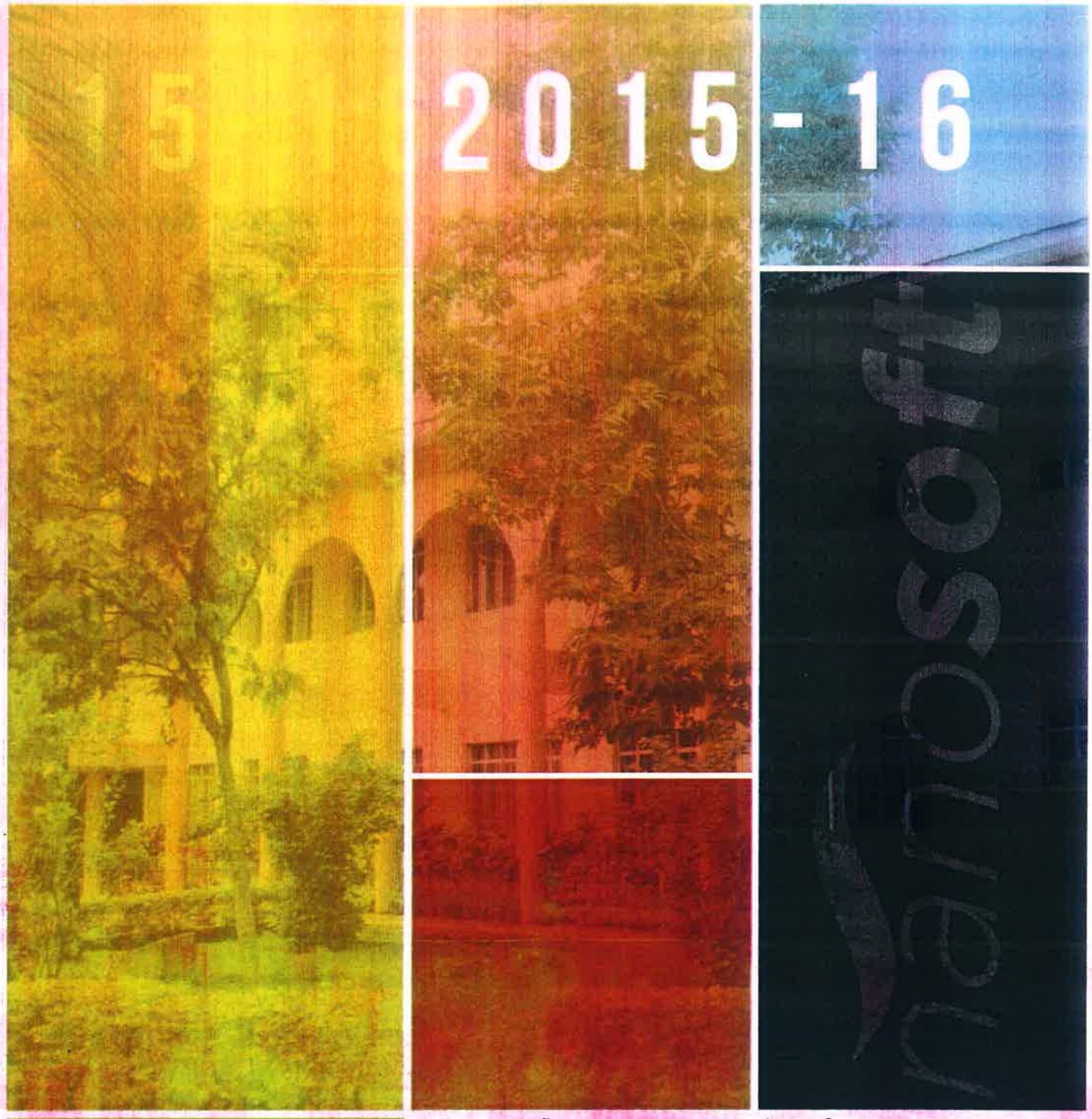

वार्षिक रिपोर्ट
ANNUAL REPORT

CeNS

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

CENTRE FOR NANO AND SOFT MATTER SCIENCES

BENGALURU

ANNUAL REPORT

2015 – 2016

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(One vacancy has arisen on account of Prof. Ashutosh Sharma's assumption of charge as Secretary, DST)

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CONTENTS

FOREWORD

Centre for Nano and Soft Matter Sciences (CeNS) in the present form, has entered into its third year. The in-house inventions in Nanotechnology interlaced with soft matter principles are aiming translation towards flexible, ergonomic futuristic technology. Nanotechnology being the focus, the diversity in research borne out of interdisciplinarity will be all but natural; Nano can connect and percolate seamlessly into the diverse areas of science and technology. In short, CeNS exercises an open-minded approach to R&D in Nanotechnology with high emphasis on IP generation and technology realisation. The Centre has embarked on collaborative activity with well-known industries. It will be growing to newer heights in the coming years serving the society at large.

With the objective of popularization of science among school children, an innovative programme, विज्ञानि विद्यार्थि विचार विनिमय (V4), has been launched and several V4 sessions have also been conducted in and outside of the campus during the last one year. The Centre has introduced an internship programme called Research Outreach Initiative (ROI) for the benefit of students in their post graduate degree in science or in engineering. Increasingly higher number of students are being enrolled for research programmes leading to PhD, in the area of nanoscience and technology.

The Centre is being mentored by eminent scientists, administrators as well as policy makers, in particular by the Nano Mission of the Government of India.

DIRECTOR

1. INTRODUCTION

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

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

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

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

2. CORE FUNDED PROJECT

While the Department of Information Technology provided funds in the early years, since 2004 the Centre has been getting grants from DST. The year-wise break-up of the outlay proposed by the Centre, as per the 12th Plan document, is as follows:

Proposed Outlay as per the Twelfth Plan document (Rs. in Lakhs)

2012-13	2013-14	2014-15	2015-16*	2016-17	Total
1044.00 (FE 560.00)	1205.00 (FE 540.00)	1393.00 (FE 600.00)	1308.00 (FE 460.00)	1610.00 (FE 850.00)	6560.00 (FE 3010.00)

* During the year 2015-16, a grant of Rs. 800 lakhs was released by DST.

3. 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.

4. OFFICIAL LANGUAGE

4.1 Hindi Day

The Centre observed the Hindi Divas on 14 September 2015. On this occasion, Dr. Sulochana H.I., Assistant Professor (Hindi), K.L.E. College, Rajajinagar, Bengaluru, gave a lecture entitled "राष्ट्रभाषा हिन्दी का महत्व".

Dr. Sulochana H.I., Assistant Professor (Hindi), K.L.E. College, Rajajinagar, Bengaluru, delivering the talk, on the occasion of 'Hindi Divas' celebration.

4.2 Hindi Karyashala

The Centre has been organizing 15th of every month 'Hindi Karyashala' among the staff of the Centre. Also to popularize usage of Hindi at CeNS, a scientific word is displayed everyday on the Notice Board under "आज का शब्द".

5. RESEARCH AND DEVELOPMENT ACTIVITIES

5.1 New generation transparent conductors

Visibly transparent yet electrically conducting materials are rare. Tin doped indium oxide (ITO) is a conventionally used material in optoelectronics but is quite expensive. Transparent conductors made from the present invention, Invisible Metal Mesh (i2M), provide affordable solutions besides adding many novel features.

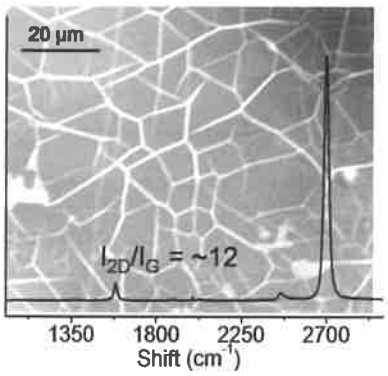
Based on a crackled template, fine metal wire meshes are built onto common substrates (glass or PET) over large areas, maintaining high degree of uniformity. The resulting transparent conductors, i2Ms, show transmittance up to 90% and very low sheet resistance (~few ohm per square). A wide variety of metals including Sn, Cu, Ag and Au are possible, depending on the application.

Many optoelectronics and optoelectrical devices have been fabricated replacing ITO with i2Ms. These include touchscreens, defogging and defrosting panels, organic solar cells, thermochromic and electrochromic displays as well as high temperature thin film heaters.

Investigators: G.U. Kulkarni, K.D.M. Rao, Ashutosh Singh and Indrajit Mondal
Collaborators: Ritu Gupta, IIT-Jodhpur; Kiruthika, Ankush, Jawaharlal Nehru Centre for Advanced Scientific Research, Bengaluru

5.2 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.



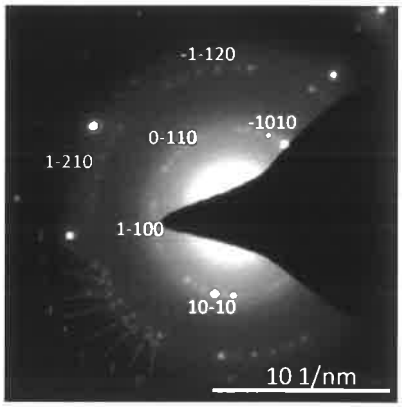


Figure 5.2.1: A twisted graphene stack exhibiting wrinkle network. Raman Spectrum is also shown.

Important features

- Graphene stacks with thicknesses of ~ 100 nm over mm^2 areas
- Defect-free layers: No D band in Raman spectra, sharp ED spots
- Network of Wrinkles
- Twist angles in the range, 3 - 28 degrees
- 2D/G intensity ratio, 2 – 14
- C-axis resistance ~ three orders higher compared to in-plane resistance
- Truly decoupled stack ~ Suspended grapheme

Investigators: G.U. Kulkarni, Sunil Walia and Suman Kundu
Collaborators: Chandrabhas Narayana, Umesh Mogera, Nikita Gupta, Jawaharlal Nehru Centre for Advanced Scientific Research, Bengaluru

5.3 Nobler than the noblest: The non-FCC gold crystallites

Cubic lattice structure preferred by noble metals (e.g., Au, Ag, Pd and Pt) is thermodynamically highly stable. Lower symmetry crystal structures are not known to stabilize relative to the face-centered cubic (FCC) bulk even at high pressures. Observing a structural transformation in these metals is therefore fundamentally exciting and can be possibly useful in tuning their otherwise noble behavior. Recent explorations in this direction have focused on nanocrystals, as the energy needed for lattice distortion is relatively low when the size is only a

few nanometers. Inducing lattice strain at larger length scales to cause structural transformation in the crystallite is indeed a herculean task. The same has been achieved by us, in the case of Au, by stabilizing a nanocorrugated morphology induced via strain, through a simple synthetic method involving thermolysis of a metal-organic precursor in air.

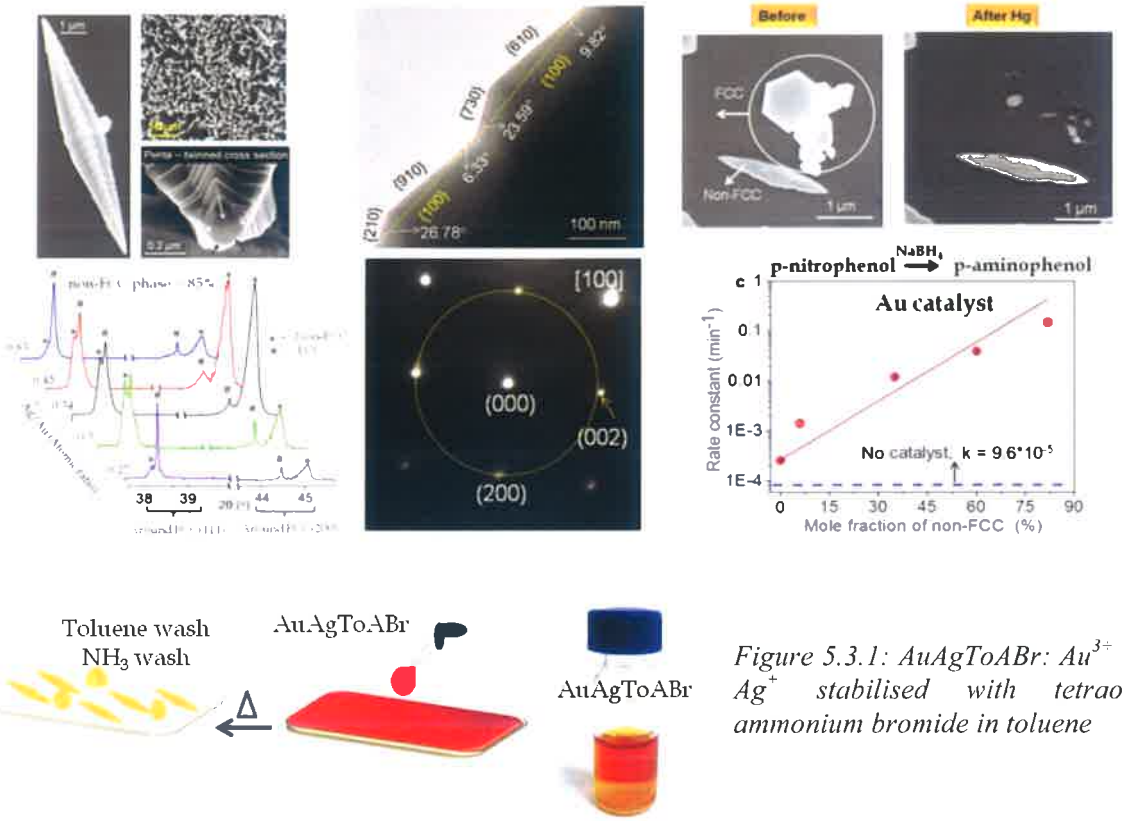


Figure 5.3.1: AuAgToABr: Au^{3+} and Ag^{+} stabilised with tetraoctyl ammonium bromide in toluene

Important features

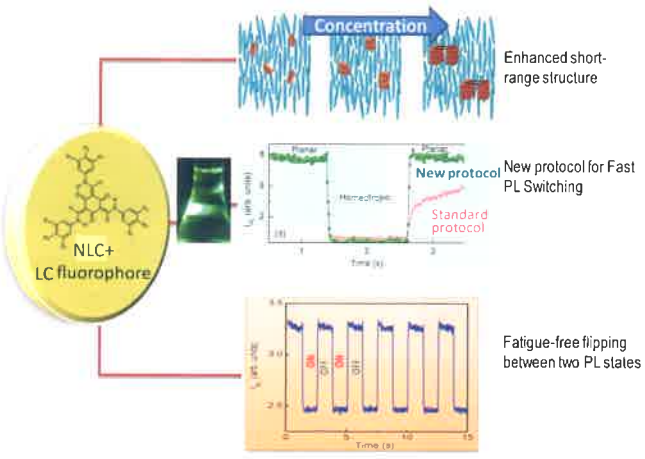
- Morphology: Bipyramidal tapered and corrugated crystallites with penta-twinned tips
- Up to ~ 85% non-fcc phases (body-centered tetragonal and body-centered orthorhombic unit cells)
- Unusual stability: Structured transformation to conventional FCC only around 700 °C
- Nanofacets of unusually high indices
- Extraordinary catalytic activity
- Stable in aqua regia and mercury

Investigators: G.U. Kulkarni, S. Karthikeya
Collaborators: G. Mettala, C. Sow, Jawaharlal Nehru Centre for Advanced Scientific Research, Bengaluru

5.4 Two-orders of magnitude faster photoluminescence switching with a new protocol

A photoluminescent (PL) system comprising a prolate nematic host with oblate fluorescent dopant which can be switched at fast rates between two anisotropic values of

photoluminescence using a two-frequency addressing scheme. The employed unprecedented protocol, exhibiting the desirable higher contrast, switches two-orders of magnitude faster than the standard mode of addressing, and is fatigue-free. The methodology employed can be generalized and thus caters to a variety of fluorophores to cover the required PL wavelength.

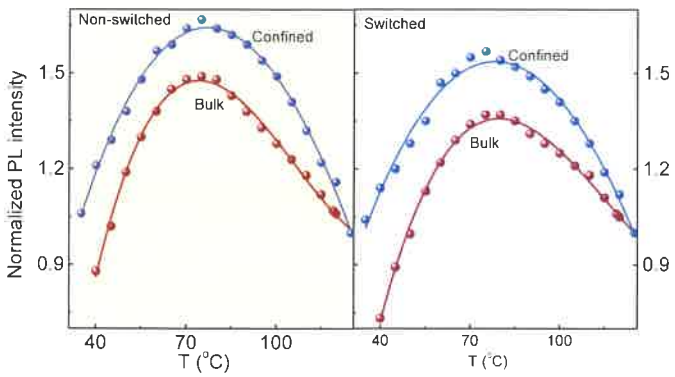


From structural data we demonstrate that as the oblate content is increased, the extent and nature of the short range order in the nematic phase changes, from that of a standard nematic to that of the locally columnar type.

Investigators: S. Krishna Prasad, P. Lakshmi Madhuri, D.S. Shankar Rao, C. V. Yelamaggad
Collaborator: A.S. Achalkumar, IIT Guwahati

5.5 Enhancement of photoluminescence through confinement

As an additional dimension in our quest for fast photoluminescence switching systems we have investigated a material aimed at realizing self-supported membranes with the desired property. This has been achieved by creating a hydrogen-bonded association between such nanoparticles



dispersed randomly in the medium. The resulting fragile network containing the host molecules imposes a geometrical restriction on the natural length scale of the host structure. The surprising feature is that the geometrical restriction yields higher emission in both the field-on (switched) and field-off (non-switched) situations. A possible explanation is that owing to the hydrogen-bonding property the nanoparticles also turn the system to be a soft gel, a feature that would reduce the thermal fluctuations in the medium thereby enhancing the emission.

Investigators: S. Krishna Prasad, P. Lakshmi Madhuri, D.S. Shankar Rao, C. V. Yelamaggad
Collaborator: A.S. Achalkumar, IIT Guwahati

5.6 Influence of virtual surfaces on Frank elastic constants in polymer-stabilized bent-core nematic liquid crystal

Effect of a polymer network on the threshold voltage of the Freedericksz transition, Frank elastic constants, switching speed and the rotational viscosity are investigated in a polymer-stabilized bent-core nematic liquid crystal (PSBLC) with different polymer concentrations. These polymer networks form virtual surfaces with a finite anchoring energy. The studies bring out several differences in comparison to similar studies with a calamitic liquid crystal as the nematic host. For example, on varying the polymer content the threshold voltage decreases initially, but exhibits a drastic increase above a critical concentration. A similar feature – reaching a minimum before rising – is seen for the bend elastic constant, which gets enhanced by an order of magnitude for a polymer content of 2.5 weight%. In contrast, the splay elastic constant has a monotonic variation although the overall enhancement is comparable to that of

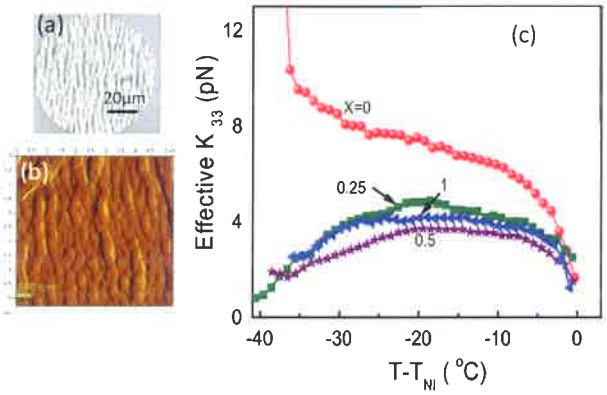


Figure 5.6.1: Optical (a) and atomic force microscopy images (b) of the polymer-stabilized bent-core liquid crystal. (c) Thermal variation of the Frank bend elastic constant at low concentrations of the polymer (indicated as numbers against the curves) presenting the convex behaviour for the composites ($X \neq 0$).

the bend elastic constant. The behaviour changing at a critical concentration is also seen for the switching time and the associated rotational viscosity. The presence of the polymer also induces a shape change in the thermal dependence of the bend elastic constant. We explain the new features observed here on the basis of images obtained from the optical and atomic force microscopy.

Investigators: P. Lakshmi Madhuri, Uma S. Hiremath, C.V. Yelamaggad, K. Priya Madhuri and S. Krishna Prasad

5.7 Diminished splay stiffening in weak gels of calamitic – bent-core nematic composites

Composites of calamitic and bent-core nematic molecules exhibiting a nematic to nematic-gel transformation have been investigated using thermal, electrical, Xray and mechanical probes. The studies focusing on the Frank elastic behaviour show a surprising result that the thermal behaviour of the threshold voltage and the dependent splay elastic constant (K_{11}) are remarkably different in temperature regions identified as weak and strong gels (Figure 5.7.1).

In the former gel, the parameters exhibit values significantly smaller than the higher temperature fluid nematic. This effect is strong enough to annul the order parameter controlled enhancement of K_{11}, a feature that is important from the view point of low threshold optical devices. XRD studies reveal that the mechanical strength of the gel is controlled by the nature of ordering of the gel fibers: plastic crystalline in the weaker gel and truly crystalline in the

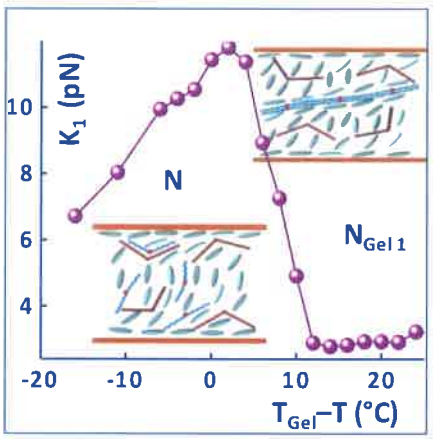


Figure 5.7.1 : Calamitic – Bent-core nematic composite exhibiting diminished and temperature-independent splay elastic constant on gelation.

stronger one. We argue that the different elastic behaviour in the two gel phases is caused by the nature of the fibres: they are stiff in both the gels but the inter-fibre interaction is weaker in the weak gel allowing the splay elastic constant to be lowered. The Xray and rheological data lend support to the characterization of the fibres.

