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Abstracts

1. Simultaneous determination of norepinephrine, melatonin and nicotine based on the electrochemical immobilization of NAD on WO_3 film

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Norepinephrine (NEP) is one of the most important endogenous adrenoceptor agonist, present mainly in central nervous systems. Extreme abnormalities of NEP concentration levels may lead to the ganglia neuroblastoma and Parkinson's disease. Melatonin (MEL) is an indolamine hormone that regulates the amount of NEP release synapsing with the pineal gland. Nicotine (NIC) is one of the pyridine derivative alkaloid and acts on the central nervous system in the form of elevation of mood, sense of euphoria and revitalizing energy [1]. Therefore, it is very important to develop a simple and rapid method for simultaneous determination of these biomolecules in analytical applications.

Herein, we propose a novel strategy of using the nicotinamides (NAD) immobilization on ethylene diamine tetra acetic acid (EDTA) assisted gamma irradiated tungsten trioxide (GI-WO_3) surface [2] and its application for the simultaneous determination of NEP, MEL and NIC shown in Fig.1. NAD, one of the potential electron transfer mediators as well as biosensor interface for the electrochemical biomolecules determination was deposited on WO_3 nanoparticles modified glassy carbon electrode (GCE) and the interface was investigated by powder XRD, PL spectra and FESEM studies. Cyclic voltammetry studies revealed the presence of NAD immobilization at an oxidation potential at 0.42 V in 0.1 M phosphate buffer solution (PBS, pH 7).Differential pulse voltammetric (DPV) studies exhibited well-defined peaks at potentials of 120, 570 and 840 mV, corresponding to the oxidation of NEP, MEL and NIC respectively, indicating that simultaneous determination of these compounds is feasible at the NAD/GI-WO_3/GCE. The proposed sensor displayed lowest detection limit of 1.4 nM for NEP, 2.6 nM for MEL and 1.7 nM for NIC and successfully applied in real sample applications.

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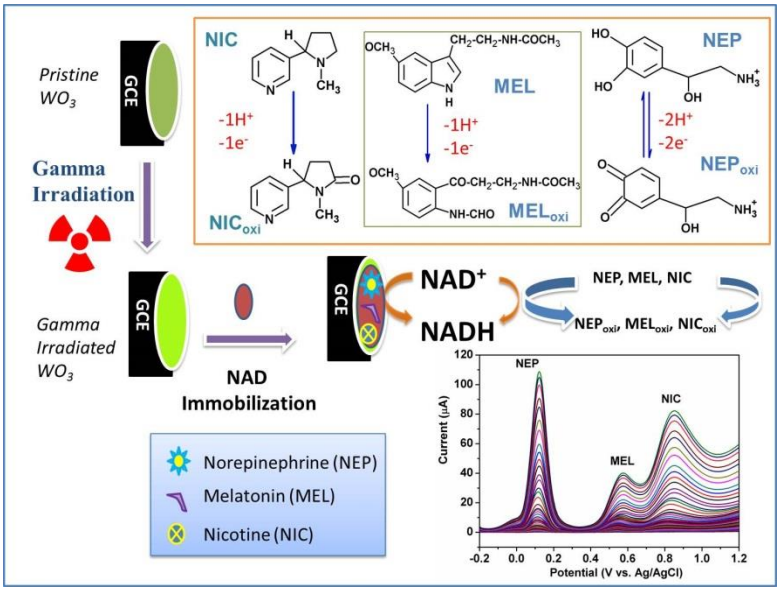

Fig. 1 Plausible detection mechanism for the electrochemical response of NEP, MEL and NIC on NAD immobilized on GI-WO_3/GCE.

2. OXIDE THERMOELECTRICS: A Key for Power generation

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Electricity remains the most convenient form of energy in the near future; the conversion of heat into electricity acquires wide acceptance. The demand for alternative energy technologies to reduce our dependence on fossil fuels leads to important regimes of research, including that of high temperature energy harvesting through direct recovery

of waste heat and its conversion into useful electric energy. The simplest technology applicable for direct heat–electricity conversion is thermoelectricity using thermoelectric devices (TE) which does not require any moving components or green house gas emission more over they are compact, responsive and feasible for miniaturization. TE materials found novel applications in power generation include biothermal batteries to power heart pacemakers, deep space applications of NASA's voyager and spacecraft missions using radioisotope thermoelectric generators (RTGs) where solar energy is insufficient to power the control, data collection and communication system. ZT is the material parameter of significant importance in thermoelectric research defined as figure of merit $ZT=\frac{S^2\sigma}{\kappa}T$ Where S is the seebeck coefficient, σ is the electrical conductivity and κ is the thermal conductivity [1]. For an ideal thermoelectric material it should simultaneously possesses a high σ and low κ to act like a 'Phonon glass electron crystal' along with a large thermopower. Degenerate semiconductors or semimetals can be considered as a best TE material because its carrier concentration will maximize the thermopower. Doping effect will enhance the electrical conductivity and reduce the lattice thermal conductivity by scattering mechanism and thereby to obtain a desirable ZT. Thermoelectric modules can be constructed by properly sandwiching a p type and n type thermoelectric material between two ceramic substrate so that it can scavenge heat energy from the environment and can be utilized for power generation. In this work, we focus on oxide thermoelectric materials which can be used for high temperature thermoelectric application such as in space crafts and in nuclear power [2]. Although the ZT value of oxide materials is still low compared with the TE materials, they posses several inherent merits from fundamental and application point of view. The high chemical and thermal stability of oxides allows for a large temperature gradient across the thermoelectric materials which may induce novel nonlinear, nonlocal TE effects that are thermoelectrically favorable [3].Oxides are featured by their chemical versatility and structural intricacy , which offers a flexibility of structural and compositional tailoring. A synergistic approach of optimizing the band gap energy and lattice thermal conductivity is the key parameter in controlling the thermoelectric properties of oxide materials. Oxides are also advantageous in terms of cost of raw materials and environmental friendliness.

Among the group of oxide materials for TE application we here by choose SnO_2 doped with magnetic ion Nickel prepared by solid state reaction mechanism and the effect of doping on the transport properties for power generation was investigated. Introduction of defects in the crystal lattice found to enhance the electrical conductivity and thereby cause an increment in thermoelectric properties. Oxygen vacancy can be created by annealing the pristine and doped sample at $700\ ^0$ C for 5 hours in an inert atmosphere.

Results and Discussion: XRD reveal the structural integrity and crystallinity of the sample having P42/mnm space group (ICDD NO: 01-071-5328) having rutile tetragonal crystal structure. Morphological study using Scanning Electron Microscopy (SEM) depicts the particle size is in the micrometer range and EDS ensured the chemical composition of nickel present in the sample. Raman spectroscopy ensures the Sn-O vibrational modes present in the sample along with the presence of oxygen vacancy. Optical band gap analysis using UV spectrometry shows the increase in band gap energy with doping which can be explained on the basis of Burstein Moss shift which is inherent for the degenerate semiconductors. Photoluminescence ensured the presence of in plane, bridging and sub bridging oxygen vacancy in SnO_2 and in the nickel doped material. Photoluminescence intensity got enhanced due to the increase in concentration of free charge carriers formed due to the presence of oxygen vacancies. Thermoelectric properties were measured using ULVAC ZEM 3 M8 which is used to measure simultaneously the electrical resistivity and seebeck coefficient of the material.

As the nickel concentration increases the thermo emf induced in the material also increases. 3 at% of nickel doping was found to have optimum seebeck coefficient and electrical conductivity and thereby causes an increase in power factor. Inducing oxygen vacancy for the 3 at% nickel doped samples found to have enhanced thermoelectric property due to the presence of defects which will act as efficient traps for electrons, holes and excitons and strongly influence the thermal transport and optical properties of the host material. Thus Nickel doped SnO_2 can be considered as a good TE material at high temperature.

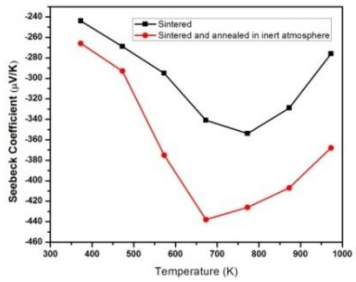

Figure 1: Variation of Seebeck coefficient with temperature

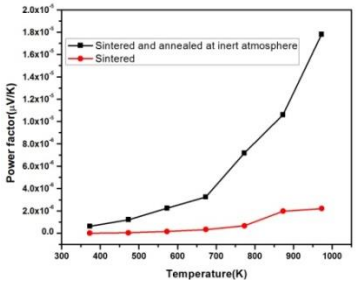

Figure 2: Variation of Power factor with temperature

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3. Probing of radio frequency alternating magnetic field induced heating in surfactant capped iron oxide nanoparticles using infrared thermography for hyperthermia aided cancer treatment

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Magnetic fluid hyperthermia (MFH) is a therapeutic procedure, where fluids containing superparamagnetic nanoparticles are injected into a tissue containing cancerous cell and thereafter, subjected to an alternating magnetic field that causes the fluid temperature to increases which in turn increases the tissue temperature beyond 42 ^{0}C leading to cellular degradation or thermal ablation (beyond 45 ^{0}C) of the cells aiding in cancer treatment. Superparamagnetic nanopartilces undergo Neel-Brown relaxation under the action of an alternating magnetic field. In Neel relaxation, the moments of the individual magnetic nanoparticles (MNP) follow the alternating magnetic field by rotating against the anisotropic energy barrier with a characteristic time whose natural logarithm is linearly proportional to the ratio of anisotropic energy to thermal energy. Stored magnetic energy is released from the MNP to the surrounding fluid during withdrawal of the external field, leading to a rise in fluid temperature. On the other hand, in Brownian relaxation, heating is achieved through wholescale rotation of the MNP, where the directions of the magnetic moments remain fixed with respect to the crystallographic orientations and the characteristic time scale is linearly proportional to the ratio of fluid viscosity and hydrodynamic volume to thermal energy. For efficient MFH treatment systematic understanding of the heating mechanism and the factors affecting the heating efficiency of the suspended particles is a perquisite. The stability of the ferrofluid, particle size, polydispersity, saturation magnetization, surface coating etc. strongly affect the rate of field induced heating. Magnetite (Fe_3O_4) is the most widely used candidate for MFH due to its superior bio-compatibility. In this work we present the radiofrequency (RF) alternating magnetic field induced heating of oleic acid coated Fe_3O_4 MNP which was synthesized and characterized in house. The fluid temperature was measured using infrared thermography (IRT) and later compared with RF immune fiber optic sensor. The effect of sample concentration and external field amplitude on heating efficiency was also studied.

Fe_3O_4 MNP were synthesized by a chemical co-precipitation technique using 1:1 acidic solution of 0.8M $FeCl_3.6H_2O$ and 0.4M $FeSO_4.7H_2O$. The Fe_3O_4 MNP were coated with oleic acid to provide stabilization against van der Waals attraction and the coated MNP were dispersed in kerosene. Samples of 23.0, 16.5, 11 and 7.5 wt. % were used in the present study. The size of the synthesized MNP was characterized using powder X-ray diffraction (XRD) (~8.0 ± 0.8) and small angle X-ray scattering (SAXS) (~7 nm, $\sigma = 0.14$). The Porod's plot [ln(I(q)) vs. ln(q)] at high q region, showed spherical shape of the synthesized MNP. The hydrodynamic size (~11 nm, $\sigma = 0.25$) was measured using dynamic light scattering (DLS) studies. Magnetization measurements were performed in the range of -1.5 T to 1.5 T using vibrating ample magnetometer (VSM). The room temperature hysteresis curve showed superparamagnetic behavior and the saturation magnetization was obtained as 42 emu/g. The average size obtained from magnetization data was ~ 11.3±1.8 nm. The presence of oleic acid was confirmed using Fourier transform infrared (FTIR) spectroscopy under attenuated total reflection (ATR) mode using ZnSe crystal. High frequency

alternating magnetic field induced heating was carried out at a fixed frequency of 126 kHz and under five different external field amplitudes of 57.3, 51.4, 45.0, 36.7 and 26.0 kAm^{-1}. The rise of fluid temperature was measured using fiber optic temperature sensor and IRT. Though the temperature rise curves obtained from IRT and fiber optic temperature sensor showed similar trend, IRT based data indicated higher initial rate of temperature rise and lower maximum temperature rise which were attributed to the internal and external convection effects. An empirical data analysis protocol was developed for correction of the IRT data and it was observed that convection corrected IRT data were in good agreement with the data obtained from fiber optic temperature sensor. The maximum temperature rise, initial rate of temperature rise under non-adiabatic limit and specific absorption rate (SAR) were studied as a function of external field amplitude for four different sample concentrations. The highest SAR obtained in the present study was ~ 75.1±3.1 W/g for 23 wt. % sample under an external field amplitude of 57.3 kAm^{-1}. It was also observed that SAR increased linearly with the square of the external field amplitude, in accordance with the theoretical expectations. IRT based data indicated a reversible thermal response and uniformity in surface temperature distribution of the ferrofluid samples, which are essential for delivery of homogeneous thermal dose during MFH based cancer treatment.

Keywords: Magnetic fluid hyperthermia (MFH), Superparamagnetism, Magnetite, Infrared thermography (IRT), Oleic acid coating

4. Solvothermal Synthesis, Non-vacuum based Deposition and characterization of Cost-efficient p-type $CuSbS_2$ Nanoparticles

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Ternary $CuSbS_2$ nanomaterials with orthorhombic crystal phase and sphere like morphology were successfully synthesized using facile solvothermal method. A non-vacuum based drop casting method was used for the deposition of $CuSbS_2$ thin films. The obtained $CuSbS_2$ nanoparticles and the deposited films were characterized for their structural, morphological, optical and electrical properties by means of suitable analytical techniques. The XRD results showed that the obtained sample showed orthorhombic crystallinity with (310), (101), (410), (301), (620), (521) and (222) planes of the $CuSbS_2$ nanoparticles with average crystallite size of 9.20 nm and the product confirmation was carried out by Raman spectroscopy. The morphological investigation results given by the FESEM with EDS showed that average particle size of the sample was around 23 nm and yielded a Cu rich property. The HRTEM image of $CuSbS_2$ nanoparticles gave the crystallite size of 3-4 nm, whereas the DLS provided a hydrodynamic average diameter of 2.7 nm. UV-Vis-NIR results revealed that there was broad absorption in the entire visible region and estimated direct band gap was found to be 1.45 eV. The cross sectional SEM images of the deposited film gave spherical surface with the thickness of 2 μ m and clean cross sectional analysis using focused ion beam scanning electron microscope showed linked formation of sphere like Cu-Sb-S nanoparticles. The hall measurement studies showed that the deposited $CuSbS_2$ films exhibited p-type conductivity with carrier concentration in the range of 10^{19} cm^{-3}. Device was fabricated with the configuration of FTO/n-TiO_2/p-$CuSbS_2$/Ag and the electrical properties were studied by recording the current- voltage (*I-V*) characteristics of heterojunction device structure. These results indicate that $CuSbS_2$ nanomaterials are a promising absorber material for photovoltaic applications.

Keywords: $CuSbS_2$ nanoparticles, solvothermal method, hall measurement, absorber material, photovoltaics
Acknowledgement: This research was performed using facilities at CeNSE, Indian Institute of Science, Bengaluru, funded by the Ministry of Electronics and Information Technology (MeitY), Govt. of India.

5. Green synthesis of iron oxide nanostructures for biomedical applications: Mimicking bacterial magnetosomes

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Magnetotactic bacteria (MTB) are known for their alignment along the earth's magnetic axis due to the presence of magnetosomes, which are intracellular organelles synthesized in MTB comprising of iron oxide Fe_3O_4 (magnetite) or less commonly, iron sulphide Fe_3S_4 (greigite) enveloped in a lipid-protein membrane. These magnetosomes possess unique characteristics that have attracted a broad interdisciplinary interest for a range of applications from microbiology and cell biology to nanobiotechnology. The iron oxide from bacterial magnetosomes has a narrow size distribution (35 to 120 nm) with uniform morphology. Their small size allows easy diffusion across the tissues in the human body and the membrane prevents the nanoparticles from aggregation. Furthermore, they also show less

toxicity compared to chemically synthesized magnetic nanoparticles. Iron oxide nanoparticles have proven potential MRI, hyperthermia and drug delivery. Here, it is proposed to synthesize iron oxide nanostructures using plant extract from the inflorescences of *Cannabis sativa* L., (commonly known as hemp) by mimicking these MTB magnetosomes. The synthesized nano- Fe_3O_4 is expected to show enhanced properties comparable to the bacterial magnetosomes for targeted applications in biomedicine. Gaining an insight into the physiology of MTB as well as the structure and composition of magnetosomes would be imperative to achieve this objective. The plant-mediated synthesis of iron oxide with biomimetics of bacterial magnetosomes provides a novel and green pathway in the growing field of nanotechnology.

6. Investigation of Implantation Effect on One Dimensional Nanostructures

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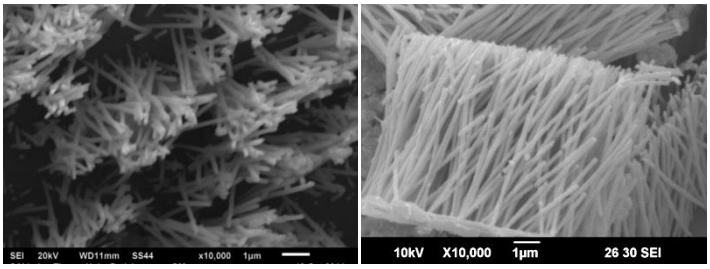
Nanowires (NWs) exhibit peculiar and unique properties superior to their bulk counterparts that can be attributed to the restricted motion of electrons in the confined dimensions of the nanostructure (quantum effects). Recent studies suggest that one-dimensional (1D) metallic and semiconducting nanowires have gained extensive attention due to their novel properties and their application as interconnects in future nanometer-scale electronics devices [1]. Copper is considered as one of the best host material for interconnects in nanoelectronics and optoelectronics devices due to its low cost, high accessibility and exceptional electrical and thermal properties. Also, CdSe with a band gap of 1.74 eV (ca. 712 nm) at room temperature exhibits remarkable optical properties and efficient carrier multiplication which endows it with potential application in light-emitting devices, photo detectors and photovoltaic. For large-scale production of high quality nanowires with precise morphological control, the template based synthesis is a convenient route which involves electrochemical deposition [2]. Ion implantation possesses indispensible characteristics where in the implanted species and the embodied implanted concentration along side or in depth can well be guarded beyond any solubility limits and with inexistence of any extra elements. With an appropriate choice of the experimental parameters such as energy, current, fluence, the ion depth can be tuned significantly affecting various properties of the nanostructure [3].

