeNS	Poster presentation & Oral Interlayer Water of Tungsten Oxide Unlocks the Jahn-Teller Distortion to Boost the Performance of Aqueous Electrochromic Battery
29	30.11-01.12.2023	Radha Rathod SRF	In-House-Symposium (IHS 2023), CeNS	Oral Presentation Improving stability and restricting anion exchange in lead halide perovskite Nanocrystals
30	30.11.-01.12.2023	Savithri Vishwanathan SRF	In-House-Symposium (IHS 2023), CeNS	Poster Presentation Strategies to enhance the fast-charging performance of conversion anodes for lithium-ion batteries
31	30.11-01.12.2023	Harshit Pandey JRF	In-House-Symposium (IHS 2023), CeNS	Poster Presentation Potassium Poly (Heptazine Imide) as a Novel Binder for Lithium-ion Batteries
	30.11.2023	Modasser Hossain	In-House-Symposium (IHS 2023), CeNS	Dimensionality control in perovskites: structural and optoelectronic properties
32	04-06.12.2023	Swathi S P SRF	International Winter School 2023 and Recent Advances in Materials at JNCASR	



Sl. No.	Date	Name & Designation	Name of Conference attended	Mode of Presentation and Title
33	04-06.12.2023	Athira Chandran M SRF	International Winter School on Frontiers in Materials Science	Poster presentation Multicomponent alloy as an Efficient Saline Water Electrocatalyst for Hydrogen Evolution Reaction
34	04-06.12.2023	Muhammed Safeer N K SRF	International Winter School on Frontiers in Materials Science	Poster Presentation In-situ generated Ni(OH) ₂ on chemically activated spent catalyst sustains urea electro-oxidation in extensive alkaline conditions
35	04-06.12.2023	Abhishek Kumar SRF	International Winter School on Frontiers in Materials Science	Poster presentation Highly frustrated twist grain boundary phase of liquid crystal A-B-A Type trimers exhibiting ESIPT dual- fluorescence: The first examples
36	01-31.06.2023	Rohit Thakur SRF	National Taipei University of Technology, Taipei Tech under the Taiwan Education Experience Programme (TEEP)	Lab Visit
37	07-09.12.2023	Athira Chandran M SRF	International Conference on Recent advances in Material (RAM-90), JNCASR, Jakkur, Bengaluru	Poster presentation Multicomponent alloy as an Efficient Saline Water Electrocatalyst for Hydrogen Evolution Reaction
38	07-09.12.2023	Abhishek Kumar SRF	International Conference on Recent advances in Material (RAM-90), JNCASR, Jakkur, Bengaluru	Attended
39	07-09.12.2023	Radha Rathod SRF	International conference on Recent Advances in Materials (RAM-90), JNCASR, Jakkur, Bengaluru	Poster Presentation Improving stability and preventing anion exchange in CsPbX ₃ Nanocrystals for optoelectronics applications
40	07-09.12.2023	Harshit Pandey JRF	International Conference on Recent Advances in Materials (RAM-90), JNCASR, Jakkur, Bengaluru	Poster Presentation Potassium Poly (Heptazine Imide) as a Novel Binder for Lithium-ion Batteries
41	12-15.12.2023	Savithri Vishwanathan SRF	34th AGM of MRSI and 5th Indian Materials Conclave, IIT BHU, Varanasi	Poster Presentation Low-temperature synthesis of crystalline pyrite FeS ₂ for high energy density supercapacitors
42	12-15.12.2023	Rahul Singh SRF	34th AGM of MRSI and 5th Indian Materials Conclave, School of Material Science and Technology, IIT (BHU), Varanasi	Poster Presentation Solid-State Synthesis of Titanium Carbonitride via Metastable Precursor for Li-ion Battery
43	12-15.12.2023	Himani Saini SRF	34th AGM of MRSI and 5th Indian Materials Conclave, School of Material Science and Technology, IIT (BHU), Varanasi	Poster Presentation Synthesis of Interconnected Porous Carbon for High Voltage Window Supercapacitors
44	12-15.12.2023	Vishnu G Nath SRF	34th Annual General Meeting of MRSI and 5th Indian Materials Conclave Programme at Swatantrata Bhawan, IIT BHU, Varanasi	Poster presentation Mixed Spinel ZnFe ₂ O ₄ structure: a promising material for ultrasensitive and selective gas detection



Sl. No.	Date	Name & Designation	Name of Conference attended	Mode of Presentation and Title
45	12-15.12.2023	Nikhil N Rao SRF	34th Annual General Meeting of MRSI and 5th Indian Materials Conclave Programme at Swatantrata Bhawan, IIT BHU, Varanasi	Poster presentation Direct mechanism of urea electrooxidation driven by resilient and CO _x poison tolerant active species generated on NdNiO ₃
46	12-15.12.2023	Jil Rose Perutil SRF	34th Annual General Meeting of MRSI and 5th Indian Materials Conclave Programme at Swatantrata Bhawan, IIT BHU, Varanasi	Poster presentation A Ceria-based hybrid film towards stable and efficient SERS substrates
47	12-15.12.2023	Manish Verma SRF	34th Annual General Meeting of MRSI and 5th Indian Materials Conclave Programme at Swatantrata Bhawan, IIT BHU, Varanasi	Poster Presentation Hierarchical microspheres of mixed metal oxide and its heterojunction with CuO and Ag/AgCl for enhanced photocatalytic oxidation of organic pollutants and hydrogen generation
48	14-15.12.2023	Mukhesh K.G SRF	Condensed Matter Physics and Applications (CMPA-2023) MIT, Manipal	Poster presentation- Fabrication of large-area, affordable dual-function electrochromic smart windows by using a hybrid electrode coated with an oxygen-deficient tungsten oxide ultrathin porous film
49	14-15.12.2023	Rahuldeb Roy SRF	Condensed Matter Physics and Applications (CMPA-2023) MIT, Manipal	Poster presentation- Interlayer water of tungsten oxide unlocks the jahn-teller distortion to boost the performance of aqueous electrochromic battery
50	14-15.12.2023	Pritha Dutta SRF	Condensed Matter Physics and Applications (CMPA-2023) MIT, Manipal	Poster presentation Highly-Stable Poly(o-methoxyaniline)/WO ₃ -Nanoflower Composite-Based Electrochromic Supercapacitors with Real-Time Charge Indication
51	14-15.12.2023	Athira Chandran M SRF	11th National Conference on Condensed Matter Physics and Applications (CMPA-2023) MIT, Manipal	Poster presentation Pt-Pd-Co-Mn-Ni High Entropy Alloy as an Efficient Saline Water Electrocatalyst for Hydrogen Evolution Reaction
52	22-23.12.2023	Modasser Hossain SRF	Hybrid Halide Perovskite – 2023, Kolkata	Poster Presentation Kinetics of cation migration in 2D/3D perovskite structures
53	22-23.12.2023	Radha Rathod SRF	Hybrid Halide Perovskite – 2023, Kolkata	Poster Presentation Improving stability and preventing anion exchange in CsPbX ₃ nanocrystals for optoelectronics applications
54	9-11.01.2024	Mukhesh K.G SRF	International Conference on Functional Materials (ICFM-2024) IIT-Kharagpur	Oral Presentation Fabrication of large-area, affordable dual-function electrochromic smart windows by using a hybrid electrode coated with an oxygen-deficient tungsten oxide ultrathin porous film



