नैनो एवं मृदु पदार्थ विज्ञान केंद्र

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

CENTRE FOR NANO AND SOFT MATTER SCIENCES

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

CeNS

वार्षिक रिपोर्ट
ANNUAL REPORT
2020-21

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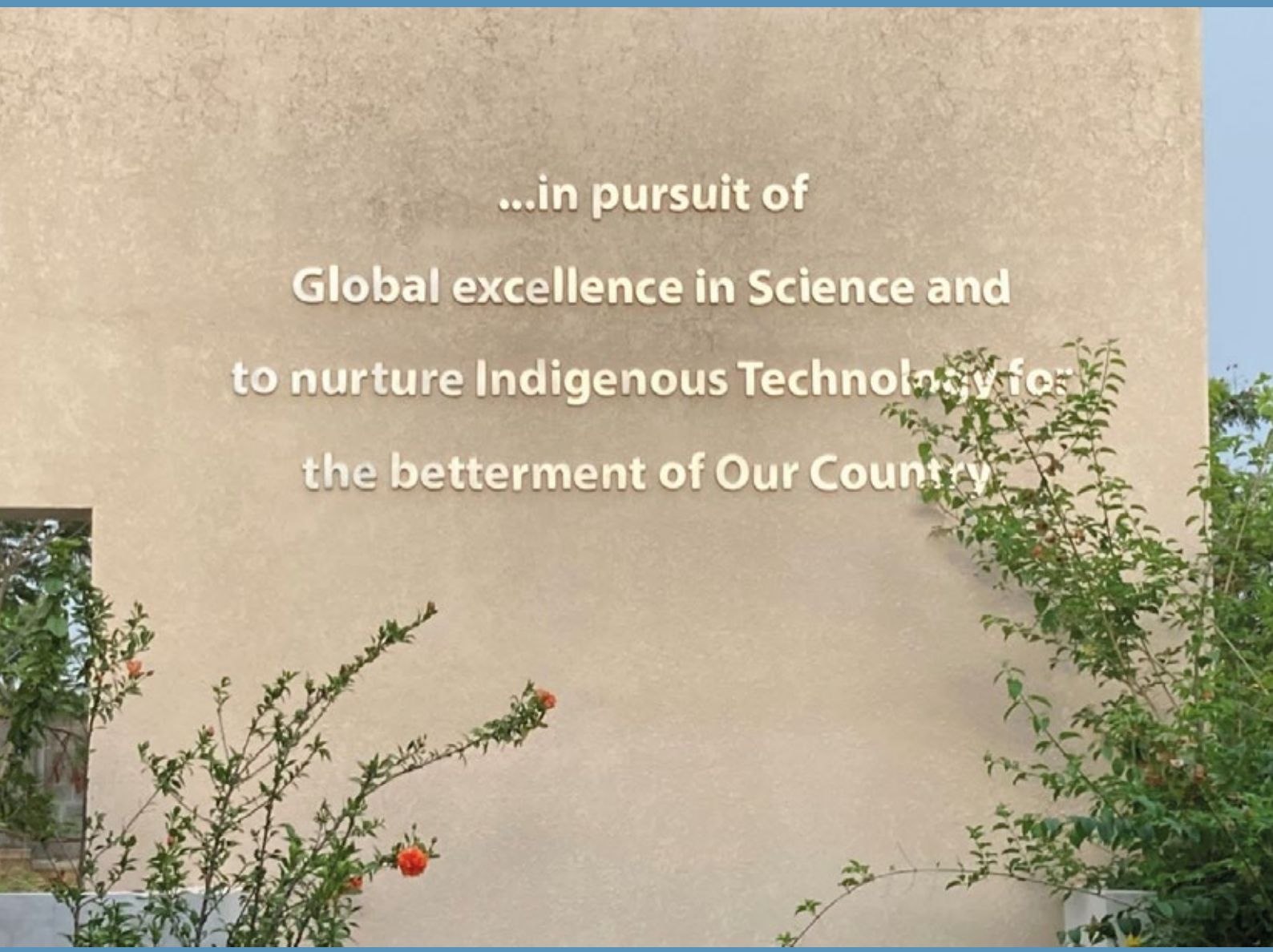

...in pursuit of
Global excellence in Science and
to nurture Indigenous Technology for
the betterment of Our Country

CONTENTS

Materials Laboratory entrance

FOREWORD

Centre for Nano and Soft Matter Sciences (CeNS) has entered into the seventh year with its renewed mandate of doing scientific research work on nanoscience and technology interlaced with soft matter principles focusing on translational activities. Year 2020-21 has been turbulent for CeNS, just like for the rest of the world, with COVID-19 playing havoc. During the interlude, CeNS moved its research and administrative activities to its own campus, 'Arkavathi', a sprawling 13 acres of land located at Shivanapura. Both the pandemic and shifting indeed had an impact on the research activities. Despite this CeNS, responding to the call from the Prime Minister of India, through the 'Greenhouse', the Technology Business Incubator (TBI) Project, funded by DST Nano Mission, supported several in-house projects. The projects' outcome is an impressive array of market-ready products such as face masks, face shields, and hand sanitizers for immediate use to combat the pandemic. The unique design of the facemask 'Tribo-E Mask' developed based on the generation of triboelectric effect was transferred to a Bangalore-based garment company that successfully marketed the product all over India for the benefit of the common public. During the last year several sophisticated equipment, such as High-resolution Digital Microscope, and Ellipsometer, were added to the "Central Research Facilities (CRF)", that continues to cater to researchers from CeNS and other academic institutions and industry. Two more sophisticated laboratories, namely, Micro/Spectroscopy and XRD/Thermo labs were commissioned under the 'Materials Laboratory'. The Prototype Gallery, that functions under the Greenhouse, and hosts several demonstrable devices added a few more prototypes such as PDLC smart window to its display. As in the past, the faculty bagged several extramural and industry projects this year as well. A new space created to house individual faculty labs is expected to be fully functional shortly.

CeNS continued its activities like every year, by inducting highly motivated masters students into the Ph. D. program. However, the academic interactions, seminars, and workshops could only be held online. The students could spend only six months from August to January physically in the labs. Despite the difficult times, CeNS researchers continued to strive and do quality research which is evident from the publications and filed patents list. Another front that suffered due to the pandemic is outreach activities of the Centre. With the school/college students confined in the safety of their homes, reaching them through the popular विज्ञानि-विद्यार्थि विचार विनिमय (V4) during the lockdown was highly challenging. The short-term internship program, Research Outreach Initiative Studentship (ROIS) had to be temporarily halted due to the uncertain situation.

As we acclimatize to the 'new normal' and wait for the vaccines, we are committed to the development of the Arkavathi campus to make it more conducive to conduct exciting research and translational activities in the coming years.

DIRECTOR

Products Developed Under TBI (Greenhouse) Project to Combat Covid-19

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 Centre for Liquid Crystal Research was established in 1991 by an eminent liquid crystal scientist, Prof. S. Chandrasekhar, FRS. In 1995, it became an autonomous institute under the Department of Electronics, Government of India, and in 2003, was brought under DST. Subsequently, in the year 2010, the name was changed to Centre for Soft Matter Research. Recently in 2014, the Centre has 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.

Nabhangan, the open air auditorium

CeNS earlier operating from two campuses, one at Jalahalli, and the other 'Arkavathi', Shivanapura, has now completely shifted to 'Arkavathi' since March 2021. The primary research facility at its new campus is located in 'Materials Laboratory', which hosts several sophisticated equipments grouped under different labs such as Fabrication Lab, Energy Lab, Gas sensor Lab, TEM-SEM Lab, Micro-Spectroscopy XRD-Thermo Lab and the Tata Steel Advanced Materials Research Centre (TSAMRC) Lab. The access to the Materials Laboratory equipment is made user-friendly to the researchers, both internal and external, via online operations covering the slot booking to each facility to 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. A new laboratory building, 'Bay Lab' with individual faculty labs and offices has recently been added to the research infrastructure. 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	Professor V. Ramgopal Rao Director, Indian Institute of Technology, Delhi Hauz Khas, New Delhi - 110 016
Member (Ex-Officio)	Professor Ashutosh Sharma Secretary to the Government of India Department of Science and Technology Technology Bhavan, New Mehrauli Road New Delhi – 110 016
Member (Ex-Officio)	Shri Vishvajit Sahay Addl. Secretary & Financial Adviser Department of Science and Technology Technology Bhavan, New Mehrauli Road New Delhi – 110 016
Member	Professor D. D. Sarma Professor Solid State and Structural Chemistry Unit Indian Institute of Science Bengaluru – 560 012
Member	Professor Amlan J. Pal Senior Professor Indian Association for the Cultivation of Science 2A & 2B Raja S C Mullick Road Kolkata 700032
Member	Shri Raja Sekhar M. V. Director (R & D) Bharat Electronics Limited Outer Ring Road, Nagawara Bengaluru – 560 045
Member-Secretary	Professor G. U. Kulkarni Director (I/C) Centre for Nano & Soft Matter Sciences Jalahalli, Bengaluru – 560 013

3. Research Advisory Board

Chairman	Professor M. K. Sanyal Emeritus Professor Saha Institute of Nuclear Physics, Kolkata
Member	Professor George K. Thomas Professor Indian Institute of Science Education and Research– Thiruvananthapuram
Member	Professor Ashok K. Ganguli Head, Department of Chemistry Indian Institute of Technology-Delhi, New Delhi
Member	Shri Chandrasekhar B. Nair Head and Founder Director Bigtec Labs, Bengaluru
Member	Professor Navakanta Bhat Professor Centre for Nano Science and Engineering, Indian Institute of Science, Bengaluru
Member	Professor Satishchandra Ogale Emeritus Professor Indian Institute of Science Education and Research – Pune
Convenor	Professor G. U. Kulkarni Director (I/C) Centre for Nano & Soft Matter Sciences Jalahalli, Bengaluru – 560 013

Micro/Spectroscopy Lab, Materials Laboratory

4. Scientists and Admin Staff

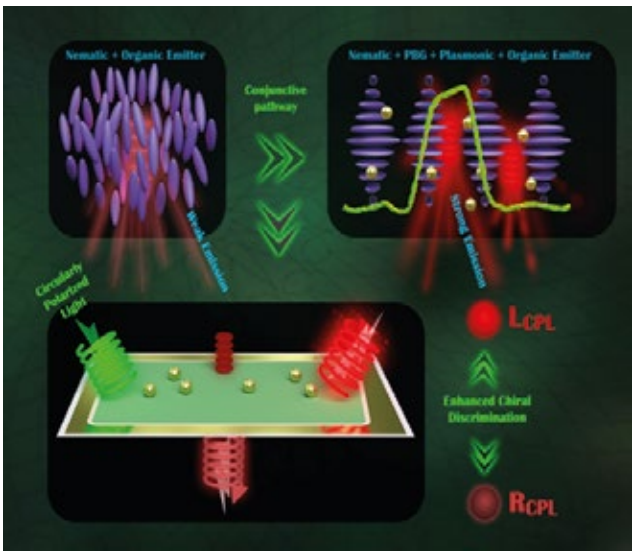
NAME	DESIGNATION
Prof. G. U. Kulkarni	Director (I/C)
Dr. Geetha G. Nair	Scientist F
Dr. D. S. Shankar Rao	Scientist F
Dr. Veena Prasad	Scientist F
Dr. C. V. Yelamaggad	Scientist F
Dr. S. Angappane	Scientist E
Dr. P. Viswanath	Scientist E
Dr. Neena Susan John	Scientist E
Dr. Pralay K. Santra	Scientist D
Dr. H. S. S. R. Matte	Scientist D (on contract)
Dr. Ashutosh K. Singh	Scientist C (on contract)
Dr. Kavita A. Pandey	Scientist C (on contract)
Dr. S. Krishna Prasad	Honorary Scientist
Dr. Uma S. Hiremath	WoS-A Scientist (under project)

NAME	DESIGNATION
Mr. Subhod M. Gulvady	Administration and Finance Officer
Mr. Vivek Dubey	Accounts Officer
Ms. P. Nethravathi	Assistant Admn. Officer
Dr. Sanjay K. Varshney	Technical Assistant
Mr. 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

Conjunctive photoluminescence enhancement through plasmonic and photonic band-gap pathways in a chiral self-assembled system

In these investigations, we describe two parallel pathways for enhancing the intrinsic photoluminescence of an organic emitter dispersed in a liquid crystal (LC) medium. The pathways have independent origins: (i) Metal enhanced fluorescence (MEF) incorporating gold nanoparticles having an organic shell of pro-mesogenic cholesterol esters; and (ii) Matching the photonic band gap (PBG) due to the helical structure in a self-assembled chiral system with the excitation wavelength. This unprecedented combination of both pathways achieves a level of photoluminescence exceeding the sum of the contribution from the individual methods. This conjunctive protocol results in an overall enhancement by a factor of 37 between the emitter dispersed in a non-chiral LC and that appealing to both MEF and PBG pathways. Circular polarized luminescence measurements also show that this protocol helps in effective discrimination of chiral light achieving a large dissymmetry factor whose magnitude (+0.33) is comparable to the highest recorded to date. Electric field switching between two states is also shown to result in appreciable fluorescence modulation. Being generic in nature the protocol employed can be adapted to a variety of situations with the large magnitude as well the modulation level suitable for applications such as biosensors, various analyte detection, and other photonic devices.



Parallel pathways for enhanced PL and discrimination of chiral light. This image was selected for Cover art of the journal issue

See: ChemPhotoChem, 4, 582(2020)

Investigators: Marlin Baral, S. Krishna Prasad, S. A. Bhat and C. V. Yelamaggad

Collaborators: R. A. Nayak, CSIR-National Chemical Laboratory, Pune

Switchable smart windows using a biopolymer network of cellulose nanocrystals imposed on a nematic liquid crystal

A polymer stabilized liquid crystal (PSLC) system formed by a nematic contained in a biopolymer network of cellulose nanocrystals, exhibiting many attractive features, is demonstrated. The threshold or the minimum voltage needed to operate the electro-optic device doesnot depend on the concentration of the polymer, a feature that is in contrast to the standard PSLC systems. A second point, more importantfrom the driving circuit point of view, is that the voltage-off response time drastically reduces and even becomes practically invariant overthe thermal range of the nematic phase. A smart window fabricated using this biopolymer network system exhibits good contrast betweenthe scattering and transparent states driven by voltage and shows an exceptionally high haze factor. A highlight of the device fabrication isthat the employed protocol is facile, making it appealing for a potentially viable smart window application.

See: Applied Physics Letters, 117, 103702(2020)

Investigators: Pragnya Satapathy, S. Parthasarathi, D. S. Shankar Rao and S. Krishna Prasad

Collaborators: S Bano, YS Negi, Department of Polymer and Process Engineering, Indian Institute of Technology Roorkee, Saharanpur Campus, Saharanpur

Tunable directional scattering from high refractive index particles dispersed in an anisotropic medium

A soft colloidal metamaterial system is fabricated by dispersing sub-micron sized TiO_2 particles functionalized with a carboxylic acid in a nematic liquid crystal, E7. The particles dispersed in the nematic medium scatters light in the forward direction and forms photonic nanojet via constructive interference of Mie resonances satisfying Kerker's conditions The unique scattering properties exhibited by the system is established using the 'Heterodyne Near-Field Scattering' (HNFS) imaging technique, which demonstrates the tunable forward scattering by quantifying the scattering intensities from the particles when the nematic director is switched between the

planar and homeotropic configurations by the application of an ac electric field. The results are in agreement with the near-field FEM simulations by considering a core-shell model of the particle. The far-field scattering analysis using FEM simulations reveals that the directionality of forward scattering is higher for the planar configuration compared to that for homeotropic. The tunability of the forward scattering seen for the anisotropic medium is also discussed with respect to the results obtained for the isotropic media, air, and water. Thus, merely by modulating the refractive index of the host NLC, the soft colloidal metamaterial exhibits forward scattering tunable both in directionality and intensity. The system finds potential applications in thin-film based solar cells, nanostructured optoelectronic devices, and anti-reflection coating.