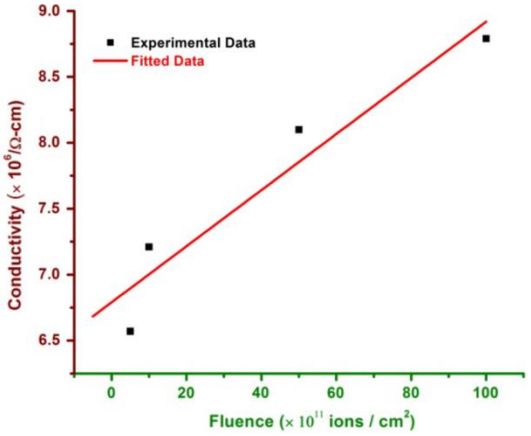
In the present study, the effect of positive and negative ion implantation on the properties of copper and cadmium selenide nanowires of 80 nm are investigated. Polycarbonate track etched membranes with a pore diameter of 80 nm and thickness of 10 μm were used for synthesizing nanowires and electrochemical deposition was done potentiostatically in a three electrode set up. Platinum wire acted as a counter electrode and saturated silver/silver chloride electrode (Ag/AgCl (sat)) was used as a reference electrode.



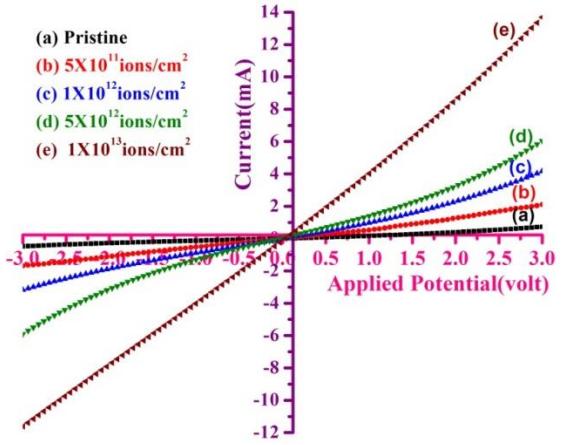
SEM image of Cu Nanowires **SEM image of CdSe Nanowires**

Synthesized Cu nanowires were exposed with 160 keV O^{-1} ion beam and 1 MeV O^{5+} ion beam with a fluence variation of 1×10^{12}, 5×10^{12} and 1×10^{13} ions/cm^2 at Inter University Accelerator Centre (IUAC), New Delhi, India. Also, CdSe nanowires were implanted with 200 keV Al^{-1} ions and 250 keV protons (H^+) with same fluences as implied for Copper nanowires. 1 cm^2 area of samples was mounted on the aluminum ladder in radiation chamber at a pressure of 5×10^{-6} mbar and was exposed to the beam for desired fluence. In each case, the range of the ion was determined by using the SRIM-2006 (version 2008.04) software and was found to be much less than the length of the nanowires (10 μm). The pre- and post implanted samples of nanowires were characterized for morphological, structural and electrical properties by using Scanning electron microscope (SEM), X-Ray diffraction (XRD) and two probe set up with Keithley source meter respectively. SEM analysis reveals no changes in morphology of nanowires

on implantation in all the cases. The structural analysis demonstrates no shifting in the '2θ' position of diffraction in both Cu and CdSe nanowires on implantation of positive and negative ions. However some new diffraction peaks of oxygen were seen in copper nanowires in both the cases of negative and positive oxygen ion implantation. Also, for negative aluminium ion implantation in CdSe nanowires, an additional peak was seen corresponding to aluminium. The experimental results of the implanted Cu nanowires showed that implantation embody the improved electrical properties without any structural damage.



Fluence versus electrical conductivity for O^{5+} implanted Cu NWs



I-V curves for pristine and Al^{-1} implanted CdSe nanowires

Electrical measurements of CdSe nanowires also revealed an enhancement in the current of the nanowires with aluminium negative ion implantation and proton implantation. CdSe nanowires were found to exhibit good ohmic behaviour with aluminium implantation at fluence of 1×10^{13} ions/cm^2. The better electrical conductivity of nanowires on implantation suggests the possibilities for suitable applications in photosensitive devices such as photovoltaic cell, heterojunction solar cells without using Si etc.

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7. Facile and robust synthesis of electron beam irradiated polypyrrole and Ce-Ni bimetal based nanocomposite for pseudocapacitor application

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With the ever-increasing power and energy requirements in modern world, recent research and developments have focused on new electrode materials for advanced energy storage devices. Nanoparticles (NPs) are used to offer enormous advantages over microparticles because of their large specific surface area, aspect ratio and excellent interfacial interactions on polymer branches. Interestingly, bimetallic NPs have superior optical, interfacial, catalytic and antimicrobial properties over single metallic NPs. It is well observed that the dispersion of NPs in the polymer matrix improves the desired properties of parent polymer matrix including tensile strength, glass transition temperature, thermal degradation, and rheological properties and conductivity. So, cerium-nickel (Ce-Ni) bietallic NPs are decorated over the electron beam (EB) irradiated PPy to fabricate the hybrid nanocomposite.

Here, we report a novel energy storage hybrid material for pseudocapacitor application based on EB irradiated polypyrrole/cerium-nickel (EB-PPy/Ce-Ni) nanocomposite. The EB irradiated PPy nanospheres (NSs) and Ce-Ni bimetallic NSs prepared in a novel solution based route and make as a composite for the improvisation of energy storage as well as charge transfer mechanism. The nanocomposite was confirmed by SEM, EDAX, XRD, Raman spectrum Analysis. Interestingly, EB-PPy/Ce-Ni modified Ni foam electrode was evaluated in 1M NaOH by cyclic voltammetry and galvanostatic charge-discharge methods for pseudocapacitor application. The Ce-Ni bimetal NSs in the EB-PPy shows a significant improvisation of specific capacitance to 605 Fg^{-1} at a current density of 1 Ag^{-1} with the capacitance retention of 69% after 1000 cycles. The optimized electrolyte concentration, current density,

scan rate and cycle stability shows promising results as the low cost energy storage and an attractive wearable power.

8. Top seeded infiltration growth of (Y,Gd)$Ba_2Cu_3O_y$ bulk superconductors with high critical current densities

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We report on the top seeded infiltration growth (IG) of bulk (Y,Gd)$Ba_2Cu_3O_y$ (YG-123) superconductor by varying the composition of $(Y,Gd)_2Ba_1Cu_1O_5$ (YG-211) as secondary phase inclusions in solid preform and compared the results with IG-processed bulk $YBa_2Cu_3O_y$ (Y-123) superconductor grown under similar conditions with only $Y_2Ba_1Cu_1O_5$ (Y-211) inclusions with no added grain refining dopants. A maximum critical current density J_c (77 K) of 3.55×10^4 A-cm^{-2} at zero field has been observed in IG grown Y-123 bulk whereas critical current density J_c (77 K) of 4.78×10^4 A-cm^{-2} at zero field has been recorded for YG-123 samples with YG-211 inclusions. The superconducting transition temperature (T_c) has also increased with reduced transition width (ΔT_c) with the highest in sample with more $Gd_2Ba_1Cu_1O_5$ (Gd-211) content. Magnetic properties and microstructural features have been studied for these samples which shows a variation in superconducting transition temperature (T_c) with volume fraction (V_{f211}) of YG-211 particles in the YG-123 phase matrix as the content of Gd-211 increases gradually in different samples. The pinning efficiency has also been observed to increase in these samples signifying that these nonsuperconducting YG-211 particles are acting as effective pinning sites showing the presence of δT_c pinning. Spatial variation in transition temperature (T_c) and critical current densities (J_c) have also been seen in YG-123 samples along both *a* and *c*-axes of the growth front from the seed crystal which also supports the microstructural features observed in these directions. It is the variation in size and percentage volume fraction of these YG-211 particles that causes spatial variation in critical current density (J_c) within the bulk sample. With the increase in Gd-211 content in the preform of samples YG-123, the volume fraction and size of the YG-211 particles decreases gradually as the rate of dissolution of Gd-211 inclusions increases with increasing Gd-211 content due to enhanced Gd ion concentration gradient from the Gd-211 inclusions in the liquid during the solidification process due to higher peritectic temperature of Gd-211 than Y-211.

Keywords: Top seeded infiltration growth, critical current density, transition temperature, pinning, microstructure, volume fraction.

9. Thermal conductivity enhancement in organic phase change materials loaded with nano-inclusions

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Organic phase change materials (PCM) have several potential applications in latent heat storage system with high storage capacity owing to their characteristic properties like high heat of fusion, self-nucleating ability and non-toxic/ non-reactive nature. The feasibility of constructing thermal energy harvesters using organic PCM have been attempted because of their ability to store and release large amount of thermal energy during melting and solidification phase transition temperature. PCM is a potential candidate for storage of solar energy in solar plants, because of their efficiency and reduced carbon footprint. Energy storage for residential solar water heaters using PCM has been experimentally demonstrated. A systematic understanding of phase stability and thermal properties of the PCM are prerequisites for rapid adaptation of PCM in industrial and household devices. For applications near ambient temperature, hydrocarbons of various chain lengths are generally used due to their ability of freezing without super cooling. On the other hand, thermal conductivity of such organic PCM are low which restricts their practical applications. For enhancing the thermal conductivity of organic PCM, several methods have been suggested like, dispersing high thermal conductivity particles in a continuous phase of PCM, using metal structures or porous materials in PCM, etc. Here we study the thermal conductivity enhancement of n-hexadecane containing nanoinclusions of graphene nano-platelets (GNP) and multi walled carbon nanotubes (MWCNT) at different concentrations. The GNP had a lateral size of ~ 2 μm with a thickness of ~ 1-4 nm, whereas the MWCNT had an outer diameter < 8 nm with length ranging from 10-30 μm. GNP and MWCNT were dispersed in n-hexadecane in as

received condition using a horn sonication. The thermal conductivity measurements were carried out using a transient hot-wire probe.
For GNP loaded n-hexadecane, thermal conductivity was found to be enhanced by 300, 282, 279, 280 and 299 % in the transition region, for sample concentrations of 0.001, 0.0025, 0.005, 0.0075 and 0.01 wt. %, respectively. It was further observed that thermal conductivity enhancement was ~ 100 %, in the solid state, well below the freezing point, whereas the thermal conductivity enhancement was limited to a mere 1-8 % in the liquid state. Larger thermal conductivity enhancement was observed in the solid state as compared to the liquid state due to changes in the microstructure of the PCM during phase transition. As the base fluid (organic PCM) freezes, inclusions are squeezed towards the grain boundaries due to development of solidification induced internal stress which also leads to an improved contact between the inclusions resulting in a reduction of interfacial thermal resistance. This leads to a larger thermal conductivity enhancement in the solid state which was also evident from the experiments performed on n-hexadecane loaded with MWCNT. In this case, thermal conductivity was found to enhance by 237, 264, 273, 243 and 209 % in the transition region for inclusion concentration of 0.001, 0.0025, 0.005, 0.0075 and 0.01 wt. %, respectively. The thermal conductivity enhancement in the solid and liquid state were ~ 100 and 1-7 %, respectively. It was also observed that the thermal conductivity enhancement initially increased with inclusion concentration up to a certain concentration and beyond that it decreased due to aggregation of nanoinclusions at higher concentrations. It was further observed that thermal conductivity enhancement in the phase transition region was higher for GNP inclusions compared to the MWCNT inclusions. These results indicate that thermal conductivity of PCM can be significantly altered by dispersing as small amount of nanoinclusions in it. Such PCM with superior heat transfer properties and energy storage capability will pave the way for rapid industrialization of low cost thermal energy harvesters.
Keywords: Thermal conductivity, Phase change materials (PCM), GNP, MWCNT, n-hexadecane, Energy harvesting

10. Effect Of heat treatment on the D.C. Electrical properties of Co-precipitated $Mn_{0.5}Ni_{0.5}Fe_2O_4$Nanoferrite systems

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The Mn-Ni nanoferrite system ($Mn_{0.5}Ni_{0.5}Fe_2O_4$) was synthesized by co-precipitation method and was sintered at 200ºC, 500ºC and 800ºC for microwave radar frequency applications. The electrical properties of the samples were investigated as a function of sintering temperature.
Two-probe method was employed for electrical characterization and Arrhenius plots were drawn. It was observed that the D.C electrical resistivity of the sintered samples decreases over a temperature range of 303 K – 423 K (30ºC - 150 ºC) indicating semiconducting behavior of samples. The room temperature D.C resistivity of the samples was found to be decreasing from 11.38 $x10^6$ to 6.81 $x10^6$ Ω-cm with increase in sintering temperature from 200ºC to 800ºC indicating increased probability of pair production of charges and hence improved mobility of charge carriers with sintering. The Curie temperatures (Tc), which indicates transition of magnetic order from ferromagnetic to paramagnetic order, calculated from Arrhenious plots, were observed to be decreasing with sintering temperature. The samples sintered at 200ºC exhibited 386ºC T_c, while it was 342 ºC in case of samples sintered at 800ºC. this decrease in Curies temperature is attributed to the ferromagnetic to paramagnetic magnetic order transition with sintering temperature, which is consistent with resistivity studies. The activation energies (ΔE) for the thermally activated hopping process, which specifies the energy required for the charge carriers for hopping process, was also observed to be decreasing with sintering temperature. The samples heat treated at 200ºC showed an ΔE of 0.28 eV where it was 0.12 eV for samples heat treated at 800ºC . These activation energy values are consistent with resistivity characterization.

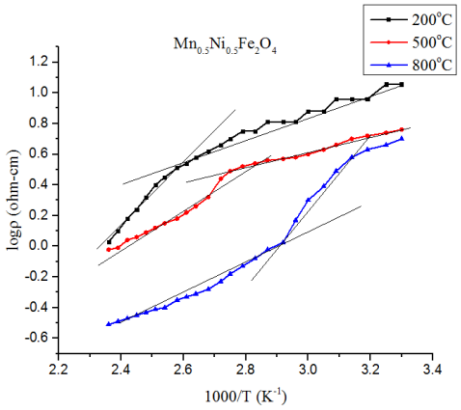

Fig.1:Arrhenius plots (variation of D.C. resistivity with inverse temperature) of. $Mn_{0.5}Ni_{0.5}Fe_2O_4$ nanoferrite samples sintered at 200ºC, 500ºC and 800ºC

Table 1:Variation of room temperature (303 K) D.C resistivity (ρ) with Mn^{2+} composition for the Mn-Ni nanoferrite samples sintered at 200ºC, 500ºC and 800ºC

Mn^{2+} composition	Resistivity (ρ)x10^6 [Ω-cm]		
	200oC	500oC	800oC
$Mn_{0.5}Ni_{0.5}Fe_2O_4$	11.38	9.21	6.81

Table 2: Variation of Curie temperature of $Mn_{0.5}Ni_{0.5}Fe_2O_4$ nanoferrite system with sintering Temperature

Mn^{2+} composition	Curie temperature (Tc) (K)		
	200ºC	500ºC	800ºC
$Mn_{0.5}Ni_{0.5}Fe_2O_4$	386	353	342

Table 3: Variation of activation energy of $Mn_{0.5}Ni_{0.5}Fe_2O_4$ nanoferrite system with sintering Temperature.

Mn^{2+} composition	Activation Energy (Ea) for conduction (eV)		
	200ºC	500ºC	800ºC
$Mn_{0.5}Ni_{0.5}Fe_2O_4$	0.28	0.16	0.12

Keywords: Nanoferrites; heat treatment; D.C. electrical studies; resistivity; Curie temperature, Activation energy,

11. Rapid extracellular biosynthesis of silver nanoparticles - an ecofriendly method

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Nanotechnology is an interdisciplinary field which impacts significantly all aspects of human's life. In recent years, Nano-sized inorganic particles, display unique physical and chemical properties and represent an increasingly important material in the development of novel nanodevices which can be used in numerous physical, biological,

biomedical, and pharmaceutical applications. Metallic silver nanoparticles (Ag NPs) have received considerable attention due to their unique properties, which depend on their morphology, dimension and colloidal stability. Silver nanoparticles have been synthesized by various physical, chemical and biological methods. However, high toxicity of chemical methods of synthesis has increased a need for the development of safe, cost effective, non toxic, sustainable, and environmental friendly method for synthesizing the nanoparticles. This study reports the rapid extracellular biosynthesis of silver nanoparticles under bright conditions. In this study, silver nanoparticles were synthesized by using bacteria isolated from soil sample collected from metal contaminated site. Silver nanoparticles synthesis was carried out by extracellular method and change in colour from transparent to yellowish brown under bright condition confirms the synthesis of silver nanoparticles. Synthesis of silver nanoparticles was started within 2 min of incubation. The nanoparticles synthesized were characterized by using transmission electron microscopy (TEM), X-ray diffraction (XRD) and ultraviolet visible (UV–Vis) absorption spectroscopy, Fourier transform infrared spectroscopy (FTIR) and Dynamic Light Scattering analysis (DLS). The antibacterial activity of biologically synthesized silver nanoparticles was assessed using Agar well diffusion assay against test pathogens (two gram +ve and two gram –ve).