Sl. No.	Date	Name & Designation	Name of Conference attended	Mode of Presentation and Title
55	9-11.01.2024	Pritha Dutta SRF	International Conference on Functional Materials (ICFM-2024) IIT-Kharagpur	Poster presentation Dual-functional electrochromic smart window using WO_3 H_2O -rGO nanocomposite ink spray coated on low-cost hybrid electrode
56	9-11.01.2024	Rahuldeb Roy SRF	International Conference on Functional Materials (ICFM-2024) IIT- Kharagpur	Poster presentation Interlayer Water of Tungsten Oxide Unlocks the Jahn-Teller Distortion to Boost the Performance of Aqueous Electrochromic Battery
57	9-11.01.2024	Athira Chandran M SRF	International Conference on Functional Materials (ICFM-2024) IIT-Kharagpur	Poster presentation High Entropy Alloy as an Efficient Saline Water Electrocatalyst for Hydrogen Evolution Reaction
58	12-14.01.2024	Ushita Roy JRF	Nanomaterials and Molecules: From Spectroscopy to Bioimaging (NaMoSBio 2024)	Poster Presentation Growth of Cu-based ternary chalcogenide nanocrystals via cation exchange
59	29-30.01.2024	Abhishek Kumar	Science Beyond Boundary: Invention, Discovery, Innovation and Society (Rasayan 18) Christ Deemed to be University Bengaluru	Attended
60	12-14.03.2024	Nikhil N. Rao SRF	India@DESY Users Workshop in JNCASR, Bengaluru	Poster Presentation Probing the nature and stability of active sites in electrocatalysts using X-ray absorption spectroscopy.
61	14-16.02.2024	Moram Veera Manikanta Tatayya Naidu, JRF	Frontiers in chemical sciences, (FCS-2024)	Poster presentation- Influence of pH on the phase behaviour of cholesteryl benzoic acid at the interfaces
62	18-22.03.2024	Modasser Hossain SRF	12th International Conference on Quantum Dots, Munich, Germany	Poster Presentation Kinetics of Cation Migration in 2D/3D Perovskite Structures
63	18-22.03.2024	Radha Rathod SRF	12th International Conference on Quantum Dots, Munich, Germany	Poster Presentation Restricting Anion Exchange in $CsPbX_3$ Nanocrystals for Optoelectronics Applications
64	21.03.2024	Himani Saini SRF	First All India Technical Seminar 2024 conducted by ARCI, Hyderabad	Oral presentation पदानुक्रमित पोरसिटेर अल्सपर अनुसंधान एवं मवकास
65	27-28.03.2024	Gayathri PR	Disordered soft systems: Recent trends (DSSR),CeNS, Bangalore	Poster Presentation Exploring photoluminescent memory devices using liquid crystal-quantum dot nanocomposites
66	March 2024	Nikhil N. Rao SRF	Royal Society of Chemistry LinkedIn Conference	Poster Presentation Direct mechanism of urea electro-oxidation driven by resilient and COpoison tolerant active species generated on $NdNiO_3$
67	27-28.03.2024	Moram Veera ManikantaTatayya Naidu JRF	Disordered and soft systems: Recent trends (DSSR)CeNS, Bengaluru	Poster presentation, Self-assembly of amino acid appended Naphthalene Diimide Derivatives in the solution phase and at the air-water interface
68	27-28.03.2024	Rahuldeb Roy SRF	Disordered and Soft systems: Recent trends (DSSR 2024),CeNS, Bengaluru	Poster presentation Interlayer water of tungsten oxide unlocks the Jahn-Teller distortion to boost the performance of aqueous electrochromic battery



Sl. No.	Date	Name & Designation	Name of Conference attended	Mode of Presentation and Title
69	27-28.03.2024	Athira Chandran M SRF	Disordered and Soft Systems: Recent Trends(DSSR 2024),CeNS, Bengaluru	Poster presentation Pt-Pd-Co-Mn-Ni High Entropy Alloy as an Efficient Saline Water Electrocatalyst for Hydrogen Evolution Reaction
70	27-28.03.2024	Abhishek Kumar SRF	Disordered and Soft Systems: Recent Trends (DSSR 2024),CeNS, Bengaluru	Poster presentation Highly frustrated twist grain boundary phase of liquid crystal A-B-A type trimers exhibiting esipt dual-fluorescence: The first examples
71	27-28.03.2024	A. An and Eswara Rao JRF	Disordered and Soft Systems: Recent trends (DSSR),CeNS, Bengaluru	Poster presentation, Angle-dependent optical studies on size-reduced monolayer of self-assembled polystyrene spheres
72	27-28.03.2024	Vishnu G Nath SRF	Disordered and Soft Systems: Recent trends (DSSR), CeNS, Bengaluru	Poster presentation, Mechanistic insight into plasma treated exfoliated MoS ₂ nanosheets: a paradigm for ppb level room temperature NO ₂ and NH ₃ sensors
73	27-28.03.2024	Nurjahan Khatun PRA	Disordered and Soft Systems: Recent trends(DSSR), CeNS, Bengaluru	Poster Presentation Self-assembly of nanoparticles and kinetics of domain growth in a liquid crystalline cubic blue phase
74	27-28.03.2024	Gayathri R. Pisharody	Disordered and Soft Systems: Recent trends(DSSR), CeNS, Bengaluru	Poster Presentation Exploring photoluminescent memory devices using liquid crystal-quantum dot nanocomposites



19. Audited statement of accounts

B.R.V. Goud & Co.
Chartered Accountants



INDEPENDENT AUDITORS' REPORT

TO THE MEMBERS OF THE GOVERNING BODY OF CENTRE FOR NANO AND SOFT MATTER SCIENCES, BANGALORE

Opinion

We have audited the accompanying financial statements of "Centre for Nano and Soft Matter Sciences", Arkavathi, Shivanapura, Bengaluru North - 562 162, which comprises the Balance Sheet as at 31st March 2024, the Statement of Income & Expenditure for year then ended, the Receipts and Payments Account for year then ended, and a summary of significant accounting policies and other explanatory information.

In our opinion and to the best of our information and according to the explanations given to us, the aforesaid financial statements give the information required and give a true and fair view in conformity with the accounting principles generally accepted in India:

- 1) In the case of Balance Sheet, of the state of affairs of the "Centre for Nano and Soft Matter Sciences", as at 31st March 2024.
- 2) In case of Income and Expenditure Account, of DEFICIT, being Excess of Expenditure over Income for the year ended on that date.