See: The Journal of Physical Chemistry C124 (34), 18698-18706, 2020. https://doi. org/10. 1021/acs. jpcc. 0c04653

Investigators: Amit Bhardwaj, Navas. M. P. and Geetha G Nair

Photo-tunable epsilon-near-zero behavior in liquid crystal – nanoparticle hybrid material

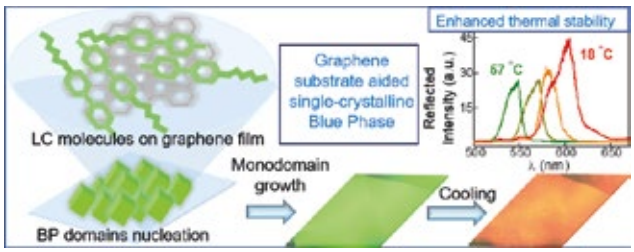
Dynamic tuning of electromagnetic response is an important parameter to realize exotic applications of optical metamaterials. Self-assembly achieved via the incorporation of soft materials is an attractive approach to achieve tunable optical properties. Among the soft materials, liquid crystals are highly sought after due to the inherent soft-stimuli responsiveness. This work reports experimental evidence of tunable epsilon-near-zero (ENZ) behavior brought about by an optical field in a self-assembled liquid crystal - nanoparticle system. The material consists of Au nanoparticles capped with a photo-active chiral liquid crystal ligand. In the liquid crystalline state, the system self-assembles into a helical lamellar superstructure, confirmed by polarizing optical microscopy, HRTEM, XRD, and circular dichroism studies. Upon irradiation with UV light, the localized surface plasmon resonance peak of Au red-shifts by ~ 10 nm and gets restored with white light illumination. The effective permittivity of the system obtained from ellipsometry indicates ENZ behavior in the visible spectrum with a bandwidth of ~ 45 nm which gets enhanced by a factor of 1. 6 on UV illumination. Theoretical calculations, carried out using the effective medium approach, support the experimental findings, making the system an efficient ENZ metamaterial in the optical regime

See: Nanoscale Adv. , 2508-2515, 3, 2021. https://doi. org/10. 1039/D0NA01039A

Investigators: Amit Bhardwaj, Vimala Sridurai, Sachin A. Bhat, Channabasaveshwar V. Yelamaggad and Geetha G. Nair

Enhanced thermal stability and monodomain growth of a Blue phase liquid crystal aided by graphene substrate

The growth of monodomain blue phase liquid crystal and its thermal stability on reduced graphene oxide-grown quartz substrates using optical reflection microscopy and spectroscopy is reported. Optical textural images show that the graphene substrate enhances the thermal range of the blue phase by a factor of four compared to conventional ITO-coated glass substrate. The phase is stabilized down to sub-ambient temperatures (from 60°C to 18°C) with the blue phase domains remaining undistorted at ambient conditions for more than three months. Also, the graphene substrate aids the monodomain formation with the average BP platelet size being nearly two orders of magnitude larger compared to the ITO / bare quartz substrates. The enhanced thermal stability and single-crystal-like growth of the blue phase are due to the improved wettability and non-covalent π-π interaction between graphene layers and liquid crystal molecules, as confirmed from the contact angle and Raman spectroscopic measurements respectively. Thus, the room temperature stable, graphene layer stabilized-blue phase is an ideal candidate for high-performance photonic applications.



See: Journal of Molecular Liquids, 115059 (1-8), 325, 2021 https://doi. org/10. 1016/j. molliq. 2020. 115059

Investigators: Nurjahan Khatun, Vimala S, Rajashekhar Pujar, Madhu B. Kanakala , Giridhar U. Kulkarni, Channabasaveshwara V. Yelamaggad and Geetha G. Nair

Collaborators: Shyam Kumar Choudhary, Tata steel LTD, Jamshedpur

Dielectric and viscoelastic investigations in a binary system of soft- and rigid-bent mesogens exhibiting the twist-bend nematic phase

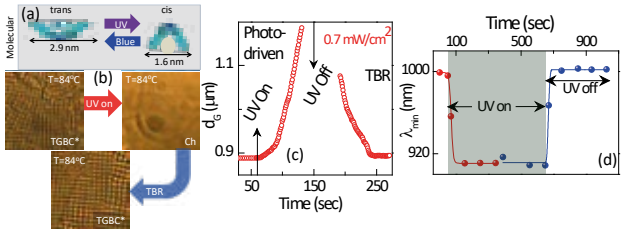
The dielectric and viscoelastic behaviour of a binary system consisting of rigid core and soft-bentnematogens, with the latter exhibiting in

addition to the conventional nematic (N), the twist-bend nematic(NTB) phase, is studied. The propensity of bent architecture towards the twist-bend structures is evident from the fact that NTB phase gets induced by the addition of even a tiny amount of the soft-bent material, and exists over a large range of concentration. The salient features of the study include stronger antiparallel coupling, trend reversal in the thermal variation of the permittivity and its average value, observation of two relaxation processes corresponding to the nematic director and cluster modes, significantly concentration-dependent splay and bend elastic constants along with drastic lowering of the elastic anisotropy. Thermal variation of rotational viscosity associated with the Freedericksz transformation for the different mixtures are also presented. These observations are explained using conformational changes of the individual molecules and cluster formations unique to bent structures exhibiting liquid crystallinity.

See: Journal of Molecular Liquids, 323, 114987 (2021).

Investigators: G. V. Varshini, D. S. Shankar Rao, U. S. Hiremath, C. V. Yelamaggad and S. Krishna Prasad

Tuning of the photonic band gap in a frustrated liquid crystal aided by Actinic Light



It has been demonstrated that the actinic light can switch the system between one and three-dimensional photonic structures, exhibited by Ch and TGBC* phases-a convenient method to control the photonic band gap of the system. The photoinduced shift in the transition temperature is four times larger for Ch-TGBC* than Iso-Ch boundary (Figure). The dynamics of a photodriven isothermal transition revealthat the Ch–Iso transition is a simple fluid–fluid transition, whereas TGBC*–Ch involves the breakdown of complicated structure, features which reflect in the associated response times. The temporal variation of the spacing (or PBG) of the square grid pattern of the TGBC*, on approaching the photo-driven Ch phase, shows a critical divergence, indicating a possible cross over from the first- to second-order transition (see Figure). The helical pitch shrinks upon UV irradiation (Figure), the change being instantaneous, a feature that can be used to construct a wavelength-specific mirror.

See: J. Phys. Chem. C, 124, pp 13920–13929 (2020)

Investigators: Rajalaxmi Sahoo, D. S. Shankar Rao, U. S. Hiremath, C. V. Yelamaggad and S. Krishna Prasad.

Topological defects due to twist-bend nematic drops mimicking colloidal particles in a nematic medium

Colloids formed of solid/fluid particle dispersions in oriented nematic liquid crystals are known to be an ideal means of realizing fundamentally significant topological defect geometries. It has been shown for the first time that twist-bend nematic (NTB) droplets formed in the N-NTB biphasic regime completely mimic colloidal particles in their ability to generate a rich variety of defects. In the biphasic regime, the topological features of both liquid crystal colloids and Ch droplets are revealed by (i) topological dipoles, quadrupoles and their patterned clusters formed in planar nematic liquid crystals orientationally perturbed by coexisting NTB drops, (ii) the transformation of hyperbolic hedgehogs into knotted Saturn rings encircling the NTB drops dispersed in a 90o-twisted nematic matrix and the Frank-Pryce defect texture evident in smaller (relative to sample thickness) NTB drops. In larger drops with fingerlike outgrowths, additional line defects appear; most of these are deemed to be pairs of disclinations to which are attached pairs of screw dislocations intervening in the growth process of the NTB droplets.

See: Soft Matter, 16, pp 7479-7491 (2020)

Investigators: K. S. Krishnamurthy, D. S. Shankar Rao, M. B. Kanakala, C. V. Yelamaggad.

Collaborators: M. Kleman, Institut de physique du globe de Paris, Université de Paris, France.

Influence of alkyl and alkoxy groups on photoresponsive behaviour of bent-core azo mesogens: Synthesis, mesomorphic and photoswitching properties

Two homologous series of 3-hydroxy benzoic acid based bent-core mesogens with an azobenzene wing bearing either alkoxy or alkyl terminal chains are synthesized and their liquid crystalline and photoswitching properties are investigated. They are found to exhibit B1, B2 and an unidentified mesophase, M. Photoswitching studies suggest that the compounds with alkoxy chain have excellent thermal back relaxation as compared to those having alkyl chains. Therefore, a representative compound from alkoxy series is used to fabricate a optical storage device and tested for the efficiency. The results obtained provide a strong evidence for the structure-property relationship in such bent-core mesogens indicating that even a small change in the chemical structure such as

changing the alkyl to alkoxy chain or even the chain length can influence the light induced state of the molecules, the property that issued for creation of optical storage devices.

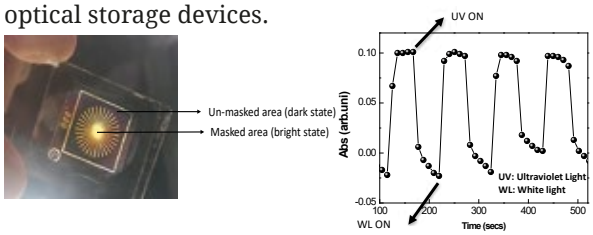


Figure: Device, fabricated using alkoxy compound, showing the clear difference between dark and bright states (left side of the image). Bright state corresponds to masked area where molecules remain in nematic state; whereas, dark state corresponds to UV illuminated area which is transformed to isotropic state. Intensity used is 1 mW/cm². Right side of the image corresponds to capability of writing and erasing the images using UV light and white light shined subsequently.

See: J. Mol. Liq. , 309, 113091 (2020).

Investigators: Ms. Rekha S. Hegde and Veena Prasad

Collaborators: Sunil B Nand, Gurumurthy Hegde, BSN Centre for Nano-materials and Displays, B. M. S. College of Engineering, Bull Temple Road, Bengaluru

Investigation of electro-optical and dielectric properties of nematic liquid crystal dispersed with biowaste based porous carbon nanoparticles: Higher birefringence for display applications

Porous carbon nanoparticles (PCNPs) of diameter 80–100nmare obtained from teak wood materials waste, using catalyst free pyrolysis method. These PCNPs are dispersed in a pure nematic liquid crystal (NLC) with different concentrations. Polarizing optical microscopic (POM) textures are recorded for pure NLC and NLC - PCNP composites showed better homogeneous alignment when nanoparticles were dispersed in the composites as compared with the pure NLC. The birefringence measurement using the transmittance technique showed interesting properties. It is found that birefringence is increased for the NLC - PCNP composites when compared to pure NLC. Contrast ratio for the NLC - PCNP composites increased after the dispersion of PCNPs. The Relative permittivity increases for NLC - PCNP composites in comparison with the pure NLC. Dielectric measurements showed that the dielectric anisotropy increases for NLC - PCNP composites when compare to pure NLC. The electro-optical study revealed that the threshold voltage of the system decreases after the dispersion of PCNPs. Presented data of the nano composite mixtures found to be very useful in flat panel displays (FPDs) and phase shutters.

See: J. Mol. Liq. , 314, 113643 (2020)

Investigators: Govind Pathak and Veena Prasad

Collaborators: Gurumurthy Hegde, BSN Centre for Nano-materials and Displays, B.M.S. College of Engineering, Bull Temple Road, Bengaluru

Octadecylamine-capped CdSe/ZnS quantum dot dispersed cholesteric liquid crystal for potential display application: Investigation on photoluminescence and UV absorbance

In the present investigation, we have undertaken the photoluminescence and UV absorbance study of a newly synthesised cholesteric liquid crystal (CLC) and CLC– octadecylamine-capped CdSe/ZnS quantum dots (QDs) composites. Three different CLC–QDs composites are prepared by varying the concentration of QDs in CLC. The thermal behaviour of both the pure CLC as well as three different CLC–QDs composites are performed by using Polarising Optical Microscopic (POM)textural studies. The photoluminescence (PL) study indicates that the PL intensity increases after the dispersion of QDs into the pure CLC. Decrement in the FWHM parameter also supports this increased PL intensity. However, the UV absorbance decreases for the QD dispersed CLC system when compared to the pure CLC. Optical band gap (by the Tauc plot method) suggests that the observed band gap reduces after the dispersion of QDs into CLC. The outcome of these investigations may be useful in the liquid crystal displays (LCDs) and other opto-electronic devices, which require less band gap materials.

See: Liq. cryst. , 48, 579 (2021)

Investigators: Govind Pathak and Veena Prasad

Collaborators: Gurumurthy Hegde, BSN Centre for Nano-materials and Displays, B.M.S. College of Engineering, Bull Temple Road, Bengaluru

Wide thermal range occurrence of technically significant chiral nematic phase

Fifteen new non-symmetric, chiraldimers belonging to three different series have been synthesized and characterized. They are formed by interlinking cholesterol with salicylaldimine core via an -oxyalkanoyloxy spacer. In most cases, the chiral nematic (N*) phase is enantiotropic and exists over a wide thermal width covering room temperature due to supercooling. This finding is notable given the fact that the N* phase possesses technologically significant optical properties. At room temperature, the N* phase displayed one of the iridescent colors characteristically caused by interference and diffraction of the reflected and scattered light. A comparative study reveals that the lengths of both the terminal chain and central spacer influence the clearing temperature of the dimers, and hence, the temperature range of the N* phase. The selective reflection measurements revealed

that the pitch of the N* phase is either temperature-sensitive or temperature-insensitive. The presence of an intense negative CD band suggests the left-handed screw sense of the N* phase helix.

See: Bull. Mater. Sci. , 43, 188 (2020)

Investigators: Sachin A. Bhat, D. S. Shankar Rao and C. V. Yelamaggad.

Collaborators: Rashmi A. Nayak, CSIR-National Chemical Laboratory, Pune

Deep-red/NIR-emissive room temperature columnar liquid crystals

A new class of discotic liquid crystals (DLCs) based on tris(hydrazone)s existing only in C3h keto-enanamine form have been designed and synthesized. Tris(hydrazone)s with six (THN(6)n series)and nine (THN(9)n series)peripheral n-alkoxy/branched tailsdisplay columnar (Col) behavior. X-ray and POM studies suggested that the THN(6)n series of DLCs stabilize Colh(Col hexagonal) phase. Likewise, the X-ray data in conjunction with the textural patterns reveal that the DLCs of THN(9)n series display the Col_r(Col reactangular) phase with an exception of the first member exhibiting Col_h phase. Most importantly, THN(9)n series of tris(hydrazone)s show Col phase existing from sub-ambient temperature to well-above the ambient temperature. The observed light emissive characteristics of these DLC_{sin} both solution and Col phase are promising for the application in organic electronics considering the fact that in such structures, the proton and electron interact with each other through the H-bonding environment. In particular, the intense emissive band in the low temperature Col phase, that too in the deep red/NIR region is noteworthy as such properties are much sought after for the bioimaging and the construction of OLEDs. The electrochemical studies revealed the redox behavior of these compounds and confirmed the these are low energy gap materials (1. 82–1. 89 eV).

See: ACS Omega, 6, 3291−3306 (2021)

Investigators: B. N. VeerabhadraswamyD. S. Shankar Rao and C. V. Yelamaggad.

Collaborators: Rashmi A. Nayak, CSIR-National Chemical Laboratory, Pun and A. S. Achalkumar, Indian Institute of Technology Guwahati, Assam

Exceptionally sensitive and selective H_2S gas aensors: Inexpensive OFET devices

A biological nose is a consortium of multiple sensing and signals conditioning elements, which are vital in identifying the airborne analytes. An important element of the biological nose that transduces the binding and identification of airborne molecules is olfactory receptor neuron (ORN). The impersonation of the ORN with the help of an organic electronic device that consists of biodegradable polymer (a) and monomer (b) is demonstrated. The fabricated device (sensor) is a p-type organic field-effect transistor (OFET) that not only operates in accumulation mode but also makes use of a synergistic heterostructure that detects H_2S gas selectively. The top layer of the heterostructure is a monomer and is realized with a novel tris(keto-hydrazone), which is both porous and contains H_2S specific functional groups. On the other hand, the bottom layer is the active channel layer of OFET and essentially plays a crucial role in altering the transduction output. Thus, the synergistic combination helps to preconcentrate the H_2S molecules, initiates acid-base chemical reaction, and alters the majority hole carriers of the channel region in the OFET device. This work highlights the use of hydrazones for the first time in OFET sensors and provides a new route to realize advanced analyte sensing applications.

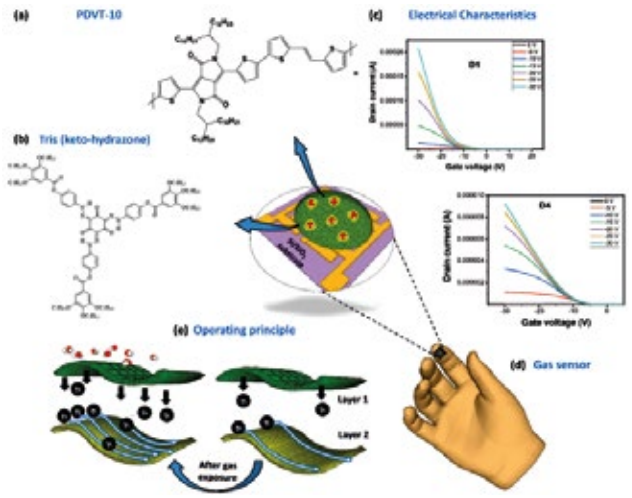


Figure: Polymer - PDVT-10 (a) and monomer - tris(keto-hydrazone) (b) OFET design and sensing principle (center). Schematicrepresentation of an OFET device on a Si/SiO2 substrate. (c) Electricalcharacteristics of OFET devices. (d) The size of the device is 5 mm X 5 mm, exactly fitting onthe tip of the forefinger. (e) The operating principle of the gas absorption layer before, during and after gas exposure.

