



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

# ANNUAL REPORT 2021 2022

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## Foreword

Centre for Nano and Soft Matter Sciences (CeNS) has entered the eighth year of its existence under the renewed and expanded mandate of doing scientific research on nanoscience and technology interlaced with soft matter principles and focusing on translational activities.

CeNS witnessed several watershed moments during 2021-22, the period of this report. Firstly, work had to be carried out over several months under stringent lockdown conditions due to the COVID-19 pandemic, primarily caused by the most virulent Delta variant. Adding to the hardship was that during the same period, the Centre had to shift the campus from the safe havens in Jalahalli to the vast, uncertain terrains of the Arkavathi campus of Shivanapura. Under these testing circumstances, I took over as the new Director of CeNS on 1 July 2021. Despite the pandemic and the shifting of the location being a twin blow, the valorous and relentless efforts of every CeNSian helped us come through this victoriously. These efforts have paid well in making the new campus look beautiful and, more importantly, functional to almost its full potential.

Around the time, a change of guard happened at our parent organization DST also. Prof. Ashutosh Sharma demitted office as Secretary DST on 31st August 2021. We are happy to note that the new Secretary, Dr. Chandrasekhar Srivari, is an equally ardent supporter of CeNS, and look forward to his continuing support and encouragement. The Governing Council and the Research Advisory Board of CeNS have been reconstituted, with Prof. KN Ganesh as the Chairperson of the GC and Prof. DD Sarma heading the RAB, with both committees packed with persons of vision and foresight. Indubitably, CeNS stands to gain significantly from the collective wisdom of both these teams.

As the details included in this report show, despite the odds loaded against us, the Centre's academic performance has been exceptionally good over the year. To quote numbers, 59 research articles are published, 10 invention disclosures filed, and 4 patents granted. Many prototypes coming out of our labs and displayed in the Greenhouse gallery have received their due share of appreciation from academic visitors, industry leaders and well-wishers of CeNS; some of them have the potential to enter the market. A notable mention is the triboelectric mask, developed at the Centre and technology transferred to M/s Camelia Industries. Perhaps there is no greater pride than seeing the logo of CeNS printed on a commercial product.

CeNS continued its academic activities with renewed vigour. The major one among these, just as in the previous years, is the induction of highly motivated postgraduate students into the PhD programme. The academic interactions in the form of seminars, workshops, etc., which could be held only in the online mode, are now progressively held in the usual in-person mode. In a similar fashion, our popular outreach programme, विज्ञान-विद्यार्थि विचार विनिमय (V4) is drawing an increasing number of visitors to the new campus.

Several CeNSians have been recognized with national and international awards, Editorial Board Memberships of reputed journals and featured in science stories in print as well as electronic media. Not to be left behind, many of our students have brought laurels to CeNS with their exceptional performance. Kudos to each one of them.

Energy, environment and manufacturing sectors are poised for tremendous growth with GoI announcing remarkable initiatives such as the National Hydrogen Mission, massive support for the Development of Semiconductor and Display Manufacturing Eco System and the "Panchamrit Agenda", unveiled by the Honourable Prime Minister of India at the COP 26 summit. The calls associated with these initiatives are ambitious and have been tied with clear goals, consequently being a boon to the Indian research community. CeNS is ideally poised to work in these areas and make noteworthy contributions.

The path ahead is not devoid of challenges with inadequate lab space, sub-critical strength of the student force, infrastructure constraints, lack of necessary amenities nearby and commuting issues owing to the remote location of the campus, being matters of much concern. I assure you all that, the leadership and administration at CeNS, together with expert guidance from GC and RAB members, and DST, is unremittingly working on each of these issues and resolving them.

DIRECTOR





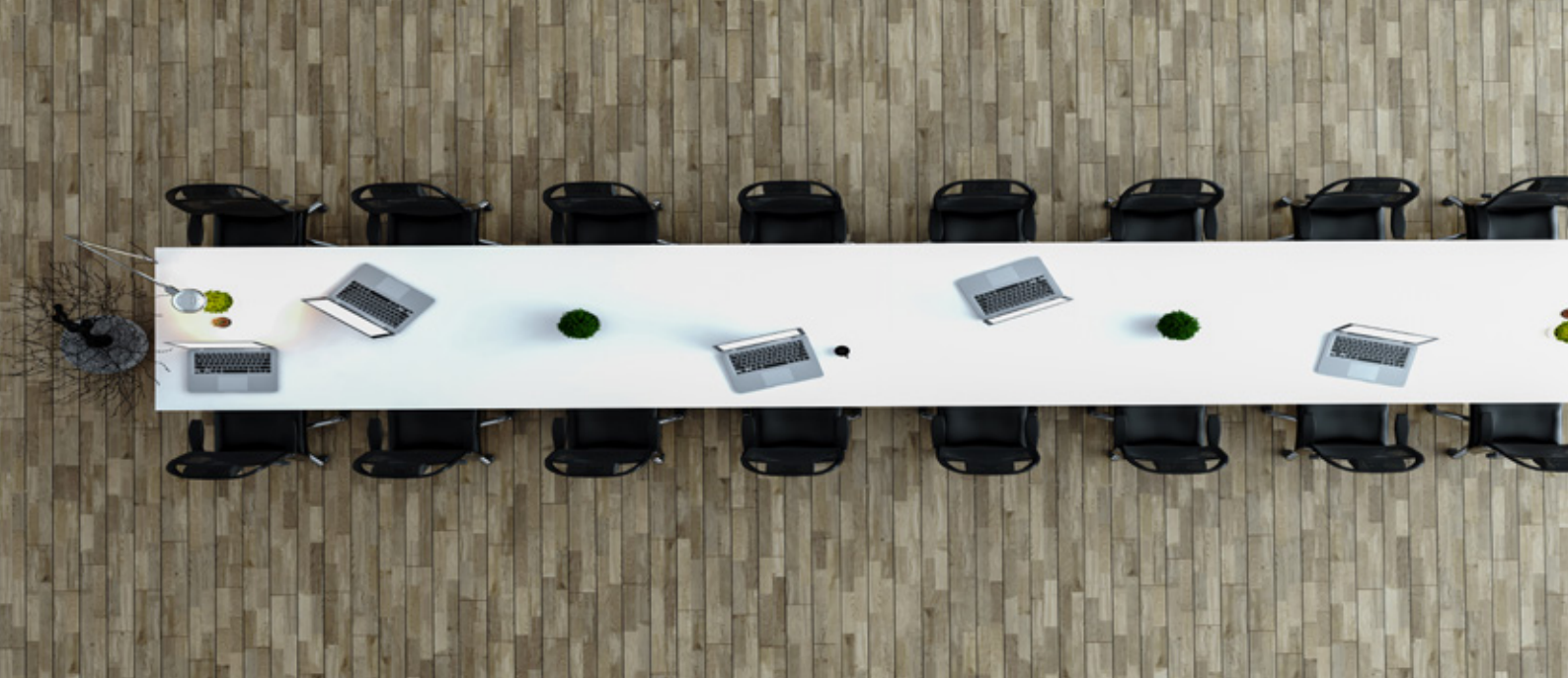
# 1. Introduction

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 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, then 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, it was brought under DST. Subsequently, in the year 2010, the name was changed to Centre for Soft Matter Research. In 2014, the Centre further widened the scope of research activities to embrace nanoscience and technology and is now known as Centre for Nano and Soft Matter Sciences (CeNS). It is being mentored by the Nano-Mission of the Government of India.

The major research facility at the campus is housed in 'Materials Laboratory', which hosts several sophisticated equipment grouped thematically under different labs such as Fabrication Lab, Energy Lab, Gas sensor Lab, TEM-SEM Lab, Micro-Spectroscopy Lab, XRD-Thermo Lab and the Tata Steel Advanced Materials Research Centre (TSAMRC) Lab. The access to the research facilities in the Materials Laboratory is made user-friendly to the researchers, both internal and external, via online operations covering the slot booking to each facility up to payment through the web portal, Central Research Facilities (CRF). The CRF and the day-to-day functioning of Materials Laboratory is managed by the 'Greenhouse', the Technology Business Incubator Project which functions as a virtual Section 8 company helping CeNS researchers to take up entrepreneurship for translational activities. In order to facilitate such activities, a 'Technology Laboratory' which is a group of incubation labs fostering technology development activities is also created. The individual faculty labs for material synthesis, sample preparation and device fabrication along with faculty offices are located in 'Bay Lab'. With its renewed research mandate, CeNS reaffirms its vision to work in pursuit of Global excellence in science and to nurture Indigenous Technology for the betterment of Our Country.



## 2. Governing Council

### Chairman

Prof. K N Ganesh

Professor and Coordinator, Chemistry  
Director, Indian Institute of Science Education and  
Research Tirupati

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Andhra Pradesh

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Member (Ex officio)

Secretary to Government of India  
Department of Science and Technology  
Government of India

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New Delhi 110 016

Shri Vishvajit Sahay

Member (Ex officio)

Additional Secretary & Financial Adviser  
Department of Science and Technology  
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Prof. Pallab Bannerji

Member

Professor and Former Head  
Materials Science Centre  
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Kharagpur, India 721 302

Prof. Shreepad Karmalkar,

Member

Department of Electrical Engineering  
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Chennai, Tamil Nadu - 600 036

Mr. Raja Sekhar M.V.

Member

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Bharat Electronics Limited  
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Bengaluru - 560 045

Prof. Ashok K Ganguli

Member

Deputy Director (Strategy & Planning)  
Professor, Department of Chemistry  
Professor, Department of Materials Science &  
Engineering  
Institute Chair Professor  
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New Delhi 110 016

Prof. K. George Thomas

Member

Professor, School of Chemistry & J C Bose National  
Fellow  
Indian Institute of Science Education and Research,  
Thiruvananthapuram (IISER-TVM)  
Maruthamala PO, Vithura,  
Thiruvananthapuram - 695 551

Prof. Umesh V Waghmare

Member

Professor, Theoretical Sciences Unit  
Jawaharlal Nehru Centre for Advanced Scientific  
Research  
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Prof. Bhagavatula L.V. Prasad

Member - Secretary

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

#### Members

Dr. Ashish Lele  
Director  
CSIR-National Chemical Laboratory,  
Dr. Homi Bhabha Road, Pune – 411 008

Prof. Chandrabhas Narayana  
Director  
Rajiv Gandhi Centre for Biotechnology  
Thiruvananthapuram, Kerala – 695 014

Dr. Sumitesh Das  
Director, Tata Steel UK R&D  
Tata Steel Limited  
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Jamshedpur – 831 007

Prof. P. B. Sunil Kumar  
Director  
Indian Institute of Technology, Palakkad  
Ahalia Integrated Campus, Kozhippara PO,  
Palakkad, Kerala 678 557

Dr. Tata Narasinga Rao  
Director (Additional Charge)  
International Advanced Research Centre for Powder Metallurgy  
& New Materials (ARCI), Balapur P.O.  
Hyderabad-500 005

#### Convener

Prof. Bhagavatula L.V. Prasad  
Director, Centre for Nano and Soft Matter Science  
Arkavathi, Survey No.7, Shivanapura,  
Dasanapura Hobli, Bengaluru – 562 162

## 4. Scientists and Admin Staff

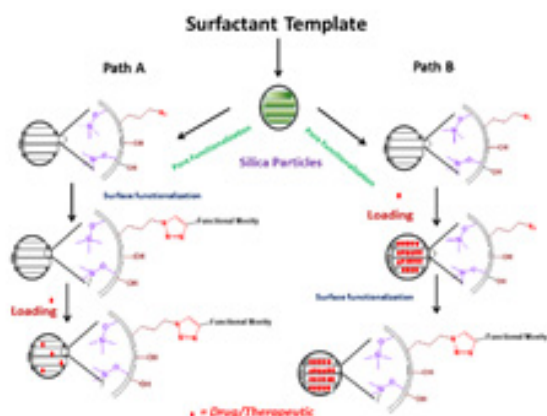
Name	Designation
Prof. Bhagavatula L.V. Prasad	Director
Prof. G. U. Kulkarni	Adjunct Professor
Dr. Geetha G. Nair	Scientist F
Dr. D. S. Shankar Rao	Scientist F
Dr. Veena Prasad	Scientist F
Dr. C. V. Yelamaggad	Scientist F
Dr. S. Angappane	Scientist E
Dr. P. Viswanath	Scientist E
Dr. Neena Susan John	Scientist E
Dr. Pralay K. Santra	Scientist D
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. S. Krishna Prasad	Honorary 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 Assistant
Ms. Sandhya D. Hombal	Technical Assistant
Mr. M. Jayaram	Assistant
Dr. Nayana J.	Library Assistant
Mr. Jayaprakash V. K.	Support Staff

## 5. Research and Development Activities

### 5.1 Nanomaterials and Composites

**Amphi-functional mesoporous silica nanoparticles with “molecular gates” for controlled drug uptake and release**



Methods of drug loading into surface functionalized mesoporous silica nanoparticles: Path A; Carrying out the surface functionalization first and then drug loading (this is the conventional path); Path B: Loading the drug first and then carrying out the surface functionalization (current method). The drug loading was always found to be higher when Path B was followed.

Selective chemical functionalization strategies have been used to transform the Mesoporous Silica Nanoparticles (MSNs) to amphi-functional systems where the pores are tuned to absorb hydrophobic drugs and outer surface was modified to be more stable under physiological conditions. In these studies, it was found that the size of outer surface modifications/coatings will adversely impact the total amount of drug that can be loaded and released and that the presence of bulkier surface groups does hinder the access of drug to hydrophobic pockets of particles (especially when the surface functionalization was carried out first and then the drug was loaded). To counter this an alternate sequence of drug loading and surface functionalization was employed where the drug was loaded first into the pores and then the surface functionalization (fixing the gate) was carried out. This was seen to result in higher drug loading capacity. It is clear from the observations that drug loading-surface functionalization sequence plays very crucial role in the final efficiency and performance of these DDS. It is expected that the findings of these studies would prove useful as guiding principles to design better drug delivery systems.

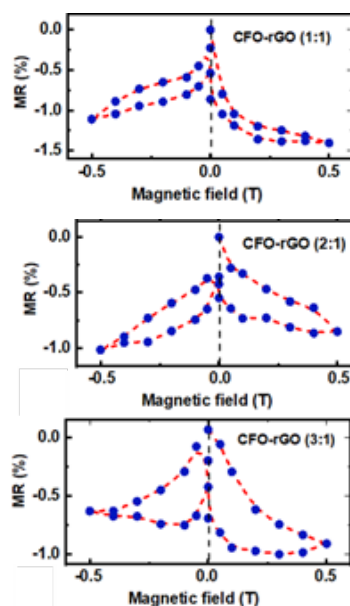
See: Particle & Particle Systems Characterization,

38,2100185 (2021)

Investigators: Bhagavatula L. V Prasad

Collaborators: Pravin Shinde, CSIR- National Chemical Laboratory, Pune.

**Observation of room-temperature low-field magnetoresistance in reduced graphene oxide/CoFe<sub>2</sub>O<sub>4</sub> nanocomposites**



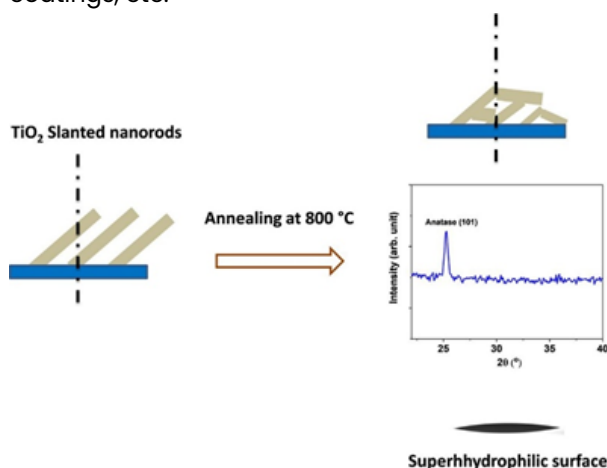
The room-temperature magnetoresistance (MR) properties of reduced graphene oxide (rGO)/cobalt ferrite (CFO) nanocomposites were studied in this work. The CFO nanoparticles were synthesized by chemical methods and mixed with rGO in different mass ratios. The magnetic field-dependent electrical resistivity shows a decrease in resistivity with the increase in magnetic field from 0 to 0.5 T, representing a negative MR in our samples. The highest MR of around -1.4% is observed in the 1:1 ratio CFO and rGO nanocomposite, whereas the samples with 2:1 and 3:1 ratio show the MR of ~-1%. In the CFO-rGO nanocomposite, the charge transport takes place mainly through the rGO layers due to the insulating nature of the CFO nanoparticles. However, the ferromagnetic moments of the CFO nanoparticles induce electron-spin scattering during the charge transport. The reduction in electron-spin scattering results due to the parallel alignment of the magnetic moments of CFO under the applied field.

See: Physica Status Solidi B, 258, pp 2100033 (2021).

Investigators: Subir Roy, Iniyan Sivakumar, Femy Francis, Varshini G. V. and S. Angappane

### Dimensional constraints favour high temperature anatase phase stability in TiO<sub>2</sub> nanorods

High temperature stable anatase phase TiO<sub>2</sub> nanostructures have the potential to advance the fields such as photocatalysis, solar cells and batteries. However, it is challenging to grow TiO<sub>2</sub> nanostructures that can retain the anatase phase at high temperatures. The slanted TiO<sub>2</sub> nanorods grown on Si substrates by glancing angle deposition technique employing electron beam evaporation showcase the anatase phase stability up to 800°C. FESEM surface morphology shows that the nanorods started deforming above 600°C and collapsed at 800 °C. The X-ray diffraction and Raman spectroscopy utilized for the phase information showed that the anatase phase is stable even at 800°C. Further, the effect of deformation on wettability of the nanorods system was explored. The stable high temperature anatase phase could find application in the solar cells, photocatalysis, smart windows, self-cleaning coatings, etc.



*See: Applied Surface Science, 577, pp 151874 (2022)*

*Investigators:* Gaurav Shukla and S. Angappane

### Inorganic Graphene Analogs (IGAs): Solution Processing and Applications

In fast emerging technologies such as 3D printing, the demonstrated use of graphene indicates the possibility of integrating IGAs, that could appreciably expand the current boundaries of 2D materials. With the increasing use of these materials, other relevant aspects such as environmental effects and impact on biological systems will require attention. As of now, there is a limited understanding of such implications. An in-depth comprehension of biological interactions such as cytotoxicity, degradability, and accumulation will be required to help bridge the gap and facilitate their incorporation in advancing areas such as drug delivery, nanotheranostics,

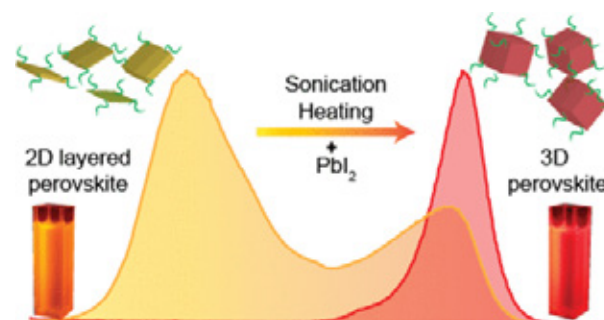
and bioelectronics. Therefore, there lies significant scope for exploring the many attributes possessed by this class of materials. The facile solution processable approaches that result from these studies could reach out across many diverse fields.

*See: Material Matters, 1, pp 14 (2021)*

*Investigators:* Kenneth Lobo and H S S Ramakrishna Matte

### Growth mechanism of 2D layered perovskites to 3D perovskites in the sonochemical synthesis and their application

Two-dimensional (2D) layered Ruddlesden-Popper metal halide perovskites (MHPs) show enhanced stability compared to three-dimensional (3D) MHPs. The general formula of 2D layered perovskite is  $L_2A_{n-1}M_nX_{3n+1}$ , where L is the large organic spacer and n is the number of metal octahedra. However, the syntheses of such 2D layered perovskites yield a mixture of 3D and 2D layered perovskites with different layers of the metal octahedra. A team of CeNS researchers and scientists have synthesized 2D layered  $(MA)_{n+1}Pb_nI_{3n+1}$  perovskite by the sonochemical method and have shown that the dimensionality “n” can be controlled by the sonication time and reaction temperature. Using absorption and photoluminescence spectroscopy, the team have probed the reaction and growth mechanisms of the 2D layered perovskites and their transformation to 3D MAPbI<sub>3</sub> (MAPI). The team also demonstrated that these mixed (2D layered and 3D MAPI) perovskites could be used to fabricate a white light-emitting diode.



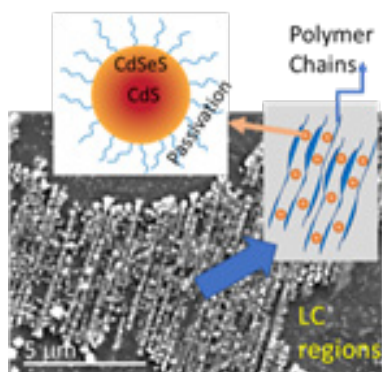
*See: Journal of Physical Chemistry C, 125, pp 12131–12139 (2021)*

*Investigators:* Modasser Hossain, Trupthi Devaiah C, and Pralay K. Santra

### Polymer confinement enhances luminescence, electric-field and actinic-light modulation of emission in nematic-CdSeS gradient quantum dot composites

Dispersing a small amount of CdSeS gradient quantum dots (QDs) in a nematic liquid crystal and geometrically confining the nanocomposite in a polymer network is observed to result in ordered

linear assembly of QDs, as observed through electron microscopy. Such an orientational order not only enhances the base photoluminescence (PL), but brings in significant anisotropy in the emission magnitude, a feature barely seen for the system without the polymer network. A high frequency (~kHz) AC field adds the attractive dimension of on-demand and spatially addressable PL modulation. Using a photoisomerizable azobenzene derivative and a carefully selected excitation wavelength, it is shown that an actinic-light driven modulation of PL is also possible, which is further enhanced by the presence of the polymer network.