Investigators: S. Vimala, Geetha G. Nair, S. Krishna Prasad, B. N. Veerabhadraswamy and Uma S. Hiremath.

5.8 Supramolecular non-symmetric dimers derived from cholesterol: Investigations of thermal, structural and electrical properties

A series of dimeric supramolecules, possessing both inter- as well as intra-molecular H-bonding, have been prepared using cholesteryl ω-(3-hydroxy-4-formylphen-oxy) alkanoates with 4-(n -alkoxy)benzohydrazides, 3,4-bis(n -decyl-oxy)benzohydrazide and 3,4,5-tris(n -decyloxy) benzohydrazide. The thermal investigations in conjunction with optical microscopy (Figure 5.8.1 (a) and (b)) and XRD showed the existence of chiral smectic liquid crystalline phases. The electrical studies carried out in the chiral smectic C phase showed ferroelectric response (Figure 5.8.1 (c)) with the magnitude of spontaneous polarization to be 50 nC/cm2. The smaller magnitude of the polarization is attributed to the weak intra-molecular transfer of the chirality from the cholesterol unit to the other mesogens. The rigid molecular associations within a given layer, arising due to the H-bonding, may also have contributed to the poor response to the applied field. The appealing part of the study is the occurrence of the ferroelectric phase over a wide thermal range of ~ 90 K. Further, microscopic images indicate

that the ferroelectric phase when aligned homeotropically (Figure 5.8.1 (b)) selectively reflects light in the visible wavelength due to the presence of inherent helical structure. Hence the potential use of these materials in optical devices such as optical collimators, polarization-converting films etc.

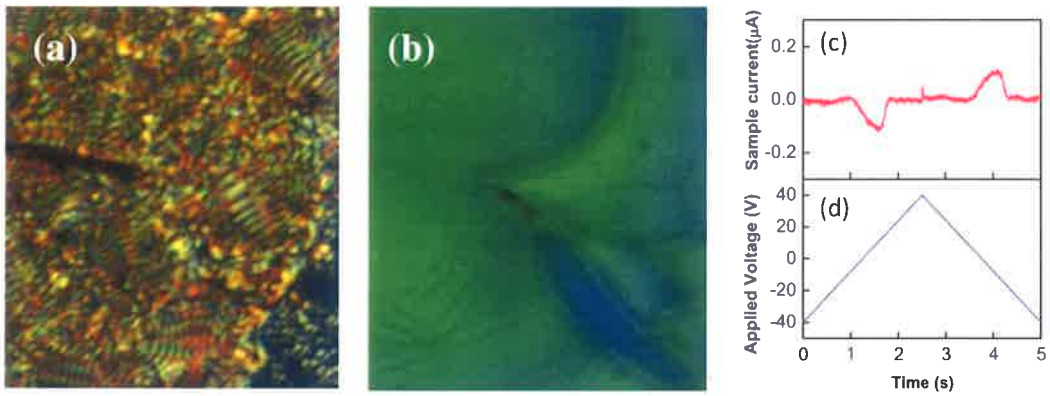


Figure 5.8.1: Polarizing microscopic images for the chiral smectic C phase in the (a) planar geometry exhibiting dechiralization lines (b) homeotropic geometry showing the selective reflection of the transmitted light. (c) Ferroelectric switching current response obtained for the dimer in the chiral smectic C phase on application of (d) a triangular-wave field, 40 V, 1 Hz.

Investigators: Uma S. Hiremath, Geetha G. Nair and D. S. Shankar Rao

5.9 Anchoring transition driven by short range ordering in calamitic-discotic composites

The anchoring of nematic liquid crystals (NLC) at interfaces over the required temperature range of operation is important for the LC devices. A change in the direction of the anchoring - referred to as anchoring transition (ANT) occurs in certain cases due to change in the anchoring energy.

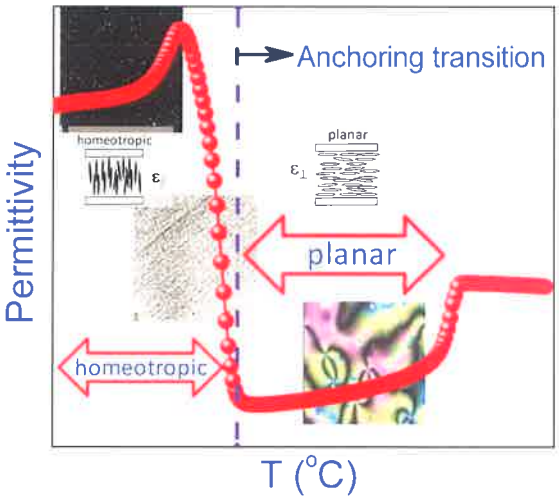


Figure 5.9.1: Schematic representation of ANT in a mixture made guest disc shaped molecule in a host rod like molecule. The polarizing microscopic textures changes over from initial planar configuration to homeotropic orientation with decreasing temperature, the temperature at which this change occurs is being identified anchoring transition temperature, with texture being gray scale at this point. The data point (filled circles-red) show the dielectric constant (ε) variation with temperature being minimum/maximum in the planar/homeotropic configuration of the director.

We have observed a novel ANT in composites of made of structurally dissimilar molecules, viz., disc like dopant in rod like host molecule. This surface transition is seen to be due to a delicate interplay between the planar anchoring at the surface, favoured by the rod-like molecules adhering to the substrate aligning forces, and the tendency of the discotic molecules wanting to orient such that their short axis is normal to the substrate. The Xray diffraction experiment has revealed that increasing the discotic component builds-up a short range order that drives the observed ANT whose temperature is strongly dependent on the concentration of discotic dopant. Imposing hydrostatic pressure on the system, reduces the tendency for the short range build-up and thus enhances the temperature range over which the planar orientation is retained. These measurements have enabled us to map the phase diagram of the anchoring transition in the temperature-concentration and temperature-pressure plane. The work assumes importance owing to the fact that anchoring transition and the concomitant birefringence change has the potential for biosensing.

Investigators: Srividhya Parthasarathi, D.S. Shankar Rao and S. Krishna Prasad
Collaborators: H. K. Singh, B. Singh, Department of Chemistry (Centre of Advance Study), Faculty of Science, Banaras Hindu University, Varanasi

5.10 In-plane modulated smectic Ã vs smectic A lamellar structures in poly(ethyl or propyl ether imine) dendrimers

Detailed polarisation optical microscopic studies and Xray diffraction studies has been carried out on poly(ethyl ether imine) and poly(propyl ether imine) dendrimers pairs modified with 4 or 8 cholesteryl esters at the peripheries in each pair. The studies reveal the observation of a change in the mesophase structure when the size of the dendritic core is modified through linkers that constitute the dendrimer, without changing the number of covalently coupled mesogenic moieties at their peripheries. The first generation dendrimer pair with ether linkage group and the first and second generation propyl-linker dendrimers showed lamellar arrangement of molecules in the mesophase, supported by focal conic fan shaped texture which proved that it is smectic A phase. These molecules prefer open annular or prolate structures, in which the peripheral cholesteryl moieties reside above and below the dendritic core. The second generation dendrimer pair with ether linkage group, showed multiple peaks in the low angle region which can be indexed to 2-dimensional rectangular lattice. It exhibits a layered structure with a superimposed in-plane modulation, the length of which corresponds to a rectangular column width. The phase is identified as in-plane modulated smectic A phase.

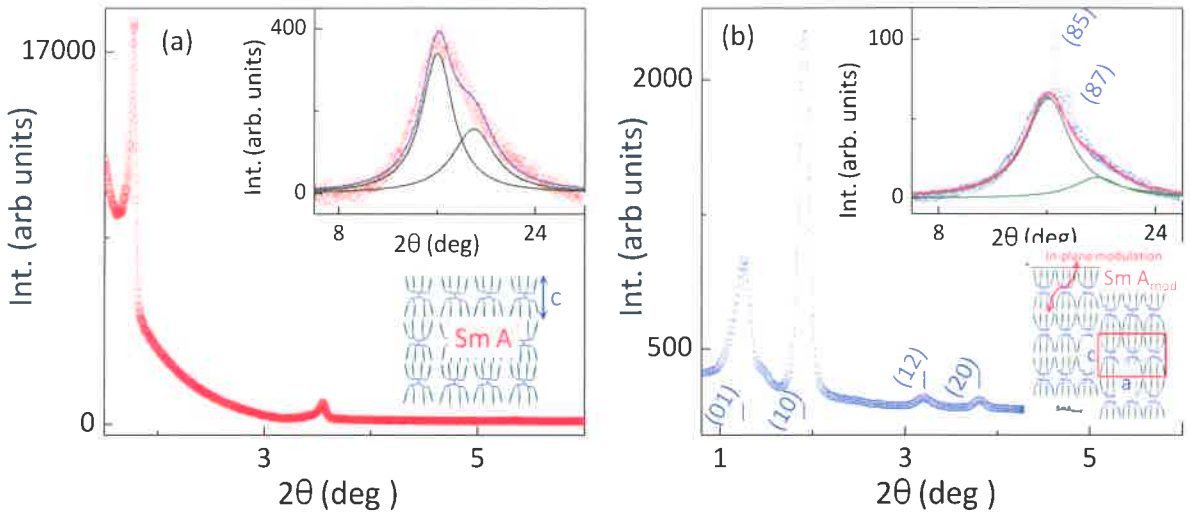


Figure 5.10.1: X-ray diffraction profiles: (a) small angle XRD of first generation with propyl linkage group at 90 °C; (b) second generation dendrimer with ethyl linkage group at 60 °C. The insets show the data in the wide angle region; the data were fit to sum of two Lorentzians (solid red line). The latter is a typical value for the liquid-like ordering of the alkylene region, and is common feature of lamellar liquid crystalline structures. The lower angle peak, with a spacing of 0.55 nm, must be arising due to the packing of the bulky cholesterol units. Also shown in the diagram are the proposed models depicting molecular arrangement in the Sm A and Sm A_{mod} phase.

Investigators: D.S. Shankar Rao an S. Krishna Prasad
Collaborators: P. Kumar and N. Jayaraman, Indian Institute of Science, Bengaluru

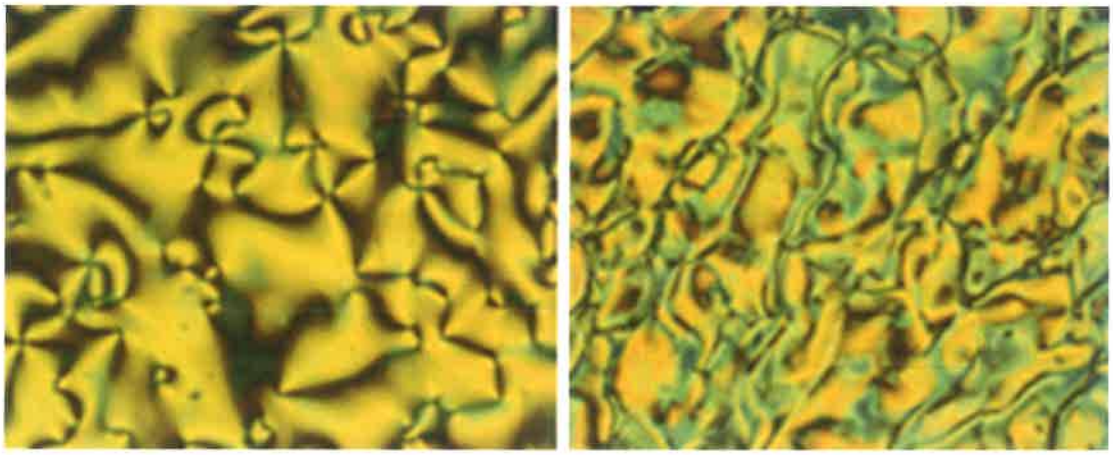
5.11 Hockey- stick shaped azo compounds

As the molecular Architecture plays an important role in liquid crystalline compounds, the designing of a mesogen, such as selection of different cores, linking groups and terminal substituents is a challenge to a chemist. Thus, it is quite interesting to study structure – property relationship of different types of compounds.

Our literature survey revealed that azo substituted hockey-stick mesogens are seldom known. Such compounds gain importance due to their photo-switching properties. Thus, in the present study we investigated several azo substituted hockey-stick compounds with an aim to study their structure-property relationship with respect to different types of linkage groups and their direction of linking. The newly synthesised compounds were characterised using chemical spectroscopy and their mesomorphic properties were investigated using polarising optical microscopy, differential scanning calorimetry and X-ray diffraction studies. They exhibited a variety of mesophases such as nematic, smectic A, anticlinic smectic C (SmC_a), B_1 etc.

Interestingly, in one of the compounds, the occurrence of two polymorphic tilted smectic phases i.e., SmC_s and SmC_a are observed.

From the experimental observations, we found that only the compounds with five phenyl rings are mesogenic. If the –N=N- linkage is directly attached to the central phenyl ring, the compounds are non-mesogenic, unlike our previous observations in the case of bent-core azo compounds. It is very clear from our investigations that the effect of direction of linkage groups have a major impact on the mesomorphic properties than the different types of linkage groups. This is in agreement with our previous findings in bent-core azo compounds. Interestingly, only 2-brush disclinations were observed in the Schlieren texture of nematic mesophases and the d-value obtained in this mesophase was much smaller than the actual molecular length. These compounds are found to be photo-sensitive.



(a) SmC_a (122°C) (b) SmC_s (110°C)

Investigators: Veena Prasad, Monika M. and Nagaveni N.G.

5.12 Stable ferroelectric liquid crystals derived from salicylaldimine core

Ten optically active mesogenic compounds, in the form of five pairs of enantiomers (Figure 5.12.1a), were prepared and characterized. The salicylaldimine-core was especially incorporated in the molecular design to maximize the probability of ferroelectric property as well as to provide resistance to heat and moisture to these new dimeric motifs. Chiral mesogens that are non-superimposible mirror images, making up a pair of enantiomers, were derived from (*R*)-octyloxy and (*S*)-octyloxy tails. The length of the *n*-alkoxy chain substituted at the other end has been varied from *n*-octyloxy to *n*-dodecyloxy. This variation influences the clearing temperatures of the mesogens; that is, the N*-I (clearing) transition temperatures decrease with the increase in the length of terminal tail; this behavior can be interpreted in terms of enhanced molecular flexibility with the increase in the length of terminal tail. All the

mesogens behave identically exhibiting BP, N* and SmC* phases meaning that the alteration in the length of the *n*-alkoxy tail has no significant effect on their LC behavior. The thermal width of the SmC* phase widens upon elongating the length of the *n*-alkoxy tail. Notably, the SmC* phase exhibits ferroelectric switching with high polarization value (Figure 5.12.1 b-c). Circular dichroism study, apart from confirming the helical structure of the N* and SmC* phases also serve to demonstrate the reversal of the helix-sense during the N* - SmC* phase transition.

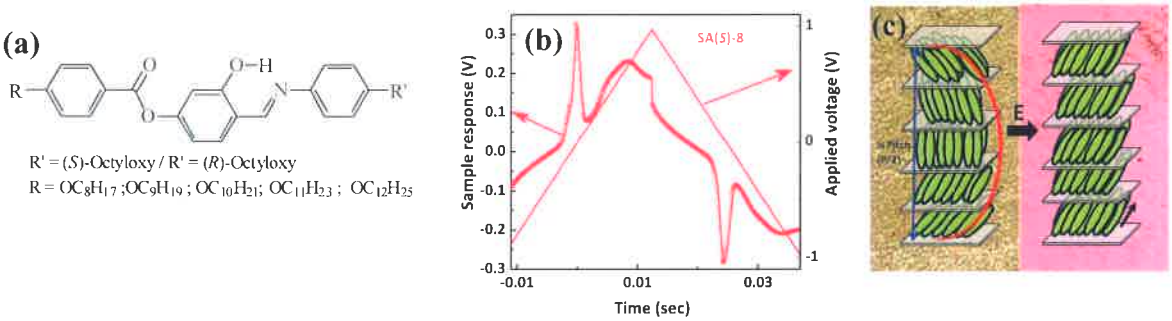


Figure 5.12.1: Molecular structures of the ten ferroelectric LCs synthesized; (b) current response peaks obtained by applying a triangular-wave filed (E) for the SmC phase; (c) schematic representation of unwinding of helix of the SmC* phase when electric field is applied.*

Investigators: B. N. Veerabhadraswamy, D. S. Shankar Rao and C. V. Yelamaggad.

5.13 Structure–property correlations in cyanobiphenyl-based dimer-like mesogens

Five series of a family of dimer-like mesogens were synthesized (Figure 5.13.1a) and characterized. They comprise cyanobiphenyl (mesogenic) and *N*-(*n*-alkyl)salicylaldimine (non-mesogenic) cores interlinked covalently *via* a flexible (oligomethylene) spacer of varying length and parity. The thermal behaviour of these new materials was studied mainly with help of polarized light microscopy, differential scanning calorimetry and powder X-ray diffraction. Mesogens with an even-carbon spacer display enantiotropic nematic (N) and / or smectic A (SmA) phase behaviour. On the contrary, the odd-spaced compounds belonging to two series show a metastable nematic phase, except for few motifs which do not show mesomorphism. Remarkably, two of the even-spaced mesogens, bearing oxyoctyloxy-nonyloxy and oxydecyloxy-nonyloxy spacer-terminal chain permutation, exhibited re-entrant nematic (N_{re}) phase below an interdigitated smectic A (SmA_d), which occurs below a high-temperature nematic phase; that is, these materials showed N-SmA_d-N_{re} phase sequence (Figure 5.13.1 b). This behaviour is in complete agreement with the fact that such a phase sequence is typically shown by mesogens possessing strong polar (-CN) group. The formation of this partially bilayered SmA (SmA_d) phase, wherein the layer spacing (*d*) remains greater than the molecular length (*L*), has been clearly evidenced by XRD studies. The main cause for the origin of N_{re}

and SmA_d phases can be attributed to the self-assembly of a molecular pair in an antiparallel manner so as to minimize the dipolar energy contribution. Importantly, these dimer-like motifs show a convincing odd–even effect when the parity of the spacer is varied, which appears to attenuate on increasing the length of the spacer. Needless to say, the present series of compounds behave similar to liquid crystal dimers and thus, support the view that they may be regarded as not only structural precursors to LC dimers but also bridge the gap between LC monomers and dimers.

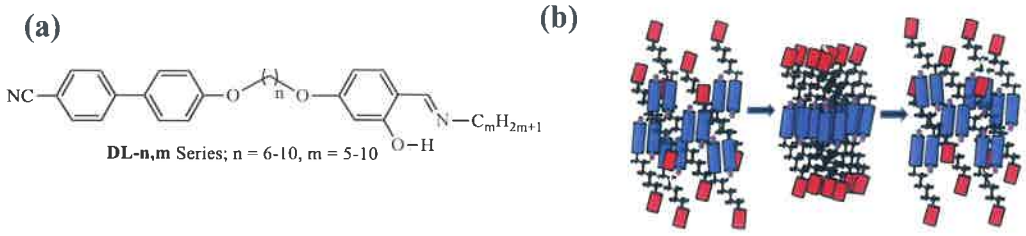


Figure 5.13.1: Molecular structures of dimer-like LCs prepared; (b) schematic representation of the N-SmA_d-N_{re} phase sequence.

Investigators: Rashmi Prabhu and C. V. Yelamaggad

5.14 Aging effect of resistive switching in Metal/ZnO/Pt device

ZnO thin film was deposited using the RF magnetron sputtering on $Pt/TiO_2/SiO_2/Si$. For the device of Ag/ZnO/Pt, the top contact was made with conducting silver (Ag) paste. The switching characteristics were carried out with top Ag contact biased and bottom Pt grounded. No switching behaviour was observed with the fresh top contact on ZnO film; *I-V* curves show a non-linear semiconducting behaviour. We kept the device in the laboratory ambience and studied the switching behaviour at regular intervals. Interestingly, on sixth day, we have observed the resistive switching behaviour with stable switching for several cycles. The same resistive switching characteristics was reproducible till eighth day. Notably, the eighth day resistive switching characteristics of our Ag/ZnO/Pt device has changed after 59 cycles. The ratio of low resistance to high resistance has decreased and the switching voltage also increased above 0.5 V. The latter behaviour continued up to 20 days. On 21st day, we have observed the fully linear *I-V* curves without switching, for several cycles. We could reproduce similar aging effect in several devices with Ag and Al top contacts, though there were differences in the days of appearance and disappearance of switching. Nevertheless, the conduction behaviour for the resistive switching curves shows the ohmic nature, which indicates the filamentary conduction between Ag and Pt electrodes across ZnO film. The photoluminescence of our ZnO films show

dominant visible emission due to defect states. Hence, we believe that over time Ag forms the AgO_x at the interface and possibly the AgO_x/ZnO shows the resistive switching. When days go by, the oxygen in AgO_x may get diffused into ZnO defects or released to atmosphere. Finally, the resistive switching disappears and the device shows a linear *I-V* due to the increased defect conductivity of ZnO.

