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3-7 January, 2012 - Bhubaneswar

99th Session of the Indian Science Congress

SECTION OF

MATERIAL SCIENCES

President

Prof. B. S. Murty

The Indian Science Congress Association

99th Indian Science Congress

January 3-7, 2012, Bhubaneswar

PROCEEDINGS

SECTION OF

Materials Science

President
Prof. B.S. Murty

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99th Indian Science Congress

January 3-7, 2012, Bhubaneswar

I

Presidential Address

President
Prof. B.S. Murty

Nanostructured Materials with Exceptional properties by Mechanical Milling/Alloying

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Abstract: The present paper highlights some of the interesting nanostructured materials prepared recently in the laboratory of the authors. These include nanostructured Al-Cu alloys with good combination of strength and ductility, nanocrystalline high entropy alloys, NiAl- and FeAl-Al_2O_3 nanocomposites with exceptional combination of strength and plasticity developed by reactive milling, Cu-W, Cu-Ta nanocomposites with good combination of strength and conductivity and nanocomposites of $BaTiO_3$ and Ni-Zn ferrite with good magneto-electric coefficient. The paper also highlights the excellent sinterability of nanocrystalline W and dramatically improved Cr recovery by acid leaching of Chromite ores achieved by high energy ball milling.

Keywords: Nanomaterials, high energy ball milling, mechanical alloying, intermetallics, nanocomposites

1. Introduction: Nanostructured materials have attracted large attention due to their high strength, excellent functional properties, better corrosion rsistance, reduced sintering temperatures, etc.[1,2,3]. Nanostructured materials can be prepared by several methods such as rapid solidification, sol-gel chemistry, sputtering and evaporation, controlled crystallization of an amorphous precursor and inert gas condensation. Mechanical milling/alloying is also a widely used method to produce nanostructured materials[4,5,6,7,8]. The advantage of this method is its relative simplicity, low cost, and the possibility to scale it up to tonnage quantities.

2. Nanostructured Al-Cu Alloys: Nanostructured Al-4Cu alloy was synthesized by mechanical alloying (MA) followed by vacuum hot pressing (VHP) as shown in Fig. 1. The nanostructured alloy showed very good thermal stability and a good combination of strength and ductility. Hall-Petch analysis of compression strength behaviour showed high frictional stress (170MPa) with a positive Hall-Petch slope of 0.13MPa√m. Nanostructured 2219 alloy was also developed by high energy ball milling and VHP of. The different contributions to the strengthening, such as grain size, dislocations, solid solution and dispersion have been calculated to get the true Hall-Petch relations for such nanocrystalline alloys[9,10,11].

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1 C. Suryanarayana, *Int. Mater. Rev.* **40** (1995) 41.
2 H. Gleiter, *Prog. Mater. Sci.* **33** (1998) 223.
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5 B.S. Murty and S. Ranganathan, *Int. Mater. Rev.* **43** (1998) 101.
6 C. Suryanarayana, *Prog. Mater. Sci.*, **46** (2001) 1.
7 B.S. Murty, M.K. Dutta and S.K. Pabi, *Sadhana* **28** (2003) 23.
8 T. Venugopal and B.S. Murty, *Encyclopaedia of Nanoscience and Nanotechnology*, **19** (2011) 1.
9 T. Shanmugasundaram, B.S. Murty and V. Subramanya Sarma, *Metall. Mater. Trans.*. **40A** (2009) 2798.
10 T. Shanmugasundaram, M. Heilmaier, B.S. Murty and V. Subramanya Sarma, *Mater. Sci. Eng.* A., **527** (2010) 7821.
11 T. Shanmugasundaram, M. Heilmaier, V. Subramanya Sarma and B.S. Murty, *Mater. Sci. Forum*, **690** (2011) 234.

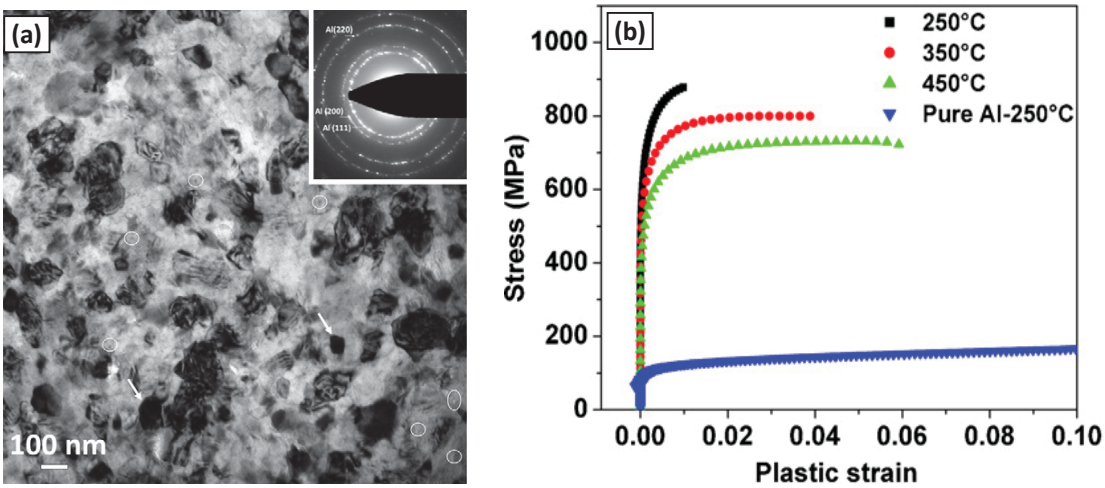

Fig. 1: (a) Bright field TEM micrograph of nanocrystalline Al–4Cu alloy powders after MA for 20h and VHP at 450°C for 2h. (circles: dispersoids, arrows: precipitates) and (b) compressive stress-strain curves of the alloy at different compaction temperatures.

3. Nanostructured High Entropy Alloys: Conventionally, alloys are based on one or two primary elements. Yeh et al.[12] have recently developed high entropy alloys (HEA), which are multicomponent equi-atomic ratio or near equi-atomic alloys. These alloys form simple solid solutions rather than many complex intermediate phases due to the large configurational entropy. The author's group is the first to develop nanostructured HEA and demonstrate high stability and good mechanical properties of such alloys[13,14,15,16]. Fig. 2 demonstrates the formation of nanocrystalline single phase BCC after MA in a hexanary AlFeTiCrZnCu equi-atomic elemental blend. This alloy retains its nanocrystalline BCC structure even after heating to 800°C and has a hardness of about 2 GPa. These alloys are consolidated either by VHP or by spark plasma sintering (SPS).

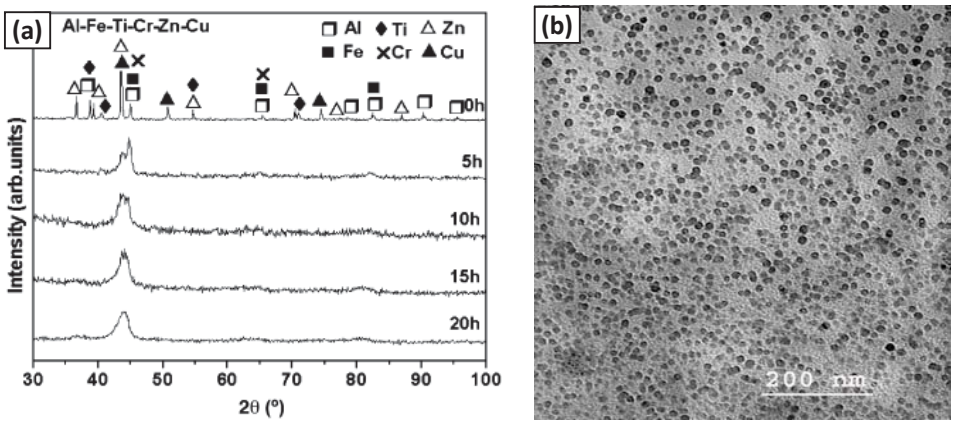

Fig. 2: (a) Evolution of BCC phase in *AlFeTiCrZnCu elemental blend* with milling and (b) its nanocrystalline nature.

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[12] J. W. Yeh, S-K. Chen, S-J. Lin, J-Y. Gan, T-S. Chin, T-T Shun, C-H. Tsau, and SY. Chang, *Adv. Eng. Mater.* **6** (2004) 299.
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[15] S. Varalakshmi, G. Appa Rao, M. Kamaraj and B.S. Murty, *J. Mater. Sci.*, **45** (2010) 5158.
[16] S. Varalakshmi, M. Kamaraj and B.S. Murty, *Metall. Mater. Trans.*, **41A** (2010) 2703.

Nanocrystalline CuNiCoZnAlTi HEA showed a compressive strength of 2.4 GPa after consolidation. Similar nanocrystalline HEA have been made in other multicomponent systems such as FeMnNiAlCrCo and NiFeCrCoMnW. However, depending on the composition chosen, some of the high entropy alloys end up in the formation of more than one phase. These phases are distributed at the nano scale and can be studied effectively by advanced techniques such as three dimensional atom probe (3DAP) as demonstrated in Fig. 3 for AlCoCrCuFeNi[17] and AlCoCrCuNiZn HEAs. It is important to better understand the thermodynamics of these alloys to design stable single phase multicomponent equiatomic alloys, which will be true HEAs.

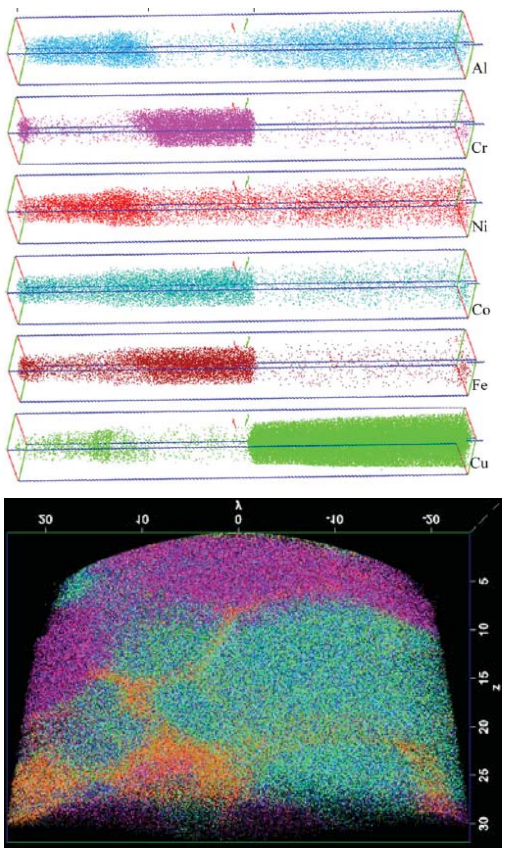

Fig. 3: 3DAP maps of AlCoCrCuFeNi and AlCoCrCuNiZn HEAs (colour codes for (b) are: Light green – Al, Blue – Co, Green – Ni, Orange – Cu, Grey – Zn, Pink – Cr)

4. Nanostructured W and its Alloys: Nanocrystalline materials show enhanced diffusion at the grain-boundaries and hence result in lower sintering temperature and time in comparison to their microcrystalline counterparts. Nanocrystalline W and W-Mo alloys can be sintered to near-full density at temperatures as low as 1500°C[18], while conventionally W is sintered at a temperature as high as 2800°C. There are attempts to understand the densification mechanism in nanocrystalline W[19,20]. The results indicate that the sintering of nanocrystalline W occurs through grain boundary diffusion mechanism.

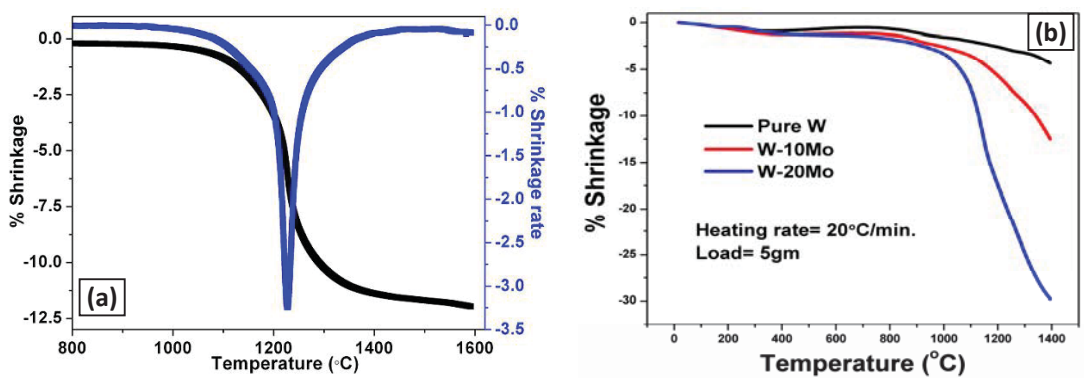

Fig. 4: Results of dilatometry showing (a) high sinterability of nanocrystalline W obtained by 2h of milling at 1200 rpm in a simoloyer (horizontal attritor – a high energy ball mill) and (b) improved sinterability of W with Mo addition after milling.

[17] Sheela Singh, Nelia Wanderka, B.S Murty, Uwe Glatzel and John Banhart, *Acta Mater.*, **59** (2011) 182.
[18] R. Malewar, K.S. Kumar, B.S. Murty, B. Sarma and S.K. Pabi, *J. Mater. Res.*, **22** (2007) 1200.
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The activation energy for sintering of nanocrystalline W was reduced from 390±12 to 159±3 kJ/mol with the addition of Mo.

5. NiAl- and FeAl-Al_2O_3 Nanocomposites by Reactive Milling: Reactive milling of NiO+Al and Fe_2O_3+Al mixture has been successfully used to develop Ni-, Fe-, NiAl- and FeAl-Al_2O_3 in-situ nanocomposites. These nanocomposites have been consolidated to their full densities, while retaining their nanocrystallinity by SPS (Fig. 5). Mechanical activation significantly reduced the activation energy for the reduction of NiO by Al from 277 to 150 kJ/mol after 20h of milling[21]. NiAl- and FeAl-Al_2O_3 nanocomposites have shown exceedingly good combination of compressive strength (up to 2500 MPa) and plasticity (up to 14%)[22,23,24,25] as shown in Fig. 6. The individual contributions of grain size and dispersoids has been calculated successfully in each case to get a better understanding of the factors contributing to the strengthening.