12. Nd doped ferroelectric materials for the application of random access memory (RAM) devices

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Ferroelectric materials simultaneously present both ferroelectric and spin orders, which enable them to have potential applications in both magnetic and ferroelectric devices. So, the development of such type of material, which has magnetoelectric properties in same phase at room temperature, is the milestone for modern technology. These materials have potential applications in memory devices where one can write ferroelectrically and read magnetically or vice versa. We report the multiferroic properties of polycrystalline homogeneous $Bi_{4-x}Nd_xTi_3O_{12}$ (BNdT) ferroelectric thin films sandwiched in Pt electrodes by chemical solution deposition. Dense and uniform BNdT films were achieved by rapid thermal annealing the spin-on films at 700 °C for 3 min in an oxygen environment. All the samples exhibited well-saturated hysteresis loops with remenant polarization ($2P_r$) increasing from 36.22 μC/cm^2 (x = 0.0) to 109.86 μC/cm^2 (x = 0.1), respectively, while the coercive field ($2E_C$) = 64.6 kV/cm remained unchanged for all compositions at room temperature. Polarization offset was observed in the compositionally graded ferroelectric thin films as a function of temperature. Polarization offset was notable after 100 °C and increased with increasing temperature, which may be related to thermionic charge injection, which is asymmetric to top and bottom electrodes.

13. Design and fabrication of Low power Hamming Distance Estimator using CNTFET based full adder

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Wide spread of handy electronic devices and advances in VLSI technology have enabled the implementation of complex digital circuits on a single chip. Digital circuit consists of a number of interconnected logic gates which together perform logical operations with many input signals. In recent years in deep submicron and low power VLSI technology, power dissipation and area become a critical parameter. In low power CMOS VLSI circuits, the Power dissipation is caused by charging and discharging of internal node capacitances due to transition activity, which is one of the major factors that also affect the dynamic power dissipation. The dynamic power cannot be estimated by the simple expression $C_L V_{DD}^2 f$, because it might not always switch when the clock is switching. The transition activity determines how often this transition occurs on a capacitive node. For N periods of ($0 - V_{DD}$) and ($V_{DD} - 0$) transitions, the transition activity E determines how many ($0\text{-}V_{DD}$) transitions occur at the output. In other words the activity E represents the probability^2 that a transition ($0 - V_{DD}$) will occur during the period T= 1/f. The average dynamic power of a complex design due to the output load capacitance is given by

$P_D = E\ C_L\ V_{DD}^2 f$

The internal power dissipation, due to internal nodes, the internal dynamic power of a cell is given by;

$P_{int\text{-}dyn} = \sum_{i=1}^{\infty} E_i C_i V_i V_{DD} f$

It is defined as due to charging and discharging the data changed from 1 to 0 or from 0 to 1 vice versa between adjacent bus wires or on the same bus wire. During data transmission via buses, the input data changes from logic

'0' to logic '1' and vice versa is called transition activity. In this work hamming distance Estimator is used to calculate the transition activity, where hamming distance'd' is equivalent to Transition activity on buses. So the hamming distance estimator estimates hamming distance'd' between the coded input data with reference data. Similarly hamming distance is calculated for all possible input data. Among all least hamming distance'd' is transmitted to the output. In the proposed work to get a power, speed and area efficiency CNTFET full adders are used to implement hamming distance Estimator. The performance characteristics of CNTFET based hamming distance estimator is compared with CMOS based hamming distance estimator.

14. Effect of dichroic dye on electro optic performance of nanoparticles induced vertically aligned liquid crystal display

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Liquid crystal (LC) dispersions containing various types of nano-particles (NPs) like metallic, semiconducting, ferroelectric, carbon-related and inorganic, have been developed in the recent years [1-6]. These NPs have their own effect on electro-optic characteristics of liquid crystals (LCs) employed in display devices. In present work, alumina NPs induced vertically aligned liquid crystal (VALC) was prepared and then characterise for display devices. Moreover, effect of dichroic dye on electro optic (EO) performance of VALC was studied and found further improved up to great extent. In this experiment VALC cells were prepared with doping of 0.3 wt% of alumina in negative dielectric anisotropic nematic LC. We observed that on addition of 0.05% dichroic dye, the polar anchoring strength at the interface of the LC and surface become extra weaker with compared to VALC cell. The switching time, threshold voltage and operating voltage values were also found reduced for dichroic dye doped VALC. Results indicate that dye plays an important role for augmented performance of the NPs induced VALC device.

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15. The Design of Low Noise CNTFET Amplifier for Radar Sensor Applications

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For better precision, industrial radar sensors must operate at higher frequencies (HF) ranges such as the mm-wave spectrum, when the range of frequencies from 30GHz to 300GHz is beneficial for, as it enhances their precision. However the problem is that the size and the high cost of such system make them only for military applications.

Many researches use CMOS technologies but the production cost is high as the surface of silicon is important due to the large number of transistors used. The development of MOS transistors has always followed the Moore's law thanks to the use of short channels. Therefore, the physical limit of this continuous scaling is achieved and it's necessary to search for new materials that can increase the performance of the transistors. Carbon Nanotubes (CNTs) are currently considered as promising materials of a future nano-electronic technology [1].

The carbon nanotube field effect transistor (CNTFET) has excellent electrical properties [2]. It offers a combination of small size, high mobility, large current density, high cut off frequency, higher temperature resistance and ballistic transport so limited noise.

In brief, the project investigates the simulation of low noise amplifier (LNA) at 164GHz with common gate configuration using CNTFET technology. Verilog-A language is used for model implementation in CADENCE-Virtuoso software. For this purpose, the CNTFET model uses an array of parallel nanotubes as the transistor channel in order to reduce the parasitic capacitances and to improve the high frequency performance.

Objective and Major Contributions:

The objectives of our research are to develop a thorough understanding of CNTFET-LNA design and to introduce novel low-power CNTFET-LNA design at 164GHz for radar sensor applications.

The CNTFET-LNA is designed with low supply voltage to reduce the total power consumption. It uses a differential stage non-cascode structure with common gate architecture using CNTFET technology. In this project, the common gate configuration is not only used to lower the LNA's noise figure (NF), but also to improve the gain of the common gate CNTFET-LNA. At 164GHz, it has an input matching better than -10 dB, a reverse isolation better

than -15 dB, produces greater than 9 dB gain and less than 2 dB NF while drawing only less than 2 mA current from a less than 1V supply voltage.
Project Deliverables:
As an outcome of this project work described, we proposed an innovative design of CNTFET-LNA at 164GHz for radar sensor application consumes the least power but still achieve a very good performance in other parameters. Compared to conventional method, CNTFET-LNA is promising and cost-effective solution, especially, such scheme has the potential advantages of monolithically integrating carbon nanotubes with FETs, giving circuit designers unprecedented flexibility to use the best material and devices for radar applications.
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16. Plasmonic Enhancement of Fluorescence from Pathogenic Cells

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Plasmonic nanoparticles having resonance due to the excitation or emission wavelength of fluorescence can amplify the electric field and charge transfer on the cell wall. In the present study, this phenomenon is characterized and further design is carried out towards the development of optical sensing methods for pathogenic cells. This research aims to develop pathogen detection assay using various signal enhancement techniques. Plasmonic nanoparticles are useful contrast agents for optical imaging. The optical response of plasmonic nanoparticles can be tuned by modifying their size and shape or by modifying their surface characteristics. Opto-fluidic schemes of inhibition, transport and activation by carrier molecules through cell membrane have interesting applications. Through plasmonic excitation of nanoparticles integrated in microfluidic channel, we observe cell membrane structural changes. Optical fiber coupled detector captures fluorescence emission spectra. Amplification of the emission peak intensity is studied and correlation with signal amplification due to various particle concentrations and varying concentration of pathogen are established.
Key words: Pathogens, fluorescence, electric field, plasmonic resonance, nanoparticle, cell membrane

17. Graphene and CNT based high performance supercapacitors

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Thales of Miletus, a greek philosopher, never thought that his discovery of electric charges by rubbing amber with cloth will lead to one of the major issues in today's 21st century, i.e. storage of electrical energy. Today, we can see how the world is developing so fast day by day, minute after minute, even every second counts. We can notice it through the electronic community that we are surrounded with, every cell phone is being replaced with better technology in the very next day, every television, electrical and electronic devices, even nowadays cars are being replaced with better technology in the very next morning. If we have a close look on the word "better technology", where it comes from, one component is storage and on-demand supply of energy or electricity. Keeping in mind on this "better technology", batteries, fuel cells and supercapacitors are drawing a great interest on the researcher's mind, as a source of energy storage and generation. Supercapacitors, on the other hand, due to its characteristics like high power density, faster charge and discharge rates, high efficiency over thousands of cycles and extremely low internal resistance are of much interest in the electrochemical energy storage platform. However, the energy density of commercial supercapacitors is typically 3-5 $Whkg^{-1}$ which is much lower than that of batteries (30-40 W h kg^{-1} for lead acid battery and 100-250 $Whkg^{-1}$ for lithium-ion battery). Such low energy density restricts its widespread applications.
Currently the electrodes of most commercial supercapacitors are made of activated carbon. Carbon-based supercapacitors store charge under the electrochemical double layer capacitance (EDLC). The carbon-based supercapacitors have excellent cyclic stability and longer life since the electrode undergoes no chemical change during the charge/discharge processes. However, their maximum capacitance (typically 0.15–0.4 Fm^{-2} or ~ 150 F g^{-1}) is restricted by the active electrode surface area and the pore size distribution. Therefore, extremely high surface area carbon is necessary to increase the energy density.
Recently, various carbon nanostructures have been widely investigated as electrode materials for supercapacitors with the purpose of advancing its performance. Notably, graphene has attracted increasing research interest for

applications in supercapacitors due to its excellent electrical conductivity, mechanical flexibility and high surface area. High specific surface area of ~ 2500 m^2g^{-1} can be achieved for single layer graphene sheets. High specific capacitances of greater than 200 F g^{-1} have been reported for graphene-based supercapacitors. However, there are also issues with the pristine graphene-based supercapacitors. Like most nanomaterials, graphene is also likely to form irreversible agglomerates or to restack to form graphite through the van-der Waals interactions during the electrochemical process. In such a case, it is difficult for the ions to gain access to the inner layers to form electrochemical double layers if the graphene sheets are stacked together. Consequently, it results in lower specific capacitance during cycling and poor life time. One solution to overcome the re-stacking of graphene is the use of spacers of metal oxides. The metal oxides also take part in storing the charges and, subsequently, enhance the energy density of supercapacitors. Therefore, my current research work focusses on fabrication of graphene based hybrid electrodes and evaluation of their electrochemical properties. A typical example of synthesized materials is shown in figure 1.

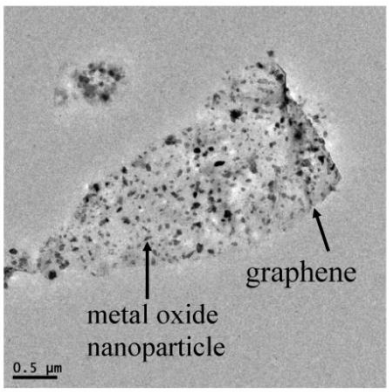

Figure 1: TEM image of graphene-metal oxide (MoO_3)

18. Effects of Swift Heavy Ion irradiation on the Structural and Electrical Characteristics of Au/Pd/Ni and Au/Pt/Ni on n-GaN Schottky diodes

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GaN based devices have been investigated for different applications like blue, ultravioet LED solar detectors MESFET, HEMT etc. Metal-Semiconductor (M-S) interfaces form an important research tool for characterization of materials. Studies of high energy ion beam are useful for modification of semiconductor devices in irradiation environments.

Schottky barrier diodes (SBD) of circular area in 2mm diameter were fabricated by depositing 1000/300/30nm thickness of Au/Pt/Ni/ n-GaN using electron beam deposition in target laboratory at IUAC, New Delhi. Multi-metal layer semiconductor diode of Au/Pt/Ni on n-GaN is subjected to irradiation of Swift Heavy Ion (SHI) beam with incremental varying ion fluence.

Using I-V and C-V electrical characterizations diode parameters like ideality factor, Schottky barrier height (SBH), forward current and reverse leakage current are determined.

19. Growth, Structural Spectroscopic, Thermal and Electrical Characterization of Cobalt Adipate Tetrahydrate single crystals

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We present the first report of the growth of single-crystalline cobalt adipate in silica gel and the determination of its structure**.** Cobalt adipate used primarily as a plasticizer in the flexible vinyl industry and is widely used in flexible poly(vinyl chloride) (PVC) food film (cling film) [1]. In gel method, the gel impregnated with adipic acids provides a controlled medium for the diffusion of supernatant cations into it, leading to the formation of crystals. Optimum conditions for the growth of cobalt adipate tetrahydrate at ambient temperature were found by investigating different

growth parameters such as pH, gel aging, gel density and concentration of reactants. The structure of the compound is studied by X-ray single crystal structure determinations, X-ray powder diffraction (XRD) technique, FT-IR and Raman spectroscopy. Thermal stability of the grown crystals was studied by the thermo gravimetric (TG), differential thermal analysis (DTA) and differential scanning calorimetry (DSC). The dielectric behaviour of the title compound crystal was investigated by measuring the dielectric constant, dielectric loss and ac conductivity as a function of frequency at room temperature.

RESULT AND DISCUSSION:

X-Ray diffraction studies: From single crystal XRD studies, it is confirmed that the structure of cobalt adipate is monoclinic. The measured cell parameters are a = 7.9805A^0, b= 14.9720 A^0, c = 9.5815 A^0, α= 90^0, β = 90.689^0, γ = 90^0. In its structure Co2+ ion is in a six coordinate environment (Fig. 1), defined by six O atoms from six different adipate groups. The Co–O bond distances vary between 2.0270 Å and 2.2100Å and the O–Co–O bond angles vary in a very wide range from 85.14Å to 180.0 Å. The crystal data and structure refinement parameters are presented in Table 1.

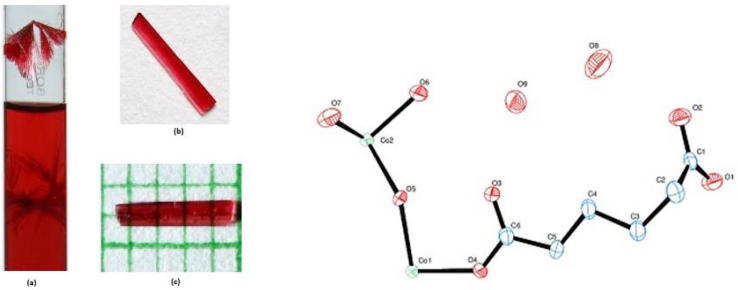


Fig.1(a) Growth apparatus and grown crystals (b) Asymmetric unit of cobalt adipate

From the X-ray powder diffraction pattern (Figure 2) the d values of the Bragg peaks of the grown crystal were compared with the corresponding ICDD values and it matched well with the standard card (No:00-051- 2302). The sharp peaks at specific Bragg's angles confirm the crystallanity of the entire sample.

FT-IR and micro Raman studies:

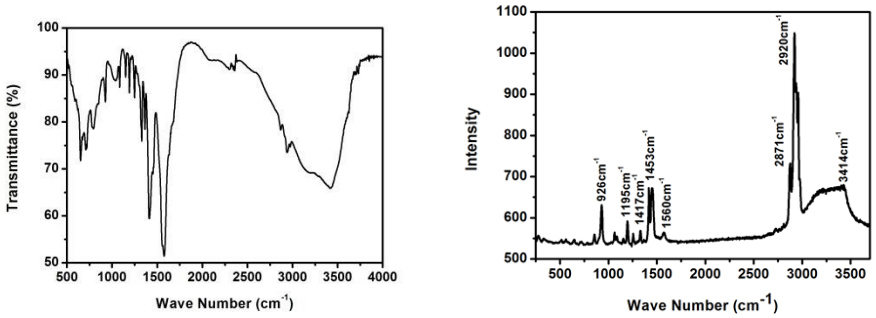


Fig. 2. FTIR spectrum and micro Raman spectrum of cobalt adipate

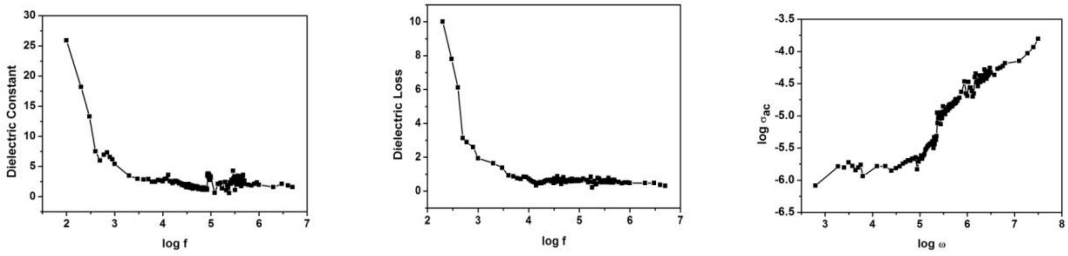
It is thus clear that the FTIR and micro Raman spectroscopic results of cobalt adipate hydrate crystals confirms the presence of water molecules, different functional groups and metal–metal bonding in the crystal.

Thermal Degradation Studies: The thermal decomposition pattern of the material suggests the different stages of degradation and the DSC curve confirms the presence of water molecules in the crystal lattice. The water of crystallization is completely lost well before the onset of anion decomposition.

Table 1. Result of decomposition process of $Co(C_6H_8O_4).4H_2O$

Decomposition step	Temperature range/^{0}C	Observed mass loss/%	Calculated mass loss/%	Loss of molecules in the step	Corresponding peak in DTG/^{0}C
I	68-142	27.141	26.188	$4H_2O$	105
II	336-403	63.963	56.741	$4H_2$+4C+CO	384
III	403-436	71.605	72.744	CO_2	421

Dielectric Property Studies: Figure 3(a) shows the variation of real dielectric constant (ε_r) with frequency, it is observed the dielectric constant is high at lower frequency region and decreases with increasing frequencies. It can be explained on the basis of various polarization mechanisms. In the present case, high value of dielectric constant at lower frequencies may be attributed to space charge polarization due to crystal lattice defects. Similar to dielectric constant, dielectric loss also decreases with increase in frequency and becomes constant at higher frequencies. Dielectric loss arises when the polarization lags behind the applied field and is caused by grain boundaries, impurities and imperfection in the crystal lattice [2]. Figure 3 (b) shows the variation of dielectric loss factor with frequency at room temperature. The conduction mechanism in the sample was determined from the AC conductivity measurement. The variation of AC electrical conductivity (σac) with frequency at room temperature is shown in Figure 3 (c).