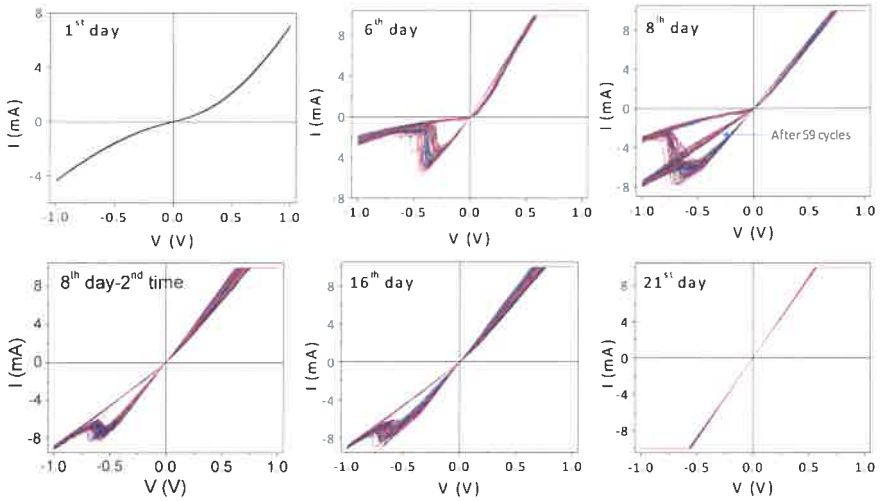


Figure 5.14.1: I-V characteristics of Ag/ZnO/Pt device showing the aging effect.

Investigators: Nagaiah Kambhala and S. Angappane

5.15 Multiferroic properties of Ba and Sm co-doped $BiFeO_3$

Ba and Sm doped $BiFeO_3$ thin films and nano particles were synthesized by chemical methods and the structural and magnetic properties of it were studied. The prepared thin films and nano

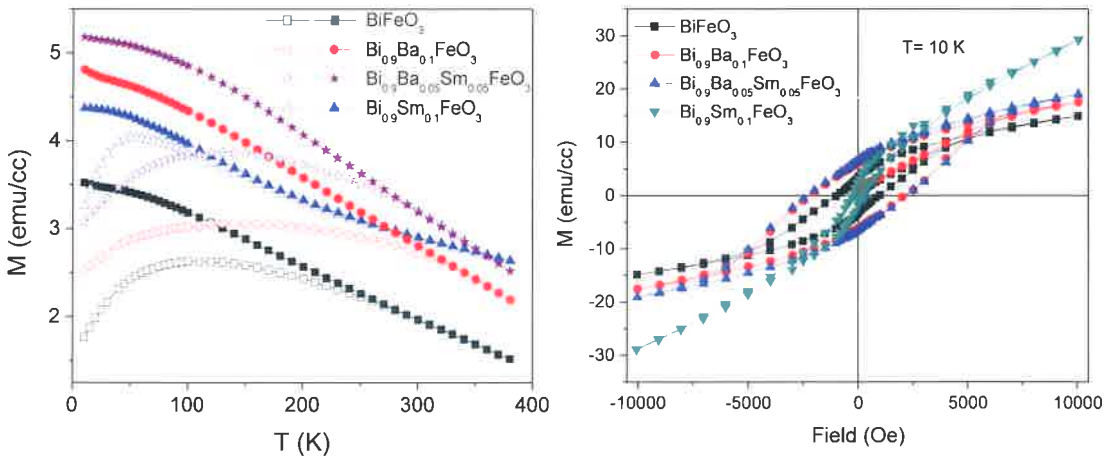


Figure 5.15.1: Magnetization of undoped and Ba and Sm co-doped $BiFeO_3$.

particles show the rhombohedral structure. Notably, the Ba and Sm doped $BiFeO_3$ thin films show the single phase behaviour compared to undoped $BiFeO_3$ thin film. $Bi_{0.9}Ba_{0.05}Sm_{0.05}FeO_3$ film shows the high magnetization and higher remnant magnetization and coercive field than undoped $BiFeO_3$ thin film. Remarkably, the coercive field of $Bi_{0.9}Ba_{0.1}FeO_3$ nanoparticles is showing 10 Oe for 10 K and 50 Oe for 300 K. The low coercivity observed in nano particles could be due to the size effect of $Bi_{0.9}Ba_{0.1}FeO_3$ and $Bi_{0.9}Ba_{0.05}Sm_{0.05}FeO_3$ nano powders.

Investigators: Nagaiah Kambhala and S. Angappane

5.16 Synthesis and Magnetic Properties of NiO Nanoparticles

We have synthesized the well dispersed NiO nanoparticles of 50 nm size by stirring the mixture of nickel acetate and PVAc solution in the 1:4 ratio for 3 hours at room temperature and heating at 450 °C. We have studied the structural, surface morphology, optical, Raman spectroscopy and magnetic properties of the synthesized NiO nanoparticles. The synthesized NiO nanoparticles exhibit face centered cubic structure. The optical band gap of NiO nanoparticles was estimated to be 2.72 eV. Room temperature Raman spectra shows the

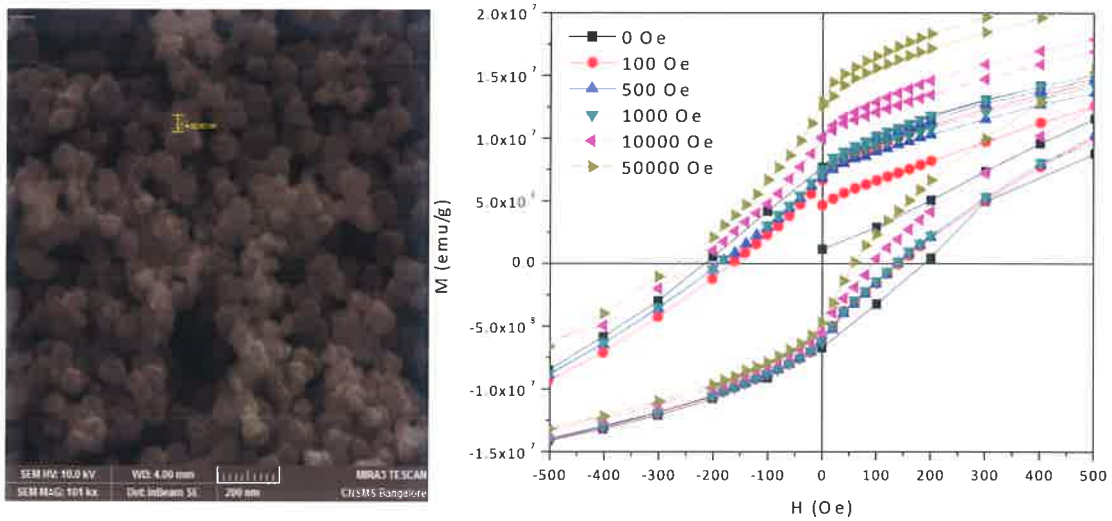


Figure 5.16.1: FESEM image of NiO nanoparticles. M-H data of NiO nanoparticles at 10 K with different cooling fields.

absence of 2M band, which suggests the room temperature ferromagnetism in NiO nanoparticles because there are no strong AFM correlation of spins. Room temperature ferromagnetism was observed in pure NiO nanoparticles with the coercive filed 62 Oe. We also observed the M–H loops shift towards the negative field axis, i.e., the exchange bias effect in our NiO nanoparticles. This proves the antiferromagnetic and ferromagnetic core/shell structure of our NiO nanoparticles. Further, we attempt to compact the nanoparticles into bulk pellet or

films to study the magnetoresistance in order to utilize these nanoparticles for tunneling magnetoresistance applications.

Investigators: Indukuru Ramesh Reddy, Nagaiah Kambhala, S. Angappane

5.17 Thermal annealing of thin Langmuir-Blodgett films of nickel octabutoxy phthalocyanine

Thin Langmuir-Blodgett (LB) films of Nickel(II)1,4,8,11,15,18,22,25-octabutoxy-29H,31H-phthalocyanine ($NiPc(OBu)_8$) is transferred onto a SiO_2/Si substrate coated with self-

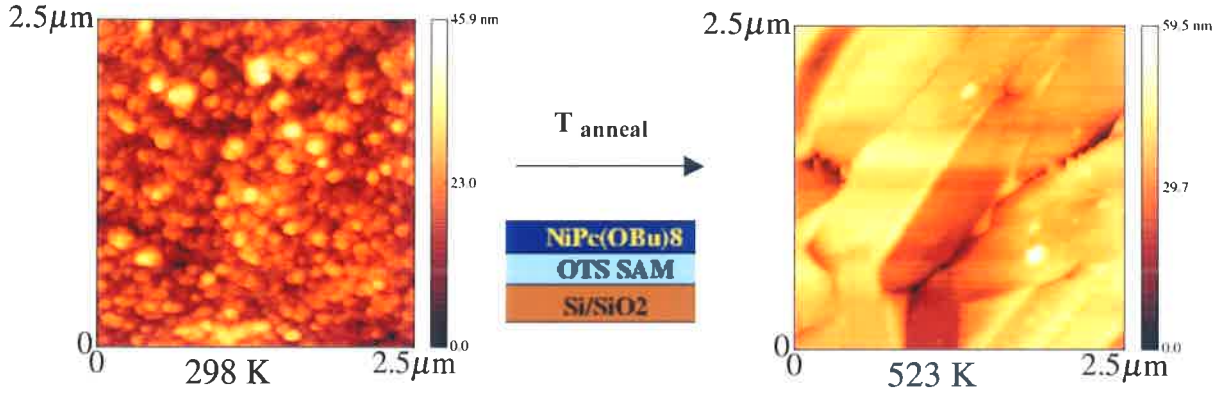


Figure 5.17.1: Topography images of the Langmuir-Blodgett films of nickel octabutoxy phthalocyanine (60 layers) obtained using AFM. Annealing of LB films results in transformation of granular morphology (as-deposited film) to elongated flat crystallites.

assembled monolayer and characterized using grazing incidence x-ray diffraction and atomic force microscopy (AFM) techniques. X-ray studies on the as-deposited LB film show a Bragg peak indicating crystallinity of the thin film. Annealing till 373 K leads to decrease in lattice spacing indicating changes in the molecular packing within the unit cell. An additional Bragg peak is observed and grows the expense of the former one coexisting between 373 and 423 K. Evidence for structural change of the crystalline lattice is gleaned from the discontinuity in lattice spacing from 2.07 to 1.51 nm. Correspondingly, the surface morphology obtained using AFM reveal a gradual transformation from spherical granules to elongated, flat crystallites suggesting asymmetric growth process. Statistical studies of the images support these claims (from the change in fractal dimension and circularity). These studies provide useful insights on the transformation of meta-stable to stable polymorphs in thin LB films of phthalocyanine by thermal annealing.

Investigators: T. Shilpa Harish and P. Viswanath

5.18 Dilatational rheology of a semi-crystalline ferroelectric copolymer at the air-water interface

Poly(vinylidene fluoride–trifluoroethylene) (70:30) is an important member of ferroelectric copolymer used in flexible devices. We have investigated the dilatational rheology response of this polymer at the air-water interface using oscillatory barrier technique under various surface pressures, temperatures and frequencies. The sinusoidal stress and strain behavior of the polymer is analyzed using Fourier transform and Lissajou's curve approach. Strain sweep studies provide evidence for hardening. For small strain and fixed angular frequency, the dilatational moduli studied with temperature show a pronounced discontinuity suggestive of order-disorder phase transition. Such a behavior is also seen in non-linear parameters obtained using Lissajous curves for compression expansion cycles. Further a crossover behavior is seen in the moduli with frequency.

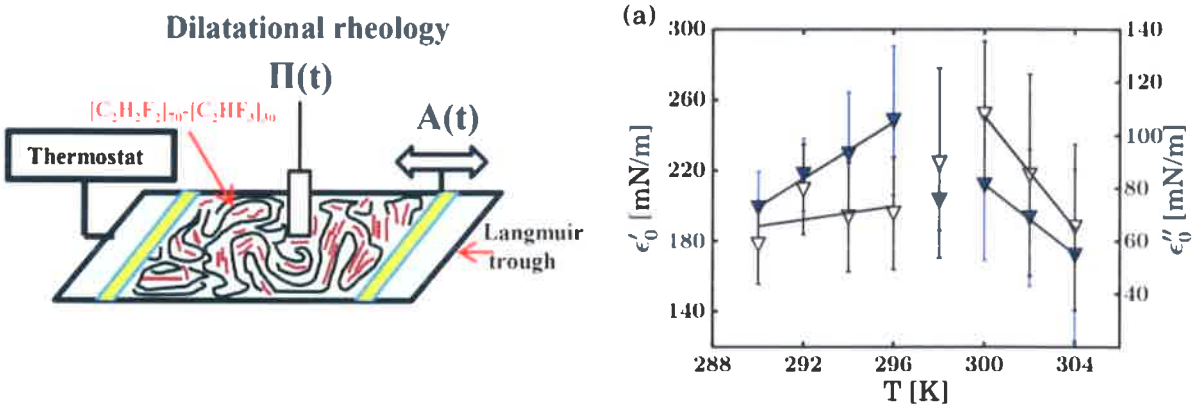


Figure 5.18.1: Dilatational rheology studies of PVDF-TrFE copolymer film using oscillatory barrier technique at the air-water interface. The temperature sweep studies show a pronounced discontinuity and change in slope of the moduli suggestive of an order-disorder phase transition at 298 K.

Investigators: Chandan Kumar and P. Viswanath

5.19 Synthesis of reduced graphene oxide based metal oxide nanoparticle hybrid films and their applications as reusable SERS substrates

Graphene and reduced graphene oxide (rGO) with its high surface area and electron delocalization is widely used as a platform to assemble various metal or metal oxide nanostructures to generate functional materials with unique properties. Free standing, thin films of rGO with ZnO, CuO and SnO_2 nanostructures have been obtained at a water/toluene interface employing a simple interfacial reaction of the precursors and self-assembly. The method can be adopted as a general route to prepare rGO based metal oxide films. The structure, optical properties and morphology are studied by X-ray diffraction, UV-visible

absorption spectra, photoluminescence and high resolution electron microscopy. rGO-ZnO, rGO-CuO and rGO-SnO_2 films exhibit unique morphologies such as hexagonal cylinders, elongated splinters, and balls, respectively, wrapped by rGO layers. rGO-metal oxide nanostructures show surface enhanced

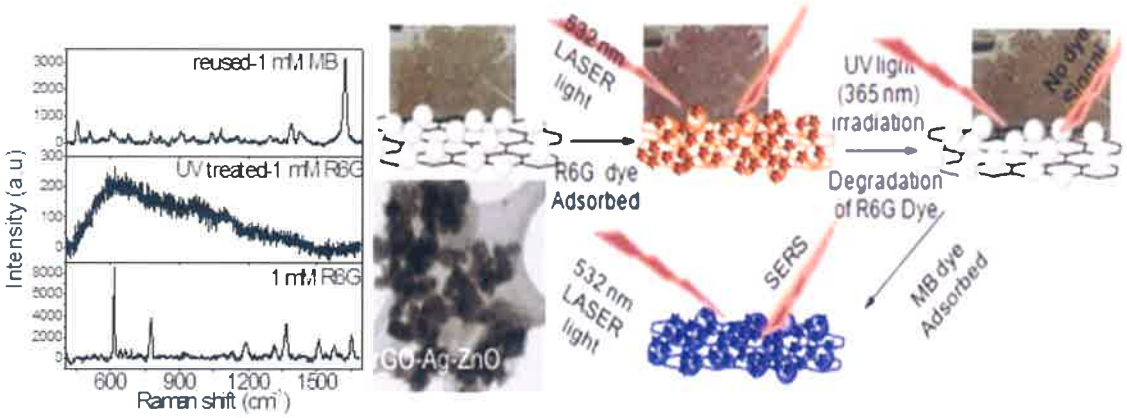


Figure 5.19.1: rGO-Ag-ZnO films as reusable SERS substrates

Raman scattering (SERS) effect of rhodamine 6G dye caused by a synergic effect of charge transfer between the dye, metal oxide and rGO, fluorescence quenching by rGO and dye molecular resonance. The enhancement factor follows the sequence rGO-CuO> rGO-ZnO>rGO-SnO_2. SERS enhancement is further improved by introducing a very small concentration of Ag^+ ions in the reaction system to obtain Ag nanoparticle doped rGO-ZnO films, exploiting the electromagnetic effect of metal surface plasmons. rGO-Ag-ZnO hybrid films show higher detection sensitivity up to 10 μM dye with an enhancement factor of 10^4. The higher photodegradation rates provided by rGO based metal oxide hybrids and metal nanoparticle doped hybrids enable regeneration of the used SERS substrate. The reusability of the hybrid films is exemplified by degradation of rhodamine 6G by UV irradiation and SERS recording of a different dye, methylene blue adsorbed on the renewed substrate (Figure 5.19.1).

Investigators : K. Bramhaiah and Neena S. John
Collaborators : C. Kavitha, BMSIT, Bengaluru and V. N. Singh, NPL, New Delhi

5.20 Synthesis and magnetic properties of rGO based Fe_2O_3 nanoparticles

Composites of iron oxide nanostructures with carbon nanomaterials are reported to have superior properties with respect to energy conversion and pollutant degradation. In the present study, we report the synthesis of dispersions and thin films of rGO with γ-Fe_2O_3 nanoparticles. A simple hydrolysis in presence of sodium citrate is presented for obtaining dispersions and liquid/liquid interface is exploited to obtain thin films of the composite. A comparative study of

the magnetic properties of the dispersion and thin films with spherical and rod morphologies of γ-Fe_2O_3 on rGO is performed. The magnetization (M) versus magnetic field (H) at room temperature shows an S curve without hysteresis loop indicating superparamagnetic nature of the composites (Figure 5.20.1). The saturation magnetization (Ms) of the composite, rGO-γFe_2O_3 is lower than that of bare γFe_2O_3, possibly arising from the coupling of nanoparticle spins with that of rGO. In the case of films, Ms is observed to be even much lower than that of dispersions and is associated with the presence of αFe_2O_3 phase (antiferromagnetic) along with γFe_2O_3, deduced from XRD. Field cooled and zero-field curves indicate a broad particle size distribution with blocking temperature and strong dipolar interaction.

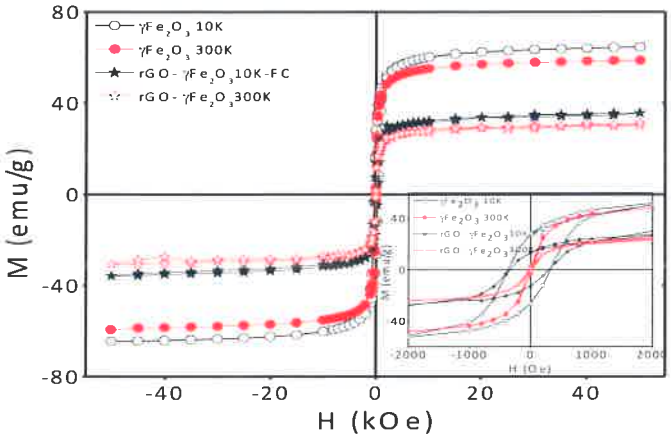


Figure 5.20.1: M-H curve of γFe_2O_3 and rGO- γFe_2O_3 dispersions

Investigators : K. Bramhaiah, Neena S. John and S. Angappane

5.21 Nanoscale photocurrent distribution in ultra-thin films of ZnO nanoparticles and its hybrid with rGO

Bulk device characteristics provide an averaged photoresponse from the nanostructured thin films and associating contributions from nanoscale features is challenging. However, it is important to understand the interfacial electron transport and homogeneity of the photocurrent generation across nanoscale. In this study, the photocurrent distribution in ZnO and rGO-ZnO films, obtained by liquid/liquid interface method, at nanoscale under UV irradiation is explored using conducting atomic force microscopy (C-AFM) and compared with the bulk electrical measurements. At rGO-ZnO interface, ohmic contact is achieved rather than a Schottky junction encountered in bare ZnO with metal electrode. Enhancement in the photocurrent is observed in both the cases and the photoresponse mapping by C-AFM reveals an inhomogeneous current distribution at nanoscale associated with various ZnO nanostructures in the film (Figure 5.21.1). While a small population of the nanostructures contributes higher photocurrents in bare ZnO film, majority of the photoresponsive ZnO nanostrucures provide

high photoresponse in rGO-ZnO. This nanoscale electrical study gives insights in to the local current contribution from individual nanostructures toward bulk electrical properties and can aid in understanding photovoltaic device performances.

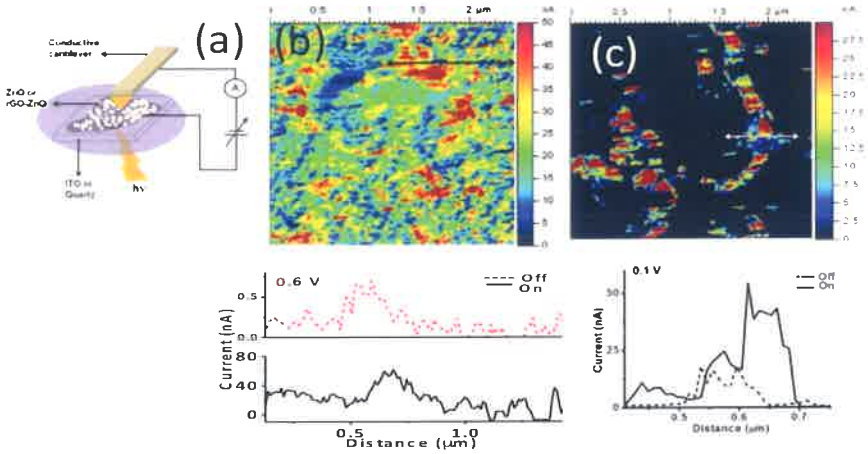


Figure 5.21.1. (a) Illustration of C-AFM setup; (b) current image of ZnO NP film at 0.6 V sample bias in UV-On state (c) current image of rGO-ZnO NP film at 0.1 V in UV-On state; current profiles are given below.

Investigators : K. Priya Madhuri, K. Bramhaiah and Neena S. John

5.22 Nanoscale conductance in nonplanar metallo-phthalocyanine films: Influence of molecular packing

Metallophthalocyanines (MPcs) constitute an important class of organic materials with high optical absorption in vis-NIR regions, delocalized π electron system and tunable properties from the choice of co-ordinated metal ions. Nonplanar MPcs such as PbPc and SnPc have their metal ions projecting out of the Pc planes. They crystallize in various polymorphs, importantly, monoclinic and triclinic forms.