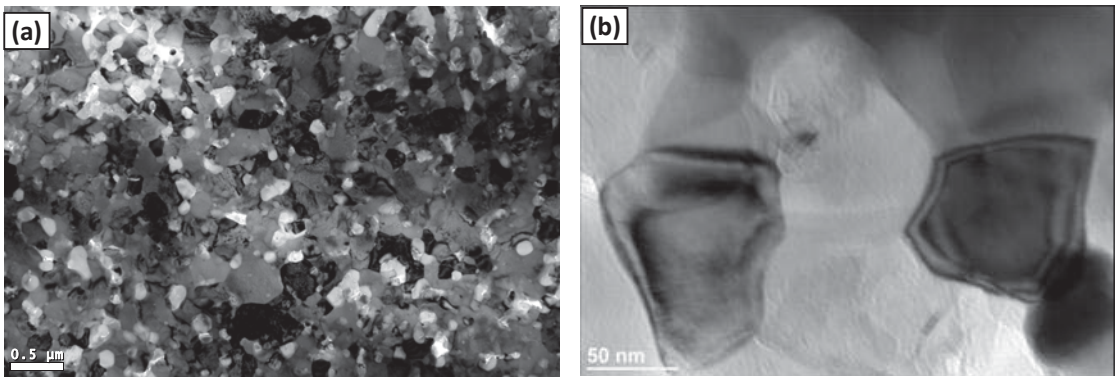

Fig. 5: TEM images of (a) NiAl-Al_2O_3 and (b) FeAl- Al_2O_3 nanocomposites obtained by reactive milling and SPS

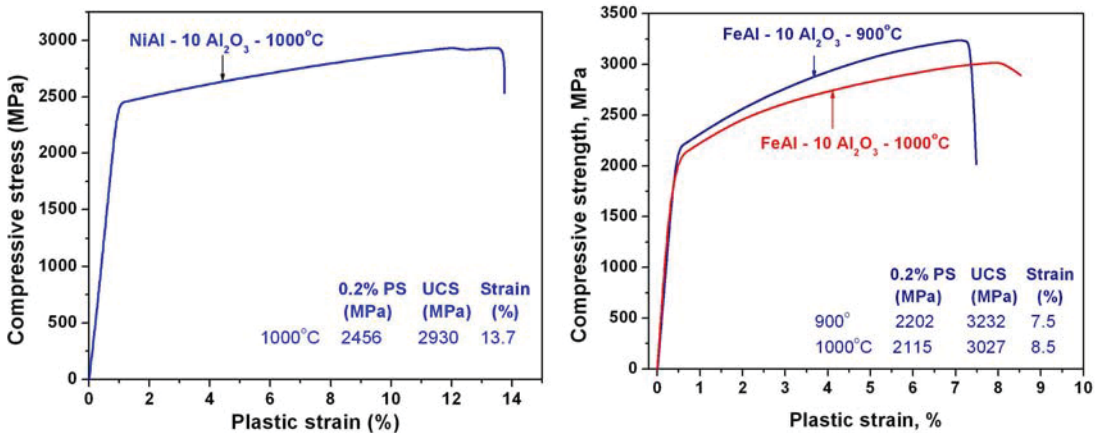

Fig. 6: Compressive stress–strain curves of NiAl– and FeAl-10 vol.% Al_2O_3 nanocomposites

[21] V. Udhayabanu, Navneet Singh and B.S. Murty, *J. Alloys Comp.*, **497** (2010) 142.
[22] V. Udhayabanu, K.R. Ravi, V. Vinod and B.S. Murty, *Intermetallics*, **18** (2010) 353.
[23] V. Udhayabanu, K. R. Ravi, K. Murugan, D. Sivaprahasam and B.S. Murty, *Metall. Mater. Trans.* A, **42** (2011) 2085.
[24] V. Udhayabanu, K. R. Ravi and B.S. Murty, *J. Alloys Comp.*, **509** (2011) S223.
[25] V. Udhayabanu and B.S.Murty, *Phil. Mag.* (under review).

6. Cu based Nanocomposites: Cu based nanocomposites with nano dispersions of Al_2O_3 have been synthesised by reactive milling of CuO and Cu_2O with Al and it has been observed that the reactions reach completion only when the crystallite size of CuO and Cu_2O goes below 20nm[26] as shown in Fig. 7. Though, these nanocomposites have high strength, their electrical conductivity is low. Therefore, in order to achieve high strength without significant loss of conductivity, Cu-W and Cu-Ta nanocomposites have been developed[27,28].

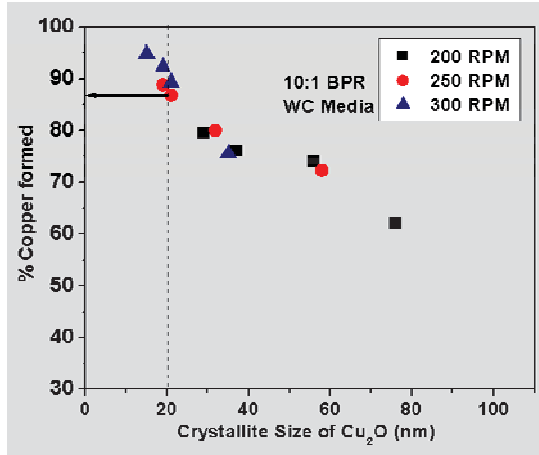

Fig. 7: Effect of crystallite size of Cu_2O on its reduction by Al during ball milling

These nanocomposites could be sintered to full density at 500°C, while microcomposites needed to be sintered at about 1000°C. The nanocrystalline grain size is retained in these composites even after sintering as shown in Fig. 8(a). The nanocomposites showed significant improvement in strength in comparison to microcomposites. This work has also shown that these nanocomposites are three times stronger than oxygen free high conductivity copper (OFHC) of a comparable conductivity.

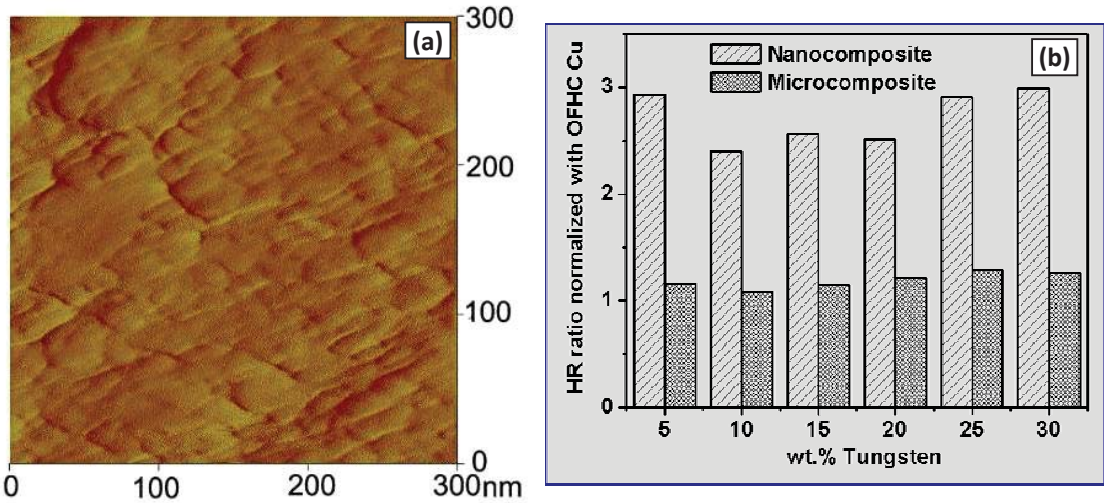

Fig. 8: (a) AFM image showing nanocrystalline nature of Cu-Ta composites after sintering and (b) significant strengthening achieved by Cu-Ta nanocomposites for comparable conductivities.

7. Nanostructured Oxide Dispersion Strengthened (ODS) Alloys: Mechanically alloyed oxide-dispersion-strengthened (ODS) ferritic/austenitic steels, now known as nanostructured ferritic/austenitic alloys, have outstanding mechanical properties due to submicron grains and high concentrations ($>10^{23}$ m^{-3}) of Ti-, Y-, and O-enriched nanoclusters. There is great interest in their potential use in fission and proposed fusion reactors and supercritical boilers,

[26] T. Venugopal, K. Prasad Rao and B.S. Murty, *Mater. Sci. Eng.*, **A393** (2005) 382.
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[28] T. Venugopal, K. Prasad Rao and B. S. Murty, *Acta Mater.* **55** (2007) 4439.

not only because of their attractive high-temperature strength, but also because the nanoclusters may result in a highly radiation-resistant material by efficiently trapping point defects to enhance recombination and by trapping transmutation-produced He in high concentrations of small cavities to limit radiation induced swelling and embrittlement. In the present study, Fe-9Cr, Fe-12Cr, Fe-18Cr-8Ni alloys with small amounts of Mo, W and with nano Y-Ti-O clusters have been developed by high energy ball milling followed by VHP and SPS[29,30,31,32]. Fig. 9 shows nano yttria in Fe-18Cr-8Ni matrix. Such alloys have shown promising high temperature properties as indicated in Fig. 10.

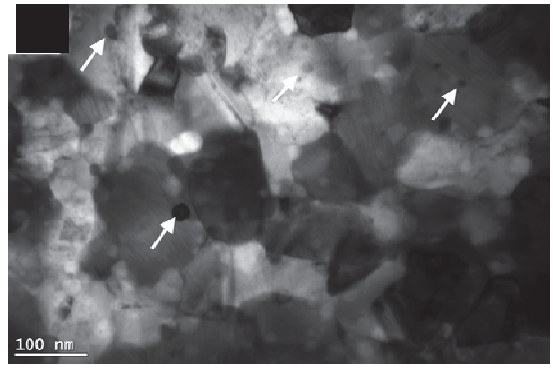


Fig. 9: TEM image showing nano yttria particles in Fe-18Cr-8Ni-0.5Y_2O_3 alloy

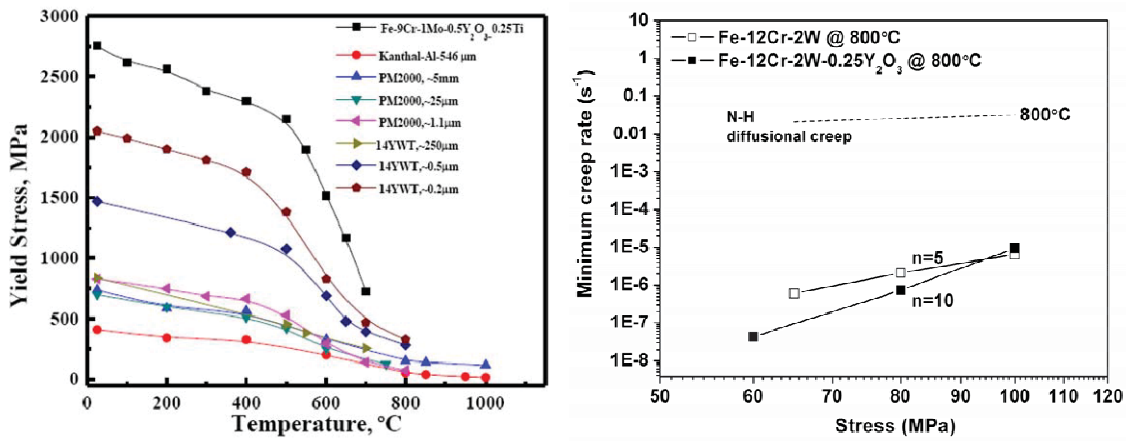


Fig. 10: Promising high temperature properties in Fe-9Cr-1Mo-0.5Y_2O_3-0.25Ti and Fe-12Cr-2W-0.25Y_2O_3 alloys.

8. Functional Nanocomposites: The group has successfully developed[33] exchange coupled magnets between soft magnetic FeCo and hard magnetic Sm_2Co_{17} with large energy product of 10.2 MGOe as shown in Fig. 11. Nanocrystalline PZT with exceptionally large dielectric constant of 35000 has been developed. PLZT with excellent sensitivity for structural health monitoring has also been developed[34,35] as shown in Fig. 12. Nanocrystalline single phase

[29] P. Susila, D. Sturm, M. Heilmaier, B.S. Murty and V. Subramanya Sarma, *J. Phys. Conf. Series*, **240** (2010) 012090.
[30] P. Susila, D. Sturm, M. Heilmaier, B.S. Murty and V. Subramanya Sarma, *Mater. Sci. Eng. A*, **528** (2011) 4579.
[31] P. Susila, D. Sturm, M. Heilmaier, B.S. Murty, V. Subramanya Sarma, *J. Mater. Sci.*, **45** (2010) 4858.
[32] P. Schloth, M.A. Weisser, H. Van Swygenhoven, S. Van Petegem, P. Susila, V. Subramanya Sarma, B.S. Murty, S. Lauterbach, M. Heilmaier, *Appl. Phys. Lett.* (under review).
[33] G. Sreenivasulu, R. Gopalan, V. Chandrasekaran, G. Markandeyulu, K.G. Suresh and B.S. Murty, *NanoTech.* **19** (2008) 335701.
[34] B. Praveenkumar, H.H. Kumar, D.K. Kharat and B.S. Murty, *Mater. Chem. Phys.*, **112** (2008) 31.
[35] B. Praveenkumar, G. Sreenivasulu, H.H. Kumar, D.K. Kharat, M. Balasubramanian and B.S. Murty, *Mater. Chem. Phys.*, **117** (2009) 338.

magneto-electric materials with exceptional properties[36] ($BiFeO_3$) and nanocomposites of $BaTiO_3$ and NiZn Ferrite with the largest ever reported magneto-electric coefficient[37,38] of 654 mV/cm Oe have also been developed by this group (Fig. 13).

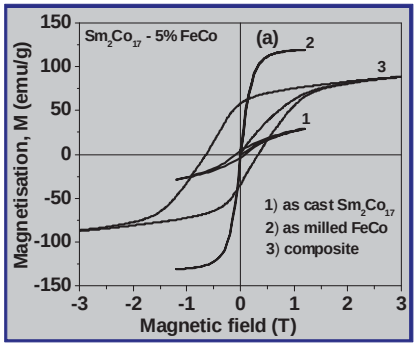


Fig. 11: Magnetization curves of Sm_2Co_{17}-FeCo magnetic nanocomposite

9. Nano in Extractive Metallurgy: Exceptional recoveries of metals have been demonstrated by mechanically activated leaching of ores due to the formation of nanostructure. High energy ball milling of chromite ore for 7h has led to Cr recovery of 98%, while the unmilled ore shows recovery of less than 10% under similar leaching conditions (Fig. 14)[39].