Basis for Opinion

We conducted our audit in accordance with the Standards on Auditing (SAs) issued by Institute of Chartered Accountants of India. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether the financial statements are free of material misstatement. An audit includes examining, on a test basis, evidence supporting the amounts and disclosures in the financial statements. An audit also includes assessing the accounting principles used and significant estimates made by management as well as evaluating the overall financial statements presentation. Our responsibilities under those Standards are further described in the Auditor's Responsibilities for the Audit of the Financial Statements section of our report. We are Independent of the Centre in accordance with the Code of Ethics issued by the Institute of Chartered Accountants of India, and we have fulfilled our other ethical responsibilities in accordance with these requirements and the Code of Ethics. We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our opinion.

Management's Responsibility for the Financial Statements

Management is responsible for the preparation of the financial statements. This responsibility also includes maintenance of adequate accounting records for safeguarding of the assets of the Centre and for preventing and detecting frauds and other



B.R.V. Goud & Co.
Chartered Accountants



irregularities; selection and application of appropriate implementation and maintenance of accounting policies; making judgments and estimates that are reasonable and prudent; and design, implementation and maintenance of adequate internal financial controls, that were operating effectively for ensuring the accuracy and completeness of the accounting records, relevant to the preparation and presentation of the financial statement that give a true and fair view and are free from material misstatement, whether due to fraud or error.

Auditor's Responsibility for the Audit of the Financial Statements

Our objectives are to obtain reasonable assurance about whether the financial statements are free from material misstatement, whether due to fraud or error, and to issue an auditor's report that includes our opinion. Reasonable assurance is a high level of assurance but is not a guarantee that an audit conducted in accordance with SAs will always detect a material misstatement when it exists. Misstatements can arise from fraud or error and are considered material if, individually or in the aggregate, they could reasonably be expected to influence the economic decisions of users taken on the basis of these financial statements.

We further report that:

- a) We have sought and obtained all the information and explanations which, to the best of our knowledge and belief, were necessary for the purpose of our audit and have found them to be satisfactory.
- b) In our opinion, proper books of account as required by law have been kept by the Centre, so far as appears from our examination of those books.
- c) The Balance Sheet and Income and Expenditure Account dealt with by this report, are in agreement with the books of accounts.

Place: Bangalore
Date: 16/09/2024

UDIN: 24201108BKBMNN6314

for B.R.V. GOUD & CO.,
Chartered Accountants
FRN: 000992S

(A B Shiva Subramanyam)
Partner
Membership No: 201108






**CENTRE FOR NANO AND SOFT MATTER SCIENCES
ARKAVATHI, SHIVANAPURA, BENGALURU NORTH - 562 162**

BALANCE SHEET AS AT 31ST MARCH, 2024

		(Amount in Rs.)	
I. CORPUS / CAPITAL FUND AND LIABILITIES	SCH	31.03.2024	31.03.2023
CORPUS / CAPITAL FUND	1	30,85,57,181	30,55,73,394
RESERVES AND SURPLUS	2	-	-
EARMARKED PROJECTS FUNDS	3	11,05,71,144	11,61,48,436
SECURED LOANS AND BORROWINGS	4	-	-
UNSECURED LOANS AND BORROWINGS	5	-	-
DEFERRED CREDIT LIABILITIES	6	-	-
CURRENT LIABILITIES AND PROVISIONS	7	2,61,88,373	3,72,06,570
TOTAL		44,53,16,698	45,89,28,400
II. APPLICATION OF FUNDS/ASSETS			
FIXED ASSETS	8	33,44,75,412	32,38,53,971
INVESTMENTS - FROM EARMARKED/ENDOWMENT FUNDS	9	-	-
INVESTMENTS - OTHERS	10	-	-
CURRENT ASSETS, LOANS, ADVANCES ETC.,	11	11,08,41,286	13,50,74,429
TOTAL		44,53,16,698	45,89,28,400
SIGNIFICANT ACCOUNTING POLICIES AND NOTES ON ACCOUNTS	24		

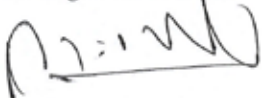

(VIVEK DUBEY)
ACCOUNTS OFFICER




(PROF. BHAGAVATULA L.V. PRASAD)
DIRECTOR

PLACE : BENGALURU
DATE : 16.09.2024

As per our report of even date
for M/s B R V GOUD & Co.
Chartered Accountants
Firm Regn. No. 000992S


[A B SHIVA SUBRAMANYAM]
Partner
Membership No. 201108





**CENTRE FOR NANO AND SOFT MATTER SCIENCES
ARKAVATHI, SHIVANAPURA, BENGALURU NORTH - 562 162**

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31ST MARCH, 2024

		(Amount in Rs.)	
A - INCOME	SCH	31.03.2024	31.03.2023
Income from Sales / Services	12	-	-
Grants / Subsidies:	13	13,56,30,838	11,09,17,681
Fees / Subscriptions	14	-	-
Income from Investments(income on investments from earmarked / endowment Funds)	15	-	-
Income from Royalty, Publications etc.,	16	-	-
Interest earned / accrued	17	54,96,890	60,06,641
Other Income	18	79,74,674	47,03,440
Increase / (decrease) in stock of finished goods and work-in-progress	19	-	-
TOTAL (A)		14,91,02,402	12,16,27,762
B - EXPENDITURE			
Establishment Expenses	20	7,03,99,999	7,27,29,359
Other Administrative Expenses etc.,	21	6,91,90,466	6,48,03,280
Expenditures on Grants, Subsidies etc.,	22	-	-
Interest to Grant providing agencies	23	3,07,883	2,41,537
TOTAL (B)		13,98,98,348	13,77,74,176
C - BALANCE BEING SURPLUS / (DEFICIT) (A-B)		92,04,054	(1,61,46,414)
D - Depreciation for the year		(2,51,61,888)	(2,36,18,373)
E. SURPLUS / (DEFICIT) CARRIED TO CORPUS / CAPITAL FUND (C-D)		(1,59,57,834)	(3,97,64,787)
SIGNIFICANT ACCOUNTING POLICIES AND NOTES ON ACCOUNTS	24		

Vivek Dubey
(VIVEK DUBEY)
ACCOUNTS OFFICER



Bhagavatula L.V. Prasad
(PROF. BHAGAVATULA L.V. PRASAD)
DIRECTOR

As per our report of even date
for M/s B R V GOUD & Co.
Chartered Accountants
Firm Regn. No. 000992S

[Signature]
[A B SHIVA SUBRAMANYAM]
Partner



CENTRE FOR NANO AND SOFT MATTER SCIENCES
ARKAVATHI, SHIVANAPURA, BENGALURU NORTH - 562 162

RECEIPTS AND PAYMENTS FOR THE YEAR ENDED 31ST MARCH, 2024

(Amount in ₹)

