
# ANNUAL REPORT 2019-2020

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


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

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# INDEX

# FOREWORD

Centre for Nano and Soft Matter Sciences (CeNS) with its present mandate has entered into the sixth year. The in-house inventions are steadily progressing towards realizing affordable futuristic technologies. Nanotechnology being the focus, the diversity in research borne out of interdisciplinary is but natural; Nano connects and percolates seamlessly into the diverse areas of science and technology. CeNS exercises an open-minded approach to R&D in Nano technology with high emphasis on IP generation and technology realization. A number of students were enrolled for research programmes leading to PhD, in the area of nanoscience and technology. The state-of-the-art 'Materials Laboratory' and the 'Technology Laboratory' was inagruated at the Arkavathi campus in August 2019 making the campus more vibrant to researchers. Several new facilities such as Electrochemical and photoelectrochemical based waters-splitting with gas chromatography, Glass cleaning and template removal system, Spin-coater etc. were created. To facilitate easy access to the sophisticated instrumentation in the Materials and Characterization laboratories, a web-based slot-booking request facility was launched under Central Research Facilities benefitting researchers not only from CeNS but also from other academia and industry. A Technology Business Incubator, nicknamed 'Greenhouse' funded by DST Nano Mission was launched in a project mode. During the COVID-19 pandemic situation, responding to the call from the Prime Minister of India, Greenhouse initiated a series of projects headed by CeNS researchers resulting in market-ready PPE products such as face masks, face shields, and hand sanitizers. It must be mentioned here that the unique face mask design 'Tribo-E Mask' developed based on the triboelectric generation was bought by a commercial entity which is already marketing the product all over India for the usage of common public. The Prototype Gallery, housed under the Greenhouse, hosting interactive technology products based on in-house inventions continues to attract a large number of academic and industry visitors. Keeping the same trend like the previous years, many extramural and industrial projects were undertaken this year as well. Several workshops were held during this period both independently and jointly with neighbouring institutions. A one day workshop, "Energy, Materials and Devices," the first technical event at Arkavathi was held last December which saw invited talks by eminent scientists from India and abroad. Another unique event was the celebration of International Year of Periodic Table(IYPT-2019) jointly with IISc and JNCASR.

Outreach programmes of the Centre launched four years ago, विज्ञानि-विद्यार्थि विचार विनिमय (V4) for the popularization of science among school children, and Research Outreach Initiative (ROI), an internship programme for the benefit of students in their post-graduate degree in science or in engineering continued to flourish this year as well. CeNS researchers actively took part in 'Nano Jatha', a prelude to 11th edition of Bengaluru INDIA NANO, under which series of lectures and live demonstrations on nanoscience and technology were held at different parts of the Country. An aesthetically designed open air space 'Nabhangan' at Arkavathi hosted some of the in-house outreach programmes to high school and college students.

The Centre, which is being constantly mentored by eminent scientists, administrators, policy makers, and in particular by the Nano Mission of the Government of India, is constantly thriving to scale newer heights with the expansion of its activities at the new campus, Arkavathi.

## Director (I/C)

# 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. 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.

CeNS is currently operating from both its campuses, the one at Jalahalli, and the other at 'Arkavathi', Shivanapura. The latter hosts the 'Materials Laboratory', 'Technology Laboratory' and the 'Greenhouse', the Technology Incubator Project. In the Materials Laboratory, a number of sophisticated equipment are grouped under different labs such as Fabrication Lab, Energy Lab, Gas sensor Lab, TEM lab, etc. The Tata Steel Advanced Materials Research Centre (TSAMRC), the joint Centre with Tata Steel, also has its laboratory at Arkavathi. The Technology Laboratory is a group of incubation labs fostering technology development activities. The Greenhouse project functions as a virtual platform for CeNS researchers to take up entrepreneurship for translational activities.

With the extended responsibility, CeNS has renewed its vision to work in pursuit of Global excellence in Science and to nurture Indigenous Technology for the betterment of Our Country.

**Nabhangan, Arkavathi**

# 2. GOVERNING COUNCIL

Chairman
**Professor V. Ramgopal Rao**
Director, Indian Institute of Technology Delhi
Hauz Khas, New Delhi - 110 016

| | | | |
|---|---|---|---|
| **Professor Ashutosh Sharma**<br>Secretary to the Government of India<br>Department of Science and Technology<br>Technology Bhavan<br>New Mehrauli Road, New Delhi – 110 016 | Member<br>(Ex-officio) | **Professor D.D.Sarma**<br>Professor<br>Solid State and Structural Chemistry Unit<br>Indian Institute of Science<br>Bengaluru – 560 012 | Member |
| **Shri B. Anand, IAS**<br>Addl. Secretary & Financial Adviser<br>Department of Science and Technology<br>Technology Bhavan<br>New Mehrauli Road, New Delhi – 110 016 | Member<br>(Ex-officio) | **Professor Amlan J. Pal**<br>Senior Professor<br>Indian Association for the Cultivation of Science<br>2A & 2B Raja S C Mullick Road ,<br>Kolkata 700032 | Member |
| **Shri V. Mahesh**<br>Director (R & D)<br>Bharat Electronics Limited<br>Outer Ring Road, Nagawara<br>Bengaluru – 560 045 | Member | **Professor G.U. Kulkarni**<br>Director (I/C)<br>Centre for Nano & Soft Matter Sciences<br>Jalahalli Bengaluru – 560 013 | Member<br>Secretary |


Greenhouse, the Technology Business Incubator, Arkavathi

Materials Laboratory, Arkavathi

# 3. RESEARCH ADVISORY BOARD

1. **Professor M.K. Sanyal** — **Chairman**
   Emeritus Professor
   Saha Institute of Nuclear Physics, Kolkata

2. **Professor George K. Thomas** — **Member**
   Professor
   Indian Institute of Science Education and Research– Thiruvananthapuram

3. **Professor Ashok K. Ganguli** — **Member**
   Head, Department of Chemistry
   Indian Institute of Technology-Delhi, New Delhi

4. **Shri Chandrasekhar B. Nair** — **Member**
   Head and Founder Director
   Bigtec Labs, Bengaluru

5. **Professor Navakanta Bhat** — **Member**
   Professor
   Centre for Nano Science and Engineering, Indian Institute of Science, Bengaluru

6. **Professor Satishchandra Ogale** — **Member**
   Emeritus Professor
   Indian Institute of Science Education and Research–Pune

7. **Professor G.U. Kulkarni** — **Convener**
   Director (I/C), Centre for Nano and Soft Matter Sciences

# 4. SCIENTISTS AND ADMIN STAFF

| Name | Designation |
|---|---|
| 1. Prof. G. U. Kulkarni | Director (I/C) |
| 2. Prof. K. A. Suresh | Honorary Professor |
| 3. Dr. S. Krishna Prasad | Scientist F (superannuated on 30.10.2020)<br>Honorary Scientist (w.e.f. 11.11.2019) |
| 4. Dr. Geetha G. Nair | Scientist E |
| 5. Dr. D. S. Shankar Rao | Scientist E |
| 6. Dr. Veena Prasad | Scientist E |
| 7. Dr. C. V. Yelamaggad | Scientist E |
| 8. Dr. S. Angappane | Scientist E |
| 9. Dr. P. Viswanath | Scientist D |
| 10. Dr.Neena Susan John | Scientist D |
| 11. Dr.Pralay K. Santra | Scientist D |
| 12. Dr. H.S.S.R. Matte | Scientist D (on contract) |
| 13. Dr. Ashutosh K. Singh | Scientist C (on contract) |
| 14. Dr. Kavita A. Pandey | Scientist C (on contract) |
| 15. Dr. Uma S. Hiremath | WoS-A Scientist (under project) |

| Name | Designation |
|---|---|
| 1. Mr. Subhod M. Gulvady | Administration and Finance Officer |
| 2. Mr. Vivek Dubey | Accounts Officer |
| 3. Ms. P. Nethravathi | Assistant Admn. Officer |
| 4. Dr. Sanjay K. Varshney | Technical Assistant |
| 5. Mr. Sandhya D.Hombal | Technical Assistant |
| 6. Mr. M. Jayaram | Assistant |
| 7. Dr. Nayana .J. | Library Assistant |
| 8. Mr. Jayaprakash V.K. | Support Staff |

Consultants (on contract)

| Name | Designation |
|---|---|
| 1. Mr. R. S. Gururaj | Consultant - Administration |
| 2. Mr. K. S. Chandrashekhar | Consultant Engineer |
| 3. Mr. Narayana M.G. | Consultant - Administration |
| 4. Dr. M.L.V. Archana | Authorised Medical Officer |
| 5. Mr. Ravishankar Solanki | Consultant – Computer Networking |
| 6. Mr. Deepak S. | Admn. Asst. (Public Relations) |
| 7. Mr. Noormuthu H. | Consultant (Internal Audit and Accounts) |

# 5. RESEARCH AND DEVELOPMENT ACTIVITIES

### Twisted properties in graphene

Currently, Graphene is perhaps the most studied material around the globe. It has served as a classic example of 2D materials not just because of the historical reasons, but importantly, due to distinctly observable dimensional crossover in it, from 2D to 3D, via Bernal stacked (AB) bilayer to multilayer culminating in graphite. The interlayer interactions that are responsible, however, tend to differ vastly in the presence of defects or disorders. Of particular interest is the angular disorder causing the layers to stack in a manner away from the conventional AB packing. The new class of graphene systems involving a twist among otherwise highly crystalline 2D layers, is often termed as twisted graphene. The twist as a new degree of freedom induces several angle dependent properties, from visible absorption to superconductivity, unheard of in the case of graphene itself. In some instances, the layers may become highly decoupled such that a layer under twist may behave as though suspended, free from any substrate influence. This is when the extraordinary properties of grapheneareobservable.In this work a new type of twisted graphene multi-stackis reported. *See: Carbon, 156, 470-487 (2019) DOI: 10.1016/j.carbon.2019.09.053*

Investigators: G. U. Kulkarni

Collaborators: U. Mogera, Samueli School of Engineering, University of California, USA

### A planar supercapacitor made of supramolecular nanofibre based solid electrolyte exhibiting 8V window

Miniaturized self-powered wearable electronic gadgets, aimed to integrate with the future lifestyle, demand compatible micro-packets of energy sources. While tiny batteries could provide the desired supply, they are simply incapable when it comes to energy requirements in the form of a power pulse which capacitors could deliver only if their energy storage capability is increased. Supercapacitors are poised to fill the gap providing desirable energy and power densities in one go. One critical step in the development of efficient supercapacitors relates to enhancing the operable voltage window, as the energy density depends quadratically on the former. Present day supercapacitors, however, operate with voltages typically below 3 V. The present work reports a simple method for the fabrication of a planar supercapacitor using organic nanofibres as solid-state electrolyte drop coated on low-cost titanium metal microelectrodes. What is noteworthy is that the fabricated device offers an operating voltage of 8 V, which is unprecedented. Other relevant parameters such as ambient stability, cyclability and capacity retention also fall in line making the device overall high performing. This is perhaps the first attempt of exploring fast ion movements in ordered conducting organic nanofibres for charge storage. *See: Nano Energy, 61C, 259-266(2019) DOI: 10.1016/j.nanoen.2019.04.054*

Investigators: S. Kundu, & G. U. Kulkarni

Collaborators: U.Mogera, Samueli School of Engineering, University of California,USA; J.G. Subi, Jawaharlal Nehru Centre for Advanced Scientific Research, Bengaluru

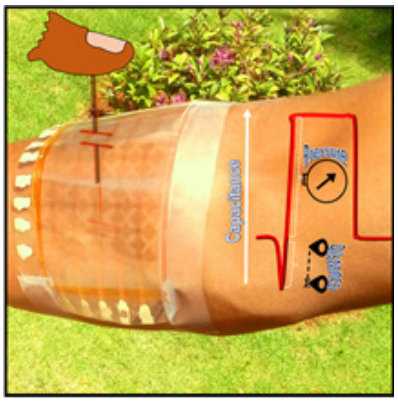
### A spring network simulation in three dimensions for designing optimal crack pattern template to fabricate transparent conducting electrodes

Desiccating cracks often form a well-connected network structure in the colloidal film due to stress arising from desiccating process. Interestingly, desiccating crack patterns can be used as a suitable lithography template for fabricating metal network based transparent conducting electrodes (TCE) for optoelectronic applications. An optimum crack pattern is desired for realizing optimum metal wire networks with high transmittance, conductance and effective charge collection properties. In this work, a crack pattern in desiccating colloidal films in three dimensions using a spring network model is simulated. A colloidal film is modeled as an array of springs, with individual spring representing bond between neighboring colloidal particles; the desiccation process leads to shrinkage of these springs and eventually breaking of few of them leading to the formation of the crack pattern. The optimal combination of system parameters, such as film thickness, material stiffness and polydispersity, which can produce the best template for producing a conducting network on transparent surfaces are looked into. Thus, the present study will be useful in the direction of crack physics, electrical percolation and engineering of crack patterns for efficient TCE applications. *See: Bull. Mater. Sci, 42:197 (2019) DOI: 10.1007/s12034-019-1826-0*

Investigators: S. Kundu, & G. U. Kulkarni

Collaborators: U. Mogera, Samueli School of Engineering, University of California,USA; J.G. Subi, Jawaharlal Nehru Centre for Advanced Scientific Research, Bengaluru

## Patterned Cu mesh based transparent and wearable touch panel for tactile, proximity, pressure and temperature sensing




Futuristic technologies are required not only to be smart but also to accomplish multiple tasks at the same time. Touch panels play an important role in this context. Achieving high figures of merit including additional transparency, process scalability, and low cost is thus the goal post. The fabrication of a flexible capacitive touch panel employing the crackle templating method is presented. Pixelation of the metal mesh electrode into interlocking diamond patterns on flexible poly(ethylene terephthalate) (PET) was done using a mask produced by laser printing of the toner. A thin (30 ~m) polydimethylsiloxane (PDMS) layer served as the dielectric. The capacitive touch panel is flexible (bending radius of ~2 cm) and transparent (~90%) and can detect multiple stimuli involving various stages of touch, finger approach, landing, and pressure touch (up to 180 kPa) and temperature (<50 °C). ) The method is scalable to make window size panels, and given the ultra-low sheet resistance of the electrodes (0.79 Ω ~ -1 the device is operable at higher operating frequencies (~8 MHz), ensuring minimal noise and cross talk. *See: ACS Appl. Elec. Mater., 1, 8, 1597-1604, (2019) [DOI: 10.1021/acsaelm.9b00330]*

Investigators: S. Walia, I. Mondal and G. U. Kulkarni

## Narrowing desiccating crack patterns by an azeotropic solvent for the fabrication of nanomesh electrodes

Desiccation of a colloidal layer produces crack patterns because of stress arising out of solvent evaporation. Associated with it is the rearrangement of particles, while adhesion to the substrate resists such movements. The nature of solvent, which is often overlooked, plays a key role in the process as it dictates evaporation and wetting properties of the colloidal film. Herein, the crack formation process by using a mixture of solvents, water, and isopropyl alcohol (IPA) is studied. Among the various ratios, a water/IPA mixture (15:85 by volume) close to the azeotropic composition possesses unusual evaporation and wetting properties, leading to narrower cracks with widths down to ~162 nm, uncommon among the known crackle patterns. The dense and narrow crack patterns have been used as sacrificial templates to obtain metal meshes on transparent substrates for optoelectronic applications. *See: Langmuir, 35,49, 16130–16135, (2019) [DOI: 10.1021/acs.langmuir.9b02442]*

Investigators: Rajashekhar Pujar & G. U. Kulkarni

Collaborators: Ankush Kumar, JNCASR; K. D. M. Rao, Indian Association for the Cultivation of Science, Kolkata; Supti Sadhukhan, Jogesh Chandra Chaudhuri College, Kolkata; Tapati Dutta, St. Xavier's College, Kolkata; Sujata Tarafdar, Jadavpur University, Kolkata

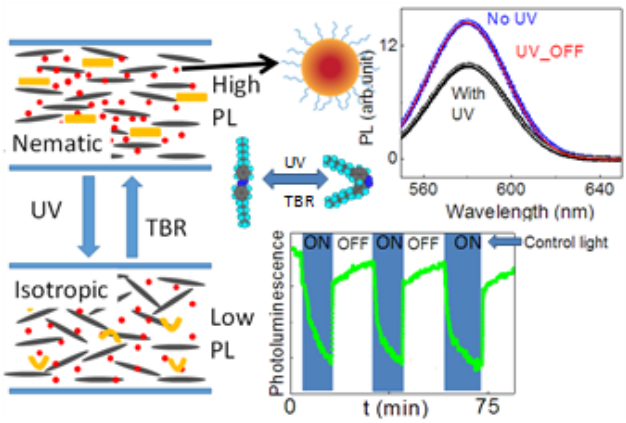
## Doubly anisotropic and electrically switchable emission from a nanocomposite of $CsPbBr_3$ quantum cuboids and nematic liquid crystal

Photophysical properties of a nanocomposite consisting of CsPbBr3 halide perovskite quantum cuboids (QCs) and a wide temperature range nematic are investigated. Contrary to observations made with conventional II-VI quantum dots dispersed in a liquid crystal, the used QCs are driven by the nematic orientation to form linear assemblies over macroscopic length scales as evidenced by polarizing optical microscopy. Interestingly, the linear assembly is actually caused by such an anisotropic arrangement at the nanometerscale, as seen from TEM studies Thin films of the nanocomposite exhibiting this unique and fascinating character exhibit absorption and photoluminescence (PL) features, which are quite appealing. These assemblies exhibit several interesting features including (i) bandwidth having the same sharpness as the native QCs, (ii) dual anisotropic: different along all the three directions ($PL_x$> $PL_Y$ >$PL_z$) with reference to the director, (iii) voltage-driven switching between anisotropic limits and (iv) fast field-driven response. *See: Invited article in Special Issue on Liquid Crystals, 9, 378 (2019)*

Investigators: Pragnya Satapathy, Pralay K. Santra and S. Krishna Prasad

## Photoisomerization-driven photoluminescence modulation in CdSeS gradient quantum dot/liquid crystal nanocomposites

This work highlights the aspect that light of one wavelength can effectively control and modulate PL in nanocomposites comprising gradient CdSeS quantum dots (QD) in a nematic, by appealing to photoisomerisation of a small amount of an azobenzene derivative. The controlling UV radiation is of low magnitude (0.6 $mW/cm^2$), and thus has




very little scope for the undesirable photooxidation. The PL modulation magnitude is high (45%) and can be addressed spatially and temporally. The dynamics of the process for the forward (UV-on) process is much faster than the return to the equilibrium situation after switching off the UV. However, by applying a DC bias field it is demonstrated that this return can be accelerated by a factor of more than 6. This low-power second-wavelength on-demand optical technique for emission modulation is generic and holds promises for the development of light-switchable QD-based emissive displays and photonic devices. *See: Chem. Photo. Chem. doi: 10.1002/cptc.201900293 (2020)*

Investigators: Pragnya Satapathy, V. Navyashree, Pralay K. Santra and S. Krishna Prasad

## Switchable smart windows using cellulose nanocrystals

A polymer stabilized liquid crystal device (PSLC), based on a bio-polymer, Cellulose Nano crystal (CNC), being extracted from groundnut shells is fabricated. Incorporation of CNC here does not only provide scalability and biocompatibility to the fabricated device but also enhances the device characteristics in many ways. The features include the following: (i) the threshold voltage Vth remains essentially same for all the composite even for the composite having the highest CNC concentration (ii) the slope of the Freederickz profiles reduces with the increase in CNC concentration suggests the faster time response of the device (iii) CNC embodiment removes the backflow effect due to better anchoring strength provided by the CNC polymeric network (iv) 10 wt% CNC composite provides a higher haze value of about 67% (v) the CNC_LC device exhibiting significant contrast between Field-OFF scattering and Field-ON transparent states. *Patent filed: A polymer doped liquid crystal composition and method thereof, IPR-10042018-P003-SKP, 202041000263*

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

## Enhanced photoluminescence in a chiral nematic liquid crystal through polymer stabilization and an erasable 3-state memory device

Here it is demonstrated how embedding in a polymer network can enhance the photoluminescence (PL) of an organic emitter dispersed in a liquid crystal. This new pathway takes germination from a novel concept that wasrecently demonstrated: Matching the wavelengths of excitation of the emitter and that of the one-dimensional photonic band gap (PBG) of a cholesteric liquid crystal host increasing the fluorescence of the system. The imposition of the polymer network and the consequent of the enhanced PL is found to be generic, applicable to non-chiral as well as chiral systems. However, the chiral system embedded in the network leads to an overall PL gain factor of 16 over the PL of the native nematic + emitter system. An erasable memory device depicting three photoluminescence levels has been developed on these concepts. *See: J. Mol. Liq. 292,111338 (2019)*

Investigators: M.Baral, V.N. Veerabhadraswamy, S. Krishna Prasad and C.V. Yelamaggad

## Effect of graphene flakes, titanium dioxide and zinc oxide nanoparticles on the birefringence, I–V characteristics and emission of a liquid crystal

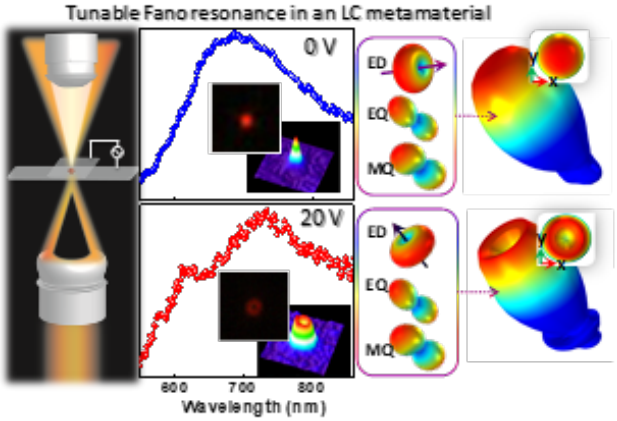
Comparative I–V characteristics and photoluminescence measurements have been made on a liquid crystal system dispersed with different nanomaterials – i). graphene flakes ii) ZnO and iii) $TiO_2$ nanoparticles (NPs). It is observed that dispersion of graphene flakes enhance not only the orientational order but also the current by three orders of magnitude higher compared to other two nano-LC composites perhaps owing to the strong π- π interaction between the LC molecule and graphene hexagonal structure. Whereas ZnO and graphene nanostructures enhance the PL intensity, $TiO_2$ nanoparticles show concentration-dependent reduction. *See: J. Mol. Liq. 302,112571(2020)*

Investigator: S. Krishna Prasad

Collaborators: N. Pushpavathi and K.L. Sandhya, M.S. Ramaiah Institute of Technology, Bengaluru

## Evidence of tunable Fano resonance in a liquid crystal based colloidal metamaterial

A colloidal metamaterial composite, realized by dispersing sub-micron sized high refractive index dielectric resonators in a nematic liquid crystal medium, exhibits electrically tunable Mie resonances in the optical regime. Darkfield hyperspectral imaging reveals that when the




NLC molecules reorient from the pristine planar state on application of an AC electric field, the scattered image from the particle splits into two, owing to the birefringence of the NLC medium. At higher voltages, a doughnut-shaped scattering pattern is obtained, indicating the occurrence of Fano resonance. The analysis of the darkfield scattering spectra based on the "Multi-pole Fano interference model" confirms the presence of Fano resonance arising due to the interference between the broad electric dipolar and narrow electric quadrupolar modes. With increasing voltage, the magnitude of Fano parameter decreases and approaches unity corresponding to an ideal Fano shape. *See:Advanced Optical Materials., DOI: 10.1002/adom.201901842*

Investigators: Amit Bhardwaj, Vimala S, Navas M P, Aswathi B. Nair and Geetha G Nair.