See: Mater. Horiz. , 2021, 8, 525-537

Investigators: B. N. Veerabhadraswamy, S. A. Bhat, and C. V. Yelamaggad

Collaborators: S. Yuvaraja, Sandeep G. Surya, and K. N. Salama, Sensors lab, Advanced Membranes and Porous Materials Center, Computer, Electrical and Mathematical Science and Engineering Division, King Abdullah University of Science and Technology (KAUST), Saudi Arabia

Exceptional dual fluorescent, ESIPT columnar liquid crystals characterized by J-stacking and large Stokes shifts

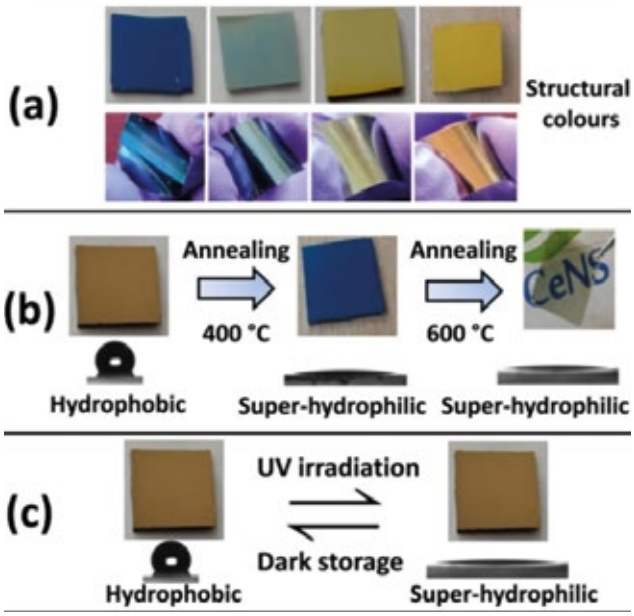
The synthesis, characterization, and ESIPT (Excited-State Intramolecular Proton-Transfer) activity of a

homologous series of novel phasmidic bis(N-salicylideneaniline) columnar (Col) liquid crystals (LCs) is reported. Optical microscopic, calorimetric and powder X-ray diffraction (XRD) studies evidence the occurrence of hexagonal columnar (Col_h) phase having p6mm symmetry where the constituent slices result from the self-assembly of a pair of mesogens in a side-by-side manner facilitated by intense longitudinal π-π interactions. Fluorescence probing clearly evidence the ESIPT occurring not only in DCM solution of the mesogens but also in their three-condensed states viz., solid, liquid crystal, and isotropic liquid phase; in general, two archetypal emission bands at ~430 nm (weak) and ~630 nm (strong) with large Stokes shifts (250 – 275 nm) of ESIPT phenomenon have been observed. XRD data confirm the formation of so-called Scheibe or J-aggregates. The redox activity, metal ion sensing ability, and solvatochromism of the mesogens have also been investigated. The study suggests that these ESIPT Col LCs with band-gap of about 3eV can be regarded as wide-bandgap semiconducting materials having the electronic characteristics falling between those of conventional semiconductors and insulators.

See: J. Mol. Liq. , 332, 115879 (2021).

Investigators: Madhu Babu Kanakala and C. V. Yelamaggad.

Self-cleaning structural colors by TiO_2/Ti nanostructures



Scalable self-cleaning nanostructures that exhibit structural colors are fabricated. The structural colors were generated by TiO_2 nanorods and thin films on Ti sputtered glass and flexible polyethylene terephthalate (PTE) substrates employing a glancing angle deposition (GLAD) technique. Theoretical calculations based on thin film interference validate the experimental results and suggest Al, Ni, Co, and Cu as an alternative of Ti for generating structural colors. Structural colors are transformed to a superhydrophilic state, i. e. , a self-cleaning state, via UV exposure and annealing at elevated temperatures. In addition to a self-cleaning state, annealing could control the opaqueness and color tunability of the structural colors. A permanent wettability state in between the superhydrophobic and superhydrophilic states of the structural colors is controlled by the GLAD technique. Moreover, the structural colors are demonstrated for information encryption and optical ethanol sensing applications.

See: Applied Optics, 59, 10483-10492, (2020).

Investigators: S Angappane and Gaurav Shukla

UV assisted room temperature oxygen sensors using titanium dioxide nanostructures

A room temperature oxygen sensor is developed using e-beam evaporated slanted nanorods (NR) of pure titanium dioxide (TiO_2) and chromium doped TiO_2(Cr-TiO_2), showcasing excellent sensing properties with ultra-violet (UV) illumination. The device fabricated using Ti/Au bottom gap electrode with Cr-TiO_2 as active material works in a broad range of oxygen concentration from 25 ppm to 100 % with good stability. Fabricated sensors exhibited fast response and recovery times of ~3s and ~10s, respectively. Superior sensing property can be attributed to the enhanced electrical conductivity, excitons created and desorption of water molecules from sensor surface by UV irradiation, facilitating the increased interaction of oxygen molecules with Cr-TiO_2 NRs.

See: Mater. Res. Bull. 140, 111324, (2021).

Investigators: S Angappane, Hiran Jyothilal, Gaurav Shukla, Sunil Walia, and Bharath S. P.

Investigation of metal-insulator transition temperature and magnetic properties of $NdNiO_3$ nanoparticles

The nanoparticles of $NdNiO_3$ have been successfully synthesized by asol-gel method followed by annealing at atmospheric pressure underoxygen medium. The structural analysis by x-ray diffraction shows theformation of the orthorhombic crystal structure with NiO_6 octahedraldistortion, which reduces with the increase of mean particle size. Formation of nanoparticles of different sizes can be seen from the FESEM and TEM images, in addition to the observation

of increased latticespacing in smaller size particles. The average particles size was observedto increase with the increase of annealing time. The study of temperaturedependent resistivity shows that metal-insulation transition (MIT) temperature, T_{MI} decreases with the increase of particle size in addition to hysteresis during cooling and heating cycles. We attribute the higher values of T_{MI} of the $NdNiO_3$ nanoparticles to the narrowing of the bandwidth of nanocrystalline $NdNiO_3$, which leads to the increase of the charge transfer gap for smaller size particles. The appearance of higher charge transfer gap in nanosized $NdNiO_3$ has beenconfirmed from the low temperature VRH conduction mechanism, where we observed the lower value of density of states at Fermi energy andhigher value of hopping distance, indicating the formation of larger polarons. The temperature dependent magnetic susceptibility measurements revealed that the magnetic phase transition (from PM to AFM) temperature T_N decreases with the decrease of particle size. We found $T_N<T_{MI}$, indicating a second order magnetic phase transition, whereas the thermal hysteresis in resistivity versus temperature data indicates the first order MIT. The higher octahedral distortion explains the origin ofsecond order magnetic phase transition in the $NdNiO_3$ nanoparticles. Remarkably, with the increase of particle size, the value of T_{MI} has been decreased towards the bulk value and the T_N has been increased and shifted towards the T_{MI}. This observation arises from the enhanced octahedral distortion and bandwidth narrowing of the $NdNiO_3$ nanoparticles, which demonstrates the significant effect of reduced particlesize on the electronic as well as magnetic properties of $NdNiO_3$.

See: Journal of Solid State Chemistry, 294, 121865 (2021)

Investigators: Subir Roy, Rajesh Katoch, S. Angappane

Collaborators: R. B. Gangineni, Department of Physics, School of Physical, Chemical and Applied Sciences, Pondicherry University, Puducherry

Ambient prepared mesoporous perovskite solar cells with longer stability

The study carried out here is the ambient preparation of $CH_3NH_3PbI_3$ (methylammonium lead iodide, MAPI) based perovskite solar cells (PSCs) without hole transport layer (HTL). The TiO_2 electron transport layer (ETL) is deposited using three different methods namely, chemical deposition, RF sputtering and e-beam evaporation and the fabricated solar cells performances compared. The common structure is FTO/compact-TiO_2/ mesoporous-TiO_2/MAPI/Au. The solar cell parameters are measured under standard AM 1.5 G light of intensity 1 sun. The e-beam based PSCs attained a maximum power conversion efficiency of 3.54% among the 25 devices fabricated on a 1 in 2 substrate. Notably, it is found that 85% or above of the initial efficiency is retained till 20 days of storage in the dark indicating slow degradation of the studied solar cells. All the solar cells performances are monitored for 130 days during the storage. Remarkably, the RF sputtered compact TiO_2 layer-based PSCs have retained 99 % of the initial average efficiency up to 112 days of storage.

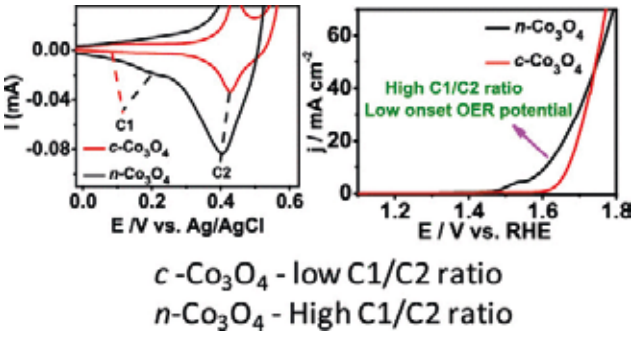
See: J. Electron. Mater. 50, 1535–1543, (2020).

Investigators: Athira Makkaramkott, and Angappane Subramanian

Collaborators: Rudra Mukherjee, and Sushobhan Avasthi, Centre for Nano Science and Engineering (CeNSE), Indian Institute of Science (IISc), Bangalore

Role of oxygen defects and Co^{3+} sites in nanocrystalline Cobalt oxidesfor oxygen evolution reaction

In Co_3O_4 electrocatalysts, oxygen vacancy is reported to improve the oxygen evolution reaction (OER) activity due to higher Co^{2+}/Co^{3+} surface ratio while $Co3^{+}$—site reducibility is considered as the key factor. In this context, the OER activity of two Co_3O_4 systems; c-Co_3O_4 with higher oxygen defects or Co^{2+}/Co^{3+} and n-Co_3O_4 with relatively less Co^{2+}/Co^{3+} ratio but more Co^{3+} reducibility has been examined. The systems, n- and c-Co_3O_4 show overpotential of 380 and 440 mV at 10 mA/cm^2 and Tafel slope of 153 and 53mV/dec, respectively for OER. Electrochemical characterization reveals that the lowering of OER onset potential is influenced by Co^{3+} reducibility rather than defects in Co_3O_4 systems while adsorption capacitance arising from surface irregularities, pores and Co^{3+}-Oh sites cause an increase in the Tafel slope or decrease in OER kinetics. The correlation of the above key factors can aid the designing of highly efficient cobalt oxide based OER catalysts.



See: ACS Appl. Energy Mater. , 3, 5439–5447 (2020).

Investigators: C Alex and Dr. Neena S John.

Collaborators: Saurav C Sarma, Prof. Sebastian C Peter, Jawaharlal Nehru Centre for Advanced Scientific Research, Bengaluru

Ultra-low detection of thiram pesticide on silver nanocubes employing surface enhanced raman scattering

Thiram (TRM) is a fungicide used in agriculture and the excess use of TRM can cause harmful effects to living systems. Silver nanocubes (Ag NCs) are demonstrated as an efficient substrate for the detection of TRM at ultra-low concentrations using surface enhanced Raman scattering (SERS) technique. The enhancement factor (EF) for TRM with Ag NCs (TRM-Ag NCs) is found to be 1.6 X 10^6 with the achieved limit of detection (LOD) as low as 10 fM (0. 002 ppt). A shape-dependent comparative SERS study carried out between Ag NCs and silver nanowires (Ag NWs) reveals that Ag NCs show a 3.5 fold enhancement compared to Ag NWs and the different facets of the NCs and NWs are responsible for the creation of hotspots enhancing the detection sensitivity.

See: Environ. Sci. : Nano, 7, 3999-4009 (2020).

Investigators: Ramya Prabhu B and Neena S John.

Collaborators: M. B. Bhavya, Swarnalatha Swain, Pragnya Bhol, Dr. M. Saxena, Dr. Akshaya K Samal, Jain University, Jain Global Campus, Bengaluru; Bhamy M Shenoy, Gopalkrishna Hegde, Indian Institute of Science, Bengaluru

Waste to wealth: Spent catalyst as an efficient and stable bifunctional oxygen electrocatalyst for energy generation

The spent catalysts obtained from catalytic decomposition of methane are often considered as waste and typically subjected to energy intensive processes for reclamation. It has been shown that the spent catalyst (NAlCNTs-750) can be used as a bifunctional electrocatalyst for possible applications in the zinc–air battery because of its suitable structural and electronic properties. The NAlCNTs-750 exhibits a low overpotential value of 370mV at 10mA cm^{-2} stable up to 20h with a Tafel slope of 119mV dec^{-1} towards the oxygen evolution reaction (OER). For the oxygen reduction reaction (ORR), the onset potential is found to be 0. 82V with a Tafel slope of 88mV dec^{-1}. Consequently, the NAlCNTs-750 employed in Zn–air batteries have displayed commendable charge–discharge performance up to 45 h with high reversibility. The bifunctional nature of NAlCNTs-750 arises from Ni nanoparticles serving as active metal sites for OER and CNTs facilitating charge transfer and ORR, whereas Al_2O_3 provides the required porous support.

See: Sustainable Energy Fuels, 5, 1406-1414 (2021).

Investigators: C Sathiskumar, Dr. Neena S John and Dr. HSSR Matte.

Collaborators: Lavanya Meesala, Pramod Kumar, Ramachandra Rao Bojja, HPCL R&D Green Centre, Devanagundi, Bengaluru

Morphology driven spatial dependence of wetting, evaporation, and unidirectional spreading of water on hexagonally patterned gold microstructure arrays

Investigations on the wettability, evaporation, and unidirectional spreading behavior of water on a patterned substrate is reported. Using colloidal lithography, hexagonally ordered gold microstructure arrays with varying morphologies were fabricated along the length of the substrate. Three different regions of the substrate exhibiting different morphologies (R1: microshells, R2: microshells with interstice, and R3: microholes) and their transition positions were identified using a field emission scanning electron microscope. Spatial dependence of wetting and the influence of surface functionalization were investigated in these regions.

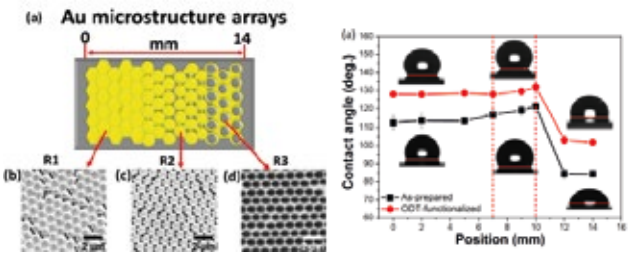


Figure: Spatially varying morphology of g old substrate. Wetting of a sessile drop at different positions along the length of the substrate.

In R1 and R2, wetting studies show hydrophobic behavior for both the as-prepared (θ=116°–120°) and octadecanethiol (ODT, θ=128°–132°) functionalized substrates. In contrast, R3 exhibits hydrophilicity (θ=84◦θ=84°), which transforms to hydrophobicity (θ=102°) post ODT-functionalization. Interestingly, underwater wettability investigations of the same substrate using oil (air bubble) show superoleophobicity (superaerophobicity) that after functionalization transforms to oleophilicity (aerophobicity) for all regions. Furthermore, the evaporation of the water droplet has been studied for different regions. It shows clear distinction in the modes of evaporation for the as-prepared and

functionalized substrates. Taking into account geometrical parameters, we calculated theoretical contact angles for different wetting states and compared them with our experimental results. We have found evidence for the occurrence of the penetrating Cassie–Baxter state for both as-prepared (water penetration angle, δ=50◦ δ=50° for all regions) and ODT-functionalized substrates (δ=56◦ for R1 and R2 and δ=0° for R3). Unidirectional spreading of water against gravity is observed for different inclinations of the substrate at the transition positions (e.g. at 10 mm, droplet velocity = 0.83 mm/s). The study has potential implications in microfluidic devices, biosensors, and water transportation.

See: Journal of Applied Physics, 128, 225305 (2020).

