CeNS

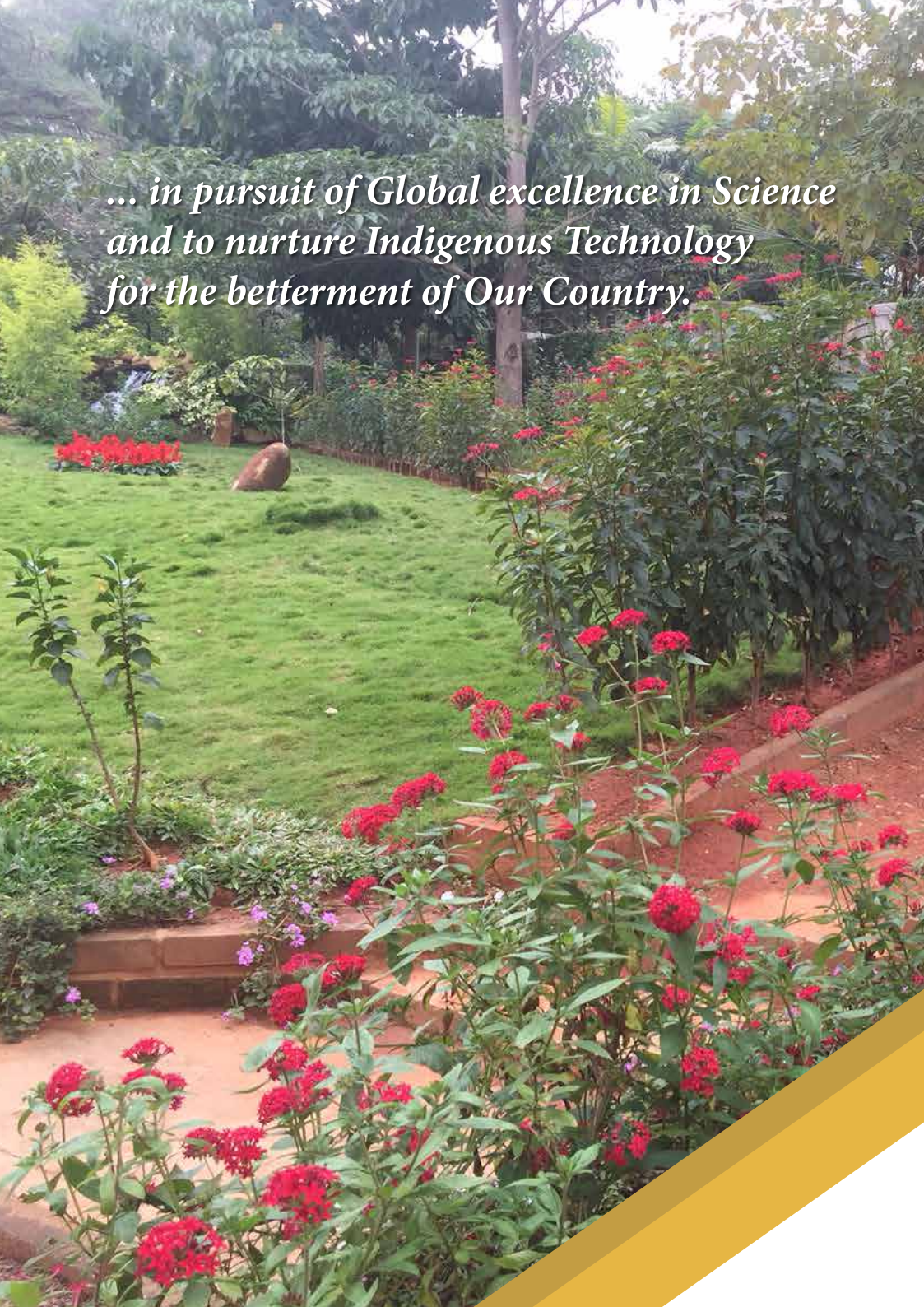
2017

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.

CONTENTS

ABOUT CeNS

The Centre for Nano and Soft Matter Sciences (CeNS) is an autonomous research institute under Department of Science and Technology (DST), Government of India. 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. CeNS is located in Jalahalli, Bengaluru.

It was established in 1991 as Centre for Liquid Crystal Research by eminent liquid crystal scientist Prof. S. Chandrasekhar, FRS. In 1995, it became an autonomous institute under the Department of Electronics (DOE), Government of India and in 2003 was brought under DST. Subsequently in the year 2010, the name was changed to Centre for Soft Matter Research. Recently, in 2014, the Centre widened the scope of research activities to embrace nano science and technology and is now known as Centre for Nano and Soft Matter Sciences (CeNS). It is being mentored by Nano-Mission of Government of India.

The Centre is engaged in Materials research at all relevant length scales. Specifically, the current activities are focused on a variety of metal and semiconductor nanostructures, liquid crystals, gels, membranes and hybrid materials. The researchers strive to take the in-house inventions towards technology realisation. The Centre has close interactions with many Institutions and Industry, in India and abroad.

Currently, CeNS is located inside Bharath Electronics Ltd campus, Jalahalli. On its new campus at Shivanapura, Bengaluru North, the laboratory and incubation centre buildings are nearing completion.

SHIVANAPURA CAMPUS

Bhoomi Pooja for the construction of laboratories at the CeNS Shivanapura campus was conducted on 19 May 2017. Bharat Ratna Prof. C.N. R. Rao, F.R.S., Chairman, Governing Council and dignitaries including the members of Governing Council and Research Advisory Board graced the occasion.

The building work is in progress for the new laboratories at Shivanapura campus.

GOVERNING COUNCIL

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Veena Prasad
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Scientist D

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Neena S. John
Pralay K. Santra

Scientist C

H.S.S.R. Matte

Honorary Professor

K. A. Suresh, FNASc, FNA

RESEARCH ACTIVITIES

At nanoscale, matter behaves differently, depending sensitively on the size and shape. Soft on the other hand, stands for interactions at relatively longer length scale and the combination, Nano and Soft, essentially signifies the overall control on wide ranging material properties, be it electronic, optical, magnetic, thermal, mechanical or rheological. Thus, the research activities in the Centre are focussed on realizing nanomaterials through novel synthetic methods, manipulation and control of material properties and translating them to potential products by up-scaling and prototyping. The researchers at the Centre work in close collaboration to realize a comprehensive picture of the materials in addition to broadening the scope of the scientific activities. The collaboration extends to other scientific groups, in India and abroad, resulting in dissemination of knowledge and publication of important papers.