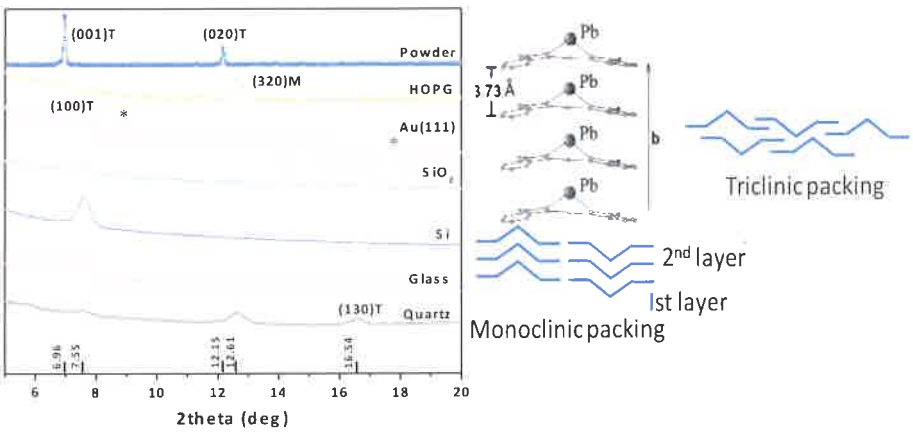


Figure 5.22.1: XRD of PbPC films on various substrates and schematic of possible crystalline packing.

We have been able to prepare thin films of MPcs on various substrates by vacuum evaporation. Interestingly, molecular packing and hence the crystallite phase is observed to be different on highly oriented pyrolytic graphite (HOPG) and other substrates such as Si, quartz and Au/mica (Figure 5.22.1). PbPc and SnPc favour monoclinic phase on HOPG, where Pc rings adopt face-on arrangement and triclinic on other substrates, where molecules adopt tilted arrangement. On Au/mica substrate, broad peak indicates a mixture of monoclinic and triclinic phases. On HOPG surface with sp^2 hybridized hexagonal network of carbons, face on arrangement of PbPc or SnPc will be favored as it maximizes π-π interaction between Pc rings and graphite surface. In the case of other substrates, face on arrangements as well as tilted arrangements can occur resulting in higher triclinic fraction. Accordingly, an enhancement in vertical transport of nonplanar MPcs is observed in on HOPG compared to other substrates. C-AFM current images are analyzed to account for the nanoscale current transport and inhomogenity (Figure 5.22.2).

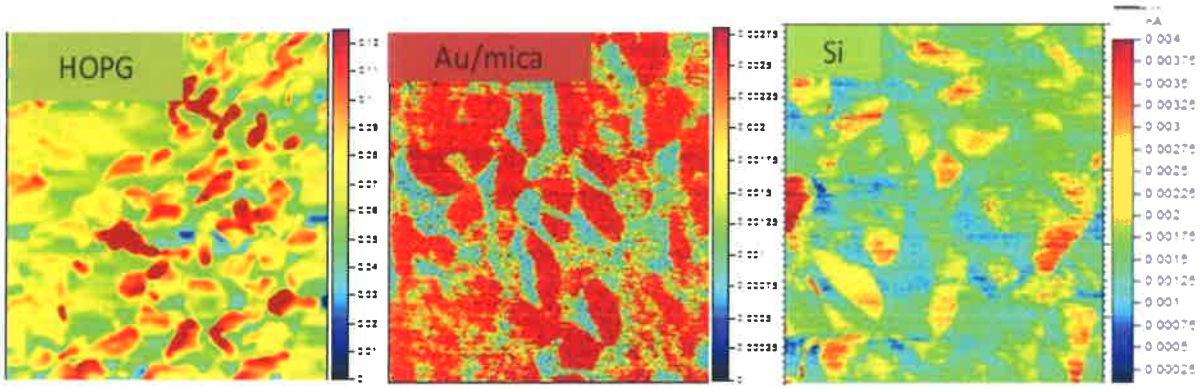


Figure 5.22.2: Current images of PbPc films on various substrates

Investigators : K. Priya Madhuri and Neena S. John

5.23 Charge transport in a liquid crystalline triphenylene polymer monolayer at air-solid interface

We have prepared a monolayer of a novel liquid crystalline polymer derived from 2,6-dihydroxy-3,7,10,11-tetraalkoxy-triphenylene (PHAT) at air-water interface. The material composed of electron rich triphenylene moieties forms a stable monolayer at A-W interface and exhibits an L_1 phase. The BAM images confirm the L_1 phase exhibited by the monolayer at A-W interface. The monolayer was transferred onto mica and gold coated mica substrates by Langmuir-Blodgett (L-B) technique. The height profile from AFM images for the L-B monolayer yields a value of 1.5 nm indicating the discs of triphenylene moieties to be in edge on configuration on both mica and gold coated mica substrates. A molecular model for PHAT monolayer is shown in Figure 5.23.1. The UV-visible spectroscopy measurements on PHAT yield the value of HOMO-LUMO gap, E_g to be 3.66 eV. Electrical measurements on the PHAT monolayer were carried out using CSAFM. The gold coated mica substrate–PHAT

monolayer–conducting tip of CSAFM form a M–I–M junction. Our analysis of the current (I) – voltage (V) data based on Simmons approach for the M–I–M junction suggested that the electrical conductivity through the junction was due to charge transport by direct tunneling mechanism. The effective electrical contact area between the tip and the monolayer, A_c was estimated to be 2.6 nm^2. The barrier height (φ) and effective mass of electron (m*) were estimated from the I-V curve fitting. Fig.5.23.2 shows the I–V characteristics of PHAT monolayer. The insets show: (a) Variation of dI/dV as a function of I indicating tunneling to be the charge transport mechanism, (b) Variation of $\ln(I/V^2)$ as function of 1/V showing the evidence of direct tunneling. The value of φ was estimated to be 1.22±0.02 eV and that of m* to be $(0.01\pm0.003)m_e$.

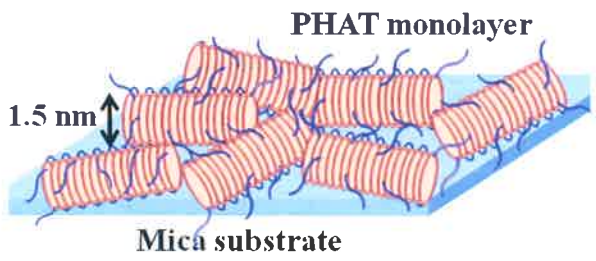


Figure 5.23.1 : Molecular model for PHAT monolayer

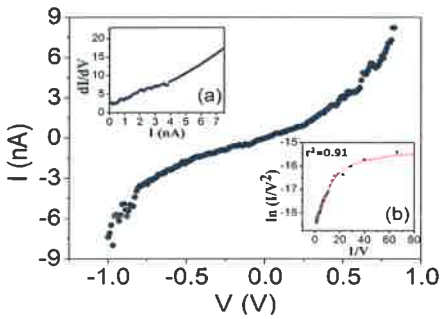


Figure 5.23.2: I-V characteristics of PHAT monolayer

Investigators : K. A. Suresh and H. N. Gayathri
Collaborators : Bharat Kumar, Central University of Karnataka, Gulbarga, H. K. Bisoyi and Sandeep Kumar, Raman Research Institute, Bengaluru

5.24 Transient, polarity-dependent dielectric response in a twisted nematic liquid crystal under very low frequency excitation

In a planarly aligned nematic layer, the dielectric reorientation manifests above a threshold field as a homogeneous symmetric distortion with maximum director-tilt in the midplane. We find that, upon excitation by a low frequency (<0.2Hz) square-wave field, the instability becomes spatially and temporally varying. This is demonstrated using rodlike liquid crystals, initially in the 90°-twisted planar configuration. The distortion occurs close to the negative electrode following each polarity switch and, for low-voltage amplitudes, decays completely in time. We use the elastically favourable geometry of wall defects to establish the location of maximum distortion. Thus, at successive polarity changes, the direction of extension of walls switches between the alignment-directions at the two substrates (Figure 5.24.1). These results are understood by taking into account the time varying and inhomogeneous field conditions

that prevail soon after the polarity reverses. Intrinsic double layers lead to an asymmetry in field distribution under an external bias. Momentary field elevation near the cathode following a voltage sign reversal, which causes locally enhanced dielectric and gradient flexoelectric torques, accounts for the surface-like phenomenon observed at low voltages.

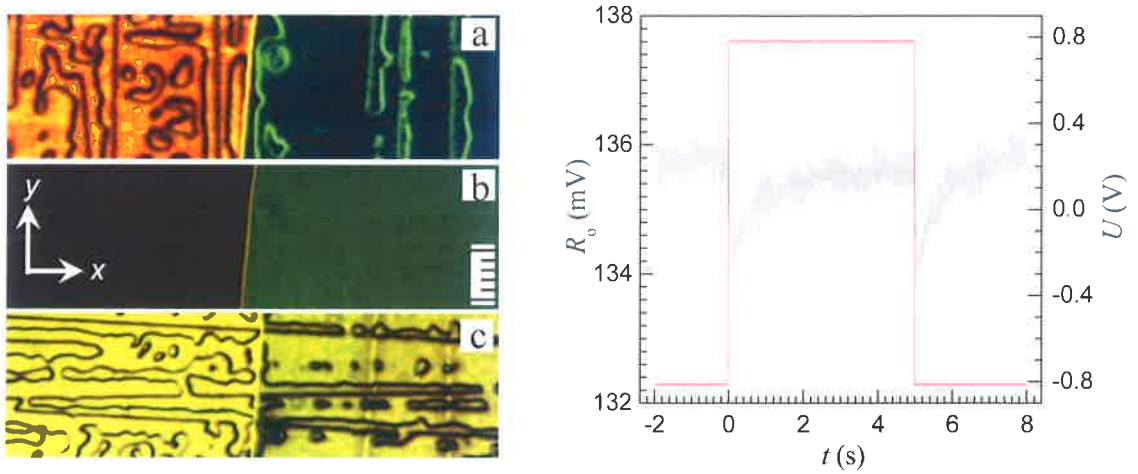


Figure 5.24.1: (Left) Polarity sensitive dielectric distortion in a TN layer under a SQW field (50 mHz; 2.6 V). The textures are of two oppositely twisted adjacent regions. (a, c) Frames captured at successive polarity reversals, showing the loops extending along y and x, respectively. (b) Texture in the distortion-free state. 10 μm scale div. (Right) Transient alignment distortion following polarity reversals, as observed in a TN layer at 0.8 V and 0.1 Hz. R_o denotes the optical response.

Investigator: K. S. Krishnamurthy

5.25 Effect of waveform of the driving field on nematic electroconvection near the dielectric inversion frequency

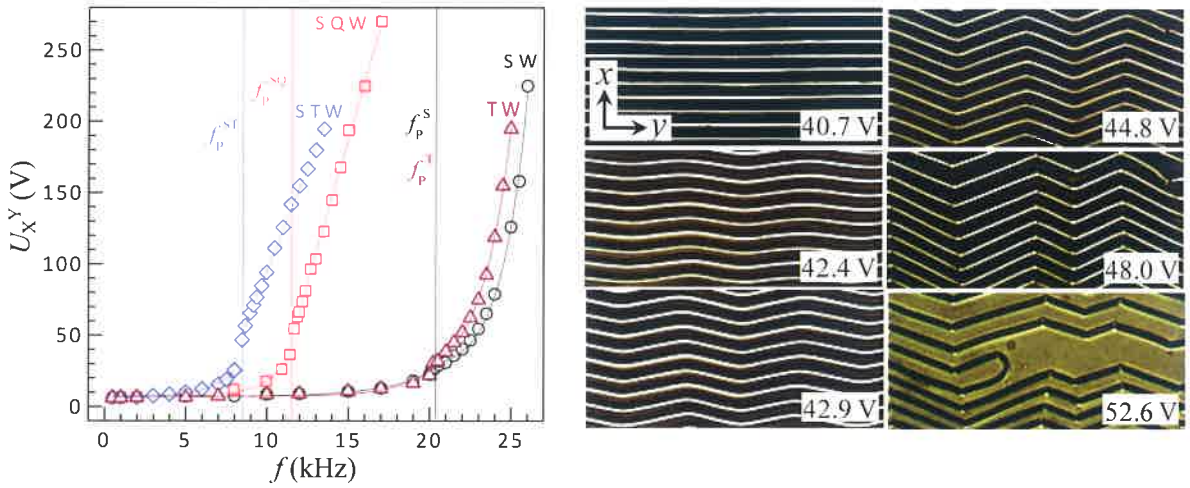


Figure 5.25.1: (Left) Frequency variation of threshold voltage U_X^Y in a planar nematic, for different waveforms. In U_X^Y, X denotes the instability state (=F for Freedericksz and P for patterned electroconvection) and Y denotes the waveform (SW, SQW, STW and TW denoting sine-, square-, saw-tooth- and triangle- wave, respectively). For $f < f_P^Y$, only the Freedericksz instability is observed at $U \geq U_F^Y$. Similarly, for $f \geq f_P^Y$, primary bifurcation into a periodic EC state occurs at threshold U_P^Y.

(Right) Texture of (a) normal rolls, (b) undulatory rolls, (c) undulatory rolls of increased amplitude, (d) zig-zag rolls, (e) zigs and zags separated by disclinations, and (f) hybrid state formed during transformation of rolls into Freedericksz loop walls. 74 kHz.

This work concerns the instability behaviour of a nematic liquid crystal in the region of dielectric inversion frequency for different excitation waveforms. The critical frequency separating the regimes of dielectric and electroconvective primary bifurcation states is found to undergo a large downshift for square-wave and sawtooth-wave fields, as compared to sine-wave and triangle-wave fields. This underscores the significance of harmonics in non-sinusoidal fields for the evolution of patterned electroconvective states.

Investigators : K. S. Krishnamurthy and Pramoda Kumar

6. HONOURS & AWARDS

G. U. Kulkarni

- Fellow of the Asia Pacific Academy of Materials
- Fellow of International Senior Fellowship of University of Bayreuth
- Member, Editorial Advisory Board, ACS Applied Materials & Interfaces
- Member, Editorial Advisory Panel, Scientific Reports
- Member, Vision Group on Nanotechnology, Department of IT, BT, S&T, Govt. of Karnataka

Veena Prasad

- Dr. Kalpana Chawla Young Women Scientist Award, Government of Karnataka for the year 2013, conferred in December 2015.

K. A. Suresh

- Member, International Advisory Board, 26th International Liquid Crystal Conference, July 31-August 5, 2016 , Kent State University, Kent, Ohio, U.S.A.
- Adjunct Professor, Department of Materials Science, Mangalore University, Mangalore

7. PUBLICATIONS

7.1 In Refereed Journals

1. Visibly transparent heaters, R. Gupta, K. D. M. Rao, S. Kiruthika and G. U. Kulkarni, *ACS Appl. Mater. Inter.*, **8**, 12559 - 12575 (2016), Impact Factor: 7.145

2. Bridging innovations in academic institutions to society, T. Pradeep, B. Raj, V. Ramgopal Rao, A. Kumar, B. R. Mehta, G. U. Kulkarni and et. al., *Curr. Sci.,* **110**, 482 - 486 (2016). Impact Factor: 0.833
3. Large area transparent ZnO photodetectors with Au wire network electrodes, K. Shanmugam, S. Singh and G. U. Kulkarni, *RSC Adv.,* **6**, 44668 - 44672 (2016). Impact Factor: 3.84
4. Evaluating conducting network based transparent electrodes from geometrical considerations, A. Kumar and G. U. Kulkarni, *J. Appl. Phys.,***119**, 015102-6 (2016). Impact Factor: 2.183
5. Defining switching efficiency of multi-level resistive memory with PdO as example, K. D. M. Rao, A. A. Sagade, R. John, T. Pradeep and G. U. Kulkarni, *Adv. Elec. Mater.,* **2**, 1500286-9 (2016).
6. Fabrication of oxidation-resistant metal wire network-based transparent electrodes by a spray-roll coating process, S. Kiruthika, R. Gupta, A. Anand, A. Kumar and G. U. Kulkarni, *ACS Appl. Mater. Inter.,***7**, 27215 - 27222 (2015). Impact Factor: 6.723
7. Site selective Cu deposition on Au microcrystallites: Corners, edges versus planar surfaces, G. Mettela and G. U. Kulkarni, *Cryst. Eng. Comm.,* **17**, 9459 - 9465 (2015). Impact Factor: 4.034
8. Highly decoupled graphene multilayers: Turbostraticity at its best, U. Mogera, R. Dhanya, R. Pujar, C. Narayana and G. U. Kulkarni, *J. Phys. Chem. Lett.,* **6**, 4437 - 4443 (2015). Impact Factor: 7.458
9. Rotational diffusion of a new large non polar dye molecule in alkanes, R. Goudar , R. Gupta, G. U. Kulkarni and S. R. Inamdar, *J. Fluoresc.,* 1 - 9 (2015). Impact Factor: 1.927
10. Solution processed nanomanufacturing of sers substrates with random Ag nanoholes exhibiting uniformly high enhancement factor, R. Gupta, S. Siddhanta, G. Mettela, S. Chakraborty, C. Narayana and G. U. Kulkarni, *RSC Adv.,* **5**, 85019 - 85027 (2015). Impact Factor: 3.84
11. Viscoelastic nature of Au nanoparticle–PDMS nanocomposite gels, R. Gupta, H. K. Nagamanasa, R. Ganapathy and G. U. Kulkarni, *Bull. Mater. Sci.,* **4**, 817 - 823 (2015). Impact Factor: 0.870
12. Transparent metal network with low haze and high figure of merit applied to front and back electrodes in semitransparent ITO-free polymer solar cells, C. Hunger, K. D. M. Rao, R. Gupta, C. R. Singh, G. U. Kulkarni and M. Thelakkat, *Ener. Tech.,* **3**, 638 - 645 (2015). Impact Factor: 2.824

13. Facet selective etching of Au microcrystallites, G. Mettela and G. U. Kulkarni, Nano Research, 8, 2925 - 2934 (2015) Impact Factor: 7.01
14. Ambient stable tetragonal and orthorhombic phases in penta-twinned bipyramidal Au microcrystals, G. Mettela, M. Bhogra, U. V. Waghmare and G. U. Kulkarni, *J. Am. Chem. Soc,* **137**, 3024 - 3030 (2015). Impact Factor: 12.113
15. Towards low cost materials and methods for transparent electrodes, G. U. Kulkarni, S. Kiruthika, R. Gupta and K.D.M. Rao, *Chem. Engg.,* **8**, 60 - 68 (2015). Impact Factor: 1.231
16. Disposable heater arrays using printed silver patterns on polyethylene terephthalate for multipurpose applications, S. Walia, R. Gupta and G. U. Kulkarni, *Ener. Tech.,* **3**, 359 - 365 (2015). Impact Factor: 2.824
17. Worldwide outdoor round robin study of organic photovoltaic devices and modules, Madsen, M, Gevorgyan, S, Gupta, Ritu, Shanmugam, Kiruthika, Kulkarni, Giridhar U., Krebs, Frederik C and et. al., *Sol Energ Mat Sol C*, **130**, 281 - 290 (2015). Impact Factor: 5.34
18. Transient, polarity-dependent dielectric response in a twisted nematic liquid crystal under very low frequency excitation, K. S. Krishnamurthy, *Phys. Rev. E* **92**, 032504 - 11 (2015). Impact Factor: 2.252
19. Effect of waveform of the driving field on electroconvection near the dielectric inversion frequency, K. S. Krishnamurthy and Pramoda Kumar, *Phys. Rev. E* **93**, 022706-7 (2016). Impact Factor: 2.252
20. Electrical conductivity in Langmuir-Blodgett films of n-alkyl cyanobiphenyls using current sensing atomic force microscope, H. N. Gayathri and K.A. Suresh, *J. App. Phys.* **117**, 245311-7 (2015) Impact Factor: 2.18
21. Charge transport in a liquid crystalline triphenylene polymer monolayer at air–solid interface, H. N. Gayathri, Bharat Kumar, K. A. Suresh, H. K. Bisoyi and Sandeep Kumar,, *Phys.Chem.Chem.Phys.,* **18**, 12101 - 12107 (2016). Impact Factor: 4.49
22. Evolution of Jahn-Teller distortion, transport and dielectric properties with doping in perovskite NdFe1-xMnxO3 (0 <= x <= 1) compounds, T. Chakraborty, Ruchika Yadav, Suja Elizabeth and H.L.Bhat, *Physical Chemistry Chemical Physics*, **18** (7), 5316 - 5323 (2016) Impact Factor: 4.493
23. Order-disorder phase transition and multiferroic behaviour in a metal organic framework compound (CH3)(2)NH2Co(HCOO)(3), Ruchika Yadav, Diptikanta Swain, H. L. Bhat and Suja Elizabeth, *Journal Of Applied Physics,* **119**(6), Article No. 064103-7 (2016) Impact Factor: 2.183

24. Fast photoluminescence switching in the nematic phase of calamitic-discotic composites, P. Lakshmi Madhuri, D.S. Shankar Rao, C. V. Yelamaggad and A.S. Achalkumar, and S. Krishna Prasad, *Adv. Opt. Mater.* ***3***, 1116 (2015). Impact Factor: 4.06

25. Enhancement of electrical conductivity of a liquid crystal-gold nanoparticle composite by a gel network of aerosil particles, B. Kamaliya, M. Vijay Kumar, C. V. Yelamaggad, and S. Krishna Prasad, *Appl. Phys. Lett.,* 083110-5 (2015). Impact Factor: 3.302

26. Dielectric properties of anti-ferroelectric B2 phase of bent core liquid crystal, P.K. Mukherjee and S. Krishna Prasad, *J. Mol. Liquids* **212**, 127 - 132 (2015). Impact Factor: 2.515