Collaborators: Tripti Ahuja, DST Unit of Nanoscience and Thematic Unit of Excellence, Department of Chemistry, IIT Madras, Chennai

## Formation of selenium superstructures: Self-assembly of monodispersed sub-micron spheres and nanorods

Self-assembly of monodispersed nanospheres and nanorods into nano- and micro-scale superstructures are important from the viewpoint of developing small scale devices. Synthesizing such particles with minimal polydispersity index is challenging due to the complexity involved in the nanoparticle growth from the constituent atoms. Monodispersed a-Se spherical particles, with polydispersity index much smaller than 0.1, are synthesized through the reduction of selenious acid using hydrazine in ethylene glycol. The size of the particle readily changed from 190 to 350 nm by varying the molar ratio of selenious acid to hydrazine. The optical extinction spectra obtained from the colloidal solution show peaks corresponding to magnetic and electric dipole resonances as verified from the Mie theory and finite element analysis. A small agitation of the a-Se nanospheres resulted in the formation of t-Se nanorods via crystal growth mechanism. Under ambient conditions, the nanorods self-assemble to form sub-micron spheres, which in turn grow into micron-sized superstructures. *See: Applied Surface Science, DOI: 10.1016/j.apsusc.2020.145862*

Investigators: Aswathi B Nair, Navas M P and Geetha G Nair.

## Combined effect of electric and optical fields on photonic band gap in a blue phase liquid crystal composite

Blue phase liquid crystals are soft 3D photonic crystals in which the liquid crystalmolecules self-assemble to form a cubic structure with lattice spacing of a few hundred nanometers resulting in selective reflection of colours in the visible spectrum. The corresponding wavelength or the 'photonic band gap' can be tuned using various external stimuli such as thermal, electric, magnetic and optical fields. Efficient tuning of photonic band gap by utilizing the combination of electric and optical fields in a blue phase liquid crystalline system is demonstrated. The studies indicate that the chirality of the medium has a direct bearing on the direction of the wavelength shift, and the extent of the photonic band gap tunability. More importantly, the synergistic effect of the two fields helps in reversible tuning of the band gap. *See: Liquid Crystals, 47, 211-218, (2020)*

Investigators: N. Sharadhi, S. Vimala, K. Nurjahan, B. N. Veerabhadraswamy, C. V. Yelamaggad and Geetha G Nair.

## Effect of gelation on the frank elastic constants in a liquid crystalline mixture exhibiting a twist bend nematic phase

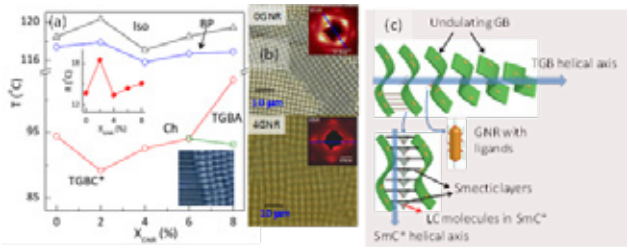
Investigations on the Frank elastic constant behaviour of a liquid crystal gel system exhibiting the twist bend nematic (Ntb) phase. Physical gelation eases the splay and stabilize the twist deformations in the nematic phase preceding the Ntb. More importantly, the ultra-low bend elastic constant (K33) of the system is enhanced by an order of magnitude on gelation. The magnitude of K33 remains high even in the vicinity of the Ntb phase, which otherwise, is susceptible to bend deformations. This phenomenon is explained from the point of view of polar interactions in the Ntb system. XRD, dynamic rheology along with the elastic constant data validate this argument. A salient feature is that, gel fibres grown in the direction orthogonal to the helical axis vanish in the Ntb phase confirmed from polarizing optical

microscopy. The growth of fibers renders a possibility to imprint directional microstructures with the gel network. *See: Soft Matter, 15, 9982-9990 (2019)*

Investigators: Vimala S.,M. B. Kanakala, C. V. Yelamaggad and Geetha G Nair

## Influence of GNR on the structure and photonic bandgap in a TGBC* blocks

The influence of gold nanorods (GNR) on the structure and photonic bandgap characters of the TGBC* phase-an analog of Abrikosov phase in type 2 superconductor- has been described, the first report of its kind. Inclusion of GNR into the host LC enhances the thermal range of the TGBC* phase (Fig a), significant variation in the pitch of the TGB helix, doubling in the spacing of the square grid pattern (Fig b) and changes the cholesteric-TGBC* transition from first to second order. A model is proposed wherein GNRs get confined in the grain boundary region (Fig c). Exploiting the anisotropic plasmonic feature of GNR, the observations




reported offer the possibility to realize periodic and anisotropic plasmonic structures, the periodicity as well as the anisotropy being tunable parameters through temperature, particle shape, and material characteristics. *See: Journal of Molecular Liquids, 299, 112117-1-10 (2020)*

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

Collaborators: P. Shinde, B.L.V Prasad, National Chemical Laboratory, Pune, India

## Suppression of the reentrant nematic and stabilization of the smectic phases by carbon nanotubes

The influence of a stiff large aspect ratio component (CNT) on the phase stability of the different mesophases, including the reentrant nematic (RN), has been investigated. The presence of the CNTs enhances the thermal range of the layered smectic phase (SmA) at the cost of the RN phase. Dielectric measurements indicate enhanced antiparallel correlation on introduction of CNT. The high aspect ratio of the nanotubes has a preference for layered phases. X-ray diffraction and the Frank elastic constant measurements corroborate these features. A Landau-de Gennes formalism is presented that explains the observed features. The magnetic field-changeable electrical conductivity of the medium is proposed as a possible conductivity switch. The studies open up a new dimension wherein nanostructures can be used to enrich phase diagrams of liquid crystalline materials and thus have potential to be employed to investigate multiple re-entrant sequences and frustrated systems. *See: Journal of Molecular Liquids, 286, 110858-1-13 (2019)*

Investigators: G.V. Varshini, D.S. Shankar Rao and S. Krishna Prasad

Collaborators: P.K.Mukherjee, Government College of Engineering & Textile Technology, Serampore

## Dielectric and electro optic studies in the vicinity of the transition between two tilted hexatic phases of a ZnO-liquid crystal nanocomposite

Dielectric and electro-optic measurements are carried out across the transition between two tilted hexatic phases of a commercially available ferroelectric liquid crystal and its composite with a small concentration of ZnO NPs. The relaxation frequency associated with the optic mode is seen to soften on approaching the transition, with the magnitude being higher for the nanocomposite. The thermal behavior of this parameter is analyzed in terms of the theoretical model by Selinger and Nelson *[J. Phys. II.1, 1363, (1991)]*. The tilt angle obtained from XRD and electro-optic methods exhibit different behaviors. Spontaneous polarization measurements bring out the first order character of the transition in both the materials and highlight the importance of the electrical measurement over the standard calorimetric studies. Addition of the NPs reduces the response time as well as the rotational viscosity, a feature of interest from application point of view. *See: Journal of Molecular Liquids, 302, 112508-1-8 (2020)*

Investigators: D.S. Shankar Rao, S. Krishna Prasad

Collaborators: K.L. Sandhya, N. Pushpavathi, Department of Physics, Ramaiah Institute of Technology, Bengaluru

## Saddle-splay induced periodic edge undulations in Smectic A discs immersed in a nematic medium

The study relates to the phase behavior of binary mixtures of CB7CB and HOAB, which exhibit nematic (N) and twist-bend nematic (NTB) phases, the induced smectic A phase for weight fraction of CB7CB between 0.05 and 0.70. In the appropriate two-phase region, above some electric field,

smectic A nuclei with positive dielectric anisotropy change over to homeotropic discs immersed in the nematic, their edges decorated by periodic bright spots. A simple theory is developed for the threshold of this distortion, which is a periodic undulation of the edge of the disc, demonstrating that it arises from the saddle-splay elasticity of smectic A. The observed increase in the number of bright spots with the field, and with the radius of the disc at a given field, are accounted for by the model. The study represents the direct visualization of saddle-splay instability in smectics for homeotropic anchoring. *See: Phys. Rev. E 101, 032704 (2020)*

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

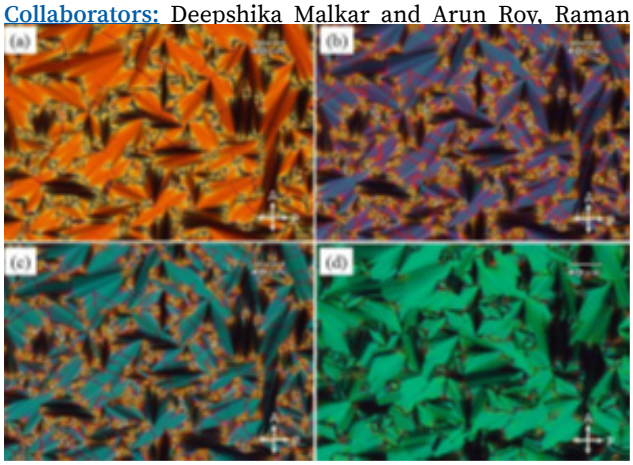
Collaborators: N. V. Madhusudana, Raman Research Institute, Bengaluru

## Pseudo-polar smectic C phases of azo substituted achiral bent-core hockey-stick shaped molecules

Experimental studies on an azo-substituted compound consisting of bent-core hockey-stick shaped compound (A14) have been performed. The results obtained establish two pseudo polar tilted smectic phases which are characterized by an in-plane axial polar order in their smectic layers. The electro-optical measurements in the mesophases indicate that the birefringence of the sample strongly depend on the applied electric field. A theoretical model was developed to account for the observed electro-optic effect of the sample. The change in the birefringence of the sample arises from the field-induced reorientation of the tilt planes of the molecules in the layer beyond a threshold field. The effect is analogous to the field induced Fredericksz transition which is quadratic in the applied electric field. *See: Phys. Rev. E 101, 012701 (2020).*

Investigators: Monika M and Veena Prasad

Collaborators: Deepshika Malkar and Arun Roy, Raman



Research Institute, Bengaluru.

## NiO powder synthesized through nickel metal complex degradation for water treatment

This study was aimed to synthesize nickel oxide (NiO) powder and its subsequent use in bactericidal activities by exploring the role of interaction at nanoparticle-bacteria interface of *E. coli* microorganism as well as water treatment by catalysing the two toxic azo dyes reduction reactions by sodium borohydride. The NiO nanoparticles were synthesized through single-step, residue free, in situ thermal decomposition method. Their size, structural and morphological features were confirmed through various analytical tools. An average size of 7–8 nm, high crystallinity and cubic crystal structure of the synthesized nanoparticles was confirmed by XRD and HR-TEM analyses. The NiO nanoparticles revealed virtuous bactericidal activities against pathogenic *E. coli.* Field emission scanning electron microscopy images were used as the evidence of the cell wall deterioration. The prepared NiO nanoparticles were also used in the catalytic reduction reactions of methyl orange (MO) and congo red (CR) dyes by sodium tetra-borohydrate. *See:Desalination and Water Treatment, 155, 216 (2019)*

Investigator: Veena Prasad

Collaborators: T. Kavitha and S. Kumar, Khalifa University of Science and Technology, Masdar Institute, UAE; A. M. Asiri and T. Kamal, King Abdulaziz University, Jeddah, Saudi Arabia and M. Ul-Islam, College of Engineering, Dhofar University, Salalah, Oman.

## Light-emitting chiral nematic dimers with anomalous odd-even effect

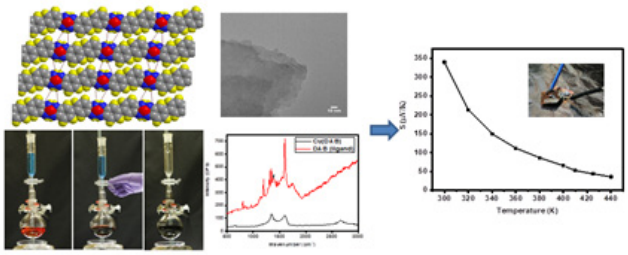
Thirty two new non-symmetric dimers belonging to two series have been prepared and their molecular structure, liquid crystallinity, photophysical and chiroptical propertieswerestudied. They are made by covalently joining cholesterol with a fluorescent (three-ring) calamitic mesogen, which is either a Schiff base or a salicylaldimine core, via an ω-oxyalkanoyloxy spacer. The influence on the thermal properties of both central spacer and terminal chain length are studied systematically. The results derived from several complementary techniques not only evidence the occurrence of BPs and/or the N* phase but also reveal an anomalous spacer-parity (odd-even) effect. That is, dimeric compounds with an even-numbered spacer exhibit blue phases (BPs), besides N* phase, and those with an odd-membered spacer display only N* phase. This reverse trend as compared to the literature reports has been interpreted in terms of geometrical (rod or bent) shapes of dimeric mesogens dictated by the orientations of the three

long terminal alkoxy chains rather than the parity of the relatively short spacers. UV-Vis and photoluminescence spectra of the dilute solutions, solids, N* and isotropic state have been recorded. DFT calculations revealthe possible structure of HOMO and LUMO orbitals, and also the theoretical value of band gap. The CD spectra measured in the N* phase suggested a right-handed twist of the helicoidal structure.*See: ChemPhysChem, 20, 2836-2851(2019)*

Investigators: B. N. Veerabhadraswamy, Sachin A. Bhat, U. S. Hiremath, C. V. Yelamaggad

## Gram-scale synthesis and multifunctional properties of a two-dimensional layered copper (II) coordination polymer

A low-cost, stable and n extremely simple gram-scale preparation of a two-dimensional copper (II) coordination polymer is explored, and its electrical conductivity, thermoelectric behaviour, redox activity and magnetism is studied. DC electrical conductivity measurements on the pellet as a function of temperature show a conductivity of 0.01 S/m at room temperature. With the aid of AC conductivity studies, the contribution of ionic species to the electrical conductivity has been ruled out unambiguously. Hall effect experiments confirm the p-type conduction of the material. It shows thermoelectric behaviour with high Seebeck coefficient value, besides redox activity. Temperature-dependent magnetic susceptibility measurements confirm the paramagnetic behaviour of the Cu(DAB) above 30 K. Thus, the COP reported herein can be regarded as a novel material that has the potential to serve as an active media in various technological applications. *See: ACS Appl. Polym. Mater, 2, 1543-1552 (2020)*



Investigators: Sachin A. Bhat, Nani Babu Palakurthy, Nagaiah Kambhala, Angappane S., D.S. Shankar Rao, S. Krishna Prasad and C.V. Yelamaggad

## Green and low-cost synthesis of zinc oxide nanoparticles and their application in transistor-based carbon monoxide sensing

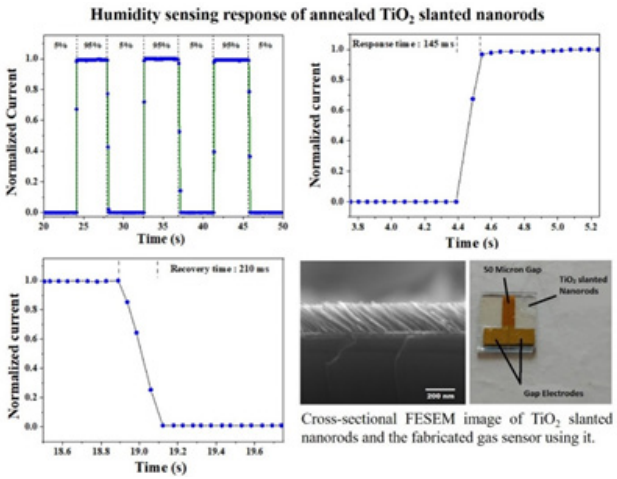
An OFET-based CO gas sensor has been fabricated using ZnO NPs synthesized by an inexpensive environmental-friendly method. An aqueous extract of Nelumbonucifera (lotus) leaves has been treated, for the first time, with $Zn(NO_3)_2$ to obtain ZnO NPs in almost pure form. One of the attractive features of this green approach is that the initiation temperature is much lower (~150°C) when compared to ones reported in the literature. The determination of chemical composition, purity, surface morphology, shape, size, photophysical properties etc., have been well accomplished with the aid of spectroscopic, microscopic and XRD studies. The electrical studies clearly revealed the selective sensing ability of CO gas with the sensitivity level reaching up to 25 ppm. This ismuch below the prescribed OSHA standards. The sensitivity of the device is 6% at VGS = −25 and VDS = −40 V and the corresponding drain current sensitivity is 106 nA ppm−1. The novelty of the fabricated device originates from the fact that it functions inambient conditions with excellent reversibility /reusability, and hence potential usage in real-time air-quality examination and medical diagnosis as an electronic (nano)nose. *See: RSC Adv., 10, 13532-13542 (2020)*

Investigators: Sachin A. Bhat and C. V. Yelamaggad

Collaborators: A.Narayana and Fathima, Rajiv Gandhi Institute of Technology, Bengaluru; S. V. Lokesh, Visvesvaraya Technological University, Chikkaballapur and S. G. Surya, Indian Institute of Technology Bombay, Mumbai

## Humidity sensing and breath analyzing applications of $TiO_2$ slanted nanorod arrays

$TiO_2$ slanted nanorods were grown by using electron beam assisted physical evaporation technique by keeping quartz substrates at a glancing angle of $80^0$. The sensing towards a wide humidity range was tested for fabricated $TiO_2$ devices of both as-deposited and annealed $TiO_2$ slanted nanorods with bottom gap electrode configuration in a homemade humidity sensing setup. Remarkably, the annealed $TiO_2$




Cross-sectional FESEM image of $TiO_2$ slanted nanorods and the fabricated gas sensor using it.

nanorod sensor is found to be having high sensitivity and fast response and recovery times of 145 and 210 ms, respectively, for 95% humidity. Finally, to check the practical applicability, the $TiO_2$ nanorod sensors were used to analyze the humidity level in exhaled human breath to determine the dehydration level. *See: Sensors and Actuators A 301, 111758 (2020)*

Investigators: Hiran Jyothilal, Gaurav Shukla, Sunil Walia, Suman Kundu and S. Angappane

## Self-cleaning structural colors by $TiO_2$/Ti nanostructures

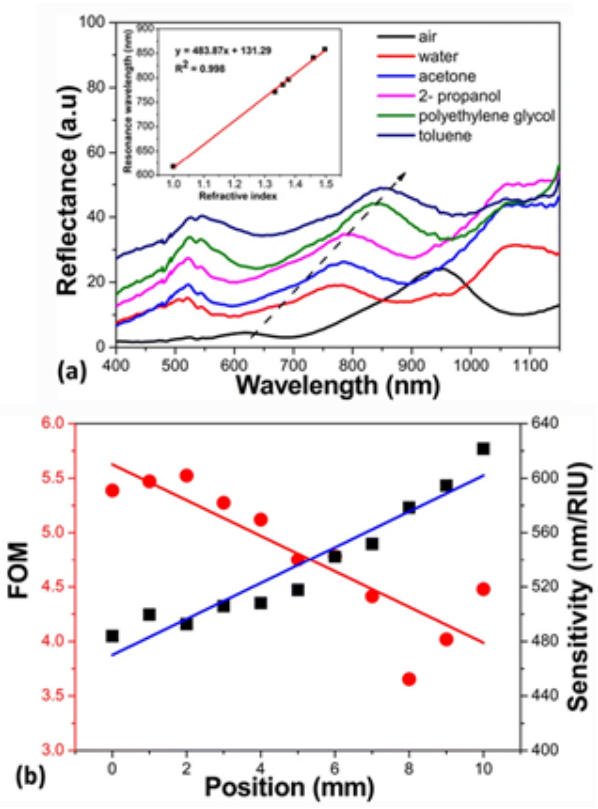
Self-cleaning structural colors generated by $TiO_2$ nanorods and thin films on Ti sputtered glass and flexible polyethylene terephthalate (PET) substrates are fabricated. Destructive interference is found to be the origin of the structural colors and hence the control in thickness of the $TiO_2$ layer can give rise to engrossing colors. Theoretical simulations confirm the experimental results and further it is suggested that Ni, Co and Al could be used in place of Ti for the same. All as-deposited $TiO_2$ nanorods are hydrophobic and $TiO_2$ thin films on Ti films are hydrophilic but both are transformed to a superhydrophilic state, a self-cleaning state, by UV irradiation. The initial state of the sample being hydrophobic or hydrophilic can be recovered when kept in dark. *See: Physica status solidi (b), 1900032 (2019). DOI: 10.1002/pssb.201900032*

Investigators: Gaurav Shukla, Chandan Kumar and S. Angappane.