RESEARCH HIGHLIGHTS

- Inorganic nanomaterials
- Electrochemical water activation
- Electroactive molecular systems
- Transparent & flexible electronics
- Twisted Graphene stacks
- Unusual forms of Gold
- Supramolecular devices
- Resistive switching in oxide thin film
- Magnetic and magnetotransport properties of thin films of lanthanum peroxides
- Magnetic nanoparticles for magnetic memory applications
- Textured thin films by GLAD
- Organic solar cells
- Printed electronics
- Layered materials for energy storage and conversion
- Dielectric materials for high frequency applications
- Quantum dot and perovskite photovoltaics
- Photoelectron spectroscopy of photovoltaic materials
- Luminescence based sensors
- Growth of dielectric materials by Atomic Layer Deposition (ALD)
- Electrically tunable soft photonic gel formed by blue phase liquid crystal for switchable colour-reflecting mirror
- Helical twisting power change-induced pitch modulation of cholesteric LC
- Fast electrically switchable anisotropic photoluminescence in a guest-host system
- Polymer stabilization of bent core nematic

contd.,

- Gold nanorod/nematic composites
- Binary system exhibiting twist bend nematic phase transition
- Viscoelastic behavior of composites comprising strongly polar bent-core and rodlike nematic molecules
- Influence of nanoparticle network on the activation enthalpy in the N phase under isobaric/isothermal conditions.
- Nematic liquid crystals composed of smectic nanoclusters
- Mesogens composed of achiral non-linear molecules
- Discotic liquid crystals for electronic devices
- Mesoporous & macroporous motifs for various proto-type devices
- Metal nanoparticles (MNPs) functionalized with LCs
- Impact of good and swelling solvents on the Langmuir and Langmuir-Schaefer films of poly(vinylidene fluoride)
- Langmuir-Schaefer multilayer of the blends of amorphous and ferroelectric semi-crystalline polymer
- Spreading and retraction dynamics of dye doped liquid crystal domains at air-water interface
- Electrical conductivity in Langmuir –Blodgett films of n-alkyl cyanobiphenyls
- Charge transport in monolayer films of liquid crystalline polymer
- Switching of molecular packing in cholesteryl laurate and self-assembly of cholesteryl esters at interfaces

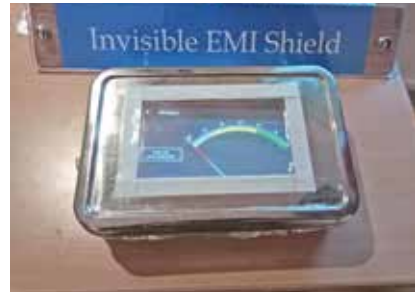
RESEARCH GRANTS

The Centre, in addition to the core funding from DST, received extramural funding from SERB, WOS-A and Nanomission projects. CeNS also bagged a project from DST Nanomission with industry as the collaborating partner.

INDUSTRY INTERACTION

CeNS signed an MoU with Hindustan Petroleum Corporation Ltd (HPCL) on 27 February 2017 to find value addition to industrial carbon waste under the "Swachh Bharath" programme. A project (funded by DST Nanomission) with Hind High Vaccum Pvt. Ltd., Bengaluru, will manufacture oxide coated metal mesh based transparent conducting plates. A technology knowhow transfer agreement was signed with Lab Engineers (India) on 22 May 2017 to commercialize a low cost projection lithography system.

PROTOTYPE GALLERY



The gallery houses about fifteen demonstrable prototypes and attracts visitors from Industry/Academic on a regular basis. The new prototypes developed during the year 2017 are:

- Luminescence based Lead Sensor
- Instant principle is based on exothermic reaction Hot Packs
- Invisible EMI shield
- Detecting the Unseen
- Breath RHgram

Contact: prototype@cens.res.in

S ANGAPPANE

S Angappane obtained Ph.D. (2004) in Physics from Indian Institute of Technology (IIT) Madras. He was a post doctoral fellow at Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), Bengaluru and SungKyunKwan University, Korea, before joining CeNS in 2008.

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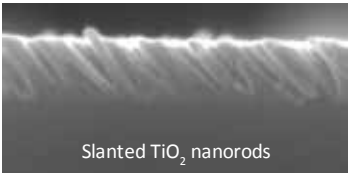
RESEARCH HIGHLIGHTS

RESISTIVE SWITCHING IN ZNO THIN FILM: We have studied the resistive switching in RF sputtered ZnO thin films deposited on Pt/TiO_2/SiO_2/Si substrate with two different top electrodes, such as Ag and Al. For a taken deposition condition, the devices showed the resistive switching behavior after few days of deposition of the top electrode and it disappeared after few weeks. We have shown the aging based filament formation and found the increase of conducting filaments above a threshold ends the switching. *Phys. Status Solidi B, DOI: 10.1002/pssb.201700208 (2017)*

MAGNETIC AND MAGNETOTRANSPORT PROPERTIES OF Bi DOPED $La_{0.67}Sr_{0.33}MnO_3$: In search of new multiferroic materials, Bi with lone pair of electrons was doped in the well known ferromagnetic compound, $La_{0.67}Sr_{0.33}MnO_3$. We observed competition of ferromagnetic and antiferromagnetic phases and large magnetoresistance. *Phys. Status Solidi B, DOI: 10.1002/pssb.201700194 (2017).*

MAGNETIC NANOPARTICLES FOR MAGNETIC MEMORY APPLICATIONS: In magnetic nanoparticles, the core/shell or core/surface spin structures easily provide the exchange bias and the required large magnetoresistance suitable for memory applications. However, the challenge lies in making the nanoparticles composite or self assembly, with less spin scattering at the interface. We study the exchange bias and magneto-resistance/capacitance properties of NiO nanoparticles synthesized by sol-gel methods. *Work in progress.*

TEXTURED THIN FILMS BY GLAD: Nanostructures namely, chevron, slanted and vertical posts were deposited by glancing angle deposition (GLAD) technique using e-beam or sputtering depositions. Various device applications of textured films are being explored. *Work in progress.*


Slanted TiO_2 nanorods

https://www.cens.res.in/faculty/angappane/profile

C V Yelamaggad

C V Yelamaggad obtained his Ph.D. (1992) in Chemistry from Karnatak University. He was a post doctoral fellow at Indian Institute of Science, Bangalore and at National Chio Tung University, Taiwan before joining CeNS in 1997.

Ph.D students

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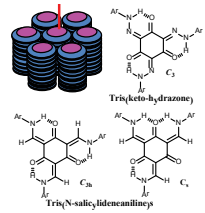
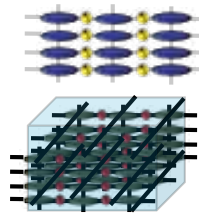
RESEARCH HIGHLIGHTS

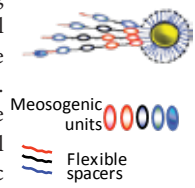
DISCOTIC LIQUID CRYSTALS FOR ELECTRONIC DEVICES: The molecular design and synthesis of organic materials suitable for thin-film electronic devices are pursued actively. In particular a range of discotic (disk-like) liquid crystals (LCs) capable of exhibiting columnar (Col) phase well below and above the room temperature have been realized. Such discotics derived either from tris (keto-hydrazone) or tris (N-salicylideneaniline) cores show promising photoluminescence and redox behaviour. These motifs with n-type / p-type characteristics are expected to serve as the ideal media for making prototype thin-film organic solar cells.