**See:** *Journal of Molecular Liquids*, 347, pp 118004 (2022)

**Investigators:** Pragnya Satapathy, V. Navyashree, J. Oinam and S. Krishna Prasad.

## 5.2 Phase Transitions

### Investigation of mesomorphic, photophysical and gelation behavior in aroylhydrazone based liquid crystals

Five series of substituted aroylhydrazone based mesogens having alkoxy chains at 3- and 5- positions at amide end have been synthesized and investigated. The first series with alkoxy chain at 4- position shows columnar hexagonal (Colh) mesophase. The series with alkoxy chains at 3- and 5- positions shows transition from Colh to columnar rectangular (Colr) on cooling for lower chain lengths. Higher chain lengths show Colh mesophase. The series with alkoxy chains at 3- and 4- positions shows Colr mesophase. The series with alkoxy chains at 2-, 3- and 4- positions shows change from Colr to columnar oblique (Colob) mesophase on cooling. The series with alkoxy chains at 3-, 4- and 5- positions shows transition in Colh mesophase. The studies confirmed the direct impact of the self-assembly of these molecules on the terminal alkoxy chain length, number of chains as well as position of chains around the core group.

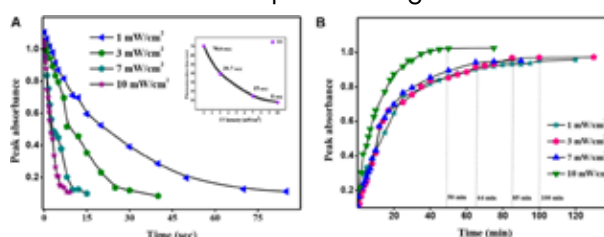
**See:** *Journal of Molecular Liquids*, 346, pp 117084-1-13 (2022)

**Investigators:** D S Shankar Rao, & S Krishna Prasad

**Collaborators:** Priyanka Kanth & Bachcha Singh, Centre of Advanced Study, Institute of Science, Banaras Hindu University, Varanasi

### Evaluation of photoswitching properties for hockey stick-shaped mesogens bearing azobenzene moieties

The photoresponsive behavior of hockey stick-shaped mesogens bearing azo wing with different terminal alkoxy chains at one end are investigated. Except for the compound E16 which exhibits a SmC phase along with a nematic phase, all the other compounds are found exhibit only a nematic mesophase. The influence of varying alkoxy chain lengths on the photo-physical properties of these are investigated using UV-vis spectroscopy. It is observed that the influence of chain length is almost negligible on the thermal back relaxation time. Spectroscopic investigation with variable intensities of UV light studies reveal that reverse cis-trans isomerization process was inversely proportional to the intensity of illuminated light. A spectroscopic study of the solid sample using guest-host mixture was also carried out and the compilation of results forecast these mesogens as ideal candidates for optical storage devices.



(A) Photosaturation time versus UV intensity plot for E-Z isomerization and (B) Thermal back relaxation or Z-E isomerization of compound E12 with different intensities.

**See:** *Frontiers in Physics*, 9, pp 728632 (1-9) (2021)

**Investigators:** Monika M. and Veena Prasad

**Collaborators:** B. N. Sunil, B.M.S. College of Engineering, Bengaluru; G. Shanker, Jnana Bharathi Campus, Bengaluru University, Bengaluru; Gurusurthy Hegde, CHRIST (Deemed to be University), Bengaluru.

### Multiple pathways to stabilize/induce an ordered phase in a system exhibiting a reentrant sequence

Liquid crystals have served as model materials for observing reentrant phases realized through chemical and thermodynamic routes. Such a reentrant nematic necessitates the existence of an intermediate smectic phase. Here we demonstrate that additives like CNT, non-aromatic polymer, or photoisomerization of a weakly polar compound also stabilize the SmA<sub>d</sub> phase if it already exists or induces, in turn a resultant re-entrant phase sequence if not present in the thermal sequence. The left panel of Figure represents the POM images





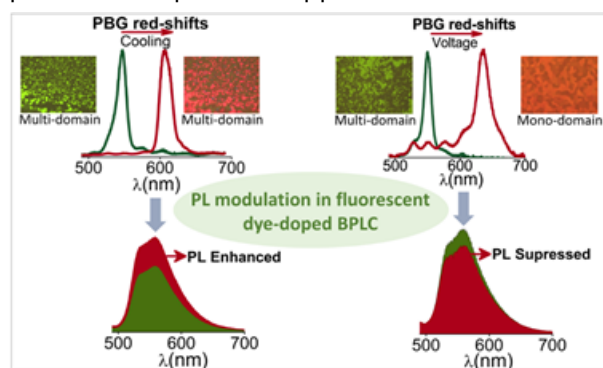
between its anisotropic limits. The experimental findings are supported by theoretical calculations based on Mie theory and simulations based on Finite Elements Method (FEM) which also reveal the formation of photonic nanojet from the particle.

*See: Journal of Molecular Liquids, 346, pp 117116 (2022)*

**Investigators:** Amit Bhardwaj, Vimala Sridurai, Navas Meleth Puthoor, Geetha G. Nair.

### Effect of photonic band gap on photoluminescence in a dye-doped blue phase liquid crystal

This work demonstrates the modulation of photoluminescence intensity in a fluorescent dye-doped blue phase liquid crystal (BPLC), a 3D soft photonic crystal. On cooling, from the isotropic fluid phase, the photoluminescence (PL) intensity in the BPLC gets enhanced due to the overlapping of the emission wavelength of the dye with the photonic band edge of blue phase liquid crystal. However, the PL intensity decreases on the application of electric field, despite both thermal and electric fields have similar effect (red-shift) on the photonic bandgap. The contrasting behaviour of PL intensity is explained in terms of scattering pathways for the emitted photons. The time-resolved photoluminescence studies show a reduction in the lifetime of the excited species of dyes upon cooling which validates the thermal dependence of PL intensity modulation due to Purcell effect. The facile modulation of PL intensity in the dye-doped blue phase system makes it appealing from the point of view of high-performance photonic applications.

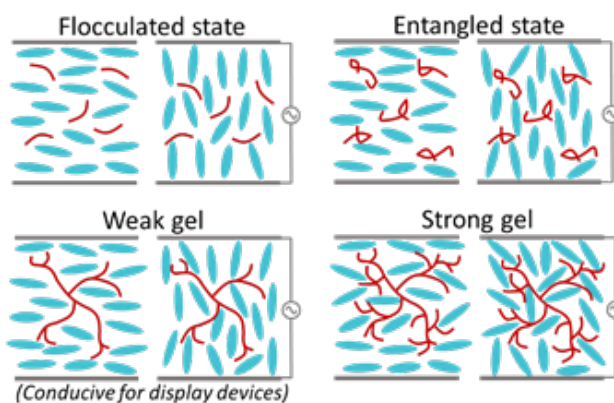


*See: Journal of Physical Chemistry B, 125, pp 11582–11590 (2021)*

**Investigators:** Nurjahan Khatun, Vimala Sridurai and Geetha G. Nair

### Interplay between bulk and molecular viscosity of a soft glassy nematic gel

The interplay between viscosity at bulk and molecular levels is studied in a nematic liquid crystal (NLC) gel prepared from a NLC host and a simple organogelator. The calorimetric and rheological

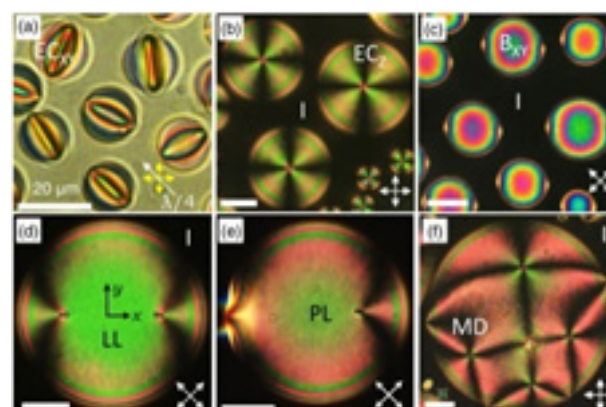


measurements distinguish between four different states depending on the gelator concentration: (i) flocculated fluid, where the nematic host and gelator molecules coexist without gel fibre formation; (ii) entangled solid, where the gel fibres exist as entangled aggregates without network formation; (iii) weak gel, which is a structured fluid and (iv) strong gel, with cross-linked gel network confining the host nematic. Electro-optic and rheological studies indicate that in the weak gel, the rotational viscosity and response time reduce by an order of magnitude whereas, the bulk viscosity gets enhanced, also by same factor, along with suppression of the undesirable backflow. Thus, the enhanced mechanical strength and electro-optic parameters make the weak gel preferred for LC display and switching devices.

*See: Liquid Crystals, pp 1–12 (2021)*

**Investigators:** S. Vimala and Geetha G. Nair

### Structure, stability, and electro-optic features of nematic drops in 1,7-bis(4-cyanobiphenyl-4-yl) heptane–surfactant binary systems



Typical textures of nematic drops with varying orientational structure observed in the N-I coexistence region of CB7CB–surfactant binary systems. (a) Escaped concentric or toroidal drops ECXY with their axes in the xy plane; CDP3. (b) Escaped concentric drops ECZ with their axes along z; COP5. (c) Bipolar drops BXY with their axes in the xy plane; CTA5. (d) Bound vortex drops with a pair of +21 disclination lines, LL; COP5. (e) Hybrid drop with the pole-half-line combination; PL; COP5. (f) Multiple

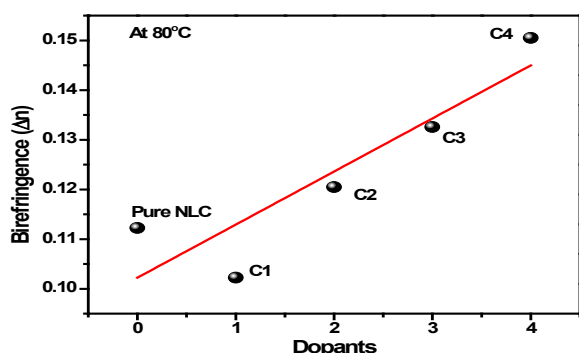
defects drop MD; COP5.  $d = 20^{\circ}\text{m}$ .  $T = 92^{\circ}\text{C}$  (a),  $91^{\circ}\text{C}$  (b), (d), (e),  $100^{\circ}\text{C}$  (c),  $90^{\circ}\text{C}$  (f). Double arrows indicate the transmission axes of polarizers.

Subjected to tangential boundary conditions, the drops of mixtures of the mesogen CB7CB and a long chain amphiphile adopt, the less common bound vortex geometry with a pair of half-strength disclination lines. The concentric drop, as it grows, switches its axis from an in-layer to the layer-normal direction. Bipolar drops in equilibrium have their axes parallel to the easy axis of the cell. Obliquely oriented bipolar drops rotate to attain the equilibrium disposition by the shorter of the clockwise and anticlockwise routes, the extent of rotation decreasing exponentially with time. The bipolar structure is marginally less stable than the concentric, and transforms to the latter geometry occasionally. In bound vortex drops, the separation between the lines varies as the drop diameter, the bipolar and concentric geometries appearing as the limiting cases.

*See: Physical Review E 105, pp 024709 (2022)*

**Investigators:** K S Krishnamurthy, D S Shankar Rao, Shreya Sharma & Channabasaveshwar V Yelamagad

#### Porous carbon nanoparticles dispersed nematic liquid crystal: influence of the particle size on electro-optical and dielectric parameters



Change in birefringence with respect to different sized dopants at  $80^{\circ}\text{C}$

Porous carbon nanoparticles (PCNPs) of four different sizes ( $\sim 180\text{ nm}$ ,  $\sim 51\text{ nm}$ ,  $\sim 41$  and  $\sim 25\text{ nm}$ ) were dispersed into a nematic liquid crystal (NLC) in 0.25 wt% concentration. PCNPs were derived from biowaste materials and pyrolyzed at elevated temperatures to get the porous structure. Polarising optical microscopic observations were carried out in dark and bright states on both the pure NLC as well as NLC-PCNPs composites. Homogeneous alignment was well maintained in all the composites except the one with the highest sized ( $\sim 180\text{ nm}$ ) PCNPs. Birefringence, relative permittivity and dielectric anisotropy, increases as the size of the PCNPs is decreased in the

composites. The threshold voltage was also found to decrease with the decrease in the size of the PCNPs. Such investigations may be useful for the fabrication of display devices such as flat panel displays (FPDs) and phase shifters.

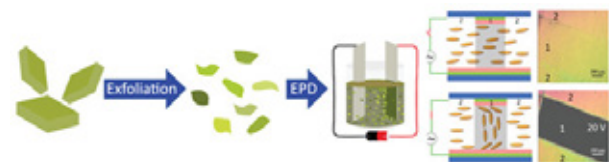
*See: Liquid Crystal, pp 1-12 (2021)*

**Investigators:** Govind Pathak, Rekha S. Hegde and Veena Prasad

**Collaborators:** Supriya S Punjalkatte, Gurumurthy Hegde, Centre for Nano-materials & displays, B.M.S. College of Engineering, Bengaluru, Thitima Rujiralai, Centre of Excellence for Innovation in Chemistry and Division of Physical Science, Prince of Songkla University, Thailand.

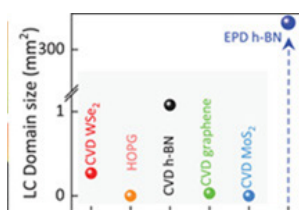
#### Solution-processed h-BN film as an alignment layer for liquid crystal devices: realization of a non-polymer approach for unidirectional alignment over unprecedentedly large areas

Fabrication of liquid crystal devices heavily relies on the alignment layer providing the mandatory unidirectional orientation of the nematic molecules. Drawbacks of the traditional mechanically rubbed polymer layer have prompted to find better alternatives. However, cost-effective methods for large-area unidirectional alignment are still elusive. The latest attempt has been to use 2D materials deposited through the well-known chemical vapor deposition process, invariably inviting all the associated complexities including high-temperature processing, cumbersome transfer onto the required substrate, etc. Most importantly, the achieved domain size over which the nematic molecules exhibit unidirectional planar orientation, has been too small ( $\text{sub-mm}^2$ ) for employable devices. Here, the authors present a room temperature solution process for obtaining



h-BN dispersion and directly depositing it as a film on the device substrate using the electrophoretic technique. The achieved layer far surpasses the size limitation

mentioned above, resulting in unidirectional LC orientation over at least  $4\text{ cm}^2$  and promising for much larger areas with the electrical and electro-optic switching performance being comparable to an industry-standard device. The success of this simpler method establishes 2D materials as strong contenders for achieving non-contact LC alignment and, in a broader sense, brings the





much-needed impetus to explore new horizons for solution-processed devices.

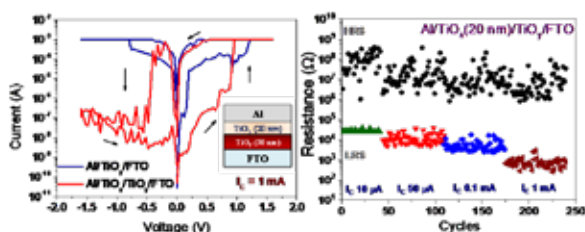
*See: Advanced Materials Interfaces, pp 2200486 (2022)*

**Investigators:** Gayathri R Pisharody, D S Shankar Rao, S Krishna Prasad, Priyabrata Sahoo and H S S Ramakrishna Matte

## 5.4 Displays and Devices

### Low power multilevel resistive switching in titanium oxide-based RRAM devices by interface engineering

A simple bilayer oxide-based device structure of  $\text{Al}/\text{TiO}_x/\text{TiO}_y/\text{FTO}$  ( $x < y$ ) was employed to address the variability issue and improve the overall performance of the memory device. The bipolar resistive switching performance remarkably improved in these bilayer devices with lower forming voltage ( $\sim 1$  V), set/reset voltages of 0.4/–0.6 V, a programming current of 10  $\mu\text{A}$ , an enlarged ON/OFF ratio ( $>10^3$ ), longer retention ( $>10^3$  s), and better uniformity as compared to the control  $\text{Al}/\text{TiO}_y/\text{FTO}$  device. Moreover, the modulation of  $\text{TiO}_x$  layer thickness enables tunability of switching voltages, currents, and the resistance window. In addition, reliable and reproducible multiple resistance states, more specifically different low resistance states, can be achieved in bilayer devices by controlling the programming current down to 10  $\mu\text{A}$ . These findings pave the way for low power, low cost, and high-density data storage applications.



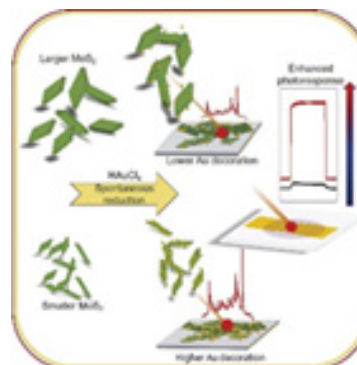
*See: Journal of Science: Advanced Materials and Devices, 6, pp 601–610 (2021)*

**Investigators:** S. P. Swathi and S. Angappane.

### Spontaneous formation of gold nanoparticles on $\text{MoS}_2$ nanosheets and its impact on solution-processed optoelectronic devices

Understanding size-dependent properties of 2D materials is crucial for their optimized performance when incorporated through solution routes. In this work, the chemical nature of  $\text{MoS}_2$  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 higher extent of reduction. Further corroboration through

surface-enhanced Raman scattering using the gold-decorated  $\text{MoS}_2$  nanosheets as substrates exhibited an enhancement factor of  $1.55 \times 10^6$  for smaller nanosheets which is 7-fold higher as compared to larger nanosheets. These plasmonic-semiconductor hybrids are utilized for photodetection, where decoration is found to impact the photoresponse of smaller nanosheets the most, and is optimized to achieve responsivity



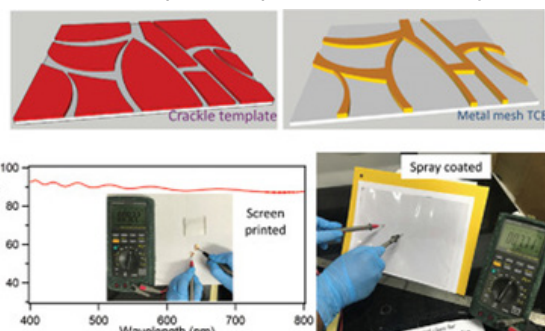
of  $367.5 \text{ mAW}^{-1}$  and response times of  $\sim 17$  ms. The simplistic modification via solution routes and its impact on optoelectronic properties provides an enabling platform for 2D materials-based applications.

*See: iScience, 25, pp 104120 (2022)*

**Investigators:** Kenneth Lobo, Vijaya Kumar Gangaiah, Harsha Priya and H.S.S. Ramakrishna Matte

### Large-area, flexible, transparent conducting electrodes using screen printing and spray coating techniques

Fabrication of large-area transparent conducting electrodes (TCEs) of high performance through cost-effective high throughput methods has been an area of intensive research. In this context, the fabrication of flexible,  $25 \text{ cm}^2$  wide TCEs with high figure of merit (FoM) ( $\sim 494 \Omega^{-1}$ ) is achieved by two roll-to-roll compatible processes, namely screen



printing and spray coating, by suitably modifying crackle lithography in a cost-effective manner. The fabricated TCEs exhibit low sheet resistance ( $<10 \Omega/\text{sq}$ ) and high transmittance ( $\sim 86\text{--}90\%$ ) in

the visible region. The TCEs are shown to be highly bendable, the change in the sheet resistance is only ~2% up on 6000 bending cycles. The application of these TCEs as transparent bendable uniform Joule heaters and surface capacitive touchscreens has also been demonstrated. The TCEs are, thus, just as good as any TCE produced using spin-coating or similar small area coating techniques.

*See: Advanced Materials Technologies, pp 2101120 (2021)*

**Investigators:** Remya K. Govind, Indrajit Mondal, Kaushik Baishya, Mukhesh K. Ganesha, Sunil Walia, Ashutosh K. Singh and G. U. Kulkarni

**Collaborators:** Prof. G. U. Kulkarni, JNCASR-Bengaluru.

### SnO<sub>2</sub>@Al-mesh hybrid electrodes as an alternative of ITO plates for smart window applications

CeNS scientists have come-up with an inexpensive recipe of making transparent conducting electrodes which has properties similar or better than ITO plates. Although ITO is supreme as a material, it is quite expensive due to the low abundance of In and deposition involving vacuum sputtering. The price of a ITO coated plate depends critically on its sheet resistance; as ultralow sheet resistance (<5 ohm/square) is possible only for thickness above 2000 nm which is to be achieved through prolonged deposition, the cost can shoot up several times non-linearly. To overcome this issue of non-uniform electric field in metal mesh electrode, a hybrid electrode fabricated, in which, a thin conducting layer of oxide SnO<sub>2</sub> is coated over Al- mesh by solution spray coating process. These electrodes are used to fabricate various prototype devices such as polymer dispersed liquid crystal (PDLC) based smart window shown in pictures below.