## Tunable plasmonic resonances in hexagonally ordered gold nanostructure arrays with increasing interstice size

Patterned structures are fabricated by combining colloidal lithography with inclined reactive ion etching and inclined sputtering techniques. Optical spectroscopy measurements were performed at each position along the direction of increasing intervening voids which reveal the presence of localized surface plasmon resonance (LSPR), surface plasmon polaritons and hybridized modes. Such substrates are sensitive to change in the refractive index of the surrounding medium and can detect biologically important molecules and chemicals in the laboratory.

The glass substrate is decorated with gold nanostructure arrays and is embedded with intervening voids of increasing size along the length of it, which leads to tunability of the plasmonic resonances in the visible range.




The substrate has potential applications in chemical sensing and can help one to follow up the kinetics of a reaction as in enzyme-linked immunosorbent assay. These applications demand adjustable spectral range and resolution for high throughput screening to test efficiently under identical conditions at a time, avoiding the necessity of using multiple substrates. These resonances were found to shift towards longer wavelengths with the position. Different morphologies on the substrate lead to 50 nm spectral tunability across 10 mm length. For refractive index sensing application, an optimum peak arising due to LSPR in reflectance was selected. The highest sensitivity of 621.6 nm/RIU was obtained for the structure in which the interstice size is maximum. *See :Plasmonics, (2020). DOI: 10.1007/s11468-019-01108-3*

Investigators: Brindhu Malani S and P. Viswanath

## Studying haemoglobin and a bare metal–porphyrin complex immobilized on functionalized silicon surfaces using synchrotron x-ray reflectivity

Hemoglobin adsorption characteristics on silicon substrates with varying chemical functionalities are investigated using synchrotron X-ray reflectivity. Hemoglobin at isoelectronic point and at negative charge is immobilized on functionalized hydrophilic (hydroxyl, carboxylic, amine) and hydrophobic (alkylated) silicon surfaces for the study. As a control, the bare cofactor

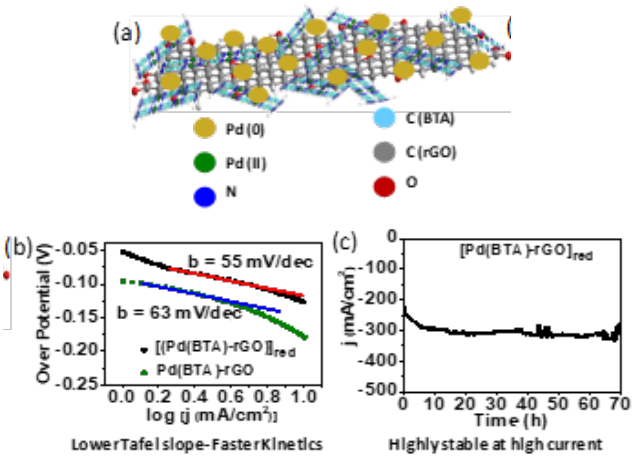
hemin (containing only the metal and porphyrin with no amino acid residues) is also studied under similar conditions. Ordered layers (grown using the Langmuir–Blodgett technique) are observed to be less affected by the surface chemistry compared to the multilayers formed by physical absorption. Surface chemistry and charge of the proteins are critical in controlling the protein adsorption characteristics on silicon, such as thickness (correlated to molecule size) and roughness. In this study, this is very well realized by varying both the hydrophobicity and hydrophilicity of the substrate. The fundamental studies provide with a set of important guidelines as to how electrode surface functionalization can control molecular conformation/orientation, especially protein adsorption on the substrate. This in turn is expected to have a significant impact on the protein electrochemical function and response of biomolecular devices. *See: J. Phys. Chem. B 2019, 123, 35, 7492-7503*

Investigators: Chandan Kumar and P. Viswanath

Collaborators: R. N. Samajdar, Aninda J Bhattacharyya, Solid State and Structural Chemistry Unit, Indian Institute of Science, Bengaluru

## A novel electrocatalyst based on coordination polymer-reduced graphene oxide composite for efficient and sustained electrochemical hydrogen evolution

The eventual specific use of an electrocatalyst for the hydrogen evolution reaction (HER) largely depends on its durability, ability to lower the over potential of an electrochemical reaction, and cost of synthesis. Facile preparation, characterization, and excellent HER activity of a robust and cost-effective electrocatalyst by partially reducing a composite of coordination polymer (COP) and reduced graphene oxide (rGO), resulting from the reaction of 1,2,4,5-benzenetetramine (BTA) ligand with palladium(II) chloride ($PdCl_2$) in the presence of rGO, labeled as [Pd(BTA)-rGO]red (Fig. a) has been achieved. The catalyst exhibits a remarkable overpotential of −127 mV at −10 mA/cm$^2$ current density featuring a Tafel slope of 55 mV/dec with high durability of 70 h at −300 mA/cm$^2$ (Fig. b,c). A combination of high activity due to Pd nanoparticles, less charge transfer resistance due to rGO, and stability due to encapsulation of Pd nanoparticles by 2D sheets of Pd(BTA) and rGO works in favor of the high efficiency and durability of the material. *See: ACS Appl. Energy Mater., 2, 8098-8106, (2019)*




Investigators: C. Alex, Sachin A. Bhat, Dr. C. V. Yelamaggad and Neena S. John

## Nickel cobalt phosphite nanorods decorated with carbon nanotubes as bifunctional oxygen electrocatalysts

It is highly desirable to develop an energy generation system comprising alow-cost and earth-abundant non-noble metal catalyst for bifunctional electrocatalysis with good overall process performance, especially for applications in fuel cells or metal-air batteries. It is shown that nickel cobalt phosphite (NiCo-Phi) decorated with carbon nanotubes (CNTs) can perform as a bifunctional electrocatalyst for the oxygen evolution (OER) and oxygen reduction reactions (ORR). The composite exhibits enhanced electrochemical OER activity with an overpotential of 400 mV at a current density of 10 mA/cm$^2$ and a Tafel slope value of 117 mV/dec in 1M KOH, possessing high stability towards the OER for 20 h. The ORR using the same catalyst shows an onset potential of 0.75 V and a Tafel slope of 100 mV/dec in 0.1 M KOH with high-yield production of $H_2O_2$ (85%). The predominant formation of $H_2O_2$ occurs mainly through a two-electron transfer process, as established by mass-controlled kinetic studies and has not been observed previously in these phosphorous oxy anion-based materials. *See :ChemElectroChem, 7, 1935–1942, (2020).*

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

## Synthesis of molybdenum chalcogenide films at a liquid/liquid interface under hydrothermal conditions

The utility of hydrothermal method applied to liquid/liquid interface for obtaining free-standing films of molybdenum chalcogenides is demonstrated. A general route for

obtaining films of $MoO_3$, $MoS_2$ and $MoSe_2$ at a water/toluene interface is illustrated employing a universal Mo precursor and the desired chalcogenide reactant in the two different phases. The hydrothermal conditions promote the formation of emulsions of water and toluene. A mechanism is proposed wherein the in-situ chalcogenation happens at the interfaces of tiny droplets of toluene in water and the nanosheets of the chalcogenide self-assemble at the regenerated interface during quenching to form films. The free-standing films are transferred on to various substrates for characterization. $MoO_3$ films consist of nanobelts while $MoS_2$ and $MoSe_2$ films consist of a dense assembly of nanosheets. The advantage of transferring the films on arbitrary substrates is exemplified for electrochemical applications. The method holds immense scope towards the synthesis of other diverse transition metal chalcogenide thin films. *See: Appl. Surf. Sci. 511, 145579, (2020).*

Investigators: Ramya Prabhu B., Kaushalendra K. Singh, C. Alex and Dr. Neena S. John

## Graphene and $MoS_2$ dispersions for lubricant applications in industrial oils

Tribological studies of the 2D nanoadditives such as $MoS_2$ and graphene are mostly performed in base oils such as SN500, SN150, or paraffin. The effect of the nano additives on the lubrication properties of industrial oils (e.g., axle, transmission, and compressor oils) employing a four-ball tester have been focused. Two types of graphene powders (GpowA with fewer defects than GpowC), $MoS_2$ powder, and their physical mixtures are chosen as nanoadditives. The tribology performance for 0.05 wt% of additives in various industrial oils is evaluated by monitoring the coeffcient of friction (COF) during rubbing and wear scar diameter (WSD) of the steel balls after rubbing. GpowA favors antifriction for axle and transmission oils with 40% reduction in axle oil, whereas it improved antiwear properties in most of the oils. GpowC shows a COF decrement by 12% only for compressor oil, but contribute to wear reduction in all oils. The observed COF reduction is attributed to the compatibility of nonfunctionalized GpowA with nonpolar axle oil and functionalized GpowC with polar compressor oil. The study indicates that a large sheet size of high-quality graphene aids antifriction and addition of surfactant molecules facilitates a cooperative effect between $MoS_2$ and graphene for improved tribology. *See: ACS Omega, 4, 14569−14578, (2019)*

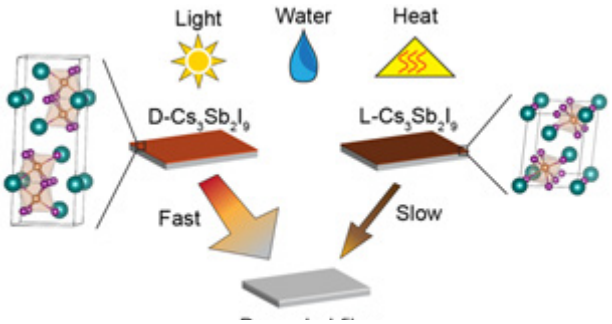
Investigators: Kaushalendra K. Singh, Ramya Prabhu B,andNeena S. John

Collaborators: Shyam Choudhary, Chandrani Pramanik, Tata Steel Limited, Graphene Centre, Jamshedpur

## Degradation studies of $Cs_3Sb_2I_9$: A Lead-Free Perovskite

Cesium antimony iodide ($Cs_3Sb_2I_9$), is a lead free material which has a high absorption coeffcient, 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 using X-ray diffraction and thermogravimetric analysis have 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., 3, 47−55,(2020)*

Investigators: 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

## Origin of luminescence-based detection of metal ions by Mn–doped ZnS quantum dots

Colorimetric/visual sensors based on plasmonic nanomaterials and quantum dots (QDs) for detection of heavy metal ions have been developed world wide. Attempts for specific detection of metal ions have been partially achieved through the interaction between the metal ion and the passivating ligands around the QD. Here, to understand the underlying mechanism of sensing, water-soluble Mn-doped ZnS QD was used which effectively detects $Hg^{2+}$, $Pb^{2+}$, and $Cd^{2+}$ through the quenching of QD emission. The metal ions bind to the QD through the passivating ligand. So, after excitation, the electron from

the conduction band of the QD can get injected to the metal ion –causing photoluminescence quenching. The electron injection depends on the reduction potential of the metal ion, the orbital overlap and the overall stabilization energy of the metal ions bound to the QD. Hence, this method of sensing is not selective to a specific metal ion. A solid-state sensor of QD-rGO composite detects $Pb^{2+}$ down to 0.4 ppb. *See: Chemistry Select, 4, 13551–13557 (2019)*

Investigators: Trupthi Devaiah Chonamada, Bhagwati Sharma, Abhishek Shibu, Kommula Bramhaiah, Nasani Rajendar, Neena S. John, and Pralay K. Santra

Collaborators: Jayashree Nagesh, Shyamashis Das, Solid State and Structural Chemistry Unit, Indian Institute of Science, Bengaluru

## Understanding the chemical nature of the buried nanostructures in low thermal conductive Sb-Doped SnTe by variable-energy photoelectron spectroscopy

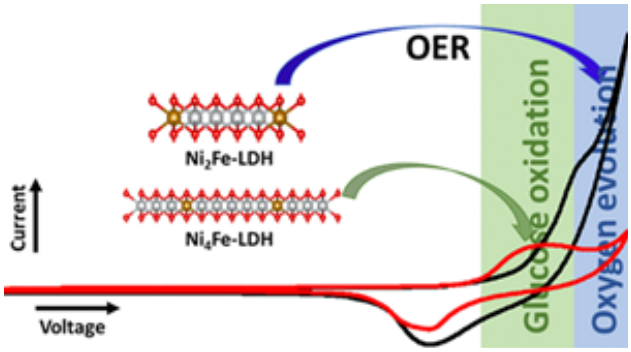
Nanoprecipitates embedded in a matrix of thermoelectric materials decrease the lattice thermal conductivity significantly by extensive heat carrying phonon scattering. Recently, two-dimensional layered intergrowth nanostructures of SnmSb2nTe3n+m embedded in SnTe matrix have provided record low lattice thermal conductivity in SnTe, but an understanding of the chemical nature of these layered nanostructures is still not clear. Herein, the chemical nature of the intergrowth nanostructures of a series Sb-doped SnTe by variable-energy X-ray photoelectron spectroscopy at synchrotron, which is well known to probe buried interfaces and embedded nanostructures has been studied. The primary oxidation states of Sb, Sn, and Te in these intergrowth structures are found to be in +3, +2, and −2, respectively, which is expected from the composition. However, both the Sn and Sb are found to be slightly oxidized in the surface. The intensity variation with photon energy shows a thin layer of $SnO_2$ (~4.5 nm) on the sample surfaces, and the thickness decreases with Sb doping. Te is also found in 0 oxidation states, which corroborates with the variation of Sn vacancies with Sb doping. The valence band features near the edge do not change significantly with Sb doping. This understanding of the chemical nature of low lattice thermal conductive Sb-doped SnTe will help further to design the thermoelectric materials with their surface phenomenon. *See: J. Phys. Chem. C, 123, 10272–10279 (2019)*

Investigators: Anamul Haque, and Pralay K. Santra

Collaborators: Rahul Mahavir Varma, Solid State and Structural Chemistry Unit, Indian Institute of Science, Bengaluru; Ananya Banik, Kanishka Biswas, Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), Jakkur, Begaluru; Indranil Sarkar, Deutsches Elektronen-Synchrotron DESY, Germany

## Role of transition metals in layered double hydroxides for differentiating the oxygen evolution and non-enzymatic glucose sensing

Layered double hydroxides (LDH) belong to the class of two-dimensional materials having a wide variety of applications ranging from energy storage to catalysis. Often, these materials when used for non enzymatic electrochemical glucose sensing tend to be interfering with oxygen evolution reaction (OER), resulting in over0estimation of the glucose. Herein, to address this, NiFe-based LDH were selected because of their ability to vary the metal ratios. The synthesized LDH have been characterized using various spectroscopic and microscopic techniques. Among the LDH synthesized, $Ni_4$FeLDH have been able to differentiate the glucose oxidation potential and the onset potential of OER with minimum interference. The $Ni_4$Fe-LDH sensor shows a sensitivity of 20.43 μA $mM^{-1}cm^{-2}$ in the linear range of 0–4 mM concentrations. To further enhance the sensitivity, composites of reduced graphene oxide (rGO) have been synthesized in situ, and the Ni4Fe/rGO5 composites have shown an increased sensitivity of 176.8 μA $mM^{-1}$ $cm^{-2}$ attributed to the charge-transfer interactions. To understand the experimental observations, detailed computational studies have been carried out to study the effect of the electronic structure on the metal ratios of the LDH and its role in differentiating glucose sensing and the oxygen evolution reaction. Along with this, theoretical calculations are also carried out on LDH–graphene composites to study the charge-transfer interactions. *See: ACS Appl. Mater. Interfaces., 2020, 12, 6193-6204*




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

Collaborators: Chi Ho Lee, Sang Uck Lee, Department of Bionano Technology, Hanyang University, Ansan 15588, Republic of Korea

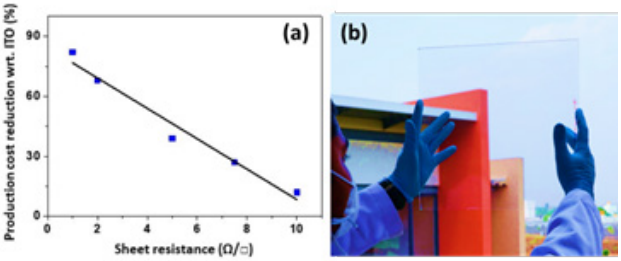
## Exfoliation in a low boiling point solvent and electrochemical applications of $MoO_3$

$MoO_3$ is a versatile two-dimensional transition metal oxide having applications in areas such as energy storage devices, electronic devices and catalysis. To efficiently utilize the properties of $MoO_3$ arising from its two-dimensional nature exfoliation is necessary. In this work, the exfoliation of $MoO_3$ is carried out in 2-butanone for the first time. The achieved concentration of the dispersion is about 0.57 $mg{\cdot}mL^{-1}$ with a yield of 5.7%, which are the highest values reported to date. These high values of concentration and yield can be attributed to a favourable matching of energies involved in exfoliation and stabilization of $MoO_3$ nanosheets in 2-butanone. Interestingly, the $MoO_3$ dispersion in 2-butanone retains its intrinsic nature even after exposure to sunlight for 24h. The composites of $MoO_3$ nanosheets were used as an electrode material for supercapacitors and showed a high specific capacitance of 201 $F{\cdot}g^{-1}$ in a three-electrode configuration at a scan rate of 50 $mV{\cdot}s^{-1}$. *See: Beilstein J. Nanotechnol. 2020, 11, 662–670*

Investigators: Matangi Sricharan, Bikesh Gupta, Sreejesh Moolayadukkam and H. S. S. Ramakrishna Matte

## Low-cost hybrid transparent conducting glasses

Industrially relevant conducting glasses come up with conducting coatings such as ITO with few hundred nm of thicknesses, where significant cost is attached to the slow deposition rates adopted for high-quality films. In this work, the issue has been circumvented by making hybrid transparent conducting electrodes (TCEs) consisting of metal mesh on a glass substrate with sputtered thin overlayers of metal oxides (<50-300 nm). The design is attractive as the hybrid electrode possesses excellent conductive property of the metal mesh (sheet resistance, ~5 ohms/square) while offering oxide surface finish for the conductive glass, which makes it relate well with the existing industry requirements based on ITO. Also, the problems such as non-uniform electric field prevalent in the wire network systems,and the surface roughness are addressed in these hybrid TCEs. *See: Materials Chemistry and Physics, 239, 121997 (2020)*




Investigators: Ashutosh K. Singh, R. K. Govind, S. Kiruthika, M. G. Sreenivsasn and G. U. Kulkarni

Collaborators: M.G. Sreenivasan, Hind High Vacuum Company Private Limited, Bengaluru; G. U. Kulkarni, JNCASR/CeNS, Bengaluru

## Photoanodes for photoelectrochemical water splitting

Solar driven photoelectrochemical (PEC) water splitting is a clean and sustainable approach to generate green fuel, Hydrogen. Hematite ($Fe_2O_3$) is considered as potential photoanode because of its abundance, chemical stability and suitable band gap, though its short carrier diffusion length puts a limit on the film thickness and subsequent light absorption capability. In this regard, a unique photoanode by depositing ultrathin films of $Fe_2O_3$ on purpose-built three-dimensional (3D) nickel nanocone arrays has been designed and constructed. In this design, 3D nanostructures not only provide ameliorated surface area for PEC reactions but also enhance light absorption capability in ultrathin $Fe_2O_3$ films, while ultrathin films promote charge carrier separation and effective transfer to the electrolyte. The 3D electrodes exhibit a substantial improvement in light absorption capability within the entire visible region of solar spectrum, as well as enhanced photocurrent density as compared to the planar $Fe_2O_3$ photoelectrode. Detailed investigation of reaction kinetics suggests an optimum $Fe_2O_3$ film thickness on 3D nanocone arrays obtained after 6 deposition cycles in achieving maximum charge carrier separation and transfer efficiencies (82 % and 88 %, respectively), mainly ascribable to the increased charge carrier lifetime overcoming recombination losses. *See: ChemCatChem, 239, 121997 (2019)*

Investigators: Ashutosh K. Singh

Collaborators: D. Sarkar, Department of Physics, Malaviya National Institute of Technology Jaipur, Rajasthan