Investigators: S. Brindhu Malani and P. Viswanath

Spontaneously self-assembled fluidic bilayer of cholesteryl nonanoate at interfaces: Thermal stability and post collapse scenario

Investigations on the thermal stability of the intermediate homologue of cholesteryl ester, cholesteryl nonanoate (ChN) at the air–water (A–W) and air–solid (A–S) interfaces are reported. Surface manometry studies on ChN at the A–W interface reveal that the limiting area and the collapse pressure of the film decrease with an increase in the temperature. Brewster angle microscopy studies show the co-existing gas (G) and the homogeneous phase (bilayer) that, with compression, transforms to a bilayer phase followed by a collapse to circular domains. These collapsed circular domains (CCDs) coarsen and nucleate to form 3D structures, and their evolution and growth are further tracked at different temperatures using the reflection mode of the microscope. For temperatures between 288 K and 293 K, we find that the dendritic growth is favored. From 298 K to 303 K, the CCD transforms to a fractal domain with its branches changed from the left-handed to right-handed sense via an intermediate state. Based on these observations, a morphological phase diagram ChN in the collapsed state with different temperatures is constructed. Topography images of the ChN film using an atomic force microscope yield a thickness of about 3. 5 nm, which is larger than its molecular length (2. 7 nm). This is attributed to the partial vertical segregation of ChN molecules at the interfaces, which is consistent with the m-ii packing model proposed by Guerina and Craven (J. Chem. Soc. , Perkin Trans. 2 1979, 1414). Investigations are also carried out on the thermal stability of the bilayer at the A–S interface through imaging ellipsometry. It highlights that the thermal dewetting of the confined bilayer proceeds via the random nucleation and growth of voids, and the transition temperature is estimated to be 396. 3 ± 1. 2 K with a width of 7. 6 ± 0. 8 K.

See: AIP Advances, 10, 085026 (2020).

Investigators: Pinchu Xavier and Padmanabhan Viswanath

Collaborators: Jigyasa Watwani, University of Delhi, New Delhi

Degradation studies of $Cs_3Sb_2I_9$: A lead-free Perovskite

Cesium antimony iodide ($Cs_3Sb_2I_9$), is a lead-free material that has a high absorption coefficient and nearly direct bandgap, studied for its application in photovoltaics. This needs a clear understanding of the stability of this material. The degradation of both the polymorphs of $Cs_3Sb_2I_9$ (dimer and layer forms) in water, light, and elevated temperature the well-known factors causing degradation in perovskites using X-ray diffraction and thermogravimetric analysis has been studied. The study suggests that the layered polymorph (88 days in ambient atmosphere) is more stable compared to the dimer polymorph (49 days in ambient atmosphere). The diffusion of iodine from the system is the prime reason for the degradation in $Cs_3Sb_2I_9$. Also, the reactivity of antimony iodide (SbI_3) in oxygen adds up to accelerate the degradation process. Light, water, and heat equally cause the degradation of $Cs_3Sb_2I_9$, and hence, use of this material for application in the ambient atmosphere would need proper encapsulation or necessary measures.

See: ACS Appl. Energy Mater. , 2020, 3, 47−55.

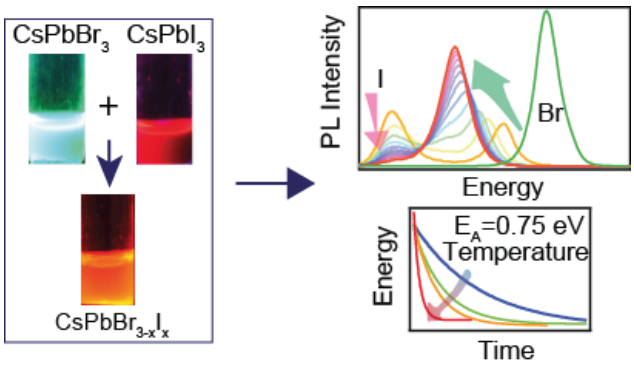
Investigator: Trupthi Devaiah Chonamada and Pralay K. Santra

Collaborators: Arka Bikash Dey, Surface Physics & Material Science Division, Saha Institute of Nuclear Physics, 1/AF Bidhannagar, Kolkata

Near unity luminescent perovskite nanocrystals – Probing reaction mechanism and local atomic structures

All inorganic $CsPbX_3$ (X=Cl, Br, and I) perovskite nanocrystals have attracted attention in recent past because of their tunable bandgap via composition variation, near-unity photoluminescence quantum yield (PLQY), defect tolerance nature, narrow emission width, and have achieved a maximum photovoltaic power conversion efficiency of ~19.03%. In case of such all inorganic $CsPbX_3$ nanocrystals, post-synthesis anion exchange is now a routine technique to form mixed halide $CsPbX_3$. Understanding the reaction mechanism

and the kinetics of the interparticle mixing is essential for fundamental aspects and device applications.

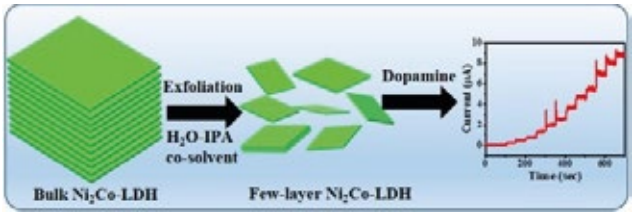


The kinetics of the ion migration through time-dependent steady-state photoluminescence (PL) spectroscopy has been probed. Three primary PL peaks have been found after mixing of NCs-bromide side, iodide side, and a new peak that emerges during the reaction. The reaction follows first-order kinetics, and the activation energy is 0. 75 ± 0. 05eV. It is proposed that the reaction proceeds via the free oleylammonium halides, which is in dynamic equilibrium with the NCs and eventually promote the interparticle mixing, followed by the rate limiting step of the anion migration from the surface to the core of the nanocrystal. Thus, the inherent reaction rate between the halide anions and the $CsPbX_3$ nanocrystals govern the reaction kinetics.

See: Nanoscale, 2020, 12, 20840 - 20848.

Investigators: Anamul Haque, Trupthi Devaiah and Pralay K. Santra

Solution processed Ni_2Co layered double hydroxides for high performance electrochemical sensors



Layered double hydroxides (LDH) are an important class of two-dimensional materials having exotic properties with potential applications from catalysis to energy storage. The performance of these materials can be significantly enhanced by exfoliating them to mono- and few-layers. For the first time, the liquid phase exfoliation of the Ni_2Co-LDH was carried out in low boiling point water/IPA co-solvent system with CO32− ion as intercalant using probe sonication. To confirm the exfoliation of the obtained dispersions, various microscopic and spectroscopic characterization were carried out. The obtained Ni_2Co-LDH dispersions were used for electrochemical sensing of dopamine and achieved a sensitivity of 148.2 $\mu A\ mM^{-1}\ cm^{-2}$ in the linear range of 0. 001–0. 42 mM. Along with that, the selectivity for dopamine sensing is studied in the presence of other interfering biomolecules such as Cl^- ion, citric acid, glucose and uric acid. To understand the underline mechanism, computational simulations have been carried out, and the results suggest the charge-transfer interactions between the dopamine and Ni_2Co-LDH are responsible for such high sensitivity.

See: Appl. Surf. Sci. , 541, 148270, (2021)

Investigators: Ramesh Chandra Sahoo, Sreejesh Moolayadukkam, H. S. S Ramakrishna Matte

Collaborators: Siby Thomas and Mohsen, Asle Zaeem, Colorado School of Mines, USA.

Ordered donor–acceptor complex formation and electron transfer in co-deposited films of structurally dissimilar molecules

The electrical and optoelectronic properties of organic semiconductor thin films can be tailored by mixing two molecular materials, e.g. by co-deposition. Possible resulting morphologies include phase separation or mixed crystals, which can form either solid solutions or ordered complexes, but it is difficult to predict a priori the morphology that will result for a given material combination. Here, the electron transfer between planar electron-donor molecules and a nonplanar electron acceptor in co-deposited films by analyzing morphological, vibrational, and optical properties has been studied. For the donor under study, that does not undergo ground-state electron transfer to the acceptor, phase separation in mixed film has been found. If ground-state electron transfer is present, the balance between crystal binding energy of the single-component materials and the Coulomb attraction between ions formed in the co-deposited film drives the co-deposited films either into phase separation or mixed-crystal formation. To rationalize the resulting morphology of these co-deposited films within the laws of thermodynamics, it is necessary to consider structural incompatibility of the molecules as well as the Coulomb attraction between molecular ions when formed via ground-state electron transfer.

See: J. Phys. Chem. C, 120, 11023–11031, (2021)

Investigator:H. S. S Ramakrishna Matte

Collaborator:Dr. Norbert Koch, Humboldt University of Berlin, Germany

Invisible Shield for Electromagnetic Interference (EMI)

Non-transparent metal sheets or films are well known established materials as EMI-shield or Faraday cages. In this work, instead of continuous film of metal (Cu) coating on any transparent substrate (glass, PET) where transparency can be compromised. In this method, we deposited metal mesh networks on the substrate, which covers only 7% area of substate, unlike 100% coverage of continuous film. This makes metal mesh transparent compare to continuous metal film. Metal mesh provides better electromagnetic shielding compare to same thickness of continuous metal film where transparency can be compromised. The invisible shield can be used in various military stealth applications and can cover electromagnetic wave emitter or absorber devices without compromising their aesthetics. We have developed a copper metal mesh on polyethylene terephthalate (PET) sheet as its substrate, which exhibited a visible transmittance (T), a parameter of visible transparency of about 85% and sheet resistance (R_s) ~0.83 ohm per square. These transparent and flexible EMI shields made of metal mesh coatings on desired transparent substrate showed remarkably high values for total EMI shielding (SET), with the average value being ~41dB over a wide spectral range of the Ku band (12 to 18 GHz).

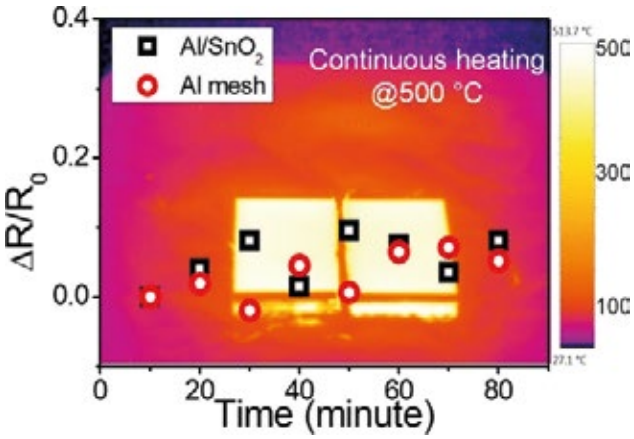
See: Bulletin of Materials Science 43, 187 (2020).

Investigators: Sunil Walia, Ashutosh K. Singh, VSG Rao, S. Bose and G. U. Kulkarni

Collaborators: S. Bose, Indian Institute of Sciences Bangalore; G. U. Kulkarni, JNCASR - Bangalore/CeNS - Bangalore

Scalable fabrication of scratch-proof transparent Al/SnO_2 hybrid electrodes with unusual thermal and environmental stability

Fabrication protocols of transparent conducting electrodes (TCEs), including those which produce TCEs of high values of figure of merit, often fail to address issues of scalability, stability, and cost. When it comes to working with high-temperature stable electrodes, one is left with only one and that too, an expensive choice, namely, fluorine-doped SnO_2 (FTO). It is rather difficult to replace FTO with a low-cost TCE due to stability issues. In the present work, we have shown that an Al nanomesh fabricated employing the crack template method exhibits extreme thermal stability in air even at 500°C, compared with that of FTO. In order

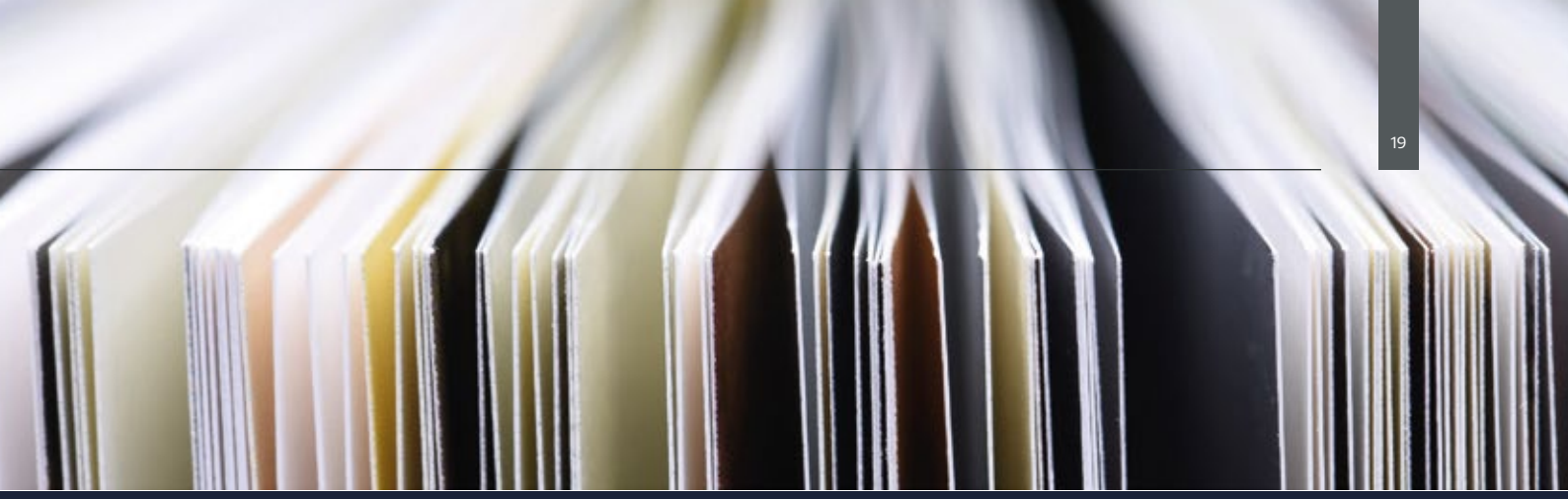


to fill in the non-conducting island regions present in between the mesh wires, a moderately conducting material SnO_2 layer was found adequate. The innovative step employed in the present work relates to the SnO_2 deposition without damaging the underneath Al, which is a challenge in itself, as the commonly used precursor, $SnCl_2$ solution, is quite corrosive toward Al. Optimization of spray coating of the precursor while the Al mesh on a glass substrate held at an appropriate temperature was the key to form a stable hybrid electrode. The resulting Al/SnO_2 electrode exhibited an excellent transparency of ~83% at 550 nm and a low sheet resistance of 5. 5 Ω/□. SnO_2 coating additionally made the TCE scratch-proof and mechanically stable, as the adhesion tape test showed only 8% change in sheet resistance after 1000 cycles.

See: ACS Applied Materials & Interfaces, 12, 48, 54203–54211 (2020)

Investigators: Indrajit Mondal, Gaurav Bahuguna, Mukhesh K. Ganesha, Mohit Verma, Ritu Gupta, Ashutosh K. Singh, and Giridhar U. Kulkarni

Collaborators: Ritu Gupta, IIT-Jodhpur; G. U. Kulkarni, JNCASR - Bangalore/CeNS - Bangalore



6. Publications

The total number of publications in:

Refereed Journals:	52
Conference Proceedings:	1
Chapters in Books:	4

Details shown in Annexure A

Average Impact Factor: 3.67

Journal	Publications
ACS Appl. Energy Mater.	2
ACS Appl. Polym. Mater	1
ACS Applied Materials & Interfaces	1
ACS Omega	1
AIP Advances	1
Appl. Surf. Sci.	1
Applied Optics	1
Applied Physics Letters	1
Beilstein J. Nanotechnol.	1
Bull Mater Sci.	3
ChemistrySelect	2
ChemPhotoChem	2
Environ. Sci.: Nano	1
Ferroelectrics	1
J. Adv. Dielectr.	1
J. Appl.Polym. Sci	1
J. Electron. Mater	1
J. Mol. Liq	3
J. Phys. Chem. C	4
J. Solid State Chem	1
Journal of Applied Physics	1
Journal of Energy Storage	1
Journal of Molecular Liquids	2
Journal of Nanoscience and Nanotechnology	1
Langmuir	1
Liq. cryst	3
Mater. Horiz.	1
Mater. Res.Bulletin	1
Materials Science and Engineering	1
Nanoscale	1
Nanoscale Adv.	2
New Journal of Chemistry	1
Phys. Rev. E	1
RSC Adv.	1
Soft Matter	1
Sustainable Energy Fuels	2
Z. Anorg. Allg. Chem	1

7. Patents

#	Title	Inventors	Patent Application No.
1	Photoactive Gel Exhibiting Optical Memory States	S Vimala, Geetha G Nair et al	Patent No.357118 granted on 29/01/2021
2	Inexpensive, Industrially Viable Luminescent 2D-Coordination Polymers [COPs] for Sensing High Energy Materials [HEMs]	Sachin A Bhat and C. V. Yelamaggad	Indian patent No.202031018271 filed on 28.04.2021
3	Antimicrobial Face Mask	Pralay K Santra, Ashutosh K.Singh, GU Kulkarni	Indian patent No. 202041020512 filed
4	A VisibilityControlling Device	G. U. Kulkarni, Ashutosh K. Singh and Rahul M.	US National Phase of PCT/IB2019/057762 filed
5	A Hybrid Transparent Conducting Electrode And Method Thereof	G. U. Kulkarni, Indrajit Mondal and Ashutosh K. Singh	Indian Patent No. 202041016742 filed PCT Application filed (No.PCT/IB2021/052083) on 12.02.2021
6	Antimicrobial Face Mask	Pralay K Santra, Ashutosh K. Singh and G. U. Kulkarni	Indian Patent No. 202041020512 filed
8	Turbostratic Graphene dispersions, coatings, and process thereof	G.U.Kulkarni, Nikita Gupta and Umesh Mogera	Patent granted on 06.11.2020 vide No. 351040
9	Compounds exhibiting chiral nematic phase	C V Yelamaggad, Govindaswamy Shanker	Patent granted on 30.08.2020 vide No. 345638
10	A synaptic device and method of fabrication thereof	G.U. Kulkarni et al.	Indian Patent Application No: 202041032038 filed on 27.07.2020