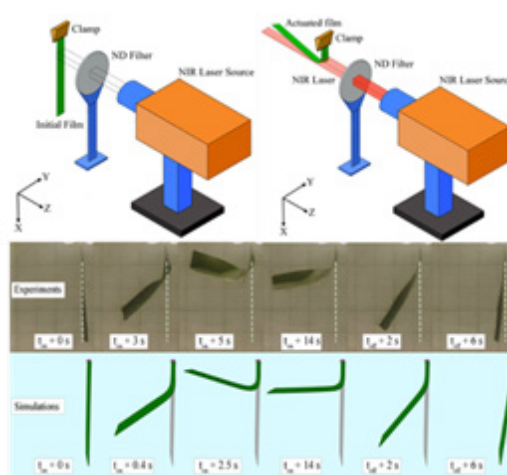
*See: Journal of Materials Chemistry A, 9, pp 23157-23168 (2021)*

**Investigators:** I. Mondal, S. Kiruthika, M. K. Ganesha, M. Baral, A. Kumar, S. Vimala, P. L. Madhuri, G. G. Nair, S. K. Prasad, Ashutosh K. Singh

**Collaborators:** Prof. G. U. Kulkarni, JNCASR-Bengaluru

### Liquid crystal polymer networks photo-stimulate fast bidirectional actuator

NIR-driven Photo-thermo-mechanical actuation has been achieved in spatially splay-deformed LCN films fabricated by crosslinking a mixture of mono-functional and bi-functional liquid crystal



mesogens and incorporating NIR-active dye into the system. The observed large magnitude macroscopic shape change arises due to the significant rise in the local temperature and the ensuing order-disorder transition. Careful tuning of the film's geometric and material parameters allowed large, fast and bidirectional actuation that is explained by modelling and simulation studies using finite element analysis in addition to providing insights into the long term as well as short term dynamics of actuation.

*See: Soft Matter, 18, pp 3358-3368 (2022)*

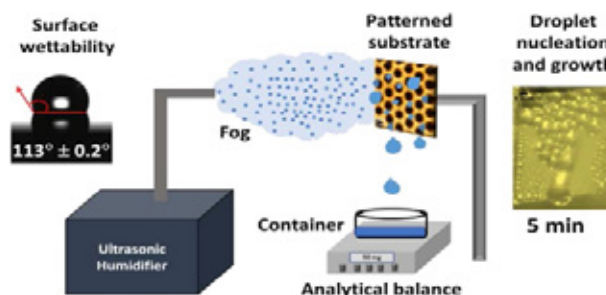
**Investigators:** Divya Jayoti and S. Krishna Prasad

**Collaborators:** Divya Jayoti, Akhil Reddy Peeketi and Ratna Kumar Annabattula, IITM, Chennai

## 5.5 Surfaces and Interfaces

### Enhanced fog harvesting using biomimetic, patterned and chemically modified surface

Inspired by the Stenocara beetle's hydrophobic-hydrophilic surface, we fabricated hexagonally patterned hydrophobic-hydrophilic surfaces consisting of silicon and gold regions using colloidal lithography and also selectively modified the surfaces using self-assembled monolayer. Fog harvesting studies show that the patterned substrate has a higher water collection rate, a factor of 1.32, than the nonpatterned substrates. A further enhancement in water collection (almost twice) is observed with selective functionalization. The patterned (nanohole) and mercapto-





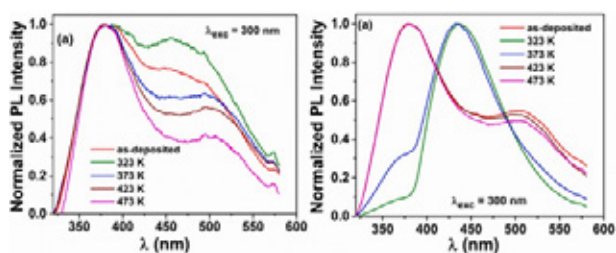
hexadecanoic acid/octadecyl trichloro silane modified substrate facilitates rapid falling of droplets at a frequency of 20 mHz and an average droplet mass of  $15 \pm 2 \text{ mg cm}^{-2}$ . Furthermore, it yielded a maximum water collection rate of  $1051 \pm 132 \text{ mg cm}^{-2} \text{ h}^{-1}$ . This work provides valuable insights into the influence of surface wettability and morphology for fog harvesting applications.

[See: Langmuir, 37, pp 8281-8289 \(2021\)](#)

[Investigators:](#) Brindhu Malani S and Viswanath P

### Impact of thermal annealing on photoluminescence in thin Langmuir-Blodgett films of crystalline polymorphs of metallophthalocyanine

Studies on the formation and growth of thin film polymorphs of organic semiconductor like metallo-phthalocyanine (MPc) is quite essential for many applications. Polymorphic transitions can be achieved through thermal annealing. The influence of the crystalline nature and morphology of the as-deposited (through Langmuir-Blodgett method) and annealed films of copper and zinc octakis-octyloxy phthalocyanine ( $\text{CuPcOC}_8$  and  $\text{ZnPcOC}_8$ ) and their mixture were studied. Surface topographies obtained using AFM reveal nanowire morphology for the as-deposited film of  $\text{CuPcOC}_8$  whereas a grainy texture is observed for  $\text{ZnPcOC}_8$ . Upon annealing to 373 K, the coexistence of nanowire with thin crystalline flakes for  $\text{CuPcOC}_8$  and the coexistence of needle-like structures with granular features for  $\text{ZnPcOC}_8$  were observed. Photoluminescence studies showed a clear dependence of emission features with different



excitation wavelengths for the as-deposited and annealed films of  $\text{CuPcOC}_8$ ,  $\text{ZnPcOC}_8$  and their mixture. Based on these studies, the occurrence of different polymorphs is established.

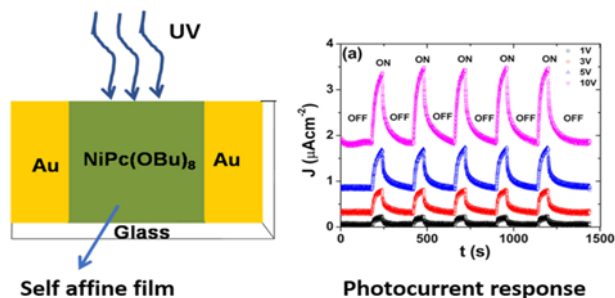
[See: Optical Materials, 125, pp 112069 \(2022\)](#)

[Investigators:](#) Prashanth Nayak and Viswanath P

### Self-affine Langmuir-Blodgett film of octabutoxy nickel phthalocyanine as UV photodetector

Langmuir-Blodgett (LB) films of different thicknesses of Nickel (II) 1,4,8, 11, 15, 18, 22, 25-octabutoxy-29H, 31H-phthalocyanine ( $\text{NiPc}(\text{OBU})_8$ ) doped with stearic acid on silicon and quartz substrates and

were characterized using grazing incidence X-ray diffraction (GIXD), atomic force microscopy and UV-visible spectroscopy techniques. Multilayers deposited at 25 mN/m exhibited a Bragg peak at  $4.15^\circ$  ( $d = 21.3 \text{ \AA}$ ). The crystallite size is found to increase with thickness and saturates beyond 75 nm. The height difference correlation analysis of these multilayers show that they are of self-affine nature. The scaling exponents ( $\alpha = 0.92 \pm 0.05$ ,  $\beta = 0.22 \pm 0.1$  and  $1/z = 0.17 \pm 0.01$ ) signifies kinetic roughening. Further, the transient photocurrent



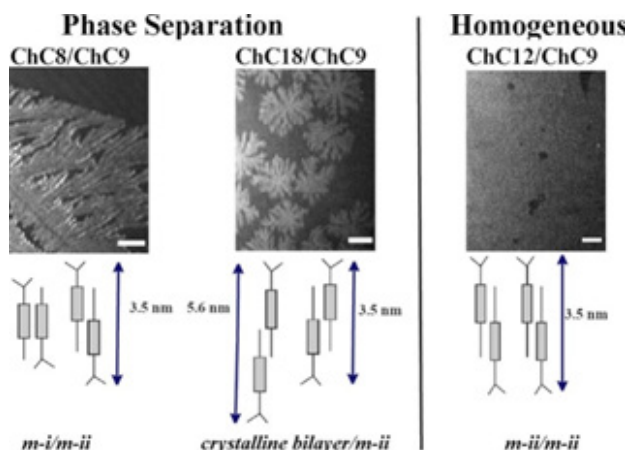
behaviour of the device for different illumination cycles is measured at different power densities and bias voltages. A slower response ( $\sim$  few tens of sec) is inferred from the response time of the rise and decay curves.

[See: Optical Materials, 122, pp 111807 \(2021\)](#)

[Investigators:](#) Prashanth Nayak and Viswanath P

### Miscibility studies of some homologues of cholesteryl n-alkanoates at interfaces

Cholesteryl n-alkanoates of saturated fatty acids and their mixtures are widely studied in different physical states and also due to their significance in biology. They are known to exhibit different molecular packing in bulk. Here, we address the miscibility of some homologues of them at different interfaces. Surface manometry and Brewster angle microscopy studies on  $\text{ChC}_8$  (cholesteryl-cholesteryl interaction, m-i packing)/ $\text{ChC}_9$  (cholesteryl-chain interaction, m-ii packing)



and also on  $\text{ChC}_{18}$  (chain-chain interactions, referred to as the crystalline bilayer)/ $\text{ChC}_9$  mixtures reveal phase separation at the air-water interface plausibly due to the difference in the molecular packing. In contrast,  $\text{ChC}_{12}/\text{ChC}_9$  (both m-ii packing) mixtures form a homogeneous phase and exhibit a higher collapse pressure (almost twice) than that of  $\text{ChC}_9$ . The height profile also reveals homogenous thickness. Our studies offer new insights into the compatibility of molecular packing influencing the phase behavior and may be of relevance to tear film studies.

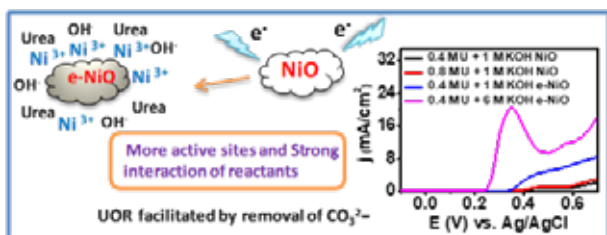
*See: Langmuir 37, pp 11203-11211 (2021)*

**Investigators:** Pinchu Xavier, Brindhu Malani S and Viswanath P

## 5.6 Energy and Environment

### Introduction of surface defects in nickel oxide catalyst for improved electrochemical urea oxidation

The electrochemical urea oxidation reaction (UOR) is a promising energy efficient method to replace water oxidation for hydrogen production. Surface defects in NiO (e-NiO) has been introduced by electron beam bombardment and e-NiO is shown to oxidize urea more effectively than pristine NiO with an onset potential of 0.33 V vs  $\text{Ag}/\text{AgCl}_{(\text{sat.KCl})}$  and Tafel slope of 34.69 mV/dec for 0.4 M urea in 1 M KOH electrolyte. The higher UOR current density by e-NiO is associated with the higher number of  $\text{Ni}^{3+}$  ions on the surface leading to enhanced formation of  $\text{NiO}(\text{OH})$  active species. The higher UOR performance of e-NiO in 6 M KOH containing 0.4 M urea has revealed a drastic reduction in Tafel slope (22.29 mV/dec), lower onset potential (0.24 V vs  $\text{Ag}/\text{AgCl}_{(\text{sat.KCl})}$ ) and high UOR current maxima of 20  $\text{mA}/\text{cm}^2$  at the applied potential of 0.35 V vs  $\text{Ag}/\text{AgCl}_{(\text{sat.KCl})}$  indicating effective removal of  $\text{CO}_x$  poisoning.



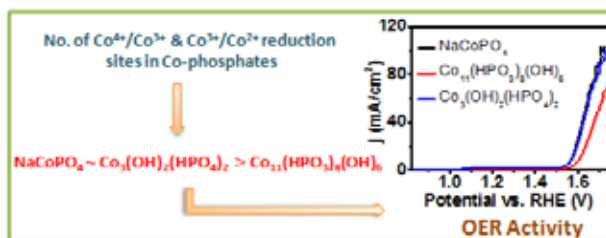
*See: Electrochimica Acta, 385, pp 138425 (2021)*

**Investigators:** C.Alex, Gaurav Shukla and Neena S John

### Metal ion sites in bivalent cobalt phosphorus oxygen systems towards efficient oxygen evolution reaction

In cobalt phosphate systems, the influence of various phosphorous oxyanion ligands in efficient

proton abstraction has been highlighted for the observed higher oxygen evolution (OER), activity. The role of  $\text{CoO}(\text{OH})$  active sites has not been given sufficient importance. Three different cobalt phosphorous oxyanion systems such as  $\text{NaCoPO}_4$  (CP-1),  $\text{Co}_{11}(\text{HPO}_3)_8(\text{OH})_6$  (CP-2),  $\text{Co}_3(\text{OH})_2(\text{HPO}_4)_2$  (CP-3) have been prepared and compared their OER activity. Though CP-2 and CP-3 possess higher number of protons abstracting ligands per metal site than CP-1, it is observed that CP-1 shows almost same OER activity as CP-3 in terms of onset potential and Tafel slope values. A careful estimation of the effective number of reduction sites in terms of  $\text{Co}^{4+}$  to  $\text{Co}^{3+}$  and  $\text{Co}^{3+}$  to  $\text{Co}^{2+}$  reduction reveals it follows the OER activity trend, CP-1 ~ CP-3 > CP-2. The average number of  $\text{Co}^{3+}$  reduction sites explain the OER activity in such cases than the ratio of reduction current density or  $\text{Co}^{3+}$ -reducibility.

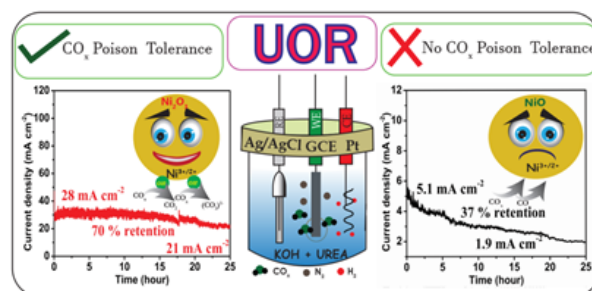


*See: The Journal of Physical Chemistry C, 125, pp 24777-24786 (2021)*

**Investigators:** C. Alex, C. Sathiskumar and Neena S John

### $\text{Ni}_2\text{O}_3$ catalyst with high poison tolerance for sustained electrochemical urea oxidation

Though, UOR is an effective way to generate hydrogen, sustained activity and long-term catalyst usage are retarded by  $\text{CO}_x$  poisoning.  $\text{Ni}_2\text{O}_3$  is shown as a promising UOR catalyst with  $\text{Ni}^{3+}$  ions being highly active with six times higher activity than that of NiO.  $\text{Ni}_2\text{O}_3$  shows retention of 70% UOR performance even after 25 hours at an average current density of 25  $\text{mA}/\text{cm}^2$ . The efficient and sustained UOR activity of  $\text{Ni}_2\text{O}_3$  can be correlated with the highly tolerant  $\text{Ni}^{3+}$  ions in  $\text{Ni}_2\text{O}_3$  system towards  $\text{CO}_x$  poisoning compared to that of NiO, as proved from impedance studies.



A lower Tafel slope value ( $21 \text{ mV dec}^{-1}$ ) of  $\text{Ni}_2\text{O}_3$  indicates the fast electro-oxidation kinetics. The higher  $\text{CO}_x$  tolerance is the main reason behind the remarkable stability of the catalyst. The theoretical modelling supports the high activity of  $\text{Ni}_2\text{O}_3$  through effective adsorption of reactants such as urea and hydroxide with feasible  $\text{CO}_2$  removal on the  $\text{Ni}_2\text{O}_3$  surface.

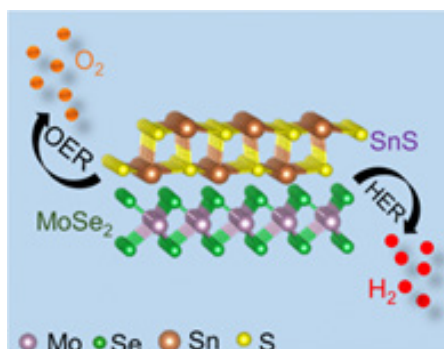
*See: Journal of Materials Chemistry A, 10, pp 4209–4221 (2022)*

**Investigators:** Muhammed Safeer N.K., C. Alex and Neena S John

**Collaborators:** Rajkumar Jana and Ayan Datta, Indian Association for Cultivation of Science, Kolkata

### Nanoheterostructures for water splitting

In collaboration with a team at IIT Delhi, CeNS researchers have developed the colloidal growth of SnS nanosheets (NS), a group IV metal chalcogenide (MC), on  $\text{MoSe}_2$  NS, a transition metal dichalcogenide (TMDC), results in the



formation of type-II nano heterostructures (NHS). The  $\text{MoSe}_2/\text{SnS}$  NHS exhibit more active sites, and the built-in electric field at the interface enhances the rate of charge transfer. The largely enhanced electrocatalytic activities are attributed to the electronic property manipulation due to the synergistic interactions between  $\text{MoSe}_2$  NS and SnS NS. This work provides insights into the design of multicomponent low-dimensional 2D/ 2D (D = dimension) NHS based on TMDC/MC combination with enhanced electrochemical properties, in particular for applications of water splitting.

*See: ACS Applied Nano Materials, 5, pp 4293–4304 (2022)*

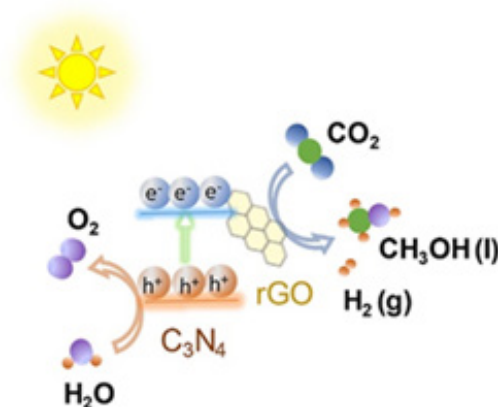
**Investigators:** Trupthi Devaiah C and Pralay K. Santra

**Collaborators:** Ajeet Singh, Jyoti Rohilla, Md. Samim Hassan, Pravin P. Ingole, Dibyajyoti. Ghosh and Sameer Sapra, IIT Delhi

### Bandgap engineered $\text{g-C}_3\text{N}_4$ and its graphene composites for stable photoreduction of $\text{CO}_2$ to methanol

Carbon nitride ( $\text{g-C}_3\text{N}_4$ ) is a two-dimensional material with several advantages over

other photocatalysts, such as metal-free, biocompatible, chemically and thermally stable, to name a few. However, it usually suffers from low charge carrier mobility, high recombination rate, low electrical conductivity, and, more importantly, low absorption in the visible range. To address the multiple shortcomings, a simple and cost-effective copolymerization strategy was developed to synthesize  $\text{g-C}_3\text{N}_4$  by selecting the appropriate precursors and optimizing the synthesis parameters, which resulted in lowering the bandgap from 2.80 eV to as narrow as 2.40



eV. To further improve the charge separation and conductivity,  $\text{g-C}_3\text{N}_4$  and reduced graphene oxide (rGO) based composites were synthesized. The obtained composite catalysts were studied for photocatalytic  $\text{CO}_2$  reduction. It is important to note that  $\text{g-C}_3\text{N}_4/\text{rGO}$  composites resulted in the selective photoreduction of  $\text{CO}_2$  to methanol as the only liquid product with evolution rates of  $\sim 114 \mu\text{mol g}^{-1} \text{h}^{-1}$  along with  $\text{H}_2$  ( $68 \mu\text{mol g}^{-1} \text{h}^{-1}$ ) under scavenger free conditions and exhibited robust stability.

*See: Carbon, 192, pp 101–108 (2022)*

**Investigators:** Ramesh Chandra Sahoo, Dimple Garg and H.S.S. Ramakrishna Matte

**Collaborators:** Haijiao Lu, and Zongyou Yin, Australian National University, Australia

### Solution processing of topochemically converted layered $\text{WO}_3$ for multifunctional applications

Solution processing of nanomaterials is a promising technique for use in various applications owing to its simplicity and scalability. However, the studies on liquid-phase exfoliation (LPE) of tungsten oxide ( $\text{WO}_3$ ) are limited, unlike others, by a lack of commercial availability of bulk  $\text{WO}_3$  with layered structures. Herein, a one-step topochemical synthesis approach to obtain bulk layered  $\text{WO}_3$  from commercially available layered tungsten disulfide ( $\text{WS}_2$ ) by optimizing various parameters like reaction time and temperature is

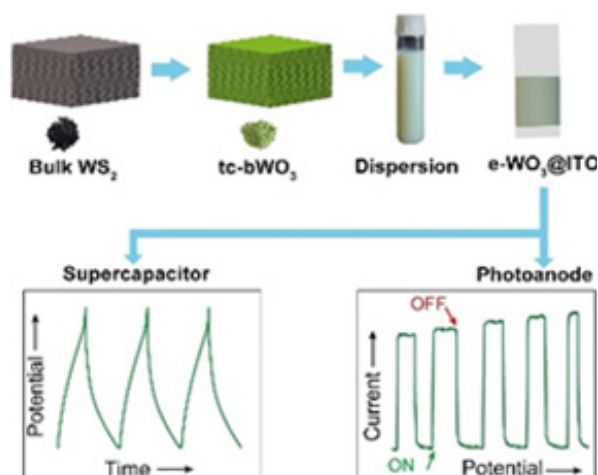


reported. Detailed microscopic and spectroscopic techniques confirmed the conversion process. Further, LPE was carried out on topochemically converted bulk layered  $\text{WO}_3$  in 22 different solvents; among the solvents studied, the propan-2-ol/water (1:1) co-solvent system appeared to be the best. This indicates that the possible values of surface tension and Hansen solubility parameters for bulk  $\text{WO}_3$  could be close to that of the co-solvent system. The obtained  $\text{WO}_3$  dispersions in a low-boiling-point solvent enable thin films of various thickness to be fabricated by using spray coating. The obtained thin films were used as active materials in supercapacitors without any conductive additives/binders and exhibited an areal capacitance of  $31.7 \text{ mF cm}^{-2}$  at  $5 \text{ mV s}^{-1}$ . Photo-electrochemical measurements revealed that these thin films can also be used as photoanodes for photo-electrochemical water oxidation.