# 6. PUBLICATIONS

The total number of publications in

Refereed Journals: 62

Conference Proceedings: 1

Chapters in Books: 3

**Average Impact Factor: 4.16**

| Journal | Publications |
|---|---|
| ACS Appl. Elec. Mater | 5 |
| ACS Appl. Mater. Interfaces | 1 |
| ACS Appl. Polym. Mater | 1 |
| ACS Omega | 1 |
| Adv. Opt. Mater. | 2 |
| Appl. Surf. Sci., | 2 |
| Bioresource Technology | 2 |
| Bull. Mater. Sci | 2 |
| Carbon | 1 |
| Ceramics International | 2 |
| Chem. Asian J. | 1 |
| Chem. Photo. Chem. | 1 |
| ChemCatChem | 1 |
| ChemElectroChem | 1 |
| Chemistry Select | 3 |
| ChemPhotoChem | 2 |
| Crystals | 1 |
| Desalination and Water Treatment | 1 |
| Fuel | 1 |
| J. Nanotechnol | 1 |
| J. Phys. Chem. B | 1 |
| J. Phys. Chem. C | 1 |
| Journal of Molecular Liquids | 7 |
| Langmuir | 2 |
| Liquid Crystals | 6 |
| Mater. Chem. Phys | 2 |
| Nano Energy | 1 |
| Nanoscale Adv. | 1 |
| Phys. Chem. Chem. Phys | 2 |
| Phys. Rev. E | 2 |
| Physica status solidi (b) | 1 |
| Plasmonics | 1 |
| RSC Adv. | 1 |
| Sensors and Actuators | 1 |
| Soft Matter | 1 |

Details shown in Annexure A

# 7. PATENTS

Total number: 11

| Title | Inventors | Patent Application No. |
|---|---|---|
| A process for producing graphene, a graphene and a substrate thereof | Choudhary Shyam Kumar; Das Sumitesh; Kulkarni Giridhar; Udapi Rao; Pujar Rajashekhar Ningappa | US Patent granted on 10.09.2019 No: 16466903 China Patent granted Appln. 201780084759.4 on 21.11.2019 |
| Method of preparation of reduced graphene oxide | Choudhary Shyam Kumar; Das Sumitesh; Gedda Murali; Kulkarni Giridhar; Udapi Rao; Pujar Rajashekhar Ningappa; Sen Anand | 201831019387 Filed 23.05.2018 |
| A visibility controlling device | G. U. Kulkarni, Ashutosh K. Singh and Rahul M. | PCT/IB2019/057762 Filed on 16.09.2019 |
| A process for producing graphene based transparent conductive electrode and the product thereof | S. K. Choudhary, S. Das, G. U. Kulkarni and R. N. Pujar | Israelian Patent Application no: 271451 Filed |
| A polymer doped liquid crystal composition and method thereof | S.Krishna Prasad, Srividhya Parthasarathi, Pragnya Satapathy and D.S Shankar Rao | No:202041000263 Filed on 03/01/2020 |
| Chiral plasmonic liquid crystalline gold nanoparticles and method thereof | C.V. Yelamaggad, D S Shankar Rao, S. Krishna Prasad, G. G Nair, Sachin Ashok Bhat | No: 201841001456 Patent granted 20/01/2020 Patent No: 329687 |
| Cholesteric liquid crystals and device thereof | Veena Prasad, Nagaveni N.G., Gurumurthy Hegde and Rekha S. Hegde | No: 201941036986 Filed on 13/09/2019 |
| Method for rapid synthesis of porous and metallic $MoO_2$ nanostructures | Vivek Ramakrishnan, Neena S. John | No: 201841038753 Filed on12/10/2018 |
| A method of exfoliation of layered material and method thereof | H.S.S.R.Matte, Kenneth Lobo, Shivam Trivedi | No: 201841014328; Filing date:16/04/2018 Patent granted on 20/04/2020 with Patent number 335655 |
| A method of exfoliation of layered material and product thereof | H.S.S.R.Matte, Kenneth Lobo, Shivam Trivedi | PCT Application filed on 12.04.2019; No. PCT/ IB2019/053044 |
| Compounds exhibiting chiral nematic phase | C.V. Yelamaggad, G. Shanker | No. 201741034439 Patent granted on 30/08/2020 Patent No. 345638 |

# 8. ENTREPRENEURSHIP ACTIVITIES

CeNS participated in the prestigious 5th International India Science Festival (IISF-2019) held at Kolkata during 5-8 Nov 2019. At the "Mega Science, Technology and Industrial Expo," the Centre put up a stall and exhibited three prototypes, namely, Luminescence - based light Sensor, Invisible EMI shield and Hydrogen generator, all developed by CeNS researchers based on their lab-level findings. The team also put up posters that highlighted the outcome of the latest research findings as well as the Centre's outreach activities.

CeNS along with its industry partner, HHV participated in the 2nd edition of IESA Spacetronics and Deftronics -2019, hosted by the premier industry body, India Electronics and Semiconductor Association (IESA), in collaboration with ISRO, held during Sept 19-20, 2019 in Bengaluru. The products "Hybrid Transparent Conducting electrodes based on (ITO/Al-mesh) and Al-Mesh", "Transparent Heaters" and "Transparent EMI shielding", developed through the collaborative efforts between CeNS and HHV were exhibited in the exposition.

CeNS jointly with Tata Steel Ltd., the industry partner, exhibited the prototypes developed by CeNS researchers during an expo, "Tata Steel Collaboratory 2019" as part of the Tata Steel Annual Business Plan meeting held in Kolkata on 18 May 2019. Three prototypes – Smart Window, EMI Shielding and the Photo-Detector were demonstrated.

CeNS actively participated in the 11th Edition of BENGALURU INDIA NANO held during 2-3, March 2020 in Bengaluru by exhibiting the prototype devices based on various technologies developed in-house as well posters based on important research findings. CeNS bagged the "Best Exhibitor Award for the Year 2020" in the category of Interactive and Best Managed Stall. In the months leading to the event, CeNS was involved in a unique series of outreach programme, "Nano Jhatha", organized by Karnataka Science and Technology Promotion Society (KSTePS), across various parts of the country to educate the school and college students about Nanoscience and Nanotechnology.

CeNS at Tata Steel Collaboratory 2019

**Prototype Gallery**

The gallery that houses demonstrable prototypes developed by CeNS researchers attracts visitors from industry and academic institutes on a regular basis. The following prototypes were added to the gallery during the year.

wireless operated window (5 ft x 4.5 ft)
installed in Green house, CeNS

- A Translucent - Transparent switching microfluidic glass
- ITO-free electrodes for PDLC smart windows
- Tribo-E Face Masks
- Hand sanitizer
- Low-cost face shield

**TechBuddy**

The R&D Programme 'From in-house Inventions to Prototype Development (FIPD)" launched in April 2018 to hire 'TechBuddies' (candidates with engineering/science background) to assist researchers to translate the innovative lab-level research findings to commercially viable products saw one TechBuddy being trained during this period.

# 9. TEACHING

| Code | Title of the course | Credit |
|---|---|---|
| CeNS-IA | Instrumental Methods &Analysis | 1:1 |
| CeNS-SC | Scientific Communication | 1:0 |
| CeNS-IP | Intellectual Property | 1:0 |
| CeNS-SW | Safety & Waste management | 1:1 |
| CeNS-NS | Basics of Nano and Soft Matter | 2:1 |
| CeNS-ED | Energy Materials and Devices | 2:1 |

# 10. EXTRAMURAL RESEARCH PROJECTS

## COMPLETED

| Sl No | Title of the project | Sponsoring/ collaborative agency | Duration From … To… | Budget sanctioned (Rs. in lakhs) |
|---|---|---|---|---|
| 1 | Transparent conducting glasses made of metal nanomesh coated with metal oxide overlayer and scaling their production to $m^2$ area SR/NM/NT-03/2016(G) dt. 23.08.2017 & SR/NM/NT-03/2016(C)dt. 23.08.2017 | DST Nano Mission | 2017 – 2019 | 850.00 |
| 2 | Nanostructured hybrid transparent network electrodes for large area visibly transparent solar cells (METNETWORK) Sanction Order No. IGSTC/Call 2015/METNETWORK/07/2017-18/78 dt. 31.08.2016 | Indo-German Science Forum | 2016 -2019 | 185.80 |

## ONGOING

| Sl No | Title of the project | Duration From … To… | Budget sanctioned (Rs. in lakhs) |
|---|---|---|---|
| 1 | DST-Nano Mission Thematic projects in frontiers of nano S&T (TPF-Nano) “Chemical Physics of Functional Nanostructures and Interfaces” Sanction Order: No.SR/NM/TP-25/2016 dt. 09.11.2016 | 2016 - 2019 | 1115.00 |
| 2 | 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 |
| 3 | DST-SERB Project “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 | 2017-2020 | 47.70 |
| 4 | Tata Steel Advanced Materials Research Centre (TSAMRC) | 2016-2021 | 872.00 |
| 5 | DST-SERB Project “Magnetic nanoparticles for memory applications” Sanction Order No. EMR/2016/005081dt. 24.07.2017 | 2017 – 2020 | 23.44 |
| 6 | 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 |

| Sl No | Title of the project | Duration From … To… | Budget sanctioned (Rs. in lakhs) |
|---|---|---|---|
| 7 | DST WOS-A project "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 | 2017 – 2020 | 22.8 |
| 8 | DST-SERB Project on "Investigations of optical, electro-optical, and mechanical properties of liquid crystal based soft photonic composites", Sanction Order No. CRG/2018/000736dt. 08.05.2019 | 2019-2022 | 42.5 |
| 9 | DST Nano Mission Project "Technology Business Incubator" Sanction Order No. SR/NM/TBI-01/2017(G) dt. 10.07.2019 | 2019-2022 | 518.56 |
| 10 | 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 |
| 11 | 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 |
| 12 | 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 |
| 13 | DST-Nano Mission project on "Aesthetically accepatable, breath friendly triboelectric face masks: Design, fabrication, testing & technology transalation" Sanction order No. DST/NM/COVID-159/2020 (G) dt. 15 July 2020 | 2020-2021 | 7.014 |

# 11. NEW RESEARCH FACILITIES

## New Facilities

A one-stop solution for complete characterization of nano and soft materials and device fabrication known as "Central Research Facilities (CRF)" was created to cater to the needs of researchers from CeNS as well as those from other academia and industry. The request to carry out measurements leading to data transfer is wholly made on-line. Several new equipments were added to CRF that include Electrochemistry work station, Micro-GC and Xe lamp for electro photo-electrocatalytic studies, Spray Pyrolysis system, Non-contact mode sheet Resistance meter, Surface area, Ball Milling & Zeta Potential, Atomic Layer Deposition Unit, and IQE/EQE measurement unit.


Electrochemical Workstation, Materials Laboratory, Arkavathi

## New Laboratories

TEM Lab, Energy Lab, Fabrication lab, Gas sensors lab, Microscopy Lab, Battery fabrication lab were created under Materials Laboratory at Arkavathi. A Technology Laboratory unit was also launched which houses the CeNS-HHV joint project.

# 12. OUTREACH PROGRAMME

## 12.1 V4: विज्ञानि-विद्यार्थि विचार विनिमय

To stimulate and nurture scientific curiosity in young minds, CeNS initiated a science outreach programme aimed at high school, pre-university, and university level students in 2015. Under this programme, in the last academic year, Centre reached out to nearly 5536 students who participated in innovative science learning activities, which included lab tours, scientific talks, and experimental demonstrations on its campus. Apart from this CeNS faculty visited various academic institutes/schools/colleges and conducted workshops, and delivered lectures for the student community. Since its inception, more than 16500 students from over 184 schools/colleges have benefitted from this programme.

High school students at V4 demonstration

*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. The goal of the programme is to identify brilliant students having the potential to pursue research as a career. During the year 2019-20, thirty three students successfully completed various projects in research areas of Nano and Soft Matter Sciences.

The list is given in Annexure C.

# 13. Ph.D. & TECHNICAL TRAINING

| Sl. No. | Name of the Student | Ph.D | Date |
|---|---|---|---|
| 1. | Ms. S. Vimala | Awarded | 02.03.2019 |
| 2. | Mr. Arup Sarkar | Awarded | 04.04.2019 |
| 3. | Mr. Veerabhadraswamy B. N. | Awarded | 17.07.2019 |
| 4. | Mr. Chandan Kumar | Awarded | 30.08.2019 |
| 5. | Ms. Monika M. | Awarded | 21.10.2019 |
| 6. | Ms. K. Priya Madhuri | Awarded | 20.11.2019 |
| 7. | Mr. Sunil Walia | Submitted | 20.01.2020 |

Number of Ph.D. produced

Awarded: 6

Submitted: 1

# 13. Ph.D. & TECHNICAL TRAINING

| Senior Research Fellows | |
|---|---|
| Mr. Sachin Ashok Bhat | Ms. Pragnya Satapathy |
| Mr. Madhu Babu Kanakala | Ms. Varshini G.V. |
| Ms. Ramya Prabhu B | Ms. Rekha S. Hegde |
| Mr. Indrajit Mondal | Mr. Rajashekhar N. Pujar |
| Ms. Brindhu Malani S | Mr. Kenneth Lobo |
| Mr. Suman Kundu | 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. Marlin Baral | Mr. Sunil Walia |

| Junior Research Fellows | |
|---|---|
| Mr. Amit Kumar Patel | Ms. Swathi S.P. |
| Ms. Gayathri R. Pisharody | Ms. Savithri Vishwanathan |
| Ms. Nurjahan Khatun | Mr. Modasser Hossain |
| Mr. Ramesh Chandra Sahoo | Ms. Radha Jitendra Rathod |
| Mr. Priyabrata Sahoo | Mr. Bhupesh Yadav |
| Mr. Muhammed Safeer N.K. | |

| Research Associates | |
|---|---|
| Dr. Vivek Ramakrishnan | Dr. Remya K. Govind |
| Dr. Jitendra Kumar | Dr. P. Chithaiah |
| Dr. Sreejesh M. | Dr. Vaishali Sharma M. |
| Dr. Navas M.P. | Dr. Govind Pathak |
| Dr. C. Sathiskumar | Dr. S. Vimala |
| Dr. Rithesh Raj D(N-PDF) | Dr. Bharath S.P. |
| Dr. Manjunath K | Dr. Lubna Sheikh |
| Mr. Yathisha R.O. (Prov) | Dr. Monika M. |

| R&D / Technical / Project Assistants | |
|---|---|
| Mr. Rahul M. | Mr. Hiran Jyothilal |
| Mr. Madhanmohanraju S | Mr. Shivam Trivedi |
| Mr. Veerabhadraswamy B.N. | Ms. Krithi M G |
| Ms. Sharadhi N Raj | Ms. Keerthan Acharya |
| Ms. Sruthi Y | Mr. Ravi Kumar C R |
| Ms. Lavanya B | Mr. Kaushik Baishya |
| Mr. Bikesh Gupta | Ms. ReetuKellur |
| Mr. BramhaiahKommula | Mr. Mukhesh K.G. |
| Mr. Sanjit Kumar Parida | Ms. Chaitali Sow |
| Mr. Bharath B. | Ms. Jil Rose Perutil |
| Mr. Ankush Kumar | Ms. Meenakshi M. Varier |
| Ms. Tejaswini S Rao | Ms. Deeksha G |
| Ms. Akshatha M.R. | Ms. Chalana G.H. |
| Mr. Siddi Nagendra | |

| Techbuddy |
|---|
| Ms. Sabitha Ann Jose |

## Visiting Faculty / Students

| Name | Visiting Faculty / Students | Address | Period |
|---|---|---|---|
| Dr. A. Pradeep | Visiting Faculty | Asst. Professor, PG & Research Dept. of Physics, Arignar Anna Government Arts College, Villupuram, Tamilnadu | 17.05.2019 to 16.06.2019 |
| Ms. Sahana Naik | Visiting Students | NITK, Surathkal | 06.05.2019 to 05.07.2019 |
| Mr. Sankalp Choudhuri | | IISER, Pune | 08.05.2019 to 25.07.2019 |
| Mr. Rajapandy | | Bharathidaran University, Palkalaiperur, Tiruchirappalli (School of Physics) | 08.05.2019 to 05.07.2019 |
| Ms. Anusha Dsouza | | Manipal Institute of Technlogy, Manipal | 13.05.2019 to 12.07.2019 |
| Ms. Mouli Roy Chowdhury | | School of Physical Sciences, Jawaharlal Nehru University, New Delhi | 22.05.2019 to 22.07.2019 |
| Ms. Nithyashree | | IISER, Bhopal | 27.05.2019 to 21.07.2019 |
| Mr. Trilok Kumar Gaur | | Kota University | 18.7.2019 to 17.09.2019 |

# 14. EVENTS at CeNS

On the occasion of International Yoga Day, Ms. Asha Ravikiran, Asha Yoga Centre, Bengaluru, gavealecture demonstration on yoga on 21 June 2019 at CeNS.

The Independence Day was celebrated with national flag hoisting on 15 August 2019 at both the campuses.


Inauguration of Materials and Technology Laboratory Facilities: The state-of-the-art 'Materials Laboratory' was inaugurated by Bharat Ratna Prof. C.N.R. Rao, FRS on 17 August 2019 at the pristine campus 'Arkavathi' located at Shivanapura, Bengaluru North, Prof. Ashutosh Sharma, Secretary to Government of India, Department of Science and Technology (DST) inaugurated 'Technology Laboratory' on the same day, in the esteemed presence of Prov. V.Ramgopal Rao, Director, IIT-Delhi and the Chairman of the Governing Council of CeNS. Several luminaries in the arena of Science and Technology from premier institutes like IISc, JNCASR, IACS, IIT-Delhi, IIT-Bombay etc. participated in the event. The Director, Prof. G.U.Kulkarni welcomed the gathering and took the dignitaries around for a guided tour of the laboratories.

Fresher's Day to welcome new Ph.D. students was held on 30 August 2019.

CeNS celebrated Hindi Pakhwada from 16 to 30 September 2019 by organizing competitions on Hindi translation, typing, debate, essays, sentence construction competition etc.

The birth anniversary of Sardar Vallabhbhai Patel was commemorated by celebrating Rashtriya Ekta Diwas (National Unity Day) on 31 October 2019. The CeNS community took the National Unity Pledge on the day.

CeNS observed the Vigilance Awareness Week during 28 October to 2 November 2019. The Faculty and the administrative staff took pledge on vigilance.

On the occasion of Kannada Rajyotsava, a more inclusive programme titled "Rashtrotsava" was celebrated on 11 January 2020. Multilingualevents consisting of songs rendition, essay competition, quiz and several other cultural programmes were presented by CeNS community.

Organized a visit to research facility at Arkavathi campus to the visiting faculty (under faculty development program) from Acharya Institute of Technology, Bengaluru on February 5, 2020

The National Science Day was celebrated on February 28, 2020. This Nation-wide event commemorating the announcement by Sir C V Raman of the scientific effect that now bears his name, had the theme of "Women in Science" suggested by DST. The show put up at CeNS, took special care to see that the event lives upto the theme. To impress upon the young minds that with right determination and proper effort women can overcome challenges and come up in science, the Centre invited girl students from BEL high school (CBSE stream). The speaker, Prof. Ranjini Bandyopadhyay, an acclaimed scientist from the Raman Research Institute, Bengaluru gave a brilliant lecture on "How Materials Flow" while

constantly encouraging the students to interact. This was followed by two videos, one on Women Scientists who have made remarkable achievements in their field and are worth emulating, and another on the life and works of Sir C.V. Raman, and completed by a live tabletop demonstration of the Raman effect. The visiting students were led through demonstration of the science experiments at our Learn it Through Experiments (LiTE) Gallery and conducted by our enthusiastic PhD students.

CeNS observed International Women's Day on 12 March 2020. On this occasion, Ms. Saranya S. Hegde, President, 'MahilaDakshata Samiti,' Vidyaranyapura, Bengaluru, gave a talk covering various issues being faced by women. In a lucid and straightforward manner, she brought out some of the day-to-day challenges, with examples faced by women, and gave useful tips to overcome them. Mrs. Indira Kulkarni was the Guest of Honour. The entire CeNS community and the support staff attended the gathering.

# 15. HONOURS & AWARDS

### 15.1. AWARDS

- MRSI-Distinguished Lectureship Award (2019-20) to Prof. G. U.Kulkarni
- SASTRA-CNR Rao Award for Excellence in Chemistry & Materials Sciences (2019 - 20) to Prof. G. U. Kulkarni
- Dr Raja Ramanna State Award 2019 from Karnataka State Council for Science and Technology (KSCTC) to Prof. G. U.Kulkarni
- 'Outstanding woman in Science' award for achievement in the field of materials chemistry by Venus International Centre Foundation, Chennai, 2020, to Dr. Neena S. John.

### 15.2. HONOURS

- Dr. C. V. Yelamaggad was elected as an Executive Member of the Royal Society of Chemistry (RSC) - London, India (Deccan Local Section) on 1st February 2020.
- Dr. Geetha G Nair was invited to be a Member, Board of Studies in Masters in Materials Science, Mysore University
- Dr. Geetha G Nair was elected as a Treasurer, Indian Liquid Crystal Society, Bengaluru, India.
- Dr.Pralay K Santra was invited to be Member of Inaugural Early Career Advisory Board of ChemNanoMat, 2019, Dr.PralaySantra

### 15.3. AWARDS TO STUDENTS

- Gayathri R Pisharody, JRF, Course Excellence Award in appreciation of performance in the course "Nano science and device fabrication credited during the term January-April 2019. Award falls under the Reward programme 2018-2019 at CeNS
- Nurjahan Khatun, JRF, Course Excellence Award in appreciation of performance in the course *"Nano science and device fabrication (IN224)."* Credits: 3+0, January-April 2019. Award falls under the Reward programme 2018-2019 at CeNS
- Chaitali Sow, *Ar+ ion induced generation of a series of BCT phases during phase transformation of noncubic au microcrystallites to cubic lattice,* Best Poster Award at the 10th International Conference on Materials for Advanced Technologies (ICMAT), Singapore, Marina Bay Sands, Singapore, 23-28 June 2019
- Chaitali Sow, *Diffraction imaging of a non-cubic Au microcrystallite,* Best Poster Award at the 15th JNC Research Conference on Chemistry of Materials, Trivandrum, 30 September-2 October 2019
- Ramya Prabhu B. secured 2nd place in oral presentation for research paper titled *'Sea urchin-$MoO_3$ nanostructures as an efficient substrate for SERS detection of dyes'* at the International Conference on Recent Advances in Applied Sciences (ICRAAS-2019) held on 17-18, October 2019 at REVA University, Bengaluru, India.