MESOPOROUS & MACROPOROUS MOTIFS FOR VARIOUS PROTO-TYPE DEVICES: We are engaged in the strategic design, synthesis and characterization of mesoporous and macroporous materials such as covalent organic frameworks, metal-organic hybrid frameworks including coordination polymers incorporating a wide range of organic-ligands and metal-centres. Owing to their potential as functional materials, featuring 1D, 2D, or 3D architecture, may find applications in various device fabrications.



Metal nanoparticles (MNPs) functionalized with LCs: One of our recent studies involves binding of NPs with multifunctional oligomeiric LCs to realize single-component LC-NP hybrids. These thermotropic hybrids show the properties of polymers, while still retaining the fluidity and anisotropic properties of the low molar mass LCs as well as NPs. Thus they have the potential to generate multifunctional networks capable of serving as vital media in wide range of applied and fundamental research areas.



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Geetha G Nair

Geetha G Nair is a Ph.D. (1993) in Physics from Raman Research Institute (RRI), Bengaluru. She was a Post Doctoral Fellow at RRI and later worked as a visiting scientist at Kent State University, USA. Currently she is working as a scientist at CeNS.

Ph.D students

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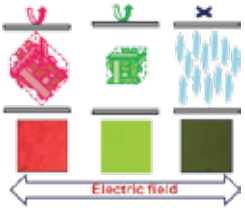
RESEARCH HIGHLIGHTS

ELECTRICALLY TUNABLE SOFT PHOTONIC GEL FORMED BY BLUE PHASE LIQUID CRYSTAL FOR SWITCHABLE COLOUR-REFLECTING MIRROR: Blue phase liquid crystals (BPLC) with their inherent periodic cubic structure can be considered as 3D photonic crystal systems with stop band in visible wavelengths. In this work, the effect of gelation on the electric field driven tuning of photonic band gap is explored in a BPLC by adding a low molecular weight organogelator. The wavelength tunability is reversible and the switching of the selective reflection colour between red (zero field) and green (with field) is highly repeatable. The highlight of the study is that the reflecting coloured BP can be driven to helix unwound nematic state at higher fields bringing in the possibility to fabricate a tunable mirror device. *See: ACS Appl. Mater. Interfaces, 2017, 9, 39569-39575*



HELICAL TWISTING POWER CHANGE-INDUCED PITCH MODULATION OF CHOLESTERIC LC: Cholesteric LC (CLC), due to the presence of macroscopic helix, give rise to finger print texture acting like a diffraction grating with a periodicity in the range of a few to tens of micrometers. The pitch of the helix, responsible to the grating can be easily tuned by external fields such as temperature, electric field, optical field etc. In the present study, a CLC obtained by the addition of small concentration of a chiral dopant to a nematic LC exhibited a right handed helical pitch at ambient temperatures. Upon heating, pitch diverges leading to unwinding of the helix resulting in a compensated nematic phase. On further heating the composite, a left-handed helical superstructure is formed before finally transforming to the isotropic phase. Such tunability of helical pitch and thus the grating spacing is promising in beam steering applications. *See Adv. Mater. 2017, 29, 1700676(1-5)*

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G U KULKARNI

G U Kulkarni obtained his Ph. D (1992) in Solid State and Structural Chemistry from Indian Institute of Science. He was a post doctoral fellow at Cardiff University, UK, before joining Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR) in 1995. He took charge as Director, CeNS in April 2015.

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RESEARCH HIGHLIGHTS

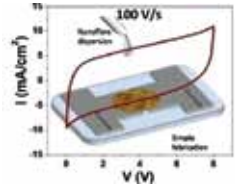
TRANSPARENT & FLEXIBLE ELECTRONICS: Visibly transparent yet electrically conducting materials are rare. Conventionally used tin doped indium oxide is quite expensive. Transparent conductors made from our invention, invisible metal nanomesh, provide affordable solutions besides adding many novel features. Using nanomesh electrodes, many optoelectronics and optoelectrical devices have been fabricated including touchscreens, EMI shields and smart windows. *See: J. Mater. Chem. C, 5, 5917 (2017).*

TWISTED GRAPHENE STACKS: The extraordinary properties of graphene are truly observable when it is suspended, being free from any substrate influence. In this work, a new type of multilayer graphene system has been made wherein each layer is turbostratically decoupled, resembling the suspended graphene, while maintaining high degree of 2D crystallinity. *See: J. Phys. Chem. C, 121 (25), 13938 (2017).*

UNUSUAL FORMS OF GOLD: Inducing lattice strain in crystals may cause structural transformation and the same has been achieved in the case of gold, by stabilizing nanocorrugated morphologies. This 'microrice gold' is more nobler than the conventional gold; it stands aquaregia and mercury treatments and exhibits interesting catalytic properties! *See: Chem. Mater., 29 (4), 1485 (2017).*

SUPRAMOLECULAR DEVICES: Supramolecules particularly in the form of nanofibres offer advantages in electrical transport as they are essentially 1D systems. Using nanofibres built via self-assembly of donor and acceptor molecules, high mobility FET, supercapacitors and ultrafast humidity sensors have been fabricated. The latter have been applied to measure humidity in human breath dynamically.
See: ChemNanoMat, 3 , 39 (2017).

Supramolecular Supercapacitor



Also see: http://www.jncasr.ac.in/kulkarni/

S KRISHNA PRASAD

S Krishna Prasad got his Ph. D. (1987) in Physics from Raman Research Institute (RRI), Bengaluru. He did his Post Doctoral studies at the Technical University, Berlin. He worked as a scientist at RRI before joining CeNS in 1995.

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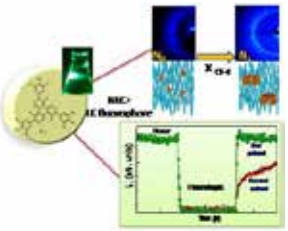
RESEARCH HIGHLIGHTS

FAST ELECTRICALLY SWITCHABLE ANISOTROPIC PHOTOLUMINESCENCE IN A GUEST-HOST SYSTEM:

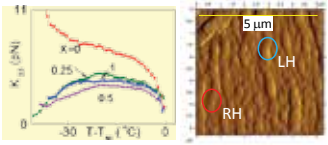
- New protocol for Fast PL Switching
- Fatigue-free flipping between two PL states
- Enhanced short-range structure



POLYMER STABILIZATION OF BENT CORE NEMATIC:

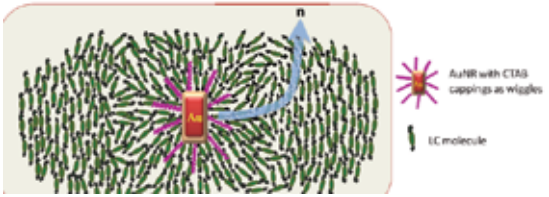
- Local (nematic-like) elasticity controlled by the confiner-elasticity
- Short strands lower the elasticity compared to pure LC
- Non-monotonic dependence of threshold voltage
- Helical fibres in an achiral system!
- Locally chiral, Globally achiral: Transfer of chirality

Field-driven PL device



GOLD NANOROD/NEMATIC COMPOSITES

- Large reduction in magnitude and thermal variation of Frank elastic constants
- Advantages of incorporating nanorods with photofunctionality



https://www.cens.res.in/faculty/prasad/profile

NEENA S JOHN

Neena S John obtained her Ph.D. (2007) in Materials Chemistry from Jawaharlal Nehru Centre for Advanced Scientific Research, Bengaluru. She did her post doctoral research at the University of Manchester, U.K. and Indian Institute of Science, Bengaluru before joining CeNS in 2010.