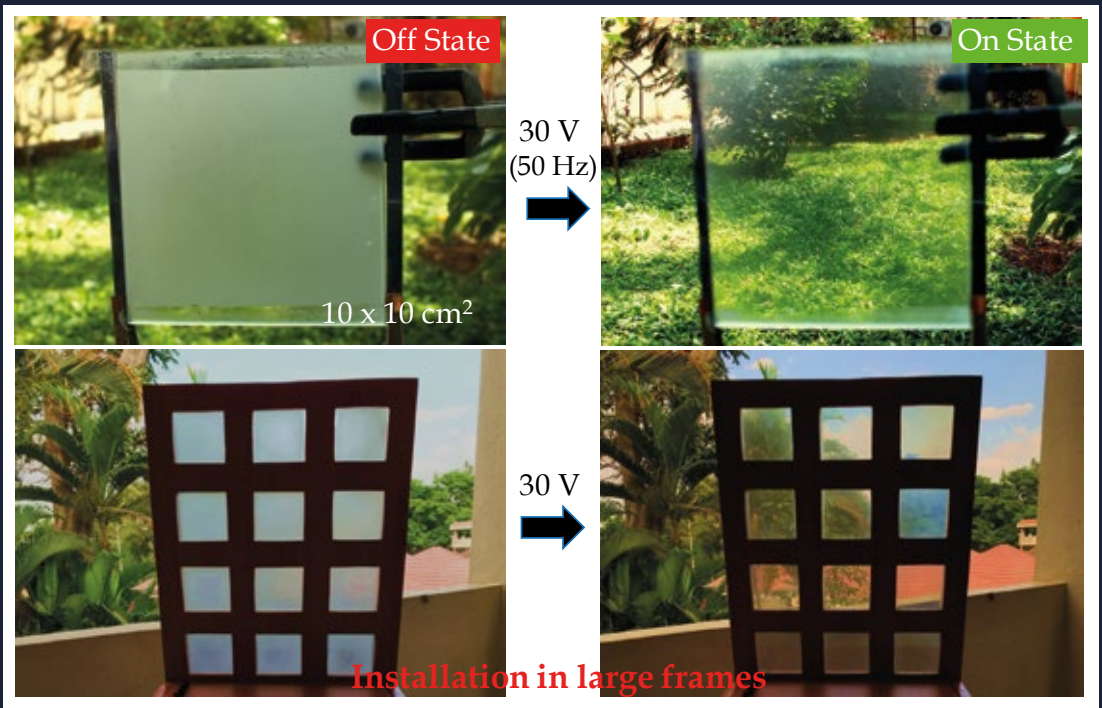
8. Entrepreneurship Activities

TECHNOLOGY TRANSFER

- Design of “Triboelectric Facemask” licensed to Camellia Clothing Pvt. Ltd. in May 2020. The masksproduced by the company are available at various e-commerce platforms including at the company’s online platformwww.3bo.in.
  Inventors: Pralay K. Santra, Ashutosh K Singh and G. U. Kulkarni
- The “Translucent - Transparent switching microfluidic glass” technology transferred to Saint-Gobain Research India on 01 Feb 2021.
  Inventors: Ashutosh K Singh, G. U. Kulkarni and Rahul M.

Prototype Gallery

- Antimicrobial facemasks
  Inventors: Neena S. John, Ramya Prabhu
- Affordable Smart Window by using ITO free Transparent Electrodes
  Inventors: Indrajit Mondal, Mukhesh K G, Ashutosh K Singh,G. U. Kulkarni.
- Face shield with social distancing alarm reminder
  Inventors: Ashutosh K. Singh, PralaySantra, Mukhesh K G, SanjitParida, G. U. Kulkarni
- Tribo-e facemask
  Inventors: PralaySantra, Ashutosh K Singh, G. U. Kulkarni



9. Teaching

September-December

Course code	Course name	Credits
CPE-RPE	Research and Publication Ethics	2:0
CeNS-lP	Intellectual Property Rights	1:0
CeNS-NS	Basics of Nano and Soft Matter	2:0
CeNS-SW	Safety, Health & Waste Management	Certificate Based Course

January-May

Course code	**Course name**	**Credits**
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

Completed

#	Title of the project	Sponsoring/ collaborative agency	Duration From ... To...	Budget sanctioned (Rs. in lakhs)
1	Synthesis of chiral liquid crystals and their composites with nanoparticles Development of functional mesophases for applied science Sanction Order No. SR/WOS-A/CS-134/2016 dt. 22.05.2017	DST WOS-A project	2017 – 2020	22.8
2	Chemical Physics of Functional Nanostructures and Interfaces Sanction Order: No.SR/NM/TP-25/2016 dt. 09.11.2016	DST-Nano Mission Thematic Projects in frontiers of nano S&T (TPF-Nano)	2016 - 2019	1115.00
3	Molecular design directed synthesis and characterization of inexpensive, functional organic materials exhibiting technologically relevant liquid crystal phases Sanction Order No.EMR/2017/000153 dt. 17.08.2017	DST-SERB Project	2017-2020	47.70
4	Magnetic nanoparticles for memory applications Sanction Order No. EMR/2016/005081 dt. 24.07.2017	DST-SERB Project	2017 – 2020	23.44

Ongoing

#	Title of the project	Duration From ... To...	Budget sanctioned (Rs. in lakhs)
1	CeNS-Centre for High Technology (CHT) Project "Scale up studies of hydrogen production from methane decomposition: Value addition from spent catalyst"	2017 - 2021	100.00
2	Tata Steel Advanced Materials Research Centre (TSAMRC)	2016 - 2021	872.00
3	DST-SERB Project on "Development of band-engineered buffer layer at the interfaces of photovoltaic devices and study of its effect on charge recombination" Sanction Order No. CRG/20l8/001698 dt. 10.05.2019	2019 - 2022	46.66
4	DST-SERB Project on "Investigations of optical, electro-optical, and mechanical properties of liquid crystal based soft photonic composites", Sanction Order No. CRG/2018/000736 dt. 08.05.2019	2019 - 2022	42.5
5	DST Nano Mission Project "Technology Business Incubator" Sanction Order No. SR/NM/TBI-01/2017(G) dt. 10.07.2019	2019 - 2022	518.56
6.	DST-SERB Project on "Effect of nanoparticles on the liquid crystal analogue of the Abrikosov phase at atmospheric and elevated pressures" Sanction Order No. CRG/2019/001671 dt. 20 Nov 2019	2020 - 2023	17.82
7.	DST-SERB Project on "Investigating the influence of self-assembled molecular layers on Au crystallites exhibiting unconventional non-FCC lattices"Sanction Order No. CRG/2019/002281 dt. 7th Feb 2020	2020-2023	37.01
8.	DST-SERB Project on "Role of Molecular Interactions in Solution Processed Layered Pnictogens" Sanction Order No. CRG/2019/002963dt. 14 Dec 2019	2020-2023	54.85
9.	DST-Nano Mission project on "Aesthetically acceptable, breath friendly triboelectric face masks: Design, fabrication, testing & technology translation" Sanction order No. DST/NM/COVID-159/2020 (G) dt. 15 July 2020	2020-2021	7.014
10.	SERB Project "Rational design, synthesis and characterization of optically active monomers and dimers capable of exhibiting technologically significant liquid crystal phases" Sanction Order No. CRG/2020/001779	2020-2023	30.3
11.	Industrial Project "Privacy Curtain Glass" sanctioned by Saint Gobain Research India	2021-2022	33.5*
12.	IUSSTF Project "HyPe – 2020" *Sanctioned and the conference been postponed.	Sep. 2020	103.00
13.	Design and Fabrication of microfluidic based transparency switching smart glasses suitable as windows (as Co-PI) SERB under SUPRA Scheme	Dec. 2020 to Nov. 2024	33.5* Funds handled by PI's institute
14.	Indo UK ISCC Innovation and Sustanaibility Chemistry Consortium British Council and Royal Society of Chemistry	Sep. 2020 to Apr. 2021	100000 GBP**

** The project money is handled PI, from JNCASR.*
*** The funding is with the Univ College of London, UK and Institute of Chemical Technology, Mumbai. Details of the project can be found here https://indouk-iscc.net/index.html*

11. New Research Facilities

New Facilities Created: Darkfield Hyper Spectral Imaging; Ellipsometer; High Resolution Digital Microscope; Dispersion Analyser; Ball Milling, BET Surface Area Analyser; Hand-held Electrochemical Workstation.

New Laboratories Created: Micro/Spectroscopy Lab, Individual Faculty Labs, XRD/Thermo Lab, TEM-SEM Lab

12. Outreach Programme

12.1 V4: विज्ञानि-विद्यार्थिविचारविनिमय

The V4 outreach programme initiated in 2015 is extremely popular with high school and college students. Under this programme, Centre reached out to nearly 460 students through online lectures and webinars. Due to Covid-19 pandemic, the live science demonstrations and visits to labs by students did not take place. Since its inception, more than 16960 students from over 186 schools/colleges have benefitted from this programme.

Details are shown in Annexure B.

12.2 Research Outreach Initiative Studentship(ROIS)

ROIS is a programme designed to provide research experience to highly motivated students pursuing post-graduate studies in Physical/Chemical Sciences or a relevant branch of Engineering/Technology. Again due to the pandemic, ROIs programme was halted temporarily and therefore the student intake reduced. However, two students whose work was pending, were allowed to complete the projects .

The list is given in Annexure C.

13. Ph.d. & Technical Training

Number of Ph.D. produced - Awarded: 2; Submitted: 2

#	Name of the Student	Ph.D	Date
1.	Mr. Sunil Walia	Awarded	04.09.2020
2.	Ms. Marlin Baral	Submitted	29.10.2020
3.	Mr. Indrajit Mondal	Submitted	23.12.2020
4.	Mr. Suman Kundu	Awarded	27.04.2021

Ph.D. students

Senior Research Fellows

Mr. Madhu Babu Kanakala	Ms. Pragnya Satapathy	Ms. Varshini G.V.
Ms. Ramya Prabhu B	Ms. Rekha S. Hegde	Mr. Rajashekhar N. Pujar
Ms. Brindhu Malani S	Mr. Kenneth Lobo	Mr. Amit Bhardwaj
Mr. Gaurav Shukla	Ms. Rajalaxmi Sahoo	Mr. Subir Roy
Ms. Suchithra P	Mr. Prashanth Nayak	Ms. Pinchu Xavier
Mr. Anamul Haque	Ms. Athira M	Mr. Alex C.
Ms. Trupthi Devaiah C	Ms. Gayathri R. Pisharody	Ms. Nurjahan Khatun
Mr. Ramesh Chandra Sahoo	Mr. Priyabrata Sahoo	Mr. Muhammed Safeer N.K.
Ms. Swathi S.P.	Mr. Sunil Walia	

Junior Research Fellows

Ms. Savithri Vishwanathan	Mr.Modasser Hossain	Ms.Radha Jitendra Rathod
Ms. Aishwarya Ajit Mungale	Ms. Athira Chandran M	Ms. Jil Rose Perutil
Ms. Mouli Das	Mr. Mukhesh K G	Mr. Nikhil N Rao
Mr. Rahul Singh	Mr. Sabiar Rahaman	Mr. Vishnu G Nath
Ms. Yogitha S N	Ms. Pritha Dutta	Mr. Rahul Deb Roy

Industry Sponsored Ph.D. Student

Ms. Himani, JRF

Research Associates

Dr. P. Chithaiah	Dr. Sreejesh M.	Dr. Govind Pathak
Dr. C. Sathiskumar	Dr. Manjunath K	Dr. S. Vimala
Dr. Bharath S.P.	Dr. Lubna Sheikh	Dr. Subash C.K.
Dr. Dipayan Pal	Mr. Suman Kundu (Prov. RA)	Mr. Indrajit Mondal (Prov. RA)
Dr. Divya Jayoti (CSIR-RA)		

R&D / Technical / Project Assistants

Mr. Rahul M.	Mr. Hiran Jyothilal	Mr. Veerabhadraswamy B.N.
Ms. Krithi M G	Ms. Sruthi Y	Mr. Ravi Kumar C R
Ms. Lavanya B	Ms. Reetu Kellur	Mr. Bramhaiah Kommula
Mr. Mukhesh K.G. (upto 31.08.2020)	Mr. Sanjit Kumar Parida	Ms. Chaitali Sow
Mr. Bharath B.	Ms. Meenakshi M. Varier	Ms. Tejaswini S Rao
Ms. Deeksha G	Ms. Chalana G.H.	Mr. Jaimson T. James
Dr. Vijaya Kumar	Mr. Madhu Babu Kanakala	Mr. Nikhil Karki
Mr. Shashi Bhushan Inchal	Mr. Abhinandan Reddy B	Dr. Rajalakshmi R
Ms. Usha Harini S		

Visiting Faculty / Students

Name	Visiting Faculty / Students	Address	Period
Dr. M. Krishna Kumar	Visiting Faculty under the Visiting Fellowship of Indian National Science Academy (INSA).	Assistant Professor, Department of Physics, School of Advanced Sciences, Kalasalingam Academy of Research and Education, Krishnankoil, Tamilnadu	14 Dec. 2020 to 13 Jan. 2021

14. Events at CeNS

Constitution Day Celebrations was observed as Samvidhan Divas at CeNS on 26 November 2020. This included “Reading the Preamble along with Hon’ble President of India”, essay competition "My views on Aristotle's Classification of the Constitutions", flash talk contest "My favourite article/topic in the Indian Constitution", written test 'Constitution Awareness Contest'.

Media coverage on **“Smart screens from discarded groundnut shells”** https://dst.gov.in/indian-scientists-develop-smart-screens-discarded-groundnut-shells

Media coverage on **“Juxtaposition of pathways can help intensity fluorescent dyes for biosensing applications”** https://bit.ly/3bdSAEO”

CeNS participated in the 6th India International Science Festival (IISF-2020) held from 22nd to 25th December 2020 virtually. The theme of IISF-2020 was 'Science for self-reliant India and Global welfare to support the Government's initiative of making Atmanirbhar Bharat'. A video demonstration of the fifteen prototype devices developed by the researchers was showcased in a virtual stall created for CeNS, which was thronged by more than a thousand industry, student, and academic visitors. Several industries contacted the principal investigators of the devices during the festival via online chat.

National Science Day 2021: The 9th and 10th standard level students and their science teachers from the Government High School, Hullegoudana Halli, Bangalore North were invited to actively participate in the event on 1 March 2021. Prof. G.U. Kulkarni, Director (I/C) in his address stressed on the importance of developing scientific curiosity. The students enjoyed participating in live experimental demonstrations of scientific concepts.

DST media cell covered the following innovative findings from CeNS:

(i) Infusion of Gold Nanorods modifies peacock feather-like photonic structure in a frustrated liquid crystal - https://dst.gov.in/infusion-gold-nanorods-modifies-peacock-feather-photonic-structure-frustrated-liquid-crystal

(ii) Newly discovered interaction between light and molecules can power optical devices - https://dst.gov.in/newly-discovered-interaction-between-light-and-molecules-can-power-optical-devices

Vigilance awareness

Centre observed Vigilance Awareness Week starting 27th Oct. to Nov. 2, 2020. The entire CeNS community took the “Integrity Pledge” and “सतर्कभारत, समृद्धभारत, (Vigilant India, Prosperous India) pledge”, during the week. The faculty, administration and students participated in an essay competition on a topic titled “Vigilant India, Prosperous India” held as a part of the event.

Jan Andolan Pledge:

As a part of Jan Andolan Campaign on Covid-19, a pledge was taken 8 October 2020, by all staff of the Centre.

15. Honours & Awards

AWARDS

- Dr. C.V.Yelamaggad, CRSI Bronze Medal, Chemical Research Society of India, IISc, Bangalore (2021)
- Dr. C.V.Yelamaggad, Silver Medal, ChirantanRasayan Sanstha, Vidyasagar University, West Bengal (2020),

HONOURS

- Dr H S S R Matte, "Associate Fellow of A.P. Akademi of Sciences" for the year 2020,

AWARDS TO STUDENTS

- Subir Roy, SRF, finalists award at the Magnetism and Magnetic Materials (MMM 2020) Virtual Conference, November 2-6, 2020, for his piece “Magnetism as Art Showcase”
- Anamul Haque, SRF, Best ePoster award, ACS Energy Letters from an International conference on “Perovskite for Energy Harvesting: From Fundamentals to Devices (PERENHAR)”, organized by nanoGe during 19-20 November 2020.