(a) (b) (c)

Fig. 3 Variation of dielectric constant, dielectric loss and ac conductivity with frequency.

CONCLUSION:

Cobalt adipate single crystals were grown by the single gel diffusion technique and the effects of different parameters like pH, concentration of reactants, gel density and gel aging on the growth were discussed. It was found that experimental conditions, such as pH, density of gel, concentration of reactants and gel aging, have strong influence on the nucleation kinetics and growth of the crystals. From single crystal X-ray diffraction and powder X-ray diffraction studies the structure of the crystal is determined to be monoclinic. The FTIR and micro Raman studies confirmed the major functional groups in the crystal. The thermal decomposition pattern of the material suggests the different stages of degradation and the DSC curve confirms the presence of water molecules in the crystal lattice. The water of crystallization is completely lost well before the onset of anion decomposition. The dielectric constant is found to decrease with frequency, attaining a constant value at higher frequencies.

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20. Synthesis of blue light emitting 5-carboxylicacid-2-arylsubstituted benzimidazoles as photosensitizers for dye-sensitized solar cells

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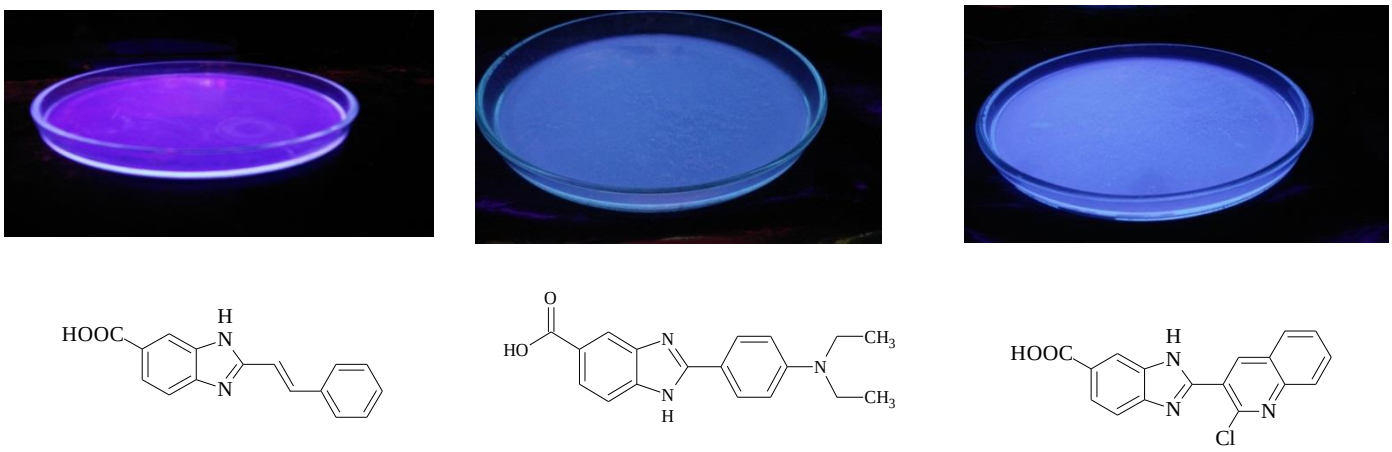
A series of 5-carboxylicacid-2-arylsubstituted benzimidazoles (**3a-c**), were synthesized by one pot reaction of 3,4-diaminobenzoic acid and various substituted aryl aldehydes . The synthesized compounds (**3a-c**) were confirmed by

the spectral characterization (IR, ^{1}HNMR), and their photophysical properties such as Photoluminescence. Among the tree dyes, 3c dye containing quinoline as a donor, benzimidazole carboxylic acid shows higher efficiency (2.87%).

Keywords: Benzimidazole derivatives, Photoluminescence, 3,4-diaminobenzoic acid, DSSC,



21. Nano-comb backcontact design of Cadmium sulphide (CdS)/ Cadmium telluride (CdTe) thin film Photovoltaic (PV) cell with ATLAS SLVACO simulation

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Texturing the surface of thin film PV cell, has generated enormous attention in PV technology, due to its property of enhanced light absorption. In thin film PV cell, the major gap for optimization is to increase the absorption of incoming photons before it gets reflected back to the atmosphere. This work demonstrates a novel way to fabricate thin film CdS/CdTe PV having nano-comb backcontact pattern (Fig.1), designed using electron beam (E-beam) lithography; the contacts are at the bottom of the heterostructure PV to reduce the reflection of light caused due to the top contact. The deposition technique used is RF magnetron sputtering of CdS/CdTe on a patterned PV cell using E-beam lithography process. Furthermore, the physical, optical and chemical properties of the CdS/CdTe films are investigated for optimising the material properties. In this work, CdS is the window layer with a wide band gap of 2.45 eV and the absorber layer is CdTe with a band gap of 1.45 eV. The contact material used is Gold (Au) for both the semiconductor materials. The current generated during the separation of opposite charges, drive the electrons through the external circuit. By texturing the surface of the PV, the junction area which is formed at the interface of CdS/CdTe thin films increases, providing enhanced ways of light absorption. The line width of textured nanowall and the gap between each wall is 130 nm. The result of this work will help to find a way for next generation solar cell architecture, the need to texture the surface of the thin film PV cell and the importance of placing both top and rear contacts at the bottom. Along with the fabricated structure, the Atlas Silvaco simulation results are with similar nano-comb device structure (Fig.2) for theoretical investigation.

22. Synthesis and Characterization of Hetro-junction Cu-Se Nanowires

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Nanoscale one-dimensional structures like, nanowires, nanobelts, nanotubes, nanoribbions, nanowhiskers etc. have stimulated great interest due to their wide-ranging functionality in scientific and technological areas. The nerve of exceptionality of the nanowires originated in their two dimensional confinement that leaves only one degree of freedom for the transportation of the charge carriers. This confinement enables the high carrier mobility and an expected resistance owing to scattering from surface and boundaries imperfections. Nanowires attracted those who

seek to design the nano-devices for potential applications in various areas such as nanoelectronics, biotechnology solar cell and among others. A wide range of nanowires exist, including metallic, semiconducting; single, binary or ternary compounds, hetrojunction/metal-semiconducting junctions, nitrides, carbides, insulating and molecular nanowires.

Template synthesis approach entails the fabrication of a variety of nanostructures of desired morphology. The template serves as a scaffold against which materials with acquired morphology are synthesized. The pores of templates are filled with different methods such as sol-gel, electrodeposition or other chemical methods. Among these, electrodeposition is a simple, convenient and versatile technique to synthesize the nanostructures using templates. Electrodeposition is most widely used procedure due to numerous advantages viz. higher deposition rate, low cost, ability to produce nanostructures with feature size and more.

Synthesis of the copper (Cu) nanowires was carried out via template-assisted approach using SP-240 potentiostat. The polycarbonate membranes of different pore diameters 50, 80, 100 and 200 nm and 10 μm thickness were used for the deposition. The same composition of the electrolyte ($CuSO_4.5H_2O$) was used for the synthesis of all the diameter nanowires. The experiment was carried out for 15, 18, 19 and 20 minutes for nanowires of diameters 50, 80, 100 and 200 nm respectively. Deposition potential was optimized with the help of cyclic voltammetry. In cyclic voltammetry, working electrode potential was linearly scanned at a constant rate with respect to reference electrode and provides the optimum deposition potential (0.37 Volt) corresponding to maximum cathodic current. Copper nanowires were characterized to investigate the morphological, structural and electrical properties of the nanowires.

Fig. 1 is shown the artifact of copper nanowires of diameters 50, 80, 100 and 200 nm. Copper nanowires have the cubic lattice geometry with lattice parameter 3.608, 3.618, 3.61 and 3.62 Å for 50, 80, 100 and 200 nm diameters, which is in good agreement with the 3.615 Å as mentioned in standard database (JCPDS). An interesting aspect came into picture from the comparative analysis of XRD spectra that for low diameter nanowires, the growth of the planes increases along a particular direction {400}. This growth gave strength to anisotropic nature of the nanowires due to strong bonding of the neighboring atoms with same helical chain. The combined I-V characteristics (IVC) of the different diameter nanowires sustained the ohmic and symmetric nature, while the slope declined as we approach towards low diameter (Fig. 2).

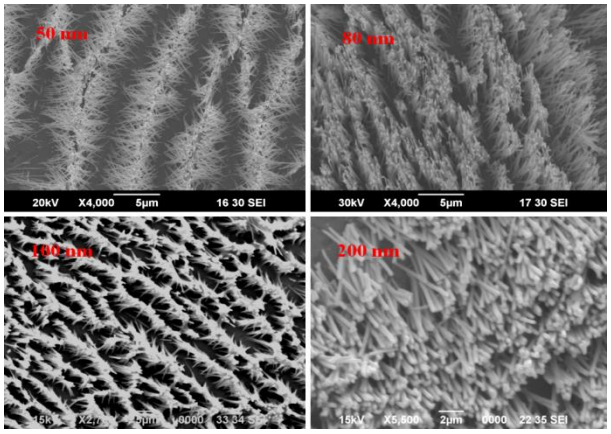

Fig1: SEM image of Cu nanowires

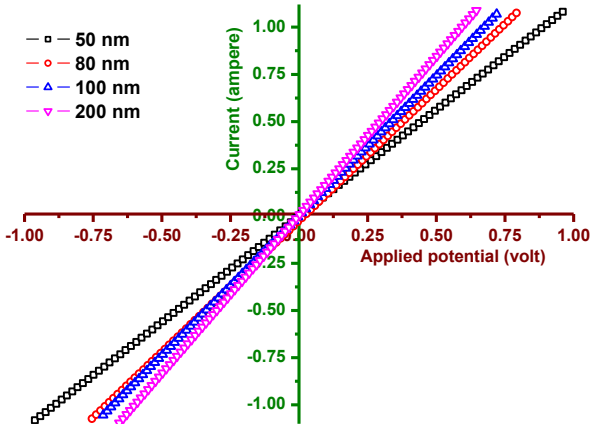

Fig2: IVC of different diameter Cu nanowires

Synthesis of Cu-Se hetero-junctions of 50 and 80 nm diameter was done with PC controlled potentiostat and a three electrode set-up. The copper wire segment was deposited using electrolyte consisting of $CuSO_4.5H_2O$ and dilute H_2SO_4 at room temperature, and a potential difference of 0.4V was applied. During the electro-deposition process, we record the current as a function of time. When the pores of membrane were approximately half-filled up with copper metal the electrolyte was exchanged with second electrolyte consisting of SeO_2 and Boric acid. A potential of 1V was applied for 5 minutes and deposition of selenium nanowires over copper nanowires takes place. SEM images of deposited hetrojunction reveals a parallel alignment of approximately equal wire length. Current voltage characteristic was recorded with the help of Ecopia probe station and Keithley source meter, and shows increase in current with increase of voltage, in both forward and reverse direction.

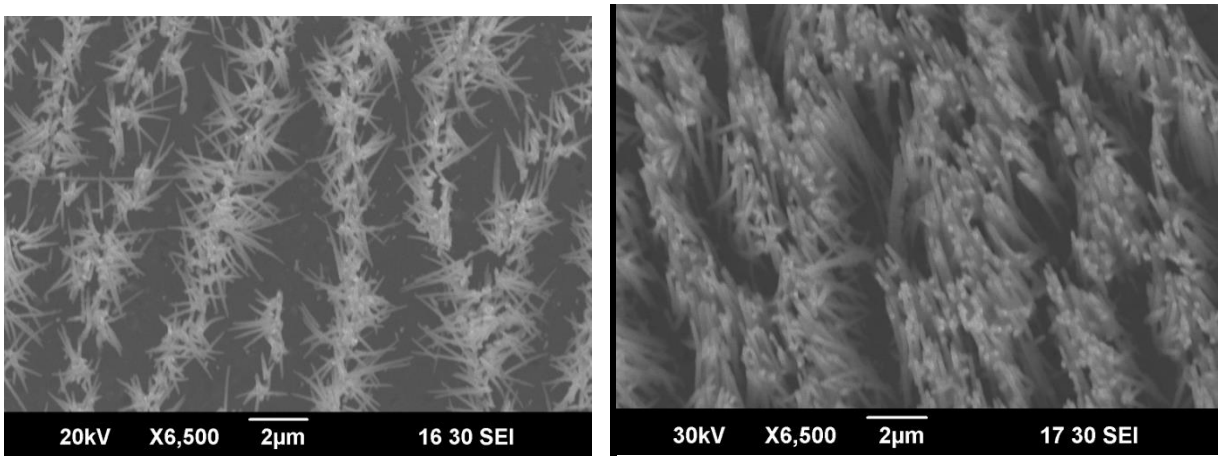

Fig3: SEM image of Cu-Se hetero-junctions of 50 and 80 nm diameter

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23. Effect of Cross linking on the toxicity of CdTe QDs in solid/ liquid medium

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Highly luminescent GSH capped CdTe quantum dots (GSH-CdTe QDs) were prepared through a facile microwave (MW) aided wet chemical method. The GSH-CdTe QDs were water soluble and biocompatible. The higher intensity of Photoluminescence (PL) emission can be attributed to the highly crystalline structures of crosslinked GSH-CdTe quantum dots (cGSH-CdTe QDs) observed in the X-ray diffraction (XRD). The cell death experiment shows that cross linking effectively controls the toxicity of CdTe QDs both in liquid and solid media which makes them suitable for biomedical application. Toxicity control was attributed to the effective surface passivation through cross-linking the GSH shell with 1-ethyl-3-(3-dimethyl aminopropyl carbodiimide hydrochloride/N-hydroxysuccinimide (EDC/NHS).

24. 3D printing based Rapidly Prototyped Membraneless Microfluidic Enzymatic Biofuel Cell

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Today the sustainable and qualitative electrical power is the crucial factor in any electronic devices. In portable and implantable devices, such requirement is even more essential, which can be provided by the Enzymatic Biofuel Cell (EBFC) as well. In EBFC, glucose is oxidized at the anode side and an oxidant such as O_2 is reduced at the cathode side, leading to the generation of potential between the electrodes. Due to its biocompatibility, normal operating conditions and high enzyme selectivity, EBFC can be implanted in small-powered medical devices such as pacemaker, insulin pump and brain simulator. However, to integrate with the existing micro-electronics devices, EBFC need to be miniaturized without compromising in their power output. Membraneless Microfluidics Enzymatic Biofuel Cell (M-MEBFC) is not only prone to be miniaturized, but provide multiple advantages, such as possibility to avoid membrane, requirement of sufficiently less electrolyte, material compatibility and higher power densities. In this study, a novel rapid fabrication methods for M-MEBFC is proposed, where the electrodes are fabricated with graphene on both sides of a Y-shaped microfluidic channel using a 3D printer to reduce the complex fabrication time and cost. The electrodes are fabricated using various nanomaterial (MWCNT) to attain higher efficiency, and immobilized with appropriate enzymes for redox reaction. The device characterization, in terms of electron microscopy, and electrochemical analysis, in terms of cyclic voltammetry (CV), open circuit voltage

(OCV), chronopotentiometry (CP) and chronoamperometry (CA) will be presented. Further, results from the overall device testing will also be discussed.
Keywords: Enzymatic biofuel cell, Microfluidics, Membraneless biofuel cell, Carbon nanotube, Graphene.