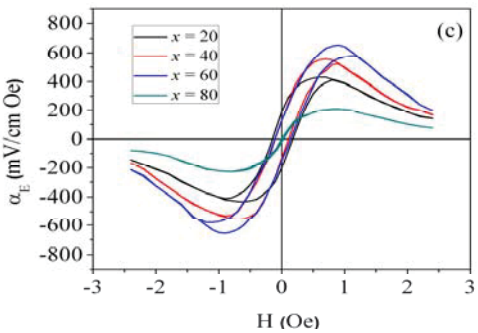


Fig. 13: Exceptional ME coefficient for (100-x) BT - xNZ Ferrite nanocomposite

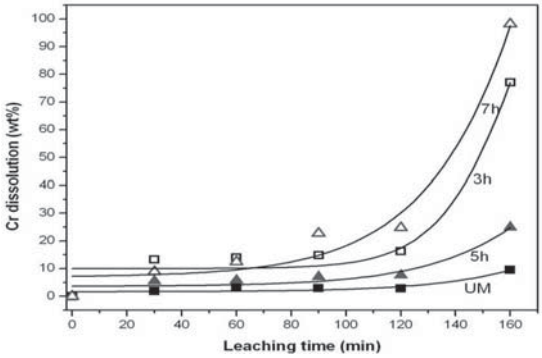
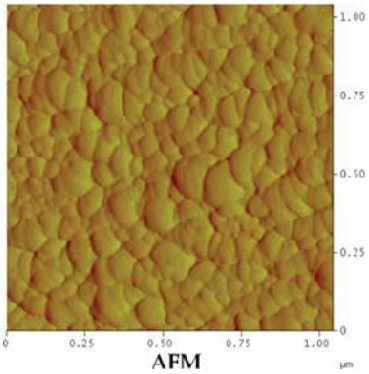


Fig. 14: Exceptional recovery of Cr by mechanically activated leaching of chromite ore



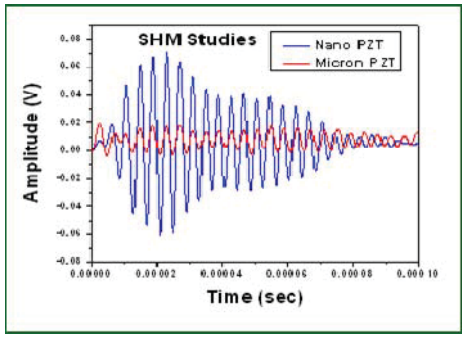


Fig. 12: (a) AFM image of nano PLZT and (b) nano PLZT showing high sensitivity for structural health monitoring studies in comparison to micro PLZT

Acknowledgements: Prof. B.S. Murty is highly indebted to his students, Shanmugasundaram, Varalakshmi, Pradeep, Udhayabanu, Venugopal, Susila, Karthikeyan, Sreenivasulu, Praveen Kumar, Alamelu, Ajeet and his collaborators Dr. V. Subramanya Sarma, Prof. M. Kamaraj, Prof. K. Prasad Rao, Prof. M. Balasubramanian, Prof. G. Markandeyulu, Dr. S. Srikanth who were involved in this work.

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[36] Ch. Sree Rama Linga Prasad, G. Sreenivasulu, S. Roopas Kiran, M. Balasubramanian and B.S. Murty, *J. Nanosci. Nanotech.*, **11** (2011) 4097.

[37] G. Sreenivasulu, V. Hari Babu, G. Markandeyulu and B.S. Murty, *Appl. Phys. Lett.*, **94** (2009) 112902.

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[39] K. Alamelu, M.S. Chandrasekar, G. Bhaskar Raju, S. Srikanth and B.S. Murty, *Int. J. Min. Proc.* (under review)

99th Indian Science Congress

January 3-7, 2012, Bhubaneswar

II

Abstract of

Platinum Jubilee Lecture

High Resolution Electron Microscopy of Novel Materials

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With the advent of high-resolution electron microscopy (HREM), structural investigations of alloy phases have become considerably easier because atomic arrangements can be imaged directly by HREM. This mode of microscopy has not only helped in unraveling the structure of materials which have been at the forefront of materials development, but also is fast becoming a technique for solving some outstanding issues in the case of commercial alloys, thereby helping alloy development. Since this mode of microscopy allows direct observation of structure with remarkable clarity, it is very useful in revealing the nature of deviation from the perfect crystalline structure which is responsible for the origin of various types of crystallographic defects in crystals. HREM has emerged as a very powerful tool for probing the structure of the electronic materials. The multilayered structures of contemporaneous interest for their desirable properties from scientific as well technological viewpoints are being examined in considerable detail using this form of microscopy. HREM has been particularly useful in this area because of its ability to resolve the interface structures in these materials. This form of microscopy is also being extensively used in the study of the nano-crystalline phases. With the advent of aberration-corrected electron optics, an entirely new generation of instruments has emerged which enable studies in materials science to be performed at subangstrom resolution to meet the growing demand of nanosciences and nanotechnology for the atomic-scale characterization of materials, nanosynthesized products and devices. Equipped with electron-energy filters and electron-energy-loss spectrometers, the new instruments allow studies not only of structure but also of elemental composition and bonding.

This presentation describes results of HREM investigations on some Ti, Ni and Zr based intermetallic compounds. Specific examples are cited from studies carried out on TiAl, NiTi, Ni-Mo and Zr-Nb-Al alloys. Structure imaging of the phases observed has been carried out. The nature of the atomic arrangement around interfaces such as twins, stacking faults and antiphase domain boundaries has been investigated in these alloys. The direct observation of the orientation relationship between the lattices of a second phase and the matrix phase has been demonstrated.

The results of HREM investigations on some interfaces in ultrafine microstructures have been described. The nature of the interfaces associated with nano-crystallline and nano-quasicrystalline phases produced by the crystallization of Zr based metallic glasses has been examined by HREM. The nanocrystals produced by the crystallization of Zr based bulk glass have been found to lie in the size range of 15 to 50 nm. Various types of interfaces in these phases, such as twin boundaries, stacking faults and antiphase domain boundaries, have been studied. The nature of the nanograin boundary and the boundary between two nano-quasicrystalline grains have been examined and compared.

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III

Abstract of

Young Scientist Award Lecture

Electrically stimulated enhanced cell proliferation on ferroelectric composites

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Recently there has been a thrust towards faster osteointegration of the implanted biomaterials with the bone tissue through the application of external stimulus like electric and magnetic fields. This paper reports the influence of electrical stimulation on cellular density, spreading and viability in contact with the developed Hydroxyapatite-40wt% $BaTiO_3$ composite. The samples were clustered using fibroblast cells and analysed qualitatively as well as quantitatively by means of SEM, Fluoroscent microscopy and MTT [3(4,5dimethylthiazol-2-yl)-2, [5-diphenyltetrazolium bromide] assay. The results show that the pulsed electrical stimulation (1-2V, 6% duty cycle and 100Hz frequency) modified the cellular functionality indicating the enhanced biocompatibility of developed biomaterial.

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IV

Abstracts of

Invited/Oral Presentations

Light Alloy Processing Revolutionizing the Automotive Industry

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Light alloys of magnesium and aluminum hold the key for weight reduction, fuel consumption, engine efficiency and emission control. Focused advances in processing of cast and wrought light alloys are being accomplished over the past decade. Such processing techniques include casting, welding and heat treatment. However, challenges remain in materials development, and these include hot tearing, fluidity and melt cleanliness. Nevertheless, the impact of potential achievements on the automotive sector, human ecology and environment can be spectacular.

Rare Earth Oxide Nanoparticles: From Corrosion Protection to Biological Antioxidants

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Nanomaterials, especially cerium oxide nanoparticles, have been shown to effectively protect stainless steels from high temperature degradation. However, recently we discovered the unique antioxidant properties of Nanoceria, where it protects mammalian cells against damage caused by increased reactive oxygen or nitrogen species, and has been shown to act as effective superoxide dismutase mimetic in vitro. The redox ability of rare earth oxides (ceria, lanthanides, etc) has been used in a wide range of applications such as three way catalysis, oxygen buffer systems, sensors and corrosion prevention. While these nanostructures have been widely used in many inorganic applications, their role in biology as catalyst is not explored fully. This presentation will provide a brief overview of the applications of nanoceria in treatment of disorders caused by ROS. The role of size and stability has also been explored. For various practical applications, synthesis of biocompatible and stable suspensions of nanoceria is essential. It was found that the redox kinetics of regenerative ceria nanoparticles can be controlled with the type of medium and their implications in nanobiomedicine is presented.

Nanocure: Curing Diseases with Nanomaterials

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The grand challenges of disease treatment include: (a) delivery of therapeutic drugs only to the disease site, (b) subsequent controlled release of the drug at the optimum value and (c) monitoring of the disease through imaging techniques. Nanomedicine is a powerful new approach to solve these three outstanding challenges; I will describe our ongoing work on the use of nanomaterials for disease treatment. Novel and significant applications such as targeted drug and gene delivery, biosensors and artificial muscle applications have been developed using magnet (core) - polymer (shell) composite nanoparticles. Multimodal cancer therapy and gene transfection using these functionalized magnetic nanoparticles will be presented. Magnetic oxide nanoparticle (core)-thermoresponsive polymer (shell) composite nanoparticles (CNP) loaded with the anti-cancer drug doxorubicin were studied for multimodal cancer therapy, i.e., magnetic drug targeting followed by simultaneous chemotherapy and hyperthermia. In the presence of an alternating magnetic field, the CNP exhibited on/off switching behavior for drug release. Excellent *in-vitro* hyperthermia with simultaneous chemotherapeutic drug release was observed. *In vivo* targeting of CNP to hepatocellular carcinoma in a buffalo rat model was studied by MRI and histology and efficient *in vivo* drug targeting was verified. Thus, such drug loaded CNP exhibit excellent potential for cancer treatment by combined drug targeting, hyperthermia, controlled drug release and imaging of tumor remission. These studies are being extended to vaccine based approaches to cancer therapy. Our work on enhanced gene delivery using magnetic nanoparticles will be discussed. *In vitro* studies of magnetic transfection in COS-7 cells using pEGFP-N1 and pMIR-REPORT complexed polyethylenimine (PEI) coated magnetic iron oxide nanoparticles were conducted. Magnetic transfection required much shorter incubation time, significantly less PEI for transfection compared to conventional techniques and was also suitable for high cell viability applications. These studies demonstrate the high potential to cure diseases using nanomaterials.

Synthesis of nano materials through Vedic technologies

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The present work enumerates the Vedic process used to produce nano materials through herbal extracts using energy efficient, eco-friendly and economical processing routes. The process starts with captivating herbal extracts either in pulp, powder or juice form dissolved in calculated amount of water. This solution is mechanically stirred for about 15 minutes to ensure that the whole herbal extract gets dissolved in water (From here onwards referred as herbal solution). Now the ore (of the desired nano material to be produced) is taken in a powder form (μm) and is well mixed with the above herbal solution and is stirred for 15 minutes to ensure complete dissolving of the ore in the herbal solution. This entire solution is taken into a vessel where the reaction starts. The powder is collected after 12 minutes from the vessel and filtration is done. The whole process is optimized taking all the process parameters viz., PH of the water/solution, quantity of water/herbal powder/ore, temperature of the solution, time of precipitation, number of filtrations, yield etc. The powder is characterized for micro-structural using TEM and SEM which showed the powder range from 5 nm to 50 nm. XRD was done to check the phase formed and their relative crystalline structure.

High Performance Nanomaterials for Lithium Ion Batteries

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In recent years Lithium Ion Batteries (LIBs) have found applications in electric/hybrid electric vehicles apart from several portable devices. For such high-power applications, the LIBs need to satisfy several criteria, namely, cost-reduction, improvement in the energy density, safety-in-operation at high current charge/discharge rates and improvement in the low and high-temperature operation. To satisfy the above criteria, researches are being carried out worldwide to find alternative electrode materials by novel preparative methods to produce nano structured materials with optimum particle size, shape and surface area. In this presentation, after a brief introduction about basic principles of operation and materials perspectives of Lithium Ion Batteries, results from the studies on novel and existing electrode materials such as $LiVPO_4F$, $LiFePO_4$, $Li(M_{1/6}Mn_{11/6})O_4$ ($M=Mn,Co,Co_{1/12}Cr_{1/12}$), novel Sn-based mixed oxides: $(V_{1/2}Sb_{1/2}Sn)O_4$, $(In_{1/2}Sb_{1/2}Sn)O_4$, Co_3O_4, CoN and nanofiber TiO_2 will be presented. High performance studies and reaction mechanisms of nano materials for lithium ion batteries applications will be discussed.

Discovering the Materials Gene: informatics for materials discovery

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Recently, the US White House Office of Science and Technology issued a policy paper on the next grand challenge science initiative in the United States. Called the Materials Genome Initiative, this document summarized the need for accelerating materials discovery and design in the face of global challenges associated with energy, health and climate1. The report notes that “the word genome, when applied in non-biological contexts, connotes a fundamental building block toward a larger purpose”. However, the challenge remains as to what exactly is a “materials gene”? In this talk, I present an explicit definition of the materials gene in terms of specific classes of materials discovery and design problems. Ranging from discovering new multifunctional materials to exploring the limits of materials design at the mesoscale, it is shown that the challenge in discovering the fundamental building block for materials behavior can be met by carefully applying the tools of information theory with the computational and experimental based materials science data. This new paradigm of materials informatics offers unprecedented opportunities that can permit materials scientists to address global societal needs.

Multifunctional Devices using Semiconductor Nanostructures

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Multifunctional electronic devices integrate more electronic functions in a single device. These are devices where the active layer has the properties of emitting/absorbing light and/or conducting/trapping charges. In particular, electronic charges can efficiently recombine or be trapped in quantum sized nanocrystals. Therefore, nanocrystals embedded metal-oxide-semiconductor (MOS) structures are attractive for dual function applications, as in light emitting diodes (LEDs) and floating gate memory devices. We shall present the structural and optical properties of Ge quantum dots and CdSe nanocrystals embedded in oxide or polymer matrices for memory and light emitting devices. The light emission in the visible wavelength range from Ge nanocrystals embedded in different high band gap matrices was attributed to quantum confinement of carriers. An anti-clockwise hysteresis behavior was observed in capacitance-voltage measurements of MOS devices for different sweep voltages, indicating net electron trapping in nanocrystal based floating gates. The efficacy of II-VI semiconductor nanostructure composites for multifunctional devices will be discussed.