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

On the occasion of Hindi Pakhwada, a discussion was organized on the topic of "spreading science through Hindi"

Also to popularize usage of Hindi at CeNS, a scientific word is displayed everyday on the Notice Board under "आजकाशब्द".

18. Audited Financial Results

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, 2021, 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, 2021
2) In case of Income and Expenditure Account, of **DEFICIT,** being **Excess of Expenditure over Income** for the year ended on that date.

Basis for Opinion

We conducted our audit in accordance with 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,

G.R. VENKATANARAYANA Chartered Accountants BANGALORE

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 for 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: 21018067AAAAIC3459

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

Place: Bangalore
Date: August 31, 2021

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

BALANCE SHEET AS AT 31ST MARCH, 2021

(Amount in Rs.)

I. CORPUS / CAPITAL FUND AND LIABILITIES	SCH	31.03.2021	31.03.2020
CORPUS / CAPITAL FUND	1	29,03,28,703	26,58,16,841
RESERVES AND SURPLUS	2	-	-
EARMARKED PROJECTS FUNDS	3	14,27,78,951	16,92,10,145
SECURED LOANS AND BORROWINGS	4	-	-
UNSECURED LOANS AND BORROWINGS	5	-	-
DEFERRED CREDIT LIABILITIES	6	-	-
CURRENT LIABILITIES AND PROVISIONS	7	6,97,22,185	3,74,27,037
TOTAL		**50,28,29,839**	**47,24,54,023**
II. APPLICATION OF FUNDS/ASSETS			
FIXED ASSETS	8	30,64,77,924	29,06,91,892
INVESTMENTS - FROM EARMARKED/ENDOWMENT FUNDS	9	-	-
INVESTMENTS - OTHERS	10	-	-
CURRENT ASSETS, LOANS, ADVANCES ETC.,	11	19,63,51,915	18,17,62,131
TOTAL		**50,28,29,839**	**47,24,54,023**
SIGNIFICANT ACCOUNTING POLICIES AND NOTES ON ACCOUNTS	24		

(SUBHOD M GULVADY)
ADMINISTRATION & FINANCE OFFICER

(PROF. BHAGAVATULA L.V. PRASAD)
DIRECTOR

PLACE : BENGALURU
DATE : 31.08.2021

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
618, 75th Cross, 6th Block,
Rajajinagar, BANGALORE-560 01

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

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31ST MARCH, 2021

(Amount in Rs.)

A - INCOME	**SCH**	**31.03.2021**	**31.03.2020**
Income from Sales / Services	12	-	-
Grants / Subsidies:	13	10,24,00,000	11,60,22,000
Fees / Subscriptions	14	-	-
Income from Investments(income on investments from earmarked / endowment Funds)	15	-	-
Income from Royalty, Publications etc.,	16	-	-
Interest earned / accrued	17	23,06,970	45,95,529
Other Income	18	59,52,745	36,51,662
Increase / (decrease) in stock of finished goods and work-in-progress	19	-	-
TOTAL (A)		**11,06,59,715**	**12,42,69,191**
B - EXPENDITURE			
Establishment Expenses	20	5,79,08,289	6,58,01,788
Other Administrative Expenses etc.,	21	4,09,69,590	4,67,24,308
Expenditures on Grants, Subsidies etc.,	22	-	-
Interest	23	45,95,529	-
TOTAL (B)		**10,34,73,408**	**11,25,26,096**
C - BALANCE BEING SURPLUS / (DEFICIT) (A-B)		71,86,307	1,17,43,095
D - Depreciation for the year		(1,76,74,445)	(1,83,09,877)
Prior period adjustment		-	-
E. SURPLUS / (DEFICIT) CARRIED TO CORPUS / CAPITAL FUND (C-D)		(1,04,88,138)	(65,66,782)
SIGNIFICANT ACCOUNTING POLICIES AND NOTES ON ACCOUNTS	24		

(SUBHOD M GULVADY)
ADMINISTRATION & FINANCE OFFICER

(PROF. BHAGAVATULA L.V. PRASAD)
DIRECTOR

PLACE : BENGALURU
DATE: 31.08.2021

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, 2021

(Amount in Rs.)

Particulars	As at 31.03.2021	As at 31.03.2020
SCHEDULE 1		
A. CAPITAL FUND:		
As Per Previous Balance Sheet	26,58,16,841	25,25,59,623
ADD: Capital Grants received:		
Campus Development		
Capital Assets	3,50,00,000	1,98,24,000
	30,08,16,841	27,23,83,623
ADD/(LESS): Surplus / (Deficit) for the year	(1,04,88,138)	(65,66,782)
TOTAL	**29,03,28,703**	**26,58,16,841**
SCHEDULE 2 - RESERVES AND SURPLUS:	-	-
SCHEDULE 3 - EARMARKED / PROJECT FUNDS:	**14,27,78,951**	**16,92,10,145**
(See Annexure A for details)		
SCHEDULE 4 - SECURED LOANS AND BORROWINGS:	-	-
SCHEDULE 5 - UNSECURED LOANS AND BORROWINGS:	-	-
SCHEDULE 6 - DEFERRED CREDIT LIABILITIES:	-	-
SCHEDULE 7-CURRENT LIABILITIES & PROVISIONS:		
A) CURRENT LIABILITES:		
1) Statutory Liabilities	17,12,647	10,63,110
2) Other Liabilities	4,28,32,519	1,56,77,716
TOTAL (A)	**4,45,45,166**	**1,67,40,826**
B) **PROVISIONS:**		
Salaries and Services and Supplies	2,51,77,019	2,06,86,211
TOTAL (B)	**2,51,77,019**	**2,06,86,211**
TOTAL (A+B)	**6,97,22,185**	**3,74,27,037**
SCHEDULE 8 - FIXED ASSETS	**30,64,77,924**	**29,06,91,892**
SCHEDULE 9- INVESTMENTS FROM EARMARKED / ENDOWMENT FUNDS:	-	-
SCHEDULE 10 - INVESTMENTS - OTHERS:	-	-
SCHEDULE 11 - CURRENT ASSETS,LOANS, ADVANCES:		
A) CURRENT ASSETS:		
1) Inventories	-	-
2) Sundry Debtors:		
3) Cash Balances in Hand	59,493.00	59,493
4) Bank Balances:- Nationalised Banks		
a. Term Deposit Receipts (includes margin money)	8,98,76,675.44	5,73,64,100
c. Savings Accounts:		
SBI SB A/c No.274	1,86,19,058.02	97,99,554
SBI SB Project A/c 219	9,90,965.44	3,37,65,770
SBI SB A/c 24430	40,90,907.82	3,05,79,629
SBI SB A/c 75676	21,50,383.32	52,29,126
TOTAL (A)	**11,57,87,483**	**13,67,97,672**

Particulars	As at 31.03.2021	As at 31.03.2020
B) LOANS,ADVANCES AND OTHER ASSETS:		
1) Loans	-	-
2) Advances and Other amounts recoverable in Cash		
or in kind or for value to be received:	7,77,75,635.08	4,22,12,090
K P T C L Deposit (SERC/CLCR)	10,22,510.00	10,22,510
Deposit with BSNL	87,000.00	87,000
3) Deposits HMT Ltd., Mohan Gas and Bhuruka Gas	4,82,690.00	4,82,690
4) Grant in Aid Receivable	0.00	-
5) Accrued Interest & Prepaid Exp.(Insurance)	0.00	-
6) Deposit with Balmer Lawrie	2,75,000.00	2,75,000
7) TDS By Bank/ BESCOM & Others	9,21,597.27	8,85,169
TOTAL (B)	**8,05,64,432**	**4,49,64,459**
TOTAL (A+B)	**19,63,51,915**	**18,17,62,131**
SCHEDULE 12 - INCOME FROM SALES / SERVICES:	-	-
SCHEDULE 13 - GRANTS / SUBSIDIES:		
Grant in Aid -Salaries	5,74,00,000	5,55,55,000
Grant in Aid -General	4,50,00,000	6,04,67,000
Grant in Aid -Other	-	-
TOTAL	**10,24,00,000**	**11,60,22,000**
SCHEDULE 14 - FEES / SUBSCRIPTIONS:	-	-
SCHEDULE 15 - INCOME FROM INVESTMENTS:	-	-
SCHEDULE 16 - INCOME FROM ROYALTY, PUBLICATIONS ETC.:	-	-
SCHEDULE 17 - INTEREST EARNED/Accrued:		
1) On Term Deposits - Nationalised Banks	7,51,924	38,92,437
2) On Savings Accounts - Nationalised Bank	15,55,046	7,03,092
TOTAL	**23,06,970**	**45,95,529**
SCHEDULE 18 - OTHER INCOME:		
Sample charges	7,74,191	12,31,292
Miscellaneous Income	51,78,554	24,20,370
Conferences and workshops	-	-
TOTAL	**59,52,745**	**36,51,662**
SCHEDULE 19 - INCREASE (DECREASE) IN STOCK OF FINISHED GOODS & WORK IN PROGRESS:	-	-
SCHEDULE 20 - ESTABLISHMENT EXPENSES:		
1) Salaries, Allowance and Wages to Staff	4,36,08,020	5,17,38,738
2) Medical Expenses Reimbursed	87,083	67,582
3) Fellowship & Book Grant	1,36,28,689	1,34,88,601
4) Welfare Expenses	5,84,497	5,06,867
TOTAL	**5,79,08,289**	**6,58,01,788**

Particulars	As at 31.03.2021	As at 31.03.2020
SCHEDULE 21 - OTHER ADMINISTRATIVE EXPENSES,ETC:		
Auditors Remuneration	76,700.00	53,100
Chemicals, Glasswares & Consumables etc.,	39,21,717.56	26,19,015
Duties & Taxes	5,16,050.00	3,50,638
Electricity & Water Charges	36,67,749.00	44,56,687
Fees & Professional charges	11,59,834.00	40,99,864
Fuel Charges for Genset	3,34,060.20	3,30,630
Housekeeping / Manpower supply / Security charges	1,93,50,518.00	1,68,50,253
Journals & Periodicals /Books	31,175.00	1,72,307
Meritorius Awards	0.00	1,32,550
Conveyance/ Transportation Charges	19,48,859.00	32,79,446
Other Miscellaneous Charges / Bank Charges	3,85,784.64	4,81,890
Advertisement and Publicity Charges	1,48,072.00	10,80,719
Printing & Stationery	2,47,819.00	5,34,697
Registration & Renewals	-	-
Rent & Insurance	46,20,644.00	43,19,185
Repairs & Maintenance	32,20,503.00	34,85,320
Seminars and Conferences	17,379.00	7,94,346
Telephone & Postage	6,78,985.00	5,49,498
Travel Expenses	1,88,334.00	14,74,007
Foreign Travel Expenses	0.00	2,00,000
Testing (N.M.R.) & Sample analysis charges	-	-
IPR Related Expenses	-	-
Inauguration Expenses	23,010.00	14,60,156
Shifting Expenses	4,32,397.00	
TOTAL	**4,09,69,590**	**4,67,24,308**
SCHEDULE 22 - EXPENDITURE ON GRANTS, SUBSIDIES ETC:	-	-
SCHEDULE 23 - INTEREST:	45,95,529	-

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

SCHEDULE 3 - EARMARKED / PROJECTS

Annexure - A to Schedule 3

(Amount in Rs.)

Particulars	Government and Governmental bodies Sponsored Projects																			
	Balance Under Closed Project	DST/TPF/ GUK / 05/16-19	DST/NMNT/GUK/ 06/2017-19	IGSTC/GUK/0 3/16-19	IUSSTF/ GUK /02/16-18	Inspire Fellowship	Nano Mission School (Workshops)	National Post Doctrol Fellowship	SERB/EMA/S ANG/01/2017-20	SERB/EMR/C VV/01/2017-20	WOS-A/CS134/US H/01/2017-20	SERB/EMR/G GN/01/2019-22	SERB/EMR/G UK/01/2020-22	SERB/EMR/D SSR/01/2020-23	SERB/EMR/P KS/01/2019-22	SERB/EMR/H SSRM/01/2020-23	SERB/CVY/2 020-23	DST/PKS/Cov id-19	DST/TBI/GUK/2019-22	Project Administr - ation	Total Under Government Project
a) Opening Balance of the Funds	49,86,106	6,80,06,602	2,61,30,583	56,34,980	13,664	7,56,330	(1,91,693)	(1,44,600)	5,36,626	21,44,375	1,15,981	14,05,485	19,23,520	10,69,554	35,07,470	14,35,000	-	-	3,09,23,930	66,91,182	15,49,50,381
b) Additions to the Funds:																					
i) Grants or Other recei	-	-	-	-	-	16,68,337	-	-	3,00,000	2,00,000	7,00,000	7,00,000	-		3,00,000	2,00,000	10,49,209	3,93,200	-	3,56,844	58,67,590
ii) Income from investment made	-					-	-	-											-	-	-
iii) Other Receipts																					-
iii) Trfrd. during the year																					-
TOTAL (a+b)	**49,86,106**	**6,80,06,602**	**2,61,30,583**	**56,34,980**	**13,664**	**24,24,667**	**(1,91,693)**	**(1,44,600)**	**8,36,626**	**23,44,375**	**8,15,981**	**21,05,485**	**19,23,520**	**10,69,554**	**38,07,470**	**16,35,000**	**10,49,209**	**3,93,200**	**3,09,23,930**	**70,48,026**	**16,08,12,685**
c) Utilisation/Expenditure towards objectives of Funds																					
i) Capital Expenditure													4,00,000	7,60,054		12,00,000					23,60,054
Fixed Assets																				-	-
Others																				-	-
ii) Revenue Expenditure		72,596																			72,596
Salaries, Wa	-	(7,032)	32,500	48,000	-	17,81,146	-	-	2,48,909	2,45,000	5,10,840	6,99,360					99,162	1,60,373	8,18,100		46,36,358
Allowances c	-	-	-	-	-	-	-	-	-	-	-									10,14,108	10,14,108
Consumables	-	24,455	29,833	17,813	-	-	-		88,929	3,47,053	94,304	1,30,831		55,181	1,86,530	15,829	11,229	45,123	4,78,620	-	15,25,730
Contingencie	-	-	-	-	-	1,15,168	-	-	48,538	11,413	9,857	25,774		44,747	51,020	10,654	12,000	-	2,82,154	-	6,11,325
Depreciation	5,71,062	78,11,124	30,83,725	6,88,379	-	-	-	-	39,039	1,98,342	-				4,85,576			-	74,445	-	1,29,51,692
Overheads	-	-	-	-	-	-	-		1,25,000	1,53,344	78,500	-	-	-	-	-	-	-		-	3,56,844
Grant Refunded / Transferred	-		-			-	-	-	-	-			15,23,520								15,23,520
TOTAL (c)	**5,71,062**	**79,01,143**	**31,46,058**	**7,54,192**	**-**	**18,96,314**	**-**	**-**	**5,50,415**	**9,55,152**	**6,93,501**	**8,55,965**	**19,23,520**	**8,59,982**	**7,23,126**	**12,26,483**	**1,22,391**	**2,05,496**	**16,53,319**	**10,14,108**	**2,50,52,227**
NET BALANCE AT THE YEAR END (a+b-c)	**44,15,044**	**6,01,05,459**	**2,29,84,525**	**48,80,788**	**13,664**	**5,28,353**	**(1,91,693)**	**(1,44,600)**	**2,86,211**	**13,89,223**	**1,22,480**	**12,49,520**	**-**	**2,09,572**	**30,84,344**	**4,08,517**	**9,26,818**	**1,87,704**	**2,92,70,611**	**60,33,918**	**13,57,60,458**

Annexure - A to Schedule 3

(Amount in Rs.)