27. Self-assembly of luminescent n-annulated perylene tetraesters into fluid columnar phases, R. K. Gupta, B. Pradhan, D. S. Shankar Rao, S. Krishna Prasad and A. S. Achalkumar, *Soft Matter* **11**, 3629 - 3636 (2015) Impact Factor: 4.029

28. Anchoring transition driven by short range ordering in calamitic-discotic composites, Srividhya Parthasarathi, D.S. Shankar Rao, Hemant Kumar Singh, B. Singh, and S. Krishna Prasad, *Thermochim. Acta* **616**, 61 - 68 (2015). Impact Factor: 2.184

29. Tuning the thermotropic properties of liquid crystalline p-substituted aroylhydrazones, H. K. Singh, S. K. Singh, R. Nandi, M. K. Singh, Vijay Kumar, R. K. Singh, S. Krishna Prasad, D.S. Shankar Rao and B. Singh, *RSC Adv.*, **5**, 44274 - 44281 (2015) Impact Factor: 3.84

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32. In-plane modulated smectic Ã vs smectic 'A' lamellar structures in poly(ethyl or propyl ether imine) dendrimers, P. Kumar, D.S. Shankar Rao, S. Krishna Prasad, N. Jayaraman, *Polymer*, **86**, 98 - 104 (2016) Impact Factor: 3.562

33. Photo-controllable electro-optics of aerosil/7CB nanocomposite nematic doped with azo-bonded molecules, YG Marinov, GB Hadjichristov, AG Petrov, S. Krishna Prasad, *J. of Phys.*, **682** , 012030-5 (2016). Impact Factor: 2.209

34. Thin films of silica nanoparticle doped nematic liquid crystal 7CB for electro-optic modulation, YG Marinov, GB Hadjichristov, AG Petrov, S. Krishna Prasad, *Photonics Lett. Poland* **7**, 94 - 96 (2016).
35. Diminished splay stiffening in weak gels of calamitic–bent-core nematic composites, S Vimala, GG Nair, S. Krishna Prasad, BN Veerabhadraswamy, US Hiremath, *J. Phys. Chem. B* **120** , 2596 - 2603 (2016) Impact Factor: 3.302
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38. Hockey stick-shaped azo compounds: effect of linkage groups and their direction of linking on mesomorphic properties, M. Monika, Veena Prasad and N.G. Nagaveni, *Liq. Cryst.*, **42**, 1490 - 1505 (2015). Impact Factor: 2.486
39. Studies of intermolecular hydrogen bonded complex of butyloxy benzoic acid and dipyridyl ethylene, A. Sambyal, G. Kour, S. Sharma, R. K. Bamezai, S. Anthal, V. K. Gupta, R. Kant and C. V. Yelamaggad. *Mol. Cryst . Liq. Cryst.*, **608**, 135 - 145 (2015). Impact Factor: 0.491
40. Stable ferroelectric liquid crystals derived from salicylaldimine-Core, B. N. Veerabhadraswamy, D. S. Shankar Rao and C. V. Yelamaggad. *J. Phy. Chem. B*, **119**, 4539 - 4551 (2015). Impact Factor: 3.302
41. Structure–property correlations in cyanobiphenyl-based dimer-like mesogens, Rashmi Prabhu and C. V. Yelamaggad, *J. Phy. Chem. B*, **119**, 11935 - 11952 (2015). Impact Factor: 3.302
42. Influence of virtual surfaces on Frank elastic constants in polymer-stabilized bent-core nematic liquid crystals, P. Lakshmi Madhuri, Uma S. Hiremath, C.V. Yelamaggad, K. Priya Madhuri and S. Krishna Prasad *Phys. Rev. E* **93**, 042706-11 (2016). Impact Factor: 2.252
43. Effect of phase symmetry on the NMR spectrum of acetonitrile oriented in a uniaxial-biaxial-uniaxial phase, H. S. Vinay Deepak, C. V. Yelamaggad, C. L. Khetrapal, K V Ramanathan. *J. Mol. Struct. 1119*, 110 - 114 (2016). Impact Factor: 1.602

44. Study of coexisting phases in Bi doped $La_{0.67}Sr_{0.33}MnO_3$, Nagaiah Kambhala, Miaoxiang Chen, Peng Li, Xi-xiang Zhang, Desapogu Rajesh, K.S. Bhagyashree, Lora Rita Goveas, S.V. Bhat, P. Anil Kumar, Roland Mathieu, S. Angappane, *J. Magn. Magn. Mater.* 406, 22 - 29 (2016). Impact Factor: 1.97
45. Annealing assisted structural and surface morphological changes in Langmuir-Blodgett films of nickel octabutoxy phthalocyanine, T. Shilpa Harish and P. Viswanath, *Thin Solid Films*, **598**, 170 - 176 (2016). Impact Factor: 1.759
46. Dilatational rheology studies on a semicrystalline ferroelectric copolymer at the air-water interface, Chandan Kumar and P. Viswanath, *RSC Advances*, **6**, 16673 - 16678 (2016), Impact Factor: 3.84
47. Low cost, ultra-thin films of reduced graphene oxide–Ag nanoparticle hybrids as SERS based excellent dye sensors, C. Kavitha, K. Bramhaiah, Neena S. John, B.E. Ramachandran, *Chem. Phys. Lett.*, **629**, 81 - 86 (2015). Impact Factor: 1.89
48. Hybrid materials of ZnO nanostructures with reduced graphene oxide and gold nanoparticles: Enhanced photodegradation rates in relation to their composition and Morphology, K. Bramhaiah, V. N. Singh, N. S. John, *Phys. Chem. Chem. Phys.*, **18**, 1478 - 1486 (2015). Impact Factor: 4.49
49. Nanoscale photocurrent distribution in ultra-thin films of zinc oxide nanoparticles and their hybrid with reduced graphene oxide, K. Priya Madhuri, K. Bramhaiah and Neena S John, *Mater. Res. Exp.*, **3**, 035004 (2016). Impact Factor: 0.968
50. Interfacial and morphological features of a twist-bend nematic drop, K. S. Krishnamurthy, Pramoda Kumar, Nani B. Palakurthy, C. V. Yelamaggad, and Epifanio G. Virga, *Soft Matter*, 2016, DOI: 10.1039/C6SM00482B. Impact Factor:3.798
51. Influence of virtual surfaces on Frank elastic constants in polymer-stabilized bent-core nematic liquid crystal, P. Lakshmi Madhuri, Uma S. Hiremath, C.V. Yelamaggad, K. Priya Madhuri and S. Krishna Prasad, *Phys. Rev. E*, DOI: 10.1103/PhysRevE.93.042706. Impact Factor: 2.252
52. Electro-optic modulation by silica-nanostructured nematic system (aerosil/7CB nanocomposite), YG Marinov, GB Hadjichristov, AG Petrov, S. Krishna Prasad, *Composites Part B: Engineering*, DOI: 10.1016/j.compositesb.2016.01.034. Impact Factor: 3.850
53. Molecular approach to phase transitions in a calamitic ester substituted aroylhydrazone liquid crystal, R. Nandi, S. K. Singh, H. K. Singh, D. S. Shankar

Rao, S. Krishna Prasad, B. Singh and R. K. Singh, *J. Raman Spectrosc.* DOI: 10.1002/jrs.4933. Impact Factor: 2.395

54. Photoluminescent discotic liquid crystals derived from tris(N-salicylideneaniline) and stilbene conjugates: Structure–property correlations, A.S. Achalkumar, B.N. Veerabhadraswamy, U.S. Hiremath, D.S. Shankar Rao, S. Krishna Prasad and Yelamaggad CV, *Dyes and Pigments*, DOI: 10.1016/j.dyepig.2016.05.010. Impact Factor: 4.055
55. Supramolecular non-symmetric dimers derived from cholesterol: synthesis and phase transitional properties, U. S. Hiremath, G. G. Nair and D. S. Shankar Rao, *Liq. Cryst.*, http://dx.doi.org/10.1080/02678292.2016.1142010; Impact Factor: 2.486
56. s-triazine-based functional discotics: Synthesis, mesomorphism and photoluminescence, B. N. Veerabhadraswamy, Hashambi K. Dambal, D. S. Shankar Rao and C. V. Yelamaggad. *Chem Phys Chem*, 2016 DOI: 10.1002/cphc.201600280. Impact factor: 3.419

7.2 In Conference Proceedings

1. Investigations on growth, structure, optical properties and laser damage threshold of organic nonlinear optical crystals of Guanidinium L-Ascorbate, Ravi K., Saripalli, S. Kumar, H. L. Bhat and S.Elizabeth, Edited by: M. Bertolotti, JW. Haus, AM Zheltikov, Conference on Nonlinear Optics and Applications IX, Prague, CZECH REPUBLIC, : APR 13-15, 2015 , SPIE (Optics and Optoelectronics).
2. Resistive switching behavior of RF magnetron sputtered ZnO thin films, R. Rajalakshmi and S. Angappane, AIP Conf. Proc. 1665, 080051 (2015).

7.3 Technical Reports / Monographs / Books

1. Reference Module in Materials Science and Materials Engineering, S. Krishna Prasad and Geetha G. Nair, Nematic Liquid Crystals: Elastic Properties, (Elsevier Science Ltd., Amsterdam), 2016, doi:10.1016/B978-0-12-803581-8.02949-0.
2. Reference Module in Materials Science and Materials Engineering, S. Krishna Prasad and D.S Shankar Rao, Liquid Crystals Under High Pressure, (Elsevier Science Ltd., Amsterdam), 2016, doi:10.1016/B978-0-12-803581-8.03047-2.

8. PATENTS APPLIED / GRANTED

1. **A strain sensor and method thereof,** G.U. Kulkarni, K.D. Mallikharjuna Rao, K. Srivastava and Ritu Gupta, Indian Patent Application Number-201641013578.

2. **A synergictic mixture of water and isopropyl alcohol and application thereof,** G.U. Kulkarni, K.D. Mallikharjuna Rao and Rajashekhar N. Pujar, Indian Patent Application Number -201641012112.

3. **Turbostratic Graphite and Process of Preparing the Same,** G. U. Kulkarni and U. Mogera, Indian Provisional Patent Application No.: 2967/CHE/2015

9. TECHNOLOGY TRANSFER / ENTREPRENEURSHIP ACTIVITIES

G. U. Kulkarni

A process for hybrid transparent electrodes consisting of invisible metal mesh - graphene film has been developed working jointly with Tata Steel.

S. Krishna Prasad

A prototype device "Polysoft switchable glass" was exhibited at the

(1) Mega Science Expo, part of India International Science Festival (IISF), held in IIT Delhi during 4-8 December 2015.

(2) 8th Bangalore INDIA NANO 2016, March 3-4, 2016

Geetha G. Nair

A prototype device based on "Fast responding Energy Efficient Anisotropic organogels" was exhibited at the

(1) Mega Science Expo, part of India International Science Festival (IISF), held in IIT Delhi during 4-8 December 2015.

(2) 8th Bangalore INDIA NANO 2016, March 3-4, 2016

10. NEW TEACHING PROGRAMMES / MATERIALS DEVELOPED

CeNS offered a variety of credit courses to students who have enrolled for their Ph.D

Course Code	Course Title	Credits
CeNS-IA	Instrumental methods and analysis	1:1
CeNS-SC	Scientific Communication	1:0
CeNS- IP	Intellectual property	1:0
CeNS-SW	Safety and Waste Management	1:1
CeNS- NS	Basics of Nano and Soft Matter	2:1

11. NEW RESEARCH FACILITIES CREATED / MAJOR EQUIPMENT ACQUIRED

11.1 Devices and Interfaces Lab (Di-lab)

CeNS opened the Di-lab to facilitate the device fabrication, characterization and interface studies. The Di-lab equipped with a state-of-art HEPA filter fitted clean vertical laminar flow bench housed inside a yellow room. The clean bench includes a mask-less photolithography system to fabricate patterns down to 5 μm and the wet bench with all instruments for chemical synthesis of films. The photolithography system consists of an in-house designed projection lithography setup with optical microscope to fabricate any pattern without mask. In order to provide a complete device fabrication capability, a table-top automatic metal sputtering deposition system is placed adjacent to the yellow room. A thermal evaporation system to deposit metals is also given to fabricate sharp features. In addition, a reactive ion etching system is placed to carry out the etching of masks and films. A probe station with best low current capabilities, semiconductor characterization system to measure upto four terminal devices and electrochemical work station are provided for the electrical characterization. The contact angle meter will be used to characterize the solid-liquid interface at a given temperature. With the given facilities in the Di-lab, the fabrication and study of variety of semiconductor devices can be carried out efficiently.

11.2 Characterization Lab (C-Lab)

The characterization lab (C-lab) at CeNS provides basic as well as sophisticated facilities such as UV- Vis-NIR spectrophotometer, spectrofluorometer, X-ray diffractometer, Field emission scanning electron microscope, atomic force microscope and confocal Raman spectrometer. In addition to the normal modes of imaging, specialized research suitable for nanoscience activities such as conducting and kelvin probe mode, magnetic mode etc are available with AFM while back scattered imaging, scanning transmission mode etc can be operated with FESEM .Up gradation of the instrument hardware and software is taken up whenever the research at the Centre demands it. Around 45 researchers use this facility for routine measurements on materials generated in the laboratory. The C-lab is maintained round the clock for the usage of researchers. Training is provided to students on a regular basis by competent personnel for efficient functioning of the lab.

Di-Lab facility

11.3 Equipment acquired

- Vaccum Furnace
- Electrochemical Work Station
- Fabrication of Projection Lithography System
- Confocal Raman Microscope
- Automatic Contact Angle Meter
- Reactive Ion Etching (RIE) System
- Integrated IV/CV Characterization System
- Thermal Evaporation System
- STA 2500 Regulus Simultaneous Thermal Analyser
- Probe Station

FESEM housed in the C-Lab

12. HUMAN RESOURCE DEVELOPMENT

Number of Ph.D produced : 7

Sl. No.	Name of the Student	Ph.D	Date
1	Nagaveni N.G.	Awarded	18th April 2015
2	Bhargavi R.	Awarded	7th June 2015
3	Vijay Kumar M.	Awarded	4th Jan 2016
4	Rajalakshmi R.	Submitted	October 2015
5	Nagaiah Kambhala	Submitted	March 2016
6	Shilpa Harish	Submitted	24th June 2016
7	Gayathri H. N.	Submitted	5th July 2016

Number of RAs mentored : 6
Short term Workers (STW) trained : 16

13. CONFERENCE / SYMPOSIA / SEMINARS / WORKSHOPS ORGANIZED

1) Symposium on "Recent Advances in Nano and Soft Materials", VIT University, Vellore, 17 October 2015.
2) Symposium on "Nano Science & Nano Technology", Alva's Institute of Engineering, Moodabidri, 11-12 March 2016.
3) Symposium on 'Advances in Chemical Sciences', Dept. of Chemistry, Gulbarga University at Gulbarga University, 11th March 2016

Prof. G.U. Kulkarni interacting with students, Alva's Institute of Engineering, Moodabidri during symposium on "Nano Science & Nano Technology".

14. COLLOQIA AND SEMINARS BY VISITING SCIENTISTS

14.1 Colloquia

1. "Third generation solar cells: Materials & Processes", Prof. Mukundan Thelakkat, University of Bayreuth Bayreuth, Germany, 11 September 2015

2. "Emerging thermal and energy nanomaterials for rapid transient events", Prof. Timothy S. Fisher, USA, 10 December 2015

3. "Playing dice with metal organophosphate building blocks: Entry to a new class of porous solids", Prof. R. Murugavel, IIT Bombay, Mumbai, 11 December 2015

14.2 Seminars

1. "Schiff base and their coordination compounds as versatile synthons for accessing liquid crystalline material", Prof. Chira Bhattacharjee, Assam University, Assam, 6 May 2015

2. "Molecular shape related effects in liquid crystals", Prof. L. Komitov, Gothenburg Univ., Sweden, 19 June 2015

3. "Computer simulations of nanomaterials and soft matter", Dr. M. Krishnan, International Institute of Information Technology, Hyderabad, 22 and 23 July 2015

4. "Sustainable nanocatalysts", Dr. Dinesh Jagadeesan, National Chemical Laboratory, Pune, 08 August 2015

5. "Basic invention to technology realisation: The importance of a prepared mind" Prof. M. Eswaramoorthy, Jawaharlal Nehru Advanced Scientific Research, Bengaluru, 13 August 2015

6. "Electroconvection in concentration polarization", Dr Pramoda Kumar, Harvard-School of Engg. & Appl. Sc., Germany, 14 August 2015. During the period from 1 May 2015 to 30 September 2015 he carried out collaborative experimental work on liquid crystals

7. "Affordable drinking water using advanced materials: From lab to market", Prof. T. Pradeep, Indian Institute of Technology Madras, Chennai, 10 September 2015

8. "Functional soft materials by molecular assembly of π- systems and polymers", Dr. Suhrit Ghosh, Indian Association for the Cultivation of Science, Kolkatta, 30 September 2015

9. "Carbohydrates in medicinal and material chemistry: Challenges and opportunities", Dr. Naresh Kottari, Max Planck Institute of Colloids and Interfaces, Potsdam, Germany, 05 October 2015

10. "Controlling recombination kinetics in quantum dot solar cells, Dr. Pralay K. Santra, Stanford University, USA, 06 October 2015

11. "Graphene devices for probing matter and physics at nanoscale", Dr.Shishir Kumar, Indian Institute of Science, Bengaluru, 08 October 2015

12. "Raman spectroscopy: Principle, realization and application, Prof.Chandrabhas Narayana, JNCASR, 07 November 2015

13. "Flow induced nonequilibrium self-assembly of nanostructured materials", Dr. Rema Krishnaswamy, Indian Institute of Science, Bengaluru, 19 November 2015

14. "Theory and fabrication of atomic sized thermoelectric devices", Dr. K. A. Gillemot, Wigner Research Centre for Physics, Hungary, 16 November 2015. Visited the Centre under INSA-HAS Joint Research Project during 9-22 November.2015.

15. "Elongated particles on different length scales", Dr. B. Szabo, Wigner Research Centre for Physics, Hungary, 17 November 2015. Visited the Centre under INSA-HAS Joint Research Project during 9-22 November.2015.

16. "Nanomaterials for spectroscopic signal amplification, Dr. Jatish Kumar, Nara Institute of Science and Technology (NAIST), Japan, 03 December 2015

17. "Photothermal deflection spectroscopy studies of perovskites", Dr. Aditya Sadhanala, Cambridge University, UK, 09 December 2015

18. "Nanostructured materials for energy storage and conversion", Dr. M.V. Reddy, National University of Singapore, Singapore, 09 February 2016

Prof. Mukundan Thelakkat from University of Bayreuth, Germany, delivering a colloquium on "Third generation solar cells: Materials & Processes" at CeNS on 11 September 2015

15. ASSISTANCE PROVIDED BY THE FACULTY IN ACADEMIC ACTIVITIES OF OTHER INSTITUTIONS

G.U. Kulkarni

- Academic Council Member at The National Institute of Engineering, Mysore
- Evaluation Committee for the post of Chief Research Scientist, IISc, Bengaluru
- Faculty selection committee member, IISER Pune
- Member, POCC committee- Nano Mission, Govt. of India
- Ph. D. thesis examiner, I.I.T. Kanpur

K. A. Suresh

- Ph. D. thesis examiner and evaluator, of Ms. Jhuma Dutta I. I. T., Kanpur
- Ph. D. thesis evaluator, of Mr. B.S. Avinash, R.R.I., Bengaluru
- Project Proposal evaluator of 4 projects DST, CSIR
- Chairman, 9th meeting of Program Advisory Committee, Condensed Matter Physics and Material Sciences, 20-22, May 2015, JNCASR, Bengaluru
- Member, Sectional Committee for Physics, Selection of Fellows, Indian National Science Academy, 27-28, July 2015, at INSA, New Delhi
- Member, Steering Committee for SAIF program, 9/4/2015, Technology Bhavan, DST, New Delhi
- Member, Steering Committee for SAIF program, 28/3/2016, Technology Bhavan, DST, New Delhi
- Member, Central Management Committee, Sophisticated Instrumentation Centre for Applied Research and Testing (SICART), 20/8/2015, Vallabh Vidyananagar, Anand, (Gujarat).
- Member, 51st meeting of Facility Management Committee of SAIF, IIT Bombay, 28/12/2015, Mumbai.
- Member, DST, INSPIRE Faculty Fellows selection committee, 26-28, November 2015, INSA Building, New Delhi
- Member, Advisory Board, DST SERC School on Physics and Chemistry of themoelectric materials, 21/11/2015, Materials Research Centre, I.I.Sc.
- Chairman, Research work evaluation of DST/INSPIRE Fellow, Ms. Jhansi Rani, Sri Krishnadevaraya University, 18/9/2015, CeNS
- Member, Evaluation Committee, Prof. Alokmay Datta, Saha Institute of Nuclear Physics(SINP), Promotion, Senior Professor 'H' to Senior Professor 'H+'
- Member, Evaluation Committee, Dr. Krishnacharya, Dept. of Physics, IIT Kanpur, Promotion to Associate Professor
- Member, Evaluation Committee, Dr. Santanu K. Pal, Chemical Sciences, IISER Mohali, Promotion to Associate Professor
- Member, Evaluation Committee, 30/9/2015, Dr. Rajesh Ganapathy, JNCASR, Bengaluru, Promotion to Associate Professor

H. L. Bhat

- Member, Governing Council, The National Education Society of Karnataka, Bengaluru
- Member, Academic Council, M.S. Ramaiah University of Applied Sciences, Bengaluru
- Member, Academic Council, National Degree College, Bengaluru (Autonomous)
- Member, Board of Studies, PESIT University, Bengaluru
- Member, Doctoral Committee, VIT University Vellore, Tamil Nadu
- Vice President, Materials Research Society of India

- Advisor, Conference Organizing Committee, 18th International Workshop on Physics of Semiconductor Devices (IWPSD-2015), Indian Institute of Science, Bengaluru, 7-10 December 2015.
- Subject Expert in the Assessment Committee, RAC, DRDO, Hyderabad, 18-19 May 2015

Geetha G. Nair

- Member, Selection committee to appoint Research Assistant, Soft Condensed Matter Lab, Raman Research Institute, Bengaluru; 7th January 2016

Veena Prasad

- Chairperson, Ph. D. Viva-Voce examination of Ms. Nagaveni N.G., Mangalore University, Mangalore, 18 April 2015.