Green-synthesis of optical nanofluids for biosensors and medicines

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Our research group at Indian Institute of Technology, Kharagpur, is exploring green chemistry in order to produce variety of functionalized materials of noble metals, transition metals, oxides and derivatives in the forms of nanofluids, nanopastes, or films.[1-3] This is an easy approach to devise functional materials and chemical processes without causing harm to the environment and human life. We observed that in modest reactions carried out in a rheological polymeric host at an elevated temperature, a desired material nucleates and grows of small particles, or self-assembles of small particles, in conjunction with a kind of a specific bonded topotactic surface layer in a core-shell nanostructure. This specific surface co-layer controls the shape, size and surface topology in a growing structure in controlled conditions in conjunction with other parameters. It also determines functional properties of the material produced. This is demonstrated in this work with selective examples of metals and oxides embedded in a rheological polymeric fluid in the forms of optical nanofluids. Coated entities by a polymer molecule are easier in dispersing homogeneously in a rheological medium required to devise a stable nanofluid for biological sensors and medicines, biological labeling, contrast imaging, color pigments, micro-barcoding, etc. In-situ growth of a topotactic layer not only immobilizes the particles by extending a cross-linking through the medium but also modifies the rheology and other useful properties of a nanofluid. Effects of a graphene like bonded surface overlayer on a surface modification of desired properties are described with optical, magnetic, and rheological properties studied for selective nanofluids before and after optimal thermal annealing at elevated temperatures in ambient air. Controlled thermal annealing modifies sensitively the surface-interface structure, the dynamics of the surface-plasmons and surface spins and in-turn useful functional properties. Novel results are analyzed in correlation to the microstructure, XPS (confirm the surface structure) and other functional properties.
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Li ion Batteries for Electric Vehicles

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The talk is designed to provide an overview of the material, geometrical and functional aspects of Li ion Batteries especially in the context of their commercial application in Electric Vehicles. The basic concepts of rechargeable batteries will be presented along with the history of the development. The physics of anode, cathode separator, electrolyte and other constituents will be highlighted. Aspects such as, safety, ageing of the cell material, manufacturing, recyclability and cost will be touched upon briefly. It is also proposed to cover the comparison of various promising and competing Li ion battery materials those are still in the research stage.

Steel industry meeting strategic challenges by innovative developments

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The steel industry is addressing the global trends in environment which are characterized by scarcity of raw materials, energy and water. The strategic challenge for manufacturing industries is to develop market leading products and processes that will help us and our customers address the global trends of scarcity and to significantly reduce CO2 emissions. This paper presents examples of innovative product and process development work carried out by Tata Steel to address the strategic challenges.

Among renewable energy resources, solar energy is emerging as the most promising source. Work is carried out worldwide to find effective and affordable technologies for harvesting this uninterrupted energy source. Tata Steel is working on advanced technology for harvesting solar energy efficiently. We are also developing integrated solutions, such as energy independent houses, which would increase the living standard for the population with minimal output of greenhouse gasses.

Our customers in the automotive industry are looking to meet the global environmental trends by developing lighter cars with increased crash safety. Often alternative materials such as magnesium, aluminium, plastics, and composites are considered. The advantage of steel is however its recyclability, formability, and relative inexpensive raw materials. Tata Steel looks to enable this trend at our customers by development of advanced high strength steel that combines high strength with high formability.

In addressing the strategic challenges, Tata Steel is also looking to increase the sustainability of the steelmaking process by innovative. As an example, we are developing technologies to increase heat transfer coefficients in order to enhance energy efficiency in existing processes. We are also involved in a European project for an alterative route for ironmaking that allows the use of wider range of iron ores and drastically lowers the CO2 emissions of the ironmaking process.

Development of Advanced High Strength Steel: Step towards Green Steel Concept

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Two major industries fuelling the perpetual development of high strength steels are automotive industry and petroleum pipe line industry. The automotive industry is using increasing proportion of high strength steel in a bid to reduce the weight of the vehicle and thereby achieve a better fuel efficiency. On a long term, this results in lesser carbon dioxide emission on a sustainable level. In the case of petroleum industry, the driving force is transportation of gases at higher pressures, thereby increasing the specific throughput of the pipeline with minimal project cost. Yet other field where use of high strength steel is gaining momentum is structural fabrication.

The average energy consumption for production of one ton of steel in India is about 6.5Gcal. The specific energy consumption for plain carbon steel and micro-alloyed high strength does not differ by large extent. With marginal additional energy consumption, steels with nearly double the strength of common grade steels can be produced. For example, by replacing normal structural grade steel with an yield strength of 275MPa with high strength steel of yield strength 500 MPa, the weight of steel consumed can be reduced to nearly 50% while additional energy requirement is not more than 10%. Increasing substitution of normal steel with high strength steel will lead to overall lesser energy consumption and hence lesser gas emissions.

At JSW Steel Limited, steel grades for all the above mentioned applications are being produced. Currently, the highest strength level of steel developed and commercially produced are of typically of 550MPa yield strength, while typical strength level of the steel used by the industry at present range from 235 MPa to 355 MPa. To achieve such high strength levels, various approaches are employed depending on the thickness and application of the steel. Automotive industry, in general, requires thinner sheets while structural and pipeline requirements are in thicker sections, typically more than 12mm in thickness. Steel offers a variety of strengthening mechanisms. Recent developments in cooling technologies in hot strip mills have made it possible to achieve desired kind of microstructure in the hot rolled steel, including martensitic structure, during normal production conditions.

At JSWSL, for automotive applications, two high strength grade steels have been developed: (i) Dual Phase steel, DP600, with YS > 450MPa and TS > 600 MPa; (ii) Ultra fine grained high strength low alloy steel, HS780, with YS>600 MPa and TS> 780. DP600 is based on the Ferrite + Martensite dual phase micro-structure, where the larger ferrite fraction provides adequate ductility for forming, martensite provides the high strength. In case of HS780, the steel is basically Ferrite + Pearlite steel with carbide precipitate strengthening with very small fraction of pearlite. The carbide precipitates retard grain coarsening after hot rolling and result in ultra-fine grains.

High strength structural steel was developed on the solid solution strengthening and micro-alloying principle. The microstructure of the structural grade steel is typically ferrite + pearlite with carbide precipitates as strengtheners. Ferrite, strengthened by Mn and Si in solid solution, forms the major fraction of microstructure and strength levels of more than 550MPa Yield Strength are achieved by increasing the fraction of carbide precipitates and pearlite fraction.

In contrast to the structural application requirement, the pipe line industry requires steel with high toughness in addition to the high strength levels. Due to the harsh climatic conditions the pipe lines may experience, the low temperature toughness and hence a lower ductile to brittle transition temperature is a critical requirement of pipe line grade steel. While an approach similar to the structural steel development can be employed to attain the strength level, the presence of pearlite affects the toughness often increasing the ductile to brittle transition temperature. At JSWSL, API-5L-X80 grade steel, with YS > 560MPa has been developed using the ferrite + carbide precipitate approach. The matrix of the steel is solid solution strengthened ferrite with fine carbide precipitates. However, unlike the equiaxed ferrite grains obtained during normal cooling during hot strip rolling, JSWSL employs intensive cooling technique to achieve acicular ferritic structure. The single phase acicular ferritic matrix gives excellent low temperature toughness and high strength the pipe line grade steel.

The strengthening mechanism and micro-structures shall be discussed in detail.

Science and Technology of Dye Sensitized Solar Cells

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A continuous increase in demand of energy and rapid consumption of fossil fuels in the country have made it mandatory to find an alternative and affordable source of energy for making the country's economy grow. As our country is blessed with abundance of sun light, it becomes an obvious and reasonable choice to use solar cells to generate electricity efficiently and economically for meeting the increasing demand in energy. Since 1991, following the demonstration by Michael Gratzel, dye sensitized solar cell (DSSC) has been attracting attention of both researchers and industries worldwide and it is being considered to be a potential alternative to conventional inorganic p/n junction solar cells because of several advantages of the former over the latter. Easy and inexpensive methods of fabrication, low material cost and reasonably good power conversion efficiency (10-12%) have made DSSCs an attractive and viable technology for converting solar energy to electricity more economically. It has been observed that DSSCs perform better in diffused light than silicon solar cells and hence find attractive indoor applications. Moreover, these cells, made on flexible substrates, find wide range of applications, such as power on clothes, bags, car tops etc. The translucency/transparency and good performance in diffused day light and at moderate temperature - up to 80°C have promoted its use on various parts of buildings.

DSSCs operate differently from other types of solar cells in many ways, with some remarkable analogies to the natural process of photosynthesis and therefore this system has repeatedly been described in terms of artificial photosynthesis. Like the chlorophylls in plants, a monolayer of dye molecules (sensitizers) in DSSCs absorbs the incident light, giving rise to generation of positive and negative charge carriers. Like any electrochemical cell, a DSSC is composed of an anode (photoanode), a cathode and an electrolyte. The photoanode is essentially a mesoporous film made of a wide band gap semiconductor (e.g. TiO_2, SnO_2, ZnO, etc.) with a dye (pigment/ sensitizer) adsorbed on it. This mesoporous film of the semiconductor is made on a conducting glass substrate (e.g. FTO, ITO coated glass), nanoparticles of the semiconductor provide a large internal surface area for the dye to be adsorbed on it. The cathode is often a FTO/ITO substrate with Pt deposited on it, which works as a catalyst for reduction of triiodide to iodide at the cathode. The photoanode and

cathode are assembled together with a spacer sandwiched between the two to maintain a constant gap between the electrodes. And, the gap is filled with an electrolyte, which often contains a iodide and tri-iodide redox couple. The dye adsorbed on the semiconductor absorbs light in visible range of the solar spectrum and gets excited, known as photoexcitation of the dye. The photoexcited electron from the lowest unoccupied molecular orbital (LUMO) of the dye is then injected into the conduction band (CB) of the semiconductor. The electron diffuses through the porous film of the semiconductor to reach the substrate, from where it moves to the counter electrode through an external circuit. The oxidized species of the redox couple (i.e. tri-iodide) gets reduced to iodide at the cathode by electron leaving the photoanode and the iodide then gets transported through the electrolyte to reach the oxidized dye. The oxidized dye is reduced by iodide, known as dye regeneration. The above steps go in cycle as long as the light is incident on the cell and hence the cell keeps on generating electricity.

Light harvest and electron transport in the mesoporous TiO_2 photoanode are two important processes, which influence the photocurrent density and open circuit voltage of DSSCs. The lifetime and reliability of DSSCs is significantly influenced by the nature of electrolyte and sealing materials. Techniques used for deposition of platinum in preparation of counterelectrodes have a significant bearing on DSSC performance. The present work has examined these aspects in detail examining the scientific and technological aspects. Light absorbed by the dye adsorbed in opaque and transparent photoanodes were found to be different. The light harvest by a thin and transparent TiO_2 film with a light scattering layer, made from larger TiO_2 particles, on it has been found to be more than that by an opaque and thick photoanode. This, as a consequence, increased the current density in DSSCs made from transparent TiO_2 films with light scattering layer. Sintering temperature and time for the TiO_2 films has been found to change the current and voltage of the cells significantly by altering the particle size, surface area and interparticle connectivity. TiO_2 films, sintered at high temperature, exhibited faster electron but led to low current density due to low dye loading in the films. DSSCs with titania nanotubes (TNT) were prepared and compared with those prepared using titania nanoparticulates. Nanoparticles loaded electrolytes which must have significantly vaporization of electrolyte yielded performance close to that of liquid electrolytes thus demonstrating potential for their use in cells for enhanced lifetime.

Challenges of structure-property correlations in nano-metallic systems

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The synthesis and characterization of nanomaterials have posed many novel problems. They have led to a paradigm shift in our way of thinking. The purpose of this lecture is to bring out some of the novel aspects of challenges based on our recent experiences of synthesis and characterization of nano-metallic systems. We have recently studied the surface plasmon characteristics of colloidal suspension of Ag, Cu and Ag-Cu alloys in sol state. The nature of absorption during UV-Vis spectroscopic investigations clearly demonstrated the effect of microstructural features of the nano-metallic dispersion. We wanted to characterize the shape, size and distribution of these dispersions. For this, we have undertaken transmission electron microscopic studies of the dry powders of nano-metals after centrifuge. We could see the beginning of agglomeration and the statistics for particles shape and size distribution seem to be not in conformity with the observed surface-plasmon behaviours. Having encountered this, we decided to use small angle X-ray scattering (SAXS) of the sol to resolve aforesaid problems. SAXS studies have given us insight into the nature of microstructural characterization and appear to be better tools of

investigation having average statistics of colloidal suspensions comparable to those that give rise to absorption in UV-Vis spectra in sol state. The scope and challenges of research in these areas will be highlighted.

Evolution of crystallographic textures in materials processing and its implications

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Processing of materials involve the evolution of crystallographic textures. An adequate control in processing parameters can lead to specific textures, which might render the desirable property in the processed material. The processing domain is extended from conventional to modern trends in materials processing and the property domain extends from mechanical to functional properties. The evolution of texture and its role on mechanical properties has been widely investigated and is well known for many structural materials for conventional processes. However, this is not fully understood for structural materials subjected to unconventional processes as well as for functional materials. This presentation will cover some of the ongoing activities in this area in the author's laboratory and will also highlight some of the unexplored issues.

Solidification of undercooled Heusler alloys

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Undercooling plays an important role in determining the phase selection and microstructure of solidified alloys. Electromagnetic levitation and molten flux immersion are two techniques to control and determine bulk undercooling during solidification of metallic droplets. Heusler alloys are being studied with renewed interest in the recent past due to their magnetic applications. In this presentation, recent studies on nickel based Heusler alloys will be presented. Phase selection as a function of undercooling will be discussed. The results will be corroboration with detailed characterization studies and compared with other solidification techniques.

Computational Intelligence in Ti-6Al-4V alloy design

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Ti-6Al-4V is the most widely used titanium alloy, accounting for more than 50% of all titanium tonnage in the world. The aerospace industry accounts more than 80% of this usage. The next largest application is medical devices or implants, which accounts 3% of the market. This two-phase alpha-beta alloy exhibits an excellent combination of corrosion resistance, strength and toughness. The properties of Ti-6Al-4V alloy depend mainly on alloying elements, method of production, mechanical and thermal treatments. The relationships between the process variables and final properties of the alloy are complex, non-linear and interdependent in nature, which is the biggest hurdle in developing proper correlations between them by conventional methods.

Artificial neural networks and Genetic algorithms are recently emerging area of fundamental and applied research exploiting a number of advanced information processing technologies. An artificial neural network is an information processing and modeling system, which mimics the learning ability of biological systems in understanding an unknown process or its behavior. The genetic algorithms are powerful probabilistic heuristic procedure for global search and robust optimization in multi-parameter search spaces based on the mechanics of natural genetics.

Sensitivity analysis of trained neural network model resulted to find the instantaneous impact of inputs on output parameters. Genetic algorithms are applied to optimize the input parameters for the desired mechanical properties. The model predictions and the analysis are well in agreement with the experimental results. Since, the artificial neural networks and genetic algorithms are the computational models of learning and evolution process of naturally intelligent system, the proposed framework is referred as Computational Intelligence (CI). In the present work, CI models were developed for the analysis and prediction of the correlation between the process parameters, the alloying elements, microstructural features, beta transus temperature and mechanical properties in Ti-6Al-4V alloy.

Liquid metal route foaming of aluminium alloys – Scientific Challenges and Opportunities

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Making closed-cell aluminum alloy foams directly from molten alloys promises to be economical as fewer processing steps are required compared to manufacturing routes based on metal powders. Foams produced in this way require ceramic or intermetallic particles for stabilization. We develop novel foamable aluminum alloys reinforced with sub-µm or nano sized ceramic particles prepared by in-situ/ex-situ synthesis, mainly for the cost reduction and good machinability of the foam products. Foaming is done by direct and indirect methods and the foam evolution is studied in-situ by X-ray radioscopy. The stabilization behaviour of particles is studied by electron microscopy, synchrotron X-ray tomography and focused ion beam tomography. The drainage, cell wall coalescence and density distribution in liquid foams are studied under microgravity. In parallel new processing routes are being explored, such as foaming under reduced pressure and foaming scraps.