*See: Chemistry-A European Journal, 27, pp 11326-11334 (2021)*

**Investigators:** Priyabrata Sahoo, Bikesh Gupta, Ramesh Chandra Sahoo, HSS Ramakrishna Matte

**Collaborators:** Kiran Vankayala, Department of Chemistry, Birla Institute of Technology & Science, Goa



### New method can efficiently transform phenol to a key ingredient for manufacturing food preservatives, pharmaceuticals & polymers

It has been found that electrolysis using surface modified electrodes for efficient large-scale transformation of phenol to 1,4 hydroquinone which is used as intermediate in the manufacturing of food preservatives, pharmaceuticals, dyes, polymers. Conventionally, phenol oxidation is carried out by chemical methods using catalysts involving precious metals, metal oxides, and enzymes along with hazardous oxidants. But these methods suffer from many disadvantages including incomplete conversion of starting material and lack of product selectivity along with environmental hazards.

In this background electrolysis was considered as an effective way to carry out the oxidative transformation of phenol to 1,4 hydroquinone. Through detailed cyclic voltammetric studies, it was established that the existing difficulties with metal electrodes could be overcome using electrodes having disordered graphene like structures with desired number of oxygens bearing surface functional groups such as hydroxyl ( $-\text{C}-\text{OH}$ ), carboxyl ( $-\text{COOH}$ ) and carbonyl ( $-\text{C}=\text{O}$ ) groups. With such appropriately surface modified carbonaceous electrodes the conversion of phenol was excellent (99%) with 87% selectivity to 1,4-hydroquinone.

*See: New Journal of Chemistry, 46, 2518-2525 (2022)*

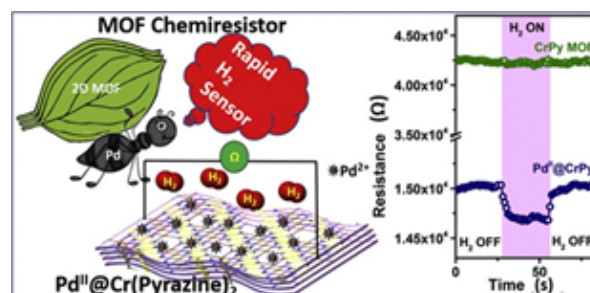
**Investigators:** Bhagavatula L.V. Prasad

**Collaborators:** Mayur D. Baravkar, CSIR-National Chemical Laboratory, Pune

## 5.7 Sensors

### Pd (II) decorated conductive two-dimensional chromium-pyrazine metal-organic framework for rapid detection of hydrogen

The utilization of  $\text{H}_2$  for versatile application has demanded highly selective, low cost and rapid hydrogen sensors that are proficient in sensing  $\text{H}_2$  near flammability limit. In this report,  $\text{Cr}^{\text{III}}\text{Cl}_2(\text{pyrazine})_2$  MOF with negatively charged pyrazine linkers in its structure is used



for the stabilization of Pd (II) via charge transfer interactions. This material design turned an innocent MOF into selective hydrogen sensor that can respond (through decrease in resistance under dynamic sensing setup) to  $\text{H}_2$  in 5–7 s with a detection range of 0.25%–1%  $\text{H}_2$  concentration. A correlation of  $\text{H}_2$  sensing characteristics and the structure-property relationship is established using density functional theory (DFT) calculations. The calculations suggested that near Fermi level in  $\text{Pd}^{\text{II}}@\text{CrPy}$ , the bandwidth increases upon interaction with  $\text{H}_2$  thereby the phase space for electron delocalization increases leading to better carrier mobility. This new approach not only yields novel sensing properties but also enables limited usage of precious metal to develop cost-effective sensors.

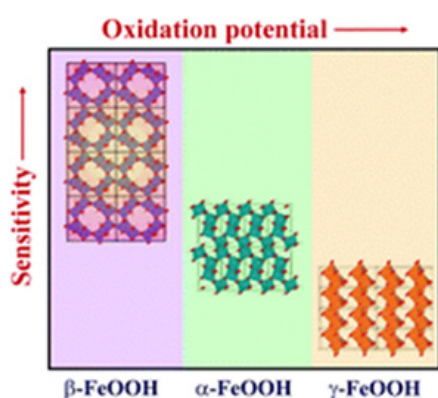
[See:](#) *International Journal of Hydrogen Energy*, 47, pp 9477–9483 (2022)

[Investigators:](#) Ramesh Chandra Sahoo and H S S Ramakrishna Matte

[Collaborators:](#) Marilyn Escalante DMello & Ganapati V Shanbhag, Poornaprajna Institute of Scientific Research, Bengaluru, Rajamani Raghunathan & Priyanka Yadav, UGC-DAE Consortium for Scientific Research, Indore & Suresh Babu Kalidindi, Andhra University, Visakhapatnam

### Unveiling the effect of the crystalline phases of iron oxyhydroxide for highly sensitive and selective detection of dopamine

Electrocatalysis is key to the development of several important energy and biosensing applications. In this regard, the crystalline phase-dependent electrocatalytic activity of materials has been extensively studied for reactions such as hydrogen evolution, oxygen reduction, etc.



But such comprehensive studies for evaluating the phase-dependence of electrochemical biosensing have not been undertaken. Herein, three crystalline phases ( $\alpha$ -,  $\beta$ -, and  $\gamma$ -) of iron oxyhydroxide (FeOOH) have been synthesized and characterized by spectroscopic and microscopy techniques. Electrochemical studies revealed their high sensitivity and selectivity towards dopamine (DA) detection. Amongst the three electrocatalysts,  $\beta$ -FeOOH shows the highest sensitivity ( $337.15 \mu\text{A mM}^{-1} \text{cm}^{-2}$ ) and the lowest detection limit ( $0.56 \mu\text{M}$ ). The enhanced electrocatalytic activity of  $\beta$ -FeOOH, as compared to that of  $\alpha$ - and  $\gamma$ -FeOOH, was attributed to its higher active site percentage and facile electrode kinetics. Furthermore, theoretical studies probed into the DA-FeOOH interactions by evaluating the charge transfer characteristics and hydrogen adsorption energies of the three phases to support the experimental findings.

[See:](#) *Dalton Transactions*, 50, pp 13497–13504 (2021)

[Investigators:](#) Sreejesh Moolayadukkam, Savithri Vishwanathan and HSS Ramakrishna Matte

[Collaborators:](#) Byeongsun Jun, and Sang Uck Lee, Hanyang University, Republic of Korea

## 5.8 Others

### Development of triboelectric facemask

Since the beginning of the COVID-19 pandemic, several attempts have been made worldwide to control the spread of the virus. It is widely accepted that wearing face masks in public and workplaces suppresses the transmission of the virus. Highly effective face masks, e.g., N95, have high filtration efficiency but with a large pressure drop which does not allow one to wear the mask comfortably for long hours. A larger population wearing a moderate efficiency mask can also cut the transmission at large. The CeNS researchers developed mask panels from readily available fabrics that can generate triboelectricity which enhances the filtration efficiency by around 18% without compromising the pressure drop – allowing one to wear the mask for an extended period. The unique cup-shaped design of the mask provides a snug fit with no speech distortion or fogging on the glasses. The designed product has been successfully commercialized and is currently available in the market as “3BO” mask.

Step 1: Cut fabrics into the octagonal shape



Step 2: Stitch the fabrics together to create the mask panel



Step 3: Make pleats and attach string to generate the cup-shaped mask



[See:](#) *Energy Technology*, 2100614, pp 1–6 (2021)

[Investigators:](#) Pralay K. Santra, Ashutosh K Singh, G.U. Kulkarni, Suman Kundu, Tejaswini Rao and Mukhesh K. G



## 6. Publications

The total number of Publications in

Referred Journals	59
Conference Proceedings	2
Chapters in Books	2

Details are given in Annexure A

Average Impact Factor **4.77**

Journal	Publications
ACS Omega	1
ACS Applied Nano Materials	1
Advanced Electronic Materials	1
Advanced Materials Technologies	1
Applied Surface Science	2
Applied Physics Letters	1
Astrophysical Journal	1
Biochimica Et Biophysica Acta-Biomembranes	1
Bulletin of Materials Science	1
Catalysis Letters	1
Carbon	1
Chemistry-A European Journal	1
Chemistry an Asian Journal	1
Chemical Engineering Journal	1
Current Science	1

Journal	Publications
Dalton Transactions	1
Electrochimica Acta	1
Energy Technology	1
Frontiers in Physics	1
Iscience	1
International Journal of Hydrogen Energy	1
Journal of Applied Polymer Science	1
Journal of Electrochemical Society	1
Journal of Materials Chemistry A	2
Journal of Molecular Liquids	2
Journal of Nanostructure in Chemistry	1
Journal of Physical Chemistry B	1
Journal of Physical Chemistry C	3
Journal of Science: Advanced Materials and Devices	1
Langmuir	2
Liquid Crystals	7
Molecular Liquids	1
Materials Advances	1
Journal of Materials Science: Materials in Electronics	1
Material Letters	1
Material Matters	1
New Journal of Chemistry	1
Optical Materials	1
Particle and Particle Systems Characterization	1
Physical Review E	2
Physica Status Solidi B	1
Polymers for Advanced Technologies	1
Renewable Energy	1
Sensors and Actuators B-Chemical	1
Soft Matter	1
Thin Solid Films	1

## 7. Patents

Sl. No.	Title	Inventors	Patent Application No. (India)	Filed/Granted
1.	Scalable and tunable synthesis of visible to near IR absorbing and emitting library of metal sulfides QDs	Bhagavatula L V Prasad and Abhijit Bera	384312	Granted 14/12/2021
2.	Atomically thin metal sheets from soluble metal thiolate precursors through simple inert-heating technique	Bhagavatula L V Prasad and Balanagulu Busupalli	357638	Granted 03/02/2021
3.	Polymer stabilized liquid crystal device, composition and method thereof	S. Krishna Prasad, Marlin Baral and S.N. Jaisankar	IN 201741002313	Granted 27/10/2021
4.	Passive radiative cooling system and preparation thereof	Geetha G Nair, H S S R Matte and Amit Bhardwaj	IN 202141031113	Provisional Indian Patent filed on 12/07/2021
5.	Synergistic composition of a liquid crystal mixture exhibiting wide temperature range of Blue Phase III and method thereof	Nurjahan Khatun and Geetha G. Nair	IN 202241013809	Complete Indian Patent filed on 14/03/2022
6.	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 and Priyabrata Sahoo	IN 202141029054	Filed
7.	A covert security device and method thereof	Pralay K. Santra, Radha Rathod and Mdoasser Hossain	IN 202241023459	Filed
8.	A Visibility Controlling device	G. U. Kulkarni, Ashutosh K. Singh and Rahul M.	(CHINA) CN112789549A	Filed
9.	Light Transmittance control device and methods thereof	Ashutosh K. Singh, Indrajit Mondal and Nilay Awasthi	IN 202141053629	Filed
10.	Lanthanide metal-based Coordination Polymers and methods thereof	Kavita Pandey, Manmohansingh Waldiya, Madhu B Kanakala, Sabiar Rahaman and Channabasaveshwar V Yelamaggad	IN 202241019317	Filed
11.	Cholesteric liquid crystals and device thereof	Veena Prasad, Nagaveni N.G., Gurusurthy Hegde and Rekha S. Hegde	IN 201941036986	Granted 20/09/2021

Sl. No.	Title	Inventors	Patent Application No. (India)	Filed/Granted
12	Photoactive gel exhibiting optical memory states	Vimala S., Geetha G. Nair, S. Krishna Prasad, Sathya S. and C. V. Yelamaggad	IN 201641033449	Granted on 29/01/2021
13	Antimicrobial nanoformulation and synthesis method thereof	Neena Susan John and Ramya Prabhu B	IN 202141025077	Filed
14	A method for fabrication of liquid crystal device with unidirectional alignment of liquid crystals	D.S.Shankar Rao et al	IN 202141029054	Filed

### DST media cell covered the following innovative findings from CeNS:

- Scientists develop gold microstructure substrate with tunable wettability useful in water transportation & self-cleaning  
<https://dst.gov.in/scientists-develop-gold-microstructure-substrate-tunable-wettability-useful-water-transportation>
- New material that can tune electromagnetic (EM) waves to scatter in one direction useful for thin-film solar cells  
<https://dst.gov.in/new-material-can-tune-electromagnetic-em-waves-scatter-one-direction-useful-thin-film-solar-cells>
- New electronic nose with biodegradable polymer and monomer can detect hydrogen sulphide from sewers  
<https://dst.gov.in/new-electronic-nose-biodegradable-polymer-and-monomer-can-detect-hydrogen-sulphide-sewers>  
Published in Bengaluru mirror <https://Bengalurmirror.indiatimes.com/Bengaluru/others/scientists-develop-e-nose-to-detect-noxious-fumes/articleshow/82090140.cms>
- Cost-effective, bio-compatible nanogenerators can harvest electricity from vibrations for optoelectronics, self-powered devices  
<https://dst.gov.in/cost-effective-bio-compatible-nanogenerators-can-harvest-electricity-vibrations-optoelectronics-self>  
Published in The Economic Times (<https://m.economictimes.com/news/science/scientists-develop-technique-that-can-generate-electricity-from-vibrations-for-self-powered-devices/articleshow/83874314.cms>)
- Liquid crystal-nanoparticle composites with nanoparticles synthesized from biowaste can reduce power consumption of display devices <https://dst.gov.in/liquid-crystal-nanoparticle-composites-nanoparticles-synthesized-biowaste-can-reduce-power>
- Wealth from Waste: Spent catalyst from industry can be an efficient catalyst for batteries <https://dst.gov.in/wealth-waste-spent-catalyst-industry-can-be-efficient-catalyst-batteries>
- Porous carbon nanoparticles from waste onion peels used for making soft actuators with enhanced photomechanical capacity  
<https://dst.gov.in/porous-carbon-nanoparticles-waste-onion-peels-used-making-soft-actuators-enhanced-photomechanical>  
Published in Indian Express <https://indianexpress.com/article/technology/science/soft-robots-waste-onion-peels-dst-7450800/>

- Scalable synthesis method developed of nanocrystals with bright emission colours useful for LED <https://dst.gov.in/scalable-synthesis-method-developed-nanocrystals-bright-emission-colours-useful-led>
- Silica nanoparticles developed by Indian Scientists can help design better drug delivery systems <https://dst.gov.in/silica-nanoparticles-developed-indian-scientists-can-help-design-better-drug-delivery-systems>  
Times of India <https://timesofindia.indiatimes.com/city/bengaluru/scientists-develop-silica-nanoparticles-for-better-systems-of-drug-delivery/articleshow/88442149.cms>
- New method can efficiently transform phenol to a key ingredient for manufacturing food preservatives, pharmaceuticals & polymers <https://dst.gov.in/new-method-can-efficiently-transform-phenol-key-ingredient-manufacturing-food-preservatives>
- Scientists develop energy-efficient hydrogen production by urea electrolysis <https://dst.gov.in/scientists-develop-energy-efficient-hydrogen-production-urea-electrolysis>  
Hindu Business Line <https://www.thehindubusinessline.com/business-tech/hydrogen-from-electrolysis-of-urea/article65217146.ece>
- Touchless touchscreen technology developed can restrain viruses spreading through contact <https://dst.gov.in/Touchless-touchscreen-technology-developed-can-restrain-viruses-spreading-through-contact>  
Times of India <https://timesofindia.indiatimes.com/home/science/now-tech-for-touchless-touchscreen-to-prevent-virus-spread-through-contact/articleshow/90219649.cms>

## 8. Entrepreneurship Activities

CeNS had interaction with various industries for technology-oriented projects. CeNS has signed an NDA with ITC Limited and a joint project is ongoing for the development of Photocatalytic nanoparticles.

An MoU has been signed with Maithri Aquatech Pvt. Ltd to work on a joint project for the design and development of Atmospheric Water generator.

A joint project with Saint-Gobain Research India is ongoing for the design and development of Smart windows.

CeNS also operates technology-oriented projects with Tata Steel Pvt. Ltd. enabled by Tata Steel Advanced Material Research Centre (TSAMRC@CeNS).

CeNS also provided consultancy services to Module Innovations Pvt. Ltd.





## 9. New teaching programmes/materials developed

	Course code	Course name	Credits
Sep-Dec	CPE-RPE	Research and Publication Ethics	2:0
	CeNS-IP	Intellectual Property Rights	1:0
	CeNS-NS	Basics of Nano and Soft Matter	2:0
	CeNS-SW	Safety, Health & Waste Management	Certificate Based Course
Jan-May	CeNS-IA	Instrumental Methods and Analysis	1:2
	CeNS-ED	Energy Materials and Devices	2:1
	CeNS-NS	Basics of Nano and Soft Matter	0:1

## 10. Extramural Research Projects

### A. Completed during the year

Sl. No.	Title of the project and sanction number	Sponsoring agency	Duration (From ... to ...)	Budget sanction (Rs. in lakhs)
1.	Magnetic nanoparticles for memory applications	SERB	Aug 2017- Feb 2021	28.53
2.	Molecular design directed synthesis and characterization of inexpensive, functional organic materials exhibiting technologically relevant liquid crystal phase	SERB	Aug 2017- Mar 2021	50.32

### B. Ongoing / Sanctioned during the year

Sl. No.	Title of the project and sanction number	PI / Co-PI Name	Sponsoring agency	Duration (From ... to ...)	Budget sanction (Rs. in lakhs)
1.	Scalable coating of metal oxides on hybrid transparent electrodes and fabrication of smart window devices	Dr.Ashutosh Kumar Singh	DST	Mar 2022 to Mar 2025	102.00
2.	Advice on Nanoparticle Surface Modifications	Prof. B L V Prasad	Module Innovations Pvt Ltd	July 2021 to Apr 2022	4.54

Sl. No.	Title of the project and sanction number	PI / Co-PI Name	Sponsoring agency	Duration (From ... to ...)	Budget sanction (Rs. in lakhs)
3.	Effect of nanoparticles on the liquid crystal analogue of the abrikosov phase at atmospheric and elevated pressures	Dr. D S Shankar Rao	SERB	Jan 2020 to Jan 2023	17.82
4.	Synthesis of chiral liquid crystals and their composites with nano particles: development of functional mesophases for applied science	Dr. Uma S Hiremath and Dr. Geetha G Nair	DST	Mar 2018 to May 2022	33.65
5.	Investigations of optical, electro-optical and mechanical properties of liquid crystal based soft photonic composites	Dr. Geetha G Nair	SERB	May 2019 to Sep 2022	42.52
6.	Tata Steel Advanced Material Research Centre (TSAMRC)	Prof. B L V Prasad	Tata Steel	Oct 2016- Oct 2026	8.70
7.	Technology Business Incubator (TBI)	Prof. B LV Prasad / Dr. Geetha G Nair	DST	July 2019 to July 2022	516.71
8.	Privacy Curtain Glass (as Co-PI) CeNS-SGRI-01	Dr. Ashutosh Kumar Singh	Saint Gobain India Pvt Ltd	May 2021 to May 2025	39.53
9.	Scale-up studies and process development for hydrogen production by catalytic decomposition of natural gas Phase-I; Analysis and value addition of Spent catalyst	Dr. Neena S John / Dr. H S S R Matte	Centre for High Technology in collaboration with Hindustan Petroleum Corporation Ltd (HPCL R&D Centre, Bengaluru) and IIT Delhi	Feb 2017 to Mar 2023	100.00
10.	Development of band-engineered buffer layer at the interfaces of photovoltaic devices and study of its effect on charge.	Dr. Pralay K Santra	SERB	May 2019 to Nov 2022	46.65

11.	Covid project – aesthetically acceptable breath friendly triboelectric face masks: design, fabrication, testing & technology translation	Dr. Pralay K Santra	DST	Jul 2020 to Jun 2022	8.58
12.	Designing coatings for the aluminium fins to improve the water harvesting efficiency of AWG	Dr. Pralay K Santra / Dr. Viswanath P	Maithri Aquatech Pvt Ltd	Mar 2022 to Sep 2022	10.06
13.	Role of molecular interactions in solution processed layered pnictogens	Dr. H S S R Matte	SERB	Jan 2020 to Jan 2023	22.36
14	Synthesis and characterization of highly active UV-Visible photocatalysts	Dr. H S S R Matte	ITC Ltd	Nov 2021 to Nov 2022	17.15
15	Rational design, synthesis and characterization of optically active monomers and dimers.	Dr. C V Yelamaggad	SERB	Dec 2020 to Dec 2023	30.27

## 11. New Research Facilities / Major Equipment Acquired

Sl. No.	New Facilities Created
1.	Modified the existing Differential Scanning Calorimeter (Perkin Elmer DSC) to perform Photo Calorimetric measurements
2.	Added components to perform X-ray diffraction measurements simultaneously in the presence of variable intensity UV irradiation
3.	Microwave Synthesizer, CEM Discover 2.0 was installed
4.	BET Surface Area
5.	Dispersion Analyser
6.	Ball Milling
7.	Electrochemical Work Station – Gamry 1010E
8.	Thermal IR- Camera (Testo 885)

## 12. Outreach Programme

### 12.1 V4: विज्ञान-विद्यार्थि विचार विनिमय

The novel science initiation programme V4 is aimed at students studying in the high school/+2 level to stimulate and nurture scientific curiosity in young minds. During the year 2019 to 2022, 6086 students benefitted from this programme.