- Pragnya Satapathy, *Synergistic path for dual anisotropic and electrically switchable emission from a nanocomposite of $CsPbBr_3$ quantum cuboids and nematic liquid crystal,* Best poster award , 26th National conference on Liquid Crystals, October 21-23, 2019, Chitkara University Patiala, Punjab.
- Chaitali Sow, *Diffraction imaging of a non-cubic Au microcrystallite,* Poster teaser award at the JNCASR In-House Symposium, 2019, JNCASR, Bengaluru, 13-14 November 2019
- Muhammed Safeer N.K., *High performance electrochemical NRR by $MoO_2$ catalysts,* Best Poster Award at Emerging frontiers in Chemical Sciences held at Farook College, Kozhikode, Kerala on 13-15 December 2019.
- Suman Kundu, *Planar supercapacitor made of aligned supramolecular nanofibre electrolyte exhibiting 8 V potential window,* Best Poster Award at the IGSTC workshop on 'Energy, Materials and Devices, Bengaluru, 16 December 2019
- Alex C, *Effect of phosphorous oxy anionic ligands on OER activity in bivalent cobalt systems,* Best poster award at one day workshop 'Energy, Materials and Devices' organized at CeNS, Bengaluru on 16 December 2019.
- Muhammed Safeer N.K., *High performance electrochemical nitrogen reduction by molybdenum dioxide catalysts,* Best poster award at one day workshop 'Energy, Materials and Devices' organized at CeNS, Bengaluru on 16 December 2019.
- Indrajit Mondal, *$SnO_2$ coated large area Aluminum micromesh as low-cost transparent conducting electrode for liquid crystal-based smart window,* Best Poster Presentation Award at the 11th Bengaluru India Nano, The Lalit Ashok, Bengaluru, 2-4 March 2020
- Ramesh Chandra Sahoo, *Poster Award, Role of transition metals in layered double hydroxides for differentiating the oxygen evolution and non-enzymatic glucose sensing,* 11 Bengaluru India Nano, 2-4 March 2020
- Chaitali Sow, *Diffraction imaging of a non-cubic Au microcrystallite,* Best Poster Award at the International Conference on Nano Science and Technology (ICONSAT), 2020, Biswa Bangla Convention Centre, New Town, Kolkata, 5-7 March 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, several programmes were conducted during 16-30 September 2019. The programme consisted of Hindi translation, Hindi Typing, Debating Competition, Hindi Short Articles (for non-Hindi speaking people), Sentence construction and lecture etc. have been organized. The prizes for the competitions organized, were distributed. Also to popularize usage of Hindi at CeNS, a scientific word is displayed everyday on the Notice Board under "आज का शब्द".

# 18. AUDITED STATEMENT OF ACCOUNTS

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

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

## INDEPENDENT AUDITORS' REPORT

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

### Opinion

We have audited the attached Balance Sheet of **"Centre for Nano and Soft Matter Sciences"** Prof. U R Rao Road, Jalahalli, Bangalore-560013, which comprises the Balance Sheet as at March 31, 2020, 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, 2020
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 judgements 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: 20018067AAAAGL7930

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

Place: Bangalore
Date: September 16, 2020

**CENTRE FOR NANO AND SOFT MATTER SCIENCES**
**JALAHALLI, BENGALURU - 560 013**

## BALANCE SHEET AS AT 31ST MARCH, 2020

(Amount in Rs.)

| I. CORPUS / CAPITAL FUND AND LIABILITIES | SCH | 31.03.2020 | 31.03.2019 |
|---|---|---|---|
| CORPUS / CAPITAL FUND | 1 | 26,58,16,841 | 25,25,59,623 |
| RESERVES AND SURPLUS | 2 | - | - |
| EARMARKED PROJECTS FUNDS | 3 | 16,92,10,145 | 15,56,87,203 |
| SECURED LOANS AND BORROWINGS | 4 | - | - |
| UNSECURED LOANS AND BORROWINGS | 5 | - | - |
| DEFERRED CREDIT LIABILITIES | 6 | - | - |
| CURRENT LIABILITIES AND PROVISIONS | 7 | 3,74,27,037 | 2,25,97,863 |
| **TOTAL** | | **47,24,54,023** | **43,08,44,689** |
| **II. APPLICATION OF FUNDS/ASSETS** | | | |
| FIXED ASSETS | 8 | 29,06,91,892 | 28,79,45,401 |
| INVESTMENTS - FROM EARMARKED/ENDOWMENT FUNDS | 9 | - | - |
| INVESTMENTS - OTHERS | 10 | - | - |
| CURRENT ASSETS, LOANS, ADVANCES ETC., | 11 | 18,17,62,131 | 14,28,99,288 |
| **TOTAL** | | **47,24,54,023** | **43,08,44,689** |
| **SIGNIFICANT ACCOUNTING POLICIES AND NOTES ON ACCOUNTS** | 24 | | |

(SUBHOD M GULVADY)
ADMINISTRATION & FINANCE OFFICER

(PROF. G.U. KULKARNI)
DIRECTOR(I/C)

PLACE : BENGALURU
DATE : 16.09.2020

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-560 010

**CENTRE FOR NANO AND SOFT MATTER SCIENCES**
**JALAHALLI, BENGALURU - 560 013**

**INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31ST MARCH, 2020**

(Amount in Rs.)

| A - INCOME | SCH | 31.03.2020 | 31.03.2019 |
|---|---|---|---|
| Income from Sales / Services | 12 | - | - |
| Grants / Subsidies: | 13 | 11,60,22,000 | 8,26,42,000 |
| Fees / Subscriptions | 14 | - | - |
| Income from Investments(income on investments from earmarked / endowment Funds) | 15 | - | - |
| Income from Royalty, Publications etc., | 16 | - | - |
| Interest earned / accrued | 17 | 45,95,529 | 40,41,175 |
| Other Income | 18 | 36,51,662 | 52,43,581 |
| Increase / (decrease) in stock of finished goods and work-in-progress | 19 | - | - |
| **TOTAL (A)** | | **12,42,69,191** | **9,19,26,756** |
| **B - EXPENDITURE** | | | |
| Establishment Expenses | 20 | 6,58,01,788 | 5,73,19,818 |
| Other Administrative Expenses etc., | 21 | 4,67,24,308 | 4,35,20,126 |
| Expenditures on Grants, Subsidies etc., | 22 | - | - |
| Interest | 23 | - | - |
| **TOTAL (B)** | | **11,25,26,096** | **10,08,39,944** |
| **C - BALANCE BEING SURPLUS / (DEFICIT) (A-B)** | | 1,17,43,095 | (89,13,188) |
| **D** - Depreciation for the year | | (1,83,09,877) | (2,06,59,023) |
| Prior period adjustment | | - | - |
| **E. SURPLUS / (DEFICIT) CARRIED TO CORPUS / CAPITAL FUND ( C-D )** | | (65,66,782) | (2,95,72,211) |
| **SIGNIFICANT ACCOUNTING POLICIES AND NOTES ON ACCOUNTS** | 24 | | |

(SUBHOD M GULVADY)
ADMINISTRATION & FINANCE OFFICER

(PROF. G.U. KULKARNI )
DIRECTOR(I/C)

PLACE : BENGALURU
DATE: 16.09.2020

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,
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Receipts and Payments for the FINANCIAL YEAR 2019-20

From 01/04/2019 - To 31/03/2020

| Account | Opening | Receipt | Source | | Payment | Closing |
|---|---|---|---|---|---|---|
| | | | SCHEDULE 11 - CURRENT ASSET, LOANS AND ADVANCES | | | |
| | | | | **Cash Balance on Hand** | | |
| CH274 | 5,721.00 | | 60101 | Cash in Hand | | |
| CHSEP | | | 60102 | Cash in Hand (Sept) | | |
| | | | | **Scheduled Bank Balance - Savings Account** | | |
| 10838600274 | 29,63,594.52 | | 60201 | SBI (00274) | | |
| 64040 724430 | 56,93,967.00 | | 60204 | SBM (4430) | | |
| | | | SCHEDULE 21 - OTHER ADMINISTRATIVE EXPENSES | | | |
| | | | | **Other Administrative Expenses** | | |
| | | 1,838.00 | 70113 | Lab Consumables/Glassware | 14,52,650.00 | |
| | | 18,006.00 | 70114 | Electricity & Water Charges | 43,62,332.00 | |
| | | 15,000.00 | 70115 | Meetings and Honorarium | 3,31,589.00 | |
| | | | 70116 | Insurance | 1,45,725.00 | |
| | | 75,813.00 | 70117 | Repair & Maintenance | 33,84,043.00 | |
| | | | 70118 | Duties and Taxes | 2,57,538.00 | |
| | | 46,960.00 | 70119 | Rent, Rates & Taxes | 65,35,877.00 | |
| | | 48,166.00 | 70120 | Travel Expenses | 11,32,481.46 | |
| | | 6,888.00 | 70121 | Postage, Telephone & Communication Charges | 5,67,847.00 | |
| | | | 70122 | Printing & Stationery | 5,76,602.28 | |
| | | 10,133.00 | 70123 | Transportation & Conveyance Expenses | 32,92,117.00 | |
| | | 8,120.00 | 70124 | Seminars / Workshops/Conferences | 3,15,016.00 | |
| | | | 70125 | Books, Journals and Subscription | 50,223.00 | |
| | | | 70126 | Reimbursement of Fees | 21,750.00 | |
| | | | 70128 | Gas Refilling Charges | 2,95,911.00 | |
| | | 1,45,800.00 | 70129 | Fees & Professional Charges | 41,89,786.00 | |
| | | | 70131 | Bank Charges | 8,370.77 | |
| | | 2,892.00 | 70134 | Miscellaneous Expenses | 1,71,180.00 | |
| | | | 70135 | Advertisement & Publicity | 10,70,467.00 | |
| | | | 70137 | Fuel charges | 3,31,130.00 | |
| | | | 70138 | Welfare Expenses | 5,27,205.00 | |
| | | | 70139 | Outsourced Services | 79,49,519.00 | |
| | | | 70140 | Foreign Travel Expenses | 36,114.00 | |
| | | | 70146 | Meritorious Awards | 1,28,050.00 | |
| | | 3,83,076.00 | 70323 | Inauguration Expenses | 20,93,218.00 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | **SCHEDULE 11 - CURRENT ASSET, LOANS AND ADVANCES** | | | |
| | | | | **Scheduled Bank Balance - Savings Account** | | |
| | | | 60201 | SBI (00274) | | |
| | | | | **Sundry Debtors** | | |
| | | 62,000.00 | 60111 | Advances Released - PI | 10,13,822.00 | |
| | | | 60112 | Advances Released - Supplier | 13,59,401.00 | |
| | | 4,32,367.00 | 60316 | Other Receivables | 2,43,800.00 | |
| | | 50,00,311.00 | 60320 | Receivable from Project Account | 61,15,344.00 | |
| | | | 60412 | Deposit with Balmer Lawrie | 75,000.00 | |
| | | | **SCHEDULE 12A - INCOME FROM SERVICES** | | | |
| | | | | **Others** | | |
| | | 1,97,140.00 | 80525 | Sample Characterization Fee | 11,070.00 | |
| | | 22,770.00 | 80527 | AFM - Fee | | |
| | | 8,700.00 | 80528 | Contact Angle - Fee | | |
| | | 31,500.00 | 80529 | DSC - Fee | | |
| | | 1,80,480.00 | 80530 | FESEM - Fee | 2,400.00 | |
| | | 3,500.00 | 80531 | FTIR - Fee | | |
| | | 29,810.00 | 80532 | Raman Spectroscopy - Fee | | |
| | | 43,702.00 | 80533 | Spectrofluorometer- Fee | | |
| | | 4,59,900.00 | 80534 | TEM - Fee | | |
| | | 65,970.00 | 80535 | TGA & TA - Fee | 17,600.00 | |
| | | 1,81,540.00 | 80536 | XRD - Fee | | |
| | | 37,350.00 | 80537 | UV-VIS Fee | | |
| | | | **SCHEDULE 14 - FEES / SUBSCRIPTIONS** | | | |
| | | | | **Annual Fee / Subscription** | | |
| | | 1,04,057.00 | 80575 | ROIS Project Fee | | |
| | | 26,000.00 | 80576 | ROIS Certification Fee | | |
| | | 19,000.00 | 80577 | Application Fee / Other Fees | 500.00 | |
| | | 12,260.00 | 80578 | Tender Application Fee | | |
| | | 2,550.00 | 80579 | Other Fee | | |
| | | | | **Entrance Fee** | | |
| | | 3,73,596.00 | 80571 | Laboratory Fees / Re-registration Fee | | |
| | | | **SCHEDULE 15 - INCOME FROM INVESTMENTS** | | | |
| | | | | **Others** | | |
| | | 3,42,065.00 | 80901 | Interest Earned | | |
| | | | | **Rent** | | |
| | | 24,908.00 | 80605 | Rent | | |
| | | | **SCHEDULE 17 - INTEREST EARNED** | | | |
| | | | | **On Loan** | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | 2,74,205.00 | 80692 | Others | 9,428.00 | |
| | | | | **On Savings Account** | | |
| | | 3,61,027.00 | 80403 | Interest on SB Account | | |
| | | | | **SCHEDULE 18 - OTHER INCOME** | | |
| | | | | **Miscellaneous Income** | | |
| | | 4,28,064.00 | 80401 | License Fee/Hostel Rent | 3,97,041.00 | |
| | | 10,09,310.00 | 80402 | Other Income | 3,95,696.00 | |
| | | | | **SCHEDULE 20 - ESTABLISHMENT EXPENSES** | | |
| | | | | **Salaries and Wages** | | |
| | | 10,85,624.00 | 70001 | Salaries & Wages | 5,99,08,799.00 | |
| | | | | **SCHEDULE 3 - EARMARKED / ENDOWMENT FUND** | | |
| | | | | **Earmarked / Endowment Fund** | | |
| | | | 50117 | Initial Balance | 26,17,219.00 | |
| | | | | **SCHEDULE 7 - CURRENT LIABILITIES** | | |
| | | | | **Advances Received** | | |
| | | 45,000.00 | 50315 | Workshop Fee Received (Category IV) | | |
| | | 31,02,749.00 | 50316 | Other Advance Receipts | 62,05,498.00 | |
| | | | | **Other Current Liabilities** | | |
| | | | 50015 | General Reserve - Surplus / (Deficit) During the Year | 40,41,175.00 | |
| | | 9,50,000.00 | 50113 | Supplier - Deposit / EMD | 10,44,252.00 | |
| | | 45,935.00 | 50116 | Salary Payable | 45,935.00 | |
| | | 4,71,471.00 | 50120 | Caution Money Deposit | 42,071.00 | |
| | | | 50125 | Dining Recovery - Payable | 5,16,385.00 | |
| | | 5,66,466.00 | 50131 | Provision for Supplies - Consumable A.c | | |
| | | 13,58,46,000.00 | 50312 | Grants received from DST | | |
| | | 9,93,16,056.00 | 50320 | Payable to Project Account | 9,89,74,956.00 | |
| | | 7,32,025.00 | 50702 | Rent Payable | | |
| | | | | **Statutory Liabilities** | | |
| | | 60,687.00 | 50325 | TDS - Payable | | |
| | | | 50335 | Consolidated GST Payable (Plan And Projects) | 1,12,233.00 | |
| | | | 50401 | Central Provident Fund | 11,21,035.00 | |
| | | | 50402 | Voluntary-CPF | 13,37,301.00 | |
| | | | 50403 | CPF Employer Share - Payable | 36,62,580.00 | |
| | | 1,95,548.00 | 50501 | New Defined Contributory Pension Scheme | 11,63,136.00 | |
| | | 2,45,033.00 | 50502 | NDCPS Employer Share - Payable | 14,66,880.00 | |
| | | | 50602 | Professional Tax | 1,71,000.00 | |
| | | | 50605 | CPF LOAN | 10,000.00 | |
| | | | 50902 | Central Government Employees Group Insurance Scheme | 2,187.00 | |
| | | 10,25,110.00 | 51115 | Income Tax | 57,32,845.00 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | **Sundry Creditors Others** | | |
| | | 70,007.00 | 50111 | Account Payable (PI) | | |
| | | | **SCHEDULE 8 - FIXED ASSETS** | | | |
| | | | | **Building** | | |
| | | | 60503 | Buildings | 23,30,242.00 | |
| | | | | **Other Fixed Assets** | | |
| | | 29,400.00 | 60501 | Capital | 1,11,12,455.00 | |
| | | | 60502 | Site Development Cost | 15,500.00 | |
| | | | 60504 | Infrastructure | 26,25,268.00 | |
| | | | **SCHEDULE 11 - CURRENT ASSET, LOANS AND ADVANCES** | | | |
| | | | | **Cash Balance on Hand** | | |
| CH274 | | | 60101 | Cash in Hand | | 20,818.00 |
| CHSEP | | | 60102 | Cash in Hand (Sept) | | |
| | | | | **Scheduled Bank Balance - Savings Account** | | |
| 10838600274 | | | 60201 | SBI (00274) | | 97,99,554.01 |
| 64040 724430 | | | 60204 | SBM (4430) | | |
| | **86,63,282.52** | **25,42,83,885.00** | | | **25,31,26,795.51** | **98,20,372.01** |
| **GRAND TOTAL** | | **26,29,47,167.52** | | | | **26,29,47,167.52** |

(SUBHOD M GULVADY)
ADMINISTRATION & FINANCE OFFICER

(PROF. G.U. KULKARNI )
DIRECTOR(I/C)

PLACE: BENGALURU
DATE: 16.09.2020

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**
**JALAHALLI, BENGALURU - 560 013**

**SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH, 2020**

(Amount in Rs.)

| Particulars | As at 31.03.2020 | As at 31.03.2019 |
|---|---|---|
| **SCHEDULE 1** | | |
| **A. CAPITAL FUND:** | | |
| As Per Previous Balance Sheet | 25,25,59,623 | 25,92,58,834 |
| **ADD:** Capital Grants received: | | |
| Campus Development | | 1,94,00,000 |
| Capital Assets | 1,98,24,000 | 34,73,000 |
| | 27,23,83,623 | 28,21,31,834 |
| **ADD/(LESS):** Surplus / (Deficit) for the year | (65,66,782) | (2,95,72,211) |
| **TOTAL** | **26,58,16,841** | **25,25,59,623** |
| **SCHEDULE 2 - RESERVES AND SURPLUS:** | - | - |
| **SCHEDULE 3 - EARMARKED / PROJECT FUNDS:** | **16,92,10,145** | **15,56,87,203** |
| (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 | 10,63,110 | 35,39,333 |
| 2) Other Liabilities | 1,56,77,716 | 65,11,932 |
| **TOTAL (A)** | **1,67,40,826** | **1,00,51,265** |
| B) **PROVISIONS:** | | |
| Salaries and Services and Supplies | 2,06,86,211 | 1,25,46,598 |
| **TOTAL (B)** | **2,06,86,211** | **1,25,46,598** |
| **TOTAL (A+B)** | **3,74,27,037** | **2,25,97,863** |
| **SCHEDULE 8 - FIXED ASSETS** | **29,06,91,892** | **28,79,45,401** |
| **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 | 34,315 |
| 4) Bank Balances:- Nationalised Banks | | |
| a. Term Deposit Receipts (includes margin money) | 5,73,64,100 | 5,14,80,477 |
| c. Savings Accounts: | | |
| SBI SB A/c No.274 | 97,99,554 | 29,63,595 |
| SBI SB Project A/c 219 | 3,37,65,770 | 6,34,57,046 |
| SBI SB A/c 24430 | 3,05,79,629 | 56,93,967 |
| SBI SB A/c 75676 | 52,29,126 | 34,81,683 |
| **TOTAL (A)** | **13,67,97,672** | **12,71,11,083** |

| Particulars | As at 31.03.2020 | As at 31.03.2019 |
|---|---|---|
| **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: | 4,22,12,090 | 81,93,764 |
| K P T C L Deposit (SERC/CLCR) | 10,22,510 | 10,22,510 |
| Deposit with BSNL | 87,000 | 87,000 |
| 3) Deposits HMT Ltd., Mohan Gas and Bhuruka Gas | 4,82,690 | 3,82,690 |
| 4) Grant in Aid Receivable | - | - |
| 5) Accrued Interest & Prepaid Exp.(Insurance) | - | 49,96,451 |
| 6) Deposit with Balmer Lawrie | 2,75,000 | - |
| 7) TDS By Bank/ BESCOM & Others | 8,85,169 | 11,05,790 |
| **TOTAL (B)** | **4,49,64,459** | **1,57,88,205** |
| **TOTAL (A+B)** | **18,17,62,131** | **14,28,99,288** |
| **SCHEDULE 12 - INCOME FROM SALES / SERVICES:** | - | - |
| **SCHEDULE 13 - GRANTS / SUBSIDIES:** | | |
| Grant in Aid -Salaries | 5,55,55,000 | 6,13,87,000 |
| Grant in Aid -General | 6,04,67,000 | 2,12,55,000 |
| Grant in Aid -Other | - | - |
| **TOTAL** | **11,60,22,000** | **8,26,42,000** |
| **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 | 38,92,437 | 35,12,749 |
| 2) On Savings Accounts - Nationalised Bank | 7,03,092 | 5,28,426 |
| **TOTAL** | **45,95,529** | **40,41,175** |
| **SCHEDULE 18 - OTHER INCOME:** | | |
| Sample charges | 12,31,292 | 5,50,480 |
| Miscellaneous Income | 24,20,370 | 18,05,101 |
| Conferences and workshops | - | 28,88,000 |
| **TOTAL** | **36,51,662** | **52,43,581** |
| **SCHEDULE 19 - INCREASE (DECREASE) IN STOCK OF FINISHED GOODS & WORK IN PROGRESS:** | - | - |
| **SCHEDULE 20 - ESTABLISHMENT EXPENSES:** | | |
| 1) Salaries, Allowance and Wages to Staff | 5,17,38,738 | 5,68,91,429 |
| 2) Medical Expenses Reimbursed | 67,582 | 34,131 |
| 3) Fellowship & Book Grant | 1,34,88,601 | - |
| 4) Welfare Expenses | 5,06,867 | 3,94,258 |
| **TOTAL** | **6,58,01,788** | **5,73,19,818** |

| Particulars | As at 31.03.2020 | As at 31.03.2019 |
|---|---|---|
| **SCHEDULE 21 - OTHER ADMINISTRATIVE EXPENSES,ETC:** | | |
| Auditors Remuneration | 53,100 | 41,300 |
| Chemicals, Glasswares & Consumables etc., | 26,19,015 | 18,22,982 |
| Duties & Taxes | 3,50,638 | 37,263 |
| Electricity & Water Charges | 44,56,687 | 37,95,331 |
| Fees & Professional charges | 40,99,864 | 8,59,345 |
| Fuel Charges for Genset | 3,30,630 | 2,63,205 |
| Housekeeping / Manpower supply / Security charges | 1,68,50,253 | 1,80,92,735 |
| Journals & Periodicals /Books | 1,72,307 | 1,31,801 |
| Meritorius Awards | 1,32,550 | - |
| Reimbursement of Fees to Students | - | 4,14,335 |
| Conveyance/ Transportation Charges | 32,79,446 | 27,59,074 |
| Other Miscellaneous Charges / Bank Charges | 4,81,890 | 6,66,258 |
| Advertisement and Publicity Charges | 10,80,719 | 52,107 |
| Printing & Stationery | 5,34,697 | 6,10,647 |
| Registration & Renewals | - | 55,200 |
| Rent & Insurance | 43,19,185 | 53,57,148 |
| Repairs & Maintenance | 34,85,320 | 33,30,774 |
| Seminars and Conferences | 7,94,346 | 32,58,876 |
| Telephone & Postage | 5,49,498 | 5,94,764 |
| Travel Expenses | 14,74,007 | 11,77,386 |
| Foreign Travel Expenses | 2,00,000 | - |
| Testing (N.M.R.) & Sample analysis charges | - | 58,395 |
| IPR Related Expenses | - | 1,41,200 |
| Inauguration Expenses | 14,60,156 | - |
| **TOTAL** | **4,67,24,308** | **4,35,20,126** |
| **SCHEDULE 22 - EXPENDITURE ON GRANTS, SUBSIDIES ETC:** | - | - |
| **SCHEDULE 23 - INTEREST:** | - | - |