The fundamental of stabilization in aluminium foams is studied by a model system called single films. The films are pulled from molten aluminium alloys under controlled atmosphere to understand the influence of the particles and the oxides on each other as well as their individual contribution on stabilization. Our work focuses on establishing a stabilization mechanism and It appears that both particles and oxides are essential for foam stabilization.

Shape controlled synthesis of α-Fe_2O_3 : A novel photocatalyst for dye-degradation

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In last decade, great interests and efforts have been taken by the mission-oriented material designers to fabricate the architectural nanostructures. Here we have fabricated one-dimensional (1D) hematite (α-Fe_2O_3) nanorods by hydrothermal technique using $(NH_4)_2HPO_4$ as the structure directing agent. The effect of surfactant (SDS and PEG) on the surface morphology was also investigated. The above synthesized samples were characterized by various techniques such as XRD, TEM, and SEM. Analytical results reveal the phase and morphology of the synthesized sample. The synthesized materials were also studied for photocatalytic degradation of different dyes such as phenol, methylene blue and congored.

Biomechanics of polymeric nanocomposites for orthopedic applications-effect of processing

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Biodegradable nanocomposite materials have potential scope in orthopedic applications. Dynamic compression bone fixation plate prototypes were prepared using biodegradable polyester, HT-poly (propylene fumarate) HT-PPF resin and hydroxy apatite particulate nanofiller as per the specifications ASTM F 786 I. The effect of casting process on the dynamic biomechanical behaviour of the nanocomposites was investigated by comparing with nanocpomsite sheet (rectangular bar 50 mm long, 10 mm wide and 1 mm thick). Hydroxy apatite (HAP nanopowder 200 nm (BET) Sigma/Aldrich) was used. The studies reveal that prototypes made by casting process have rapid decrease of storage modulus and undergo premature failure in simultated physiological fluid.

Tempering of Martensite in Dual-Phase Steels and Its Effects on Softening Behavior

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Dual-phase (DP) steels offer high strength and good deformability, which has made them potential candidate for the fabrication of automobile body frame structures with the purpose of reducing fuel consumption through down-gauging and to improve the crashworthiness behavior. However, an important issue with DP steel, which restricts its use in practical applications, is the heat affected zone softening that occurs in welding due to tempering of the martensite phase in the base metal. In the context of explaining the martensite tempering that causes softening, the present study was aimed at investigating the isothermal and nonisothermal tempering of martensite in DP steels mainly by analytical transmission electron microscopy and the consequent effect on softening behavior. The isothermal tempering resulted in coarsening and spheroidization of cementite and complete recovery of

laths. However, nonisothermal tempering manifested fine quasi-spherical intralath and platelike interlath cementite, decomposition of retained austenite, and partial recovery of laths. The finer size and platelike morphology of cementite coupled with partial recovery of lath resulted in reduced softening in nonisothermal tempering compared to severe softening in isothermal tempering due to large spheroidized cementite and complete recovery of lath substructure. The substitutional content of precipitated cementite in nonisothermal tempering was correlated to the richness of particular steel chemistry. Softening resistance during nonisothermal tempering was related to DP steel chemistry, i.e., Cr and Mn content. Fine cementite and less decomposed martensite in rich chemistry confer high resistance to softening compared to leaner chemistries, which indicated severe decomposition of martensite with coarser cementite.

Mechanical and Thermal Properties of Carbon Nanotube Reinforced Aluminium Composites at Multiple Length Scales

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Carbon nanotubes (CNTs) have created a huge amount of expectation as potential reinforcements in metal matrix composites (MMCs). Interest in CNT reinforced MMCs have been increasing since last decade and a lot of research is being carried out. The potential applications include structural load bearing members as well as functional applications such as thermal management materials, anode for Li batteries and hydrogen storage applications. CNT reinforced aluminum composites are potential candidates for space applications requiring high specific strength and specific stiffness. The mechanical properties of these composites have been shown to depend strongly on the CNT dispersion. In this study, the mechanical and wear properties of plasma sprayed Al-Si-CNT composites has been studied at different length scales using nano-mechanical tests such as nano-indentation and nano-scratch and macro-scale tests such as bulk tensile and compression tests and ball-on-disc wear tests. The effect of CNT dispersion on thermal conductivity of the Al-Si-CNT composite has been studied using Object Oriented Finite Element Modeling. The properties measured/computed at different length scales are compared to elucidate the effect of CNT clustering.

Crystallization of Metallic Glass

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Since its discovery in 1960 by Paul Duwez, glassy structure in alloy systems has been a subject of interest among the researchers. The stabilized liquid can be useful for studying many aspects of phase transformations in the liquid state. Transformation of a liquid metallic melt to the glassy phase requires kinetic suppression of nucleation and growth process of crystal by application of proper kinetic constraints. The extent to which the kinetic constraint is to be applied varies from system to system. However, understanding glass formation is equivalent to understanding both the thermodynamic and kinetic aspects of crystallization. The present talk will concentrate on the thermodynamics and kinetics aspects of glass formation and its crystallization. In the present context, some of the factors deciding glass formation such as Gibb's free energy difference between liquid-crystal, interfacial energy for solid-liquid interface, viscosity of the undercooled liquid, maximum nucleation temperature

during crystallization of an undercooled liquid will be focused for a better understanding of the formation criteria of a glass. A method to determine kinetic parameters like growth velocity, diffusion constant, etc. for the devitrification of glass has been found out with the help of pseudo-DSC experiment. One new method for determining isothermal kinetics for crystallization of glass from nonisothermal data has been thought of. Moreover, recent investigation has shown that the growth direction to be taken by solidification front can be well understood with the help of glassy structure.

Evaluation of glass forming ability for metallic glasses based on thermodynamic criteria

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Since the invention of Metallic Glasses there has always been a scientific curiosity among researchers to understand the formation of glassy phase. The bottom line problem in the field of metallic glass is to search and screen the composition that transforms crystalline structure into glassy phase easily. Over past five decades extensive work has been done to understand the scientific basis for glass formation and number of glass forming ability (GFA) schemes has been proposed by metallic glass research community. Well known proposed GFA parameter relies on availability of thermal analysis data such as glass transition, crystallization and liquidus temperature. A thermodynamic parameter P_{HS}, which is a product of enthalpy of chemical mixing (ΔH_{chem}) and mismatch entropy ($\Delta S_{\sigma}/k_B$), is one of the theoretical GFA criteria which have been successfully applied by present author to optimize metallic glass forming composition in various multicomponent systems. It is found that the most negative P_{HS} value has higher glass forming ability. In the present work P_{HS} is calculated for the entire Zr rich region in Cu-Zr-Ti family. Cu rich Cu-Zr-Ti alloy is well known for its GFA and has been widely studied to understand the influence of Ti addition on GFA of $Cu_{60}Zr_{40-x}Ti_x$ and $Cu_{50}Zr_{50-x}Ti_x$. $Cu_{50}Zr_{42.5}Ti_{7.5}$ alloy is experimentally reported in literature for maximum critical diameter of 5mm which according to present model also have most negative P_{HS} value. In present investigation, role of P_{HS} in GFA is studied in Cu-Zr-Ti system and compared with reported experimental results.

Novel methodologies for exploration of the deformation behavior of emerging engineering materials at diminishing length scales

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The advent of instrumented nanoindentation has opened up several exciting avenues to understand the local deformation characteristics of wide variety of materials. The restriction of deformation to highly localized regions allows the enthusiastic scientists to understand the atomic level processes that are responsible for the initiation of deformation and its sustainability. At the newly established School of Engineering Sciences and Technology (SEST), University of Hyderabad (UoH), efforts have been made to understand these localized deformation characteristics in a spectrum of materials including bulk single crystals, thin films of diamond based composites, structural polycrystalline steels, novel nanostructured alloys and composites. This talk would discuss the load-displacement

behavior of these materials, evaluation of strain rate sensitivity using nanoindentation and its dependence on grain size and/or composition of the constituent phases. The correlation between the properties obtained by other conventional mechanical testing procedures and the properties evaluated by using nanoindentation would also be made. This work in part is supported by the Department of Science and Technology, Government of India.

Intermetallic phase formation in DC casting of Al alloys

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Wrought aluminium alloys are widely produced by direct chill (DC) casting. Intermetallics in DC cast Al alloy billets vary from the surface to the centre as the result of changes in local solidification conditions. Despite cost and energy factors, homogenisation is applied to the cast billets to produce a more favourable and uniform microstructure. But an increase in the recycling of scrap metals is pushing the casting process to tolerate more impurities and inclusions. Inclusions in liquid metal are unavoidable, they either enter through inoculant additions or form during liquid metal handling. This presentation highlights the role of inclusions/inoculants on intermetallic phase formation during solidification. An intermetallic phase extraction technique is used to facilitate the physical interaction of inclusions with intermetallics. This technique also helps in analysing three dimensional interconnectivity, morphology and fraction of intermetallics in both as-cast and homogenised billet.

Excitement of Nanocrystalline ZnO

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Intrinsic defecsts play a vital role for changing the properties of nanocrystals. For a deeper understanding of the intrinsic and extrinsic defects in undoped and doped nanocrystaline ZnO, further improving synthetic control and dopant incorporation, optimisation of their concentrations and processing, and investigations of emerging phenomena are required. Defect studies have been considered for more than 50 years, but now there is need for a revisit in the context of normal applications using nanostructured materials. In the past, defect chemistry was studied in relation to ZnO properties and applications as ZnO varistor: defects significantly alter the grain boundary (GB) properties and also V-I characteristics. But the origin of non-linearity in *U-I* characteristics at nanoscale ZnO is still not clear. Here, we report for the first time the origin of the non-linearity of the V-I behaviour in nanocrystalline ZnO.

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Abstracts of

Poster Presentations

MSP1 Removal of Hexavalent Chromium from contaminated groundwater using nano zero valent Iron

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In this present study, a typical batch reactor included a 100mL solution with the desired dose of mmZVI or nZVI iron nanoparticles for each pH of 2, 4, 6, 8 and 10 at 150rpm. nZVI showed better Cr(VI) removal percentage compared to mmZVI, because of its enormous surface area. The former one gave more than 80% of its total removal within first 1hr of its total reaction time, and the second one was taken 4hrs to reach 80% of its total removal. As the pH increased, the removal of Cr(VI) decreased. Speciation studies showed that total Fe species present in the aqueous phase was less than the total Fe present in the solid phase at acidic pH and more alkaline pH condition. The presence of Chromium species in the solid phase was less compared to the Cr species in aqueous phase at all pHs. Precipitation will end with the clogging of pores in the actual field condition, if this technique is applied as in-situ. Based on the mass balance results, we can conclude that acidic pH reduces the chance of clogging of pores than alkaline pH

MSP2 synthesis and characterization of Diaminoalkyl Polysiloxane nano emulsion for water repellent finishing of cotton fabric

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Diaminoalkyl polysiloxane(DAAPS) has been synthesized using ring opening polymerization and characterized by analyzing FTIR and H NMR spectra. The nanoemulsion of DAAPS has been applied on to cotton fabric by a pad-dry-cure technique at different concentrations (5-25gpl) with 70% expression at padding. The results showed that the treatments of nano emulsion of DAAPS not only improved the water repulsion of the fabric but also influenced the Tensile strength of the fabric sample positively without hampering the comfort properties with respect to air permeability and bending length. o significant change in water repellency was observed even after continuous rubbing with skin simulating friction partner under significant load. The treatment was found to enhance the color depth and fastness properties of cotton samples dyes with direct dye.

MSP3 Study of high directivity in low permittivity metamaterial slabs for leaky-wave models

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Investigation has been carried out on the directivity of grounded low-permittivity metamaterial slab structures that achieve highly directive broadside radiation. Two dimensional (2D) configurations excited by electric Jine sources are considered, adopting a scalar plasma like dispersive permittivity for the metamaterial medium that suitably models a wire medium in the presence of a 2D electromagnetic field, with the electric field directed

along the wire axis. The role of leaky waves in producing the high directivity attainable with such structures is illustrated by comparing it with a simple ray optic model for the radiatopn mechanism.

MSP4 Study of Millimeter Wave Metamaterial Development Using the Design of Experiments Technique

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In this paper a design of Experiments (DOE) approach in a feasibility and design study of a metamaterial structure is presented. The frequency of interest is 40 GHz and the technology used is multilayer Low Temperature Co-fired Ceramic (LTCC). The chosen approach for the Double Negative Metamaterial implementation is a loaded Coplanar Waveguide (CPW) transmission line. The design goals are a resonant frequency of 40 GHz and minimum insertion loss at that frequency. The electromagnetic performance of the loaded transmission line is simulated with a full wave time domain commercial simulator. The results of these simulations are incorporated into the DOE technique. First, the significant factors in achieving each of the goals are identified, then statistical models are developed for the two output variables and applied to optimize the structure.

MSP5 Study of Negative index meta-materials with two-dimensional metallic structures

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The electromagnetic properties of two-dimensional metal lie nanostructures in the optical frequency range are studied. One example of such a structure is a periodic array of thin metallic strip pairs. The magnetic response of these structures is studied, as is the closely related emergence of the negative index of refraction propagation bands. The presence of such hands is found to critically depend on the proximity of electric and magnetic dipole resonances. It is demonstrated that the frequencies of those resonances ate strongly dependent on the ratio of the structure thickness and the plasmonic skin depth. Electromagnetic structures that are much thicker than the plasmonic skin depth are shown to exhibit standard broad antenna resonances at the wavelength roughly twice the strip length. As the structures are scaled down to resonate in the visible/mid-infrared, electrostatic resonances determine the electromagnetic properties of such materials.

MSP6 Study on physico-chemical behavior of fibres extracted from banana plant available in North East India

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Two species of banana plants viz *Musa sapientum* and *Musa paradisica* available in North East India were selected for present study considering their higher biomass yield and good physical properties of the fibres. The fibres of above two banana species were extracted by

i) mechanical process and ii) chemical process. The chemical compositions, spectroscopic and thermal properties of these fibres extracted by the above two methods were characterized to investigate their suitability for commercial exploration. The chemical constituents of both mechanically and chemically extracted banana fibres were analyzed as per to TAPPI standard method. Chemical constitutional analysis of banana fibres shows that the cellulose content was comparatively higher (66.2 %) in chemically extracted than mechanical one (52.75 %). Structural analyses of these fibres were carried out by FTIR and XRD. These studied showed that due to the chemical extraction, noncellulosic constituents such as hemicelluloses and lignin were removed and crystalline properties of the fibres were increased, while in case of mechanically extracted fibres show little crystallinty predominant with amorphous behavior.