Industries Sponsor Project/ Joint Venture with Industries				Total of Projects			
FUNDS	**TSAMRC**	**Tata Steel**	**HPCL/IIT/NSJ/01/17-18**	**Total of Industry projects (A)**	**Total of Govt. Projects (B)**	**Total of (A+B)**	**Previous Year**
NET BALANCE AT THE YEAR END (a+b-c)	1,27,71,013	8,19,548	6,69,203	1,42,59,764	15,49,50,381	16,92,10,145	14,65,57,284
b) Additions to the Funds:							
i) Grants	-	-	8,87,502	8,87,502	58,67,590	67,55,092	6,56,33,903
ii) Income from				-	-		15,60,065
investment made					-	-	
iii) Other Receipts				-	-		
iii) Trfrd. during the year				-	-		
TOTAL (a+b)	**1,27,71,013**	**8,19,548**	**15,56,705**	**1,51,47,266**	**16,08,17,971**	**17,59,65,237**	**21,37,51,252**
c) Utilisation/Expenditure towards objectives of Funds:							
					23,60,054	23,60,054	
Rental and Maintenance Charges	10,31,451	-	-	10,31,451	-	10,31,451	18,32,377
Project Cost	40,05,936	-	-	40,05,936	-	40,05,936	46,34,899
Other Expenditure as per project	-	-	44,548	44,548	72,596	1,17,144	2,82,431
Salaries, Wages and	-	-	4,94,000	4,94,000	46,36,358	51,30,358	90,14,025
Allowances etc.,	-	-	-	-	10,14,108	10,14,108	-
Consumables/ travel	-	-	68,601	68,601	15,25,730	15,94,331	1,01,40,116
	-	-	-	-	6,11,325	6,11,325	11,37,645
Depreciation	21,72,292	-	1,11,945	22,84,237	1,29,51,692	1,52,35,929	1,55,34,843
Overheads	-	-	2,00,000	2,00,000	3,56,844	5,56,844	6,79,548
Grant Refunded	-	-	-	-	15,23,520	15,23,520	12,85,223
TOTAL (c)	**72,09,679**	**-**	**9,19,094**	**81,28,773**	**2,50,52,227**	**3,31,81,000**	**4,45,41,107**
NET BALANCE AT THE YEAR END (a+b-c)	**55,61,334**	**8,19,548**	**6,37,611**	**70,18,493**	**13,57,60,458**	**14,27,78,951**	**16,92,10,145**

CENTRE FOR NANO AND SOFT MATTER SCIENCES
ARKAVATHI, SHIVANAPURA, BENGALURU NORTH - 562 162
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH, 2021

SCHEDULE - 8 : FIXED ASSETS

A. CENS :

(Amount in Rs.)

DESCRIPTION	W.D.V. as on 01.04.2020	Additions during the year			Total as on 31.03.2021	Rate of Dep.	Depreciation Full Rate	Dep. For Addition <180 Days	Total Depreciation for the year	W.D.V. as on 31.03.2021
		>180 days	<180 Days	Total additions						
CIVIL WORKS					-				-	-
Aluminium Partitions	15,06,906	-	19,24,981	19,24,981	34,31,887	10	1,50,691	96,249	2,46,940	31,84,947
Brick Base(Partitions)	58,657				58,657	10	5,866	-	5,866	52,791
Construction of Cycle Stand	23,143				23,143	10	2,314	-	2,314	20,829
Construction of Shed	23,850				23,850	10	2,385	-	2,385	21,465
Vinyl Flooring	1,14,141				1,14,141	10	11,414	-	11,414	1,02,727
Other Miscellaneous Works	18,20,662		1,65,018	1,65,018	19,85,680	10	1,82,066	8,251	1,90,317	17,95,363
New Campus (WIP)	5,17,38,526		71,25,175	71,25,178	5,88,63,704	-	-	-	-	5,88,63,704
Infrastructure	3,62,22,464	-	2,899	2,899	3,62,25,363	-	-	-	-	3,62,25,363
BUILDINGS	40,65,397		12,74,616	12,74,616	53,40,013	10	4,06,540	63,731	4,70,271	48,69,742
ELECTRICAL INSTALLATIONS	30,25,281	3,44,075	17,10,862	20,54,937	50,80,218	10	3,36,936	85,543	4,22,479	46,57,739
COMPUTERS										
Computers	7,01,770		6,67,809	6,67,809	13,69,579	60	4,21,062	2,00,343	6,21,405	7,48,174
FURNITURE & FIXTURES										
Carpentry Works	2,64,206		2,76,886	2,76,886	5,41,092	10	26,421	13,844	40,265	5,00,827
Furniture & Fixtures	48,50,326	2,21,550	6,43,520	8,65,070	57,15,396	10	5,07,188	32,176	5,39,364	51,76,032
Fume Cupboard	78,377				78,377	10	7,838	-	7,838	70,539
GENERAL EQUIPMENTS										
Air Conditioner	10,66,091	6,18,180	-	6,18,180	16,84,271	15	2,52,641	-	2,52,641	14,31,630
Generator Set	4,85,976	2,95,000	17,05,493	20,00,493	24,86,469	15	1,17,146	1,27,912	2,45,058	22,41,411
Canteen Vessels and Equipments	1,55,018				1,55,018	15	23,253	-	23,253	1,31,765
Equipment	1,52,17,382	10,44,421	9,18,715	19,63,136	1,71,80,518	15	24,39,270	68,904	25,08,174	1,46,72,344
Workshop & Other Equipments	99,770				99,770	15	14,966	-	14,966	84,804
SCIENTIFIC EQUIPMENTS	7,48,69,544	43,95,202	23,97,113	67,92,315	8,16,61,859	15	1,18,89,712	1,79,783	1,20,69,495	6,95,92,364
Total - (A)	**19,63,87,487**	**69,18,428**	**1,88,13,087**	**2,57,31,518**	**22,21,19,005**		**1,67,97,709**	**8,76,736**	**1,76,74,445**	**20,44,44,560**

B. PROJECTS

(Amount in Rs.)

DESCRIPTION	W.D.V. as on 01.04.2020	Additions during the year			Total as on 31.03.2021	Rate of Dep.	Depreciation Full Rate	Dep. For Addition <180 Days	Total Depreciation for the year	W.D.V. as on 31.03.2021
		>180 days	<180 Days	Total additions						
					-					
I. Assets Under Closed Projects	38,07,079				38,07,079	15	5,71,062	-	5,71,062	32,36,017
II. DST/TPF/ GUK / 05/16-19										
Equipment	4,89,60,977	31,13,184	-	31,13,184	5,20,74,161	15	78,11,124	-	78,11,124	4,42,63,037
II. IGSTC/GUK/03/16-19										
Equipment	45,89,196		-	-	45,89,196	15	6,88,379	-	6,88,379	39,00,817
III. DST/NMNT/GUK/06/2017-19			-	-						
Equipment	1,90,14,668	15,43,500	-	15,43,500	2,05,58,168	15	30,83,725	-	30,83,725	1,74,74,443
IV. SERB/EMR/SANG/01/2017-20										
Equipment	2,60,261				2,60,261	15	39,039	-	39,039	2,21,222
V. SERB/EMR/CVY/01/2017-20										
Equipment	13,22,282				13,22,282	15	1,98,342	-	1,98,342	11,23,940
VI. TSAMRC										
Equipment	1,20,17,162	24,64,783	-	24,64,783	1,44,81,945	15	21,72,292	-	21,72,292	1,23,09,653
VI. HPCL/IIT/NSJ/01/17-18										
Equipment	7,46,303	-		-	7,46,303	15	1,11,945	-	1,11,945	6,34,358
VII. SERB/EMR/PKS/01/2019-22										
Equipment	32,37,176	-	-	-	32,37,176	15	4,85,576	-	4,85,576	27,51,600
VIII. DST/TBI/GUK/2019-22										
Equipment	3,49,301	2,76,570	-	2,76,570	6,25,871	15	93,881	-	93,881	5,31,990
IX. CWIP				1,55,86,287	1,55,86,287		-	-	-	1,55,86,287
Total (B)	**9,43,04,405**	**73,98,037**	-	**73,98,037**	**11,72,88,729**		**1,52,55,365**	-	**1,52,55,365**	**10,20,33,364**
Grand Total (A+B)	**29,06,91,892**	**1,43,16,465**	**1,88,13,087**	**3,31,29,555**	**33,94,07,734**	-	**3,20,53,074**	**8,76,736**	**3,29,29,810**	**30,64,77,924**
Previous Year Grand Total (A+B)	***28,79,45,401***	***1,63,09,564***	***1,95,84,631***	**3,65,91,211**	***32,45,36,612***		***3,24,62,500***	***13,82,220***	***3,38,44,720***	***29,06,91,892***

PLACE : BENGALURU
DATE: 31.08.2021

(SUBHOD M GULVADY)
ADMINISTRATION & FINANCE OFFICER

(PROF. BHAGAVATULA L.V. PRASAD)
DIRECTOR

As per our report of even date
for M/s G.R.Venkatanarayana
Chartered Accountants,
Firm Regn No. 0046T6S

[G R Venkatanarayana]
Partner
Membership No. 018067

G.R. VENKATANARAYANA * BANGALORE * Chartered Accountants

CENTRE FOR NANO AND SOFT MATTER SCIENCES, JALAHALLI, BENGALURU

SCHEDULES FORMING PART OF THE ACCOUNTS FOR THE YEAR ENDED 31ST MARCH 2021

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 System namely SFACTS since 1st of October 2018. The balances up to 30th September 2018 were migrated from Tally ERP system to the new software after proper verification and the statement of accounts finalized 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.

	Block Depreciation Rate
MACHINERY AND PLANT -Computers including computer software	60.00
MACHINERY AND PLANT -Electrical equipment	15.00
MACHINERY AND PLANT - Scientific & Other Equipment	15.00
FURNITURE AND FITTINGS - including electrical fittings include 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 interest earned on investments relating to project funds, to earmarked project funds, to recognise the interest attributable to those funds. To meet exigencies in project related expenditure, a fund called Project Administration is maintained under project accounts and allocation of funds to any project is made out of the said fund.

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. 17674445/- is debited to Income and Expenditure account. Depreciation on fixed assets acquired out of project funds amounting to Rs. 15255365/- 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 and form an integral part of the Balance Sheet as at 31st March 2021 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

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
Nanotechnology in Agriculture	G V Varshini	25.09.2020
Nano LASERs	Gaurav Shukla	09.10.2020
Surface enhanced Raman spectroscopy for biological and biomedical applications	Ramya Prabhu B	23.10.2020
Liquid-crystal photonic applications	Pragnya Satapathy	20.11.2020
Nanomagnets for future data storage	Subir Roy	18.12.2020
Photoswitchable solubility of fullerene-doped polymer thin films	TrupthiDevaiah	29.01.2021
Transpiration driven electrokinetic power generator	Anamul Haque	05.02.2021

Journal Article based Seminar

Title of Colloquia/Seminar	Speaker	Date
Bioinspired bio-voltage memristors	Swathi S. P.	16.10.2020
Reconfigurable and responsive droplet-based compound micro-lenses	Pinchu Xavier	16.10.2020
Strain engineering of two-dimensional multilayered hetero structures	Kenneth Lobo	06.11.2020
Opto- Thermoelectric nanotweezers	Amit Bhardwaj	06.11.2020
Diffraction Gratings in Cholesteric Polymer with Phototunable Helix Pitch of presentation:Electroinduced	Rajalaxmi Sahoo	13.11.2020
Wearable MXene nanocomposites based strain sensor with tile-like stacked hierarchical microstructure for broad range ultrasensitive sensing	Muhammed Safeer N K	20.11.2020
Highly Stretchable Photonic Crystal Hydrogels for a Sensitive Mechano-chromic Sensor and Direct Ink Writing	Nurjahan Khatun	27.11. 2020
Silicon-nano forest-based solvent-free microsupercapacitors with ultrahigh spatial resolution via IC-compatible in situ fabrication for on-chip energy storage	Ramesh Chandra Sahoo	27.11.2020
Anomalous Absorption Of Electromagnetic Waves By 2D Transition Metal Carbonitride Ti_3CNT_x (MXene)	Priyabrata Sahoo	04.12.2020
Self-healing electronic skin	Gayathri Pisharody	11.12.2020
Si-embedded metal oxide transparent solar cells	Athira M	08.01.2021

Thesis Colloquia

Title of Colloquia/Seminar	Speaker	Date
Optical and wettability studies on nanostructured arrays formed using self-assembled colloidal particles	BrindhuMalani S	22.01.2021
Synthesis and studies of some thermotropic liquid crystals	Ms. Rekha S Hegde	28.01.2021

19.2 FACULTY VISITS INDIA

Faculty: S. Krishna Prasad

Place and period of visit	Purpose of visit	Title of talk
Online 11 Dec. 2020	Invited Talk IISF Curtain Raiser	Swiss cheese and rollable displays
Online 21-23 Dec. 2020	Invited talk at 27th National Conference on Liquid Crystals (NCLC-2020) held at Amity University, Noida	Conjunctive Photoluminescence Enhancement in a Chiral Self-assembled System: Plasmonic and Photonic Bandgap Pathways
Online 24-26 Nov. 2020	Invited Talk at Three-day webinar on “Physical Chemistry” organised by KSTA.	Liquid Crystals and their applications
Online 14-16 Dec. 2020	Invited Talk at the 4th International Conference on Soft Materials (ICSM 2020) organized by MNIT Jaipur,	Anisotropic fluorescence and its electric field modulation in composites of nematic-quantum cuboids/discotic fluorophores
Online 29 Jan 2021	Webinar series on “Science and Technology for the common man” organized by KSTePS	A glimpse to the nano world

Faculty: C.V. Yelamaggad

Place and period of visit	Purpose of visit	Title of talk
Online 26.06.2020	Invited talk presented at the Five Days (22nd to 26th June 2020) Online FDP on the topic entitle “The role of advanced materials and nanotechnology in present scenario”. This was conducted by Vemana Institute of Technology, Bengaluru, and Department of chemistry, in Association with Royal Society of Chemistry (London), UK, India Deccan Local Section and Department of Nanotechnology, VTU, Center for Postgraduate Studies, Bengaluru Region Muddenahalli.	Soft-Nano Composites for Science and Technology of Invisibility
Online 16.07.2020	Invited talk presented at the IQAC National Webinar Organized by S. K. Arts and H. S. Kotambri College, Hubballi (Karnataka) in association Royal Society of Chemsitry (London, UK) Local Section Decccan, India. About 280 participants attended the lecture on-line.	Nanoworld and Soft Matter: Science and Technology without Boundaries
Online 23.09.2020	Invited talk presented at the Faculty Development Programme on the topic entitled “Recent Trends in Chemical Sciences (RTCS-2020)”Organized by the, Departments of Chemistry, Nitte Meenakshi Institute of Technology, Yelahanka, Bangalore	Liquid Crystals: Life, Science & Technology
Online 30.09.2020	An invited virtual talk presented at the Two Week Online Refresher Course on Basic Sciences (Physical, Chemical, Mathematical, Life Sciences and Sports) organized by UGC-Human Resource Development Centre (HRDC) Guru Nanak Dev University, Amritsar.	Liquid Crystals: Life, Science & Technology
Online 19.10.2020	Invited talk presented at the One Day User’s Discussion Meeting organized by Sophisticated Analytical Instrument Facility (SAIF), NMR Research Center, IISc, Bangalore	Molecular Structural Elucidation of Liquid Crystals with the aid of NMR Spectroscopy
05.12.2020	An AWARD LECTURE presented in the One-Day Webinar on Science Beyond Boundary: Invention, Discovery, Innovation and Society “Rasayan 6” organized by Chirantan Rasayan Sanstha® in association with Department of Chemistry, Raja Narendra Lal Khan Women's College	Liquid Crystals: Life, Science & Technology

Place and period of visit	Purpose of visit	Title of talk
Online 21-23 Dec. 2020	Invited talk was presented at the 27th National Conference on Liquid Crystals, 27th NCLC-2020, 21-23 December 2020	Exceptional Dual Fluorescent, Excited-State Intramolecular Proton-Transfer (ESIPT) Columnar Liquid Crystals Characterized by J-Stacking & Large Stokes shifts
Online 13 Mar. 2020	Invited talk presented to the postgraduate students of the Central Institute of Petrochemicals Engineering & Technology (CIPET) (Formerly Plastics Engineering Technology) CHENNAI SIDCO Industrial Estate, Guindy, Chennai, Tamil Nadu	Liquid Crystals: Life, Science and Technology
Online	Invited virtual talk (with experimental demonstration) presented to the PUC students of MES Kishore Kendra Pre-University College, Malleswaram, Bengaluru-03. About 800 students and 55 faculty members attended the talk and demonstrations.	Liquid Crystals: Life, Science and Technology

Faculty: S. Angappane

Place and period of visit	Purpose of visit	Title of talk
CSIR-IMMT, Bhubaneshwar 27-28 Aug. 2020	Talk presented at NREHA-2020	Humidity Sensor made of TiO2 Nanorods' delivered at "Global Challenges in Nanomaterials Research for Environmental and Healthcare Applications
Jain University, Bangalore 28 Sept. 2020	Invited Talk in the Webinar Series	Structural Colors
Online 04 Nov. 2020	Project presentationon the proposal, 'Developing highly sensitive gas sensors for CO_x, NO_x, volatile organic compounds (VOCs), etc' in the SERB-PAC evaluation meeting	
Online Department of Physics, Pondicherry University 23 Nov. 2020	Invited talk in Webinar on Magnetism and Magnetic Materials (MMM 2020)	Understanding high temperature metal - insulator and magnetic transitions in $NdNiO_3$ nanoparticles
Online UGC - Human Resource Development Centre, Jawaharlal Nehru University, New Delhi 24 Nov. 2020	Invited talk in the 18th Refresher Course in Physical Sciences & Nano Sciences	'Self- Cleaning Structural Colors by TiO_2/Ti Nanostructures

Faculty: Neena S. John

Place and period of visit	Purpose of visit	Title of talk
Online 08.09.2020	India-Japan Webinar on Nanotechnology, organized by INST Mohali, DST and Scientific Attache of Indian Mission, Japan	
Online 17.09.2020	Webinar on Evaluation of Innovation Indicators of R&D Organizations, organized by confederation of Indian Industry, CII	
Online 18.09.2020	ESRF Science Webinar on X-ray absorption spectroscopy for solvingchemical problems (European synchrotron)	
Online 21.09.2020	Virtual workshop on 'Surface and interface scattering experiments at PETRA IV', DESY beamline, Germany	