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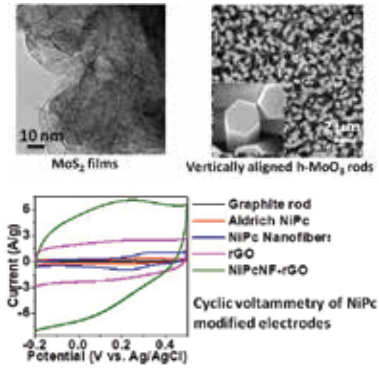
C Sathiskumar

RESEARCH HIGHLIGHTS

INORGANIC NANO MATERIALS: New Synthesis routes to obtain films of molybdenum chalcogenides are explored via bottom-up approach. These films could be obtained on any substrate and their applications in electrochemical energy generation and photovoltaics are investigated. The lubrication properties of nano molysulfide and their composites with graphene are also studied. A microwave route for the synthesis of hexagonal MoO_3 nanorods of several microns in length has been achieved within 90s in a vertically aligned manner. These could be faithfully converted into the layered polymorph. *See CrystEngComm, 2017,19, 6568.*

ELECTROCHEMICAL WATER ACTIVATION: Synthesis of new materials based on non-precious metal oxides such as Ni, Co, Cu, Mo etc are investigated as potential electrocatalysts for hydrogen evolution and oxygen evolution reactions. These materials can replace the use of Pt in future for water activation. Photoactive materials for photoelectrochemical water splitting are also of interest.

ELECTROACTIVE MOLECULAR SYSTEMS: Nanostructures of metallophthalocyanines have been synthesized and they are dispersible in most organic solvents, which otherwise require substituted functional groups for achieving solubility. The dispersions allow facile electrode modifications and higher active area for electrochemical applications.
See Appl. Surf. Sci., (2017), https://doi.org/10.1016/j.apsusc.2017.12.



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PRALAY K SANTRA

P K Santra obtained his M.S. (2006) and Ph.D. (2011) from Solid State and Structure Chemistry, Indian Institute of Science, Bangalore. He worked as postdoctoral research assocaite at University of Notre Dame, USA and Stanford University, USA. He spent one year as Carl Tryggers' fellow at Uppsala University, Sweden before joining CeNS in November 2016.

Ph.D students

Anamul Haque

Trupthi Devaiah C.

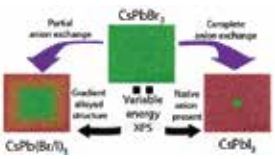
Dr. Pralay Santra has initiated his research activities at CeNS recently. More details about the group can be found at www.psantra.wixsite.com/santragroup

RESEARCH HIGHLIGHTS

QUANTUM DOT AND PEROVSKITE (QD) PHOTOVOLTAICS: Quantum dot solar cells have gained much attention as they show promise toward next generation photovoltaic devices. The overall photovoltaic properties of quantum dot solar cells can be improved by controlling interfacial recombinations by doping and band enginnering of quantum dots using dipole moment of the passivating ligand molecules.

PHOTOELECTRON SPECTROSCOPY OF PHOTOVOLTAIC MATERIALS: X-ray photoelectron spectroscpy is ideally suited to study the chemical composition, oxidation states and electronic properties of different materials. The use of hard x-ray photoelectron spectroscopy (HAXPES) allow to study of the bulk properties rather than just the outer surface. Both synchrotron and lab based photoelectron spectroscopy are employed to elucidate internal heterostructure and electronic properties of relevant photovoltaic nanomaterials.

LUMINESCENCE BASED SENSORS: The group also focuses on developing various sensors based on photoluminescence of quantum dots. Currently, the group have developed a quick and easy method to detect heavy metal ions in water.



Growth of dielectric materials by Atomic Layer Deposition (ALD): ALD is an unique thin film deposition technique based on gas phase reactions and can be used to different materials with high conformity and uniform thickness. The growth processes of different dielectric materials are being developed.

H. S. S. RAMAKRISHNA MATTE

H. S. S. Ramakrishna Matte obtained his B.Sc from Government College, Rajahmundry in 2006 and MS, PhD in Chemical Sciences in 2009 and 2013, respectively, under the guidance of Prof. C. N. R. Rao, FRS from the Jawaharlal Nehru Centre for Advanced Scientific Research. He did his first Postdoc at Northwestern University during 2013-2015 later he moved to Humboldt University, Berlin before joining CeNS in January 2017.

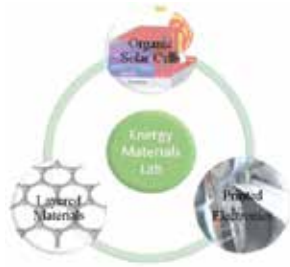
Ph.D student
Kenneth Lobo

Research Assistants
Shivam Trivedi
Bikesh Gupta

RESEARCH HIGHLIGHTS

ORGANIC SOLAR CELLS: Organic photovoltaics (OPV) provides an abundant and low-energy-production photovoltaic (PV) solution for converting light into electrical energy. In our group we focus on various device fabrication aspects of OPV like modifying interfacial layers, non fullerenes acceptors with the aim of increasing the stability/lifetime of the devices.

PRINTED ELECTRONICS: Printed electronics industry relies on functional inks of various materials. Our approach is to find innovative ways for dispersing the nanomaterials with high concentrations, enhanced stability using liquid phase exfoliation. The obtained inks can be used for fabricating thin film transistors, OLEDS, OPVs, smart textiles etc.



INORGANIC GRAPHENE ANALOGUES (IGA): IGA are an important class of layered materials with properties varying from metals to insulators. They need to be exfoliated/synthesized in to single- and few-layers for various applications for that we develop new synthetic protocols.

DIELECTRICS: Dielectric materials forms an important component of electronic devices. But they generally suffer either from low band gap or low dielectric constant or feeble polarization at higher frequency (more than MHz range). Here in our group we aim to develop low temperature solution combustion route to fabricate thin films of dielectric materials addressing the afore mentioned issues.