MSP7 Synthesis of poly (acrylate-acrylic acid-co-maleic acid) hydrogel for removal of heavy metal ions of effluent water

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New methods are being developed to correct the imbalances of water system caused by effluents as removal of metal ions from sewage and industrial waste is posing a big problem. Super absorbing hydrogels i.e., cross linked hydrophilic polymer of three dimensional network having porous structure, were reported to be an effective material for the safe and convenient treatment of industrial effluents. The comparatively moderate cost and the ease of preparation make the hydrogels a promising candidature for the said application. Here we report a new poly (acrylate-acrylic acid-co-maleic acid) hydrogel synthesized by copolymerization of acrylic acid and maleic acid in aqueous media using N, N-Methylene bis acrylamide as cross linker and ammonium persulfate as initiator. It is observed that the swelling ratio and metal adsorption capacity of hydrogels vary markedly with the amount of cross linker added. Swelling kinetics in distilled water is shown to be non-Fickian.

MSP8 TO STUDY ELECTROLUMINESCENCE IN (Al_2O_3-ZnS) Cu,Cl SAMPLE

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Investigation of electroluminescence in (Al_2O_3-ZnS) Cu, Cl composite .A different composition of (Al_2O_3-ZnS) Cu, Cl with blue green emission has been prepared by heat treatment technique. Copper is used as the activator atom in (Al_2O_3-ZnS) Cu, Cl mixed lattice, and chlorine has been used as co-activator .Spectral distribution shows maxima at 5460 Å with excitation frequency and voltage . The intensity increases and usual laws of luminescence are followed. ZnS (Eg ≈ 3.6 eV) is though an efficient luminescent material Al_2O_3(Eg ≈ 5eV) in non – luminescent .Hence an attempt is made to study the behavior of composite. In current years, scientist have studied electroluminescence in nano-particles like self assembled film of PPV and Cd-Sc nano-particles[1] . In general, the visible luminescence spectrum of CdS shows yellow orange and red emission[2,3]. Photoluminescence and electroluminescence have also been reported from polymer composites[4]. Much work has been reported on single base material. While less work has been reported in mixed lattice[5] .

After Destriau , new material such as (Zn,Cd,Hg)S[6] , $BaTiO_3$[7] ,$CaSO_4$[8] etc. and mixed compound viz. (ZnO – CdO)[9] and (PbO - ZnO)[10] have been examined.

MSP9 Studies to validate computationally designed Molecularly Imprinted Polymers (MIPs) for Gallic acid

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Molecularly imprinted polymers (MIPs) were prepared for Gallic acid by thermal polymerization method. The selection of the optimal monomer was done using the quantum chemical computational analysis. The solvent interaction with template and monomer was computed through Onsager self-consistent reaction field (SCRF) model. To validate the molecular modeling experiments, MIPs were prepared using acrylic acid as functional monomer and ethylene glycol dimethacrylate (EGDMA) as crosslinker in presence of four different porogenic solvents i.e. 1-4 dioxan, tetrahydrofuran, acetonitrile, and methanol separately. The performance of prepared MIPs was evaluated by rebinding experiments. The experimental results indicated validity of the molecular simulation experiments. The composition of the MIPs was optimized by systematic investigations of the influences of quantity of porogen, functional monomer and crosslinker on the rebinding performance of the MIPs.

MPS10 Effect of chemical treatment of coir fibre on quality of coir-polyethylene waste composite board

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Coir is an important lignocellulosic fibre can be utilized with waste polyethylene in different ways for achieving making composite board to get desired properties and texture. As such coir fibre is hard, rigid having the properties of high level of moisture absorption, poor wettability and insufficient adhesion with polymer matrix leads to debonding with time. In order to get better quality product from coir fibre, some improvement of the coir fibre property with the help of chemical treatment is needed. In our present work, chemical treatment of coir fibre with NaOH, dilute HCL, Acetic acid and Alcohol-benzene solution were used for improvement of fibre property as well as composite boards prepared from treated fibre and waste polyethylene. The chemical constituents of coir fibre like cellulose, lignin, ash, hot water soluble, alkali soluble were tested before and after the chemical treatment. Lignin content of fibre was reduced from 44.48% to 21.50%, 14.50%, 28.30% and 33.65% after the treatment with HCL, NaOH, Acetic acid and Alcohol benzene respectively. Likewise, hot water soluble reduced from 13.9% to 2.35%, 5.40%, 5.84% and 6.78% in HCL, NaOH, Acetic acid and Alcohol benzene treated fibre respectively. The composite boards made from different chemically treated fibres were tested and found that water absorption, total swelling values reduced drastically and the mechanical strength properties i. e. ultimate tensile strength (UTS) and modulus of rupture (MOR) increased. Among different chemical treatment, 15% NaOH treated fibre was found more effective to improve the composite board quality.

MPS11 Effects of NiO addition in ZnO-based gas sensors prepared by thick film process

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A gas sensing performance of pure and effect of NiO by surface modification in ZnO thick films were studied at various operating temperatures. The pure AR grade powder of Zinc Oxide (ZnO) was calcinated at 600ºC for 12 hrs. The thick films of pure ZnO were prepared by screen printing technique. The surface modification of ZnO thick films were obtained by dipping them in to 0.01 M aqueous solution of NiCl2 for 10, 15, and 20 min time interval.The films were fired at 550º C for 30 min. The surface morphology and elemental analysis of the films were studied by SEM and EDAX The gas response of pure and surface modified ZnO films was studied for different gases such as CO, Cl_2, H_2S, Ethanol, and NH3 etc. at different operating temperatures The pure film shows the response to H2S gas at 300ºC while surface modified films shows the response at 250ºC temperature to same gas for 500 ppm gas level. The main characteristics of films such as the Selectivity, Response and recovery time were studied and presented in this paper.

MSP12 Molecular Strucural change of Coir Fiber under mercerization and thermal treatment

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The cellulosic fiber under NaOH treatment (mercerization) undergoes decrystallization and depolymerization . The crystallinity index has been estimated by the ratio of the absorption bands at 1433 per cm and 893 per cm.The IR band at 1267 per cm shows depolymerization at higher degree of mercerization. The absorption band ratio of C=O band (1735 per cm) to C-H band (2929 per cm) gives the oxidation.

MSP13 Formation of stable monolayer of water soluble eosin Y *with dodecyl trimethyl ammonium bromide* and stearic acid

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The Langmuir Blodgett (LB) technique is a way of making ultra-thin nanostructure films with a controlled layer structure. Amphiphilic molecules are ideally suited for LB technique. However, water soluble materials can also be assembled onto ultra-thin films using LB technique.

In the present work, the formation of complex films of eosin Y (EY), stearic acid (SA) and dodecyl trimethyl ammonium bromide (DTAB) with the help of Langmuir – Blodgett (LB) technique was reported. The reaction kinetics in the complex monolayer have been studied by recording the increase in surface pressure with time ($\pi - t$) graph at air – water interface. Formation of complex monolayer at the air water interface was confirmed by in situ BAM investigation.

MSP14 Adsorption of Congored in cationic Langmuir-Blodgett films: spectroscopic investigations

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Langmuir-Blodgett (LB) technique is a unique technique for creating highly organized molecular assemblies of amphiphilic molecules, which has vast applications in the field of molecular electronics. However it is difficult to fabricate LB films using water- soluble materials. This may be avoided by using LB-LbL bi-techniques for the preparation of such films.
In the present paper, the incorporation of an anionic water-soluble dye Congo-Red (CR) in the cationic Octadecylamine (ODA) LB films has been reported. ATR-FTIR spectra confirm the presence of CR molecules in the adsorbed LB films. The adsorption kinetics of the CR molecules in the mixed film has been confirmed by the absorption spectra. SEM pictures reveal the aggregation of CR in the mixed LB films.

MSP15 Study of Cost Effective Technology for Thin film Crystalline Silicon Solar Photovoltaic Cells

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In Crystalline Silicon Cells the bottom layer is doped with boron atoms to create electron “holes,” and the top layer is doped with phosphorous atoms to create excess electrons. The resulting sandwich of these two layers generates an electric field and is called a P-N junction. When Solar Radiations hits the surface of the SPV cell, it stimulates electrons, which are then induced by the electric field to flow through the connected electrical load. This current flow is directly proportional to the intensity of Solar Radiations striking the cell. In this paper we study the advantage of Cost Effective technology for Thin film Crystalline Silicon Solar Cell.

MSP16 Nanocrystalline Spinel from quasicrystalline precursor

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In the present study, low-temperature synthesis of $(Co,Ni)Al_2O_4$,$(Ni,Fe)Al_2O_4$, $(Cu,Fe)Al_2O_4$ and $(Cu,Cr,Fe)Al_2O_4$ spinels from the quasicrystalline phases was investigated with the variation of process parameters during milling and annealing. The milling of the quasicrystalline materials was carried out in an attritor mill at 400 rpm for 40 hours with ball to powder ratio of 40:1 in hexane medium. Subsequently, annealing was performed in an air ambience for 10, 20, 40 and 60 h at 400, 500, 600 and 700°C in side a furnace in order to oxidize the mechanically milled quasicrystalline phase for the possible formation of the spinel

phase. It was found that after annealing at ~500°C temperature, mechanically milled quasicrystalline alloy transformed to spinel phase whereas annealing at lower temperature (<500°C) it led to the formation of B2 phase as a major one along with minor amount of oxide phase. The X-ray diffraction and transmission electron microscopy of the annealed samples confirmed the formation of spinel phase with an average grain size of ~20-40 nm. It is interesting to note that the nanospinel phases showed the different colors during various annealing time and temperature. The optical properties of nanospinel materials, investigated employing UV visible spectrometer exhibited absorption characteristics. The magnetic properties of the nano-decagonal and nano (Co, Ni)Al_2O_4 spinel have been done by simple M–H curve.

MSP17 Synthesis and Investigations of Chemo and Fluorosensor Properties of Zns Nanoparticles

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ZnS and Mn doped ZnS nanoparticles were synthesized by chemical precipitation reflux and centrifuge method. The characterization techniques used were X-ray diffraction (XRD), scanning electron microscope (SEM), infra-red (IR) and UV-visible spectroscopy. The ZnS nanoparticles were found to have hexagonal structure while Mn- doped ZnS nanoparticles were in cubic phase. The particles size ranges from 30-100 nm. SEM studies reveal the clustered shape of NPs. Doping of these nanoparticles with a receptor Napthalene salicylaldehyde (NapSal) was carried out in order to develop the chemo-sensor. It is a condensation product of 1,8-Diaminonapthalene and salicylaldehyde which is designed by molecular modeling method .The infrared spectrum shows peaks at 3417 cm^{-1} characteristics peaks for O-H and the C=N peaks was observed at 1600 cm^{-1}. The maximum emission band (λ_{em}) of Napsal, ZnS nanoparticle-napsal and Mn doped ZnS nanoparticle-napsal are at 410, 385 and 385 nm respectively. The UV spectra of Napsal, ZnS nanoparticle-napsal and Mn doped ZnS nanoparticle-showed peaks at 231 nm, 270, 271 nm respectively. Significant shifting in peaks were observed due to interaction of complexes with Fe(III). Fluorometric titration of these systems also carried out in presence of Fe(III) ion in ethanolic medium and it was observed that with increase in the concentration of Fe(III) the fluorescence emission intensity of these system decreases significantly. The order of decrease of fluorescence intensity with Fe(III) concentration is, Napsal > Mn doped ZnS-Napsal > Zns-napsal. Hence three systems can be used as efficient fluorescent sensor based on ZnS nano-particles. In the present paper we report the synthesis of ZnS and Mn doped ZnS nanoparticles and their chemo and fluorosensor properties.

MSP18 Ammonia and petroleum gas sensing characteristics of nanocrystalline $Ag_6Mo_{10}O_{33}$ and $Ag_2Mo_2O_7$ powders and their spin coated thin films synthesized by wet chemical method

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A wet chemical method has been developed for the synthesis of nano-crystalline powders of $Ag_6Mo_{10}O_{33}$ and $Ag_2Mo_2O_7$. Gas sensing characteristics of their porous pellet and thin film configurations were measured. The compound $Ag_6Mo_{10}O_{33}$ was found to sense selectively ammonia at 503 K. Above 503 K, it has significant cross sensitivity to petroleum gas (PG). $Ag_2Mo_2O_7$ showed sensitivity of about 46% towards 100 vppm of ammonia at 623

K. Spin coated thin films of both these compounds were found to exhibit high resistance. On employing interdigitated platinum electrode, film resistance came down to a measurable value and their sensing characteristics towards different analytes are reported in this paper.

MSP19 Photoinduced Charge Transport Mechanism in Pristine and Ion Irradiated Kapton-H Polyimide

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The Photo-induced charge transport mechanism in pristine and 75 MeV oxygen ion irradiated kapton-H polyimide have been investigated. The charge transport mechanism was studied by different mechanisms such as photoinduced polarization, pre-photoexcitation and photoconduction behaviour under visible light in the temperature region 30^0-250^0C at different electric fields under different illumination conditions. A strong dependence of photocurrent on temperature signifies thermallization of exciton.

MSP20 CHARACTERIZATION OF RICE HUSK BASED NANOCOMPOSITE

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In this investigation rice husk (RH), a waste product of agriculture industry is used as filler to be reinforced into the polymer matrix of p-nitro aniline (PNA) and resorcinol (R). A prepolymer of PNA and R was prepared by the condensation polymerization method in presence of formaldehyde as condensing agent and 2N sulphuric acid. RH at different wt% of 10, 30 and 50 was reinforced into the polymer matrix by heating to 80 °C for 8 hrs. to get the biomass composites. The composite was sonicated with 2N oxalic acid for 20 min at room temperature to get the nanocomposites. The structural conformation was made by SEM, FTIR and ^{13}CNMR analysis. XRD data reveals the particle size to vary from 7 – 80 nm along with presence of silica. TG curve for the nanocomposite with 50 wt% of biomass shows that it is thermally more stable than other nanocomposites with 10 and 30 wt% of biomass due to possible linkage between different functional groups of RH with the polymer. The dc electron conductivity of the nanocomposites shows that they are bad conductors. Hence, the nanocomposites can be used as suitable heat resisting insulators.