CENTRE FOR NANO AND SOFT MATTER SCIENCES
JALAHALLI, BENGALURU - 560 013

EDULE 3 - EARMARKED / PROJECTS
exure - 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/03/16-19 | IUSSTF/GUK /02/16-18 | Inspire Fellowship | Nano Mission School | National Post Doctrol Fellowship | SERB/EMA/ SANG/01/2017-20 | SERB/EMR/ CVY/01/2017-20 | WOS-A/CS134/USH/01/2017-20 | SERB/EMR/ GGN/01/2019-22 | SERB/EMR/ GUK/01/2020-22 | SERB/EMR/ DSSR/01/2020-23 | SERB/EMR/ PKS/01/2019-22 | SERB/EMR/ HSSRM/01/2020-23 | DST/TBI/GUK/2019-22 | Project Administr - ation | Total Under Government Project |
| ening Balance of the Funds | 56,57,944 | 8,77,48,586 | 3,14,38,767 | 73,77,340 | 13,664 | (2,68,726) | (1,91,693) | (88,723) | 3,91,964 | 20,12,543 | 18,261 | - | - | - | - | - | - | 50,19,284 | 13,91,29,211 |
| dditions to the Funds: | | | | | | | | | | | | | | | | | | | |
| i) Grants or Other receipts | - | - | 6,90,000 | - | - | 31,43,705 | - | 3,20,274 | 6,50,000 | 10,00,000 | 8,88,000 | 20,44,000 | 20,60,520 | 11,14,100 | 39,02,000 | 14,85,300 | 3,11,96,000 | 6,79,548 | 4,91,73,447 |
| ii) Income from investment made | - | | | | | - | - | - | | | | | | | | | 5,62,429 | 9,97,636 | 15,60,065 |
| iii) Other Receipts | | | | | | | | | | | | | | | | | | | - |
| iii) Trfrd. during the year | | | | | | | | | | | | | | | | | | | - |
| TOTAL (a+b) | 56,57,944 | 8,77,48,586 | 3,21,28,767 | 73,77,340 | 13,664 | 28,74,979 | (1,91,693) | 2,31,551 | 10,41,964 | 30,12,543 | 9,06,261 | 20,44,000 | 20,60,520 | 11,14,100 | 39,02,000 | 14,85,300 | 3,17,58,429 | 66,96,468 | 18,98,62,723 |
| ilisation/Expenditure | | | | | | | | | | | | | | | | | | | |
| rwards objectives of Funds | | | | | | | | | | | | | | | | | | | |
| i) Capital Expenditure | | | | | | | | | | | | | | | | | | | |
| Fixed Assets | | | | | | | | | | | | | | | | | | | |
| Others | | | | | | | | | | | | | | | | | | - | - |
| ii) Revenue Expenditure | | | | | | | | | | | | | | | | | | - | - |
| Salaries, Wages a | - | 25,45,936 | 7,91,660 | 6,12,511 | - | 20,43,947 | - | 2,75,000 | 3,29,773 | 3,80,111 | 6,05,000 | 4,53,080 | | | | | 3,15,155 | | 83,52,173 |
| Allowances etc., | - | - | - | - | - | - | - | - | - | - | - | | | | | | | 5,286 | |
| Consumables/ tra | - | 83,54,633 | 98,825 | 5,26,539 | - | - | - | | 93,652 | 2,06,713 | 88,009 | 70,355 | | 500 | 15,788 | | 4,44,971 | - | 98,99,985 |
| Contingencies | - | 2,33,816 | 5,30,490 | 79,779 | - | 74,702 | - | 1,01,151 | 35,984 | 48,000 | | 10,078 | | | 1,068 | | 22,577 | - | 11,37,645 |
| Depreciation | 6,71,838 | 86,07,599 | 33,11,257 | 3,73,531 | - | - | - | - | 45,929 | 2,33,344 | - | | | | 2,62,474 | | 51,796 | - | 1,35,57,768 |
| Overheads | - | - | | 1,50,000 | - | - | - | | - | | 78,000 | 1,05,002 | 1,37,000 | 44,046 | 1,15,200 | 50,300 | | - | 6,79,548 |
| t Refunded | - | | 12,65,952 | - | | - | - | - | - | - | 19,271 | | | | | | | | 12,85,223 |
| TOTAL (c) | 6,71,838 | 1,97,41,984 | 59,98,184 | 17,42,360 | - | 21,18,649 | - | 3,76,151 | 5,05,338 | 8,68,168 | 7,90,280 | 6,38,515 | 1,37,000 | 44,546 | 3,94,530 | 50,300 | 8,34,499 | 5,286 | 3,49,12,342 |
| BALANCE AT THE R END (a+b-c) | 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 |

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**Annexure - A to Schedule 3**

(Amount in Rs.)

| FUNDS | Industries Sponsor Project/ Joint Venture with Industries | | | Total of Projects | | | |
|---|---|---|---|---|---|---|---|
| | TSAMRC | Tata Steel | HPCL/IIT/NS J/01/17-18 | Total of Industry projects (A) | Total of Govt. Projects (B) | Total of (A+B) | Previous Year |
| a) Opening Balance of the Funds | 51,08,663 | 9,95,276 | 13,24,134 | 74,28,073 | 13,91,29,211 | 14,65,57,284 | 16,62,94,624 |
| b) Additions to the Funds: | | | | | | | |
| i) Grants | 1,59,75,000 | - | 4,85,456 | 1,64,60,456 | 4,91,73,447 | 6,56,33,903 | 1,87,62,870 |
| ii) Income from investment made | | | | - | 15,60,065 | 15,60,065 | 63,21,159 |
| iii) Other Receipts | | | | | - | - | |
| iii) Trfrd. during the year | | | | - | - | | 3,91,866 |
| **TOTAL (a+b)** | **2,10,83,663** | **9,95,276** | **18,09,590** | **2,38,88,529** | **18,98,62,723** | **21,37,51,252** | **19,17,70,519** |
| c) Utilisation/Expenditure towards objectives of Funds: | | | | | | | |
| Rental and Maintenance Charges | 18,32,377 | - | - | 18,32,377 | - | 18,32,377 | 9,42,818 |
| Project Cost | 46,34,899 | - | - | 46,34,899 | - | 46,34,899 | 29,32,915 |
| Other Expenditure as per project | - | 1,75,728 | 1,06,703 | 2,82,431 | - | 2,82,431 | 9,97,411 |
| Salaries, Wages and | - | - | 6,61,852 | 6,61,852 | 83,52,173 | 90,14,025 | 81,50,754 |
| Allowances etc., | - | - | - | - | - | - | - |
| Consumables/ travel | - | - | 2,40,131 | 2,40,131 | 98,99,985 | 1,01,40,116 | 39,88,682 |
| | - | - | - | - | 11,37,645 | 11,37,645 | 14,08,974 |
| Depreciation | 18,45,374 | - | 1,31,701 | 19,77,075 | 1,35,57,768 | 1,55,34,843 | 1,35,69,935 |
| Overheads | - | - | | - | 6,79,548 | 6,79,548 | 9,75,045 |
| Grant Refunded | - | - | - | - | 12,85,223 | 12,85,223 | 31,16,782 |
| **TOTAL (c)** | **83,12,650** | **1,75,728** | **11,40,387** | **96,28,765** | **3,49,12,342** | **4,45,41,107** | **3,60,83,316** |
| **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** | **15,56,87,203** |

CENTRE FOR NANO AND SOFT MATTER SCIENCES
JALAHALLI, BENGALURU - 560 013
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH, 2020

**SCHEDULE - 8 : FIXED ASSETS**

**A. CENS :**

(Amount in Rs.)

| DESCRIPTION | W.D.V. as on 01.04.2019 | Additions during the year | | | Total as on 31.03.2020 | Rate of Dep. | Depreciation Full Rate | Dep. For Addition <180 Days | Total Depreciation for the year | W.D.V. as on 31.03.2020 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | >180 days | <180 Days | Total additions | | | | | | |
| **CIVIL WORKS** | | | | | - | | | | - | - |
| Aluminium Partitions | 15,09,158 | 1,65,182 | | 1,65,182 | 16,74,340 | 10 | 1,67,434 | - | 1,67,434 | 15,06,906 |
| Brick Base(Partitions) | 65,175 | | | - | 65,175 | 10 | 6,518 | - | 6,518 | 58,657 |
| Construction of Cycle Stand | 25,715 | | | - | 25,715 | 10 | 2,572 | - | 2,572 | 23,143 |
| Construction of Shed | 26,500 | | | - | 26,500 | 10 | 2,650 | - | 2,650 | 23,850 |
| Vinyl Flooring | 1,26,823 | | | - | 1,26,823 | 10 | 12,682 | - | 12,682 | 1,14,141 |
| Other Miscellaneous Works | 20,22,958 | | | - | 20,22,958 | 10 | 2,02,296 | - | 2,02,296 | 18,20,662 |
| New Campus (WIP) | 5,02,80,435 | | 14,58,091 | 14,58,091 | 5,17,38,526 | - | - | - | - | 5,17,38,526 |
| Infrastructure | 2,85,10,761 | 72,65,089 | 4,46,614 | 77,11,703 | 3,62,22,464 | - | - | - | - | 3,62,22,464 |
| **BUILDINGS** | 45,17,108 | | | - | 45,17,108 | 10 | 4,51,711 | - | 4,51,711 | 40,65,397 |
| **ELECTRICAL INSTALLATIONS** | 16,88,459 | 6,97,016 | 1,90,882 | 15,84,914 | 32,73,373 | 10 | 2,38,548 | 9,544 | 2,48,092 | 30,25,281 |
| **COMPUTERS** | | | | | | | | | | |
| Computers | 12,09,400 | | 3,11,443 | 3,11,443 | 15,20,843 | 60 | 7,25,640 | 93,433 | 8,19,073 | 7,01,770 |
| **FURNITURE & FIXTURES** | | | | | | | | | | |
| Carpentry Works | 2,93,562 | | | - | 2,93,562 | 10 | 29,356 | - | 29,356 | 2,64,206 |
| Furniture & Fixtures | 48,03,010 | 2,02,960 | 3,63,108 | 5,66,068 | 53,69,078 | 10 | 5,00,597 | 18,155 | 5,18,752 | 48,50,326 |
| Fume Cupboard | 87,086 | | | - | 87,086 | 10 | 8,709 | - | 8,709 | 78,377 |
| **GENERAL EQUIPMENTS** | | | | | | | | | | |
| Air Conditioner | 7,64,799 | | 4,49,743 | 4,49,743 | 12,14,542 | 15 | 1,14,720 | 33,731 | 1,48,451 | 10,66,091 |
| Generator Set | 2,28,942 | | 3,15,000 | 3,15,000 | 5,43,942 | 15 | 34,341 | 23,625 | 57,966 | 4,85,976 |
| Canteen Vessels and Equipments | 1,82,374 | | | - | 1,82,374 | 15 | 27,356 | - | 27,356 | 1,55,018 |
| Equipment | 1,76,64,753 | 1,43,031 | 87,315 | 2,30,346 | 1,78,95,099 | 15 | 26,71,168 | 6,549 | 26,77,717 | 1,52,17,382 |
| Workshop & Other Equipments | 1,17,377 | | | - | 1,17,377 | 15 | 17,607 | - | 17,607 | 99,770 |
| **SCIENTIFIC EQUIPMENTS** | 8,43,65,320 | | 34,15,159 | 34,15,159 | 8,77,80,479 | 15 | 1,26,54,798 | 2,56,137 | 1,29,10,935 | 7,48,69,544 |
| **Total - (A)** | **19,84,89,715** | **84,73,278** | **70,37,355** | **1,62,07,649** | **21,46,97,364** | | **1,78,68,703** | **4,41,174** | **1,83,09,877** | **19,63,87,487** |

**B. PROJECTS**

(Amount in Rs.)

| DESCRIPTION | W.D.V. as on 01.04.2019 | Additions during the year | | | Total as on 31.03.2020 | Rate of Dep. | Depreciation Full Rate | Dep. For Addition <180 Days | Total Depreciation for the year | W.D.V. as on 31.03.2020 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | >180 days | <180 Days | Total additions | | | | | | |
| | | | | | - | | | | | |
| **I. Assets Under Closed Projects** | 44,78,917 | | | - | 44,78,917 | 15 | 6,71,838 | - | 6,71,838 | 38,07,079 |
| **II. DST/TPF/ GUK / 05/16-19** | | | | | | | | | | |
| Equipment | 5,38,14,639 | 33,84,775 | 3,69,162 | 37,53,937 | 5,75,68,576 | 15 | 85,79,912 | 27,687 | 86,07,599 | 4,89,60,977 |
| **II. IGSTC/GUK/03/16-19** | | | | | | | | | | |
| Equipment | 17,688 | | 49,45,039 | 49,45,039 | 49,62,727 | 15 | 2,653 | 3,70,878 | 3,73,531 | 45,89,196 |
| **III. DST/NMNT/GUK/06/2017-19** | | | | | | | | | | |
| Equipment | 2,17,68,164 | 56,000 | 5,01,761 | 5,57,761 | 2,23,25,925 | 15 | 32,73,625 | 37,632 | 33,11,257 | 1,90,14,668 |
| **IV. SERB/EMR/SANG/01/2017-20** | | | | | | | | | | |
| Equipment | 3,06,190 | | | | 3,06,190 | 15 | 45,929 | - | 45,929 | 2,60,261 |
| **V. SERB/EMR/CVY/01/2017-20** | | | | | | | | | | |
| Equipment | 15,55,626 | | | | 15,55,626 | 15 | 2,33,344 | - | 2,33,344 | 13,22,282 |
| **VI. TSAMRC** | | | | | | | | | | |
| Equipment | 69,86,605 | 37,55,842 | 31,20,089 | 68,75,931 | 1,38,62,536 | 15 | 16,11,367 | 2,34,007 | 18,45,374 | 1,20,17,162 |
| **VI. HPCL/IIT/NSJ/01/17-18** | | | | | | | | | | |
| Equipment | 5,27,857 | 3,50,147 | | 3,50,147 | 8,78,004 | 15 | 1,31,701 | - | 1,31,701 | 7,46,303 |
| **VII. SERB/EMR/PKS/01/2019-22** | | | | | | | | | | |
| Equipment | | | 34,99,650 | 34,99,650 | 34,99,650 | 15 | - | 2,62,474 | 2,62,474 | 32,37,176 |
| **VIII. DST/TBI/GUK/2019-22** | | | | | | | | | | |
| Equipment | | 2,89,522 | 1,11,575 | 4,01,097 | 4,01,097 | 15 | 43,428 | 8,368 | 51,796 | 3,49,301 |
| ***Total (B)*** | **8,94,55,686** | **78,36,286** | **1,25,47,276** | **2,03,83,562** | **10,98,39,248** | | **1,45,93,797** | **9,41,046** | **1,55,34,843** | **9,43,04,405** |
| | | | | | | | | | | |
| **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** |
| ***Previous Year Grand Total (A+B)*** | ***18,74,67,242*** | ***8,78,42,413*** | ***4,68,64,704*** | **13,47,07,117** | ***32,21,74,359*** | | ***3,22,67,004*** | ***19,61,954*** | ***3,42,28,958*** | ***28,79,45,401*** |

PLACE : BENGALURU
DATE: 16.09.2020

(SUBHOD M GULVADY)
ADMINISTRATION & FINANCE OFFICER

(PROF. G.U. KULKARNI)
DIRECTOR I/C

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

G.R. VENKATANARAYANA * Chartered Accountants * BANGALORE

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

### SCHEDULES FORMING PART OF THE ACCOUNTS FOR THE YEAR ENDED 31ST MARCH 2020

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.

2. **Investments**: Investments are stated at cost and Interest from Investments are accounted on accrual basis.

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

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

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

| | Depreciation Rate |
|---|---|
| Civil Works and Buildings | 10.00% |
| Electrical Installations | 10.00% |
| Computers | 60.00% |
| Furniture and Fixtures | 10.00% |
| Scientific and General Equipment | 15.00% |
| Project Equipment | 15.00% |

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 is debited to Income and Expenditure account. Depreciation on fixed assets acquired out of project funds 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 2020 and the Income and Expenditure Account for the year ended on that date.