D S Shankar Rao

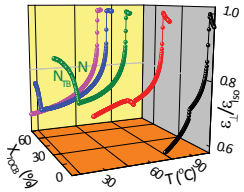
D S Shankar Rao obtained Ph. D. (1994) in Physics from Raman Research Institute, Bengaluru. He worked as a Post Doctoral fellow at Samsung Advanced Institute of Technology, Seoul, South Korea before joining CeNS in 1995.

Ph.D students
Srividhya Parthasarathi
Varshini G.V

Research Associate
S.R Srither

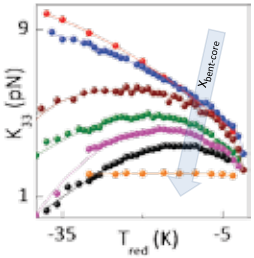
RESEARCH HIGHLIGHTS

BINARY SYSTEM EXHIBITING N-N_{TB} TRANSITION:



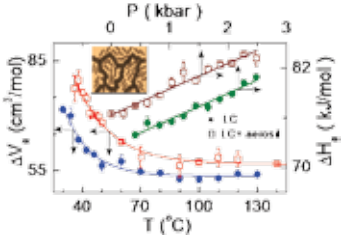
- Existence of N_{TB} upto higher concentration of RLN (X_{70CB})
- Clear signature in $\varepsilon_\perp$ across N–NTB; Changes signature for higher X_{7OCB}

VISCOELASTIC BEHAVIOR OF COMPOSITES COMPRISING STRONGLY POLAR BENT-CORE AND RODLIKE NEMATIC MOLECULES:



Convex shaped anomaly in the K_{33} vs. T plot which is absent for the pure compounds.

INFLUENCE OF NANOPARTICLE NETWORK ON THE ACTIVATION ENTHALPY (ΔH_A)/VOLUME (ΔV_A) IN THE N PHASE UNDER ISOBARIC/ISOTHERMAL CONDITIONS.



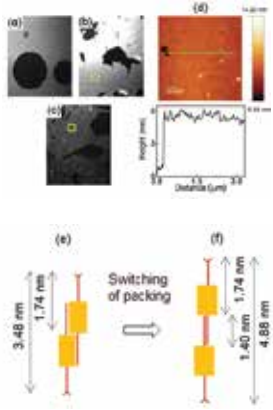
https://www.cens.res.in/faculty/shankarrao/profile

Kattera A Suresh

Kattera A Suresh obtained his Ph.D.(1979) at the Raman Research Institute, Bengaluru. He did his post doctoral work at College de France, Paris. He worked as a Research Scientist at Dowell Schlumberger, St. Etienne, France and then he was a Visiting Scientist at Carnegie Mellon University, Pittsburgh, USA. He was a Senior Professor at Raman Research Institute, Bengaluru before joining CLCR as the Director in 2007. Currently he is Honorary Professor at CeNS.

Ph.D student

Arup Sarkar

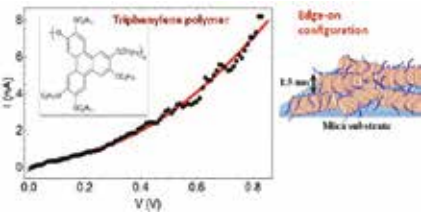


RESEARCH HIGHLIGHTS

SPREADING AND RETRACTION DYNAMICS OF LIQUID CRYSTAL DOMAINS AT AIR-WATER INTERFACE: Under illumination, the dye doped smectic domain spreads assymetrically. The size increases during spreading to about 2.2 times and then under retraction decreases to 1.4 times its initial size. The spreading , retraction dynamics can be accounted by the photoinduced modification of the interfacial tension.

CONDUCTIVITY IN LANGMUIR –BLODGETT FILMS OF N-ALKYL CYANOBIPHENYLS: Electrical conductivity was measured in alkyl cyanobiphenyls (nCB) using current sensing atomic force microscope. The analysis of the I-V curve indicates a transition from direct to injection tunneling in 9CB and 10 CB and the barrier heights to be 0.71 eV and 0.37 eV respectively. *(J. Appl.Phys.117,245311(2015))*

CHARGE TRANSPORT IN MONOLAYER FILMS OF LIQUID CRYSTALLINE POLYMER:



Charge transport studies in liquid crystalline triphenylene polymer monolayer film shows direct tunneling mechanism. The barrier height for the polymer derived from dihydroxy –tetraalkoxy triphenylene was 1.22 eV. *(Phys.Chem.Chem.Phys. 18, 12101 (2016)).*

SWITCHING OF MOLECULAR PACKING IN CHOLESTERYL LAURATE AND SELF-ASSEMBLY OF CHOLESTERYL ESTERS AT INTERFACES: BAM images of ChL (a) fluidic bilayer (unstable); (b) crystalline bilayer phases. (c) Ellipsometric and (d) AFM images of ChL. Switching of molecular packing in ChL from (e) m-ii to (f) crystalline bilayer packing.

Cholesteryl esters with alkyl chain 2,9,12,14 exhibit homogeneous ordered phase whereas those with alkyl chain 16 and 18 exhibit inhomogeneous and less-ordered phase. (J. Chem. Phys. 146, 214702 (2017))

https://www.cens.res.in/faculty/suresh/profile

Veena Prasad

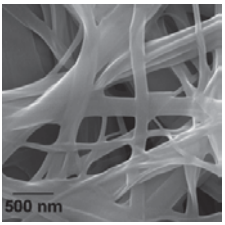
Veena Prasad obtained her Ph.D (1994) in Liquid Crystals from Raman Research Institute, Bengaluru. She joined CeNS in 1995 as a research associate and later she was a post doctoral fellow at Korea University, seoul, South Korea. Since 1997, she is a faculty at CeNS. She was a visiting scientist at Kent state University, USA.

Ph.D students
Monika M.
Rekha S. Hegde

Research Associate
Jitendra Kumar

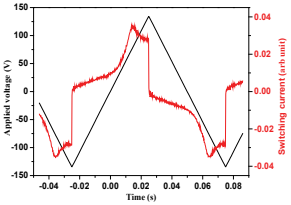
RESEARCH HIGHLIGHTS

NEMATIC LIQUID CRYSTALS COMPOSED OF SMECTIC NANOCLUSTERS: Nematic liquid crystals composed of smectic nano clusters, a topic of much interest after the claims of biaxial nematic phase in bent-core mesogens. We have synthesised and investigated four series of azo dimers forming smectic nano clusters in their nematic mesophases. some of the dimers here form organogels which are thermo as well as photo-sensitive, the property that can be exploited for practical applications. *See: New. J. Chem., 41, 11576 (2017).*



Xerogel formed by dimer in acetone

MESOGENS COMPOSED OF ACHIRAL NON-LINEAR MOLECULES: Mesogens composed of achiral non-linear molecules have attracted considerable interest due to the chirality and polarity of some of the mesophases exhibited by such compounds. The compounds forming orthogonal polar smectic mesophases, such as SmAPA and B5 are of technological importance. We have reported, the first observation of a B5 mesophase and a direct transition of the isotropic phase to a polar biaxial smectic A mesopahse (SmAPA) in V-shaped compounds with acute angle. *See: J. Mol. Liq., 249, 97 (2018).*



Switching current response of B_5 mesophase

P. Viswanath

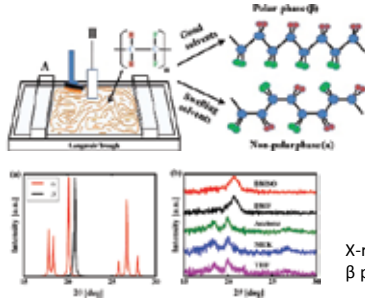
P. Viswanath obtained his Ph.D (2004) in Physical Sciences from Raman Research Institute, Bengaluru. He did his post doctoral work at Laboratoire Interdisciplinaire sur l'Organisation Nanometrique et Supramoleculaire, Saclay, France and at theMax Planck Institute for Colloids and Interfaces, Golm, Germany before joining CeNS in 2008.