MSP21 High temperature conductivity in CuO doped Borophosphate Glasses

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A series of borophosphate glasses, $(B_2O_3)_{0.10}$-$(P_2O_5)_{0.40}$-$(CuO)_{0.50-x}$,$0.05 \leq x \geq 0.50$ have been synthesized by the standard melt quenching technique and annealed at appropriate temperature to relieve thermal strains. The glasses were investigated for dielectric properties and alternating conductivity in the frequency range from 100Hz to 5MHz and temperature range from 325K to 550K. It is observed that ε' and ε'' decrease with increase in frequency and increase with increase in temperature. By regressional analysis of the total conductivity,

the frequency exponent, *s*, dc and ac components of the conductivity were determined. Mott's small polaron hopping (SPH) model has been applied to understand the temperature dependence of both dc and ac conductivities and their activation energies have been determined. The activation energy increased with increasing CuO content. The temperature dependence of frequency exponent, *s*, was observed to be nonlinearly varying with temperature and it has been looked at in terms of Correlated Barrier Hopping and Quantum Mechanical Tunneling models. It is for the first time that CuO doped borophosphate glasses have been investigated for dielectric properties and conductivity over wide temperature and frequency ranges and the data analyzed thoroughly.

MSP22 Dielectric and conductivity studies in vanadophosphate Glasses

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A series of vanadophosphate glasses doped with alkali ions have been investigated for dielectric properties and ac conductivity over a wide temperature range and in the frequency range 10Hz to 1kHz. Conductivity increased with temperature and alkali content and, decreased with increase in frequency. High temperature activation energy for ac conduction has been determined by employing Mott's small polaron hopping model. Frequency exponent values for ac conductivity have been determined for this series of glasses. Dielectric constant and dielectric loss were decreased with increase of frequency and increased with increase of temperature. The variations of conductivity and dielectric properties with temperature, frequency and composition are discussed. It is for the first time that vanadophosphate glasses doped with alkali ions of the present compositions were studied investigated for dielectric properties and conductivity as a function of frequency and temperature.

MSP23 Efficient synthesis of silver nanoparticles from Prosopis juliflora leaf extract and its anti-microbial activity against sewage bacteria

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In this paper, aqueous extract of fresh leaves of *Prosopis juliflora* was used for the synthesis of silver (Ag) nanoparticles. UV-visible spectroscopy studies were carried out to asses silver nanoparticles formation, scanning Electron Microscopic was used to characterize the Ag nanoparticles, X-ray diffraction analysis confirms the nanoparticles as metallic silver and facecentered cubic type and fourier transform infra- red assed that shows biomolecule compounds which are responsible for reduction and capping material of silver nanoparticles. The anti-microbial activities were performed using synthesized silver nanoparticles. The approach of plant-mediated synthesis appears to be cost efficient, eco-friendly and easy methods.

MSP24 Advanced piezoelectric transducers for high frequency applications

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Lead titanate ($PbTiO_3$) is tetragonal perovskite structure at room temperature the transition temperature is found to be 490ºC. Modified lead Titanate ceramics have potentiality for using electro-mechanical devices. They are the new materials with applications in ultrasonic transducer and lead zirconte titanate ceramics are commonly used as piezoelectric transducers. $PbTiO_3$ belongs to an important and largest family of ABO_3 type of ferroelectric perovskite material. The basic requirements of a Piezoelectric transducer for ultrasonic applications are the ability to generate short acoustic purposes and also to receive them with high sensitivity in a frequency range of 1-10MHz. For this purpose the material should have a high electromechanical coupling coefficient for high sensitivity and the acoustic impedance of the transducer should be well matched to that of the load to minimize the reflection layers at the interface which in fact determines the mechanical quality factor Qm of the transducer material modified lead titanate ceramics are very promising piezoelectric material for high temperature and high frequency, applications because of their high curie temperature and low Qm values. The study of literature on $PbTiO_3$ ceramics reveal a broad variation in calcinations times ranging from 2-15 hrs the following multiple cations doped lead titanate ceramics were prepared through solid state reactions. The effect of dopants on $PbTiO_3$ ceramics have been investigated.

MSP25 BIODEGRADATION STUDY OF LDPE/ STARCH COMPOSITES

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1, 5, 15 & 25 wt. % starch filled LDPE thin films (20 µm) have been prepared by solution evaporation technique. For biodegradation study, soil burial technique is used. Experimental samples are characterized by X-RD and SEM. Biodegradability has been studied after 90 & 180 days by SEMs. It is observed that biodegradability increases with starch content and it is due to microbial organisms.

MSP26 Synthesis and characterization of PVC micro porous films

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Polymer films of PVC: PVA were prepared in 25:25 compositions (by weight) by a simple solution casting technique using DMSO and DMF as solvent. A simple dissolution method has been used for the preparation of PVC micro porous polymer films. The characterization of the prepared PVC micro porous film was carried out by X-RD and it reveals the amorphous nature of the sample. Thermogrvametric analysis shows first decomposition was started at the temperature 283°C with a weight loss of 45% and second decomposition at 432°C, with wt. loss of 19% which indicates the film is stable up to 600˚C. The DTA trace

shows an exothermic peak around 250°C indicating the decomposition of PVC as evidenced by rapid weight loss observed in the TG curve.

MSP27 SYNTHESIS AND STUDY OF PVA BASED GEL ELECTROLYTE

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PVA gel electrolyte with different concentration of PVA (0.5, 1 ,1.5, 2 ,2.5 by weight) in NH_4SCN+DMSO electrolyte has been prepared by simple technique and characterized by X-RD and measuring d.c. conductivity electrical conductivity as a function of temperature in the range $0^0$to 100^0c . Variation of conductivity of gel electrolyte with loading concentration of PVA has also been studied .It has been observed that all gel sample are amorphous in nature with a broad peak at nearly $2\theta=22^0$.As loading of PVA in 0.2 M electrolyte of NH_4SCN+DMSO increases conductivity decreases. But conductivity is found to be increases with increases in temperature for all sample consisting VTF and Arrhenius behavior.

MSP28 Influence of Heavy Metal Cation (Pb^{+2}) on the Structure of Gallo silicate Halide Sodalite

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Lead derivative of Gallosilicate chloride sodalite, $Na_{2.20}Pb_{5.80}[GaSiO_4]_6(Cl)_2$ have been synthesized at low temperature by hydrothermal method (373 K) and characterized by IR, X-ray powder diffraction and SEM. Parent chloride and its lead derivative show cubic symmetry in a space group $P\bar{4}3n$. The incorporation of heavy metal like lead in the gallo silicate framework affect IR spectra in the pseudo lattice modes of vibration. The unit cell parameters (a^o) are found to be 8.9502 Å and 8.9950 Å for sodium and lead sodalite respectively. The other structural parameters are also modified considerably. The SEM pictures are very regular and show sharp growth for parent sodalite, while the crystal morphology slightly modified for the lead derivative.

MSP29 Structural and Dielectric Properties of $Sr_{0.5}Mn_{0.5}TiO_3$ Prepared by Solid State reaction method

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Manganese doped $SrTiO_3$ as well as in other Mn doped ABO_3 perovskite type oxides, is mainly caused by the recently recognized doping effects in these compounds in the form of ceramics, enriching the multifunctional properties of this remarkable material. Further progress in and optimization of practical devices are hindered by the apparent lack of knowledge about the nature of Mn centers in $SrTiO_3$. In the present work $Sr_{0.5}Mn_{0.5}TiO_3$ ceramic sample is prepared by conventional solid-state reaction method. Crystal structure, crystallite size and lattice parameters for the $Sr_{0.5}Mn_{0.5}TiO_3$ are determined from X-ray

diffraction (XRD) data. Bulk densities of the sintered ceramics were measured by the Archimedes method with xylene (density = 0.87 gcm^{-3}) as the liquid media and found to be 97~98% of X-ray density. Microstructural analysis using Scanning Electron Microscope (SEM) supplemented with EDAX is carried out to find the grain size as well as to find the chemical composition of prepared sample. The grain size estimated from SEM is found to be ~2μm. Dielectric constant (ε_r) and Dielectric loss tangent (tan δ) as a function of temperature are studied from frequencies 100Hz to 1MHz. The dielectric constant increases gradually with an increase in temperature up to transition temperature (T_c, K) and then decreases. The dielectric loss tangent and the dielectric constant decreases with increasing of measured frequencies. The dielectric losses of the sample at low temperature appear to be stable but sensitive at high temperatures. The higher values of tan δ at high temperatures may be due to transport of ions with higher thermal energy. The sharp increase in tan δ may be due to the scattering of thermally activated charge carriers and some defects in the sample.

MSP30 A.C Impedance Spectroscopy studies on Zinc Cobalt Oxide ($ZnCo_2O_4$) Ceramics

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Zinc Cobalt Oxide has been extensively studied owing to their potential uses in many applications such as solar energy cells as photoelectric energy conversion materials, Photo catalyst. In the present work Zinc Cobalt Oxide is prepared by conventional solid state method. Dielectric constant (k), dielectric loss(tan δ), ac conductivity (σ_{ac}) as a function of temperature are studied varying frequencies from 1 KHz to 1MHz using an impedance analyzer (HIOKI 3532 LCR Hi-TESTER). The dielectric constant increases gradually with an increase of temperature and decreases with increase of frequency. At room temperature the dielectric constant and dielectric loss is found to be 71.55 and 4.26. At low frequencies the space charges have enough time to move longer distances in the sample, creating a larger electronic polarization. At higher frequencies the space charges no longer follow the field, leading to lower values of dielectric constant. With increasing temperature, the effect of charge polarization is enhanced, giving rise to higher permittivity values. Therefore the high dielectric constant measured at high temperature does not mainly arise from the ionic polarization, but more significantly from the ionic polarization of space charges. The conductivity also increases with increase of temperature and at room temperature its ac conductivity is found to be $0.016\Omega^{-1}cm^{-1}$ for the frequency 1MHz.

MSP31 Parametric influence on delamination in drilling of Glass fabric Epoxy/Random Zylon Hybrid Composite

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This paper presents the experimental results in drilling 8mm diameter hole in Glass fabric Epoxy/Random Zylon Hybrid Composite using HSS and K20 Carbide drills. The effects of feed rates, cutting speeds and the type of drill on delamination and cutting forces are studied.

The experimental results show that delamination free drilling process may be obtained by the proper selections of drill material and the process parameters. However, at low spindle speed and high feed rate the heat generation due to friction between cutting edges and the work material facilitate softening of the matrix which resulted in poor surface finish and lower delamination. The results revealed that the proper selections of process variables are capable of producing quality holes for extended lifetime.

MSP32 Synthesis and Characterization of WO3 Nanopowder and It's Gas Sensing Properties

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Nanosized WO_3 powders were synthesized from WCl_6 using chemical co-precipitation method. The WO_3 single crystal with mean particle size 68 nm was observed at 700°C.Thick film resistors were prepared using screen printing technique for building sensitive and selective gas sensors. The response at different temperatures ranging from 100°C to 450°C were studied and presented for various gases. High sensitivity has been obtained towards H_2S, revealing the capability of the material to detect concentration as low as 10 ppm (Threshold Limit Value). Results highlight that nano-materials can be adopted for the development of gas sensors for practical applications.

MSP33 RHEOLOGICAL AND MORPHOLOGICAL STUDY OF DYNAMICALLY VULCANIZED NYLON6,610 /EPDM BLENDS

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In this work melt rheological behaviour of nylon/EPDM blends has been investigated. The effect of dynamic vulcanisation on the rheological behaviour is discussed . Attempts were made to correlate the phase morphology with rheology

MSP34 Effect of Mg concentration on structural, optical and electrical properties of $Zn_{1-x}Mg_xO$ thin films deposited by sol-gel route

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The $Zn_{1-x}Mg_xO$ multilayered thin films were deposited on p-type silicon with different concentration of magnesium (x =0.00 to 0.40) by sol-gel route. These samples were annealed at 700ºC in oxygen environment for an hour. The Mg content in $Zn_{1-x}Mg_xO$ alloy was confirmed by X-Ray diffraction measurements. The measurements indicated that the samples for $x \leq 0.20$ have wurtzite crystal structure with (002) preferred orientation and crystallinity varies with Mg concentration. For $x \geq 0.25$ phase segregations is initiated and mixed phase of hexagonal and cubic crystal structure was observed. The surface morphology studied by atomic force microscopy depicts that deposited thin films are nanocrystalline in nature and grain size reduced with the Mg content. The resistivity

measurements by Van der Pauw method and UV-Vis spectroscopy indicated that the electrical resistivity and optical band gap increased as a function of Mg alloying. The optical band gap is tuned from 3.34 eV (x =0.00) to 3.77 eV (x =0.20); for further enhancement in Mg (x ≥0.25) the band gap little bit reduced. The room temperature Photoluminescence spectra displayed the existence of oxygen vacancies defects in the samples. It is found that intensity and wavelength of UV emission altered with Mg incorporation. Infra red emission at higher magnesium content may be related to magnesium interstitials.

MSP35 Synthesis and characterization of SWCNT Borosilicate glass composite

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A composite has been synthesized by impregnating SWCNT in borosilicate glass by melt-quench technique. Electrical conductivity of the composite was studied with different temperatures which were found to increase substantial with the increase of temperatures. FESEM and TEM clearly show the random orientations of the nanotubes throughout the glassy host. Charge transport phenomena were found to be well explainable by the FIT model. The results show that the SWCNT-borosilicate glass composite is a potential candidate for structural and conductor-insulator device applications.

MSP36 Two-step simplistic synthesis and study of optical and magnetic novelties of different transitional metal (Ni, Co, Mn, Fe,) oxide nanostructures

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Simplistic and generalized hydrothermal route was followed to synthesize well crystalline uniform nanostructures of different transitional metal (Ni, Co, Mn, Fe) oxide. The morphology can be well controlled with precise control of reaction parameters. The morphology and crystal structures were investigated using XRD, SEM and TEM and it is interesting to note different morphologies are coming out of different transitional metals with pure crystalline structure. The optical absorptions and photoluminescence properties of the prepared sample were investigated and explained on the basis of their electronic transitional energy. Magnetic behavior of each metal oxide has been studied from 5K to 300K and under the field up to 10 tesla. The magnetic phase transitions have been observed and have been discussed for the various metal oxide nanostructurs. The study overall reports, first time, the general synthesis route to produce well crystalline nano structure of different transitional metal oxide nanoparticles and also reports their different optical behaviors and magnetic novelties depending upon the materials.

MSP37 Vapour Phase Nitration of Benzene using solid acid catalysts

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Study of nitration of benzene using dilute nitric acid over solid acid catalysts such as zeolite H-beta, oxides Mo/SiO_2, MoO_3, and various compositions of Fe / Mo/SiO_2 (A, B, C, D, E, F

catalysts). The results of catalytic vapor phase nitration of benzene with dilute nitric acid (30 %) gives nitrobenzene as a major product and dinitrobenzene in minor amount. Among the catalysts, Mo/Fe/SiO_2 (F) catalyst gives higher conversion and selectivity for longer time period of about 300 hours. The results are correlated with structure and acidity of the catalysts.