(SUBHOD M GULVADY)
ADMINISTRATION & FINANCE OFFICER

(PROF. G.U. KULKARNI)
DIRECTOR (I/C)

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

(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 |
|---|---|---|
| Fighting plastic pollution: Recent development in degradation process | Rekha S. Hegde | 28.06.2019 |
| Auxetic smart materials - which tend to stretch when stressed | Marlin Baral | 19.07.2019 |
| Evolution of high energy materials –developments in azo-linked heteroaromatics | Madhu Babu Kanakala | 06.09.2019 |
| Neuromorphic Systems | Suman Kundu | 13.09.2019 |
| Smart Window | Indrajit Mondal | 06.12.2019 |
| Bio-inspired optics | BrindhuMalani S | 17.01.2020 |

### Journal Article based Seminar

| Title of Colloquia/Seminar | Speaker | Date |
|---|---|---|
| Colouration by total internal reflection and interference at microscale concave interfaces. | Pinchu Xavier | 14.06.2019 |
| Sustainable production of highly conductive multilayer graphene ink for wireless connectivity and IoT applications | Kenneth Lobo | 05.07.2019 |
| Casimir torque makes liquid crystals do twist | Pragnya Satapathy | 11.07.2019 |
| Coexistence of Diamagnetism and Vanishingly Small Electrical Resistance at Ambient Temperature and Pressure in Nanostructures | Suchithra P. | 16.07.2019 |
| Programmable helical twisting in oriented humidity-responsive bilayer films generated by spray-coating of a Chiral nematic liquid crystal | Rajalaxmi Sahoo | 17.07.2019 |
| Scalable-manufactured randomized glass-polymer hybrid Meta material for daytime radiative cooling | Amit Bhardwaj | 23.07.2019 |
| Optically rewritable transparent liquid crystal displays enabled bylight-driven chiral fluorescent molecular switches | VarshiniG.V | 26.07.2019 |
| Moth-eye structured polydimethylsiloxane films for high-efficiency perovskite solar cells | Athira M. | 31.07.2019 |
| Large area graphene nanomesh/ carbon nanotube hybrid membranes for ionic and molecular nanofiltration | Ramya Prabhu B. | 02.08.2019 |
| Impacts of surface depletion on theplasmonic properties of doped semiconductor nanocrystals | Gaurav Shukla | 06.08.2019 |
| Atomic scale insights into surface species of electrocatalysts in three dimensions | Alex C | 09.08.2019 |
| Bacteria photosensitized by intracellular gold nanoclusters for solar fuel production | Tripthi Devaiah C | 23.08.2019 |
| Evidence of bipolaron condensation during the metal-insulator transition in rare-earth nickelates | Subir Roy | 30.08.2019 |
| Organic field-effect opticalwaveguides | Prashanth Nayak | 01.11.2019 |
| Light emitting Perovskite solar cell | Anamul Haque | 03.01.2020 |

### Thesis Colloquia

| Title of Colloquia/Seminar | Speaker | Date |
|---|---|---|
| Investigation of Optoelectronics Properties and Fabrication of Devices based on Decoupled Graphene Multi-stacks and Metal Wire Networks | Sunil Walia | 27.11.2019 |
| Functional materials for fundamental research and applied science: Synthesis and characterization | Sachin Ashok Bhat | 23.01.2020 |
| Effect of polymeric architecture on anisotropic soft matter | Marlin Baral | 11.03.2020 |

### 19.2 COLLOQIA/ SEMINARS BY VISITORS

| Title of Colloquia/Seminar | Speaker | Date |
|---|---|---|
| How the trap states affect charge carrier dynamics of semiconductor quantum dots | Prof. K. George Thomas<br>School of Chemistry, IISER-TVM, Thiruvananthapuram | 29.04.2019 |
| Discussion on a collaboration work | Dr. Ramesh Babu Gangineni<br>Assistant Professor,<br>Department of Physics,<br>Pondicherry University | 21.05.2019 |
| Hybrid nanomaterials for photon harvesting | Prof. Amitava Patra<br>School of Materials Sciences, Indian Association for the Cultivation of Science, Jadavpur, Kolkata | 27.05.2019 |
| High-performance XPS with multi-technique integration | Dr. Richard While<br>Global Director Surface Analysis, Thermi Fisher Scientific India Pvt. Ltd. | 19.06.2019 |
| Creation of hierarchically ordered nanostructures in block copolymers and star polymers | Dr. E. Bhoje Gowd<br>Material Sciences and Technology Division, CSIR-National Institute for Interdisciplinary Science and Technology (CSIR-NIIST), Thiruvananthapuram | 10.07.2019 |
| Scalability challenges in electrocatalyst for energy conversion and storage devices | Dr. Ritu Gupta<br>Asst. Professor and Head, Department pf Chemistry, Indian Institute of Technology, Jodhpur, Karwar | 12.07.2019 |
| Single use plastic and recycling plastic for value added natural fibres rain forced composites | Dr. Shakti Chauhan<br>Scientist, Institute of Wood Science and Technology, Bengaluru | 01.10.2019 |
| Hazards of plastics of living beings and nature: Management & control | Prof. B.V.Shivaprakash<br>Director of Research, Karnataka Veterinary, Animal & Fisheries Sciences University, Bidar | 08.11.2019 |
| Nanoscale chemical imaging materials beyond the optical diffraction limit | Dr BasudevLahiri<br>Dept. of Electronics & Electrical Communication Engg.<br>IIT Kharagpur | 25.11.2019 |
| Seminar: Enhanced electro – optical transition in photoisomerizableeph/aerosil/7cb nematic nanocomposite | Dr.Yordan G. Marinov<br>Georgi Nadjakov Institute of Solid State Physics, Bulgarian Academy of Sciences, Bulgaria<br>Under the Indo-Bulgarian joint project supported by DST | 26.11.2019 |
| Seminar: Nanocomposites of liquid crystals/ single wall carbon nanotubes: design and properties | Dr. Ginka Exner<br>Faculty of Physics and Technology, University of Plovdiv "PaisiiHilendarski", Bulgaria<br>Under the Indo-Bulgarian joint project supported by DST | 26.11.2019 |

| Title of Colloquia/Seminar | Speaker | Date |
|---|---|---|
| Seeing is believing: Experimental insights about supercooled liquids, glasses and controlled crystallization | Dr. Chandan Kumar Mishra<br>Post-doctoral Researcher,Department of Physics and Astronomy, University of Pennsylvania | 27.12.2019 |
| Molecular modelling of materials: The third eye peering into their microscopics | Prof. Balasubramanian Sundaram<br>Jawaharlal Nehru Centre for Advanced Scientific Research, Bengaluru | 10.01.2020 |
| To initiate collaborative activity related to Hybrid Transparent Electrode use in Solar Cells and self-cleaning glasses | Prof. Raghunath Bhattacharya | 17.01.2020 |
| Liquid Crystal Polymer Based Smart Materials | Dr. Kamalesh Kumar<br>Senior Scientist, Ubiquitous Analytical Techniques, CSIR-Central Scientific Instruments Organization, Chandigarh<br>24 and 25 Feb 2020 | 25.02.2020 |
| Synchrontron radiation techniques in material science: Applications to correlated electron systems and magnetism | Prof. Olof Karis,<br>Dept. of Physics and Astronomy, Uppsala University, USA | 18.02.2020 |

## 19.3 FACULTY VISITS INDIA/ABROAD

| Faculty | Place and period of visit | Purpose of visit | Title of talk |
|---|---|---|---|
| Dr. C.V. Yelamaggad | Rajiv Gandhi Institute of Technology and Research Centre, 30.04.2019 | Presented a key note lecture at the International Conference of Engineering and technology | Engineering and Technology of Liquid Crystals |
| Dr. Ashutosh K. Singh | Kolkata India 18.05.2019 | Tata Steel ABP Exhibition – 2019 | For participation in exhibition: A CeNS stall showcased with various prototypes based on CeNS inventions |
| Dr. C.V. Yelamaggad | Department of Chemistry, Gulbarga University, Gulbarga, 28.05.2019 | Presented a lecture at the one–day seminar | Functional Materials for Science and Technology of Invisibility |
| Dr. H.S.S.R. Matte | Singapore, 23-28 June 2019 | Attend 10th International Conference on Materials for Advanced Technologies (ICMAT-2019) | Insights into Liquid Phase Exfoliation of Layered Materials and Applications |
| Dr. S. Angappane | INSA, New Delhi, 30.07.2019 | SERB project review meeting | Magnetic nanoparticles for memory applications |
| Dr. C.V. Yelamaggad | Ramaiah Institute of Technology, Bengaluru. 03 Aug. 2019 | Presented a lecture at the Faculty Development Program (FDP) organized | Fluid Birefringent Gold Nanoparticles |
| Dr. Neena S. John | Anna Adarsh College for Women, Chennai, 22.08.2019 | For delivering invited lecture at 'National Seminar on Nanotechnology - The Fascinating World of Science' | Nanomaterials for Applications in Sensing and Electrocatalysis |

| Faculty | Place and period of visit | Purpose of visit | Title of talk |
|---|---|---|---|
| Dr. Ashutosh K. Singh | Karnataka Science and Technology Academy, Bengaluru, 30.08.2019 | KSTePS-DFG Indo-German Research Proposal Writing Workshop | Attended workshop |
| Dr. C.V. Yelamaggad | B. V. V. S. Basaveshwar Science College, Bagalkot, 19.09.2019 | Invited lecture at the one day workshop on "Functional Materials – Recent Advances | Liquid Crystals - Fourth State of Matter: Life, Science and Technology |
| Dr. S. Krishna Prasad | Chitkara University, Punjab 21-23 Oct 2019 | To give Invited talk at 26th National Conference on Liquid Crystals (NCLC-2019) held at Chitkara University, Punjab, during October 21-23, 2019 | Invited talk: Enhanced photoluminescence in a chiral nematic through polymer stabilization & an erasable 3-state memory device |
| Dr. Geetha G. Nair | | To give invited talk at 26th National Conference on Liquid Crystals | Photonic Band Gap Tuning via Combined effect of Electric and Optical fields in a Blue Phase Liquid Crystal |
| Dr. D.S. Shankar Rao | | Invited talk at 26th National Conference on Liquid Crystals (NCLC-2019) held at Chitkara University, Punjab, during October 21-23, 2019 | Invited talk: Influence of Gold Nanorods on the Structure and Photonic Bandgap in a Twist Grain Boundary Phase with Smectic C* Blocks |
| Dr. C.V. Yelamaggad | | Invited talk at 26th National Conference on Liquid Crystals (NCLC-2019) held at Chitkara University, Punjab, during October 21-23, 2019 | Anomalous Odd-Even Effect in Light-Emitting Chiral Nematic Dimers |
| Dr. C.V. Yelamaggad | Belgaum 16.11.2019 | Homeopathy Scientific Seminar on 16 November 2019. Over 1600 delegates (homeopathic doctors, academicians, Ph.D. students and other researchers ) from different parts of the country attended. | Chief guest |
| Prof. G.U. Kulkarni | MAHE, Manipal 23.11.2019 | One day workshop on Atoms, Molecules and Materials | Rediscovering the periodic table of chemical elements |
| Dr. C.V. Yelamaggad | KAUST, Saudi Arabia; 25-11-2019 to 28-11-2020 | Collaboration work | A New Class of n-Type Discotic Liquid Crystals with $N_3B_3O_3$ Core: Probable Materials for Organic Electronics |
| Dr. Geetha G. Nair | IISERB, Bhopal, India Dec. 5-7, 2019 | To give invited talk at CompFlu 2019 | Liquid Crystal Physical Gels:Smart Functional Materials |
| Dr. Pralay K Santra | Kolkata, 27 - 29 Nov, 2019 | National Conference on Electronic Spectroscopy and Electronic Structure | Variable energy photoelectron spectroscopy to study perovskite nanocrystal |
| Dr. S. Angappane | Kendra Vidyalaya, JIPMER campus, Pondicherry 10.01.2020 | Organized 'Nano Jatha- Lecture series, Road show and Exhibition' | Structural Colors |

| Faculty | Place and period of visit | Purpose of visit | Title of talk |
|---|---|---|---|
| Dr. S. Angappane | Ministry of Earth Sciences, New Delhi 14.01.2020 | To attend the DST Media cell meeting | |
| Dr. S. Angappane | Periyar University, Salem, Tamilnadu 28.02.2020 | To deliver a Science day special lecture | Structural Colors |
| Dr. Ashutosh K. Singh | The Lalit Ashok Hotel, Benagluru, 2-3 March 2020 | Bengaluru India Nano-2020 | For participation in exhibition: A CeNS stall showcased with various prototypes based on CeNS inventions |
| Dr. Ashutosh K. Singh | S. N. Bose National Centre for Basic Sciences, Kolkata, 5-7 March 2020 | International Conference on Nanoscience and Technology (ICONSAT-2020) | Low Cost Hybrid Transparent Conducting Electrodes |

## 19.4 ACADEMIC ACTIVITIES BY RESEARCH STUDENTS AND POSTDOCTORAL FELLOWS

| Sl. No. | Date(s) | Name & Designation* | Name of Conference attended | Presentation mode and Title |
|---|---|---|---|---|
| 1 | 26-27 April 2019 | Indrajit Mondal SRF | NanoIndia conferenceM G University, Kerala | Poster: Patterned Cu mesh based transparent and wearable touch panel for tactile, proximity, pressure and temperature sensing |
| 2 | 14-16 May 2019 | Swathi S P JRF | "Basic Training Program in Nano Science and Technology" under INUP, CeNSE, IISc, Bengaluru | Participated |
| 3 | 29 May 2019 | Gaurav Shukla, Subir Roy, Athira M., SRFs<br><br>Swathi S P, JRF | "International Year of the Periodic Table of Chemical Elements (IYPT)-2019" | Participated |
| 4 | 16-21, June, 2019 | Sunil Walia SRF | Gordon Research Conference on "Clusters and Nanostructures",at Les Diablerets, SwitzerlandSwitzerland | Oral / Poster: Rotated multilayer rapheme: Insights using Raman and SAED pattern |
| 5 | 20-22 June 2019 | Subir Roy SRF | MRS-Singapore Summer School on Magnetic and Spintronics Materials | Poster: Metal-Insulator transition and magnetic properties of $NdNiO_3$ nanoparticles |
| 6 | 23-28 June 2019 | Subir Roy SRF | 10th International Conference on Materials for Advanced Technologies (ICMAT), Singapore | Oral: Ambient synthesis of $NdNiO_3$ nanoparticles |
| 7 | | Athira M SRF | | Oral: Ambient prepared PSCs without HTL showing longer stability |

| Sl. No. | Date(s) | Name & Designation* | Name of Conference attended | Presentation mode and Title |
|---|---|---|---|---|
| 8 | 23-28 June 2019 | Chaitali Sow<br>Research Assistant | 10th International Conference on Materials for Advanced Technologies (ICMAT), Singapore | Poster: Ar+ Ion Induced Generation of a Series of BCT Phases During Phase Transformation of Noncubic Au Microcrystallites to Cubic Lattice<br>&<br>Oral: Noncubic Gold Exhibits Higher Stability in Hg and Aqua Regia than Conventional Gold |
| 9 | | Indrajit Mondal<br>SRF | | Oral: Patterned Cu mesh based transparent and wearable touch panel for tactile, proximity, pressure and temperature sensing |
| 10 | 23-28 June 2019 | Suman Kundu, SRF | 10th International Conference on Materials for Advanced Technologies (ICMAT), Singapore | Poster: Ultrafast humidity sensing by supramolecular nanofibre for real-time breath and hydration monitoring via smart-phone or PC<br>&<br>Oral: Supramolecular nanofibre as a solid-state electrolyte exhibiting 8 v voltage window for high-performance micro-supercapacitor |
| 11 | 22.9.2019-4.10.2019 | Indrajit Mondal, SRF | Collaborative project, IIT Jodhpur, Rajasthan | |
| 12 | 15.10.2019 | Gayathri R Pisharody, JRF<br>PragnyaSatapathy, SRF<br>Marlin Baral, SRF<br>Rajalaxmi Sahoo, SRF<br>Varshini G.V, SRF<br>Madhu Babu Kanakala, SRF<br>Anamul Haque, SRF<br>Radha Jitendra Rathod, JRF<br>Divya Jayoti, RA<br>S. Vimala, RA<br>Nurjahan Khatun, JRF | Symposium on "Emerging Trends in Liquid Crystal Research", CeNS | Participated |
| 13 | 17-18, October 2019 | Ramya Prabhu B, SRF | International Conference on Recent Advances in Applied Sciences (ICRAAS-2019) at REVA University, Bengaluru, India | Oral: Sea urchin-MoO3 nanostructures as an efficient substrate for SERS detection of dyes |
| 14 | 21-23 October 2019 | Pragnya Satapathy, SRF | 26th National Conference on Liquid Crystals (NCLC-2019), Chitkara University, Punjab | Poster: Synergistic path for dual anisotropic and electrically switchable emission from a nanocomposite of $CsPbBr_3$ quantum cuboids and nematic liquid crystal |

| Sl. No. | Date(s) | Name & Designation* | Name of Conference attended | Presentation mode and Title |
|---|---|---|---|---|
| 15 | 21-23 October 2019 | Pragnya Satapathy, SRF | 26th National Conference on Liquid Crystals (NCLC-2019), Chitkara University, Punjab | Poster: Synergistic path for dual anisotropic and electrically switchable emission from a nanocomposite of $CsPbBr_3$ quantum cuboids and nematic liquid crystal |
| 16 | | Madhu Babu Kanakala, SRF | | Oral: Synthesis and characterization of optically active calamitic liquid crystals stabilizing room temperature chiral phases |
| 17 | | Pinchu Xavier, JRF | | Poster:Miscibility studies of some cholesteryl esters at the air-water interface |
| 18 | 5-8 November 2019 | B. N. Veerabhadraswamy, Research Personnel | India International Science Festival (IISF-2019) | Prototype demonstration |
| 19 | 21-22 Nov. 2019 | Navas M.P, RA | National Seminar on Recent Trends in Physics, Sree Neelakanta Govt Sanskrit College, Pattambi, Kerala | Oral:Metamaterials: Artificial materials beyond nature & Oral: Nanomaterials, an Overview |
| 20 | 5 – 7 December 2019 | Brindhu Malani S, SRF | CompFlu 2019, IISER Bhopal | Poster: Spatial dependence of wetting on a hexagonally orderedgold nanostructured substrate of varied morphology |
| 21 | 5 – 7 December 2019 | Pinchu Xavier, JRF | CompFlu 2019, IISER Bhopal | Poster: Cholesteryl nonanoate bilayer at interfaces: Thermal stability and post collapse scenario |
| 22 | 13-15 December 2019 | Muhammed Safeer N K, JRF | Emerging frontiers in Chemical Sciences held at Farook College, Kozhikode, Kerala on 13-15 December 2019. | Poster: High performance electrochemical NRR by $MoO_2$ catalysts |
| 23 | 16 December 2019 | Ramesh Chandra Sahoo, JRF | IGSTC workshop on 'Energy, Materials and Devices' | Poster: Solution Processed Ni2Co Layered Double Hydroxides for High-performance Electrochemical Sensors |
| 24 | | Dr. Sreejesh M, RA | | Oral: Role of transition metals in layered double hydroxides for differentiating the oxygen evolution and non-enzymatic glucose sensing |
| 25 | | Anamul Haque SRF | | Poster and oral talk: Stability of inorganic halide perovskites for optoelectronics |
| 26 | | Suman Kundu, SRF | | Poster and oral: Planar supercapacitor made of aligned supramolecular nanofibre electrolyte exhibiting 8 v potential window |
| 27 | | Indrajit Mondal, SRF<br>Radha Jitendra Rathod, JRF<br>Modasser Hossain, JRF | | Participated |

| Sl. No. | Date(s) | Name & Designation* | Name of Conference attended | Presentation mode and Title |
|---|---|---|---|---|
| 28 | 16.12.2019 | Gayathri R Pisharody, JRF<br>Pragnya Satapathy, SRF<br>Marlin Baral, SRF<br>Rajalaxmi Sahoo, SRF<br>Varshini G.V, SRF<br>Dr. Divya Jayoti, RA | Workshop on "Energy, Materials and Devices", at CeNS | Participated |
| 29 | 18-22 December 2019 | Swathi S P, JRF | "64th DAE Solid State Physics Symposium (DAE SSPS)-2019" IIT Jodhpur | Oral and Poster: Grain boundary assisted bipolar resistive switching in solution-processed NiO films |
| 30 | 11.2.2020-13.2.2020 | Indrajit Mondal | Nano Jatha, IIT Goa, Goa | Participated |
| 31 | 2-4, March 2020 | Ramesh Chandra Sahoo, JRF | 11th Bengaluru India Nano-2020, Bengaluru | Poster: Role of transition metals in layered double hydroxides for differentiating the oxygen evolution and non-enzymatic glucose sensing |
| 32 | | Nurjahan Khatun, JRF | | Poster: Tuning of photonic bandgap via combined effect of electric and optical field in a blue phase liquid crystal composite. |
| 33 | | Indrajit Mondal, JRF | | Prototype and poster: $SnO_2$ coated large area Aluminum micromesh as low-cost transparent conducting electrode for liquid crystal-based smart window |
| 34 | 2-4 March 2020 | Marlin Baral, SRF | 11th Bengaluru India Nano, Bengaluru | Poster: Graphene-augmented electrically switchable liquid crystal smart window |
| 35 | | Madhu Babu Kanakala, SRF | | Poster: Liquid crystalline Bimetallic Nanoparticles: Synthesis and Characterization of Core-Shell Ag/Au Nanoparticles Coated with Dimer-like Mesogenic ligands |
| 36 | 2-3 March 2020 | Gaurav Shukla, SRF | | Poster: Self-Cleaning Structural Colors by $TiO_2$/Ti Nanostructures |
| 37 | | Brindhu Malani S, SRF | | Poster: Wettability studies on hexagonally ordered gold microstructured substrate: Influence of morphology and Functionalization |
| 38 | 3-4 March, 2020 | Ramya Prabhu B, SRF | | Poster: Sea urchin-$MoO_3$ nanostructures as an efficient substrate for SERS detection of dyes |

| Sl. No. | Date(s) | Name & Designation* | Name of Conference attended | Presentation mode and Title |
|---|---|---|---|---|
| 39 | 5-7 March 2020 | Gaurav Shukla, SRF | International Conference on Nano Science and Technology (ICONSAT 2020), Kolkata | Poster: Self-Cleaning Structural Colors by $TiO_2$/Ti Nanostructures |
| 40 | | Subir Roy, SRF | | Poster: Size dependent effects on metal-insulator transition and magnetic properties of $NdNiO_3$ nanoparticles |
| 41 | | Prashanth Nayak, SRF | | Poster: Self-affine Langmuir Blodgett films of Nickel octabutoxyphthalocyanine doped with stearic acid. |
| 42 | | Anamul Haque, SRF | | Poster: Mechanism and kinetics of interparticle mixing of $CsPbBr_3$ and $CsPbI_3$ nanocubes |

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

## 19.5 CONFERENCE / SYMPOSIA / SEMINARS / WORKSHOPS ORGANIZED

IYPT-2019: To commemorate its formulation by Dmitry Mendeleev 150 years ago, UNESCO declared 2019 as the International Year of the Periodic Table of Chemical Elements (IYPT-2019). CeNS, jointly with Indian Institute of Science (IISc) and Jawaharlal Nehru Centre for Advanced Scientific research (JNCASR) organized a unique science programme conducted at the J.N. Tata Auditorium in the IISc campus on 29th May in which about 700 pre-university level students were invited from 23 different colleges from in and around the City. The seating arrangement itself was carefully designed to have the participants "wear different colours" so as to create a "human periodic table." A series of lectures focussing on different dimensions of the periodic table and the scientists behind its creation were well articulated by eminent researchers, led by Bharat Ratna Prof. C. N. R. Rao, FRS. In the afternoon the whole auditorium complex looked like a carnival with activities like Elements at work involving experiments, interactive quiz, dumb charades, play & win game shows, all highlighting the close association between elements and the periodic table along with a skit on Mendeleev and other great names associated with the periodic table.