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

Details are shown in Annexure B

### 12.2 Research Outreach Initiative (ROI)

The ROI programme provides first-hand experience in front-line research to highly motivated students pursuing a post-graduate course in Physics/Chemistry/Materials Science. Due to covid pandemic it was put on-hold temporarily.

## 13. PhDs & Technical Training

Number of Ph D. Produced – Awarded: Submitted

Name of the Student	Ph.D.	Date
Mr Suman Kundu	Awarded	21/04/2021
Mr Indrajit Mondal	Awarded	28/06/2021
Ms Marlin Baral	Awarded	20/07/2021
Mr. Sachin Ashok Bhat	Submitted	31/10/2021
Ms. Pragnya Satapathy	Submitted	03/12/2021
Mr. Anamul Haque	Submitted	17/12/2021
Mr. Gaurav Shukla	Submitted	17/12/2021
Mr. Subir Roy	Submitted	17/12/2021
Mr. Rajashekhar Pujar	Submitted	31/12/2021
Mr. Madhubabu Kanakala	Submitted	25/01/2022
Ms. Rekha S Hegde	Submitted	31/01/2022
Ms. Brindhu S. Malani	Awarded	30/03/2022

## Research Associates

Abhijit Bera	Manmohan Singh G Waldiya
Anamul Haque	P Chithaiah
Anil Kumar Rathod	Pragnya Satapathy
Bharath S P	Rajashekhar Pujar
Brindhu Malani	Santosh Yellapa Khatavi
Dipayan Pal	Shivaranjani
Divya Jayoti	Sreejesh M
Gaurav Shukla	Subir Roy
Govind Pathak	Suman Kundu
Madhu Babu Kanakala	Vijaya Kumar G
Manjunath K	Vimala S

## Visiting Students

Name	Visiting Student	Address	Period
Mr. Alex Sam	Ph.D.	SRM Institute of Technology	1 - 10 September 2021
Dr. Indrajit Mondal	Ph D	JNCASR Bengaluru	July 2021 - March 2022
Mr. Satish A. Ture	Ph D	Gulbarga University	
Ms Sonali M K	Research Scholar	MAHE	Nov 2021 - Feb 2022

## TechBuddy

Mr. Nilay Awasthi

## Senior Research Fellows

Mr. Alex C	Mr. Priyabrata Sahoo
Mr. Amit Bhardwaj	Ms. Radha Jitendra Rathod
Ms. Athira M.	Ms. Rajalaxmi Sahoo
Ms. Gayathri R. Pisharody	Mr. Ramesh Chandra Sahoo
Mr. Kenneth Lobo	Ms. Ramya Prabhu B
Mr. Modasser Hossain	Ms. Savithri Vishwanathan
Mr. Muhammed Safeer N. K.	Ms. Swathi S.P.
Ms. Nurjahan Khatun	Ms. Suchithra. P.
Ms. Pinchu Xavier	Ms. Trupthi Devaiah C
Mr. Prashanth Nayak	Ms. Varshini G.V.



## Junior Research Fellows

Mr. Abhishek Kumar	Mr. Nikhil N Rao
Mr. Abhishek Roy	Mr. Palash Jyoti Gogoi
Ms. Aishwarya Ajit Mungale	Ms. Pritha Dutta
Ms. Athira Chandran M	Mr. Rahuldeb Roy
Ms. Arya K	Mr. Rahul Singh
Ms. Jil Rose Perutil	Mr. Rohit Thakur
Mr. Kaiffee Sayeed	Mr. Sabiar Rahaman
Mr. Manish Verma	Mr. Vignesh Raaj .A.S
Ms. Mouli Das	Mr. Vishnu G Nath
Mr. Mukhesh K G	

## Industry Sponsored PhD Student

Ms. Himani	Mr. Rahul M
------------	-------------

## R & D/Technical/Project Assistants

Athul K	Mithun N
Benexy Correya	M N Rajendra
Deeksha G	Nikhil Karki
Deepak Kumar Tumudia	Poornima S.K
Fathima Shafna	Rajalakshmi R
Hafiz Hakeem	Rajesh P.R
Harshitha R	Reetu K
Jaimson James	Sanjit Kumar Parida
Jaisas Jeny Praisys Chandran	Savitha N
Manjula P	S S Inchal
Mayur N	Shreya Sharma
Meenakshi Varier	Sumana S

## 14. Events at CeNS

**Samvidhan Divas** was celebrated on November 26, 2021, to commemorate the adoption of our Constitution on this day in 1949. CeNSians joined Hon'ble President of India Shri Ramnath Kovind, virtually for a community reading of the Preamble to the Constitution."



### International Yoga Day

International Yoga Day was celebrated on 21 Jun 2021. the Centre organized jointly with JNCASR, Bengaluru, an online lecture by Yoga Guru, Shri Prasanna V Raju of "Prabha, VyayamRathna" fame. The lecture emphasized the benefits of Yoga for both mental and physical well-being.

### 75<sup>th</sup> Independence Day Celebrations



Responding to the call of the Government of India to mark the commencement of the 75<sup>th</sup> year of independence, CeNSians participated in the Fit India Freedom Run 2.0 event. A 5.0 km / 3.0 km Walkathon, starting from the CeNS Main Gate to Kenganahalli Village and back was organized by CeNS. Enthusiastic walkers, runners, and bikers brought a lot of cheer to the event. The winners

under different categories like, "saree-clad walkers", "senior-walkers" were honoured along with those who reached the final point first.

### Vigilance Awareness Week

Centre observed Vigilance Awareness Week starting from October 26 to November 1, 2021. 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. As an important component of the program, the Integrity Pledge circulated by Gol was communicated to all the employees of the Centre at the beginning of the week.



The main event was held on October 29, 2021. Among the activities at the event was verbal pledging. Dr. D.S Shankar Rao, Vigilance Officer, CeNS, administered the pledge with the theme "Independent India @ 75, Self-Reliance with Integrity" and the members of the Centre repeated it. Following this was a special lecture by Dr. Senthil Kumar, a retired officer from BHEL. The speaker was General Manager, served as Vigilance Officer, and has vast experience at different administrative levels in various branches of BHEL. The title of the presentation was "Better understanding of system and procedures in the procurement cycle and Vigilance Awareness". He described at length several aspects of vigilance associated with everyday life and the happenings in the office. He said that as a public servant, one should follow the organization's guidelines, purchase policy, and work policy. He stressed striving towards excellence in individual and collective efforts to maintain the efficiency of administration. He concluded by saying that all the employees should follow the policy and procedures for the betterment of the organization.

## IISF Expo 2021



CeNS represented by Mr. Vishnu G Nath, Mr. Rahuldeb Roy and Dr. P. Viswanath actively participated in the 7th edition of the India International Science Festival (IISF 2021), Panaji, Goa from December 10 to 13, 2021. This Mega Science, Technology and Industry Expo was organised by the Ministry of Earth Sciences, Ministry of Science & Technology and Vijnana Bharati along with the Government of Goa. National Centre for Polar and Ocean Research acted as nodal agency to organise IISF 2021. The mission statement, research and outreach activities along with other services (like central research facility) offered by CeNS were shared with the visitors through posters. Further, some of the recent inventions and prototypes (like triboelectric mask, invisible electromagnetic shield fabricated using crackle lithography, graphene coated transparent conductive glass, gas sensors and so on) developed at CeNS were showcased which largely coincides with the theme of the event, 'Celebrating Creativity in Science, Technology and Innovation for Prosperous India'. Researchers of CeNS explained the working principle of these prototypes and lively demonstrated them to visitors representing different industry and academic institutions. It also caught the attention of many young and enthusiastic college and school students who visited the stall and posed several interesting queries.

## 8<sup>th</sup> Anniversary of Sexual Harassment of Women at Workplace Act-2013

To commemorate the 8<sup>th</sup> anniversary of "Sexual Harassment of Women at Workplace Act, 2013", and to bring awareness among the community about the Sexual Harassment of Women at Workplace (Prevention, Prohibition and Redressal) Act, 2013, two special lectures were arranged on

9<sup>th</sup> December 2021 through online mode. Prior to the lectures, a survey was conducted to know how aware the CeNSians are about Act. The feedback received from the survey was passed on to the speakers so that they could address the community accordingly to bring out the nuances of the Act itself.



Dr Swati Dyahadroy, Assistant Professor, Women's Studies Centre, University of Pune, gave the first talk titled "Understanding Gender: Issues and Challenges". Following this Dr Durba Sengupta, Senior Scientist, National Chemical Laboratory, Pune spoke about "Women Researchers in Indian Academia". At the end of each talk question and answer sessions were conducted during which time the audience had the opportunity to clarify several aspects of the act and related topics.

## National Girl Child Day

An Essay Competition was held to celebrate National Girl Child Day from 19-25 Jan 2022. Entries were invited on the theme "Girl child Education". Eight entries were received and the Winners of the competition were Ms Himani (First Place), Ms Pinchu Xavier (Second Place) and Ms Rajalaxmi Sahoo (3rd place). The Prizes were distributed on 2 March, 2022 during the Freshers Day celebration

## National Science Day

Prof. Sabyasachi Bhattacharya, Director, TCG-CREST, Kolkata, gave a special talk on Feb. 28, 2022, on the occasion of National Science Day. This programme was one of the series of events held at the Centre for Nano and Soft Matter Sciences (CeNS) to commemorate the 75th anniversary of India's Independence – Aazadi Ka Amrit Mahotsava. The program began with a brief introduction to the speaker by Prof B LV Prasad, Director, CeNS.





Prof Bhattacharya began by explaining the importance of National Science Day, the discovery of the Raman effect by Prof Sir. C V Raman, its importance, usage in the present-day world. Followed by this, he gave a presentation on the title "Perfectly Reasonable Approximations: Dealing with the Real World". In this talk, he discussed strategies used in the physical sciences to understand and utilize the "real" world through approximations/idealizations. He mentioned Feynman's "minimum sentence" remark and possible extensions using the well-known Fermi-problem methods. The aim is to illustrate both the power and the limitations of approximations, a subject rarely included in science curricula.

### International Day of Women and Girls in Science

CeNS celebrated "International Day of Women and Girls in Science" celebrated on 14<sup>th</sup> Feb 2022



with the theme "CeNS women in Science Reach out". The women scientists and research scholars from CeNS gave technical cum motivational talks to young women students from four city colleges, namely, Bishop Cotton Women's Christian College, Maharani Lakshmi Ammani College for Women, MES College of Arts, Commerce and Science, and Vijaya College. The event, which was held via an

online platform, began with welcome remarks by Dr Geetha Nair, scientist, CeNS, followed by inspirational opening remarks by Prof. B L V Prasad, Director, CeNS. While acknowledging the various challenges women face while pursuing higher education, he stressed that one could overcome hurdles such as internal conflict, conflict with family and society if one is passionate about whatever one wants to pursue in life. In the technical session, Ms Athira M, Ms Nurjahan Khatun, and Ms Trupathi Devaiah, all senior research scholars, spoke about their respective research works covering topics such as thin films, liquid crystals and quantum dots.

### International Womens' Day



CeNS celebrated International Women's Day-2022 on 11<sup>th</sup> March 2022 with an event highlighting the importance of sustainable menstruation practices. Rotarian Ms Nisha Bellare, founder of Reva Econauts, which promotes new age menstrual hygiene products like the NariYari Menstrual Cups and cloth pads, and Ms Uma Khemuka, homemaker, presented a special lecture titled "Roopantara - Transformation - A talk on sustainable menstruation", to CeNS (in-person) and JNCASR (on-line) audience. The talk, both in English and Kannada, was one of the series of events at the Centre to commemorate the 75th anniversary of India's Independence - Aazadi Ka Amrit Mahotsava.

### Felicitation to Dr Geetha G Nair

As part of the International Women's Day celebrations, the Centre felicitated Dr. Geetha G. Nair for her career achievements and contributions to science on 1 April 2022. Prof. Ashok K. Ganguli, Member, Governing Council, CeNS, graced the





event as the Chief Guest. Prof. B L V Prasad, Director, CeNS talked about the achievements of Dr. Geetha. Dr. S. Krishna Prasad gave glimpses of the women achievers around the globe and few memories of his association with Dr. Geetha. Dr. Geetha was felicitated by Prof. Ashok K. Ganguli and Prof. B L V Prasad.

### **Bengaluru INDIA NANO**

India's Flagship Nanotech Event Bengaluru INDIA NANO is an excellent platform bridging Nanotech Research, Industry, Government and Academia successfully over the last 11 years. The event is organised by the Department of Electronics, IT, Bt and S&T, Government of Karnataka under the guidance of Vision Group on Nanotechnology led by Prof. C.N.R. Rao, FRS, Jawaharlal Nehru Centre

for Advanced Scientific Research (JNCASR). The event is aimed at giving fillip to the growth of Nanotech Industry in the country. The 12th edition of 'BENGALURU INDIA NANO 2022' was held from 7 – 8 March, 2022 and Tutorials on 9 March, 2022 in the Virtual Format with the central theme 'NanoTech for Sustainable Future'. The 3 days Exhibition brought together Researchers, Scientist's, Professors, and Industrialist together on a single Virtual Platform.

Virtual Expo gave a platform during COVID – 19 pandemics to communicate / promote our Green House prototypes to a Global audience by setup stalls, provide chat forums and enable online Interactions which also helped to promote the Green House through the EXPO. The Conference was open for public and approximately 110 people visited the CeNS stall. In this 3days Exhibition a greater number of Researchers/scientists visited our stall asked information about Greenhouse prototypes. We have shared the information with them regarding our Prototypes such as mist driven smart window, antimicrobial nanoformulation, triboelectric face mask etc. Mr. Muhammed Safeer N K, Ph.D student from CeNS was awarded Best Poster Prize for his presentation titled 'One in a million':  $\text{Ni}^{3+}$  in  $\text{Ni}_2\text{O}_3$  that loves urea and hates  $\text{CO}_2$ , during the event

## 15. Honours & Awards

### AWARDS

- Prof. B L V Prasad, Director CeNS, was awarded Gold Medal Lecture -Chirantan Rasayan Sanstha, Vidya Sagar University, Midnapore, West Bengal, India (2021)
- Dr C V Yelamaggad has been conferred with prestigious Bronze Medal by the Chemical Research Society of India for his remarkable contribution in the field of Chemistry, especially liquids crystals (2021)



### HONOURS

- Prof. B L V Prasad, invited as "Associate Editor" Journal of Chemical Sciences (Indian Academy of Sciences and Springer)
- Dr Geetha G Nair, invited as Internal Quality Assurance Cell member JNCASR, Bengaluru
- Dr. S. Angappane was awarded "Certificate of Reviewer Excellence 2020" from Bulletin of Materials Science for the year 2021
- Dr. Pralay K Santra, invited as Early Career Editorial Advisory Board Member, 'ChemNanoMat', Wiley-VCH Publications, 2021
- Dr S Krishna Prasad has been conferred the Fellowship of the Karnataka Science and Technology Academy (KSTA), 2021 for his significant contributions in the area of Science & Technology (2021)
- Geetha G Nair, elected as Treasurer, Indian Liquid Crystal Society, India

### AWARDS TO STUDENTS

- Mr. Muhammed Safeer N K was awarded Best Poster Prize during 12<sup>th</sup> Bengaluru Nano, 7-8 Mar, 2022, for the poster titled 'One in a million: Ni<sup>3+</sup> in Ni<sub>2</sub>O<sub>3</sub> that loves urea and hates CO<sub>2</sub>
- Ms.Trupthi Devaiah has received one of the Best Poster prizes sponsored by the Journal of Materials Chemistry C at the Interdisciplinary Topics in Materials Science (ITAM-2021) conference. July 27-30 2021, for poster titled "Degradation Studies of Cs<sub>3</sub>Sb<sub>2</sub>I<sub>9</sub>: A Lead-Free Perovskite."
- Dr. S. Vimala, Research Associate, won 1<sup>st</sup> position in the "IP Hackathon" conducted by CeNS and Legasis, Pune, 29-30 April, 2021, under the auspices of "Aazadi ka Amrita Mahotsav".
- Mr. Amit Bhardwaj, SRF won Publication award for the year 2020, Centre for Nano and Soft Matter sciences, Bengaluru on 10th November 2021
- Dr. Ashutosh K Singh, Scientist CeNS was awarded "Six Sigma green belt" certification from Indian Statistical Institute (ISI) Bengaluru, 31 October 2021.
- Ms. Ramya Prabhu B, SRF, was awarded best oral presentation award for her work 'Self-cleaning spiky mixed metal oxide nanoformulation for antimicrobial applications' during Third Indian Materials conclave and 32<sup>nd</sup> Annual General Meeting of MRSI (Theme symposium: Nanomaterial synthesis and solution route), held in virtual mode organized by IIT-M, Dec 20-22, 2021
- Ms. Ramya Prabhu, PhD student won second place in "IP Hackathon" conducted by CeNS and Legasis, Pune, 29-30 April, 2021, under the auspices of "Aazadi ka Amrita Mahotsav".

## 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 celebrated from 14-30 September 2021. Hindi Rajbhasa Committee organised various programs such as quick sentence formation, dictation, Hindi translation, Hindi reading, essay, and seminar.

The competition was enthusiastically participated by the members of the Centre. As part of the event, three employees were honoured for passing the Hindi Praveen exam.



## 18. Audited Statement of Accounts



**G.R. VENKATANARAYANA**  
CHARTERED ACCOUNTANTS

No. 618, 75th Cross, 6th Block, Rajajinagar, Bangalore-560 010.  
Ph: 23404921 Email: grvauditor@gmail.com / 1grvenkat@gmail.com

Partners :

CA. G.R. Venkatanarayana, B.Com., F.C.A.,  
CA. G.S. Umesh, B.Com., F.C.A.,  
CA. Venugopal N. Hegde, B.Com., F.C.A.,

### INDEPENDENT AUDITORS' REPORT

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

#### Opinion

We have audited the attached Balance Sheet of "Centre for Nano and Soft Matter Sciences" Arkavathi, Shivapura, Bengaluru North - 562162, which comprises the Balance Sheet as at March 31, 2022, and the Statement of Income & Expenditure for the year ended on that.

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 March 31, 2022
- 2) In case of Income and Expenditure Account, of SURPLUS, being Excess of Income Over Expenditure for the year ended on that date.

#### Basis for Opinion

We conducted our audit in accordance with Standards on Auditing (SA's) 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. And 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. We are Independent for the Centre in accordance with the Code of Ethics issued by Institute of Chartered Accountants of India, and we have fulfilled our ethical responsibilities in accordance with these requirements. We believe that our audit provides reasonable 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 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.

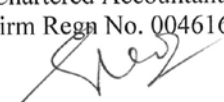
### **Auditors' Responsibility for the Audit of the Financial Statements**

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 the SA's 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:**

1. We have obtained all the information and explanations, which to the best of our knowledge and belief were necessary for the purpose of our audit.
2. In our opinion proper books of accounts as required by law have been kept by the Centre for Nano and Soft Matter Sciences so far as it appears from our examination of those books.
3. The Balance Sheet and Income and Expenditure Account and Receipts and Payment account dealt with by this report are in agreement with the books of account.
4. The Balance Sheet and Income and Expenditure Account dealt with by this report are prepared in accordance with the Accounting Standards issued by the Institute of Chartered Accountants of India subject to the following observation:  
  
(i) Non-Provisions of accrued liability in respect of leave encashment which is not in conformity with the Accounting, Standard 15 [Accounting for retirement benefits in the financial statements of Employers] issued by the Institute of Chartered Accountants of India.