RECEIPTS	For the year 23-24	PAYMENTS	For the year 23-24
I Opening Balances		I. Establishment Expenses	7,37,51,030
1) Cash in Hand	-	II Administrative Expenses	7,05,63,106
2) Bank Balances including TDR	10,52,45,572	III Fixed Assets (Additions)	4,13,85,682
II Grants-in-aid from DST, Govt of India		IV Current Liabilities	3,26,44,655
a) Grant in Aid Capital	2,00,00,000	V Current Assets	1,31,66,708
b) Grant in Aid General	6,89,00,000	VI Investments	
c) Grant in Aid Salary	7,04,00,000	Fixed/Term Deposits made	
III Interest Received		VII Earmarked Project Expenses	3,75,95,849
a) On Savings Bank Accounts	10,55,566	VIII Refund of Grant and other Income	47,07,211
b) On Fixed/Term Deposits	13,17,094	IX Closing Balance	
IV Other Income		1) Cash in Hand	-
a) Sample charges	17,92,681	2) Bank Balances including TDR	9,05,48,317
b) Miscellaneous Receipts	62,13,763		
V Current Liabilities	3,77,14,995		
VI Current Assets	16,51,503		
VII Grants/Financial Assurances received for Earmarked Projects	4,56,43,708		
IX Receipts towards Expenditure	44,27,676		
TOTAL	36,43,62,558	TOTAL	36,43,62,558

Vivek Dubey
(VIVEK DUBEY)
ACCOUNTS OFFICER

T. R. ...

As per our report of even date,
for B.R.V. GOUD & CO.
Chartered Accountants

B.R.V. Goud



CENTRE FOR NANO AND SOFT MATTER SCIENCES
ARKAVATHI, SHIVANAPURA, BENGALURU NORTH - 562 162

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH, 2024

Particulars	(Amount in Rs.)	
	As at 31.03.2024	As at 31.03.2023
SCHEDULE 1		
A. CAPITAL FUND:		
As Per Previous Balance Sheet	30,55,73,394	33,26,46,238
ADD: Capital Grants received:		
Capital Assets	2,00,00,000	2,50,00,000
	32,55,73,394	35,76,46,238
ADD/(LESS): Surplus / (Deficit) for the year	(1,59,57,834)	(3,97,64,787)
Grant returned	(10,06,279)	(92,44,466)
Prior Period Adjustments	(52,100)	(30,63,591)
TOTAL	30,85,57,181	30,55,73,394
SCHEDULE 2 - RESERVES AND SURPLUS:	-	-
SCHEDULE 3 - EARMARKED / PROJECT FUNDS:	11,05,71,144	11,61,48,436
(See Annexure A for details)		
SCHEDULE 4 - SECURED LOANS AND BORROWINGS:	-	-
SCHEDULE 5 - UNSECURED LOANS AND BORROWINGS:	-	-
SCHEDULE 6 - DEFERRED CREDIT LIABILITIES:	-	-
SCHEDULE 7-CURRENT LIABILITIES & PROVISIONS:		
A) CURRENT LIABILITIES:		
1) Statutory Liabilities	12,10,657	27,74,176
2) Other Liabilities	2,28,60,206	1,99,41,527
TOTAL (A)	2,40,70,863	2,27,15,703
B) PROVISIONS:		
Salaries and Services and Supplies	21,17,510	1,44,90,867
TOTAL (B)	21,17,510	1,44,90,867
TOTAL (A+B)	2,61,88,373	3,72,06,570
SCHEDULE 8 - FIXED ASSETS	33,44,75,412	32,38,53,971
SCHEDULE 9- INVESTMENTS FROM EARMARKED / ENDOWMENT FUNDS:	-	-
SCHEDULE 10 - INVESTMENTS - OTHERS:	-	-
SCHEDULE 11 - CURRENT ASSETS, LOANS, ADVANCES:		
A) CURRENT ASSETS:		
1) Inventories	-	-
2) Sundry Debtors:		
3) Cash Balances in Hand	-	10,000
4) Bank Balances:- Nationalised Banks		
a. Term Deposit Receipts	6,23,46,600	2,12,10,911
b. Margin Money	-	99,64,151
c. Savings Accounts:		
RBI A/c No. 10695601014	-	-
SBI SB A/c No.274	95,90,226	6,40,06,861
SBI SB Project A/c 219	1,62,84,970	60,08,833



Particulars	As at 31.03.2024	As at 31.03.2023
B) LOANS,ADVANCES AND OTHER ASSETS:		
1) Loans	-	-
2) Advances and Other amounts recoverable in Cash or in kind or for value to be received:	1,40,31,158	2,78,95,364
3) Deposits		
a) K P T C L Deposit (SERC/CLCR)	14,66,430	12,65,510
b) Deposit with BSNL	42,588	42,588
c) Deposit with HMT Ltd	1,24,020	1,24,020
d) Deposit with Mohan gas	8,650	8,650
e) Deposit with Bhuruka Gas	1,00,000	1,00,000
f) Deposit with Balmer Lawrie	2,75,000	2,75,000
4) Grant in Aid Receivable	-	-
5) Accrued Interest & Prepaid Exp	31,18,817	-
6) TDS By Bank/ BESCOM & Others	11,26,306	1,17,726
TOTAL (B)	2,02,92,969	2,98,28,858
TOTAL (A+B)	11,08,41,286	13,50,74,429
SCHEDULE 12 - INCOME FROM SALES / SERVICES:	-	-
SCHEDULE 13 - GRANTS / SUBSIDIES:		
Grant in Aid -Salaries	7,04,00,000	5,67,00,000
Grant in Aid -General	6,89,00,000	5,64,00,000
Grant in Aid returned	(36,69,162)	(21,82,319)
TOTAL	13,56,30,838	11,09,17,681
SCHEDULE 14 - FEES / SUBSCRIPTIONS:	-	-
SCHEDULE 15 - INCOME FROM INVESTMENTS:	-	-
SCHEDULE 16 - INCOME FROM ROYALTY, PUBLICATIONS ETC.:	-	-
SCHEDULE 17 - INTEREST EARNED/Accrued:		
1) On Term Deposits - Nationalised Banks	44,27,330	48,64,303
2) On Savings Accounts - Nationalised Bank	10,69,560	11,42,338
TOTAL	54,96,890	60,06,641
SCHEDULE 18 - OTHER INCOME:		
Sample charges	17,78,111	9,78,180
Miscellaneous Income	61,96,563	37,25,260
Conferences and workshops	-	-
TOTAL	79,74,674	47,03,440
SCHEDULE 19 - INCREASE (DECREASE) IN STOCK OF FINISHED GOODS & WORK IN PROGRESS:	-	-
SCHEDULE 20 - ESTABLISHMENT EXPENSES:		
1) Staff Salary	7,03,99,999	7,27,29,359
TOTAL	7,03,99,999	7,27,29,359