- Thesis referee and member of Viva-Voce examination committee of Mr. Prashanth Kumar K, NITK, Surathkal, Mangalore, 1 October 2015.

C. V. Yelamaggad

- Project proposal evaluator for 7 projects from BRNS and SERB

S. Angappane

- Ph D thesis examiner of Mr. Muruganantham R., Anna University, Chennai

16. PEER REVIEWING OF MANUSCRIPTS

Name of the Journal	Number of manuscripts refereed	Name of the Journal	Number of manuscripts refereed
ACS Applied Materials & Interfaces	10	Solid State Communications	2
		Micro & Nano Letters	4
Bulletin of Materials Science	32	Small	1
Scientific Reports	10	Advanced Materials	2
The Journal of Physical Chemistry	2	Carbon	2
		Phys. Rev. E	4
Composites Science and Technology	1	Liquid Crystals	3
		Physical Chemistry Chemical Physics	1
RSC Advances	6		
Chem Phys Chem	1	Journal of Molecular Structure	1
Journal of Materials Chemistry C	3	Journal of Applied Physics	1
Journal of Organometallic	1	Journal of Magnetism and Magnetic Materials	3
RSC ChemComm	1		
Journal of Alloys and Compounds	1	EuroPhysics Letters	1
		Mol. Cryst. Liq. Cryst.	1
Journal of Chemical Sciences	1	J. Phys. Chem. B	1
Langmuir	4	The J .Chem. Phys.	1
Crystal Research & Technology	1		

17. EXTRAMURAL RESEARCH PROJECTS

Sl. No.	Title and PI of the project	Sponsoring/collaborative agency	Duration From ... To...	Budget sanctioned Rs. in lakhs
1.	Graphene-Metal mesh transparent hybrid electrodes PI: G.U.Kulkarni	Tata Steel Limited	November 2015 to April 2016	40.00
2.	Nanomaterials for Clean Energy and Environmental Sensors Project Co-ordinator: G.U.Kulkarni	IUSSTF	May 2015 to November 2018	73.44
3.	Charge transport and calorimetric studies on liquid crystals and plastic crystals doped with metal nano particles PI: S.Krishna Prasad	SERB, DST	May 2012 to November 2015	46.20
4.	Electro-optic and rheological investigations on liquid crystal gels PI: Geetha G. Nair	SERB, DST	September 2013 to September 2016	55.00
5.	Optically active supramolecular liquid crystals, photochromic trimers and functional trimer-like mesogens: Synthesis and characterization PI: Geetha G. Nair	Women Scientist Programme, DST	January 2014 to January 2017	23.75
6.	Dynamics of soft condensed matter Project Leader: K.A.Suresh	INSA-HAS Bilateral Exchange Programme	April 2014 – March 2017	-
7.	Investigations of photostimulation effects in nano-structured liquid crystals PI: S.Krishna Prasad	Indo-Bulgarian Joint Programme	March 2013 – March 2016	8.25
8.	Synthesis and characterization of novel thermotropic liquid crystals: functional discotics, dimers and dimer-like mesogens PI: C.V.Yelamaggad	SERB, DST	June 2013 to June 2016	23.66
9.	Magnetic studies on magnetic ion doped ZnO thin films and resistive switching applications PI: S. Angappane	SERB, DST	July 2012 to July 2015	17.64
10.	Local conductance, gas sensing and molecular magnetism studies of electroactive systems of metal phthalocyanines PI: Neena S. John	SERB, DST	December 2012 to December 2015	23.00

18. FACULTY VISITS INDIA/ABROAD

1. "Gold crystallized in non-FCC lattices", G.U. Kulkarni, Invited talk, Chemical Frontiers 6th Edition 2015, Goa, 15-18 August 2015
2. "A facile method of synthesis of high quality grapheme", G.U. Kulkarni, Invited talk, One-day Mini Symposium on 'Graphene for Energy Application', IIT, Jodhpur, 14 October 2015
3. "Turbostratic graphene", G.U. Kulkarni, Joint Workshop on Recent advances in Nano and Soft Materials, VIT, Vellore, 17 October 2015
4. "Ultrafast humidity sensors using supramolecular nanofibres as active element", G.U. Kulkarni, Seminar on Indo-French workshop on Chemistry and Physics of Materials, UPMC, Paris, 26-27 October 2015
5. "Highly decoupled graphene multilayers, G.U. Kulkarni, Australia-India Strategic Research Fund Meeting (AISRF 2015 workshop)", IISER, Mohali, 25-27 November 2015
6. "New developments in graphene research", G.U. Kulkarni, ICFCR-2008 Endowment Lecture 2015-16, Mangalore University, Mangalore, 03 February 2016
7. "Transparent and flexible large area devices", G.U. Kulkarni, Israel-India workshop on Nanoscience & Nanotechnology, Weizmann Institute of Science, Israel, 22-23 February 2016
8. "Nobler than the noblest: non-FCC gold crystallites; make your own touch screen", G.U. Kulkarni, International Conference on Nanoscience and Technology (ICONSAT 2016), IISER, Pune, 29 February to 02 March 2016
9. Tutorial on "Nano fabrication technologies", G.U. Kulkarni, 8th Bangalore India Nano 2016, The Lalit Ashok, Bengaluru, 03-05 March 2016
10. "Polarity-dependent transient dielectric response in a twisted nematic liquid crystal under very low frequency excitation", K. S. Krishnamurthy, Invited talk, 22nd National Conference on Liquid Crystals, DIT University, Dehradun, 21-23 December 2015
11. "Charge transport in liquid crystalline triphenylene polymer monolayers", K. A. Suresh, Wigner Research Centre for Physics, Hungary, 07.07.2015. Prof. Suresh visited Wigner Research Centre for Physics, Hungary under collaborative project from 22 June to 19 July 2015.
12. "AFM studies on thin films of calamitic and discotic liquid crystals", K. A. Suresh, Wigner Research Centre for Physics, Hungary, 15.07.2015. Prof. Suresh visited Wigner Research Centre for Physics, Hungary under collaborative project from 22 June to 19 July 2015.

13. "Fluorescent dye induced spreading and retraction dynamics of nematic domains at the air-water interface", K. A. Suresh, Invited Talk, 22nd National Conference on Liquid Crystals, DIT University Dehradun, 21-23 December 2015
14. "Charge transport in thin films of discotic liquid crystals", K. A. Suresh, On invitation to deliver Public Lecture under local chapter of INSA, Indian Institute of Technology Kanpur, Kanpur, 18-20 February 2016
15. MRSI council meeting, H.L. Bhat, Participated in the 27th Annual General Meeting of MRSI, CSIR-NEIST, Jorhat, Assam, 18-21 February, 2016
16. "Anisotropic organogels: Energy efficient smart materials", Geetha G. Nair, Invited talk, 6th MRS Trilateral Symposium, INST, Mohali, 23-25 November 2015
17. "Anchoring transition driven by short range ordering in calamitic- discotic composites", D.S. Shankar Rao, 22nd National Conference on Liquid Crystals, DIT University, Dehradun, 21-23 December 2015
18. "Xray diffraction studies of liquid crystals", One day symposium on Advances in Chemical Sciences, Gulburga University, Kalaburgi, D.S. Shankar Rao, 11 March 2016
19. "Ph.D programme at CeNS", Manipal University, Manipal, Veena Prasad, 18 January 2016
20. "Ph.D programme at CeNS", Mangalore University, Mangalore University, Mangalore, Veena Prasad, 19-22 January 2016
21. "Soft matter science and technology", Invited talk, Symposium on 'Soft Matter Science and Nanotechnology', Gudleppa Hallikeri College, Haveri, C.V. Yelamaggad, 10 October 2015
22. "Self-Assembly of homomeric dipeptides (phasmids) into polar, helical Fluid columnar LCs via H-bonding", Invited talk, International conference on condensed matter and applied physics (ICC-2015), Govt. Engineering College, Bikaner, Rajasthan, C.V. Yelamaggad, 30 October 2015
23. "Thermotropic liquid crystals in drug discovery: Synthesis and antimicrobial activity of cholesterol-based motifs, mesoionics and biphenyl derivatives", Invited talk, International Conference on 'Current Challenges in Drug Discovery Research', Malaviya National Institute of Technology, (MNIT) Jaipur, C.V. Yelamaggad, 24 November 2015
24. "Discotic, fluorescent tris (*N*-salicylideneaniline)s: Structure-property correlations", 22nd National Conference on Liquid Crystals, DIT University Dehradun, C.V. Yelamaggad, 21-23 December 2015
25. "Supramolecular liquid crystals: Synthesis and characterization", Invited talk, Faculty Development program on 'Recent Advances in Materials Design and Characterization', M. S. Ramaiah Institute of Technology, Bengaluru, C.V. Yelamaggad, 12 Januaury 2016

26. "Liquid crystals and Nanoworld: science and technology without boundaries", Invited talk, Seminar on 'Recent Advances in Nanoscience and Nanotechnology', Government Science College, Hassan, C.V. Yelamaggad, 26 February 2016
27. "Mega Science Expo", S. Angappane, India International Science Festival (IISF 2015), IIT Delhi, 4-8 December 2015
28. "Nanoscience for applications", S. Angappane, Invited talk, One day workshop on Nanotechnology in Agriculture: A focus on insects and insect resources", ICAR – National Bureau of Agricultural Insect Resources (NBAIR), Bengaluru, 19 March 2016
29. "Thermal annealing of Langmuir-Blodgett films of metallo phthalocyanine", P. Viswanath, 22nd National Conference on Liquid Crystals, DIT University Dehradun, 21-23 December 2015
30. "Dynamics of liquid crystalline domains at air-water interface", P. Viswanath, Complex Fluid (Compflu-16) Conference, IISER, Pune, 2-4 January 2016
31. "Organic thin films at interfaces", P. Viswanath, One day symposium on Advances in Chemical Sciences, Gulbarga University, Gulbarga, 11 March 2016
32. "Enhanced photocatalysis with rGO-ZnO based hybrids", Neena S. John, Poster presentation, Frontiers in Advanced Materials, IISc, Bengaluru, 15-18 June 2015
33. "Nanoscale photocurrent distribution in photovoltaic materials", Neena S. John, Poster presentation, 6th MRSI Trilateral Symposium, INST, Mohali, , 23-25 November 2015
34. "Os nanoparticles and hybrids with rGO", Neena S. John, Poster presentation, RSC Faraday Discussion on Nanoparticle Assembly: From Fundamentals to Applications, IIT, Mumbai, 7-9 January 2016

19. FACULTY SEMINARS @ CeNS

1. "Self-assembly of homomeric dipeptides into polar, helical fluid columns via H-bonding", C.V. Yelamaggad, 29 May 2015
2. "Perovskite solar cells", S. Angappane, 26 June 2015
3. "Thermal reversal of the Frank bend elastic constant in an orientationally ordered fluid", D.S. Shankar Rao, 24 July 2015
4. "Annealing effects on Langmuir-Blodgett films of metallo-phthalocyanine", P. Viswanath, 28 August 2015
5. "Hybrids of reduced graphene oxide with metal and metal oxide nanoparticles for surface enhanced Raman scattering applications", Neena S. John, 18 September 2015
6. "Fluorescent dye induced spreading and retraction dynamics of liquid crystal domains at interfaces", K. A. Suresh, 30 Oct 2015

7. "Self-assembly of simple tiny molecules to exhibit unusual mesomorphic properties", Veena Prasad, 27 November 2015
8. "Cesium lithium borate single crystals for NLO applications in the UV region", H. L. Bhat, 5 February 2016
9. "Electroconvection in the dielectric inversion region", K. S. Krishnamurthy, 18 March 2016

20. OUTREACH PROGRAMME

20.1 V4: विज्ञानि विद्यार्थि विचार विनिमय

With a view to stimulate and nurture scientific curiosity in the young minds, CeNS embarked on a science initiation programme aimed at students on 1st August 2015. Under this programme, the Centre invites high school or +2 students to its campus to participate in innovative science learning activities which includes lab tours, scientific talks and experimental demonstrations. Since the launch, 270 students from 12 schools have taken part in the programme. Apart from this CeNS faculty also visit other academic institutes and conduct workshops /deliver lectures for the student community.

High School students interacting with CeNS researcher under V4: Science Programme @CeNS programme

Prof. H.L. Bhat speaking to young students about the Science and Technology of Lasers, V4: Science Programme @CeNS, 1 August 2015

20.1.1. V4 Science Programme @ CeNS

Sl. No.	Date	Institution Name & Address	Participation Details		Topic
			Student	Staff	
1	01.08.2015	BEL School Jalahalli, Bengaluru	20	1	Science & Technology of Lasers
2	28.08.2015	Lourdes School Mathikere, Bengaluru	8	1	Colors
3	19.09.2015	SJRC Womens College Rajajinagar, Bengaluru	23	3	BioInspiration and Innovation
4	10.10.2105	BEL Composite PU College, Jalahalli, Bengaluru	24	3	Mimicking Nature
5	15.10.2015	SJRC Women College - Rajajinagar & Kendriya Vidyalaya-East, Jalahalli, Bengaluru	35	3	Rocket Science & Abdul Kalam Contibution
6	28.10.2015	SJRC School HBR Layout, Bengaluru	24	2	Microscopy for Nano World
7	07.11.2015	Kendriya Vidyalaya-East, Jalahalli, Bengaluru	32	3	Light, Colour and Raman
8	05.12.2105	NMKRV Womens College, Jayanagar, Bengaluru	26	2	Visible and Invisible Light
9	19.12.2015	New Cambridge English School, Vijayanagar, Bengaluru	26	2	Magnetic Storage

10	27.02. 2016	Venkat International School and Venus International School, Rajajinagar, Bengaluru	52	4	Fun In Chemistry

20.1.2 V4: Science Programme @ your Institution

Sl. No.	Date	Institution Visited & Address	Participation Details		Topic
			Student	Staff	
1	07.05.2015	RNS Institute of Technology, Bengaluru	150	5	Many facets of soft matter
2	16.05.2015	BMS R&D Centre, Bengaluru	50	10	Soft Matter
3	27.08.2015	SJR Public School , HBR Layout, Bengaluru	152	4	Liquid Crystal Basic Aspects & Application
4	08.09.2015	SJR Primary & High School, Rajajinagar, Bengaluru	226	5	Liquid Crystal Basic Aspects & Application
5	22.09.2015	Karnataka Rajya Vijnana Parishath, Gulbarga	300	10	Drava sphaticagalu
6	10.10.2015	Haveri Lions Education Society, Haveri	130	30	Crystals That Flow
7	17.10.2015	VIT University Vellore, Tamilnadu	60	5	Recent Advances in Nano and Soft Materials
8					Many facets of soft matter – engineers' dream materials
9					Synthesis of nanomaterials at liquid/liquid interfaces
11					Self-Assembly of LC homomeric dipeptides into polar and helical fluid columns *via* H-bonding
12	29.10.2015	Tagore International School, Jaipur	50	2	
13	30.10.2015	Nalanda International School, Jaipur	120	2	Liquid crystal: Basic aspects & application
14	02.11.2015	Saraswathi School Doddaballapur	120	3	

15	08.11.2015	Shri Gavisiddheshwar Shikshana, Mahavidyalaya, Koppal	250	3	Liquid crystal: Basic aspects & application
16	08.11.2015	Ramaraj School, New Delhi	105	8	
17	19.01.2016	Manipal University, Manipal	40	5	Nano Research activities
18	22.01.2016	University College, Mangalore	38	4	Liquid Crystal - A step wise Melting Phenomenon
19	23.01.2016	Higher Secondary School, Uruvalu	32	5	Science : a way of life
20	25.01.2016	Govt PU College, Kanyana, Bantwal (DK)	28	3	Water : a common yet mysterious solvent
21	11.03.2016 to 12.03.2016	Alva's Institute of Engineering, Moodabidri	89	41	Symposium on Nano Science & Nano Technology
22	11.03.2016	Gulbarga University	100	10	Synthesis of nanoparticles
23					Organic thin films at interfaces
24					Xray diffraction studies of liquid crystals
25					Liquid crystals: Science and technology

20.2 Research Outreach Initiative (ROI)

The Research Outreach Initiative Studentship (ROIS) is a programme aimed at providing 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 a potential to pursue research as a career. Since inception in December 2015, seven ROI students successfully completed various projects under Nano and Soft matter sciences. The list is given below:

Sl. No.	Name of ROI student	Name of the Parent Institute	Mentor
1.	Janani .M.	Amrita University, Coimbatore, Tamil Nadu	G.U. Kulkarni
2.	Rohit Goyal	VIT University, Vellore, Tamil Nadu	S.Krishna Prasad

3.	Seema Choudhury	Central University of Karnataka, Gulbarga, Karnataka	P. Viswanath
4.	Indukuru Ramesh Reddy	Central University of Karnataka, Gulbarga, Karnataka	S. Angappane
5.	Bindhyabasinee Mishra	Central University of Karnataka, Gulbarga, Karnataka	D.S. Shankar Rao
6.	Rutuparna Samal	Symbiosis International University, Pune, Maharashtra	Neena S. John
7.	Shiva Goutham Kumar	VIT University, Vellore, Tamil Nadu	Geetha G. Nair

21. ACADEMIC ACTIVITIES BY RESEARCH STUDENTS AND POST DOCTORAL FELLOWS

21.1 Conferences attended and presentations made

Sl. No.	Date(s)	Name & Designation*	Name of Conference attended	Presentation mode and Title
1.	15.06.2015 To 18.06.2015	Nagaiah Kambhala, SRF	Frontiers in Advanced Materials (FAM-2015), IISc, Bengaluru	Poster: Phase separation in $La_{0.67-x}Bi_xSr_{0.33}MnO_3$
2.	04.12.2015 to 08.12.2015	P. Lakshmi Madhuri, SRF	India International Science Festival (IISF-2015), IIT Delhi	Participated in the Techno-Industrial Expo to showcase CeNS achievements
3.	21.12.2015 to 23.12.2015	H.N. Gayathri, SRF	22nd National Conference on Liquid Crystals, DIT University, Dehradun	Oral: Charge transport studies in the monolayer films of nonyl and decyl cyano biphenyls at air-solid interface using current sensing atomic force microscope
4.	- do -	P. Lakshmi Madhuri, SRF	22nd National Conference on Liquid Crystals, DIT University, Dehradun	Oral: Fast photoluminescence switching in the nematic phase of calamitic-discotic composites
5.	21.12.2015 To 25.12.2015	K. Priya Madhuri, SRF	60th DAE-Solid State Physics Symposium at Amity University, UP	Poster: Electrical Properties of Films of Zinc Oxide Nanoparticles and its Hybrid with Reduced Graphene Oxide
6.	02.01.2016	Vimala S, SRF	COMPFLU – 2016,	Participated

	to 04.01.2016,		IISER, Pune	
7.	04.01.2016 to 06.01.2016,	Vimala S, SRF	Workshop on Synthesis, Characterization and Application of Nanoparticle Assemblies, IUSSTF, CSIR-NCL, Pune	Participated
8.	07.01.2016 to 09.01.2016	Vimala S, SRF	Faraday discussion on "Nanoparticle Assembly - from fundamentals to applications", IIT-Bombay	Participated
9.	29.01.2016	Madhu Babu Kanakala, JRF	Workshop on 100 years of chemical bond, JNCASR, Bengaluru	Participated
10.	29.02.2015 to 02.03.2015	Mr. Chandan Kumar, SRF	ICONSAT 2016, IISER, Pune	Presented a poster " Impact of solvent polarity on Poly (Vinylidene Fluoride) films at air-water and air-solid interface"
11.	- do -	Sachin A. Bhat, JRF	- do -	Presented a poster "Nanoparticles Coated With Dimer-Like Mesogenic Ligands: Synthesis and Characterization of A Liquid-Crystalline Nanoparticle Composite"
12.	29.02.2015 to 02.03.2015	K. Bramhaiah, SRF	ICONSAT 2016, IISER, Pune	Presented a poster "Hybrid films of metal/metal oxides with reduced graphene oxide as reusable SERS substrates for fluorescent analytes"
13.	29.02.2015 to 02.03.2015	K. Priya Madhuri, SRF	ICONSAT 2016, IISER, Pune	Presented a poster "Local Conductance of Lead Phthalocyanine Thin Film in Response to Humidity"
14.	03.03.2016 to 04.03.2016	Nagaiah Kambhala, SRF	8th Bangalore India Nano, The Lalith Ashok, Bengaluru	Presented a poster "Aging effect of resistive switching in Ag/ZnO/Pt device"
15.	- do -	Ashutosh Kumar Singh, RA-I	Bangalore India Nano-2016	Presented a poster "Flexible thermal display using Cu wire network based transparent conducting electrodes"

16.	03.03.2016 to 04.03.2016	P. Lakshmi Madhuri, SRF	Bangalore India Nano-2016, Bengaluru	Presented a poster "Electrically Switchable Fluorescent Polysoft Device"
17.	- do -	Srividhya Parthasarathi, SRF	8th Bangalore India Nano, The Lalith Ashok, Bengaluru	Presented a poster "Tailoring surface forces: Anchoring transitions in a nano topographical surfaces"
18.	- do -	K. Priya Madhuri, SRF	8th Bangalore India Nano, The Lalith Ashok, Bengaluru	Presented a poster "Photocurrent Mapping in Ultra-thin Films of Zinc Oxide Nanoparticles and its Hybrid with Reduced Graphene Oxide using Current Sensing Atomic Force Microscopy"
19.	- do -	- do -	8th Bangalore India Nano, The Lalith Ashok, Bengaluru	Presented a poster "Large area ultra-thin films of reduced graphene oxide with metal/metal oxides nanoparticles as reusable SERS substrates for dyes"
20.	- do -	Sunil Walia, SRF	Bangalore India Nano-2016	Presented a poster "Microfluidics device using crackle lithography"
21.	- do -	- do -	Bangalore India Nano-2016 NanoSpark	Presented a poster "Laser printer printed toner patterns to fabricate Ag conducting pattern on PET substrate for bio applications"
22.	- do -	Sachin A. Bhat, JRF	8th Bangalore India Nano, The Lalith Ashok, Bengaluru	Participated
23.	- do -	Vaisakh V.M., JRF	8th Bangalore India Nano, The Lalith Ashok, Bengaluru	Presented a poster "Magnetic field dictated memory in anisotropic magneto-gels"
24.	- do -	Indrajit Mondal , JRF	Bangalore India Nano-2016	Presented a poster "Flexible thermal display using Cu network based transparent conducting electrodes"

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

21.2 Seminars given at CeNS

General

- "Effect of cations on the mesogenic amphiphilic molecule at the air-aqueous electrolyte interface", Shilpa Harish T., 10 July 2015
- "Synthesis of twist bend nematic materials supramolecules and columnar liquid crystals", Nani Babu Palakurthy, 07 August 2015
- "Dilational rheology of ferroelectric copolymer at air-water interface", Chandan Kumar, 4 September 2015
- "Electrical conductivity in Langmuir-Blodgett films of n-alkyl cyanobiphenyls using current sensing atomic force microscope", H. N. Gayathri, 9 October 2015
- "Carbon based Perovskite solar cells", K. Bramhaiah, 6 November 2015
- "Synthesis and electrical and magnetic properties of some multiferroic and colossal magnetoresistance materials", Nagaiah Kambhala, 18 November 2015
- "A brief introduction to supercapacitors", Ashutosh Kumar Singh, 8 January 2016
- "Tailoring surface forces: Anchoring transitions in a soft elastic medium", Srividhya Parthasarathi, 22 January 2016

Thematic

- "Thematic Seminar "Optics extraordinaire: metamaterials", Vimala .S, 19 February 2016

Journal article based

- "High-precision twist-controlled bilayer and trilayer grapheme", Sunil Walia, 12 February 2016
- "Motion-driven electrochromic reactions for self powered smart window system", K. Priya Madhuri, 26 February 2016

Thesis

- "Synthesis, characterization and device applications of ZnO and transition metal doped ZnO thin films", R. Rajalakshmi, 3 July 2015

21.3 Awards / recognition

- Ashutosh Kumar Singh (RA) and Indrajit Mondal (JRF) shared "Best Poster Award" for the poster titled "Flexible thermal display using Cu wire network based transparent conducting electrodes "at the Bangalore India Nano 2016, held at Lalit Ashok, Bengaluru.
- Ashutosh Kumar Singh (RA) won a Certificate of Outstanding contribution in reviewing Journal of Alloys and Compounds- Elsevier, Amsterdam, The Netherlands.