25. Towards Automated Paper based Microfluidic Viscometer for Biochemical Applications
Puneeth S B, Abyn Mathew Scaria, Sai Ram Manoj Isukapalli, Abyn, Prakash Rewatkar and Sanket Goel, Department of Electrical and Electronics Engineering, BITS Pilani, Hyderabad Campus

Viscosity is one of the primary characteristics of any fluid. Its variation becomes a monitoring and sensing parameter in diverse applications, such as biochemical, biomedical, energy etc. Mathematically, quantitative relation between sheer stress and sheer rate gives the viscosity of a fluid. Even though, several benchtop systems are available to measure fluid viscosities, they lack in terms of optimum accuracy, cost and time. Such limitations lead towards the development of microfluidic devices. So far, such devices have been fabricated using material, such as silicon, glass, PDMS etc, using approaches, such as photolithography, soft-lithography, hot-embossing etc. While, microfluidic viscometer gives much higher limit-of-detection and range-of-detection, but due to the complicated fabrication process, they are beyond commercialization. Newer approaches, such as 3D printing and paper-based devices, open the door to eradicate such challenges while incorporating all the microfluidic principles with rapid fabrication methods. This work presents development of paper-based microfluidic viscometer and its application to monitor adulterants in milk. Capillary action is observed in paper which makes the fluid to flow without any external force. Using microfluidic concept, from the time taken to travel during the known length of the paper based channel viscosity was calculated. Experiment was performed using the liquids with known viscosity, which gave expected results at room temperature. Future scope of the work is to make a non-optical method, to realize a handheld and fully automated device to obtain results in real time free from lab environment.
Keywords: Paper-based microfluidic devices, Viscometer, Capillary action, Optical Detection

26. The Structural and Optical study on $Mn_{1-x}Cu_xFe_{1.85}La_{0.15}O_4$(x=0.2, 0.4, 0.6, 0.8 and 1) Nanoferrites
R. Rajesh Kanna, N. Lenin, M. Sivabharathy and K. Sakthipandi*, Department of Physics, Sethu Institute of Technology, Kariapatti 626 115, Tamil Nadu, India, *E-mail of corresponding author: sakthipandi@gmail.com

The spinel ferrites are very interesting to a lot of researchers in the world. Due to these materials exhibit good electrical, magnetic, thermal and optical properties. The nanoferrite materials have different physical and chemical properties which gives more advantages than the bulk ferrites. These materials have been employed in several applications such as microwave devices, antenna rods, recording heads, magnetic media, sensors, ferrofluid and opto-electronics. The rare earth oxides are becoming assures additives to get better magnetic and electronic properties due to its great ionic radii and restricted 4felectrons. It also has high electrical resistivity with excellent electrical insulators. The rare earth material lanthanum doped nanoferrite has involved immense attention by virtue of its broad applications in magnetic and electronic materials. The properties of manganese ferrites ($MnFe_2O_4$) depend upon the doping concentration, the nature of the doping and the method of preparation. The Cu^{2+} ion substituted to nano ferrites, there is an effect on electrical, structural and optical properties. It can be examined widely, Due to their potential significance as electronic materials, microwave and catalysts. Spinel structure of $Mn_{1-x}Cu_xFe_{1.85}La_{0.15}O_4$ (x=0.2, 0.4, 0.6, 0.8 and 1) nanoferrites were prepared by the sonochemical method. Because of, the sonochemical method overcomes the non-uniform particle size, high temperature; long processing time and contamination through impurities. In this process, nitrate materials were used as source materials. Initially, the nitrate materials were dissolved in deionized water and applied to the sonication process. The temperature of the sonication was kept constant at 80°C.Then, the pH value of the solution was adjusted to ~7 by NaOH was added drop-wise in the prepared solution while stirring at ambient temperature. After these processes, the solution was allowed to dry in a hot air oven at a constant temperature of 80°C for 24h. The residue formed was collected and then calcinated in air at 400°C for 3h. The obtained powder was sintered at 1000°C for 24h in atmospheric air. The prepared nanoferrites are characterized by X-rays diffraction (XRD), X-ray photoelectron spectroscopy (XPS), infrared spectroscopy (IR), ultra violet (UV) spectroscopy and scanning electron microscopy (SEM-EDS). The formation of single phase cubic spinel structure, average crystallite size (25-50 nm) and macrostructure were analyzed through XRD and SEM. The results of Fourier transform infrared (FT-IR) spectra showed the presence of wave numbers correspond to octahedral (450 cm^{-1}) and tetrahedral (537, 588 and 700 cm^{-1}) site of nanoferrites. The stoichiometric ratio, oxidation state and binding energy of the nanoferrites are obtained by XPS. The intensity of XPS peak varied with increase in Cu^{2+} content and decrease in Mn^{2+} content. The absorption wavelength of nanoferrite was acquired from UV- Vis diffuse reflectance spectrum (DRS). The optical bandgap energy values

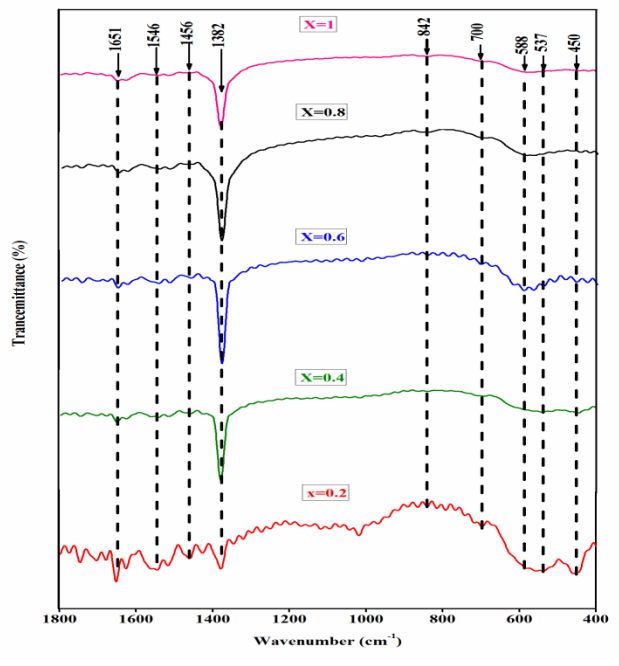
(5.23-5.42 eV) of the nanoferrites were examined from the observed wavelength (228-237 nm). The composition and data of the results are given in below table and figure.

Keywords: Nano Ferrites, Sonochemical, XPS, Optical bandgap

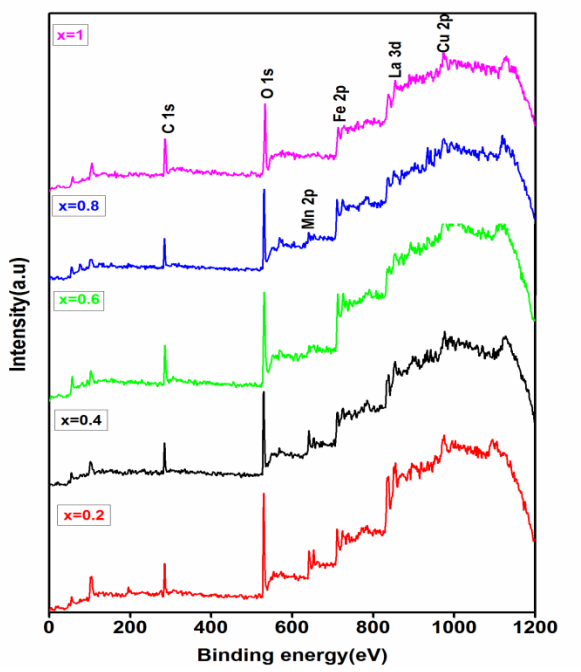
Table: XRD, UV and SEM Details of prepared nanoferrites

Samples	Crystallite size (nm)	Surface morphology	Absorption Wavelength(nm)	bandgap (eV)
$Mn_{0.8}Cu_{0.2}Fe_{1.85}La_{0.15}O_4$	56.28	spherical	228	5.42
$Mn_{0.6}Cu_{0.4}Fe_{1.85}La_{0.15}O_4$	42.02	spherical	231	5.36
$Mn_{0.4}Cu_{0.6}Fe_{1.85}La_{0.15}O_4$	40.49	spherical	233	5.30
$Mn_{0.2}Cu_{0.8}Fe_{1.85}La_{0.15}O_4$	38.95	spherical	235	5.27
$Mn_0Cu_1Fe_{1.85}La_{0.15}O_4$	25.95	spherical	237	5.23

Figure: FT-IR and XPS Spectra of prepared nanoferrites



FT-IR Spectra of prepared nanoferrites



XPS Spectra of prepared nanoferrites

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27. Synthesis of Ag deposited ZnO Nanorods by Hydrothermal method for Hydrogen Production

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In the present work, crystalline and one-dimensional ZnO/Ag nanorods were synthesized by hydrothermal process with zinc acetate as the precursor. The most important benefit of this procedure is the use of water as the solvent cheaper and more environmentally friendly than other chemical solvents. The as-synthesized ZnO/Ag nanorods have diameters of 40–200 nm and lengths up to 5 μm. X-ray powder diffractometry (XRD), FESEM, transmission electron microscopy (TEM) and selected area electron diffraction (SAED), Photoluminescence (PL), DRS, SAED and Fourier transmission infrared spectroscopy (FTIR) were used to characterize the structural and the chemical features of the ZnO nanorods and nanorods exhibited much higher catalytic efficiency for the hydrogen production from water splitting.

Key Words: ZnO Nanorods, SEM, TEM, FTIR, DRS, PL, SAED and Water Splitting etc.

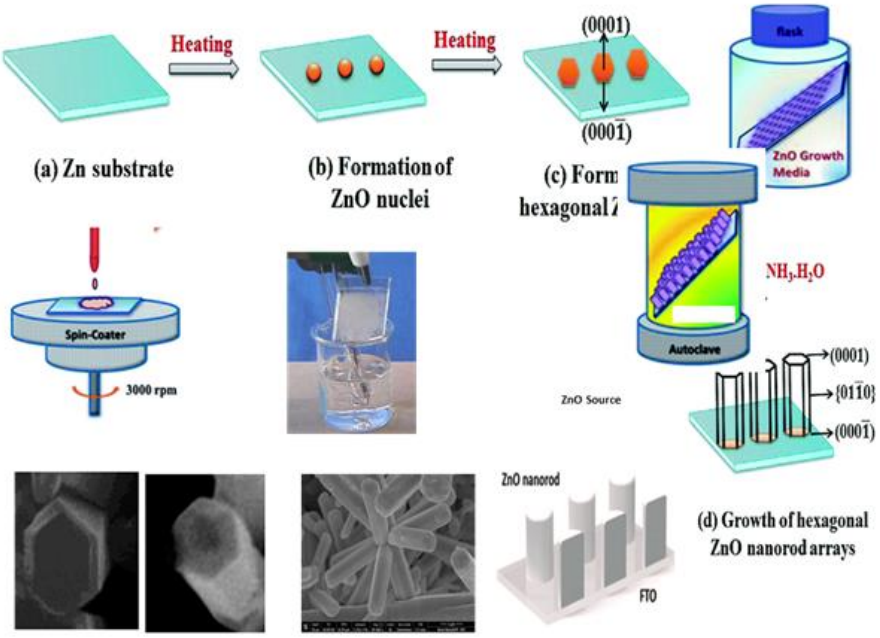

Figure: Synthetic Routes of ZnO Nanorods by Hydrothermal method

28. Materials Synthesis and Characterization

Ramavenkateswaran Nagarajan, R. V. College of Engineering, Bengaluru, KA

Large Area and Flexible Microelectronics (LAFM) or Macroelectronics is expected to be one of the key enablers of the “More Than Moore” (MTM) with market expected to cross a few trillion dollars in the coming year. Emerging new amorphous and nanomaterials, Organic materials, and metal oxide or nitride based semiconductors grown using existing and novel process technologies , and the associated devices, circuits, and systems based on them, on flat and flexible substrates with development of new architectures, which are affordable and scalable for consumer electronics, information systems and wearable electronics makes this domain very interesting. Thus also provides scope of innovation and new knowledge creation.

The current semiconductor technologies are predominantly based on manufacturing grade pure crystalline silicon(c-Si) and in some cases III-V compound semiconductors. However the materials have limitation with respect to large area flat and flexible substrate, due issues of purity, maintaining crystalline structure over larger area, and higher temperature fabrication process unsuitable for low melting point substrates like glass or polymer, ceramic and fabric type substrates. Hence there is the requirement for alternate material for large area and flexible electronics .Many non crystalline materials are being studied like amorphous silicon (a-Si:H), metal oxides, diamond like carbon and organic semiconductors. However these materials have their own limitation like mobility, high temperature process, stability and reliability.

Recently there has been great interest in carbon based materials like CNT, Graphene, Nanocrystalline graphite, Nano diamond, fullerene and nanocluster carbons. However most of them are grown using high temperature process and hence not very relevant to Large area applications. Hence in this thesis, it is proposed to work on a novel low or room temperature grown material referred to as Nanocluster carbon (NCC) using cathodic arc and possibly also using plasma CVD.

Feasibility study of NCC TFT [6] shows that when temperature then dark conductivity decreases one to two order. When He Pressure increases then conductivity two orders at fixed temperature (3.2 *1000 /T (K)).Results shows that conductivity of deposited NCC film depends on amount inert gas pressure. But proper understanding of conductivity, cluster size and partial pressure are yet to be established. Raman Spectroscopy results shows broad D Peak which corresponds to amorphous nano structured carbon .Through simulation Silvaco ATLAS[26] the drain current increases by ~6.5 orders of magnitude for Top gate structure and ~5 orders of magnitude for inverted gate structure. The understanding of drain current with respect to different structure and validity with experiment are yet to be established. The cluster size varies from 10-20 nm with He Partial pressure from 5 x 10-4 to 50 Torr and N2 partial pressure from 10^{-4} Torr to 10^{-3} Torr [1]

Most of the present fabrication processes are high temperature processes (between 500 -1200OC).

So it's unsuitable for flexible substrate. The NCC fabrication in relatively low temperature is useful for thin film flexible substrate. This process leads to high density films on any non-epitaxial substrates like glass, ceramics, metals and plastics. Even though the NCC is used as semiconducting layer for thin film transistor is reported, the defect density of states and transport properties are yet be ascertained. The repeatability of NCC layer and fabrications of different components like capacitor, resistor are to be obtained by sandwich and/or co-planar configuration.

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29. Hybrid YAG:Ce nanophosphor for tunable white light application

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Cerium doped Yttrium Aluminum Garnet (YAG) nanophosphors are well known as phosphor materials for white LEDs. The nanophosphor also possesses superior optical performance and good thermal conductivity. In the present work, we have synthesized hybrid materials (YAG:Ce@DBM and YAG:Ce@TTA) consisting of YAG:Ce nanophosphor and organic sensitizers namely, 2-Thenoyltrifluoroacetone(TTA), Dibenzoylmethane (DBM). We have synthesized YAG:Ce nanophosphor using different synthesis methods including solid-state reaction, co-precipitation, and hydrothermal methods. A comparative study between the synthesized hybrid materials and YAG:Ce nanophosphors were made using a combination of different analysis techniques like X-ray diffraction, Scanning electron microscopy, FT-IR, UV-Visible-Infrared absorption, Photo-luminescence, techniques etc.
In comparison to the other synthesis methods, highly intense and sharp Bragg's peaks were observed in the XRD pattern when nanophosphor was synthesized by Co-precipitation method. Bragg's peaks clearly indexed to the pure cubical YAG phase and in good agreement with JCPDS Card No. 75-1853 [Fig. 1]. The average crystalline size was found to be 16±2 nm and 17 ± 2 nm for the YAG:Ce nanophosphor synthesized by co-precipitation and hydrothermal method, respectively. The different concentration of cerium in YAG and different annealing temperature dependent analysis has been carried out and optimized concentration and annealing temperature was found at 1 mol % and 1100 ^{0} C [Fig. 2]. The formation of a unique environment surrounding the YAG:Ce nanophosphor leads to increased the emission intensity of the hybrid YAG:Ce@DBM and YAG:Ce@TTA. In the hybrid materials, considerable effect of TTA, DBM was noticed on the emission intensity of YAG:Ce nanophosphors. The luminescence intensity of YAG:Ce@DBM and YAG:Ce@TTA nanophosphor enhanced significantly, after modified with organic sensitizers almost by a factor of about 14% and 15% than that of YAG:Ce nanophosphor. Detail of the other result will be discuss during presentation.

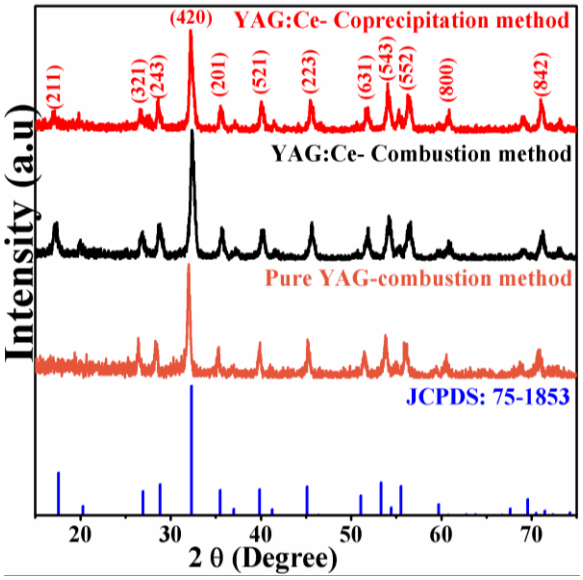

Fig. 1: X-Ray diffraction patterns of YAG:Ce synthesized by different method.

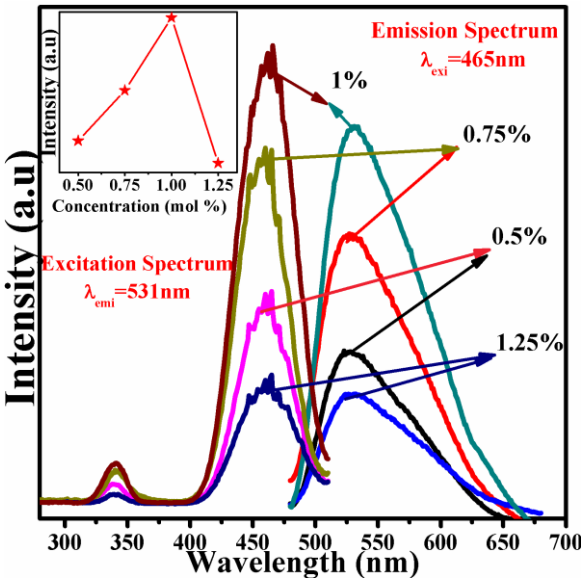

Fig. 2: PL Spectra of YAG:Ce nanophosphor at different concentration of Ce^{3+} ion.

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30. Fabrication of blue organic light emitting diodes (OLEDs) using bisimidazolylphenol Zinc(II)metal complex for solid state lighting

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Organic light-emitting diode (OLEDs) displays are a promising new display technology that possesses advantages such as thinner and flexible displays, lower power consumption, and a wider viewing angle. The materials used in OLEDs produce a high fluorescence with a small voltage which makes them more efficient than current display technology. In this study, we report the synthesis of self light emitting 2-[1-(4-butylphenyl)-4,5-diphenyl-*1H*-imidazol-zyl]phenol and and its its zinc complex bisimidazolylphenol Zinc(II)metal complex as blue fluorescent materials for non-doped electroluminescent devices. The formation of metal complex was confirmed by IR, ^{1}H NMR, mass, powder XRD, TGA analysis. Furthermore, a detailed experimental has been performed to understand the effect of functional groups on optical, thermal and electrochemical properties of bisimidazolylphenol Zinc(II)metal complex. These materials exhibit a deep blue emission of 200 cd/m^2 was obtained from device I made of bisimidazolylphenol Zinc(II)metal complex. The J-V-L characteristics and electroluminescent (EL) spectra, we conclude that direct trapping of holes and electrons and subsequent formation of the excitation occur on the dopant, leading to high quantum efficiencies at low current densities. These results show that fabricated OLED devices can successfully emit saturated blue light and can be used in applications such as opto-electronic OLED devices, displays and solid state lighting technology.