As a prelude to 11th Bengaluru Nano INDIA Expo, and to inspire young students in the field of Nano Science and Nanotechnology events labelled NanoJathas were conceptualized by the Vision Group on Science and Technology, Government of Karnataka under the mentorship of Bharat Ratna Prof. C N R Rao, FRS. CeNS organized the events jointly with Karnataka Science and Technology Promotion Society (KSTePS) in selected places around the country. The events were held at Dharwad, Laxmeshwara, Mangaluru, Mysuru, Pondicherry, Jaipur, Jodhpur, Barmar (Rajasthan), Delhi, Pune, Goa, Gudlavalleru (Vijayawada) and Bengaluru. Apart from lectures and science quiz, the students were led through demonstration of the nano kits which were developed specially for the Jatha.

CeNS organized a one-day symposium titled "Emerging Trends in Liquid Crystal Research" on 15 October 2019. Speakers from prestigious institutes from all over the country presented their recent findings covering various topics in the field of liquid crystals and related soft materials research to an audience of nearly 80 research students and scientists. As part of the event, the 60th birthday of Dr. S. Krishna Prasad, an eminent liquid crystal scientist, was celebrated given his valuable contribution to the field of liquid crystal science. Convenors: D.S Shankar Rao and Geetha G. Nair.

One day workshop, "Energy, Materials and Devices," was held at Arkavathi Campus, CeNS, on 16 December 2019. Talks and posters primarily discussed on photovoltaics, battery and supercapacitor, electrochemistry, and photocatalysis. This programme was the first technical workshop at the Arkavathi Campus.

**Workshop on "Energy, Materials and Devices", Arkavathi**

Three Day PG Special Workshop on "Nano Science and Technology" was inaugurated at Arkavathi campus and gave presentation on 'An overview of the Workshop', January 22-24, 2020, organized by CeNS and KSTA jointly. During the event, organized a visit to research facility at the Arkavathi campus, conducted quiz on Nanoscience and Technology, IYPT games to the visiting 85 PG students from all over Karnataka.

# ANNEXURE – A

## In Refereed Journals

1) Narrowing desiccating crack patterns by an azeotropic solvent for the fabrication of nanomesh electrodes, Rajashekhar Pujar, Ankush Kumar, K. D. M. Rao, SuptiSadhukhan, Tapati Dutta, Sujata Tarafdar& G. U. Kulkarni, *Langmuir*, **35,** 49, 16130–16135, (2019) [DOI: 10.1021/acs.langmuir.9b02442], IF: 3.683
2) Formation of two-dimensional network of organic charge-transfer complexes at the air–water interface, Bhattacharyya, M. K. Sanyal, U. Mogera, S. J. George, S. Dhiman, G. U. Kulkarni & P. Fontaine, *Langmuir,* **35,** 39, 12630-12635, (2019) [DOI: 10.1021/acs.langmuir.9b01635] IF: 3.683
3) A new twist in graphene research: Twisted graphene, U. Mogera & G. U. Kulkarni, *Carbon,* **156,** 470-487, (2019) [DOI: 10.1016/j.carbon.2019.09.053] IF: 7.466
4) Hybrid transparent conducting glasses made of metal nanomesh coated with metal oxide overlayer, K. Singh, R. K. Govind & G. U. Kulkarni, *Mater. Chem. Phys.,* **239,** 121997, (2019)[DOI: 10.1016/j.matchemphys.2019.121997] IF: 2.781
5) Patterned Cu mesh based transparent and wearable touch panel for tactile, proximity, pressure and temperature sensing, S. Walia, I. Mondal & G. U. Kulkarni, *ACS Appl. Elec. Mater.,* **1,** 8, 1597-1604, (2019) [DOI: 10.1021/acsaelm.9b00330], IF: 8.456
6) A planar supercapacitor made of supramolecular nanofibre based solid electrolyte exhibiting 8 V window, S. Kundu, U. Mogera, J.G. Subi& G. U. Kulkarni, *Nano Energy,* **61C,** 259-266, (2019) [DOI: 10.1016/j.nanoen.2019.04.054] IF: 15.548
7) A solution-based fast fabrication of a high-performance unlimited area Au nanostructure/Si heterojunction photodetector, B. Bannur, K.D.M. Rao, K. N. Harish & G. U. Kulkarni, *ACS Appl. Elec. Mater.,* **1 (4),** 577–584, (2019) [DOI: 10.1021/acsaelm.9b00031] IF: 8.456
8) A spring network simulation in 3 dimensions for designing optimal crack pattern template to fabricate transparent conducting electrodes, S. Sadhukhan, A. Kumar, G. U. Kulkarni, S. Tarafdar & T. Dutta, *Bull. Mater. Sci,* **42:197** (2019), [DOI: 10.1007/s12034-019-1826-0] IF: 1.264. IF: 1.392
9) Photoisomerization-driven photoluminescence modulation in CdSeS gradient quantum dot/liquid crystal nanocomposite, PragnyaSatapathy, V.Navyashree, Pralay K. Santra, and S. Krishna Prasad, *Chem. Photo. Chem.* doi: 10.1002/cptc.201900293 (2020) (I.F- 2.838)
10) Enhanced photoluminescence in a chiral nematic liquid crystal through polymer stabilization and an erasable 3-state memory device, M.Baral, V.N.Veerabhadraswamy, S.K.Prasad, C.V.Yelamaggad, *Journal of Molecular Liquids,* **292,** 111338 (2019) (I.F= 4.561).
11) Synergistic path for dual anisotropic and electrically switchable emission from a nanocomposite of $CsPbBr_3$ quantum cuboids and nematic liquid crystal, *Crystals, Invited article in Special Issue on Liquid Crystals,* **9,** 378 (2019) (I.F= 2.14)
12) Effect of graphene flakes, titanium dioxide and zinc oxide nanoparticles on the birefringence, I–V characteristics and photoluminescence properties of liquid crystal, N. Pushpavathi, K.L. Sandhya and S. Krishna Prasad, *Journal of Molecular Liquids,* **302,** 112571(2020) (I.F= 4.561)
13) Influence of gold nanorods on the structure and photonic bandgap in a twistgrain boundary phase with smectic C* blocks, Rajalaxmi Sahoo, D.S. Shankar Rao, U.S. Hiremath, C.V. Yelamaggad, P. Shinde, B.L.V Prasad, and S. Krishna Prasad, *Journal of Molecular Liquids,* **299,** 112117-1-10, (2020). IF= 4.561
14) Dielectric and electro optic studies in the vicinity of the transition between two tilted hexatic phases of a ZnO-liquid crystal nanocomposite, K.L. Sandhya, N. Pushpavathi, D.S. Shankar Rao, S. Krishna Prasad, *Journal of Molecular Liquids,* **302,** 112508-1-8 (2020). IF= 4.561.
15) Effect of regioisomerism on the self-assembly, photophysical and gelation behavior of aroylhydrazone based polycatenars: Synthesis and characterization, P. Kanth, H. K. Singh, Vijay Kumar, S. K. Singh, D. S. Shankar Rao, S. Krishna Prasad and Bachcha Singh, *Journal of Molecular Liquids,* **289,** 111133-1-13 (2019). IF= 4.561
16) Suppression of the reentrant nematic and stabilization of the smectic phases by carbon nanotubes, G.V. Varshini, D.S. Shankar Rao, P.K. Mukherjee, S. Krishna Prasad, *Journal of Molecular Liquids,* **286,** 110858-1-13(2019). IF= 4.561
17) Synthesis and self-assembly of aroylhydrazone based polycatenars: a structure-property correlation, Hemant Kumar Singh, R. K. Gupta, S. K. Singh, D. S. Shankar Rao, S.Krishna Prasad, A.S. Achalkumar and B. Singh, *Journal of Molecular Liquids,* **284,** pp 282-290 (2019). IF= 4.561
18) Photoluminescent nickel(II)-metallomesogens derived from salphen ligands: influence of halogens at the spacer on mesomorphism and emission properties, S. Chakraborty, S. Krishna Prasad, D. S. Shankar Rao and C. R. Bhattacharjee, *Liquid Crystals* **46,** pp 872-883 (2019). IF= 3.078
19) Grafting a mesomorphic Schiff base onto gold nanoparticle via ester link–photoluminescence, mesomorphism, electrical conductivity and antioxidant activity N. Das, D. Borah, H. Acharya, S. Choudhury, S. Krishna Prasad, D.S. Shankar Rao, and C.R. Bhattacharjee, *Liq. Cryst.,* **46,** p 609-617 (2019) IF= 3.078
20) Mechanochemical synthesis and temperature dependent optical poroperties of thermochromic (Ag 1-x Cux)2 HgI4, K Maji, P Acharry, P Satapathy, S K Prasad, K Biswas, *Chem. Asian J.* **14,** 4641 (2019) IF= 3.698
21) Effect of alkoxy chain density on the mesogenic properties of aroylhydrazone based liquid crystals: synthesis, characterisation, photophysical and gelation behavior P. Kanth, H. K. Singh, V. Kumar, S. K. Singh, D. S. Shankar Rao, S. Krishna Prasad and B, Singh, *Liq. Cryst., (in press);* https://doi.org/10.1080/02678292.2020.1725164 IF= 3.078 (in press)

22) Evidence of tunable fano resonance in a liquid crystal based colloidal metamaterial, Amit Bhardwaj, Vimala Sridurai, Navas MelethP uthoor, Aswathi B. Nair, Tripti Ahuja, and Geetha G. Nair, *Advanced Optical Materials,* DOI: 10.1002/adom.201901842. Impact Factor: 7.430

23) Formation of selenium superstructures: Self-assembly of monodispersed sub-micron spheres and nanorods, Aswathi B Nair, Navas M P and Geetha G Nair, *Applied Surface Science,* DOI: 10.1016/j.apsusc.2020.145862 Impact factor: 5.155

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# ANNEXURE – B

### V4 Science Programme @ CeNS

| Sl. No. | Date | Institution Name and Address | Participation Details | | Topic |
|---|---|---|---|---|---|
| | | | Student | Staff | |
| 1 | 20.02.2019 | School Chandan, Laxmeshwar, GadagDist, Sagara Science Forum, Sagara, Shimoga Dist | 50 | 4 | Mimicking nature |
| 2 | 13.07.2019 | Jawahar Navodhya Vidyalaya, Bengaluru | 42 | 2 | Nanolithography |
| 3 | 27.07.2019 | Army Public School, K Kamaraja Road, Bengaluru | 40 | 2 | Visible and invisible light |
| 4 | 31-08-2019 | PUC students who visited CeNS - CVY | 40 | 2 | Noble Prize-winning chemistry problems Related to day-to-day life |
| 5 | 15.09.2019 | BEL School | 30 | 3 | Star in a jar |
| 6 | 07.11.2019 | BEL High School, Bengaluru | 25 | 2 | C V Raman and his journey into light |
| 7 | 21.12.2019 | Jawahar Navodaya Vidyalaya, Doddaballapura | 41 | 2 | Visible and invisible light |
| 8 | 25.01.2020 | BEL PU Collge | 55 | 2 | Nanoscience: The new and big science of small |
| 9 | 27.02.2020 | Nanojatha@CeNS | 80 | | Elucidation of nanoscience in daily life |
| 10 | 08.02.2020 | B M High School, Bengaluru | 40 | 2 | A glimpse into the world of soft materials |
| 11 | 27.02.2020 | Nanojatha Event at CeNS, Bengaluru | 55 | 3 | Nanoscience: The new and big science of small |

### V4: Science Programme @ your Institution

| Sl. No. | Date | Institution Name and Address | Participation Details | | Topic |
|---|---|---|---|---|---|
| | | | Student | Staff | |
| 1 | 28.05.2019 | District Science Centre, Kalaburgi | 60 | 5 | Liquid crystals: Science and technology |
| 2 | 13.06.2019 | BMS College of Engineering, Bengaluru | 120 | 15 | C V Raman and his journey into light |
| 3 | 21.06.2019 | National Institute of Technology, Telanganau | 150 | 5 | Visible and invisible light |
| 4 | 20.08.2019 | KSTA and Tumkur University | 100 | 10 | Elucidation of nanoscience in daily life |
| 5 | 27.08.2019 | Bishop Cotton Women's College, Bengaluru | 150 | 5 | A glimpse into the world of soft materials |
| 6 | 06.09.2019 | Higher Education Academy, Dharwad | 500 | | Mimicking nature |
| 7 | 06.09.2019 | Nano Jatha, CeNS, Bengaluru | 200 | | Mobile phones work because of crystals that flow |
| 8 | | Nano Jatha, CeNS, Bengaluru | 200 | | |
| 9 | 06.09.2019 | Higher Education Academy, Dharwad | 500 | | Nanoscience: The new and big science of small |
| 10 | 19.09.2019 | Basaveshwar High School, Bagalkot | 300 | 12 | Noble Prize winning problems related to our day-to-day life |
| 11 | 20.09.2019 | Darbar PU College, Bijapur | 400 | 8 | Noble Prize winning problems related to our day-to-day life |
| 12 | 20.09.2019 | Standard Cadets of Sainik School, Bijapur | 150 | 10 | Liquid crystals - Fourth state of matter: Life, science and technology |

| Sl. No. | Date | Institution Name and Address | Participation Details | | Topic |
|---|---|---|---|---|---|
| | | | Student | Staff | |
| 13 | 10.10.2019 | SASTRA Deemed University | 200 | 4 | Noble Prize-winning chemistry problems related to day-to-day life |
| 14 | 19.10.2019 | Raichur High School | 31 | 4 | Liquid crystals : Life, science and technology |
| 15 | 22.10.2019 | GurunankDev University, Amritsar, | 150 | 4 | Organic materials for electronic devices: Facile synthesis & characterization of tris(boranil)s |
| 16 | | Government Senior Secondary Smart School, Chheharta, Amristar | 50 | 5 | Liquid crystals : Life, science and technology |
| 17 | | Government Girls Senior Secondary School, Mall Road, Amritsar | 500 | 15 | |
| 18 | 18.11.2019 | KakarapartiBhavanarayana College, Kothapeta, Vijayawada | 200 | 5 | Liquid crystals: Science and technology |
| 19 | 18.11.2019 | AcharyaNagarjuna University, Nagarjuna Nagar, Guntur, Andhra Pradesh | 150 | 10 | Liquid crystals: Life, science, and technology |
| 20 | 23.11. 2019 | MAHE, Manipal | 150 | | Star in a jar |
| 21 | 29.11.2019 | BMS Institute of Technology & Management, Yelahanka | 100 | 5 | Nanoscience: The new and big science of small |
| 22 | 12.12.2019 | School Chandan, Lakshmeswar, Hubbali | 250 | 10 | Visible and invisible light |
| 23 | 11.01.2020 | JSS College of Higher Education and Research, Mysore | 200 | | Nanomaterials as light source? |
| 24 | 18.01.2020 | Dept. of Chemistry, IIT Jodhpur | 15 | | Microscopic techniques |
| 25 | 19.01.2020 | Jawahar Navodaya Vidyalaya, Barmer | 100 | 5 | Seeing is believing |
| 26 | 12.02.2020 | Nanojatha@IIT Goa, Goa | 80 | | Glimpse of nanoscience and nanotechology |
| 27 | 21.02.2020 | Siddaganga Institute of Technology, Tumkur | 50 | 4 | Nanolithography |
| 28 | 28.02.2020 | Vijnana Bhavana, KRVP, Bengaluru | 300 | 5 | Synthesis of liquid crystals |
| 29 | 28.02.2020 | School Chandan, Laxmeshwar, Gadag | 60 | 10 | C V Raman and his journey into light (National science day lecture) |
| 30 | 28.02.2020 | School Chandan, Laxmeshwar, Hubballi | 100 | | Sir C.V. Raman and his journey into light |
| 31 | 06.03.2020 | St Agnes College Mangaluru | 172 | 6 | (i) Liquid crystals: Basics and applications<br>(ii) Viscoelastic response of soft materials |

# ANNEXURE – C

| Sl. No. | Name of ROI student | Name of the Parent Institute | Project title & duration | Research Mentor |
|---|---|---|---|---|
| 1 | Anu Vashishtha | Uttaranchal University, Dehradun, Uttarakhand | Microsupercapacitor with different electrolyte for high areal capacitance | G.U.Kulkarni |
| 2 | Nithyashree | Indian Academy of Sciences | A study on effect of UV illumination on spin coated ZnO based gas sensors. | |
| 3 | James Oinam | University of Mysore, Mysore, Karnataka | Influence of polymer network on photoluminescence from quantum dots/liquid crystal composite | S. Krishna Prasad |
| 4 | Jobin Jose | University of Calicut, Kozhikode, Kerala | Nanoparticle-pluronic hybrid gels as tunable SERS substrate for biomolecule detection | |
| 5 | Aswathi B Nair | Central University of Rajasthan, Ajmer, Rajasthan | To synthesis mono-disperse dielectric/ semiconducting submicron-sized particles for the purpose of metamaterials fabrication | Geetha G. Nair |
| 6 | Ravika Patil | Srinivas Institute of Technology, Mangalore, Karnataka | (a)The size-control of sub-micron sized spherical selenium particles by varying the reaction parameters (b) Optical studies of $TiO_2$ nanoparticles in nematic liquid crystal | |
| 7 | Vinay A | Indian Academy Degree College – Autonomous, Kalyan Nagar, Bengaluru - | Effect of metal oxide nanorods (ZnO) on the properties of TGBC* phase | D.S Shankar Rao |
| 8 | Dipesh Dubey | Central University of Jharkhand, Ratu, Jharkhand | Influence of a soft bent core on the dielectric properties of ferroelectric material | |
| 9 | Ashwini Arunkumar | Manipal Institute of Technology, Manipal, Karnataka | Influence of an electron acceptor on the structure and photoluminescence of a discotic donor fluorophore | |
| 10 | Sneha Mathew | Christ (Deemed to be University), Bengaluru, Karnataka | Synthesis and characterization of some thermotropic nematoges | Veena Prasad |
| 11 | Darren Sebastian Christi | NITK, Surathkal | Synthesis and mesomorphic properties of some azo compounds | |
| 12 | Basavaraj M. Patil | Sri Dharmasthala Manjunatheshwara College, Dharmasthala, Karnataka | Synthesis and characterisation of hydrogen bonded liquid crystalline compounds | |
| 13 | Ranu Satish Dhale | National Institute of Science Education and Research, Bhubaneswar, Odisha | Synthesis and characterization of intermediates for liquid crystals | C.V. Yelamaggad |
| 14 | Sannakki Uday Kumar | VTU University, Bengaluru | Application of organic molecukes and MOFs in OFETs | |
| 15 | Trilok Kumar Gaur | Kota University, Kota, Rajasthan | Synthesis and characterization of key precursors for TSANS discotic and bent core liquid crystals | |

| Sl. No. | Name of ROI student | Name of the Parent Institute | Project title & duration | Research Mentor |
|---|---|---|---|---|
| 16 | Mariya Aby | University of Calicut, Kozhikode, Kerala | Design, synthesis and characterization of bent core trimers | C.V.Yelamaggad |
| 17 | Krishnaraja Acharya | INM Technologies, Bengaluru | OFETs Design and Development | |
| 18 | Anju K.Sasidharan | St. Joseph's College Devagiri, Kozhikode, Kerala | Synthesis and characterization of optically active liquid crystals | |
| 19 | Jagi Rout | Central University of Karnataka, Kalaburagi, Karnataka | Aluminium battery with graphite and modified graphite electrodes | S. Angappane |
| 20 | Iniyan | K S Rangasamy College of Technolgy, Tamil Nadu | Synthesis and characterisation of CoFe2O4 – rGO Nanocomposite thin films | |
| 21 | Femy Francis | NIT Tiruchirapalli Tamil Nadu | Magnetic nanoparticles composites | |
| 22 | Rajapandy | Bharathidhasan University, Tiruchirapalli, Tamil Nadu | Structural and morphological studies on sublimed zinc phthalocyanine | P. Viswanath |
| 23 | Gowri Priya | K S Rangaswamy College of Technology, Namakkal, Tamil Nadu | Reduced graphene oxide- $MoS_2$ thin films | Neena S John |
| 24 | Debabrat Kotoky | Reva University, Bengaluru | Double hydroxides | |
| 25 | Meenakshi Varier | Amrita Institute, Kochi, Kerala | Molybdenum oxide –Ag nanostructures for SERS applications | |
| 26 | Elsa Shobby | University of Caliut, Kozhikode, Kerala | Synthesis of lead free $Cu_3SnS_4$ quantum dots for solar cells | Pralay K. Santra |
| 27 | Arbind Luha | NIT Warangal, Warangal, Telangana | Control conversion of $CsPbBr_3$ to $CsPb_2Br_5$ | |
| 28 | Mouli Roy Chowdhury | Delhi University, New Delhi | Synthesis of CTS nanoparticles and its characterization | |
| 29 | Jaikrishna. R | Amity University, Noida | Fabrication of methylammonium lead iodide solar cells | |
| 30 | Vishnu Priya H. R | Bengaluru University, Bengaluru | Visible light photoluminescence based gas sensing | |
| 31 | Udupa Sujit Manjunath. | Manipal Academy of Higher Education, Manipal, Karnataka | One step sulphidation of Gallium Oxide to form Gallium (III) Sulphide | H. S. S. Ramakrishna Matte |
| 32 | Rebecca Linal Martin | Srinivas School of Engineering, Mangalore, Karnataka | Layered cobalt oxyhydroxide for biosensing applications | |
| 33 | P. Harsha | Kerala University, Tiruvananthapuram, Kerala | In situ decoration of Au nanoparticles on stabilizer-free aqueous $MoS_2$ dispersions | |


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