22. EVENTS at CeNS

22.1 Minister's visit to the Centre

Dr. Harsh Vardhan, Union Minister for Science and Technology and Earth Sciences, visited the Centre for Nano and Soft Matter Sciences at Jalahalli, Bengaluru on 22

August, 2015. During his visit, he evinced keen interest in the demo kits and the poster displays presented by the research fellows of the Centre. While interacting with the faculty, the Minister emphasised the need for quantitative output that can reach the common man in a form that is easily perceived. Constant dialogues and brainstorming among the researchers will only help in identifying relevant scientific problems and bringing them out for the benefit of the society at large, the Minister pointed out. He counselled young researchers to shift from routine to out-of-the box thinking and to dream big that could be translated to great innovations. He later planted a sapling in the premises of the Centre and was very appreciative of the overall achievements of the Centre. He also mentioned that the Ministry of Science and Technology is prepared to extend extraordinary support in deserving cases.

Dr. Harsh Vardhan, Union Minister for Science and Technology and Earth Sciences, on his visit to CeNS on 22 August 2015.

22.2 Memorial Lectures

- **Prof. S. Chandrasekhar Memorial Lecture**

The 12th Professor S. Chandrasekhar Memorial Lecture was delivered on 6 August 2016 by Prof. Santanu Bhattacharya, Director, Indian Association for the Cultivation of Science, Kolkata. The talk titled *Drug Design via Stabilization of Unusual DNA structure* was attended by, among other invited guests, Members of the Governing Council and the Research Advisory Board of CeNS, the family of Prof. S. Chandrasekhar, faculty and research scholars.

Prof. Santanu Bhattacharya delivering Chandrasekhar Memorial Lecture on 6 August 2015

- **National Science Day**

National Science Day was celebrated by organizing a day-long programme on 27

Prof. Uday Maitra demonstrating how "Chemistry is Fun" to high school students as a part of National Science Day celebrations at CeNS, 27 February 2016

February 2016. The highlight of the programme was a lecture on "Chemistry is Fun" by the eminent Scientist, Prof. Uday Maitra, IISc, Bengaluru. Students from Venus International and Venkat International schools, Rajajinagar, were invited to participate. Prof.Maitra and his PhD student Mr. Raju Laishram enthralled the young students with

live demonstrations pertaining to various chemical phenomena such as Thermochromism, Chemiluminescence, Solvatochromism etc. After the talk, the visiting students were taken around the campus for a tour of the laboratories.

- **Sir C.V. Raman's Birthday celebration**

Special lecture on the occasion of Sir C.V. Raman's Birthday was observed by the Centre on 7 November 2015 and on the occasion a talk titled "Light, Colour and Raman" was delivered by Prof. Chandrabhas Narayana, Jawaharlal Nehru Centre for Advanced Scientific Research, Bengaluru. Students from Kendriya Vidyalaya, Jalahalli, were invited.

Sir C.V. Raman's Birthday was celebrated on 7 November 2015. Prof. Chandrabhas Narayana, JNCASR, Bengaluru spoke on "Light, Colour and Raman"

22.3 Ornamental Garden Award

Ornamental Garden Award has been received by the Centre from Mysore Horticultural Society, Lalbagh, Bengaluru on 25 January 2016.

Mr. Subhod M. Gulvady, Administrative Officer, CeNS receiving Ornamental Garden Award.

22.4 Vigilance Awareness Week

The Centre observed the Vigilance Awareness Week during 26 to 31 October 2015. The faculty and administrative staff took a pledge on vigilance while they were told about the importance of maintaining the same.

22.5 International Women's Day

The International Women's Day was celebrated on 8 March 2016. On this occasion, the women staff and students of the Centre met to discuss matters of common interest.

22.6 Fresher's Day

During the current academic year sixteen students joined the Ph.D. programme. Freshers' Day was held on 7 August 2015 to welcome the new students.

22.7 Intellectual Property and Patent Unit

The Centre opened an IP and patent unit in January 2016 to encourage and promote the translation of research/innovation carried out in its laboratories. It welcomes partnership from public and corporate R&D organizations in this pursuit of translating knowhow for societal benefits. The unit motivates the researchers by holding talks and essays.

22.8 Students' Hostel and Guest House

A small get-together was held on 9 June 2015 to mark the new look of the Students' Hostel and Guest House. More rooms and amenities such as kitchenette, Wi-Fi, gym and indoor games have been added.

22.9 Dining Hall

The Dining Hall at the Centre was inaugurated by Prof. G.U. Kulkarni, Director, CeNS on 16 July 2015 to cater to the dietary needs of the researchers and staff of the Centre. The facility is offered at an affordable rate and works on an RFID based coupon system.

22.10 Mahamana Conference Hall

A conference hall equipped with state-of-the-art audio-visual facilities to hold mini conferences and board meetings was inaugurated on 22 August 2015.

23. LIST OF SCIENTISTS AND RESEARCHERS

	Name	Designation
1.	Prof. G. U. Kulkarni	Director
2.	Prof. K. A. Suresh	Honorary Professor
3.	Prof. K. S. Krishnamurthy	Emeritus Scientist
4.	Prof. H. L. Bhat	Visiting Professor
5.	Dr. S. Krishna Prasad	Scientist F
6.	Dr. Geetha G. Nair	Scientist E
7.	Dr. D. S. Shankar Rao	Scientist E
8.	Dr. Veena Prasad	Scientist E
9.	Dr. C. V. Yelamaggad	Scientist E
10.	Dr. P. Viswanath	Scientist D
11.	Dr. S. Angappane	Scientist D
12.	Dr. Neena Susan John	Scientist D
13.	Dr. K.S. Subrahmanyam	Scientist C (under project)
14.	Dr. Uma S. Hiremath	Research Associate (under project)
15.	Dr. Nani Babu Palakurthy	Research Associate (under project)
16.	Dr. K. D. Mallikharjuna Rao	Research Associate
17.	Dr. Ashutosh Kumar Singh	Research Associate
18.	Dr. L. R. Shobin	Research Associate
19.	Dr. Indu Pandey	Research Associate
20.	Mr. Nagaiah Kambhala	Senior Research Fellow
21.	Ms. T. Shilpa Harish	Senior Research Fellow
22.	Mr. M. Vijay Kumar	Senior Research Fellow
23.	Ms. R. Rajalakshmi	Senior Research Fellow
24.	Ms. H. N. Gayathri	Senior Research Fellow
25.	Ms. P. Lakshmi Madhuri	Senior Research Fellow
26.	Ms. S. Vimala	Senior Research Fellow
27.	Mr. K. Bramhaiah	Senior Research Fellow
28.	Ms. M. Monika	Senior Research Fellow
29.	Ms. P. Srividya	Senior Research Fellow
30.	Mr. B. N. Veerabhadraswamy	Senior Research Fellow
31.	Mr. Chandan Kumar	Senior Research Fellow
32.	Mr. Arup Sarkar	Senior Research Fellow

33.	Ms. Priya Madhuri	Senior Research Fellow
34.	Mr. Sachin Ashok Bhat	Junior Research Fellow
35.	Mr. Madhu Babu Kanakala	Junior Research Fellow
36.	Mr. Suman Kundu	Junior Research Fellow
37.	Ms. Rekha S. Hegde	Junior Research Fellow
38.	Mr. Vaisakh V.M.	Junior Research Fellow
39.	Ms. Marlin Baral	Junior Research Fellow
40.	Mr. Indrajit Mondal	Junior Research Fellow
41.	Mr. Sunil Walia	Junior Research Fellow
42.	Ms. Brindhu Malani S.	Junior Research Fellow
43.	Ms. S. Sathya	Project Assistant (under project)
44.	Mr. Arun .D.	R & D Assistant
45.	Mr. Rajendra Prasad Shukla	R & D Assistant
46.	Mr. Thipperudraswamy S.P.	R & D Assistant
47.	Mr. Ravishankar Sugumar	Project Assistant
48.	Mr. Kartikeya Srivastava	Senior R & D Assistant

24. ADMINISTRATIVE STAFF

	Name	Designation
1.	Mr. Subhod M. Gulvady	Administrative Officer
2.	Mr. Vivek Dubey	Accounts Officer
3.	Ms. P. Nethravathi	Office Superintendent
4.	Dr. Sanjay K. Varshney	Technical Assistant
5.	Mr. Sandhya D. Hombal	Technical Assistant
6.	Mr. S. Deepak	PRO*
7.	Mr. R. S. Gururaj	Consultant*
8.	Dr. Rama Krishnamurthy	Consultant*
9.	Mr. Ravishankar Solanki	Consultant*
10.	Mr. Narayana M.G.	Consultant*
11.	Mr. Chandraiah	Supervisor – Dining Hall*
12.	Mr. M. Jayaram	Assistant
13.	Ms. Nayana .J.	Library Assistant
14.	Mr. Manjunatha V.	Admn. Assistant*
15.	Ms. Vanitha B.	Coordinator – Project & IP Management*
16.	Ms. Ranjita Bhat	Office Assistant*
17.	Ms. Jyothi U.V.	Office Assistant*

18.	Ms. Manasa K.R.	Office Assistant*
19.	Ms. Madhura Hegde	Office Assistant*
20.	Ms. Adithi H.M.	Office Assistant*
21.	Mr. Samuel V. Hebich	Support Staff
22.	Mr. Jayaprakash V.K.	Support Staff
23.	Mr. Kumarvelu	Consultant*
24.	Mr. Krishnappa C.	Support Staff*
25.	Mr. Ningappa K.	Support Staff*
26.	Mr. Prahlad D.G.	Support Staff*

* *Temporary appointment*

Centre for Nano and Soft Matter Sciences
Bengaluru

Statement of Accounts
for the year 2015-16
and
Balance Sheet as on 31.03.2016

G.R. VENKATANARAYANA
CHARTERED ACCOUNTANTS
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.,

No. 618, 75th Cross, 6th Block,
Rajajinagar, Bengaluru-560 010.
Ph: 23404921 / 64537325
Fax: 23500525
Email: grvauditor@gmail.com
1grvenkat@gmail.com

AUDITOR'S REPORT TO THE MEMBERS OF THE GOVERNING BODY OF CENTRE FOR NANO AND SOFT MATTER SCIENCES, BANGALORE

We have audited the attached Balance Sheet of **Centre for Nano and Soft Matter Sciences** as at March 31, 2016, the Income & Expenditure Account for the year ended on that date and the Receipts and Payment account for the year ended on that date annexed thereto. These financial statements are the responsibility of the management of Centre for Nano and Soft Matter Sciences. Our responsibility is to express an opinion on these financial statements based on our audit.

We conducted our audit in accordance with auditing, standards generally accepted in India. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether the financial statements are free of material misstatement. An Audit includes examining, on a test basis, evidence supporting the amounts and disclosures in the financial statements. An audit also includes assessing the accounting principles used and significant estimates made by Management as well as evaluating the overall financial statements presentation. We believe that our audit provides reasonable basis for our opinion.

We 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 , 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 observations:

(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

.....2

G.R. VENKATANARAYANA Chartered Accountants BANGALORE

in the financial statements of Employers] issued by the Institute of Chartered Accountants of India.

(ii) The amount spent on acquisition of fixed assets has been deducted from the total grants/ subsidies received in the Income & Expenditure account. This is not in conformity with the Accounting Standard- 5 issued by the Institute Of Chartered Accountants of India. It has been explained that this format has been consistently used to present the accounts before the authority who grant the funds.

5. In our opinion and to the best of our information and according to the explanations given to us and subject to notes on accounts and our qualifications in para 4 above, the said accounts give a true and fair view in conformity with the accounting principles generally accepted in India:

(a) in the case of Balance Sheet, of the state of affairs of the Centre for Nano and Soft Matter Sciences as at March 31, 2016; and

(b) in the case of Income and Expenditure Account, of the excess of Expenditure Over Income for the year ended on that date.

For M/s G R Venkatanarayana
Chartered Accountants

(G R Venkatanarayana)
Partner
Membership No. 018067
Firm Regn. No. 004616S

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

Place : Bangalore
Date: 21.07.2016

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

BALANCE SHEET AS AT 31ST MARCH, 2016

(Amount in ₹)

I. CORPUS / CAPITAL FUND AND LIABILITIES	SCH	31.03.2016	31.03.2015
CORPUS / CAPITAL FUND	1	184,115,942	170,578,419
RESERVES AND SURPLUS	2	-	-
EARMARKED PROJECTS FUNDS	3	11,679,029	10,585,244
SECURED LOANS AND BORROWINGS	4		
UNSECURED LOANS AND BORROWINGS	5	-	-
DEFERRED CREDIT LIABILITIES	6	-	-
CURRENT LIABILITIES AND PROVISIONS	7	27,012,065	2,639,920
TOTAL		**222,807,036**	**183,803,583**

I I APPLICATION OF FUNDS/ASSETS			
FIXED ASSETS	8	139,559,788	112,858,272
INVESTMENTS - FROM EARMARKED/ENDOWMENT FUNDS	9	-	-
INVESTMENTS - OTHERS	10	-	-
CURRENT ASSETS, LOANS, ADVANCES ETC.,	11	83,247,248	70,945,311
TOTAL		**222,807,036**	**183,803,583**
NOTES ON ACCOUNTS	24		

As per our report of even date,
for M/s. G.R.VENKATANARAYANA,
Chartered Accountants,

(PROF. G.U. KULKARNI)
DIRECTOR

(VIVEK DUBEY)
ACCOUNTS OFFICER

(G.R.VENKATANARAYANA)
PARTNER
M. No. 018067

M/s. G.R. VENKATANARAYANA
Chartered Accountants
618, 7Sth Cross, 6th Block,
Rajajinagar, BANGALORE-560 010

PLACE :BANGALORE
DATE : 21.07.2016

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

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31ST MARCH, 2016

(Amount in ₹)

A - INCOME	SCH	2015-16	2014-15
Income from Sales / Services	12	-	-
Grants / Subsidies:	13	80,000,000	51,167,000
Fees / Subscriptions	14	-	-
Income from Investments(income on investments from earmarked / endowment Funds)	15	-	-
Income from Royalty, Publications etc.,	16	-	-
Interest earned	17	6,544,096	7,015,454
Other Income	18	454,073	75,539
Increase / (decrease) in stock of finished goods and work-in-progress	19	-	-
TOTAL (A)		**86,998,169**	**58,257,993**
B - EXPENDITURE			
Establishment Expenses	20	29,341,388	21,010,729
Other Administrative Expenses etc.,	21	26,149,639	10,557,536
Expenditures on Grants, Subsidies etc.,	22	45,424,060	23,866,719
Interest	23	- -	-
TOTAL (B)		**100,915,087**	**55,434,984**
C.BALANCE BEING SURPLUS / (DEFICIT) (A-B)		(13,916,918)	2,823,009
D. Less: Prior Period Adjustment		-	-
E. SURPLUS / (DEFICIT) CARRIED TO CORPUS / CAPITAL FUND (C+D)		**(13,916,918)**	**2,823,009**
NOTES ON ACCOUNTS	24		

As per our report of even date,
for M/s. G.R.VENKATANARAYANA,
Chartered Accountants,

(PROF. G.U. KULKARNI)
DIRECTOR

(VIVEK DUBEY)
ACCOUNTS OFFICER

(G.R.VENKATANARAYANA)
PARTNER
M. No. 018067
M/s. G.R. VENKATANARAYANA
Chartered Accountants
618, 75th Cross, 6th Block,
Rajajinagar, BANGALORE-560 010

PLACE :BANGALORE
DATE : 21.07.2016

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

RECEIPTS AND PAYMENTS FOR THE YEAR ENDED 31ST MARCH, 2016

(Amount in ₹)

RECEIPTS		For the year 15-16	For the year 14-15	PAYMENTS		For the year 15-16	For the year 14-15
I Opening Balances				**I. Establishment Expenses**		25849990	18600584
1) Cash in Hand		Nil	Nil				
				II Administrative Expenses		26230914	10331439
2) Bank Balances		20455245					
a) Indian Bank	90878		87337	**III Fixed Assets (Additions)**		23068549	23585946
b) State Bank of India	16286328		21014220				
c) State Bank of Mysore 1	4070886		3049777	**IV A) Remittances/Refunds etc.,**			
d) State Bank of Mysore 2	4295		4,845	a) Earnest Money Deposit & Security Deposit & S Creditors		854283	656847
e) Bank of India	1715		1,648				
f) Union Bank of India	1143		1098	b) CPF Advance and other		-	-
II Grants-in-aid from DST, Govt of India		80000000	51167000	**B) Remittances/Refunds etc.,**		11819839	
				a) C.P.F. Employees Contribution	679035		500788
III Interest Earned		6755810		b) C.P.F. CeNS Contribution	364144		277480
a) On Savings Bank Accounts	2137967		2399863	c) Income Tax Deducted at source			
b) On Fixed/Term Deposits	4617843		4540567	from staff, contractor & rent and Professional Tax	2598488		1549957
IV Other Income		324259		d) Advance to suppliers/others etc.,	4792395		76849
a) Stale cheque	2000		-	e) Staff Advances	367170		934623
b) License Fee	52205		15993	f) New Pension Scheme Tier 1	1389452		1072542
c) Miscellaneous Receipts	270054		3126	g) Telephone Deposit	-		-
				h) Provisions for last year paid	1608321		1571327
				i) Stale cheque	-		15164
				j) Misc Income	20834		
				Investments			
				VI Fixed/Term Deposits made		13541861	29609136
V Other Recoveries etc., Security Deposit & S. Creditors		1746795	1011697	**VII Earmarked Project Expenses**	-	3606374	1976762
B)		8243708		**Closing Balance**			
i) C. P. F. Employees Contributior	679035		500788	1) Cash in Hand		6825	Nil
ii) Income Tax Deducted at source				2) Bank Balances		32048211	
from staff, contractor & rent and Professional Tax	2602762		1549957	a) Indian Bank	-		90878
				b) State Bank of India 274	26527202		16286328
iii) Advance to suppliers/others e	3045710		124571	c) State Bank of Mysore (RMV)	517184		4070886
iv) Staff Advance Recovery	831119		806536	d) State Bank of Mysore (Vyalik)	-		4295
v) CPF Advance Recovery	46776		-	e) Bank of India	-		1715
vi) New Pension Scheme Tier -1	644157		536271	f) Union Bank of India	-		1143
C)				g) State Bank Of India 219	5000000		
i) Establishment Receipts	297434		113528	h) State Bank Of India 408	3825		
ii) Other Administrative Receipts	96715		13656				
VI Investments							
a) Fixed/Term deposits matured	14026029	14026029	23263066				
b) Sale of Fixed Asset	-	-	5500				
VII Grants/Financial Assistances received for Earmarked Projec	5475000	5475000	1003645				
TOTAL		**137026846**	**111214689**	**TOTAL**		**137026846**	**111214689**