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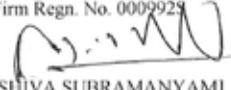
Particulars	As at 31.03.2024	As at 31.03.2023
SCHEDULE 21 - OTHER ADMINISTRATIVE EXPENSES, ETC:		
Consumable Expenditure	65,75,361	45,80,384
Electricity and Water Charges	60,42,595	45,62,709
Administrative Exps	19,72,419	16,00,543
Hiring staff through service agency	3,20,72,637	3,71,61,585
Library Books & Journals	2,72,051	2,37,719
Hiring of Car	22,71,734	27,59,326
Recurring Exps	29,45,974	17,01,144
Office Expenses	10,51,056	28,31,653
Meeting Expenditure	4,46,420	-
Repair and Maintenance	1,13,68,140	53,63,510
Seminars/Conferences/ Workshops/Symposiums	16,79,503	14,76,528
Telephone Expenses	7,21,305	13,98,759
Travelling	17,71,271	11,29,420
TOTAL	6,91,90,466	6,48,03,280
SCHEDULE 22 - EXPENDITURE ON GRANTS, SUBSIDIES ETC:		
	-	-
SCHEDULE 23 - INTEREST:		
	3,07,883	2,41,537


 (VIVEK DUBEY)
 ACCOUNTS OFFICER


 (PROF. BHAGAVATULA L.V. PRASAD)
 DIRECTOR

PLACE : BENGALURU
DATE : 16.09.2024

As per our report of even date
for M/s B R V GOUD & Co.
Chartered Accountants
Firm Regn. No. 0009929


 [A B SHIVA SUBRAMANYAM]
 Partner
 Membership No. 201108





**CENTRE FOR NANO AND SOFT MATTER SCIENCES
ARKAVATHI, SHIVANAPURA, BENGALURU NORTH - 562 162**

SCHEDULE 3 - EARMARKED / PROJECTS
Annexure - A to Schedule 3

Particulars	Government and Governmental bodies Sponsored Projects											(Amount in Rs.)
	Balance Under Closed Project	Inspire Fellowship/ Faculty Grant	CEFIPRA AKS 248	DRDO/HSS RM/0217	DST/AMT/G UK/AKS 0186	DST/AMT/P KS/0242	DST/AMT/P V/0244	DST/SUPRE ME BLY/0245	KSTEP KP 0239	KSTEP NANO JATHA	SERB/BLV0 238 MDFT	
a) Opening Balance of the Funds	9,17,28,145	(3,08,637)	-	-	55,70,301	-	-	-	-	-	-	18,49,649
b) Additions to the Funds:												
i) Grants or Other receipts	1,50,338	78,27,441	13,99,360	20,22,000	6,73,428	24,36,307	41,45,191	6,50,000	3,00,000	12,50,000	-	9,00,000
ii) Income from investment made	-	-	-	-	-	-	-	-	-	-	-	-
iii) Other Receipts	-	-	-	-	-	-	-	-	-	-	-	-
iii) Trifid. during the year	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL (a+b)	9,18,78,483	75,18,804	13,99,360	20,22,000	62,43,729	24,36,307	41,45,191	6,50,000	3,00,000	12,50,000	-	27,49,649
c) Utilisation/Expenditure towards objectives of Funds:												
i) Revenue Expenditure												
Salaries, Wages and Allowances etc.,	-	46,13,387	-	3,54,200	4,38,676	29,578	-	-	-	-	-	4,91,280
Consumables/ travel	-	2,50,305	12,236	50,000	-	5,16,110	-	2,15,132	28,296	-	-	5,77,782
Contingencies/SSR	-	2,10,000	-	-	-	2,124	-	5,87,932	3,540	-	3,99,976	68,181
Overheads	-	35,000	-	1,01,000	-	1,80,467	-	-	-	-	-	-
Depreciation	1,06,95,752	37,526	-	67,500	9,16,125	-	-	-	-	-	-	1,36,669
Grant Refunded / Transferred	82,00,000	14,38,531	-	-	6,618	17,08,028	41,45,191	-	-	-	-	-
TOTAL (c)	1,88,95,752	65,84,749	12,236	5,72,700	13,74,277	24,36,307	41,45,191	8,03,064	31,836	-	3,99,976	12,73,912
NET BALANCE AT THE YEAR END (a+b-c)	7,29,82,731	9,34,055	13,87,124	14,49,300	48,69,452	-	-	(1,53,064)	2,68,164	12,50,000	(3,99,976)	14,75,737



CENTRE FOR NANO AND SOFT MATTER SCIENCES
ARKAVATHI, SHIVANAPURA, BENGALURU NORTH - 562 162

Annexure - A to Schedule 3

Government and Governmental bodies Sponsored Projects														(Amount in Rs.)		
SERB CVY 0154	SERB/DS SR/0125	SERB/GG RAMANUJ AN0220	SERB /KP 205 SIRE	SERB KP 209	SERB KP 240	SERB HSSRM0 124	SERB HSSRM024 6	SERB NPDF/ Marilyn 0211	SERB NPDF/ Twinkled 255	SERB NSJ 207	SERB PKS 0250	SERB SA 210	Seminar and Workshops	Project Administ- ration	Total Under Government Project	
1,66,239	43,694		2,55,700	7,42,932		11,239				6,44,283		10,03,969	(6,97,865)	1,00,59,822	11,10,69,471	
6,50,000	1,50,000	23,60,000		20,04,500		60,000	32,41,400	8,00,000	7,47,179	7,50,000	17,68,542	-	-	15,74,195	3,58,59,881	
8,16,239	1,93,694	23,60,000	2,55,700	7,42,932	20,04,500	71,239	32,41,400	8,00,000	7,47,179	13,94,283	17,68,542	10,03,969	(6,97,865)	1,16,34,017	14,69,29,352	
4,26,936		16,07,127		3,84,400				8,18,400								91,63,984
3,07,074	1,08,154	5,58,074	71,748	1,51,672	21,822	91,456		2,58,966		4,55,080		75,498	7,23,255		7,26,904	7,26,904
1,06,090	20,000	1,21,928	1,83,952	49,454	9,861	30,143				26,372		49,030			43,94,898	43,94,898
49,512	44,958	60,000		58,489		14,563				57,689		40,600			14,68,607	14,68,607
				83,820								61,031			6,42,278	6,42,278
8,89,612	1,73,112	23,47,129	2,55,700	6,44,015	1,15,503	1,36,162		10,77,366		7,75,449		2,26,159	7,23,255		1,19,98,423	1,19,98,423
(73,373)	20,582	12,871	-	98,917	18,88,997	(64,923)	32,41,400	(2,77,366)	7,47,179	6,18,834	17,68,542	7,77,810	(14,21,120)	1,16,34,017	10,30,35,890	10,30,35,890