31. Fungal Extract Mediated Functionalization of Cerium oxide with silver nanoparticle

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At the advent of nanotechnology, engineered nanomaterials (ENMs) from metal oxides (e.g., TiO_2, FeO_2, CeO_2) have found application in various fields (chemical industries, the automobile sector, environmental remediation, and food and cosmetic industries). Recently, the metal oxide nanoparticles can open up new vistas in medicine and biotechnology too. Most recently, cerium oxide nanoparticles (nanoceria) have been employed as potent free-radical scavengers with neuroprotective, radioprotective, and anti-inflammatory properties. Cerium is a rare earth element of the lanthanide series which has the ability to switch oxidation states between Ce^{3+} and Ce^{4+} is crucial for many nanobiomedical applications. In the present study, a biogenic eco-friendly and simple method of synthesizing silver nanoparticle and their in situ deposition over the cerium oxide surface will be described. The AgNP: CeO_2 nanoparticle will be analysed by Transmission Electron Microscopy (TEM), X- ray diffraction (XRD) and Scanning Electron Microscopy (SEM). The fabricated functional AgNP: CeO_2 nanoparticles will be explored for its antimicrobial and antioxidant activities.

Key words: Fungal Extract; Bioreduction; Silver Nanoparticles; Antioxidant; Antimicrobial

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32. Plant Gum as Efficient Fuel in Combustion Process for the synthesis of Metal Oxide Nanostructures

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Metal oxide nanostructures have been explored extensively due to their unique physicochemical properties, which can be precisely tuned by manipulating the size, shape, chemical composition and coordination. A wide range of physical and chemical processes have been explored for the synthesis of metal oxide nanostructures. As the global demand expands for the sustainable green alternates in materials manufacturing, bio inspired processes for the synthesis of various nanostructured materials have been explored extensively in recent years including metal oxides. In the present work, plant (Albizia lebbeck (L.) Benth.) gum assisted soft combustion process was newly explored for the synthesis of $ZnFe_2O_4$ nanoparticles. Plant gum play vital role as an effective chelating agent for $Zn^{2+}$and Fe^{3+} ions, which enables the uniform distribution of metal ions throughout the gum matrix and it was identified by FTIR and SEM- EDX analysis. Thermal decomposition of the dried gel results in the formation ultrafine $ZnFe_2O_4$ nanoparticles as low as 700 ^oC. FTIR and XRD analysis confirms the formation of phase pure $ZnFe_2O_4$ nanoparticles without any organic residues. TEM investigation identified the formation of poly dispersed $ZnFe_2O_4$ nanoparticles with the size range between 15- 50nm.

Key words: Plant gum; Combustion Synthesis; Zinc Ferrite; Magnetic Materials

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33. Effect of high dose Gamma irradiation on Electrical Properties of CdTe/CdS Solar Cells

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The effect of Co-60 gamma irradiation on electrical characteristics of CdTe/CdS solar cell fabricated using the close spaced sublimation (CSS) process has been analyzed using in-situ current-voltage characterization (I-V) and capacitance-voltage (C-V) measurements. The irradiation was done over a wide range of doses from 1kGy to 100 kGy. Electrical parameters such as ideality factor (n), series resistance (R_S) and reverse bias leakage current (I_R) for each dose have been calculated from the I-V characteristics. The ideality factor of the pristine solar cell is found to be 1.80 and it gradually increased up to 3.38 for the dose of 10 kGy, then it is around 3.38-3.61 for higher doses up to 100 kGy. The I-V characteristics showed significant increase in forward bias and drastic increase in reverse leakage current. The value of I_R is 0.168 nA for pristine solar cell and it increases to 14.6 nA for 10 kGy. Further there is four times observable change in the value of I_R. However the value of R_s is 8.4 ohm for pristine and continuously decreases to 5.76 ohm for 100 kGy dose. Recombination-Generation (R-G) centers in the CdTe/CdS may be the main reason for the increase in leakage current and the higher values of ideality factor are attributed to activation of multiple transport mechanisms including multistep tunneling due to gamma irradiation. C-V analysis gives the doping profiles and the traps level distribution in the absorber material. It is found that carrier concentration continuously increases from 1.02 x 10^{11} cm^{-3} for pristine to 51.62 x 10^{11} cm^{-3} for 100 kGy dose of gamma radiation and built in potential (V_i) decrease from 0.84 V for pristine to 0.39 V for a dose of 10 kGy and then drastically increases to 7.72 V for a dose of 100 kGy. The results show significant change in the carrier transport and doping profile at higher level and stability for lower doses of Co-60 gamma irradiation. At lower doses the built in potential is nearly remain constant therefore, no major change has taken place in the depletion region . Whereas for higher doses there are significant increase in the built in potential which attribute to increase in the depletion region. This indicates that at lower doses most of primary defects produced by Co-60 gamma irradiation might have recombined before they can form stable complex defects and at higher doses primary defects produced by Co-60 gamma irradiation might have form stable complex defects.

Keywords: CdTe; Gamma Irradiation; Solar cells; Space application; Radiation hardness.

34. Effect of pH on the optical and electrochemical properties of SnO_2 nanostructures

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Nanosized metal oxides have been the subject of focused research due to their unique electronic, optical, mechanical, magnetic and chemical properties. Amongst all the metal oxides such as CuO, SnO_2, NiO, TiO_2, ZnO

etc, SnO_2 is interesting because of its n-type conductivity with a room temperature wide and direct band gap (3.6eV). It is used extensively in many devices due to its good biocompatibility, high electron mobility, large specific surface area, good thermal stability and low toxicity. These properties make it a promising material for plethora of applications such as dye-sensitized solar cells, gas sensors, photocatalyst, liquid crystal displays, optoelectronic devices and so forth. In the present work, we have synthesized SnO_2 nanostructures by co-precipitation method at different pH values (3-13) and studied their structural, optical and electrochemical properties. The samples were characterized by using XRD, UV-Visible and Photoluminescence (PL) Spectroscopy and Cyclic Voltammetry. The X-Ray Diffractometer (XRD) is used to analyze the structural properties of the crystalline sample. The XRD results reveal presence of tetragonal crystal structure of SnO_2 nanostructures (Fig.). The electrochemical properties were measured by cyclic voltammetry. A typical cyclic voltammogram depicts the current resulting from an applied potential.The optical properties of the nanostructures were studied using the UV-Visible and Photoluminescence spectroscopy at room temperature. The energy band gap of SnO_2 nanoparticles is found using UV-Visible Spectrophotometer. The PL spectra were observed for different excitation wavelengths.

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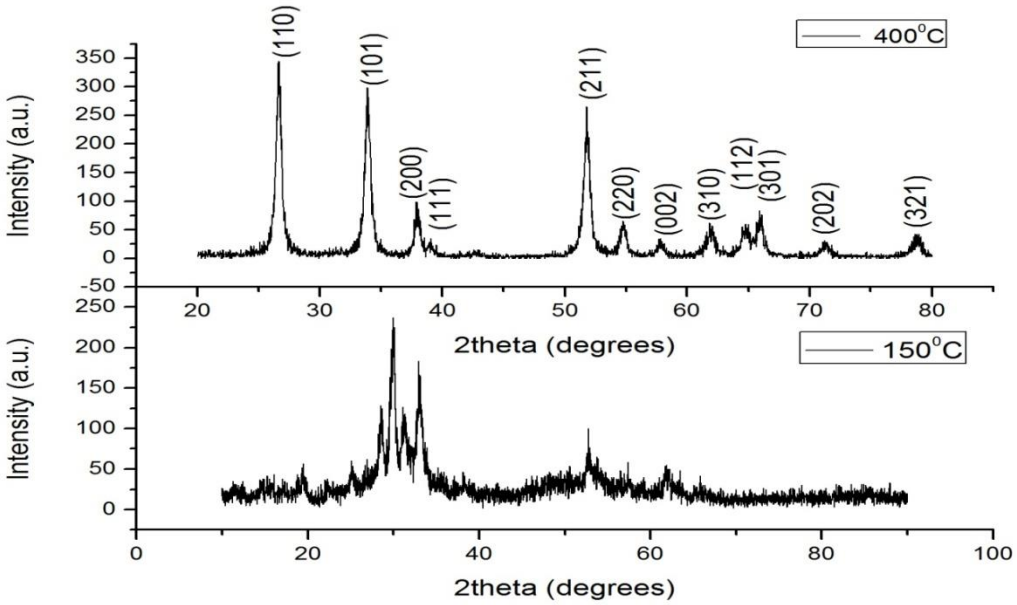

Fig.: XRD spectra for SnO_2 NPs at pH-3

35. Irradiation effect on the properties of Nanowires

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Preparation of low-dimensional materials attracts more and more interest in the last few years, mainly due to their large applications in the field of life science, medicine, biotechnology, communications and electronics.1D systems are the smallest dimension structures that can efficiently transport charge carriers in one directionand are thus expected to be critical to the function and integration of nanoscale devices. Nanowires with well controlled morphology and extremely high aspect ratio can be obtained by the filling of cylindrical pores of polycarbonate membrane. Ion beam irradiation is a unique tool for engineering the properties of nanowires. During the passage of material, energetic ions lose their energy mainly through inelastic collisions with the atomic electrons. Irradiation of materials at high energies gives rise to structural and electrical modifications. In the present study, Selenium and

Copper nanowires were synthesized potentiostatically via template method. These synthesized nanowires were then irradiated with different ions at Inter University Accelerator Centre, New Delhi, India. Structural, morphological, and electrical characterizations were made in order to analyze the effect of irradiation on the synthesized nanowires.

Lithium Ion Irradiation of Selenium Nanowires:

Selenium nanowires were irradiated with 10 MeV Li^{3+} ions for different fluences ranging from 1×10^{11} to 1×10^{13} ions/cm^2.Comparison of XRD spectra for irradiated and pristine nanowires reveals no peak shifting but a variation in peak intensity was observed. IV characteristic of pristine and irradiated nanowires was recorded in voltage range -3V to +3V. For pristine nanowire the I–V characteristics display almost symmetric and nonlinear behavior, however an increment in current with increase in ion fluence up to 1×10^{12}ions/cm^2 was observed.On the other hand at higher fluence (5×10^{12} and 1×10^{13} ions/cm^2) a decrease in current was observed fig.1.

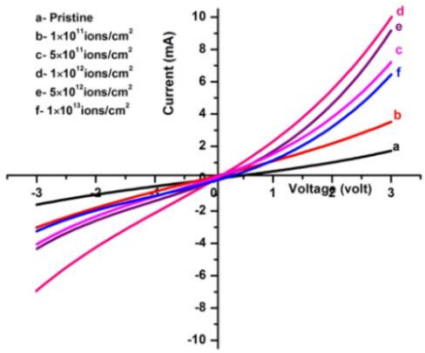

Fig. 1: IV Characteristics of pristine and irradiated selenium nanowires

At higher fluence irradiation, induced defects and grain fragmentation dominates due to which decrease in grain size takes place, due to which decrease in current takes place.

Nickel Ion Irradiation of Selenium Nanowires:

Irradiation of Senanowireswith 80 MeV Ni^{6+} ions was done for different fluences ranging from 1×10^{11} to 1×10^{13} ions/cm^2. I-V characteristicsof pristine nanowires trace almost symmetric and non-linear nature. After ion irradiation, a variation in the current was recorded with the increase in fluence. With the passage of energetic ion through a material, generation of charge carrier and formation of intermediate energy state in the forbidden energy band is a common phenomenon, which results in the band gap reduction. This trimming of band gap modifies the barriers height.XRD spectra of pristine and irradiated nanowires reveals no peak shifting but a significant change in there intensities was observed.

Gamma Irradiation of Copper Nanowires:

Cu nanowires were irradiated with gamma rays using Co-60 source at Inter University Accelerator Centre, New Delhi, India for different dose 100,150,200 and 250 kGy. The structural properties of the pristine and gamma irradiated copper nanowires were examined by XRD using CuKα radiation. Observed XRD patterns matches with the standard JCPDS cards-04-0836(Cu) and it confirmed the cubic structure of copper nanowires. When XRD spectra of gamma irradiated nanowires were compared with the pristine case, it revealed no shifting in the "2 theta" position of the diffraction peaks. Hence, after irradiation, no modification occurred in the shape and size of the unit cell of copper nanowires. I-V characteristics of pristine and irradiated nanowires show significant change in the current with fluence.

Nickel Irradiation of Copper Nanowires:

160 MeV Ni^{+12} ion beam was used to irradiate the copper nanowires for fluence 1×10^{11}, 3×10^{11}, $1\times10^{12}$and 3×10^{12} ions/cm^2.

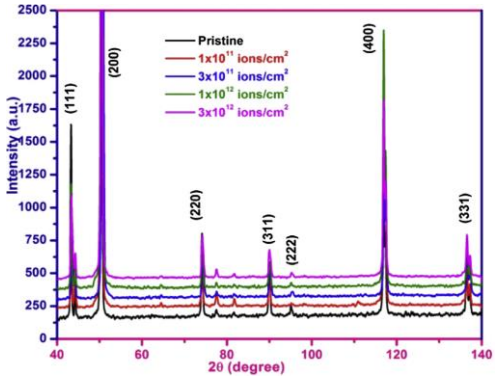

Fig. 2. XRD spectra of pristine and irradiated copper nanowires

Comparison of XRD spectra revealed no peak shifting fig.2. There was not much variation observed in the average grain size of the irradiated nanowires. A decrease in the conductivity was observed with fluence, but at last fluence, the conductivity of the nanowires increased with the applied voltage. Hence, in this case, applied potential also plays a significant role along with the fluence of the ion beam.

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36. Development of Low Fat, High Protein Butter Spreads as Health Food Using Fat and Protein Nano-particles

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Breakfast is the first and most important meal of the day. Spreads are the ready-to-eat foods which are very convenient for families where both are working and have very minimum time to cook and eat foods, especially in the morning time. But, these spreads often contain high fats which are of a major concern causing obesity and leading to hypertension in the long run. Nanotechnology offers to modify many of the macroscale characteristics of food, such as texture, taste, other sensory attributes, coloring strength, processability, and stability during storage, leading to a great number of new products. A typical product of this technology could be in the form of a low-fat nano-textured product that is as 'creamy' as the full-fat alternative and hence would offer a 'healthy' option to the consumer. With the above background, work was initiated to formulate butter spread with nano particles of protein and fat and with the feasibility of incorporating the same into the spread.

Experiments for preparation of the normal reference butter spread with varied fat contents were conducted keeping the moisture content same as that of butter (16%). The equipments like Universal Food Processor and Micronizer were used to prepare the spreads in the study. Different formulations were also prepared with the moisture content same as that of dairy spreads. Sensory evaluation study of the above formulations was conducted to know the optimum blend. The initial study revealed that the blend of 20 per cent protein as optimum and near to the control. The biggest problem faced during the use of the micronizer for preparation of the spread was the separation of the fat and moisture layer.

To understand the nature of the distribution of protein particles and to know the size of whey protein particles in their natural form, the whey proteins were dissolved in water to prepare a 5 per cent. The same was analyzed at CENSE lab, Indian Institute of Science (IISc), Bangalore. Particle size of the whey proteins were analyzed at CENSE lab, Indian Institute of Science (IISc), Bangalore. The results revealed that the particle size of the whey proteins were in the range of 185.8 nm to 216.8nm, with a mean diameter of 199.5nm. It was confirmed that 5% solution of whey proteins was naturally in nano size. Thus, it was decided to conduct further studies to analyze whey proteins at different concentrations for the particle size. The results revealed that the particle size of the whey proteins solutions were had a mean diameter of 118.2nm at 10% concentration, increased to 139.4nm, 250.5nm, 429.9nm, 868.0nm, 1781.5nm at 20%, 30%, 40%, 50% and 60%, respectively. From the results, it is confirmed that the solution of whey proteins are naturally in nano size even up to the level of 50%. Even up to 55% level, the mean diameter was observed to be 796.6nm. Thus, it was decided to use whey proteins at required concentration to get the suitable level of moisture in the formulated butter spread. The butter spread was prepared using Microfluidizer available at the Wood processing division, Institute of Wood Science and Technology, Bangalore. The butter and the various formulated products namely, butter, blend of butter and 10% WPC; blend of butter and 20% WPC; and blend of butter and 30% WPC with fixed moisture content of 50% were microfluidized at 20000 psi. The developed formulations were analyzed for particle size distribution and size of particles at IISc, Bangalore using equipments such as ZETAPALS. From the results of the study, it was inferred that the particle size of micro fluidized (@20k psi) butter had particle size with a mean diameter of 698.9nm. However, when WPC was blended to butter at 10%, the micro fluidized sample products had 16nm. This suggests that the characteristic emulsifying property of WPC being exhibited at 10% level. The formulation with the blend of butter and 20% WPC had the particle size with a mean diameter of 103.4nm, suggesting it to be the most suitable blend for the formulation in terms of uniformity of blending. However, further increase in the WPC in the blend to 30% with butter resulted in re-aggregation and change in the structure of the WPC, which completely separated out and also resulted in re-aggregation of fat as well. During this process, the particle size shifted from nano size to micron size to 8132.3nm (8.13µ). From the results, it is thus confirmed that the whey proteins (20%) that are naturally in nano size could be blended with butter to have moisture content of 50% in the final formulation and micro fluidizing the same at 20k would get reasonably a good formulation. However, further more studies are needed to confirm the repeatability and also the best suitable formulation for the butter spread.

Research outcome:

- ✓ Experiments for the preparation of normal reference butter spread with varied fat content are conducted with the moisture content same as that of butter (16%). The initial study revealed that the blend of 20 per cent protein as optimum and closer to the control. The biggest problem faced during the use of the micronizer for preparation of spread was the separation of the fat and moisture layers.
- ✓ The particle size of the 5% solution of whey proteins were in the range of 185.8 nm to 216.8nm with a mean diameter of 199.5nm, and it was confirmed that whey proteins are naturally in nano size. The particle size of the whey protein solutions had a mean diameter of 118.2nm at 10% concentration, increased to 139.4nm, 250.5nm, 429.9nm, and 868.0nm, 1781.5nm at 20%, 30%, 40%, 50% and 60% concentrations, respectively.
- ✓ The solution of whey proteins are naturally in nano size even up to the level of 50% and even at 55%, the mean diameter was observed to be 796.6nm. Thus, it was decided to use whey proteins at required concentration, to get the suitable moisture in the formulated butter spread.
- ✓ The butter and the various formulated products namely butter, blend of butter and 10% WPC; blend of butter and 20% WPC; and blend of butter and 30% WPC with fixed moisture content of 50% were microfluidized at 20000 psi.
- ✓ The particle size of micro fluidized (@20k psi) butter had a particle size with a mean diameter of 698.9nm. However, when WPC was blended to butter at 10%, the micro fluidized sample products had 16nm. This suggests that the characteristic emulsifying property of WPC exhibited at this 10% level.
- ✓ The formulation with the blend of butter and 20% WPC had a particle size with a mean diameter of 103.4nm, suggesting the most suitable blend for the formulation in terms of uniformity in blending. However, further increase in the WPC in the blend to 30% with butter, resulted in re-aggregation and changed structure of the WPC, which completely separated out and also resulted in re-aggregation of fat also.