Ph.D students

Chandan Kumar
Brindhu Malani S
Prashanth Nayak
Pinchu Xavier

RESEARCH HIGHLIGHTS

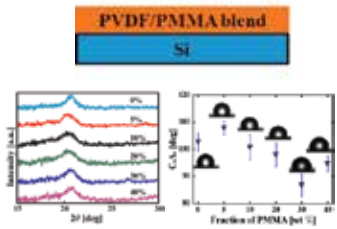
IMPACT OF GOOD AND SWELLING SOLVENTS ON THE LANGMUIR AND LANGMUIR-SCHAEFER FILMS OF POLY (VINYLIDENE FLUORIDE):



X-ray evidence for polar β phase in good solvents.

Ultrathin film of poly(vinylidene fluoride), PVDF formed by Langmuir technique using different solvents (good and swelling) as spreading agents show the lift-off area of the polymer and the sign of potential changes with the nature of solvent. Brewster angle microscope show that the textures are largely homogeneous for the good solvents in contrast to swelling agents. Further, multilayers of PVDF were transferred onto silicon substrates using Langmuir-Schaefer method show evidence for a relatively larger fraction of polar β phase formed using good solvents. *Refer: EUROPEAN POLYMER JOURNAL 86:132-142, 2017.*

LANGMUIR-SCHAEFER MULTILAYER OF THE BLENDS OF AMORPHOUS AND FERROELECTRIC SEMI-CRYSTALLINE POLYMER:



X-ray and contact angle studies on PVDF/PMMA blends.

Structural, morphological and wettability of Langmuir-Schaefer multilayer of blends of poly (vinylidene fluoride) and poly (methyl methacrylate) (PMMA) were studied. Xray studies on polymer blends show polar β beta phase presence up to 40% of PMMA. Morphological features drastically varies with increasing PMMA fraction which impacts the wetting. *Refer: EUROPEAN POLYMER JOURNAL 96:97-110, 2017*

https://www.cens.res.in/faculty/viswanath/profile

ACADEMIC PROGRAMMES

Ph.D PROGRAMME

The Centre is recognised by Mangalore University and Manipal Academy of Higher Education for the PhD programme. The students, who join for the programme at the Centre, obtain their degree awarded by either of these universities.

ADMISSIONS

Applications are called for PhD programme generally during March/April. However, candidates may apply anytime during the year and such applications will be processed from time to time. Eligible candidates who have cleared the Masters programme in Physics/ Chemistry/Materials Science/ Nano Science and Technology and also qualified in CSIR-UGC NET (JRF) / GATE / JEST examinations or INSPIRE Fellows, are encouraged to apply.

For more information on this visit CeNS website
https://www.cens.res.in/academics/research-programmes

COURSE WORK

CeNS offers a variety of credit courses to students who have enrolled for their Ph D. The courses are broadly grouped under five different categories: Instrumental Methods & Analysis, Scientific Communication, Intellectual Property, Safety & Waste Management and Basics of Nano and Soft Matter Sciences. The topics are taught by the CeNS faculty as well as experts invited from other organisations. To complete the requirement of twelve credits, the rest of the courses are taken at IISc and/or JNCASR.

SEMINARS

During the PhD programme, students deliver Journal-based-Seminar , Thematic Seminar and Thesis Colloquium.

Ph.D STUDENTS

Alex C.
Amit Bhardwaj
Anamul Haque
Arup Sarkar
Athira M.
Brindhu Malani S.
Chandan Kumar
Dimple Garg
Gaurav Shukla
Indrajit Mondal
Kenneth Lobo
Madhu Babu Kanakala
Marlin Baral
Monika .M.
Pinchu Xavier
Pragnya Satapathy
Prashanth Nayak
Priya Madhuri K.
Rajalaxmi Sahoo
Rajashekhar N. Pujar
Ramya Prabhu
Rekha S. Hegde
Sachin Ashok Bhat
Srividhya Parthasarathi
Sruthi Rose Tom
Subir Roy
Suchithra P.
Suman Kundu
Sunil Walia
Surender Goyal
Trupthi Devaiah C.
Vaisakh V.M.
Varshini G.V.
Veerabhadraswamy .B.N.
Vimala S.

RESEARCH ASSOCIATES

Bhagwati Sharma
Bramhaiah Kommula
Chithaiah P.
Jitendra Kumar
Kiruthika S.
Rajasekhar Yerrasani
Rajesh Katoch
Ram Sevak Singh
Remya K. Govind
Rithesh Raj D.
Sathiskumar C.
Srither S.R.
Sujeet Dutta
Umesha Mogera
Vivek Ramakrishnan

SCIENTIST UNDER PROJECT

Ashutosh Kumar Singh

VISITING FACULTY

- Dr. C. Kavitha, DST-Scientist, BMSIT, Yelahanka, Bengaluru
- Dr. Gurumurthy S.C., Assistant Professor, Manipal Institute of Technology, Manipal

PROJECT ASSISTANTS

Bhavin Naik B.S.
Ankush Kumar
Kiruthika S.

WOS-A SCIENTIST

Uma S Hiremath

R & D ASSISTANTS

Arun .D.
Bikesh Gupta
Dharmendra Kumar Singh
Kanaka Deepthi Voora
Kaushalendra K. Singh
Keerthan Acharya
Madhanmohanraju S.
Mukhesh K.G.
Prasanna M.
Sanjith K.K.
Sharadhi N. Raj
Shivam Trivedi
Srividya Adiga
Sowmya S.

LABORATORY FACILITIES

New research facilities and equipments added to the Tata Steel Advanced Materials Research Centre (TSAMRC), Characterization lab (C-Lab) Devices and Interfaces lab (Di-Lab) are:

- 3D printer
- Solar simulator
- Environmental test chamber precision oven
- Central glove box integrated with thermal evaporator facility
- Table top sputtering unit
- TGA/DTA
- Contact angle meter with tilting stage.
- Glancing angle deposition system with sputtering gun.
- Upgradation of confocal Raman microscope with additional lasers and variable temperature stage
- Upgradation of FESEM with plasma decontaminator attachment.