Shruti Datta

 Centre for Nano and Soft Matter Sciences
 Bengaluru North - 562 162



CENTRE FOR NANO AND SOFT MATTER SCIENCES
ARKAVATHI, SHIVANAPURA, BENGALURU NORTH - 562 162

Annexure - A to Schedule 3

FUNDS	Industries Sponsor Project/ Joint Venture with Industries										(Amount in Rs.)			
	Balance Under Closed Project	TSAMRC	Tata Steel	GAIL BLY0218	Saint Gobain/ A KS/	ITC/HSSR M	PROJEC T NO.6708- I sa 0243	DSSR 2024	MDFT 2023 AKS	GAIL NSJ 0219	Total of Industry projects (A)	Total of Govt. Projects (B)	Total of (A+B)	Previous Year
a) Opening Balance	mipi mapipv pks hpcl													
b) Additions to the Funds:	6,26,417	(11,20,791)	8,19,548	-	43,46,647	4,07,144	-	-	-	50,78,965	11,10,69,471	11,61,48,436	13,36,50,531	
i) Grants		7,43,400		43,77,800	26,57,124	6,07,110	2,15,000	11,00,871	9,44,000	1,11,42,555	3,58,59,881	4,70,02,436	1,42,87,573	
ii) Income from investment made													2,73,692	
iii) Other Receipts													33,95,100	
iv) Trfrd. during the year														
TOTAL (a+b)	6,26,417	(3,77,391)	8,19,548	43,77,800	70,03,771	10,14,254	2,15,000	11,00,871	9,44,000	1,62,21,520	14,69,29,352	16,31,50,872	15,16,06,896	
c) Utilisation/Expenditure towards objectives of Funds:														
Other Expenditure as per pro													10,00,395	
Salaries, Wages and		2,19,334	-	-	4,68,000	-	-	11,00,871	-	17,88,205	91,63,984	1,09,52,189	10,50,817	
Allowances etc.,		-	-	8,31,387	8,94,420	-	-	-	4,90,680	22,16,487	7,26,904	29,43,391	12,56,782	
Consumables/ travel		1,65,372	7,38,994	3,68,638	5,57,084	76,828	-	-	1,04,694	20,55,342	43,94,898	64,50,240	53,16,574	
Contingencel	35,391	13,696	-	-	1,07,552	97,755	-	-	44,788	3,09,507	14,68,607	17,78,114	7,66,019	
Overheads		-	9,31,917	-	-	-	-	-	-	9,31,917	6,42,278	15,74,195	1,47,86,782	
Depreciation		13,82,418	-	2,390	-	-	-	-	-	13,84,808	1,19,98,423	1,33,83,231	6,77,270	
Grant Refunded		-	-	-	-	-	-	-	-	-	1,54,98,368	1,54,98,368	35,88,532	
TOTAL (c)	35,391	17,80,820	16,70,911	12,02,415	20,27,056	1,74,583	-	11,00,871	6,40,162	86,86,266	4,38,93,462	5,25,79,728	3,54,58,460	
NET BALANCE	5,91,026	(21,58,211)	(8,51,363)	31,75,385	49,76,715	8,39,671	2,15,000	-	3,03,838	75,35,254	10,30,35,890	11,05,71,144	11,61,48,436	

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CENTRE FOR NANO AND SOFT MATTER SCIENCES
ARKAVATHI, SHIVANAPURA, BENGALURU NORTH - 562 162
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH, 2024

SCHEDULE - 8 : FIXED ASSETS

A. CENS :

DESCRIPTION	W.D.V. as on 01.04.2023	Additions during the year			Total as on 31.03.2024	Rate of Dep.	Depreciation Full Rate	Dep. For Addition <180 Days	Total Depreciation for the year	W.D.V. as on 31.03.2024
		>180 days	<180 Days	Total additions						
CIVIL WORKS	-									
Civil Works	1,86,92,907			-	1,86,92,907	10	18,69,291	-	18,69,291	1,68,23,616
Infrastructure	2,93,42,544		71,787	71,787	2,94,14,331	10	29,34,254	3,589	29,37,843	2,64,76,488
New Campus (WIP)	7,41,02,706		-	-	7,41,02,706	-	-	-	-	7,41,02,706
BUILDINGS	57,31,291	1,80,34,945	18,96,867	1,99,31,812	2,56,63,103	10	23,76,624	94,843	24,71,467	2,31,91,636
ELECTRICAL INSTALLATIONS	73,06,444	60,594	27,94,141	28,54,735	1,01,61,179	10	7,36,704	1,39,707	8,76,411	92,84,768
COMPUTERS	6,83,931	2,08,218	13,08,870	15,17,088	22,01,019	40	3,56,860	2,61,774	6,18,634	15,82,385
FURNITURE & FIXTURES	70,58,886	4,56,568	2,13,520	6,70,088	77,28,974	10	7,51,545	10,676	7,62,221	69,66,753
AIR CONDITIONER	11,74,304	-	49,900	49,900	12,24,204	15	1,76,146	3,743	1,79,889	10,44,315
GENERATOR SET	16,19,419	-	-	-	16,19,419	15	2,42,913	-	2,42,913	13,76,506
GENERAL EQUIPMENTS	1,29,19,131	64,390	3,62,055	4,26,445	1,33,45,576	15	19,47,528	27,154	19,74,682	1,13,70,894
SCIENTIFIC EQUIPMENTS	7,66,32,458	91,83,541	47,48,494	1,39,32,035	9,05,64,493	15	1,28,72,400	3,56,137	1,32,28,537	7,73,35,956
CWIP	10,80,021	-	65,69,465	65,69,465	76,49,486		-	-	-	76,49,486
Total - (A)	23,63,44,042	2,80,08,256	1,80,15,099	4,60,23,355	28,23,67,397		2,42,64,265	8,97,623	2,51,61,888	25,72,05,509





B. PROJECTS

(Amount in Rs.)

DESCRIPTION	W.D.V. as on 01.04.2023	Additions during the year			Total as on 31.03.2024	Rate of Dep.	Depreciation Full Rate	Dep. For Addition <180 Days	Total Depreciation for the year	W.D.V. as on 31.03.2024
		>180 days	<180 Days	Total additions						
I. Assets Under Closed Projects	7,13,05,016	-	-	-	7,13,05,016	15	1,06,95,752	-	1,06,95,752	6,06,09,264
II. TSAMIRC Equipment	92,16,118				92,16,118	15	13,82,418	-	13,82,418	78,33,700
III. INSPIRE / SUBASH CK/2021-26 Equipment	2,50,170				2,50,170	15	37,526		37,526	2,12,644
IV. DST/AMT/AKS 0186/2022-25 Equipment	58,27,500	2,80,000		2,80,000	61,07,500	15	9,16,125		9,16,125	51,91,375
V. SERB/BLV/2023-26 Equipment	9,11,125				9,11,125	15	1,36,669		1,36,669	7,74,456
VI. DRDO/HSSRM/0217 Equipment			9,00,000	9,00,000	9,00,000	15	-	67,500	67,500	8,32,500
VII. SERB/KP0240 Equipment			11,17,595	11,17,595	11,17,595	15	-	83,820	83,820	10,33,775
VIII. SERB/ SA210 Equipment			8,13,750	8,13,750	8,13,750	15	-	61,031	61,031	7,52,719
IX. GAIL/ BLV0218 Equipment			31,860	31,860	31,860	15	-	2,390	2,390	29,470
Total (B)	8,75,09,929	2,80,000	28,63,205	31,43,205	9,06,53,134		1,31,68,490	2,14,741	1,33,83,231	7,72,69,903
Grand Total (A+B)	32,38,53,971	2,82,88,256	2,08,78,304	4,91,66,560	37,30,20,531		3,74,32,755	11,12,364	3,85,45,119	33,44,75,412
Previous Year	30,98,20,770	3,32,91,547	2,15,59,287	5,24,38,356	36,22,59,126		3,68,22,034	15,83,121	3,84,05,155	32,38,53,971



**CENTRE FOR NANO AND SOFT MATTER SCIENCES, ARKAVATHI, SHIVANPURA,
BENGALURU**

SCHEDULES FORMING PART OF THE ACCOUNTS FOR THE YEAR ENDED 31ST MARCH 2023.