For M/s G R Venkatanarayana  
Chartered Accountants  
Firm Regn No. 004616S

  
(G R Venkatanarayana)  
Partner

Membership No. 018067  
UDIN: 22018067AQBXL3118

Place: Bangalore  
Date: August 19, 2022



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

**BALANCE SHEET AS AT 31ST MARCH, 2022**

		(Amount in Rs.)	
I.	CORPUS / CAPITAL FUND AND LIABILITIES	SCH	31.03.2022      31.03.2021
	CORPUS / CAPITAL FUND	1	33,26,46,238      29,03,28,703
	RESERVES AND SURPLUS	2	-      -
	EARMARKED PROJECTS FUNDS	3	13,36,50,531      14,27,78,951
	SECURED LOANS AND BORROWINGS	4	-      -
	UNSECURED LOANS AND BORROWINGS	5	-      -
	DEFERRED CREDIT LIABILITIES	6	-      -
	CURRENT LIABILITIES AND PROVISIONS	7	3,12,97,692      6,97,22,185
	<b>TOTAL</b>		<b>49,75,94,461      50,28,29,839</b>
II.	APPLICATION OF FUNDS/ASSETS		
	FIXED ASSETS	8	30,98,20,770      30,64,77,924
	INVESTMENTS - FROM EARMARKED/ENDOWMENT FUNDS	9	-      -
	INVESTMENTS - OTHERS	10	-      -
	CURRENT ASSETS, LOANS, ADVANCES ETC.,	11	18,77,73,691      19,63,51,915
	<b>TOTAL</b>		<b>49,75,94,461      50,28,29,839</b>
	<b>SIGNIFICANT ACCOUNTING POLICIES AND NOTES ON ACCOUNTS</b>	24	

  
 (SUBHOD M GULVADY)  
 ADMINISTRATION & FINANCE OFFICER

  
 (PROF. BHAGAVATULA L.V. PRASAD)  
 DIRECTOR

PLACE : BENGALURU  
DATE : 19.08.2022

As per our report of even date  
for M/s G.R.Venkatanarayana  
Chartered Accountants  
Firm Regn No. 004616S

  
 [G R Venkatanarayana]  
 Partner  
 Membership No. 018067

**M/s. G.R. VENKATANARAYANA**  
 Chartered Accountants  
 818, 75th Cross, 6th Block,  
 Rajajinagar, BANGALORE-560 010

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

**INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31ST MARCH, 2022**

		(Amount in Rs.)	
A - INCOME	SCH	31.03.2022	31.03.2021
Income from Sales / Services	12	-	-
Grants / Subsidies:	13	13,31,00,000	10,24,00,000
Fees / Subscriptions	14	-	-
Income from Investments(income on investments from earmarked / endowment Funds)	15	-	-
Income from Royalty, Publications etc.,	16	-	-
Interest earned / accrued	17	2,41,537	23,06,970
Other Income	18	65,21,363	59,52,745
Increase / (decrease) in stock of finished goods and work-in-progress	19	-	-
<b>TOTAL (A)</b>		<b>13,98,62,900</b>	<b>11,06,59,715</b>
<b>B - EXPENDITURE</b>			
Establishment Expenses	20	6,22,66,210	5,79,08,289
Other Administrative Expenses etc.,	21	5,30,13,143	4,09,69,590
Expenditures on Grants, Subsidies etc.,	22	-	-
Interest	23	12,62,638	45,95,529
<b>TOTAL (B)</b>		<b>11,65,41,991</b>	<b>10,34,73,408</b>
<b>C - BALANCE BEING SURPLUS / (DEFICIT) (A-B)</b>		<b>2,33,20,909</b>	<b>71,86,307</b>
<b>D - Depreciation for the year</b>		<b>(2,34,03,374)</b>	<b>(1,76,74,445)</b>
Prior period adjustment		-	-
<b>E. SURPLUS / (DEFICIT) CARRIED TO CORPUS / CAPITAL FUND ( C-D )</b>		<b>(82,465)</b>	<b>(1,04,88,138)</b>
<b>SIGNIFICANT ACCOUNTING POLICIES AND NOTES ON ACCOUNTS</b>	<b>24</b>		

  
 (SUBHOD M GULVADY)  
 ADMINISTRATION & FINANCE OFFICER

  
 (PROF. BHAGAVATULA L.V. PRASAD)  
 DIRECTOR

PLACE : BENGALURU  
 DATE: 19.08.2022

As per our report of even date  
 for M/s G.R.Venkatanarayana  
 Chartered Accountants  
 Firm Regn No. 004616S

  
 [G R Venkatanarayana]  
 Partner  
 M.No. 018067

**M/s. G.R. VENKATANARAYANA**  
 Chartered Accountants  
 618, 75th Cross, 6th Block,  
 Rajajinagar, BANGALORE-560 010

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

**SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH, 2022**

		(Amount in Rs.)	
Particulars	As at 31.03.2022	As at 31.03.2021	
<b><u>SCHEDULE 1</u></b>			
<b><u>A. CAPITAL FUND:</u></b>			
As Per Previous Balance Sheet	29,03,28,703	26,58,16,841	
<b><u>ADD: Capital Grants received:</u></b>			
Funds transferred from Projects for Capital Assets			
Capital Assets	4,24,00,000	3,50,00,000	
	33,27,28,703	30,08,16,841	
<b><u>ADD/(LESS): Surplus / (Deficit) for the year</u></b>	(82,465)	(1,04,88,138)	
<b>TOTAL</b>	<b>33,26,46,238</b>	<b>29,03,28,703</b>	
<b><u>SCHEDULE 2 - RESERVES AND SURPLUS:</u></b>			
	-	-	
<b><u>SCHEDULE 3 - EARMARKED / PROJECT FUNDS:</u></b>			
(See Annexure A for details)	13,36,50,531	14,27,78,951	
<b><u>SCHEDULE 4 - SECURED LOANS AND BORROWINGS:</u></b>			
	-	-	
<b><u>SCHEDULE 5 - UNSECURED LOANS AND BORROWINGS:</u></b>			
	-	-	
<b><u>SCHEDULE 6 - DEFERRED CREDIT LIABILITIES:</u></b>			
	-	-	
<b><u>SCHEDULE 7-CURRENT LIABILITIES &amp; PROVISIONS:</u></b>			
<b>A) CURRENT LIABILITIES:</b>			
1) Statutory Liabilities	12,16,623	17,12,647	
2) Other Liabilities	2,48,82,464	4,28,32,519	
<b>TOTAL (A)</b>	<b>2,60,99,087</b>	<b>4,45,45,166</b>	
<b>B) PROVISIONS:</b>			
Salaries and Services and Supplies	51,98,605	2,51,77,019	
<b>TOTAL (B)</b>	<b>51,98,605</b>	<b>2,51,77,019</b>	
<b>TOTAL (A+B)</b>	<b>3,12,97,692</b>	<b>6,97,22,185</b>	
<b><u>SCHEDULE 8 - FIXED ASSETS</u></b>			
	30,98,20,770	30,64,77,924	
<b><u>SCHEDULE 9- INVESTMENTS FROM EARMARKED / ENDOWMENT FUNDS:</u></b>			
	-	-	
<b><u>SCHEDULE 10 - INVESTMENTS - OTHERS:</u></b>			
	-	-	
<b><u>SCHEDULE 11 - CURRENT ASSETS, LOANS, ADVANCES:</u></b>			
<b>A) CURRENT ASSETS:</b>			
1) Inventories	-	-	
2) Sundry Debtors:			
3) Cash Balances in Hand	10,000.00	59,493	
4) Bank Balances:- Nationalised Banks			
a. Term Deposit Receipts (includes margin money)	7,63,10,912.44	8,98,76,675	
c. <u>Savings Accounts:</u>			
SBI SB A/c No.274	6,18,92,152.81	1,86,19,058	
SBI SB Project A/c 219	1,42,06,645.00	9,90,966	
SBI SB A/c 24430	1,20,78,580.78	40,90,908	
SBI SB A/c 75676	42,88,134.32	21,50,383	
<b>TOTAL (A)</b>	<b>16,87,86,424</b>	<b>11,57,87,483</b>	

Particulars	As at 31.03.2022	As at 31.03.2021
<b>B) LOANS,ADVANCES AND OTHER ASSETS:</b>		
1) Loans	-	-
2) Advances and Other amounts recoverable in Cash or in kind or for value to be received:		
K P T C L Deposit (SERC/CLCR)	1,39,29,221.58	7,77,75,635
Deposit with BSNL	12,65,510.00	10,22,510
3) Deposits HMT Ltd., Mohan Gas and Bhuruka Gas	42,588.00	87,000
4) Grant in Aid Receivable	4,82,690.00	4,82,690
5) Accrued Interest & Prepaid Exp.(Insurance)	0.00	-
6) Deposit with Balmer Lawrie	11,97,531.00	-
7) TDS By Bank/ BESCOM & Others	2,75,000.00	2,75,000
	17,94,726.27	9,21,597
<b>TOTAL (B)</b>	<b>1,89,87,267</b>	<b>8,05,64,432</b>
<b>TOTAL (A+B)</b>	<b>18,77,73,691</b>	<b>19,63,51,915</b>
<b>SCHEDULE 12 - INCOME FROM SALES / SERVICES:</b>	-	-
<b>SCHEDULE 13 - GRANTS / SUBSIDIES:</b>		
Grant in Aid -Salaries	8,00,00,000	5,74,00,000
Grant in Aid -General	5,31,00,000	4,50,00,000
Grant in Aid -Other	-	-
<b>TOTAL</b>	<b>13,31,00,000</b>	<b>10,24,00,000</b>
<b>SCHEDULE 14 - FEES / SUBSCRIPTIONS:</b>	-	-
<b>SCHEDULE 15 - INCOME FROM INVESTMENTS:</b>	-	-
<b>SCHEDULE 16 - INCOME FROM ROYALTY, PUBLICATIONS ETC.:</b>	-	-
<b>SCHEDULE 17 - INTEREST EARNED/Accrued:</b>		
1) On Term Deposits - Nationalised Banks	-	7,51,924
2) On Savings Accounts - Nationalised Bank	2,41,537	15,55,046
<b>TOTAL</b>	<b>2,41,537</b>	<b>23,06,970</b>
<b>SCHEDULE 18 - OTHER INCOME:</b>		
Sample charges	22,21,547	7,74,191
Miscellaneous Income	42,99,816	51,78,554
Conferences and workshops	-	-
<b>TOTAL</b>	<b>65,21,363</b>	<b>59,52,745</b>
<b>SCHEDULE 19 - INCREASE (DECREASE) IN STOCK OF FINISHED GOODS &amp; WORK IN PROGRESS:</b>	-	-
<b>SCHEDULE 20 - ESTABLISHMENT EXPENSES:</b>		
1) Salaries, Allowance and Wages to Staff	4,53,41,823	4,36,08,020
2) Medical Expenses Reimbursed	73,151	87,083
3) Fellowship & Book Grant	1,59,69,800	1,36,28,689
4) Welfare Expenses	8,81,436	5,84,497
<b>TOTAL</b>	<b>6,22,66,210</b>	<b>5,79,08,289</b>

Particulars	As at 31.03.2022	As at 31.03.2021
<b>SCHEDULE 21 - OTHER ADMINISTRATIVE EXPENSES,ETC:</b>		
Auditors Remuneration	59,000.00	76,700
Chemicals, Glasswares & Consumables etc.,	20,14,963.91	39,21,718
Duties & Taxes	1,27,060.00	5,16,050
Electricity & Water Charges	37,32,715.00	36,67,749
Fees & Professional charges & IPR Related Expenses	12,91,081.00	11,59,834
Fuel Charges for Genset	5,22,281.00	3,34,060
Housekeeping / Manpower supply / Security charges	2,87,64,318.00	1,93,50,518
Journals & Periodicals /Books	2,50,858.00	31,175
Meritorius Awards	0.00	-
Conveyance/ Transportation Charges	25,30,459.00	19,48,859
Other Miscellaneous Charges / Bank Charges	8,01,179.82	3,85,785
Advertisement and Publicity Charges	-	1,48,072
Printing & Stationery	2,40,006.00	2,47,819
Registration & Renewals	-	-
Rent & Insurance	21,40,446.00	46,20,644
Repairs & Maintenance	49,05,879.33	32,20,503
Seminars and Conferences	3,18,163.00	17,379
Telephone & Postage	11,86,712.00	6,78,985
Travel Expenses	1,06,345.00	1,88,334
Foreign Travel Expenses	0.00	-
Testing (N.M.R.) & Sample analysis charges	18,64,337.00	-
Inauguration Expenses	-	23,010
Shifting Expenses	21,57,339.00	4,32,397
<b>TOTAL</b>	<b>5,30,13,143</b>	<b>4,09,69,590</b>
<b>SCHEDULE 22 - EXPENDITURE ON GRANTS, SUBSIDIES ETC:</b>	-	-
<b>SCHEDULE 23 - INTEREST:</b>	12,62,638	45,95,529



### SCHEDULE J - EARMARKED / PROJECTS

Annexure - A to Schedule 3

(Amount in Rs.)

[illegible]

ANNUAL REPORT 2021-22

**CENTRE FOR NANO AND SOFT MATTER SCIENCES**  
**ARKAVATHI, SHIVANAPURA, BENGALURU NORTH - 562 162**  
**SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH, 2022**

**SCHEDULE - 8 : FIXED ASSETS****A. CENS :**

DESCRIPTION	W.D.V. as on 01.04.2021	Additions during the year		Total as on 31.03.2022	Rate of Dep.	Depreciation Full Rate	Dep. For Addition <180 Days	Total Depreciation for the year	W.D.V. as on 31.03.2022
		>180 days	<180 Days						
<b>CIVIL WORKS</b>									
Civil Works	51,78,122	43,95,741	1,03,75,262	1,47,71,003	10	9,57,386	5,18,763	14,76,149	1,84,72,976
Infrastructure	3,62,25,363			-	10	36,22,536	-	36,22,536	3,26,02,827
New Campus (WIP)	5,88,63,704	-2,86,24,338	2,60,17,327	(26,07,011)	-	-	-	-	5,62,56,693
<b>BUILDINGS</b>	48,69,742	18,76,863	-	18,76,863	10	6,74,661	-	6,74,661	60,71,944
<b>ELECTRICAL INSTALLATIONS</b>	47,28,278	5,98,728	-	5,98,728	10	5,32,701	-	5,32,701	47,94,305
<b>COMPUTERS</b>	7,48,174	1,42,781	3,87,565	5,30,346	60	5,34,573	1,16,270	6,50,843	6,27,677
<b>FURNITURE &amp; FIXTURES</b>	56,76,859	-	2,31,982	2,31,982	10	5,67,686	11,599	5,79,285	53,29,556
<b>AIR CONDITIONER</b>	14,31,630	-	-	-	15	2,14,745	-	2,14,745	12,16,885
<b>GENERATOR SET</b>	22,41,411	-	-	-	15	3,36,212	-	3,36,212	19,05,199
<b>GENERAL EQUIPMENTS</b>	1,48,88,913	2,69,344	2,35,126	5,04,470	15	22,73,739	17,634	22,91,373	1,31,02,010
<b>SCIENTIFIC EQUIPMENTS</b>	6,95,92,364	1,62,65,299	19,49,599	1,82,14,898	15	1,28,78,649	1,46,220	1,30,24,869	7,47,82,393
<b>Total - (A)</b>	<b>20,44,44,560</b>	<b>(50,75,582)</b>	<b>3,91,96,861</b>	<b>3,41,21,279</b>		<b>2,25,92,888</b>	<b>8,10,486</b>	<b>2,34,03,374</b>	<b>21,51,62,465</b>

(Amount in Rs.)

# B. PROJECTS

DESCRIPTION	W.D.V. as on 01.04.2021	Additions during the year		Total as on 31.03.2022	Rate of Dep.	Depreciation Full Rate	Dep. For Addition <180 Days	Total Depreciation for the year	W.D.V. as on 31.03.2022
		>180 days	<180 Days						
I. Assets Under Closed Projects									
II. DST/TPF/ GUK / 05/16-19 Equipment	32,36,017			32,36,017	15	4,85,403	-	4,85,403	27,50,614
II. IGSTC/GUK/03/16-19 Equipment	4,42,63,037	25,04,993	1,03,51,829	5,69,72,859	15	70,15,205	7,76,387	77,91,592	4,91,81,267
III. DST/NMNT/GUK/06/2017-19 Equipment	39,00,817		-	39,00,817	15	5,85,123	-	5,85,123	33,15,694
IV. SERB/EMR/SANG/01/2017-20 Equipment	1,74,74,443	-	-	1,74,74,443	15	26,21,166	-	26,21,166	1,48,53,277
V. SERB/EMR/CVY/01/2017-20 Equipment	2,21,222			2,21,222	15	33,183	-	33,183	1,88,039
VI. TSAMRC Equipment	11,23,940			11,23,940	15	1,68,591	-	1,68,591	9,55,349
VI. HPCL/IT/NSJ/01/17-18 Equipment	1,23,09,653	1,93,908	-	1,93,908	15	18,75,534	-	18,75,534	1,06,28,027
VII. SERB/EMR/PKS/01/2019-22 Equipment	6,34,358	-	-	6,34,358	15	95,154	-	95,154	5,39,204
VIII. DST/TBI/GUK/2019-22 Equipment	27,51,600	-	-	27,51,600	15	4,12,740	-	4,12,740	23,38,860
IX. SERB/GGN/01/2019-20 Equipment	5,31,990	33,07,199	33,08,577	71,47,766	15	5,75,878	2,48,143	8,24,021	63,23,745
IX. CWIP	1,55,86,287	-	99,168	99,168 (1,20,93,788)	15	-	7,438	7,438	91,730
<b>Total (B)</b>	<b>10,20,33,364</b>	<b>60,06,100</b>	<b>1,37,59,574</b>	<b>10,95,58,250</b>		<b>1,38,67,977</b>	<b>10,24,530</b>	<b>1,48,99,945</b>	<b>9,46,58,305</b>
<b>Grand Total (A+B)</b>	<b>30,64,77,924</b>	<b>9,30,518</b>	<b>5,29,56,435</b>	<b>34,81,24,089</b>	-	<b>3,64,60,865</b>	<b>18,35,016</b>	<b>3,83,03,319</b>	<b>30,98,20,770</b>
<b>Previous Year</b>	<b>29,06,91,892</b>	<b>1,43,16,465</b>	<b>1,88,13,087</b>	<b>33,94,07,734</b>		<b>3,20,53,074</b>	<b>8,76,736</b>	<b>3,29,29,810</b>	<b>30,64,77,924</b>

PLACE : BENGALURU  
DATE: 19.08.2022



*[Signature]*  
(SUBHOD M GULVADY)  
ADMINISTRATION & FINANCE OFFICER

*[Signature]*  
(PROF. BHAGAVATULA L.V. PRASAD)  
DIRECTOR

As per our report of even date  
for M/s G.R. Venkatanarayana  
Chartered Accountants,  
Firm Regn No. 004616S



*[Signature]*  
[G R Venkatanarayana]  
Partner  
Membership No. 018067

## CENTRE FOR NANO AND SOFT MATTER SCIENCES, ARKAVATHI, BENGALURU

### SCHEDULES FORMING PART OF THE ACCOUNTS FOR THE YEAR ENDED 31<sup>ST</sup> MARCH 2022

#### 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 recognised 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.

The Centre has adopted a new Fund Based Management and Accounting Systems viz., SFACTS since 1<sup>st</sup> October 2018. The balances up to 30<sup>th</sup> September 2018 were migrated from Tally ERP system to the new software after proper verification and the statement of accounts finalised through SFACTS.

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.

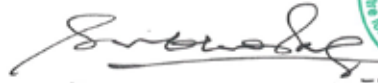
	Depreciation Rate
MACHINERY AND PLANT – Computers including Computer Software	60.00%
MACHINERY AND PLANT – Electrical Equipments	15.00%
MACHINERY AND PLANT – Scientific and Other Equipments	15.00%
FURNITURE AND FITTINGS – including electrical fittings and electrical wiring	10.00%
BUILDING – NR : Infrastructure Labs Etc	10.00%

5. **Government Grants / Other Grants:** The Grants received are recognized in the accounts on accrual basis. 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 the Overhead charges relating to project funds, to earmarked project funds, to meet exigencies in project related expenditure. For this purpose, a fund called Project Administration is maintained under project accounts and allocation of funds to any project is made out of the said fund.

## 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 Rs.2,34,03,374/- is debited to Income and Expenditure account. Depreciation on fixed assets acquired out of project funds amounting to Rs. 1,48,99,945/- 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. 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.

6. Schedules 1 to 23 are annexed to form an integral part of the Balance Sheet as at 31<sup>st</sup> March 2022 and the Income and Expenditure Account for the year ended on that date.