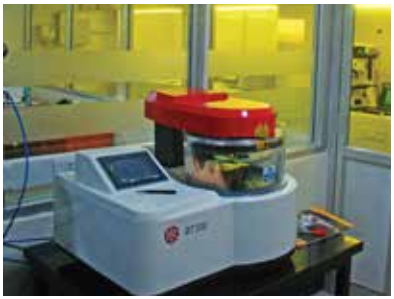


Table top sputtering unit

TGA/DTA

The Gas Sensor Testing Laboratory was inaugurated by Prof. D. D. Sarma, Chairman, Research Advisory Board on 10 July 2017. The sensing of helium gas by the Pd based gas sensor was demonstrated during the inauguration. Over all the Lab has the potential to control and monitor supply of gases such as O_2, H, N_2, CH_4, CO, NO, etc. down to ppm level.

Gas Sensor Facility

OUTREACH PROGRAMME

Both V4 ({dk‰Z {dÚ‰W {dM‰a{d{Z_`) and Research Outreach Initiative (ROI) programme continued to attract high school/undergraduate and masters students respectively in a big way. Since its inception in 2015, more than 2000 students have benefitted from the V4 programme. ROI programme saw 15 students from all over India successfully completing the projects in the year 2017 alone.

CeNS celebrated National Science Day during 22-28 February 2017 based on the theme "Science and Technology for specially-abled persons". As part of this, researchers visited Association for Persons with Disabilities, Academy for Severe Handicaps and Autism (ASHA) Charitable Trust and interacted with the students / teaching staff to explore ways where the Centre can contribute in providing additional academic interface. Children from Spastics Society of Karnataka, Asha Kiran, Deepika Special School and ASHA visited CeNS on 22 Febraury 2017 and participated in a tour of specifically designed science demonstration. On 28 February, students of B.E.L. high school took part in the day-long programme presented by CeNS researchers which included a lecture on "Science of Colour", a science-based skit and a compiled video show on specially abled achievers. A Science Quiz show was the highlight of the programme. The LitE Gallery, a hall hosting exhibits and hands-on experiments designed for school and college going students, was also inaugurated on the same day.

SPECIAL LECTURES

MEMORIAL LECTURE

The 14th Professor S. Chandrasekhar Memorial Lecture was delivered on 6 September 2017 by Prof. Ajay K. Sood, FRS, Honorary Professor, Department of Physics, Indian Institute of Science, Bengaluru. The talk titled “Active Matter: Flocking and Bacterial Heat Engine” was attended by, among other invited guests, Members of the Governing Council and the Research Advisory Board, the family of Prof. S. Chandrasekhar, faculty and research scholars.

C V RAMAN’S BIRTHDAY

A special edition of the V4 programme was held on 7 November 2017 commemorating the birthday of the Nobel Laurete Sir C.V. Raman. The students and teaching staff from the Little Flower School, Banashankari, Bengaluru participated in the event. The programme included a lecture titled "Small Questions and Big Answers" by Prof. S.M. Shivaprasad, Director, Karnataka State Higher Education Academy, Dharwad and Professor at JNCASR, Bengaluru. The students were also taken on a guided tour of the LiTE Gallery.

WORKSHOPS/ MEETINGS

An **interaction meeting** on 'Nanomaterials for Clean Energy and Environmental Sensors', under the aegis of Indo-US Science & Technology Forum (IUSSTF) was held on 11 & 13, March 2017 at CeNS, IIScand JNCASR. Scientists and students from CeNS, IISc and JNCASR from India and Purdue University, North-Western University, University of Notre Dame and the University of Akron participated in the meeting.

An **interaction session** between Prof. Prashant Kamat, Editor-in-Chief, ACS Energy Letters, and young researchers of CeNS, JNCASR and IISc was held on 12

March 2017. Prof. Kamat, a Zahm Professor of Science at the University of Notre Dame, USA, spoke to the researchers about the art of publishing scientific research. The highlight of the programme was an hour long question and answer session found extremely useful by the research student community. After the session, the festival of colors, Holi, was celebrated with lot of fervour and gaiety.

The second **CeNS – Manipal University Joint Workshop** based on the theme "Advances in Nano and Soft Materials" was held at CeNS, Bengaluru on 27-28 June 2017.

A Joint workshop between CeNS, DRDO and JNCASR on "Frontiers in Nanoscience and Technology" was held on 4 – 5 July 2017 at JNCASR, Bengaluru.

A **Joint Symposium involving CeNS, Bengaluru and INST, Mohali,** organized by CeNS, was held during 16-17 November 2017 at Hospet, Karnataka.

Bharat Ratna Professor C N R Rao, Chairman, Governing Council, CeNS and Chairman, Board of Governers, INST in his opening remarks, stressed the importance of doing quality scientific research and building active collaborations between the two institutes. The presentations covered topics in nano, bio, and soft matter sciences with an emphasis on nanoscience-related research and technology. Each scientific session was followed by a lively discussion which

culminated in newer ideas.

CeNS participated in the **9th Bengaluru INDIA NANO 2017** held during 7-9, December 2017 at Lalit Ashok, Bengaluru. Prototype devices, based on the lab inventions, showcased during the event received high recognition from the industry and academic visitors.

CeNS participated in the **India International Science Festival (IISF)-2017** in the category of "Mega Science, Technology and Industrial Expo" held during 13-16 October 2017 at Chennai. Dr. H. S. S. R. Matte, Scientist, and PhD students Mr. B. N. Veerabhadraswamy (SRF) and Mr. B. Bharath (SRF) represented CeNS and highlighted the academic, outreach and other activities of CeNS to visitors. Centre's capability to transform laboratory research into the technological applications was demonstrated through prototypes.

Nanomission School on Nanoscience and Nanotechnology-Physical Sciences, 2017, sponsored by DST Nanomission, Govt. of India, was organized by CeNS at the Jalahalli campus, Bengaluru, from 23 October– 3 November 2017. The theme of the School was 'Emerging Materials and Methods in Nanoscience and Nanotechnology' focussing on frontier areas of materials research.

The inaugural lecture was given by Bharat Ratna Prof. C N R Rao, FRS, on 'Glimpses of the Nanoworld'. Around 40 participants consisting of Ph.D students, postdoctoral fellows and young faculty, from all over India participated in the School. Visits to C-CAMP, NCBS was arranged to introduce the participants to translational research and also to Bruker Application Centre where they had a chance to learn about advanced probe microscopic techniques.

Indo-German Science & Technology Centre (IGSTC) workshop on "Solar Photovoltaics: Materials, Mechanisms and Methods" was held on 25 Sept 2017 at CeNS, Bangalore. The conference focused on various aspects of organic-inorganic hybrid perovskite materials and devices, quantum dot solar cells, organic photovoltaics, polymer, and silicon solar cells.