SCHEDULE 24: SIGNIFICANT ACCOUNTING POLICIES AND NOTES ON ACCOUNTS

OVERVIEW:

Centre for Nano and Soft Matter Sciences is registered as a society under the Karnataka Societies Registration Act, 1960 and also registered under Section 12A of the Income Tax Act, 1961. It is an autonomous institution recognized and substantially funded by the Department of Science and Technology, Government of India.

The main objects of the Centre, inter-alia, are to conduct basic and applied research in Nano and Soft Matter Sciences and specifically focused on a variety of metal and semi-conductor nanostructures, liquid crystals, gels, membranes and hybrid materials.

A. SIGNIFICANT ACCOUNTING POLICIES:

1. **Accounting Conventions:** The financial statements are drawn up in accordance with historical accounting conventions and on the going concern concept. Accrual method of accounting is followed to record Income and Expenditure.

The guidelines as per the Uniform Format of Accounts for Central Autonomous Institutions, as applicable and to the extent practicable, are followed in the presentation of the financial statements of the Centre.

2. **Investments:** Investments are stated at cost and Interest from Investments are accounted on accrual basis.
3. **Fixed Assets:** Fixed assets are stated at written down value. Fixed assets are accounted at cost of acquisition, inclusive of inward freight, duties, taxes and incidental expenses related to acquisition.

All Capital Expenditure incurred during the year for acquisition of Fixed Assets is shown under the respective heads of Fixed Assets and depreciation thereof is charged to Income and Expenditure account.





4. **Depreciation:** Depreciation on Fixed assets has been provided on Written Down Value Method at rates as under.

	Depreciation Rate
MACHINERY AND PLANT – Computers including Computer Software	40.00%
MACHINERY AND PLANT – Electrical Equipments	15.00%
MACHINERY AND PLANT – Scientific and Other Equipments	15.00%
FURNITURE AND FITTINGS – including electrical fittings and electrical wiring	10.00%
BUILDING – NR : Infrastructure Labs Etc	10.00%

5. **Government Grants / Other Grants:** The Grants are received from the Government of India in the PFMS system, and if any unspent balance remains on 31st March, it automatically becomes zero. Capital grants received for procurement of Fixed Assets is credited to the capital fund account.
6. **Retirement Benefits:**
No provision has been made in respect of the Leave Encashment and Gratuity liability in the accounts as required by AS 15. However, the same is accounted on cash basis as and when the liability is discharged.
7. **Allocation / Transfer to Earmarked Project Funds:** The Centre has a policy to transfer interest earned on investments relating to project funds, to earmarked project funds, interest paid amount shown in Schedule-23. To meet exigencies in project related expenditure, a fund called Project Administration is maintained under project accounts and allocation of funds to any project is made out of the said fund.
8. The Receipts & Payments Accounts have been prepared from 2023-24 by using Accounting software named Tally Prime.

B. NOTES ON ACCOUNTS:

1. Claims against the Centre not acknowledged as debts Rs. NIL (Previous year Rs. NIL).
2. Foreign currency transactions are translated at the rates prevailing on the date of transaction.
3. Depreciation on fixed assets acquired out of Grant-in-aid amounting to ₹ 2,51,61,888/- is debited to Income and Expenditure account. Depreciation on fixed





assets acquired out of project funds amounting to ₹.1,33,83,231/- is debited to respective earmarked project account.


4. **Income Tax:** The Centre is registered under Section 12A of the Income Tax Act, 1961 and is eligible for exemption from tax and hence no provision has been made towards Income Tax.

5. **Prior period adjustments:**

a. Current Assets – 52,100/-

6. Figures are rounded off to the nearest rupee and figures of previous year have been regrouped and reclassified to conform to that of the current year.


7. Schedules 1 to 23 are annexed to and form an integral part of the Balance Sheet as at 31st March 2024 and the Income and Expenditure Account for the year ended on that date.