The whey proteins (20%) that are naturally in nano size could be blended with butter to have moisture content of 50% in the final formulation and micro fluidizing it at 20k to get reasonably good formulation.

37. Fabrication of blue organic light emitting diodes (OLEDs) using bisimidazolylphenol Zinc(II)metal complex for solid state lighting

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Organic light-emitting diode (OLEDs) displays are a promising new display technology that possesses advantages such as thinner and flexible displays, lower power consumption, and a wider viewing angle. The materials used in OLEDs produce a high fluorescence with a small voltage which makes them more efficient than current display technology. In this study, we report the synthesis of self light emitting 2-[1-(4-butylphenyl)-4,5-diphenyl-1H-imidazol-zyl]phenol and its zinc complex bisimidazolylphenol Zinc(II)metal complex as blue fluorescent materials for non-doped electroluminescent devices. The formation of metal complex was confirmed by IR, ^{1}H NMR, mass, powder XRD, TGA analysis. Furthermore, a detailed experimental has been performed to understand the effect of functional groups on optical, thermal and electrochemical properties of bisimidazolylphenol Zinc(II)metal complex. These materials exhibit a deep blue emission of 200 cd/m^2 was obtained from device I made of bisimidazolylphenol Zinc(II)metal complex. The J-V-L characteristics and electroluminescent (EL) spectra, we conclude that direct trapping of holes and electrons and subsequent formation of the excitation occur on the dopant, leading to high quantum efficiencies at low current densities. These results show that fabricated OLED devices can successfully emit saturated blue light and can be used in applications such as opto-electronic OLED devices, displays and solid state lighting technology.

38. Engineered Graphene Flakes: A Concise Overview on Unique Characteristics

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Today graphene is one of the most exciting materials being investigated not only due to intense academic interest but also with its potential applications in mind. Graphene is the "mother" of all graphitic forms including 0-D: bucky balls, 1-D: carbon nanotubes and 3-D: graphite.1,2 Graphene has fascinating properties, such as anomalous quantum Hall effect at room temperature, an ambipolar electric field effect along with ballistic conduction of charge carriers, tunable band gap, and high elasticity. The lack of a suitable environmentally innocuous, high volume or "bulk" manufacturing method for the production of high-quality graphene restricts graphene for use in commercial applications.

To leverage the unique potential of next-generation graphene and other 2D materials Alpha has engaged in a collaborative development partnership with the University of Manchester at the National Graphene Institute (NGI) in the United Kingdom. In 2010 the Nobel Prize in Physics was awarded jointly to University of Manchester's Andre Geim and Konstantin Novoselov "for their groundbreaking experiments regarding the two-dimensional material graphene". We are fortunate to have Prof. Novoselov as the Technical Lead for Alpha's graphene Project at the NGI. The overall goal of this "Graphene Initiative" is to develop the next generation, "Graphene-Based Electronic Materials".

Initial focus of the Alpha R&D team was to develop an in-house, "High Volume Manufacturing" (HVM) capable method, to produce high quality graphene flakes. The Alpha R&D team has successfully developed a proprietary and environmentally friendly, electrochemical exfoliation process for graphene production. Graphene-flakes, produced from this process are, possess unique combination of properties such as surface and edge functionalization, high aspect ratio and excellent electrical and thermal conductivities that make them suitable for our products. The NGI Team in Manchester have been characterizing and testing Alpha graphene and have confirmed some of its unique properties. The Alpha Assembly Solutions team has now advanced to the next-stage, of formulating and testing graphene-based products, in several form factors, such as, electrically conducting pastes, inks and free-standing foils. These graphene materials will be used in innovative applications, such as "Interconnects, EMI Shielding, Thermal Management, Gas and Moisture Barrier Coating, Corrosion Protection, Polymer Composites and Energy Storage and Generation".

References:

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2. K. S. Novoselov, A. K. Geim, S. V. Morozov, D. Jiang, M. I. Katsnelson, I. V. Grigorieva, S. V. Dubonos, A. A. Firsov, Nature 2005, 438, 197.

39. Development of high quality single crystal diamond for high power device application

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According to international energy proposal, about 25% of the total CO2 reduction should come from "end use efficiency". Hence, low loss power devices are an important technology for the 21st century. The threat of global warming is becoming more and more critical; recently CO2 concentrations observed in Hawaii exceeded 400 ppm. According to the latest report by the International Energy Agency (IEA), "World Energy Outlook", the world temperature is likely to rise 5.3 °C by the end of the 21st century if new CO2 reduction policies are not implemented. To follow the "delayed" 450 ppm CO2 scenario, several technical policies are expected and the largest contribution is obligatory "end use efficiency" target that is intended to be responsible for 49% of the total worldwide emission reduction by 2030.

This is three times larger than the "Renewable energy" target of 17%. Undoubtedly, the low loss power electronics will play a major role in improving "end use efficiency". Diamond-based devices have the potential, but this would require fast development in order to contribute to the CO2 reduction plan early in this century. Diamond is also a hopeful candidate material for next generation power devices due to its favorable properties such as a high breakdown field, high thermal conductivity, high mobility and low dielectric constant. There are several big material challenges to overcome for the practical application of diamond devices. In particular, the fabrication of a single crystal wafer with large size, dislocation free, and low resistivity. ". The present status of the R&D on diamond materials for power devices is somewhat disjointed; it is considered beneficial to discuss definite target with diamond devices in order to accelerate research and contribute to the global CO2 reduction plan.

Applications of diamond power devices and specifications of diamond wafer

The wafer specifications for power device applications differ depending on the application. In this section, the expected applications for the diamond devices are reviewed before discussing the detailed specifications. Possible applications are summarized with respect to current–voltage map, as shown in Fig.1. As described in the introduction, the recent replacement of Si by SiC devices suggests a future transition to diamond devices.

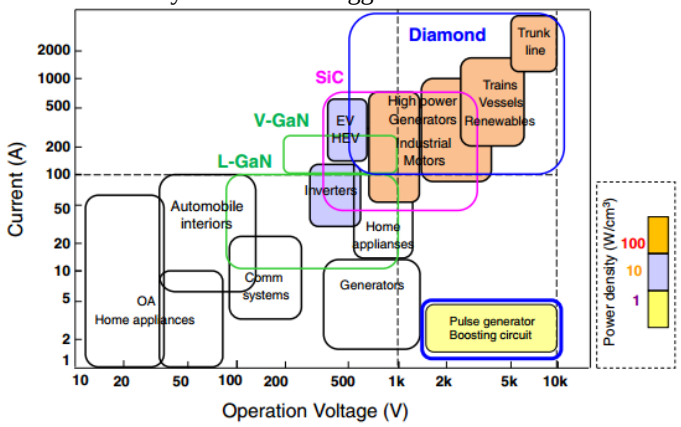


Fig. 1. Application possibilities in current- voltage map.

- Applications for diamond devices in the high voltage field, such as high power generators and inverters for trains, ships, renewable energy systems, and power trunk line systems.
- One important factor that allows SiC devices to realize low losses is the fast switching or high frequency operation, typically several microseconds. Low loss unipolar diamond power devices may have faster switching compared to SiC devices.
- For extremely high voltage applications over 10 kV devices, wide band gap bipolar devices are expected to open up new opportunity in the future, diamond bipolar devices are a hopeful candidate owing to their favorable characteristics

Proposal Idea:

Development of diamond wafers:

The two major current approaches of synthesizing single crystal diamond by chemical vapor deposition are described. In homoepitaxy, high gas pressure and high power density microwave discharges facilitating growth rates above 50 μm/h form the basis for the deposition of mm-thick single crystal samples. Cloning and tiling followed by homoepitaxial overgrowth is promising novel concepts aimed at an increase in the lateral dimensions. Heteroepitaxial deposition on large-area single crystals of a foreign material represents a second alternative

approach. A large number of different methods for the activation of the gas phase in the CVD process were subsequently developed. They facilitated an easy overcoming of the inherent size limitations of the HPHT technique (~ 1 cm) and provided a variety of polycrystalline diamond layers differing in grain size, texture, impurity content, resistivity, and transparency.
Polycrystalline diamond has been established in various demanding applications (heat spreaders, infrared and microwave windows, and wear resistant coatings). In several applications, however, the polycrystalline nature prevents diamond devices from achieving the ultimate performance levels expected from single crystal diamond (SCD) parameters. As a consequence, electronic devices suffer from drastically reduced charge carrier mobility 2 and detectors from incomplete charge collection. 3 The fundamental feasibility of high-quality SCD synthesized by CVD has already been demonstrated convincingly. Here, we focus on microwave plasma assisted chemical vapor deposition (MPACVD) as the most prominent method that combines excellent film purity with high growth rates that are homogeneous over acceptable areas. Heteroepitaxy provides a completely different approach to synthesize SCD on scalable substrate.
Our technology:
MPACVD technology will be used in our process. The process would be home epitaxi and it will grown single crystal diamond. The targeted growth rates would be 100µm/hours and the defect density would be as per the semiconductor device quality. Our technical expertises are building of MPACVD system with required doping materials and process conditions. If the project is funded, we are aiming to grown 25mmX25mm wafer with required electrical properties.
Applications of diamond single crystal wafers:
1) High power devices
2) High laser mirrors
3) Photonic applications

40. Cost Effective Raman and Universal Spectroscopy in India

R P Joshi, Ph.D., CEO & Technical Advisor, RI Instruments & Innovation India, Haldwani (Uttarakhand)

Indegeneous development of upper end scientific analytical instruments in India has always been a big challenge. We, at RI Instruments & innovation India's team have proved that with cohesive team work, this is very much possible. So far, successfully we have designed Raman Spectrometer, RIUS (Universal Spectroscopy), XRD, TEM (Under Trial), Class AAA Solar simulator,world's smallest USB microscope and few more. Presently we are in process of 7 design patents.
After success of our first ever country designed, nano material employed RAMAN Spectrometer, now we have come up with another frugal & most spectacular Innovation. This time it is unique RIUS (Universal Spectrometer), wherein so many parameters are incorporated in one machine. These are like absorbance, transmittance, reflectance, irradiance, color measurement, fluorescence, photo electrochemistry etc, which so far needed individual machines and thus the exorbitant cost implications. We could guess, probable this is first time in the history of world's instrumentation. This system is very compact and cost effective too!! We believe, this could be fit set for applications like space mission as well…
Further, we are now able to integrate mapping as well in our existing RAMAN spectrometer and excitation source used is 532nm green, variable diode LASER, Signal to Noise Ration 10000:1, 16 bit. Our RAMAN spectrometers are satisfactorily working at different locations in India and 4 of them have also been shipped abroad, even for applications of nano materials like graphene. While comparing the cost of this system with imported versions (in its segment), we are far below, which is more amazing!! Another unique feature of our RAMAN application software (RI Spectra) is the resolution in 1nm steps.
Our Low cost RAMAN spectrometer has high sensitivity detector that not only provides good resolution, but also provides spontaneously information about the material rotation and shift. It has an inbuilt cooling system with temperature range of up to – 35 Degrees Celsius, which gives freedom to researchers to carry out dynamically synthesizing processes in-situ on the RAMAN. It will quickly characterize changes of a material during a specific manufacturing process, with very low latency. We at RI Instrument & Innovation India has bought the most versatile / cost effective RAMAN in India and to the world, at very reasonable and affordable cost with maintaining world class standards and calibration / traceability norms. . We assure this will be an even contribution to the learning process at all levels, and that the RAMAN spectrometer will serve all researchers in India and abroad, as well as the high-tech industries, around the Globe.

41. Trace Level Molecules and Nitro-Aromatic Explosives Sensing at Ultra Low Concentrations using Surface Modified Amphiphilic Luminescent Nanomaterials onto different phases and surfaces

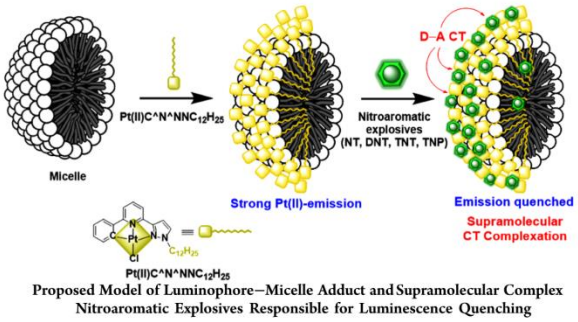
Bhavesh Agrawal, Institute of Research and Development, Gujarat Forensic Sciences University, Gandhinagar

Poly-Nitro-Aromatic molecules, e.g., DNT, TNP and (most importantly) TNT, are widely used as explosives by several terrorist groups and separatist organizations with the sole intention of mass killing. From an industry point, such materials are also extensively used in crude oil extraction, mining industries, by road and transport authorities for making tunnels, railroads, highways through mountainous regions, etc. Hence, security measures for usage, manufacture, handling, storage, transport and supply-consumption, etc. need to be strictly regulated. Despite such regulation, there have been number of incidents endangering human life since these range of materials are highly effective in small quantities too. Thus, it is of more and more importance to governments and security companies to identify their presence from common public even if found in trace quantities [Chem. Soc. Rev. 2012, 41, 1261−1296].

We have shown π-electron-rich complexes for sensing various electron deficient nitroaromatic explosives [NT, DNT, TNT and TNP], in aqueous, non-aqueous, as well as in the solid state as a paper strip with maximum detection limit of ca. 10−9 M [Langmuir, 2017, 33 (17), pp 4291–4300].

In our recent work, we have used silica surface as a substrate for such detection and upto trace level presence of nitroaromatics. Detection and sensing by using silica nanomaterials is advantageous due to its synthetic simplicity, low cost, high surface area and easy tailoring the surface character. However, it is necessary to optimize surface amphiphilicity of silica powder for its use. In one of our works, we have optimized the amphiphilicity of silica nano powders by modifying hydrophilic silica surface with different alkyl (-C5H11, -C11H23 and -C17H35) chains for maximizing its efficacy for detection and sensing applications. We found that ~C11 to ~C17 alkyl chain modified amphiphilic silica nanoparticles perform efficiently under visible light. To make a luminescent silica derivative with similar surface character, a Pt(II)(Cl)C^N^N-C12H25 luminophore with long hydrophobic chain was synthesized and anchored on the silica surface. This electron rich luminescent dye molecule can also detect trinitrotoluene (TNT) through photoinduced electron transfer process (PET). We demonstrated that this Pt(II)-dye functionalized amphiphilic and luminescent silica powder could be used for development of latent fingerprint and simultaneously can identify nitroaromatic explosives if present in the print. The work thus reports a new approach for the development of nanopowders for development of latent prints and identifying nitroaromatic explosives also in such materials [communicated].

Scheme -1



Proposed Model of Luminophore–Micelle Adduct and Supramolecular Complex Nitroaromatic Explosives Responsible for Luminescence Quenching

42. Graphene as a contact material for fabrication of a low contact resistance Radio Frequency Micro-Electromechanical switches

V. B. Sawant, Akkif Anjum, Supervisor: Dr. Suhas S. Mohite. Ph.D. IISc –Bangalore, Centre of Excellence in Computer Integrated Manufacturing, Mechanical Engineering Department, Government Engineering College, Karad, Maharashtra-415124

Micro-fabricated Radio Frequency (RF) switches are being studied extensively and are widely employed as primary movers in a variety of Micro-electromechanical systems (MEMS). The applications of RF switches include

automated test equipment's, advance telecommunication systems, Wireless communication (satellite communication, aerospace, defense applications), mobile phones, high frequency signal processing applications, environmental surveillance, patient surveillance and medical implants etc. These switches are designed to operate in frequencies (0.1-100 GHz and above) and provide low power consumption, very high isolation, very low insertion loss and low cost which enable them to be used in high frequency applications. One of the reasons for the failure of RF MEMS switch is its contact resistance. Therefore, it is one of the important performance requirements of RF MEMS switches to have low contact resistances less than 1 – 2 Ω. It is also important to understand the mechanics of contact in order to reduce the contact resistance and therefore it is necessary to know the mechanism of material deformation. In this pilot study, we have analytically calculated the contact resistances and contact forces considering elastic-plastic deformation for some of the commonly used contact materials for various applications. In elastic-plastic deformation, the deformation of the material occurs beyond the elastic limit but prior to the fully plastic deformation. In this situation, the parts of the area of contact material are deformed plastically while these areas are wholly enclosed by the material of elastic nature. For elastic-plastic deformation of contact areas, the contact force is given by,

$$F_{cEP}^2 + C_1 F_{cEP} - C_2 = 0 \quad (1)$$

Where,

$$C_1 = \frac{1}{2l^3}[(6EI_z d_c) - (2\pi H l^3 r_{eff}^2) - \left(\frac{\varepsilon_0 A_{sa} V^2}{2(g_0 - d)^2}\right) a^2(3l - a)]$$

$$C_2 = \frac{H\pi r_{eff}^2}{2l^3}[2EI_z(3d_c + \alpha_c) - \left(\frac{\varepsilon_0 A_{sa} V^2}{2(g_0 - d)^2}\right) a^2(3l - a)]$$

and the corresponding contact resistance is given by, $R_{cEP} = \frac{\rho}{2}\sqrt{\frac{H\pi}{F_{cEP}}}$

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i2n Technologies is a young Indian company, established in 2011, that works in the broad Nanotechnology space. We develop Products, provide Consultancy and Training, and also work with organizations to assist them in furthering their goals in this area.