As per our report of even date,
for M/s. G.R.VENKATANARAYANA,
Chartered Accountants,

(PROF. G.U. KULKARNI)
DIRECTOR

(VIVEK DUBEY)
ACCOUNTS OFFICER

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

(G.R.VENKATANARAYANA)
PARTNER
M. No. 018067

PLACE :BANGALORE
DATE : 21.07.2016

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

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH, 2016

(Amount in ₹)

		As at 31.03.2016	As at 31.03.2015
SCHEDULE 1 - CORPUS / CAPITAL FUND:			
As Per Previous Balance Sheet		170578419	159863630
ADD: Fixed Assets purchased during the year(net)		45424060	23866719
		216002479	**183730349**
ADD: Excess of Expenditure over Income for the year		-13916918	2823009
LESS: Depreciation for the year		17969619	15974939
	TOTAL	**184115942**	**170578419**
SCHEDULE 2 - RESERVES AND SURPLUS:	**TOTAL**	-	-
SCHEDULE 3 - EARMARKED / PROJECT FUNDS: (See Annexure A for details)	**TOTAL**	**11679029**	**10585244**
SCHEDULE 4 - SECURED LOANS AND BORROWINGS:	**TOTAL**	-	-
SCHEDULE 5 - UNSECURED LOANS AND BORROWING	**TOTAL**	-	-
SCHEDULE 6 - DEFERRED CREDIT LIABILITIES:	**TOTAL**	-	-
SCHEDULE 7-CURRENT LIABILITIES & PROVISIONS:			
A) CURRENT LIABILITES:			
1) Statutory Liabilities		113074	-
2) Other Liabilities		24265778	970979
3) Stale Cheque		62620	60620
	TOTAL (A)	**24441472**	**1031599**
B) **PROVISIONS:**			
Salaries & Allowances		2570593	1608321
	TOTAL (B)	**2570593**	**1608321**
	TOTAL (A+B)	**27012065**	**2639920**
SCHEDULE 8 - FIXED ASSETS	**TOTAL**	**139559788**	**112858272**
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		6825	-
4) Bank Balances:- Nationalised Banks			
a. Term Deposit Receipts (includes margin money)		49184028	49744268
b. Current Account : SBM Vyalikaval		-	4295
c. Savings Accounts:			
Bank of India (Malleswaram)		-	1715
Union Bank of India (Malleswaram)		-	1143
Indian Bank (BEL Road)		-	90878
SBI SB A/c No.274		26527202	16286328
SBI SB Project A/c 219		5000000	-
SBI SB Canteen A/c 408		3825	-
SBM SB A/c 24430		517184	4070886
	TOTAL (A)	**81239064**	**70199513**

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:		1526393	272857
a) K P T C L Deposit (SERC/CLCR)		362590	362590
b) Telephone		87000	87000
3) Deposits with Mohan Gas		8650	-
4) TDS By Bank/ BESCOM		23551	23351
	TOTAL (B)	**2008184**	**745798**
	TOTAL (A+B)	**83247248**	**70945311**
SCHEDULE 12 - INCOME FROM SALES / SERVICES:	**TOTAL**	-	-
SCHEDULE 13 - GRANTS / SUBSIDIES:			
(Irrevocable Grants & Subsidies Received)			
Dept of Science & Techonolgy Government of India	**TOTAL**	**80000000**	**51167000**
SCHEDULE 14 - FEES / SUBSCRIPTIONS:	**TOTAL**	-	-
SCHEDULE 15 - INCOME FROM INVESTMENTS:	**TOTAL**	-	-
SCHEDULE 16 - INCOME FROM ROYALTY, PUBLICATIONS ETC.:	**TOTAL**	-	-
SCHEDULE 17 - INTEREST EARNED:			
1) On Term Deposits - Nationalised Banks		4541861	4615591
2) On Savings Accounts - Nationalised Bank		2002235	2399863
	TOTAL	**6544096**	**7015454**
SCHEDULE 18 - OTHER INCOME:			
Licence Fee		52205	15993
Miscellaneous Income		244232	57835
Project Overhead Recovered		152648	-
Interest on Advance		4,988	1,711
	TOTAL	**454073**	**75539**
SCHEDULE 19 - INCREASE (DECREASE) IN STOCK OF FINISHED GOODS & WORK IN PROGRESS:		-	-
SCHEDULE 20 - ESTABLISHMENT EXPENSES:			
1) Salaries, Allowance and Wages to Staff		22538080	16597041
2) Medical Expenses Reimbursed		74905	16100
3) Bonus		34627	35567
4) Fellowship & Book Grant		6185741	3825582
5) Salary -SC		508035	536439
	TOTAL	**29341388**	**21010729**
SCHEDULE 21 - OTHER ADMINISTRATIVE EXPENSES,ETC:			
Chemicals, Glasswares & Consumables etc.,		1971536	1666900
Duties & Taxes		43861	106380
Electricity & Water Charges		2191389	1653511
Fees & Professional charges		503352	257633
Foreign Travel		-	152695
Fuel Charges for Genset		186833	33612
Hospitality Charges		431968	95867
House Keeping Charges		1751199	847003
Journals & Periodicals /Books		100580	41736
Foreign Exchange Fluctuation		-	6094
Liveries/Uniform		10700	22370

Vinay Dubey

Conveyance/ Transportation Charges	1381948	385672
Man Power Supply Expenses	1312412	96123
Other Miscellaneous Charges / Bank Charges	55340	89280
Advertisement and Pulbilcity Charges	170666	87247
Printing & Stationery	861725	374679
Registration & Renewals	200290	21371
Rent & Insurance	1273671	415748
Repairs & Maintenance	10280516	2449388
Security Charges	1651562	1124061
Seminar and Conferences	286974	152183
Telephone Charges	565572	288074
Travel Expenses	705907	96459
Testing (N.M.R.) & Sample analysis charges	151600	93450
IP Related Expenses	60038	-
TOTAL	**26149639**	**10557536**
SCHEDULE 22 - EXPENDITURE ON GRANTS, SUBSIDIES ETC: (Fixed assets)(net)	**45424060**	**23866719**
SCHEDULE 23 - INTEREST:	-	-

As per our report of even date,
for M/s. G.R.VENKATANARAYANA,
Chartered Accountants,

(PROF. G.U.KULKARNI)
DIRECTOR

(VIVEK DUBEY)
ACCOUNTS OFFICER

(G.R.VENKATANARAYANA)
PARTNER
M. No. 018067
M/s. G.R. VENKATANARAYANA
Chartered Accountants
618, 75th Cross, 6th Block,
Rajajinagar, BANGALORE-560 010

PLACE :BANGALORE
DATE : 21.07.2016

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

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH, 2016

Annexure - A to Schedule 3

(Amount in ₹)

SCHEDULE 3 - EARMARKED / PROJECTS FUNDS	Balance Under Closed	SERB (SKP)	SERB (SA)	SERB (NSJ)	INDO Bulgerian (SKP)	SERB (GGN)	SERB (CVY)	WOS -A - 2(USH)	Tata Steel CNSMS	Project Administration	Current Year Total	Previous YEAR
a) Opening Balance of th	3035445	1638405	867675	1049645	91174	3539976	341484	21440	-		10585244	12845073
b) Additions to the Funds:										500000	500000	
i) Grants	-	475000	-	-	-	-	200000	800000	4000000		5475000	1000000
ii) Income from investment made			2256	26871	6985	24133	13659	1584	60244	-	135732	
TOTAL (a+b)	**3035445**	**2113405**	**869931**	**1076516**	**98159**	**3564109**	**555143**	**823024**	**4060244**	**500000**	**16695976**	**13845073**
c) Utilisation/Expenditure towards objectives of Funds:												
i) Capital Expenditure		-	-									
Fixed Assets		-	-	-	-	-	-	-			-	-
Others		-	-									
ii) Revenue Expenditure		-	-									
Salaries, Wages and Allowances e		87207	-	10000	11383	126400	659936	700000	713977	-	2308903	1203763
Consumables		162135	10000	97514	-	4058	483840	54124	-	-	811671	713802
Depreciation	281270	288920	121692	85830	-	466013	-	-	-	-	1243725	1342264
Overheads		100000	52648	200000	-	150000	100000	50000	-	-	652648	
Grant Refunded	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL (c)	**281270**	**638262**	**184340**	**393344**	**11383**	**746471**	**1243776**	**804124**	**713977**	**-**	**5016947**	**3259829**
NET BALANCE AT THE YEAR END (a+b-c)	**2754175**	**1475143**	**685591**	**683172**	**86776**	**2817638**	**-688633**	**18900**	**3346267**	**500000**	**11679029**	**10585244**

G.R. VENKATANARAYANA Chartered Accountants BANGALORE

CENTRE FOR NANO AND SOFT MATTER SCIENCES
JALAHALLI, BANGALORE - 560 013
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH, 2016

SCHEDULE - 8 : FIXED ASSETS (Amount in ₹)

DESCRIPTION	W.D.V. as on 01.04.2015	Additions during the year			Total	Assets sold / replaced during	Total as on 31.03.2016	Rateo f Dep.	Depreciation Full Rate	Dep. For Addition o <180 Days	Total Depreciatio n for the year	W.D.V. as on 31.03.2016
		>180 days	<180 Days	Total additions								
A. CeNS :												
CIVIL WORKS												
Aluminium Partitions	1114958	704896	244997	949893	2064851	-	2064851	10	181985	12250	194235	1870616
Brick Base(Partitions)	99337	-	-	-	99337	-	99337	10	9934	-	9934	89403
Construction of Cycle Stand	39194	-	-	-	39194	-	39194	10	3919	-	3919	35275
Construction of Shed	40391	-	-	-	40391	-	40391	10	4039	-	4039	36352
Vinyl Flooring	193299	-	-	-	193299	-	193299	10	19330	-	19330	173969
Other Miscellaneous Works	1281340	-		-	1281340	-	1281340	10	128134	-	128134	1153206
BUILDING (Main & Annexe)	5529639	-	-	-	5529639	-	5529639	10	552964	-	552964	4976675
ELECTRICAL INSTALLATIONS												
Air Conditioner	578915	170500	73450	243950	822865	-	822865	15	112412	5509	117921	704944
Computers	219420	284441	828177	1112618	1332038	-	1332038	60	302317	248453	550770	781268
Fume Cupboard	132732	-	-	-	132732	-	132732	10	13273	-	13273	119459
Electrical Installation	-	633366	4717	638083	638083	-	638083	10	63337	236	63573	574510
Generator Set	438581	-	-	-	438581	-	438581	15	65787	-	65787	372794
FURNITURE & FIXTURES												
Carpentary Works	447434	-		-	447434	-	447434	10	44743	-	44743	402691
Furniture & Fixtures	1181550	825371	747879	1573250	2754800	-	2754800	10	200692	37394	238086	2516714
GENERAL EQUIPMENTS												
Equipment	5149813	905429	493763	1399192	6549005	-	6549005	15	908286	37032	945318	5603687
Workshop & Other Equipments	79693	128268	3278	131546	211239	-	211239	15	31194	246	31440	179799
SCIENTIFIC EQUIPMENTS	88285883	6223590	10796427	17020017	105305900	-	105305900	15	14176421	809732	14986153	90319747
Fixed Assets under Acquisition	-		22355511	22355511	22355511	-	22355511	-	-	-	-	22355511
Total - (A)	**104812179**	**9875861**	**35548199**	**45424060**	**150236239**	**-**	**150236239**		**16818767**	**1150852**	**17969619**	**132266620**

(PROF. G.U. KULKARNI)
DIRECTOR

PLACE :BANGALORE
DATE : 21.07.2016

(VIVEK DUBEY)
ACCOUNTS OFFICER

As per our report of even date,
for M/s. G.R.VENKATANARAYANA,
Chartered Accountants,

(G.R.VENKATANARAYANA)
PARTNER
M. No. 018067

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

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(Amount in ₹)

DESCRIPTION	W.D.V. as on 01.04.2015	Additions during the year >180 days	<180 Days	Total additions	Total	Assets sold / replac	Total as on 31.03.2016	Rateo f Dep.	Depreciation Full Rate	Dep. For Addition o <180 Days	Total Depreciatio n for the	W.D.V. as on 31.03.2016
B. Assets Under Closed Project	**1875132**	-	-	-	**1875132**	-	**1875132**	15	**281270**	-	**281270**	**1593862**
C. SERB (SKP) PROJECT:												
Equipment	1812983	-	226300	226300	2039283	-	2039283	15	271947	16973	288920	1750363
Total - (C)	**1812983**	-	**226300**	**226300**	**2039283**	-	**2039283**		**271947**	**16973**	**288920**	**1750363**
D. SERB (SA) PROJECT:												
Equipment	811283	-	-	-	811283	-	811283	15	121692	-	121692	689591
Total - (D)	**811283**	-	-	-	**811283**	-	**811283**		**121692**	-	**121692**	**689591**
E. SERB (NSJ) PROJECT:												
Equipment	439945	-	264500	264500	704445	-	704445	15	65992	19838	85830	618615
Total - (E)	**439945**	-	**264500**	**264500**	**704445**	-	**704445**		**65992**	**19838**	**85830**	**618615**
F. SERB (GGN) PROJECT:												
Equipment	3106750	-	-	-	3106750	-	3106750	15	466013	-	466013	2640737
Total - (F)	**3106750**	-	-	-	**3106750**	-	**3106750**		**466013**	-	**466013**	**2640737**
Total - B toF	**8046093**	-	**490800**	**490800**	**8536893**	-	**8536893**	**15**	**1206914**	**36811**	**1243725**	**7293168**
Grand Total (A to F)	**112858272**	**9875861**	**36038999**	**45914860**	**158773132**	**0**	**158773132**		**18025681**	**1187663**	**19213344**	**139559788**

(PROF. G.U. KULKARNI)
DIRECTOR

PLACE :BANGALORE
DATE : 21.07.2016

(VIVEK DUBEY)
ACCOUNTS OFFICER

As per our report of even date,
for M/s. G.R.VENKATANARAYANA,
Chartered Accountants,

(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, BANGALORE

SCHEDULES FORMING PART OF THE ACCOUNTS FOR THE YEAR ENDED 31ST MARCH 2016

SCHEDULE 24: NOTES ON ACCOUNTS

A.SIGNIFICANT ACCOUNTING POLICIES:

01. **Accounting Conventions**: The financial statements are drawn up in accordance with historical accounting conventions and on the going concern concept. Cash system is followed to record the Income , Grants and expenditure except Salary for Month of March ,which is recorded as rule no 64 of Central Government Account Receipts and Payment Rules 1983 .

As per the decision taken by the Governing Council for Accounting treatment of Grants – in- aid received from Department of Science and Technology to defray the expenses of the Centre, no bifurcation has been made between Revenue Grant and Capital Grant. The total amount of Grant received from the DST during the year is credited to the Income and Expenditure account of the Centre.

02. **Investments** : Investments are stated at cost, Interest from Investments are accounted on cash basis.

03.**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.

04. **Depreciation** : Depreciation on Fixed assets has been provided on Written Down Value Method at rates as per Income Tax Rules 1962.

05. **Government Grants/other Grants** : The Grants received are recognized in the accounts on realization basis. The total amount of grant received from DST during the year has been credited to the Income & Expenditure account of the Centre. The conditions stipulated for utilization of Grants-in-aid have been strictly adhered to by the Centre.

06. **Capital Expenditure :** All Capital Expenditure incurred during the year for purchase of Fixed Assets is charged to Income & Expenditure Account, under the head "Expenditure on Grants/Subsidy". The same is again reflected in Schedule 1 by credit to Capital Fund account.

Vinay Dubey

G.R. VENKATANARAYANA Chartered Accountants BANGALORE

B.NOTES ON ACCOUNTS:

07. **Contingent Liabilities:** The Centre opened two Letters of Credit which were outstanding as on 31st March 2016 Nil and ₹ 24,55,638/- outstanding as on 31st March 2015.

08. Claims against the Centre not acknowledged as debts Rs. Nil (Rs. Nil)

09. Foreign currency transactions are translated at the rates prevailing on the date of transaction. ₹ 2,62,80,571/- paid as foreign currency for purchase of Equipments and other expenditure during financial year 2015-16 and whereas ₹ 1,28,11,381/- paid for financial year 2014-15.

10. Balance shown under Saving Bank Accounts Include amounts held by Bank under "Auto Sweep Accounts".

11. 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.

12. The project overhead amounting to ₹ 1,52,648/- relating to completed projects has been transferred to Income Expenditure Account under the head Project Overhead Recovered and ₹ 5,00,000/- relating to ongoing projects has been carried forward under Project Administration Fund .

13. The total amount being Depreciation on fixed assets ₹ 1,92,13,344 /-, depreciation amounting to ₹ 1,79,69,619 /- on general fixed assets of the Centre has been debited to capital fund account and the depreciation on assets pertaining to projects amounting to ₹ 12,43,725 /- has been debited to the Projects fund account. This system is being followed by the centre in the respective years of acquisition of fixed assets acquired and has been treated as Expenditure on Grants in the Income & Expenditure Account, as a matter of accounting policy.

14. Schedules 1 to 24 are annexed to and form an integral part of the Balance Sheet as at 31st March 2016 and the Income and Expenditure Account for the year ended on that date.

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

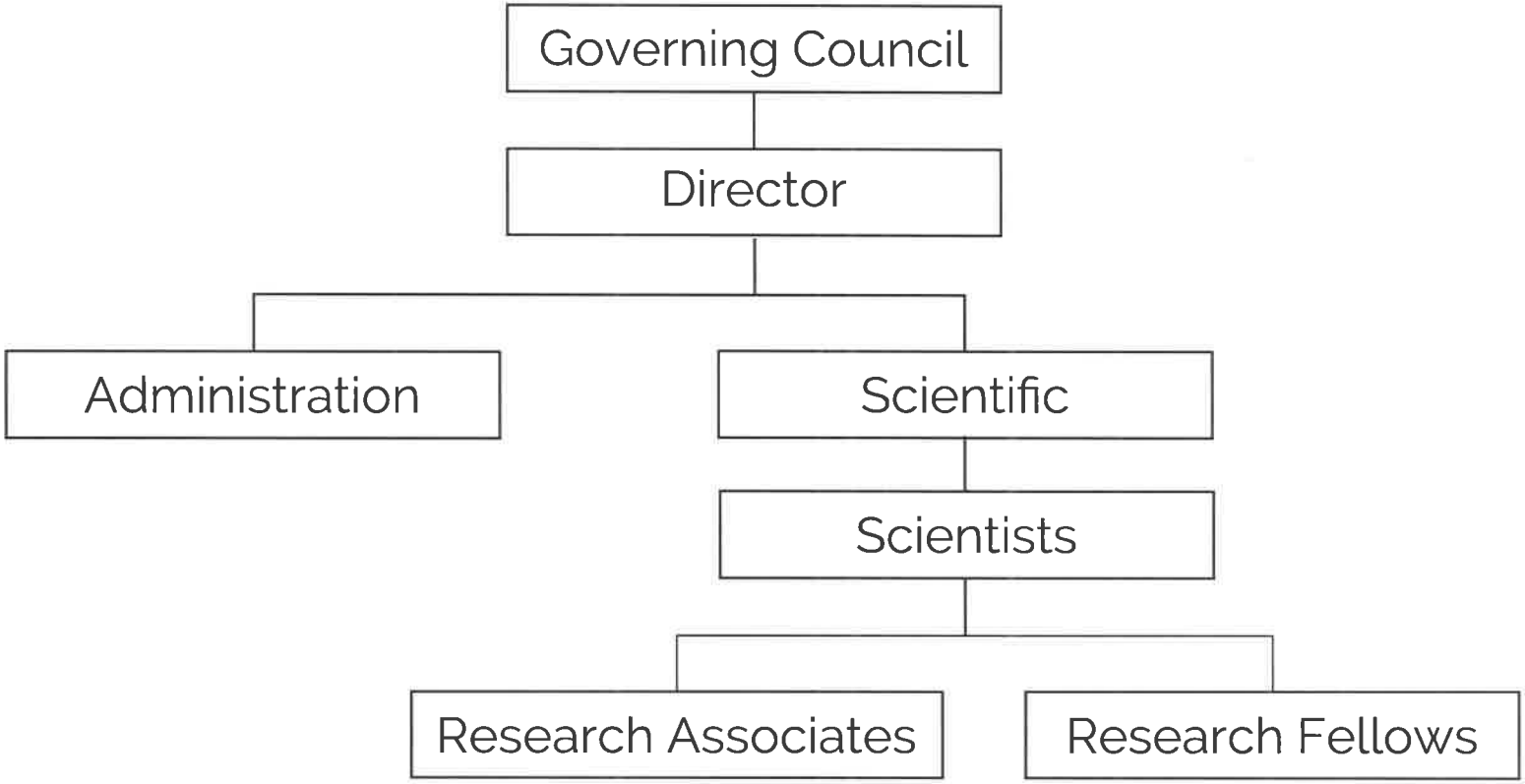
(PROF. G.U. KULKARNI)
DIRECTOR

(VIVEK DUBEY)
ACCOUNTS OFFICER

(G.R.VENKATANARAYANA)
PARTNER
M.No. 018067
M/s. G.R. VENKATANARAYANA
Chartered Accountants
618, 75th Cross, 6th Block,
Rajajinagar, BANGALORE-560 010

PLACE : BANGALORE
DATE : 21.07.2016

Centre for Nano and Soft Matter Sciences (CeNS) Organisation Chart



नैनो एवं मृदु पदार्थ विज्ञान केंद्र

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

प्रो॥ य. आर. राव मार्ग, जालहल्ली, बेंगलूरु ५६० ०१३

CENTRE FOR NANO AND SOFT MATTER SCIENCES

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

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