Faculty: P. Viswanath

Place and period of visit	Purpose of visit	Title of talk
Online 21-23 December 2020	Invited talk at 27th National Conference on Liquid Crystals.	Self-assembled fluidic bilayer of cholesteryl nonoate and its mixture with other esters at interfaces

Faculty: Pralay K. Santra

Place and period of visit	Purpose of visit	Title of talk
25-26 & 28 Sept. 2020	Invited talk in commemoration of 159th Birth anniversary of Achrya Prafulla Chandra Ray	Frontiers in chemistry: from fundamentals to applications (FCFA 2020)

Faculty: Geetha G. Nair

Place and period of visit	Purpose of visit	Title of talk
Online 13-18 December 2020	Talk at the 4th International Conference on Soft Materials, MNIT Jaipur, INDIA	Evidence of Tunable Fano Resonance in a Liquid Crystal based Colloidal Metamaterial

19.3 ACADEMIC ACTIVITIES BY RESEARCH STUDENTS AND POSTDOCTORAL FELLOWS

#	Date(s)	Name & Designation*	Name of Conference attended	Presentation mode and Title
1.	7/05/2020	Tejaswini S. Rao	Shape-Controlled Nanocrystals: Synthesis, Characterization Methods and Applications celebrated on May 07, 2020 organized by nanoGe, Switzerland (online)	Online Participation
2.	08/05/2020	Radha Jitendra Rathod	nanoGe online meetup: Shape-Controlled Nanocrystals: Synthesis, Characterization Methods and Applications	Online Participation
3.	16.05.2020	Vimala S, RA	Participated in International day of light - virtual conference; organized by IEEE, SPIE and IIT-Guwahati.	Online participation
4.	30/05/2020	Radha Jitendra Rathod	nanoGe Online International Conference on Hybrid and Organic Photovoltaics	Online Participation
5.	6-10 July 2020	Vimala S, RA	Summer School on Metamaterials and Nanophotonics (METANANO SCHOOL) 2020; organized by ITMO University, Russia,	Online participation and received 3 ECTS credits
6.	15-17 July 2020	Nurjahan Khatun, SRF	e-Conference on Soft Matter (eCoSoM-2020), Centre for Nanoscience and Nanotechnology, Sathyabama Institute of Science and Technology, Chennai, Tamil Nadu	Online Oral talk: Effect of Gelation on Frank Elastic Constants in a Twist Bend Nematic Liquid Crystal system
7.	15-17 July 2020	Nurjahan Khatun, SRF	e-Conference on Soft Matter (eCoSoM-2020), Centre for Nanoscience and Nanotechnology, Sathyabama Institute of Science and Technology, Chennai, Tamil Nadu	Online Oral talk: Tuning of photonic bandgap via combined effect of electric and optical field in a blue phase liquid crystal composite
8.	15-17 July 2020	Pinchu Xavier (SRF)	e-Conference on Soft Matter (eCoSoM-2020), Centre for Nanoscience and Nanotechnology, Sathyabama Institute of Science and Technology, Chennai, Tamil Nadu	Online Oral talk: Studies on the Miscibility of Mixed Langmuir Films of Cholesteryl Esters Exhibiting Different Molecular Packing at Interfaces
9.	18/07/2020	Radha Jitendra Rathod	nanoGe Internet Conference for Quantum Dots	Online participation
10.	24-28 August 2020	Vimala S, RA	SPIE Optics + Photonics Digital Forum; organised by SPIE;	Online particpation
12.	13-17 Sep 2020	Brindhu Malani S, SRF	International Conference on Metamaterials and Nanophotonics (METANANO)	Online Poster: Tunable plasmonic resonances in a hexagonally patterned gold substrate with varying morphology for refractive index sensing.

#	Date(s)	Name & Designation*	Name of Conference attended	Presentation mode and Title
13.	Sept 28-Oct 1, 2020	Amit Bhardwaj, SRF	Metamaterials 2020: The 14th International Congress on Artificial Materials for Novel Wave Phenomena held from in New York, USA	Online Oral talk: Tunable Fano Resonance in a Liquid Crystal Colloidal Metamaterial
14.	Oct 2-3, 2020	Amit Bhardwaj, SRF	EUPROMETA Doctoral School on "Emerging directions for controlling light-matter interaction in low-dimensional materials" co-organized by METAMORPHOSE VI AISBL and the City University of New York (CUNY), New York USA	Online participation
15.	2-6 November 2020	Subir Roy, SRF	Magnetism and Magnetic Materials (MMM 2020) Virtual Conference	Online Poster: Room temperature magnetoresistance of rGO- cobalt ferrite nanocomposite
16.	19/11/2020	Anamul Haque	International Conference on Perovskites for Energy Harvesting: from Fundamentals to Devices (PERENHAR)	Online Poster :Insights into the Interparticle Mixing of $CsPbBr_3$ $CsPbI_3$ Nanocubes: Halide Ion Migration and Kinetics
17.	19/11/2020	Modasser Hossain	International Conference on Perovskites for Energy Harvesting: from Fundamentals to Devices (PERENHAR)	Online Participation
18.	19/11/2020	Trupthi Devaiah	International Conference on Perovskites for Energy Harvesting: from Fundamentals to Devices (PERENHAR)	Online Participation
19.	21.12.2020	G.V Varshini, SRF	Faraday discussions, Chemistry of 2-dimensional materials: beyond graphene	Oral talk: Dielectric and viscoelastic investigations in a binary system of soft- and rigid-bent mesogens exhibiting the twist-bend nematic phase
20.	21.12.2020	Rajaxmi Sahoo, SRF	Faraday discussions, Chemistry of 2-dimensional materials: beyond graphene	Flash talk and a poster: Impact of iPhotoisomerization on the One-Dimensional and fluid and Three-Dimensional Abrikosov-like Photonic Structures of Liquid Crystals
21.	21.12.2020	G.V Varshini, SRF	Faraday discussions, Chemistry of 2-dimensional materials: beyond graphene	Oral talk: Dielectric and viscoelastic investigations in a binary system of soft- and rigid-bent mesogens exhibiting the twist-bend nematic phase
22.	21.12.2020	Gayathri R Pisharody, SRF	Faraday discussions, Chemistry of 2-dimensional materials: beyond graphene	Online Flash talk : Rational combination of fluorophore and liquid crystal for promising switchable photoluminescent devices
23.	21.12.2020	Dr. Divya Jayoti, RA	Faraday discussions, Chemistry of 2-dimensional materials: beyond graphene	Oral talk: Multidirectional actuation in NIR Dye based Liquid Crystalline Elastomers
19.	21.12.2020	Brindhu Malani S (SRF)	Faraday discussions, Chemistry of 2-dimensional materials: beyond graphene	Oral talk: Wetting studies on hexagonally ordered gold micro-structured substrate

**RA: Research Associate; SRF: Senior Research Fellow; JRF: Junior Research Fellow*

ANNEXURE – A

In Refereed Journals

1. The fascinating world of soft materials, Awasthi, Kamlendra, Mukherjee, Rabibrata, S. Krishna Prasad, Editorial for the thematic issue on "Soft Materials", *Bulletin of Materials Science,* 43, 1(2020) IF =1.392
2. Switchable smart windows using a biopolymer network of cellulose nanocrystals imposed on a nematic liquid crystal, Pragnya Satapathy, S Parthasarathi, DS Shankar Rao, S Bano, YS Negi, S. Krishna Prasad, *Applied Physics Letters,* 117, 103702(2020) IF = 3.597
3. Dielectric and viscoelastic investigations in a binary system of soft- and rigid-bent mesogens exhibiting the twist-bend nematic phase, G.V. Varshini, D.S. Shankar Rao, U. S. Hiremath, C.V. Yelamaggad and S. Krishna Prasad, *Journal of Molecular Liquids*, 323, 114987-1-11 (2021) IF=5.065
4. Impact of photoisomerization on the one-dimensional fluid and three-dimensional Abrikosov-like photonic structures of liquid crystals, R Sahoo, DS Shankar Rao, Uma S Hiremath, C V Yelamaggad, S Krishna Prasad, J. *Phys. Chem. C*,124, 12920 (2020) IF = 4.189
5. Conjunctive photoluminescence enhancement through plasmonic and photonic band-gap pathways in a chiral self-assembled system, Marlin Baral, S. Krishna Prasad, SA Bhat, RA Nayak, CV Yelamaggad, *ChemPhotoChem,* 4, 582(2020) IF=2.838
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10. Transparent triboelectric nanogenerator based on thermoplastic polyurethane films, S. R. Srither, N. R. Dhineshbabu, D.S. Shankar Rao, S. Krishna Prasad, O. Dahlsten, and S. Bose, *Journal of Nanoscience and Nanotechnology*, 21, May 3072-3080 (2021). IF=1.354. https://doi.org/10.1166/jnn.2021.19143
11. Metal-free C–H functionalization of pyrrolidine to pyrrolinium-based room temperature ionic liquid crystals, S Mandal, RK Gupta, SK Pathak, DSS Rao, SK Prasad, AA Sudhakar and CK Jana, *New Journal of Chemistry*, 2021 (in Press), IF=3.288. https://doi.org/10.1039/D1NJ00647A
12. Tunable Directional Scattering from High-Refractive-Index Particles Dispersed in an Anisotropic Medium, Amit Bhardwaj, Navas Meleth Puthoor, Geetha G Nair, *The Journal of Physical Chemistry C*, 124 (34), 18698-18706, 2020. https://doi.org/10.1021/acs.jpcc.0c04653 IF: 4.189
13. Photo-tunable Epsilon-Near-Zero behavior in a Self-Assembled Liquid Crystal – Nanoparticle Hybrid Material, Amit Bhardwaj, Vimala Sridurai, Sachin A. Bhat, Channabasaveshwar V. Yelamaggad and Geetha G. Nair, *Nanoscale Adv.*, 2508-2515, 3, (2021).
14. Enhanced thermal stability and monodomain growth in a 3D soft photonic crystal aided by graphene substrate, Nurjahan Khatun , Vimala Sridurai , Rajashekhar Pujar, Madhu B. Kanakala , Shyam Kumar Choudhary, Giridhar U. Kulkarni, Channabasaveshwara V. Yelamaggad, Geetha G. Nair, *Journal of Molecular Liquids,* 115059 (1-8), 325, 115059. (2021) IF=5.065
15. Topological defects due to twist-bend nematic drops mimicking colloidal particles in a nematic medium, K. S. Krishnamurthy, D. S. Shankar Rao, M. B. Kanakala, C. V. Yelamaggad and M. Kleman, *Soft Matter*, 16, pp 7479-7491 (2020); IF=3.399.
16. Wide thermal range, exclusive occurrence of technically significant chiral nematic phase: synthesis and mesomorphism of cholesterol-based non-symmetric dimmers, R. A. Nayak, S.A. Bhat, D.S Shankar Rao and C.V. Yelamaggad, *Bull Mater Sci.*, 43, pp 188 (2020); IF=1.3
17. Octadecylamine-capped CdSe/ZnS quantum dot dispersed cholesteric liquid crystal for potential display application: Investigation on photoluminescence and UV absorbance, Govind Pathak, Gurumurthy Hegde and Veena Prasad, *Liq. cryst*., 48, 579 (2021). IF=3.28
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23. Room temperature, deep-red/nir-emissive, C3-symmetric (n, π-conjugated) columnar liquid crystals: C3h-tris(keto-hydrazone)s. Rashmi A. Nayak, B. N. Veerabhadraswamy, D. S. Shankar Rao, A. S. Achalkumar and C. V. Yelamaggad. *ACS Omega,* 6, 3291−3306 (2021). IF=2.87
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ANNEXURE – B

V4 Science Programme @ CeNS

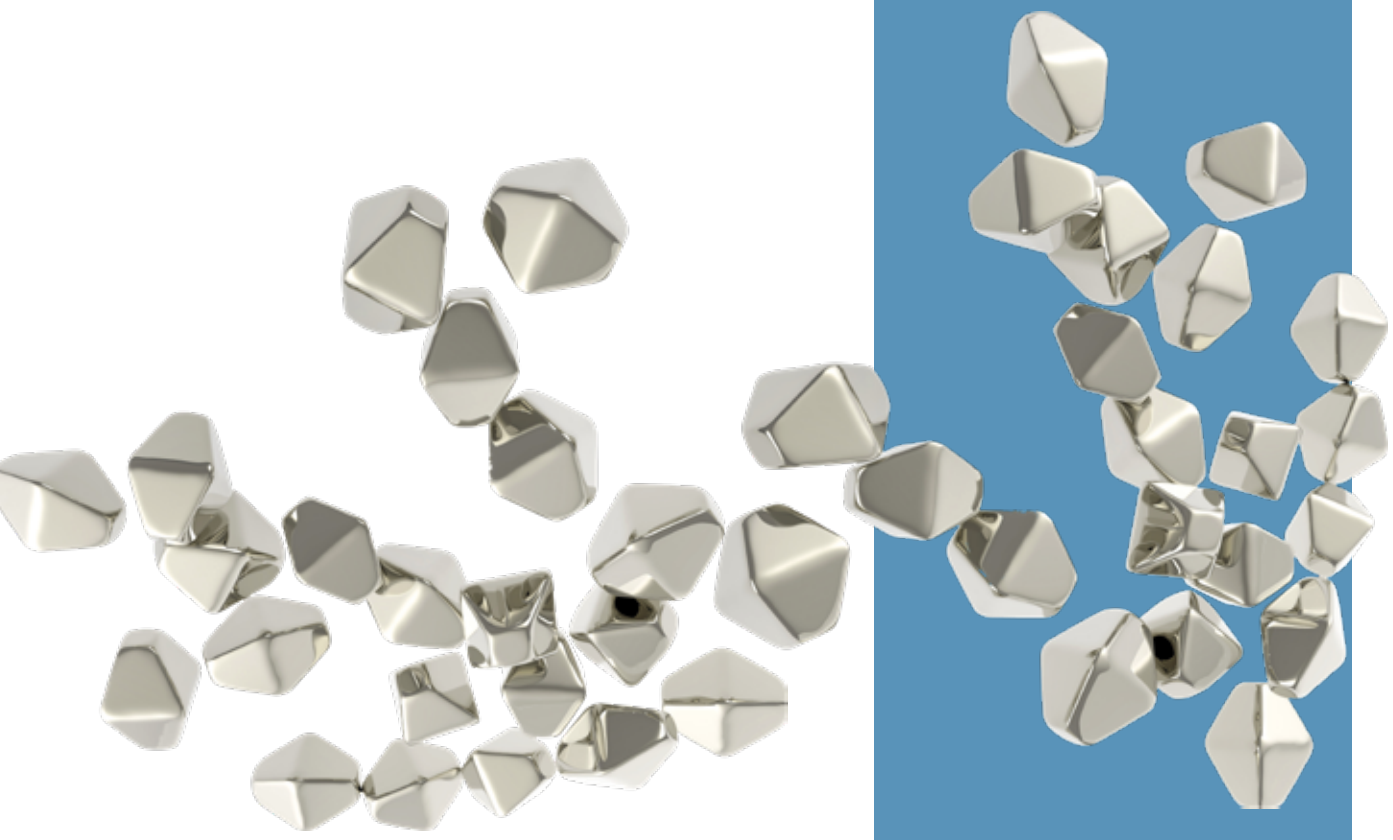
#	Date	Institution Name & Address	Participation Details		Topic
			Student	Staff	
1.	July 2020	Commissionerate of College Education, Vijayawada, Government of Andhra Pradesh	More than 240		Online talk in the Faculty Development Programme organized: The New and Big Science of Small
2.	Dec 2020	S.K.R. College for Women Rajamahendravaram, East Godavari District Andhra Pradesh and S.V.D. Govt. Degree College (W) Nidadavole, West Godavari District Andhra Pradesh	more than 100 including teachers students		Online talk given in Webinar organized: The New and Big Science of Small

V4: Science Programme @ your Institution

#	Date	Institution Name & Address	Participation Details		Topic
			Student	Staff	
1.	2 Nov 2020	Amity University	50	10	Sensitised solar cells: Design and working principle
2.	1 Aug 2020 (online)	University of North Carolina	50	10	Probing heterostructures of nanomaterials using Photoelectron Spectroscopy

ANNEXURE – C

#	Name of ROI student	Name of the Parent Institute	Project title & duration	Research Mentor
1.	Narayana M Hegde	Engineering College, Bangalore	14-02-2020 to 23-03-2020 28-10-2020 to 27-11-2020	C.V.Yelamaggad
2.	Barath Venkatesan	K. S.Rangasamy College of Technology, Tiruchengode	Oct -Nov 2020	Neena S. John



नैनो एवं मृदु पदार्थ विज्ञान केंद्र

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