(VIVEK DUBEY)
ACCOUNTS OFFICER




(PROF. BHAGAVATULA L V PRASAD)
DIRECTOR

As per our report of even date
For M/s B R V GOUD & CO.
Chartered Accountants



(A B SHIVA SUBRAMANYAM)
PARTNER
Membership No. 201108



PLACE: BENGALURU

DATE: 16.09.2024



Annexures

Annexure A: List of Publications

1. Alloying with Mn enhances the activity and durability of the CoPt catalyst toward the methanol oxidation reaction. Deshpande, P., & Prasad, B. L. V., *ACS Applied Materials & Interfaces*, 15, 26554-26562 (2023) doi:10.1021/acsami.3c01140 IF=8.3
2. Influence of Van der Waals Interactions between the alkyl chains of surface ligands on the size and size distribution of nanocrystals prepared by the digestive ripening process. Shimpi, J. R., Thomas, R., Meena, S. K., & Prasad, B. L. V., *Langmuir*, 39, 17733-17744 (2023) doi:10.1021/acs.langmuir.3c02316 IF=3.7
3. Topological phases in nanoparticle monolayers: can crystalline, hexatic, and isotropic-fluid phases coexist in the same monolayer? Bhattacharjee, K., Vaidya, S. S., Pathak, T., Shimpi, J. R., & Prasad, B. L. V., *Soft Matter*, 19, 7271-7280 (2023) doi:10.1039/d3sm00290j IF=2.9
4. Polymer Nanocomposites with UiO-derived zirconia fillers for energy generation and pressure-sensing devices: the role of crystal structure and surface characteristics. Mukherjee, G., Verma, A., Madhu, A. H., Prasad, B. L. V., & Cherumannil Karumuthil, S., *ACS Applied Nano Materials*, 7, 5809-5818 (2024) doi:10.1021/acsnm.3c04730 IF=5.3
5. Ambipolar Columnar Self-assembled organic semiconductors based on heteroatom bay-annulated perylene bisimides. Behera, P. K., Yadav, K., Rao, D. S. S., Pandey, U. K., & Sudhakar, A. A., *Chemistry-an Asian Journal*, 18, e202300086 (2023) doi:10.1002/asia.202300086 IF= 4.1
6. Tris(boranyl) columnar liquid crystalline fluorophores: pseudo-triphenylene boron(iii) complexes with peripheral N-B-O linkages. Veerabhadraswamy, B. N., Khatavi, S. Y., Rathod, A. S., Kanakala, M. B., Rao, D. S. S., & Yelamaggad, C. V., *Chemistry - A European Journal*, 29, e202202987 (2023) doi:https://doi.org/10.1002/chem.202202987 IF=4.3
7. First example of ambipolar naphthalene diimide exhibiting a room temperature columnar phase. Behera, P. K., Yadav, K., Kumar, N., Gupta, R. K., Rao, D. S. S., Pandey, U. K., & Achalkumar, A. S., *Chemical Communications*, 59, 6028-6031 (2023) doi:10.1039/D3CC00321C IF=4.3
8. Anisotropic sol-gel transition and morphological aspects of a hierarchical network of nematic gel and a superimposed photopolymer. Varshini, G. V., Rao, D. S. S., & Prasad, S. K., *Journal of Materials Chemistry C*, 11, 7682-7696 (2023) doi:10.1039/D3TC00991B IF=5.7
9. Liquid-crystalline naphthalene and perylene bisimides with a d-2-pi(2)-a architecture for high-mobility organic field-effect Transistors. Vishwakarma, V. K., Roy, M., Singh, R., Rao, D. S. S., Paily, R., & Sudhakar, A. A., *ACS Applied Electronic Materials*, 5, 2351-2364 (2023) doi:10.1021/acsaelm.3c00179 IF=4.3
10. Modulating nanostructure morphology and mesomorphic properties using unsaturation in cardanol-azo benzenes. Raju, A., Kuthanapillil, J., Mathews, M., Rao, D. S. S., Vallooran, J. J., & John, G., *Chemical Communications*, 59, 5090-5093 (2023) doi:10.1039/d2cc06766h IF= 4.3
11. Twist-bend nematic drops as colloidal particles: Structural features. Krishnamurthy, K. S., Rao, D. S. S., Khatavi, S. Y., & Yelamaggad, C. V., *Physical Review E*, 107, 034706 (2023) doi:10.1103/PhysRevE.107.034706 IF=2.4
12. Highly soluble ambipolar anti-perylene-3,4:9,10 bis(benzimidazole)s stabilize a room-temperature columnar hexagonal phase. Behera, P. K., Yadav, K., Patra, A., Gupta, R. K., Rao, D. S. S., Kumar, S., Pandey, U.K. & Achalkumar, A. S., *Chemistry-A European Journal*, 29, e202302187 (2023) doi:10.1002/chem.202302187 IF=4.3
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19. Palladium nanoparticles decorated on functionalized graphitic carbon nitride as an efficient and retrievable nanocatalyst for organic dye degradation and hydrogen peroxide sensing. Antony, A. M., Yelamaggad, C. V., & Patil, S. A., *Materials Chemistry and Physics*, 297, 127370 (2023) doi:https://doi.org/10.1016/j.matchemphys.2023.127370 IF= 4.6
20. Biomacromolecule supported N-heterocyclic carbene-palladium(II) as a novel catalyst for Suzuki-Monaural and Mizoroki-Heck cross-coupling reactions. Antony, A. M., Chamanmalik, M. I., Kandathil, V., Sampatkumar, H. G., Sasidhar, B. S., Yelamaggad, C. V., & Patil, S. A., *Cellulose*, 30, 7551-7573 (2023) doi:10.1007/s10570-023-05323-4 IF=5.7
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68. Unraveled mesophase dynamics of discotic liquid crystal using combination of vibrational spectroscopy and DFT. Chaudhary, R., Yadav, A., Bahota, A. S., Agrawal, N., Prasad, V., Araújo, B. S., Ayala, Alejandro Pedro., Singh, Swapnil & Tandon, P., *Journal of Molecular Liquids*, 397, 124076 (2024) doi:https://doi.org/10.1016/j.molliq.2024.124076 IF=5.3
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- ### Conference Proceedings:
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- ### Book Chapter
1. Machine Learning Algorithms for Smart Gas Sensor Arrays. Joshi, N.J., Navale, S. (eds) .In: Advanced Structured Materials, in, Nanostructured Materials for Electronic Nose. Nath, V.G., Bharath, S.P., Dsouza, A., Subramanian
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Annexure B: List of V4 Programmes

V4 Science Programme @ CeNS

Date	Institution	Participation Details		Topic
		Student	Staff	
24 April 2023	Shivaji University- Kolahapur	11	1	Lab Visit
30 May 2023	REVA University- Bengaluru	49	2	Lab Visit
13 June 2023	Don Bosco Engineering College - Bengaluru	40	2	Lab Visit
04 July 2023	Surana College - Bengaluru	61	2	Lab Visit
31 August 2023	Acharya Engineering College - Bengaluru	28	2	Lab Visit
10 October 2023	100th V4 Programme	180	4	Lecture Sessions
07 December 2023	APS College of Engineering - Bengaluru	55	10	Lab Visit
28 February 2024	RNS PU College & Thygaraja Central School- - Bengaluru	82	4	Experiments from our Research Students. National Science Day
20 March 2024	SJB Institute of Technology - Bengaluru		30	Lab Visit
22 March 2024	Jain University - Bengaluru	40	2	Lab Visit

V4 Science Programme @ other institutions

Date	Institution	Participation Details		Topic
		Student	Staff	
17 November 2023	Rotary Malavalli High School	110	11	Let us Re-Learn to Lead Lab Visit Fun in Chemistry
15 March 2024	VIT Chennai	250	20	Energy Storage and Transparency Switching: Dual-functional Devices
18 March 2024	SJBIT, Bangalore	100	10	Display devices from crystals that flow
17 November 2023	Rotary School at Malavalli			Chemistry a friend or foe?
10 December 2023	School Chandan Laxmeswar			Transformation to Viksit Bharat: What is our role?
26 May 2023	CSIR, NCL - Pune			"Chemistry- A friend or a foe"
	Mahila University, Telangana			Nanoparticles with different 'Attires': Dressed to Function
09 October 2023	SRM University, Amaravati, Andhra Pradesh			What are 'Designed and Tailor Made Nanoparticles?'
17 October 2023	SRR and CVR Govt. College, Vijayawada, Andhra Pradesh			Careers in Nanoscience
02 November 2023	Sheshadripuram College, Bangalore			Chemistry a friend or foe?
09 Oct 2023	Dayanand Sagar University, Bangalore			Nobel Prizes in Chemistry
05 February 2024	Gandhi Institute of Technology and Management (GITAM), Visakhapatnam			MURTI-Distinguished Lecture Series Nobel Prize in Chemistry



नैनो एवं मृदु पदार्थ विज्ञान केंद्र

विज्ञान एवं प्रौद्योगिकी विभाग, भारत सरकार के अधीन एक स्वायत्त संस्था

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