ANNUAL EVENTS

Some of the annual events held at CeNS in 2017 are Republic Day, Sports Day, Admin Day, International Yoga day, "Swachhta Hi Seva Abhiyan", Vigilance Awareness Week.

Participants of Joint Symposium involving CeNS, Bengaluru and INST, Mohali.

ADMINISTRATION AND TECHNICAL STAFF

Administrative Officer	Subhod M.Gulvady
Accounts Officer	Vivek Dubey
Office Superintendent	P. Nethravathi
Technical Assistants	Sanjay K. Varshney Sandhya D. Hombal
Assistant	Jayaram M.
Library Assistant	Nayana J.
Support Staff	V. K. Jayaprakash V. Samuel Hebich
Authorised Medical Officer (Contract)	Archana M.L.V.
Consultants	Krishnamurthy K.S. Chandrashekhar K. S. Gururaj R. S. Narayana M.G. Rajalakshmi R. Rama Krishnamurthy Ravishankar Solanki
Dining Hall – Supervisor (Contract)	Chandraiah D.
Public Relations (Contract)	S. Deepak
Admin/Accounts/Purchase Staff (Contract)	Adithi H.M. Bindu S. Jyothi U.V. Madhura Hegde Manasa K.R. Manjunatha .V. Ranjita Bhat Reetu K Tharakanath K. Veena V. Venkatesh K.
Project Coordinator	Vanitha B.

MAINTENANCE STAFF

Housekeeping
Anitha
Gangaraju
Gowramma
Muniswamy
Penchilaiah
Penchilaiah Rao
Venkatesh R
Vijaya

Technical & Other
Darshan Raj
Krishnappa C.
Kumaravel
Manjula
Murthy G.
Ningappa Kadimani
Prahlad D.G.
Praveen
Roopa N.
Sharanu

Dining Hall
Andanappa
Hanumanthe Gowda
Huligesh
Joseph
Manjula V.
Rathnamma
Sunitha
Yanishaliyonara

Hostel/Guest House
Bhavani
Jayakaran
Venkatesh R.
Yashodha R.

Security
Shivanapura Campus
Devaraju
Nagaraj K.P.
Rahul Das
Rajesh Dey
Rajshekar
Ravikiran
Rupak R. Pal
Shanmukha
Shivakumar
Thimmaraju

Jalahalli Campus
Adaiah Achari M.
Basanagouda S.I.
Ganesh Kumar R.
Madhugiriyappa
Mahesh M.
Naveen Kumar S.
Ranganathan M.
Surendra Babu
Vijay Gopalam M.

Gardening
Jalahalli Campus
Manjunath H.M.
Suryakanthi

Shivanapura Campus
Anand Kumar S.
Chikaiah
Eranna
Hombesh

AWARDS AND HONOURS

Awards

Bharat Ratna Professor C.N.R. Rao, Chairman of the Governing Council received the highly prestigious Von Hippel Award for materials research. The citation reads "…for his immense interdisciplinary contributions to the development of novel functional materials, including nanomaterials, graphene, superconductivity, 2D materials and colossal magnetoresistance". The award was presented to Prof. Rao at the MRS meeting held in Boston on 29 November 2017.

Prof. G. U. Kulkarni received Prof. C.N.R. Rao Science award in 13th Kannada Science Conference held on19 September 2017.

Dr. Neena S John is the recipient of Springer award for best paper at the conference, 'International Conference for NextGen Technologies: Silicon to Software' organized at VIT University, Chennai in March 2017

Sunil Walia, SRF, won "Best Poster Award" at the IUSSTF Workshop, 11 & 13 March 2017.

Outstanding award for Best Ornamental Garden Award was received by the Centre from Mysore Horticultural Society, Lalbagh, Bengaluru on January 2017

CeNS was bestowed with "Best Exhibit Award for the Year 2017" in the category of Innovative Display at the 9th Bengaluru INDIA NANO 2017, 7-9, December 2017, Bengaluru.

Sunil Walia was conferred with the prestigious "Karnataka DST Nanoscience Fellowship' award instituted by the Dept of S & T, Govt of Karnataka, at the 9th Bengaluru INDIA NANO 2017, 7-9, December 2017, Bengaluru.

Vaisak, V. M., won "Best Poster Award" for his poster titled "Enhanced photoluminescence in anisotropic magnetogel" at the 9th Bengaluru INDIA NANO 2017, 7-9, December 2017, Bengaluru.

Honours

G. U. Kulkarni:
Adjunct Member of the faculty for Science and Technology, Gulbarga University, Gulbarga
Chief Editor of Bulletin of Materials Science, Indian Academy of Sciences, Bangalore

S. Krishna Prasad
Associate Editor for Bulletin of Materials Science, Indian Academy of Sciences, Bangalore

Neena S. John
Member of the Royal society of Chemistry, London, UK

K.A. Suresh
Adjunct Professor, Department of Materials Science, Mangalore University

CeNS IN NEWS

During the DST-Conclave meeting held at S.N. Bose National Centre for Sciences, Kolkata during 2-4 May 2017, Honorable Union Minister for Science & Technology & Earth Sciences Dr.Harsh Vardhan tweeted about the achievement of the Centre.

A report on "Smart Hydrogel Windows" developed by Prof. Kulkarni and his group was published in the 11 Nov 2017 edition of The Hindu. The report said…" Scientists at Bengaluru have developed a smart window that automatically turns from transparent to opaque when heated and also gets back to its original transparent state when the heat is removed. These windows can potentially be used in homes, offices, and even cars and aeroplanes… windows are very cheap costing less than Rs.100 per sq foot. These can be installed to create less energy-consuming buildings…".

ALUMNI

Name (Supervisor)	Year	Currently at	Email
S. Anitha Nagamani (C.V. Yelamaggad)	2003	Portland, USA	sanithanagamani@gmail.com
K.L. Sandhya (S. Krishna Prasad)	2005	M.S.Ramaiah Institute of Technology, Bengaluru	klsandhya@gmail.com
Manoj Mathews (C.V. Yelamaggad)	2006	St. Joseph's College, Calicut	mathewsmanoj@gmail.com
I. Shashikala (C.V. Yelamaggad)	2007	Momentive Performance Materials India Pvt Ltd, Bengaluru	swamyshashi@gmail.com
Chethan V. Lobo (S. Krishna Prasad)	2007	Quantum Design India Pvt Ltd, Mumbai	chethanvishal@gmail.com
Gurumurthy Hegde (S. Krishna Prasad)	2007	R&D Centre, BMS, Bengaluru	murthyhegde@gmail.com
A. S. Achalkumar (C.V. Yelamaggad)	2008	IIT, Guwahati	achalkumar@iitg.ernet.in
G. Shanker (C.V. Yelamaggad)	2009	Bangalore University, Bengaluru	maanshanker@gmail.com
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Inventors: S.K. Choudhary, Sumitesh Das, G.U. Kulkarni and Rajashekhar N. Pujar
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