We have launched the NAMMA STM/AFM (Scanning Tunnelling Microscope/Atomic Force Microscope) – an indigenously built, high resolution, versatile scanning probe microscope with several modules to enhance functionality. We also have developed the revolutionary Glider Kit STM/AFM which allows students to assemble and disassemble a STM/AFM in order to fully understand and appreciate the various engineering and scientific concepts involved in their working. This product gives good results repeatably and is very robust. Additionally we have developed consumables and other stand alone products around the STM and AFM for our customers.

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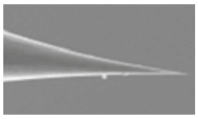
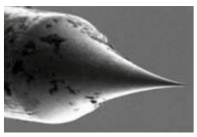
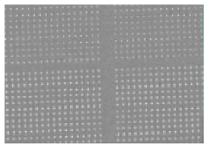
CONSUMABLES

i2n Technologies provides consumables for STM/AFM like Tips, Calibration Standard samples, CVD Graphene etc, on customized base.

STM TIPS – High Performance Tips for High resolution imaging				
	Geometry	Wire Thickness	Tip Diameter	SEM IMAGE
Platinum/Iridium	Solid Wire	200, 250 micron	40 - 100 nm	
Tungsten	Solid Wire	150, 200, 250 micron	8 - 30 nm	
CVD GRAPHENE ON COPPER FOIL - applications like Graphene research, MEMS, NEMS etc				
Available Sizes	Cu Foil Thickness	Thickness of Graphene layer on Foil		
1 cm x 1 cm 1″ x 1″ 2″ x 2″	50 micron	Single layer and Double Layer		
Calibration Standard Sample for STM/AFM				
Sample Size & Material	Pattern Area	Min and Max Dimension of the pattern	Shape of the pattern and Pitch between each pattern	
1 cm x cm & Cr/Au on Si or SiO2	0.5 x 0.5 mm 1 x 1 mm 1.5 x 1.5 mm 2 x 2 mm	150 nm and onwards	Circular(Dot), 300 nm	

SERVICES

i2n Technologies provides services in a broad spectrum of fields related to nanotechnology. We assist educational institutions and research centers in establishing their own nanotech labs, customised according to their requirements and budgets. Setting up a new nanotechonoly lab can be a daunting task for an institute unless it has a team of experienced nanotech researchers and huge funding. Our services include consultation for a phased development of the lab, budgeting, infrastructure development, sourcing and installation of the required nanofabrication and nano-characterization equipment, training on the equipment, and maintenance of the nanotech labs. Situated inside the IISc campus, i2n Technologies can leverage its access to the world class fabrication and characterization facilities at CeNSE (Centre for NanoScience and Engineering) and various other departments to provide cost-effective prototyping and testing of nanotech devices and systems.

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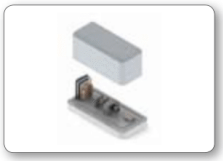
PRODUCTS

GLIDER KIT STM/AFM

Affordable and easy to use which can be built by students themselves.

- Scan Range: XY - 600nm, Z – 90nm
- Resolution: XY - .01nm, Z - .002nm (16 bit Electronics)
- Imaging modes: Constant current and constant height
- Spectroscopy modes: I-V and Current – Distance



NAMMA STM/AFM

An indigenously built, high resolution and versatile scanning probe microscope.

- Scan Range: XY - 900 nm, Z – 135 nm.
  * XY - 5 μm, Z – 0.8 μm
- Resolution: XY - 0.01nm, Z - 0.002nm
  (16 bit Electronics)
- Imaging modes: Constant current and Constant height, AM and FM modulation AFM
- Spectroscopy modes: I-V and Current – Distance, Amplitude - distance (AFM)

* with optional High Voltage Amplifier

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2 Damping Time - 20 sec

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PathShodh Healthcare Pvt. Ltd.

www.pathshodh.com

PathShodh Healthcare Pvt. Ltd. is a medical device research and development company incubated at the Indian Institute of Science (IISc), Bangalore. Driven by a social mission of making healthcare diagnosis affordable and available to all, the company is built on a very strong foundation of innovative research conducted at the Centre for Nano Science and Engineering, IISc. With a comprehensive IP portfolio (1 issued US patent and 5 more international patents filed), PathShodh has developed first of its kind handheld device for managing Diabetes and its complications. We go far beyond the conventional glucometers, and enable point of care testing of 8 bio markers on a single device. This is the only device in the world which can perform Glucose, HbA1c and Glycated Albumin tests for efficient glycemic control; Serum Albumin and Hemoglobin tests for malnutrition index and liver disease; Microalbuminuria, Urine Creatinine and Albumin to Creatinine Ratio tests for Diabetic Nephropathy. The pre-clinical validation of the device is already completed with blood and urine samples. After a comprehensive clinical validation the product will be launched in the market during third/fourth quarter of 2016.

ShanMukha Innovations Pvt. Ltd.

Faculty Entrepreneur: Dr. Sai Siva Gorthi

Assistant Professor, Optics and Microfluidics Instrumentation Lab, Department of Instrumentation and Applied Physics, Indian Institute of Science (IISc), Bangalore-12.

Company Incubated at Society for Innovation and Development (SID), Indian Institute of Science (IISc), Bangalore-12, Email: saisiva.gorthi@gmail.com, Ph: 9008974499.

ShanMukha Innovations deals with developing Innovative Technologies & Products in the application areas such as Healthcare and Environmental Sensing.

ShanMukha's Vision:

To make Clinical Diagnostics Pain-less, User-friendly, Affordable, Instantaneous, Accurate, and Self-performable – Anywhere by Anyone

To make Clinical Diagnostics suitable for Mass-Screening and Early Detection of Deadly Diseases by developing highly sensitive Point-of-Care Diagnostic Devices

To make Environmental Sensing (Testing of Water Quality, Air Quality, Soil Quality, Food Quality, Milk Quality etc.) Easy and Effortless task for every individual consumer by developing Affordable, Automated and Miniaturized Point-of-Care Sensing Devices

ShanMukha's Mission:

Developing Novel Optofluidic (synergistic combination of Optics and Microfluidics) Technologies and Products

Developing Innovative Microfluidic-Nanotechnology (Microfluidic Technologies for Nanoparticle Synthesis and their use in Sensing of various Analytes) Products

Products / Prototypes to be Showcased by ShanMukha Innovations during National Symposium at CeNSE:

(1) Malaria Diagnostic Device - Optofluidic Imaging Flow Cytometer
(2) Nanorice Making Device - Microfluidic Nanoparticle Synthesizer
(3) Milk Adulterants (Melamine) Detection Device – Interference Synthesizer

Centre for Nano Science and Engineering, IISc Bangalore

The **N**ational **P**rogram on **M**icro **A**nd **S**mart **S**ystems(NPMASS) coordinated by the Aeronautical Development Agency(ADA), identified this Centre for carrying out the development of MEMS-based pressure transducers for aerospace applications. The goal was to indigenize such sensors by designing, developing and packaging them in the in-house facility and take the devices to the qualifying level from where industry can license the knowhow and develop products for aerospace and other commercial applications.

Measure the pressure with pleasure!

Pressure transducer built at CeNSE being transferred to strategic sector

Centre for Nanoscience and Engineering(CeNSE)

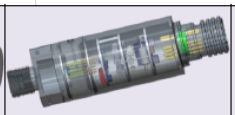
Advanced MEMS Packaging Lab

IISc, Bangalore

MEMS

PRESSUER TRANSDUCERS

Technical characteristic and specifications:

 MEMS Sensor	 0-1.2bar (Absolute)	 0-600mbar (Gauge)	 0-10bar (Gauge)	 0-600mbar (Differential)	 0-150mbar (Differential)
Output Signal:	0.25Vdc (0mbarA) to 5.25vdc (1200mbarA)	0.25Vdc (0mbarG) to 5.25vdc (600mbarG)	0.2Vdc (0.4barG) to 5.0vdc (10barG)	0.25Vdc (0mbarD) to 5.25vdc (600mbarD)	0.25Vdc (0mbarD) to 5.25vdc (150mbarD)
Supply Voltage:	28Vdc(16Vdc-32Vdc)	28Vdc(16Vdc-32Vdc)	28Vdc(16Vdc-32Vdc)	28Vdc(16Vdc-32Vdc)	28Vdc(16Vdc-32Vdc)
Accuracy:	±1% FSR	±2.5% FSR	±1% FSR	±1% FSR	±1% FSR
Proof pressure:	2.4bar(Absolute)	1200mbar (Gauge)	20bar (Gauge)	1200mbar(Differential)	300mbar(Differential)
Burst pressure:	3.6bar(Absolute)	2400mbar (Gauge)	30bar (Gauge)	2400mbar(Differential)	450mbar(Differential)
Operating Temp:	-40˚C to +65 ˚C	-40˚C to +65 ˚C	-40˚C to +85 ˚C	-40˚C to +65 ˚C	-40˚C to +65 ˚C
Storage Temp:	-55˚C to +85 ˚C	-55˚C to +85 ˚C	-55˚C to +85 ˚C	-55˚C to +85 ˚C	-55˚C to +85 ˚C
Power Consumption:	<300mW	<300mW	<300mW	<300mW	<300mW
Weight:	<150grams	<150grams	<150grams	<150grams	<150grams
Test condition:	Environmental Test (MIL-STD- 810D), EMI/EMC (MIL-STD -461), Power supply test (MIL-STD-704D), Lightning test(Do-160F)				

The spectrum of pressure sensors on a modern aircraft (both Military and civil markets) is very broad and complex. Many aircraft systems require pressure sensors as the control and measuring elements such as: in engines (oil pressure, compressor pressure, electronic engine control); hydraulics (braking system, load control), environmental applications (air conditioning, pressurization) and in helicopter (altimeter, airspeed measurement). Future aircraft systems will place increases demands on weight, size, cost, reliability and control.

Today, MEMS pressure sensors are also widely used in an ever increasing number of automotive applications. Pressure sensors are key components in reducing emissions and fuel consumption while maintaining the fun-to-drive elements of today's passenger vehicles. In addition, they are being deployed in a variety of safety applications, such as

- Tire Pressure Monitoring Systems (TPMS)
- Engine management system (MAP/BAP)
- Fuel tank vapor pressure
- Crash detection for side airbags
- Pedestrian protection
- Exhaust recuperation
- Soot particle filters
- Air conditioning
- Powertrain electronics
- Utility vehicle brakes

Typical applications:

Industry
- Hydraulic and pneumatic systems
- Measurement and control technology
- Environmental and climate protection
- Gas analyzers and meters
- Heating, ventilation and air conditioning systems in buildings

Medicine
- Respiration technology
- Anesthesia equipment
- Blood pressure monitoring

Consumer
- Barometric measurements in portable electronics such as mobile phones, personal navigation devices and watches Hard disk drives (HDD)
- Cycling computers
- Cameras with altimeter function

Centre for Nano Science and Engineering (CeNSE),

Indian Institute of Science, Bengaluru, Karnataka, India

http://www.nano.iisc.ernet.in

CeNSE facilitates **external academic researchers** in the utilization of facilities established at IISc Bengaluru under its **outreach program "INUP"**. It is the interface between the Centre for Excellence in Nanoelectronics (CEN) and researchers from around the India, as well as abroad, enabling them to access state-of-the-art laboratories and the expertise available.

Indian perspective

(Funded by Ministry of Communication and Information Technology, Govt. of India)

About INUP

- INUP Phase I: Launched in August, 2008 and completed its five successful years of operation on 31st Jan 2014.
- INUP Phase II has begun on 1st Mar 2014.
- Conceived and funded under "**Microelectronics and Nanotechnology Development Program**" of the Department of Electronics and Information Technology (**DeitY**), Ministry of Communications and Information Technology (MCIT), Govt. of India.
- Aims to make available the national facilities equipped with state-of-the-art device fabrication and measurement laboratories to researchers from around the country, who lack access to even modest capabilities of the kind.

The Three Levels of INUP

Level 1: Familiarization Workshop involving lectures and tutorials, conducted for about 100 participants at a time;

Level 2: Hands-on Training in device fabrication, measurement, and simulation, held for about twenty five people at a time, selected from among those previously "familiarized";

Level 3: Execution of Research Projects by researchers so trained.

Foreign Perspective

(Funded by Ministry of External Affairs, Govt. of India)

Familiarization Workshop involving lectures and tutorials, conducted for about 30 participants at a time; followed by Hands-on Training in device fabrication, measurement, and simulation,"

First workshop of it's kind was organized on January 17 –Feb 3, 2016 with 26 Participants from different countries:

Sri Lanka **Bangladesh** **Myanmar** **Maldives**

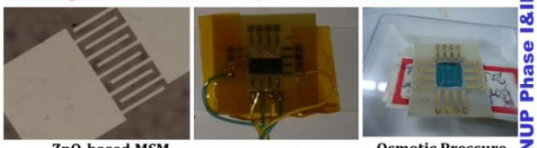
Uniqueness of INUP

Though the sharing of expensive nanofabrication facilities is the norm around the world, DeitY recognised the different needs of Indian academic researchers. INUP therefore is tailored as a comprehensive training program, leading to the execution of sophisticated research projects at the CEN facilities, with all expenses met by INUP, obviating the need for and delays in obtaining research grants. Such grants are often not available to researchers from small and remote Institutions. It is the perceptiveness of **DeitY** that has made INUP so well received and successful. The "hands-on" aspect of INUP is designed to impart skills, wherein researchers spend many hours in state-of-the-art clean rooms, making devices and getting a "feel" for the processes and technologies involved. INUP is thus very much a pathway to meeting the needs of "Make in India".

An Unexpected Bonus

A collateral benefit – a bonus – of INUP has been the participation of college teachers in Workshops and research projects. Many of them have remarked that, as a result of participating in the Workshops, they can now teach in the classroom better and more confidently – because they have, for the first time, handled a silicon wafer or seen the insides of a an actual VLSI circuit. Thanks to INUP, thousands of students from around the country will learn and know semiconductor technology better.

A Sample of Research Projects done under INUP



ZnO-based MSM Photodetectors **Micro-Heater** **Osmotic Pressure Sensor**

2200 researchers have been trained in INUP Phase I&II, Generating 110 Publications & 13 Patents (to date).

Group Photo of the Participants from India-Neighbouring Countries

Participants undergoing training in the Cleanroom

Participants with their posters

Centre for Nano Science and Engineering (CeNSE),

Indian Institute of Science, Bengaluru, Karnataka, India
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About CeNSE

Started fully functioning in 2011

21000 sq. ft. National Fabrication & Characterization Facilities

MTech, PhD and Summer Internship programs

15 Faculty Members (of which 5 are Emeritus)

150 PhD & 40 MTech Students / 130 Dedicated Staffs

Outreach Programs for Indian and Foreign Academics

Substantial discount on facility usage to Indian and Foreign Academics

What We Do

Research	• Research on fundamental aspects of science and technology
Development	• Enable the conversion of technology to products with impact
Education	• High Impact manpower for the country

Create social impact!
Additional focus on addressing problems of local relevance

Products – Using CeNSE technologies

Pressure Sensor
(400 bar)

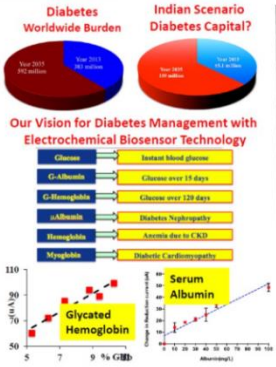
Envirobat
Gas Sensing Monitoring System

ICP
Intracranial Pressure Sensor

Electrolithography

PM Shri Modi, being presented with a memento in which "OM" was scribed by electrolithography (Nanometer Scale) on February 18, 2015

Handheld Device for Diabetes Management developed through in house R&D



Translating Ph.D. Research to Product through the Incubation of Startup

Path Shodh HEALTHCARE
Inventing lifelines...

- 7 Indian Patents, 1 US Patent, + 5 International patents to be filed
- Sept 2015: Start up incubated at SID, IISc
- Aug 2016: Expected product launch

The CVD System developed by scientists at CeNSE, in collaboration with KAS Technologies, Bengaluru

The CVD system, developed for commercialization, *was launched in March ,2016 at the Bangalore Nano Conclave"*

Cleanroom Facility~75 Tools

Characterization Facility~35 Tools

About CeNSE

The Centre for Nano Science and Engineering (CeNSE) was established in 2010. CeNSE focuses on interdisciplinary research and education in the broad area of nanoscale science and technology covering topics such as Nanoelectronics, devices, materials, micro- and Nano-electromechanical systems, bio- and Nano-photonics, bio-electronics, interfaces and integrated small-scale systems. In addition to the research programmes of the core faculty, the Centre runs an interdisciplinary research programme involving more than 40 faculty members from various departments of basic science and engineering at the Indian Institute of Science (IISc). The Centre offers a PhD programme of its own and an interdisciplinary PhD programme in allied areas, and has close interactions with industry. Starting from 2014, CeNSE has initiated an M.Tech degree program in Nano Science and Engineering. A state–of-the-art nanofabrication facility with a clean room spanning 1400 square meters is located at the Centre. In addition, there are several characterization labs that cater to material, electronic, mechanical, chemical and optical characterization. The Indian Nanoelectronics Users Programme, INUP, is a unique initiative of the Ministry of Electronics and Information Technology (MeitY), GoI, was launched in 2008 to accelerate research and development in Nanoelectronics. To this end, INUP provides training to aspiring researchers in Nanoelectronics, as well as, access to the advanced (national) facilities at CeNSE, where work on selected, meritorious research projects may be conducted with help and guidance of faculty members and technical staff at CeNSE. To date, hundreds of researchers from over 150 academic institutions from around the country have participated in INUP training workshops. Many of them have carried out research projects under the INUP, leading to research theses, publications, and patents.

To know more about CeNSE, please visit:

http://www.cense.iisc.ernet.in

https://www.youtube.com/user/censeiisc