(SUBHOD M GULVADY)

ADMINISTRATION & FINANCE OFFICER

As per our report of even date  
For M/s G R Venkatanarayana  
Chartered Accountants



(PROF. BHAGAVATULA L V PRASAD)  
DIRECTOR



(G R VENKATANARAYANA)  
PARTNER

Membership No. 018067

**M/s. G.R. VENKATANARAYANA**  
Chartered Accountants  
618, 75th Cross, 6th Block,  
Rajajinagar, BANGALORE-560 010

## 19. Miscellaneous

### 19.1 IN-HOUSE COLLOQUIA / SEMINARS

#### RESEARCH FELLOWS

##### Thematic

Title of Colloquia/Seminar	Speaker	Date
Organic light-emitting transistor	Prashanth Nayak	16.07. 2021
Chemical and Biological Sensors for Viral Detection	Alex C	11.11 2021
Photothermal water evaporation	Trupthi Devaiah C	03.12. 2021
Self-shaping systems	Pinchu Xavier	10 .12.2021
Ferroelectric materials for energy harvesting applications	Athira M	07.01.2022
Specialized Imaging techniques in Transmission Electron Microscopy	Suchithra	11.02.2022
Daytime radiative cooling	Amit Bhardwaj	18.02.2022
Photonic Crystals: Preparation techniques and Applications	Rajalaxmi Sahoo	25.02.2022

##### Journal Article based Seminar

Title of Colloquia/Seminar	Speaker	Date
Direct Photolithography of Perovskite Nanocrystals for Display Applications	Modasser Hossain	02.07. 2021
Radiative lifetime encoded security tag for anticounterfeiting applications	Radha Rathod	02 .07.2021
A flexible semitransparent photovoltaic supervisor based on water-processed MXene electrodes	Savithri Vishwanathan	23.08.2021
Spatially Shaping Waves to Penetrate Deep inside a Forbidden Gap	Nurjahan Khatun	22.10. 2021
Self-sustained green neuromorphic interfaces	Swathi S P	21.01.2022

##### Thesis Colloquia

Title of Colloquia/Seminar	Speaker	Date
Photo-driven effects in nano-soft composites with liquid crystal/ polymer hosts	Pragnya Satapathy	28.05.2021
Investigation of structural and optical properties of inorganic energy harvesting materials	Anamul Haque	30 .09.2021
Metal oxide-based nanomaterials for multifunctional application	Subir Roy	20.10.2021
Fabrication of oxide nanostructures using glad for device applications	Gaurav Shukla	21.10.2021

Title of Colloquia/Seminar	Speaker	Date
Nanomaterials for Electrochemical Water Activation	Alex C	11.11.2021
Investigations on nano-soft composites exhibiting liquid crystalline phases	G V Varshini	24.02.2022
Design, synthesis and characterization of functional materials	Madhu Babu Kanakala	31.03.2022

## 19.2 COLLOQUIA/ SEMINARS GIVEN BY VISITORS

### SCIENTIFIC TALKS

Sl. No	Title of the Talk	Name of the Speaker	On Occasion	Date
1	Healthcare in India: Post Independence Scenario	Dr. M. S. Rajanna, M.D, Former Prof and HOD. SSMC Tumkur	World Health Day	April 7, 2021
2	Let the park be green: becoming conscious and proactive to protect our environment	Dr Ganesh T, ATREE Bengaluru	World Environmental Day	June 5, 2021
3	Motivational entrepreneurs for young researchers	Dr Arun M. Isloor, NIT-Suratkal, Mangalore		June 14, 2021
4	Twistronics: A Recent Avenue in van der Waals Heterostructures	Dr.Pramoda Kumar Nayak, IIT-Madras		June 21, 2021
5	Sustainable Science: Embedding Systems Thinking in Research and Innovation	Prof. S. Sivaram, Honorary Professor and IISER Pune	Teacher's Day	September 3, 2021
6	India warming up to cold fusion	Prof. Prahalad Ramarao Padma Shri Director, S-VYASA University, Bengaluru	National Innovation Day	October 12, 2021
7	Enriching Life through Better Relationships	Dr Ali Khwaja, Founder and Head, Banjara Academy	World Mental Health Day	October 25, 2021
8	Better understanding of system and procedures in procurement cycle and Vigilance Awareness	Mr. G. Senthil Kumar, GM, BHEL, Bengaluru	Vigilance Awareness Week 2021	October 29, 2021
9		Alumni of CeNS		October 29, 2021
10	Laser spectroscopy: From physics to chemistry, biology and medicine	Prof. S. Umapathy, Director, IISER, Bhopal	Sir. C.V. Raman's Birthday	November 12, 2021
11	Science-based deep tech startups: Some learnings and insights from Venture Center	Dr. V. Premnath Head, NCL Innovations		November 18 2021, 3 pm

Sl. No	Title of the Talk	Name of the Speaker	On Occasion	Date
12	Approaches and Strategies for India's scientific cooperation	Dr Sanjay K Varshney, Adviser & Head - International Cooperation, DST		January 19, 2022
13	Victory over Polio-Lessons Learnt	Prof. H A Upendra, Former Dean, Veterinary College, Bengaluru	National Immunization Day	January 20, 2022
14	Perfectly Reasonable Approximations: Dealing with the real world	Prof. Sabyasachi Bhattacharya, Director, TCG-CREST, Kolkata	National Science Day	February 28, 2022
15	Tale of Tiger	Mr. Daniel Sukumar, Conservationist, Wildlife researcher	World wildlife Day	March 7, 2022

#### AWARENESS TALKS

Sl. No	Title of the Talk	Name of the Speaker	Date
1	Benefits of Yoga for both mental and physical well being	Shri Prasanna V Raju	June 21, 2021
2	National Handloom Day	All staff & faculty wore Handloom clothes	August 7, 2021
3	75th Independence Day	A Walkathon was organised as a part of "Fit India Freedom Run 2.0"	August 15, 2021
4	The National Nutrition Week is observed from to raise public awareness about nutrition and healthy eating habits.	Nutrition Quiz	September 7, 2021
6	Samvidhan Diwas to commemorate the adoption of our Constitution	All the CeNS members read the Preamble of the Constitution along with the Hon'ble President, Hon'ble Prime Minister, Minister and other dignitaries on November 26 2021	November 26, 2021
7	Dr Swati Dyahadroy Dr Durba Sengupta	Awareness programme on Sexual Harassment of Women at Workplace Act	December 9, 2021
8	Dr Guru Suhas & Dr Anjali Rao,	Cancer Awareness & An Overview of Breast and Cervical Cancers	February 11, 2022
9	Ms Nisha Bellare & Uma Khemuka, Founder of RevaEconauts	Roopantara - Transformation - A talk on sustainable menstruation"	March 11, 2022



## 19.3 OTHER EVENTS

### Camps

Sl. No	Name of the event	Sponsored by	Date
1	Eye screening camp	CeNS in association with Rotary Club of Cubbon Park	September 16, 2021
2	Blood Donation Camp	Rotary Club, Cubbon Park, CeNS and Indian Red Cross Society Karnataka	December 2, 2021

### Workshop

Sl No	Name of the Workshop	Date
1	CRF Orientation Workshop	June 25, 2021

### Competition

Sl. No	Name of the Competition	Occasion	Date of the Event
1	An AmritVaakya (or Slogan) contest	AKAM	April 16-17, 2021
2	The theme for 2021 is IP and SMEs: Taking your ideas to market. Greenhouse (TBI, Nano Mission Project), CeNS in collaboration with Legasis services, empanelled IP firm with CeNS, conducted IP Hackathon contest.	World Intellectual Property (IP) Day" celebrated	April 29- May 1 2021
3	Green energy and green building	Painting challenge	July 19-23, 2021
4	Essay Competition	National Girl Child Day	January 21, 2022
5	Photography competition	AKAM	February 2, 2022
6	Poetry Competition	World Poetry Day	March 16-24, 2022

## 19.4 FACULTY VISITS INDIA

### Faculty: Prof. B L V Prasad

Place & Period of Visit	Purpose of Visit	Title of Talk
IIT, Delhi 25-27 Oct, 2021	To give talk at the conference Physics and Chemistry of advanced materials	Nanomaterial synthesis: Our efforts towards bridging the "lab to market" gap.
Online Dr Babasaheb Ambedkar Marathwada University, Aurangabad 8 -12 Nov, 2021	As part of AICTE ATAL Faculty Development Program on Nanoscience and Nanotechnology	How to make nanomaterials suitable for solution processible applications
Nehru Arts and Science College, 26 Nov, 2021	Webinar organised by Centre for Research & Development Institutions Innovative Council & Red Ribbon Club	Role of soft molecules in Nanosciences
Online 8 March, 2022	Tutorial Talk at Bengaluru India Nano	Dressed to function: Surface modification strategies to prepare functional nanoparticles via bottom-up strategies

### Faculty: Dr D S Shankar Rao

Place & Period of Visit	Purpose of Visit	Title of Talk
Online 21-23 Dec, 2021	Invited talk: at 28th National Conference on liquid crystals, Organised by Department of Chemistry Assam University, Silchar, Assam	Multiple pathways to stabilize/ induce an ordered phase in a system exhibiting a re-entrant sequence

### Faculty: Dr C V Yelamaggad

Place & Period of Visit	Purpose of Visit	Title of Talk
KLS Gogte Institute of Technology, Belagavi	Invited talk: at 28th National Conference on liquid crystals, Organised by Department of Chemistry Assam University, Silchar, Assam	Multiple pathways to stabilize/ induce an ordered phase in a system exhibiting a re-entrant sequence
Online 24 Mar, 2022.	Invited talk presented at the 4th National Conference on "Emerging Trends in Chemistry and Materials Science" (ETCM-2022)"	Functional Soft-Nanomaterials: Towards Dreamy Invisibility Application

Place & Period of Visit	Purpose of Visit	Title of Talk
Online 21- 23 Dec, 2021	28th National Conference on Liquid Crystals. This was organized by the Department of Chemistry, Assam University, Silchar, Assam. In Association with Indian Liquid Crystal Society (ILCS), INDIA.	Soft-Metamaterials: Synthesis and Characterization of CD Responsive Liquid Crystalline Gold Nanoparticles
Online 28 Jan, 2022	An invited talk was presented at the National Level Virtual Workshop on the topic RESEARCH METHODOLOGIES This program was Organized by S. Nijalingappa College, Bengaluru, in association with Royal Society of Chemistry (UK), Local Section Deccan	Responsible Conduct of Research, Periodic Reports, Publications and Ethics
Online 29 Dec, 2021	Invited talk was presented at the One-Day Online Seminar on Functional Nano and Soft Materials: Fundamentals and Applications. This was organized by the Royal Society of Chemistry (UK), Local Section Deccan, in association with K.L.E Society's P. C. Jabin Science College, Hubballi	"Fascinating Soft Matter: Fundamentals and Applications"
Online 27 Dec, 2021	A invited talk was presented at the Virtual Seminar on Soft Materials: Fundamental Aspects and Applications. This was organized by the Royal Society of Chemistry (UK), Local Section Deccan in association with K.L.E Society's Jagadguru Tontadarya (J T) College of Arts, Science & Commerce Gadag - Betageri	Liquid Crystals: Life, Science and Technology
Online 22 Dec, 2021	The talk was presented at Third Indian Materials Conclave and 32 <sup>nd</sup> Annual General Meeting of MRSI	Soft-Metamaterials: Synthesis and Characterization of CD Responsive Liquid Crystalline Gold Nanoparticles
Online 21-23 Dec,2021	Invited talk was presented at the 28th National Conference on Liquid Crystals This was organized by the Department of Chemistry, Assam University, Silchar, Assam. In Association with Indian Liquid Crystal Society (ILCS), INDIA.	Soft-Metamaterials: Synthesis and Characterization of CD Responsive Liquid Crystalline Gold Nanoparticles

**Faculty: Dr S Angappane**

Place & Period of Visit	Purpose of Visit	Title of Talk
20-23 Dec, 2021	32 <sup>nd</sup> Annual General Meeting of MRSI & 3 <sup>rd</sup> Indian Materials Conclave	Low power multilevel resistive switching in titanium oxide-based RRAM devices by interface engineering

**Faculty: Dr Neena S John**

Place & Period of Visit	Purpose of Visit	Title of Talk
Online 20-23 Dec, 2021	Served as a co-chair and Theme in charge for conducting the symposium 'Nanomaterials Synthesis and Solutions Route' at Third Indian Materials conclave and 32 <sup>nd</sup> Annual General Meeting of MRSI, organized by IIT-M	NA
Online 7 Dec, 2021	Bengaluru University	Engineering materials for electrochemical energy generation
BMSIT &M, Yelahanka, Bengaluru	Conducted the comprehensive viva of a Ph.D. student as a DAC committee member	NA
Online 9-10, July 2021	Invited Online talk during 15th National Frontiers of Engineering (NatFoE) Symposium organized by IIT, Hyderabad and INAE (Theme: Advances in Materials & Manufacturing Technology)	Metal oxide structures with spiky morphology for multifunctional applications

**Faculty: Dr Pralay K Santra**

Place & Period of Visit	Purpose of Visit	Title of Talk
Online 27-30 July, 2021	Invited speaker for the conference Interdisciplinary Topics in Materials Science (ITAM-2021).	Interparticle mixing of CsPbBr <sub>3</sub> and CsPbI <sub>3</sub> nanocubes: halide ion migration and kinetics

**Faculty: Dr H S S Ramakrishna Matte**

Place & Period of Visit	Purpose of Visit	Title of Talk
28-30 Oct, 2021 Organised by Department of Studies in Physics Mangalore University.	Second International E Conference on Physics of Materials & Nanotechnology (ICPN 2021)	Low-Dimensional Materials and Applications

Place & Period of Visit	Purpose of Visit	Title of Talk
21 - 25 Feb, 2022, Presidency University, Bengaluru	VGST, Govt of Karnataka, Sponsored Online Faculty Development Programme on "Recent Developments in Advanced Materials Processing Techniques and Characterization" Organized by Department of Chemistry, School of Engineering,	Solution processing of low-dimensional materials and applications
Online; 8-9 March, 2022	Bengaluru India-Nano	Attended the event
Online 28- 29 March, 2022	"Two Dimensional Materials: Graphene and Beyond", at Centre for Nanoscience and Nanotechnology, Sathyabama Institute of Science and Technology (Deemed to be University), Chennai, T.N,	Solution processing of low-dimensional materials and applications
22 February 2022 IISc Bengaluru	Prof. Arindam Ghosh, Department of Physics, IISc, Bengaluru	To discuss on Liquid Phase Exfoliation and possibility of collaborating on entrepreneurial activity
Online 29 March, 2022	Dr. Subarna Shyamaroy, Asian Paints,	To discuss solution processing of nanomaterial.

#### Faculty: Dr Ashutosh Kumar Singh

Place & Period of Visit	Purpose of Visit	Title of Talk
Saint Gobain Research India, IIT Madras, Research Park, 5 August 2021	Collaborative Research work under ongoing Saint Gobain Project	Microfluidic Smart Windows
23 Sep, 2021 IISc Bengaluru,	Associated in organizing an interaction meeting between Saint Gobain Research India and CeNS Bengaluru hosted by Greenhouse, TBI	NA
20 Feb, 2022 JNCASR- Bengaluru,	Collaborative Research work under ongoing SERB-SUPRA with Dr. Gaurav Tomar	NA
Hind High Vacuum Bengaluru, 10 Mar, 2022	Collaborative Research work under ongoing DST-AMT project with Dr. M G Sreenivasan	NA

#### Faculty: Dr Kavita Pandey

Place & Period of Visit	Purpose of Visit	Title of Talk
Bengaluru University 23 Mar, 2022	Invited Talk	(Bio) Electrochemistry: Mechanisms to Devices



**Faculty: Dr. S. Krishna Prasad**

Place & Period of Visit	Purpose of Visit	Title of Talk
Online 4-5 Oct, 2021	Recent Perspectives on Liquid Crystalline Materials: Chemistry, Physics and Biological Applications (RPLCM-2021), Organised by Department of Chemistry Assam University, Silchar, Assam	Liquid crystal routes to amplify photoluminescence from fluorophores and quantum dots
Online 21-23 Dec, 2021	Keynote Address at 28th National Conference on liquid crystals, Organised by Department of Chemistry Assam University, Silchar, Assam	Light: A powerful tool to study liquid crystals
Online 28 Mar, 2022	Keynote Address: Emerging Trends and Modelling in Advanced Functional Materials & Devices, 28 March 2022 Organized by NIT Jalandhar	Anisotropic Soft Matter confined in Meso/Nano-Networks
Online 26 Nov, 2021	Distinguished Talk organized by KSTA, Bengaluru on 26 November 2021	Lead kindly light: Spectroscopy and the Periodic Table
Online 27 Dec, 2021	Virtual Seminar on Soft Materials: Fundamental Aspects and Applications 27th December 2021 by Royal Society of Chemistry (UK), Local Section Deccan In association with K.L.E Society	Multi-dimensional Technological Applications of Liquid Crystals
Online Feb-Apr 2022	Course lectures for JNCASR Ph.D students	Research Publication & Ethics for students

**19.5 SCIENTISTS /ACADEMIC VISITORS TO CeNS**

SI No	Name and affiliation	Within the country / abroad	Purpose of visit	Duration of visit From.... To...	Seminar given if any with title and date
1.	Dr. M G Sreenivasan, Sr. R&D Manager, Hind High Vacuum (HHV) India	Within the country	To discuss on going collaborative research project on "Electrochromic Devices" under DST-AMT	20 September 2021, 10 October 2021, 6 January 2022	Nil

Sl No	Name and affiliation	Within the country / abroad	Purpose of visit	Duration of visit From.... To...	Seminar given if any with title and date
2.	Dr. Abhay A Sagade, Associate Professor (Research) Department of Physics and Nanotechnology 8th floor, Sir C. V. Raman Research Park SRM Institute of Science and Technology SRM nagar, Kattankulathur 603 203 (Chennai), Tamil Nadu	Within the country	For discussion	27-28 Sept 2021	
3.	Dr. Srinivasprasad B S, Scientist at Saint-Gobain Research India	Within the country	To discuss ongoing collaborative research project on "Microfluidic smart window" under Saint Gobain Project	17 December 2021	Nil
4.	Dr. Debasish Sarkar, Assistant Professor, MNIT Jaipur, India	Within the country	To discuss collaborative research project possibility on "Energy storage devices"	29 December 2021	Nil
5.	Dr. Prasanna Kumar Sahoo, Assistant Professor, IIT Kharagpur	Within country	To discuss and explore the collaborative project possibilities using metal- mesh electrodes	21 March 2022	Nil

## 19.6 ACADEMIC ACTIVITIES BY RESEARCH STUDENTS AND POSTDOCTORAL FELLOWS

Sl. No.	Date(s)	Name & Designation*	Name of Conference attended	Mode of Presentation and Title
1	17 February 2021-09 June 2021	Ramesh Chandra Sahoo SRF	Pine research group	Attended the webinar
2	23 July 2021	Amit Bhardwaj SRF	META 2021, Poland - The 11th International Conference on Metamaterials, Photonic Crystals and Plasmonics	ORAL presentation: Tunable Fano Resonance in a Liquid Crystal Colloidal Metamaterial
3	23 July 2021	Amit Bhardwaj SRF	META 2021, Poland - The 11th International Conference on Metamaterials, Photonic Crystals and Plasmonics	POSTER presentation: Tunability of Epsilon-Near-Zero behavior in a Self-assembled Liquid Crystal - Nanoparticle Hybrid Metamaterial
4	27-30 July 2021	Dr. S. Vimala, Research Associate	Interdisciplinary Topics in Advanced Materials	online participation
5	27-30 July 2021	Subir Roy SRF	Online conference "Interdisciplinary Topics in Materials Science" (ITAM-2021)	Poster (online) Higher metal-insulator transition temperature and signature of second order magnetic phase transition in NdNiO <sub>3</sub> nanoparticles
6	27-30 July 2021	Modasser Hossain SRF	Interdisciplinary Topics in Advanced Materials (ITAM)	Poster: Understanding the Transformation of 2D Layered Perovskites to 3D Perovskites in the Sonochemical Synthesis
7	27 - 30 July 2021	Priyabrata Sahoo SRF	Interdisciplinary Topics in Materials Science (ITAM-2021)	Online (Poster) Solution processing of topochemically converted layered WO <sub>3</sub> for multifunctional applications
8	1 - 4 August 2021	Radha Rathod SRF	EXAFS summer School on EXAFS organized by Illinois institute of Technology and Advanced Photon Source	Participated online

Sl. No.	Date(s)	Name & Designation*	Name of Conference attended	Mode of Presentation and Title
9	1 – 4 August 2021	Aishwarya Mungale JRF	EXAFS summer School on EXAFS organized by Illinois institute of Technology and Advanced Photon Source	Participated online
10	20-23 Sep 2021	Dr. S. Vimala, Research Associate	15th International Congress on Artificial Materials for Novel Wave Phenomena (Metamaterials 2021)	online participation
11	24-25 Sep 2021	Dr. S. Vimala, Research Associate	43rd EUPROMETA Doctoral school on 'Emerging Concepts and Anomalies in Light Scattering'	online participation
12	4-5 Oct 2021	Rajalaxmi Sahoo, SRF	Poster presentation at International Webinar on Liquid Crystalline Materials: Chemistry, Physics and Biological Applications (RPLCM-2021)	Online Impact of the parity of photoisomerizable dimers on one-dimensional and three-dimensional photonic structures
13	24-27 Oct 2021	Dr. S. Vimala, Research Associate	International Hybrid Meeting on 'Physics and Chemistry of Advanced Materials (PCAM-2021)	online participation
14	14-16 Oct 2021	Pinchu Xavier, SRF	Soft Matter Young Investigators Meet 2021	Oral, Stripe to radial defect transition in nematic domains at air-aqueous electrolyte interfaces
15	1-4 Nov 2021	Swathi S P SRF	International Conference on Memristive Materials, Devices & Systems (MEMRISYS), Japan	Oral (online) Digital and analog resistive switching in NiO-based memristor by electrode engineering
16	29Nov – 4 Dec 2021	Radha Rathod SRF	12 <sup>th</sup> National Workshop on Fluorescence and Raman Spectroscopy	Participated online

Sl. No.	Date(s)	Name & Designation*	Name of Conference attended	Mode of Presentation and Title
17	20 Dec 2022	Athira SRF	32 <sup>nd</sup> annual general meeting of MRSI & 3rd Indian materials conclave	Oral (online) SnO <sub>2</sub> -NiO heterojunction based self-powered UV photodetectors
18	20-22 Dec 2021	Ramya Prabhu B, SRF	Third Indian Materials conclave and 32 <sup>nd</sup> Annual General Meeting of MRSI, (Virtual Mode)	'Self-cleaning spiky mixed metal oxide nanoformulation for antimicrobial applications (Oral presentation)
19	20 -23 Dec 2021	Nurjahan Khatun, SRF	3 <sup>rd</sup> Indian Materials Conclave (IndMac) and 32nd Annual General Meeting of MRSI.	Online, Enhanced thermal stability and monodomain growth in a 3D soft photonic crystal aided by graphene substrate
20	20 -23 Dec 2021	Vishnu G Nath, Subir Roy SRF	32 <sup>nd</sup> annual general meeting of MRSI & 3rd Indian materials conclave	Poster Presented a poster entitled "Highly selective NOX sensor based on ZnFe <sub>2</sub> O <sub>4</sub> nanoparticles with ppb level detection at room temperature"
21	20-22 Dec 2021	Muhammed Safeer N K, SRF	Third Indian Materials conclave and 32nd Annual General Meeting of MRSI (Virtual Mode)	'Synthesis of graphene- Nickel hydroxide electrocatalyst for urea oxidation reaction (Poster Presentation)
22	20-23 Dec 2021	Savithri Viswanathan SRF	3 <sup>rd</sup> Indian Materials Conclave and 32nd meeting of MRSI	Online (Poster) Unveiling the effect of the crystalline phases of iron oxyhydroxide for highly sensitive and selective detection of dopamine
23	21-23 Dec 2021	Gayathri R Pisharody, SRF	28 <sup>th</sup> National Conference on liquid crystals, Organised by Department of Chemistry Assam University, Silchar, Assam	Oral presentation online 'Solution-Processed h-BN Film as an Excellent Alternative to Polymer Alignment Layer for Liquid Crystal Devices'
24	21-23 Dec 2021	Rajalaxmi Sahoo, SRF	28th National Conference on liquid crystals, Organised by Department of Chemistry Assam University, Silchar, Assam	Oral presentation online. Impact of the parity of photoisomerizable dimers on one-dimensional and three-dimensional photonic structures'



Sl. No.	Date(s)	Name & Designation*	Name of Conference attended	Mode of Presentation and Title
25	24-25 Jan 2022	Priyabrata Sahoo SRF	International Conference for Dispersion Analysis & Materials Testing 2022	Attended the conference
26	7- 8 Mar 2022,	Nurjahan Khatun, SRF	12 <sup>th</sup> Bengaluru INDIA NANO	Online, enhanced thermal stability and monodomain growth in a 3D soft photonic crystal aided by graphene substrate
27	7-9 Mar 2022	Dr. S. Vimala, Research Associate	12 <sup>th</sup> Bengaluru India Nano	online participation
28	7-8 Mar 2022	Muhammed Safeer N K, SRF	12 <sup>th</sup> Bengaluru Nano (Virtual Mode)	'One in a million: Ni <sup>3+</sup> in Ni <sub>2</sub> O <sub>3</sub> that loves urea and hates CO <sub>2</sub> (Poster presentation)
29	7 – 8 Mar 2022	Modasser Hossain SRF	Bengaluru India Nano	Poster, Understanding the Transformation of 2D Layered Perovskites to 3D Perovskites in the Sonochemical Synthesis
30	7 – 8 Mar 2022	Radha Rathod SRF	Bengaluru India Nano	Poster, Plasma treated CsPbBr <sub>3</sub> NCs films with enhanced photoluminescence and improved water stability for optoelectronic applications
32	7-9 Mar 2022	Ramesh Chandra Sahoo SRF	Bengaluru India Nano 2022	Online (Poster) Bandgap engineered g-C <sub>3</sub> N <sub>4</sub> and its graphene composites for stable photoreduction of CO <sub>2</sub> to methanol
33	7-8 Mar 2022	Nilay Awasthi (Tech Buddy) & Mukhesh K G SRF	Bengaluru India Nano-2022	Poster Title: Mist Driven Smart Glass Technology
34	7-8 Mar 2022	Sabiar Rahaman, SRF	Bengaluru Nano 2022	Poster Presentation (Online) Bi-functional electrode for Supercapacitor and UV Detector applications using two-dimensional Layered Coordination polymers

Sl. No.	Date(s)	Name & Designation*	Name of Conference attended	Mode of Presentation and Title
35	14-18 Mar 2022	Pragnya Satapathy, SRF	Satellite meeting of the APS March meeting at ICTS, Bengaluru Session on "Emerging trends in Soft and Granular Matter Research" 14-18 March 2022	Oral (in Person) "Multiple and efficient pathways for anisotropic photoluminescence modulation in soft nanocomposites"
36	18-20 Mar 2022	Sabiar Rahaman, SRF	ACS Spring 2022	Oral talk (Online) Two-dimensional Layered Coordination Polymers Based on Lanthanide Metals for Supercapacitor Application
37	15 Mar – 14 Apr 2022	Radha Rathod, SRF	A crash course on "Next generation solar cells" by Prof. Mukundan Thelakkat under VAJRA visiting faculty scheme at JNCASR	Participated in person
38	15 Mar – 14 Apr 2022	Aishwarya Mungale JRF	A crash course on "Next generation solar cells" by Prof. Mukundan Thelakkat under VAJRA visiting faculty scheme at JNCASR	Participated in person
39	15 Mar – 14 Apr 2022	Modasser Hossain SRF	A crash course on "Next generation solar cells" by Prof. Mukundan Thelakkat under VAJRA visiting faculty scheme at JNCASR	Participated in person
40	15 Mar – 14 Apr 2022	Trupthi Devaiah C SRF	A crash course on "Next generation solar cells" by Prof. Mukundan Thelakkat under VAJRA visiting faculty scheme at JNCASR	Participated in person

Sl. No.	Date(s)	Name & Designation*	Name of Conference attended	Mode of Presentation and Title
41	28 Mar- 1Apr, 2022.	Rajalaxmi Sahoo, SRF	Short-Term Course on "Emerging Trends and Modeling in Advanced Functional Materials & Devices" organised by Dr. B. R. Ambedkar National Institute of Technology, Jalandhar	Participated online

## Annexure A:

### Publications/Referred journals/ conference proceedings/chapters in books:

1. Selective electro-oxidation of phenol to 1, 4-hydroquinone employing carbonaceous electrodes: surface modification is the key, M. D. Baravkar and B. L. V. Prasad, *New J. Chem.*, 46, 2518–2525 (2022) IF=3.591
2. Amphi-functional mesoporous silica nanoparticles with “molecular gates” for controlled drug uptake and release, P. Shinde and B. L. V. Prasad, *Part. Part. Syst. Charact.*, 2100185 (2021) IF=3.31
3. Enhanced Mie resonance in a low refractive index colloidal metamaterial aided by nematic liquid crystal, Amit Bhardwaj, Vimala Sridurai, Navas Meleth Puthoor and Geetha G. Nair, *J. Mol. Liq.*, 346, 117116 (2022) IF= 6.165
4. Effect of Photonic Band Gap on Photoluminescence in a Dye-Doped Blue Phase Liquid Crystal, Nurjahan Khatun, Vimala Sridurai, Ravindra K. Gupta, Subrata Nath, Madhu B. Kanakala, Swadhin Garain, Ammathnadu S. Achalkumar, Channabasaveshwar V. Yelamaggad, and Geetha G. Nair, *J. Phys. Chem. B*, 125, 11582–11590 (2021) IF= 2.991
5. Interplay between bulk and molecular viscosities of a soft glassy nematic gel, S. Vimala and Geetha G. Nair, *Liq. Cryst.*, ‘special commemorative issue of Liquid Crystals dedicated to Prof. BK Sadashiva’, *Liq. Cryst.*, 49: 1235–1245 (2022) IF=3.512
6. Structure, stability, and electro-optic features of nematic drops in 1, 7-bis(4-cyanobiphenyl-4-yl) heptane–surfactant binary system, K. S. Krishnamurthy, D. S. Shankar Rao, Shreya Sharma, and C. V. Yelamaggad, *Phys. Rev. E*, 105, 024709 (2022) IF=2.529
7. Multiple pathways to stabilize/induce an ordered phase in a system exhibiting a reentrant sequence, G.V. Varshini, Pragnya Satapathy, D.S. Shankar Rao & S. Krishna Prasad, *Liq. Cryst.*, 49: 952–968 (2022) IF=3.512
8. Investigation of mesomorphic, photophysical and gelation behavior in aroylhydrazones based liquid crystals: Observation of mesophase crossover phenomena, P. Kanth, D.S. Shankar Rao, S. Krishna Prasad and B. Singh, *J. Mol. Liq.*, 346, 117084–1–13 (2022) IF=6.165
9. Electric response of topological dipoles in nematic colloids with twist-bend nematic droplets as the dispersed phase, K. S. Krishnamurthy, D. S. Shankar Rao, M. B. Kanakala, and C. V. Yelamaggad, *Phys. Rev. E*, 103, 042701–1–10 (2021); IF=2.529
10. Evaluation of photo switching properties for hockey stick – shaped mesogens bearing azobenzene moieties, B. N. Sunil, M. Monika, G. Shanker, G. Hegde and Veena Prasad, *Frontiers in Physics*, 9, Article 728632 (2021) IF=3.56
11. Porous carbon nanoparticles dispersed nematic liquid crystal: Influence of the particle size on electro-optical and dielectric parameters, G. Pathak, Rekha S. Hegde, S. S. Punjalkatte, T. Rujiralai, G. Hegde and Veena Prasad, *Liq. Cryst.*, 49: 7–9, 1223–1234 (2022), (Invited Article) IF=3.512
12. Exceptionally Wide Thermal Range Enantiotropic Existence of a Highly Complex Twist Grain Boundary Phase in a Pure, Single-Component Liquid Crystal Chiral Dimer, Madhu Babu Kanakala and C. V. Yelamaggad, *ACS Omega*, 6, 11556–11562 (2021) IF=3.512
13. Polarization of three-ring Schiff base ferroelectric liquid crystals, Vijayashree Patil N, R. Sahoo, B. N. Veerabhadraswamy, S. Chakraborty, R. Dhard, R. D. Mathad and C. V. Yelamaggad. *Liq. Cryst.*, 48, 1194–1205 (2021) IF= 3.512
14. Waste biomass-derived carbon-supported palladium-based catalyst for cross-coupling reactions and energy storage applications, M. Kempasiddaiah, K. A. Sree Raj, V. Kandathil, R. B. Dateer, B. S. Sasidhar, C. V. Yelamaggad, C. S. Rout, and S. A. Patil. *Appl. Surf. Sci.*, 570, 151156 (2021) IF= 6.86
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16. Understanding of Mechanistic Perspective in Sensing of Energetic Nitro Compounds through Spectroscopic and Electrochemical studies. S. A. Ture, V. B. Patil, C. V. Yelamaggad, R. Martínez-Máñez, and V. Abbaraju. *J. Appl. Polym. Sci.*, 138, e50776 (2021) IF=3.125
17. Low power multilevel resistive switching in

titanium oxide-based RRAM devices by interface engineering, S. P. Swathi and S. Angappane, *J.Sci. Adv. Mater.Dev.* 6, 601-610 (2021) IF= 5.469

18. Observation of room-temperature low-field magnetoresistance in reduced graphene oxide/CoFe<sub>2</sub>O<sub>4</sub> nanocomposites, Subir Roy, Iniyan Sivakumar, Femy Francis, Varshini G. V. and Angappane Subramanian, *Phys. Status Solidi B*, 258, 2100033 (2021) IF=1.710

19. Dimensional constraints favour high temperature anatase phase stability in TiO<sub>2</sub> nanorods, Gaurav Shukla and S. Angappane, *Appl. Surf. Sci.*, 577, 151874 (2022) IF= 6.86

20. Emergence of long afterglow and room temperature phosphorescence emissions from ultra-small sulfur dots. Karthika S Sunil, K. Bramhaiah, S. Mandal, S. Kar, Neena S. John and S. Bhattacharyya, *Materials Advances*, 3, 2037-2046 (2022)

21. Remarkable CO<sub>x</sub> tolerance of Ni<sup>3+</sup>/active species in a Ni<sub>2</sub>O<sub>3</sub> catalyst for sustained electrochemical urea oxidation, Muhammed Safeer NK, C. Alex, R. Jana, Ayan Datta and Neena S. John. *J. Mater. Chem. A*, 10, 4209-4221 (2022). IF=12.73

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23. Introduction of surface defects in NiO with effective removal of adsorbed catalyst poisons for improved electrochemical urea oxidation, C. Alex, G. Shukla and Neena S John, *Electrochimica Acta*, 385, 138425 (2021) IF=6.901

24. Enhanced electrical transport through wrinkles in turbostratic graphene films, M. Moun, A. Vasdev, R. Pujar, K Priya Madhuri, U Mogera, Neena S John, G U Kulkarni and Goutam Sheet. *Appl. Phys. Lett.*, 119, 033102 (2021) IF=3.791

25. Molecularly Imprinted Scaffold Based on poly (3-aminobenzoic acid) for Electrochemical Sensing of Vitamin B<sub>6</sub>, A. R. Cherian, L. Benny, A. Varghese, Neena S. John, and G. Hegde, *J. Electrochem. Soc.*, 168, 077512 (2021) IF=4.316

26. Insight into the Multistate Emissive N, P-doped Carbon Nano-Onions: Emerging Visible Light Absorption for Photocatalysis, S. Kar, K. Bramhaiah,

Neena S John and S. Bhattacharyya, *Chemistry an Asian Journal*, 16, 1138-1149 (2021) IF=4.568

27. Understanding the Transformation of 2D Layered Perovskites to 3D Perovskites in the Sonochemical Synthesis, Modasser Hossain, Trupthi Devaiah Chonamada and Pralay K. Santra, *J. Phys. Chem. C*, 125, 12131-12139 (2021) IF= 4.126

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30. Bandgap engineered g-C<sub>3</sub>N<sub>4</sub> and its graphene composites for stable photoreduction of CO<sub>2</sub> to methanol, Ramesh Chandra Sahoo, Haijiao Lu, Dimple Garg, Zongyou Yin & H. S. S. Ramakrishna Matte, *Carbon*, 192, 101-108 (2022) IF=9.594

31. Spontaneous formation of gold nanoparticles on MoS<sub>2</sub> nanosheets and its impact on solution-processed optoelectronic devices, Kenneth Lobo, Vijaya Kumar Gangaiah, Harsha Priya & H. S. S. Ramakrishna Matte, *Iscience*, 25, 104120 (2022) IF=5.74

32. Pd (II) decorated conductive two-dimensional chromium-pyrazine metal-organic framework for rapid detection of hydrogen, Marilyn Esclance DMello, Ramesh Chandra Sahoo, Rajamani Raghunathan, H. S. S. Ramakrishna Matte, Priyanka Yadav, Ganapati V. Shanbhag & Suresh Babu Kalidindi, *Int. J. Hydrog. Energy*, 47, 9477-9483 (2022) IF= 5.816

33. Solution processing of topochemically converted layered WO<sub>3</sub> for multifunctional applications, Priyabrata Sahoo, Bikesh Gupta, Ramesh Chandra Sahoo, Kiran Vankayala & H. S. S. Ramakrishna Matte, *Chemistry-A European Journal*, 27, 11326-11334 (2021). IF= 5.236

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36. Large-area fabrication of high performing, flexible, transparent conducting electrodes using screen printing and spray coating techniques, Remya K. Govind, Indrajit Mondal, Kaushik Baishya, Mukhesh K. Ganesha, Sunil Walia, Ashutosh K. Singh and G. U. Kulkarni, *Adv. Mater. Technol.*, 2101120 (2021) IF= 8.09
37. ITO-free large area PDLC smart windows: a cost-effective fabrication using spray-coated SnO<sub>2</sub> on an invisible Al mesh, Indrajit Mondal, Kiruthika S, Mukhesh K. Ganesha, Marlin Baral, Ankush Kumar, S. Vimala, P. Lakshmi Madhuri, Geetha G. Nair, S. Krishna Prasad, Ashutosh K. Singh and G. U. Kulkarni, *J. Mater. Chem. A*, 9, 23157–23168 (2021) IF= 12.732
38. Enhanced luminescence and electric-field modulation in nematic-CdSeS gradient nanocrystal composites by polymer confinement, Pragnya Satapathy, V. Navyashree, J. Oinam and S. Krishna Prasad, *J. Mol. Liq.*, 347, 118004 (2022) IF= 6.165
39. Porous nanocarbon particles drive large magnitude and fast photomechanical actuators, Pragnya Satapathy, Raghavendra Adiga, Monish Kumar, Gurumurthy Hegde and S Krishna Prasad, *J. Nanostructure in Chemistry*, 12, 235 (2022) IF = 6.391
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41. Effect of pH on the phase behavior of DMPC bilayers, Anindya Chowdhury, Sreeja Sasidharan, Pinchu Xavier, P. Viswanath and V A Raghunathan, *Biochimica Et Biophysica Acta-Biomembranes*, 1863, 183695 (2021) IF 3.747
42. Electrically driven structures in bent-core nematics, Nandor Eber, Agnes Buka and K.S. Krishnamurthy, *Liq. Cryst.*, (2021) IF=3.51
43. Extended X-Ray Emission Associated with the Radio Lobes and the Environments of 60 Radio Galaxies, Ajay Gill, Michelle M Boyce, Christopher P. O Dea, Stefi A. Baum, Preeti Kharb, Neil Campbell, Grant R. Tremblay and Suman Kundu, *The Astrophysical Journal*, 912, 88 (2021) IF=5.874
44. B. K. Sadashiva (1946-2020), N. Jayaraman & S Krishna Prasad, *Current Science*, 120, 1257-1258 (2021) IF=1.102
45. Parts per billion sensitive, highly selective ambient operable, ammonia sensor with supramolecular nanofibres as active element, Suman Kundu, Subi J. George and G U Kulkarni, *Sensors and Actuators B-Chemical*, 347, 130634 (2021) IF=8.42
46. Wettability Contrast in the Hexagonally Patterned Gold Substrate of Distinct Morphologies for Enhanced Fog Harvesting, Brindhu Malani S and P Viswanath, *Langmuir*, 37, 8281-8289 (2021) IF=3.882
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50. Synthesis and fluorescence sensing of energetic materials using benzenesulfonic acid-doped polyaniline, Satish A. Ture, Shruthy D. Pattathil, Veerabhadragouda B. Patil, C V. Yelamaggad, Ramón Martínez-Máñez & Venkataraman Abbaraju, *Journal of Materials Science: Materials in Electronics*, 33, 8551–8565 (2021) IF=2.478
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52. The Role of Molecular Packing in Dictating the Miscibility of Some Cholesteryl n-Alkanoates at Interfaces, Pinchu Xavier, Brindhu Malani S and P Viswanath, *Langmuir*, 37, 11203-11211 (2021) IF= 3.882
53. Cholesterol-based nonsymmetric dimers comprising phenyl 4-(benzoyloxy) benzoate core: the occurrence of frustrated phases, C V

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54. Tris(Keto-Hydrazone): A Fully Integrated Highly Stable and Exceptionally Sensitive H<sub>2</sub>S Capacitive Sensor, Saravanan Yuvaraja, Veerabhadraswamy N B , , Sachin A. Bhat, Mani Teja Vijjapu, Sandeep G. Surya, C V Yelamaggad and Khaled Nabil Salama, *Advanced Electronic Materials*, 7 (2021) IF= 7.29

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57. Inkjet printing aided patterning of transparent metal mesh for wearable tactile and proximity sensors, Indrajit Mondal, Mukhesh.G K., Ashutosh K Singh, & G U Kulkarni, *Materials Letters*, 312(2022) IF=3.423.

58. Dynamics of the photo-thermo-mechanical actuations in NIR-dye doped liquid crystal polymer networks, Divya .Jayoti D, Akhil R Peeketi, Ratna K Annabattula & S Krishna Prasad, *Soft Matter*. 18, 3358-3368 (2022) IF= 3.679

59. Polarization investigations of Schiff base three-ring ferroelectric liquid crystals. Vijayashree Patil N, R Sahoo, B N Veerabhadraswamy, S. Chakraborty,

R Dhard, R.D. Mathad and C V Yelamaggad. *Liq. Cryst.*, 1194-1205 (2021) IF=3.51

## In Conference proceedings

1. Enhanced UV Photodetection of NiO Thin Film With Au Decoration, Athira M, S. Angappane, *Proceedings of the 65th DAE Solid State Physics Symposium*, 508-509 (2021).

2. A Facile Approach to Improve ON/OFF Ratio and Uniformity of Low-power HfO<sub>x</sub> based RRAMs, S. P. Swathi, S. Angappane, *Proceedings of the 65th DAE Solid State Physics Symposium*, 785-786 (2021).

## Book chapters

1. Metal phthalocyanines and their composites with carbon nanostructures for applications in energy generation and storage. In: Sabu Thomas, Nandakumar Kalarikkal, Ann Rose Abraham. (eds) In Micro and Nano Technologies, Design, Fabrication, and Characterization of Multifunctional Nanomaterials. Priya Madhuri, K., John, Neena S.(2022), Elsevier, 2022

2. Polymers for confinement of liquid crystals: Influence of inorganic inclusions. P M Visakh, Artem Semkin and Zeynep Güven Özdemir.(eds). In Liquid Crystal Polymer Nanocomposites. Jayoti, Divya., Baral, Marlin., Prasad, S Krishna. (2022) Woodhead Publishing, 2022

## Annexure B: Details of Outreach Programmes

### V4 Science programme @ CeNS

Date	Institutions Name & address	Participation Details		Topic
		Staff	Student	
2 Nov 2021	GKVK	1	9	Lab Visits
17 Dec 2021	Bishop Cotton Women's Christian College	1	35	Microscopy for Nano World
18 Mar 2022	Soundarya Composite PU College	4	39	Liquid Crystals: An Unique State of Matter
24 Mar 2022	NMKRV College for Womens	6	35	Science: Let Us Learn to Lead

### V4 Science programme @ other institutes

Date	Institutions Name & address	Participation Details		Topic
		Staff	Student	
15 July 2021	Shanthiniketan Group of Institutions	2	105	Nanoscience: The New and Big Science of Small
6 August 2021	P. C. Jabin Science College, Hubballi.	110	450	Nano and Soft Materials for Social Needs"
7 August 2021	Vidhya Vardhak sangha's V. B. Darbar P.U College, Bijapur	5	130	Nano and Soft Materials for Societal Needs"
1st Oct 2021	Oxford College, Bengaluru	4	110	Supercapacitor: Is it a sustainable technology
12th Nov 2021	Ramamnanda College, Bishnupur, West Bengal	3	90	Nanoscience for Materials Research
14th Feb 2022	Vijaya College, Bishop Cotton Women Christian College, MES College, Maharani Lakshmi Ammani college, Bengaluru	4	65	Women In Science
25th Feb 2022	RN Shetty PU College Murudeshwar	5	70	Let Us Learn To Lead "Nanoscience in Materials Research 'Nanolithography

## Sumedha (Campus Development)









नैनो एवं मृदु पदार्थ विज्ञान केंद्र

विज्ञान एवं प्रौद्योगिकी विभाग, भारत सरकार के अग्रणी एकस्वायत्त संस्था

**CENTRE FOR NANO AND  
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