MSP38 Variation in the Electrical Conductivity of Nickel from bulk to nanowires

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We fabricate Nickel nanowires within the pores of polycarbonate track etched membranes by the electro-deposition (in a DC mode) method. The cylindrical pores with pore diameter 100 nm have been used for present study. Negative template method via two electrode arrangement in electrochemical cell has been used to synthesize the ordered array of one dimensional Ni nanostructures. Deposition has been carried out at 41±1 ^{o}C, 1.6 V and so formed one dimensional nanostructure has been obtained at a Cu substrate. The elegant approach of template synthesis has advantage that shape and diameter of one dimensional nanostructure can be varied as per the requirement, by using the templates of different pore shapes and diameters. Crystalline nature of one dimensional Ni nanostructures is confirmed by X-ray spectroscopy using Rigaku X-ray diffractometer. I-V characteristics have also been drawn using Keithley source meter, in order to find the variation in electrical conductivity from bulk to nanoscale. Approximately 42 times decrease in the electrical conductivity is observed on the basis of I-V characteristics as we approach from bulk to 1D Ni nanowires.

MSP39 Preparation and characterization of thermally reduced graphene oxide as electrode material for supercapacitors

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Electric double layer capacitors (EDLCs) also called supercapacitors, are a class of energy storage devices, which are believed to be sources of clean energy. Supercapacitor has got much larger capacity than conventional capacitors and its charge/discharge rate capability is much higher than primary/secondary batteries. In supercapacitors, the mechanism of charge storage is the simple charge separation at the interface between the high surface area electrode and the electrolyte. The energy storage mechanism is physical rather than chemical and this makes the operation of supercapacitors much safer and provides them longer life cycle [4-6].

To develop an efficient super-capacitor, an active electrode material with high capacity performance is crucial even though all other components are important. Carbon materials in various forms are most widely used as electrode materials in supercapacitors due to their easy accessibility, good processing ability, large surface area / porosity, higher electrical conductivity, photochemical stability and low cost [7-8].
Being a new class of carbonaceous material, graphene has been studied extensively in recent years.

In the present work, graphene sheets were produced in large quantity from easily available and low-cost raw materials by a simple and efficient route of thermal exfoliation of graphene oxide. Various characterizations (X-ray diffraction (XRD), SEM, HR- TEM, TGA and electrochemical performance) of thermally reduced graphene oxide are used to confirm

graphene formation. Supercapacitors were fabricated with the graphene as electrode and the electrochemical characteristics were studied

MSP40 Fabrication and performance analysis of Diamond-like Nanocomposite thin film based MIM capacitor

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In the present study we report the frequency response of metal-insulator-metal (MIM) based thin film capacitor where diamond-like nanocomposite (DLN) film behaves as a dielectric medium, using a sinusoidal RF source with frequency range 10^2-10^6Hz. For DLN film deposition we use plasma assisted chemical vapour deposition (PACVD) method. Fourier transforms infrared spectroscopy (FTIR) and Raman spectroscopy give the structure of DLN film. After fabrication of DLN based thin film capacitor our study shows equivalent parallel capacitance (EPC) decreases sharply beyond 10^5Hz for thinner films. But for thicker films, there is no such decrease. This is due to some parasitic series resistance effect in the capacitor circuit. We present here an equivalent circuit model for real capacitor. Moreover, there is also a small decrement in EPC with frequency and this effect increases with thickness of film. This may be due to lack of sufficient time for electron transportation through bulk DLN material. The DLN based thin film capacitor has a great potential for use in electronic/electrical system.

MSP41 Optical Property of Diamond-like Nanocomposite Film Deposited by Rf-PECVD Technique

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In the present study, modified diamond-like carbon (DLC): Diamond-like nanocomposite (DLN) films are deposited on glass substrates from siloxane precursor by radio frequency plasma enhanced chemical vapour deposition (RF PECVD) technique at different deposition conditions. The DLN films are consist of two interpenetrating amorphous networks, one network being a diamond-like a-C:H network and the other a glass-like a-Si:O network. The amorphous character of the film is studied performing X-ray diffraction (XRD). The morphology and structural characteristics have been investigated by FESEM, AFM and FT-IR spectroscopy. Raman spectroscopy is used to analyze disorder in the film and sp^2-to-sp^3 bonding ratio. The optical transmission and absorption properties and the optical band gap of the films are characterized employing UV-VIS spectrophotometer. Results show that DLN may be used as a very good antireflective material for solar cell.

MSP42 Fabrication and Study of Electrical Properties of Organic Multilayered Thin Film.

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Copper Phthalocyanines and Nickel Phthalocyanines Tetrasulphonic Acid (CuPcTs, NiPcTs) has been synthesized using microwave irradiation under solvent free conditions. Thin films of the CuPcTs has been deposited on Indium Tin Oxide (ITO) coated glass slide using Poly Diallyl Dimethyl Ammonium Chloride (PDDA) , a polyelectrolyte by Electrostatic Layer by Layer Technique using water as a solvent. Multilayer films of $(PDDA/CuPcTs)_5$ and $PDDA/Ni\ PcTs)_5$ have been obtained by repeating the process several times. The proof for the multilayer films have been obtained using UV-VIS Spectroscopy. IV characteristic of the multi -layers have also been studied and which shows perfect Ohmic behavior.

MSP43 Optical band gap of swift heavy ion irradiated Polyvinylidene fluoride (PVDF) Thin Films

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The Polyvinylidene fluoride (PVDF) polymer films (9,12 and 20 μm) were irradiated with 100 MeV Ag-ion (fluence; 1.8 $X10^{11}$ ions/cm^2) , and 75 MeV Oxygen- ion (fluences; 5.6$X10^{11}$ ions/cm^2 and 5.6$X10^{12}$ ions/cm^2) using the PELLETRON facility at Inter University Accelerator Centre, New Delhi to study the swift heavy ion (SHI) irradiation effects in PVDF thin films. The optical absorption measurements were carried out on a large number of pristine and SHI irradiated samples of various thicknesses (9, 12 and 20 μm) in the wavelength range 200-1000nm. The change in optical properties was analyzed by comparing UV-Visible spectra of pristine and irradiated films. The UV-Visible absorption spectra of irradiated samples reveal hyper chromic shift, bathochromic shift and hypsochromic shift. The Spectra also used to estimate the direct optical band gap in pristine and SHI irradiated PVDF thin films. The direct optical band gaps of pristine PVDF films are found to be around 3.6 eV. The band gap decreases on irradiation and the decrease is dependent on ion beam and fluence rate. The present study opens up the scope for the applicability of SHI irradiated PVDF thin films as Micro sensors and actuators.

MSP44 SOIL-CEMENT-BENTONITE SLURRY WALLS

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Soil-Cement-Bentonite (SCB) slurry walls have been used with increasing frequency in recent years to provide barriers to the lateral flow of groundwater in situations where the strength of a normal soil-bentonite wall would be inadequate to carry foundation loads. The addition of cement to the backfill blend allows the backfill to set and form a more rigid system that can support greater overlying loads.

Construction and quality control for the SCB wall is more demanding than thatneeded for conventional soil-bentonite slurry walls. Backfill mixing, sampling and testing of this type of wall involve more exacting procedures. Recommendations are made herein for methods to carry out pre-job design mix testing and in-field quality control testing for the most reliable results.

Designing the SCB backfill is a complex issue involving conflicting actions of the various materials involved. While the SCB wall provides additional strength, permeability is one

property that generally suffers in comparison to soil-bentonite slurry walls. A normal permeability specification would be a maximum of 1 x 10-6 cm/sec. With special attention to materials and procedures, a specification of a maximum 5 x 10-7 can be achieved.

Data are presented from design mix studies and field-testing programs to illustrate the effect of increasing concentrations of the key materials in the mix design and also the impact of other factors such as time on the measured properties. Comparisons are made between soil-cement and SCB materials as used in slurry walls and other types of installations. The SCB material is normally highly variable, even when mixed under carefully controlled conditions; engineers must account for this variability in designs and when drafting specifications.

MSP45 Cadmium Stannic Oxide ($CdSnO_3$) Thick film Resistor as a Chlorine (Cl_2) gas Sensor

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In this paper the characteristics of a CdSnO3 based thick film (prepared by simple screen printing technique) Chlorine Cl_2 gas sensor was investigated. The raw powders of $CdSnO_3$ were prepared by co-precipitation method. The phase compositions and particle morphology were examined by means of X-ray diffraction (XRD) and scanning electron microscopy (SEM) Effects of calcinations temperature on gas-sensing properties, sensitivity (Rg-Ra)/Ra –operating temperature, It has better sensitivity and lower operating temperature, with a detection concentration range of from 100 ppm to 10%. The sensor also shows good stability.

MSP46 PULSED LASER DEPOSITION OF NICKEL NANOCRYSTALS FOR MEMORY DEVICES

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Nickel thin films were deposited on SiO_2/Si substrates using pulsed laser ablation. Post-deposition annealing was performed in the temperature range 900 ºC–1000 ºC in pure N_2 ambient for 5 minutes to form nickel nanocrystals. Nanocrystals sanwiched between the tunneling and Al_2O_3 blocking oxide layers were employed to fabricate the metal-oxide-semiconductor capacitors. The counter clockwise hysteresis in the *C–V* curves of the fabricated MOS structures were used to study the charge storage characteristics of Ni-NCs. Optimized samples exhibited a hysteresis width of 14 V (at bias sweep ±14 V), making the nanocrystals attractive for future nanoscale memory devices.

MSP47 Chemically bound Au and SiO_2@Au nanoparticles array with metals: Assembly, properties and SERS study of Heavy metal ions interaction

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Detection of metals ions using Au@citrate and SiO_2@Au nanoparticles has been investigated. We have studied the effect of interaction using techniques such as UV-VIS, SEM, TEM and in detail by SERS. Aggregation of the particles has been noticed in SEM images which are also supported by the shifting in the absorption bands. Adsorption kinetics of metal ions onto Au NP's has been followed by decrease in Surface Plasmon band. The SERS activity is observed with 532 nm laser radiation using CV as a molecule. This study allows us to understand the mutual influence of the co-adsorbed species with water. The excellent selectivity for Cd^{2+} is demonstrated by comparing the response to other metal ions. In addition, our evaluation indicates that SiO_2@Au offers higher sensitivity than gold nanospheres.

MSP48 Readout on different sized SiO_2@Au Nanoshells-Enhanced Raman Spectroscopy

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This paper describes an investigation of synthesis and assembly of monodispersed core (SiO_2)-shell (Au) of different thickness. The ease of dispersing gold nanocrystals on spheres of bare silica and spheres was studied as a function of pH (7.0), reaction temperature (75 ^{0}C), and time (12hrs). The evolution of gold nanocrystals growth was monitored by SEM, TEM, SERS, XRD and the bathochromic shift of ultraviolet-visible absorption was correlated with shell perfection and thickness. The influence of Au (shell) thickness to the optical absorption of SiO_2@Au core shell is investigated.SERS Spectrum of R6G,CV and TMPP has been observed on SiO_2@Au .SERS Spectra is obtained both for Au colloid and SiO_2@Au nanoshells. Weak enhancement of Raman signals is observed when the Au (shell) completely covers SiO_2 (core).

MSP49 Size dependent solubility limit in Nanosized $LiFePO_4$

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Due to its stability nano-sized olivine $LiFePO_4$ opens the door towards high power Li-ion battery technology for large scale applications The thermodynamics of nano sized Li ion insertion materials appears radically different from bulk materials. Here we give direct prove of the decreasing miscibility gap upon particle size reduction In present study using Neutron Diffraction we determined the solubility limits of Nanosize $LiFePO_4$ as a function of particle size, indicating a reduction of the miscibility gap for smaller particle sizes and detailed fits indicate that the two phases triphylite (Li rich) and heterosite (Li-poor) coexist within each particle

MSP50 Synthesis of novel N-doped GaZn mixed oxide for energy and environmental application

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A series of N-doped GaZn mixed oxides were fabricated by solid state reaction route. N-doped mixed oxides with porous morphology are poised to be the most prevailing visible light sensitive semiconducting material for energy and environmental application. Highest amount of hydrogen gas was produced over Rh/Cr_2O_3 loaded N-doped GaZn mixed oxide prepared at 500ºC with an apparent quantum efficiency of 5.1% under visible light irradiation ($\lambda \geq 400$ nm). N- doped GaZn mixed oxide prepared at 500ºC successfully degrade 54% of 100 ppm 4-chloro-2-nitrophenol solution in 4h under direct solar light irradiation.

MSP51 Dielectric properties of ceramic $Sr_{1-x}Fe_xTiO_3$(x = 0.1, 0.2 & 0.3)

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Pellets of ceramic $Sr_{1-x}Fe_xTiO_3$(x = 0.1, 0.2 & 0.3) were prepared by high temperature solid state reaction technique. The prepared pellets have been characterized using X-ray diffraction method and grain size have been found using SEM photograph. EDAX data confirm that $SrTiO_3$ can act as host lattice of iron. The frequency and temperature dependence of dielectric constant and loss tangent of prepared pellets were studied in the frequency range of 100Hz to 10 Hz and temperature range 32^0 C to 250^0 C. It was observed that all three samples behave like relaxor between room temperature to150^0 c and the value of dielectric constant increased sharply for 100 Hz. It was also observed that their loss tangent was temperature dependent and show abroad peak at 200^0 C at 100 Hz.

MSP52 Study of Microstrip Leaky Wave Antenna using Inhomogeneous Materials

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A theoretical analysis of the hybrid modes inside the open microstrip line is developed. The analytical expressions of field component the first higher order mode has been presented. The computed propagation constants using FEM code is compared with the ones calculated using TRM.

A novel full-width microstrip LWA using inhomogeneous materials is proposed designed and fabricated. The new structure shows a bandwidth increase of 55%. The radiation characteristics of the inhomogeneous LWA is equivalent to the radiation characteristics of LWA with homogeneous dielectric slab having lower permittivity of $\in_r$= 1.7. The measured return loss and relative antenna gain show a bandwidth of 3.5 GHz which match very well with the numerical results. The agreement between the measured and numerically calculated results demonstrates that the FEM numerical code is particularly suitable to model the inhomogenous LWA.

MSP53 Infleunce of heating rate on the properties of randomly orientd c/c composite

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The effect of heating rate (1, 2, 3, 4, 5 and 7 ^{0}C/min) during carbonization of carbon fiber/mesophase pitch-based carbon/carbon composite (C/C composite) on its properties was studied.

The specimens were prepared my mixing and vacuum molding of chopped hybrid carbon fibers and powdered mesophase pitch followed by hot pressing and carbonization at the same processing conditions. After first carbonization, all the specimens were kept under vacuum to evacuate pores followed by resin impregnation under same pressure and time. Specimens were also thermoset for same durations at constant temperature. After thermosetting, all the specimens were carbonized for same duration at constant temperature but at different heating rates. . The cycle of evacuation of pores to carbonization was repeated four times. After last carbonization, all the specimens were characterized for C-H-N, X-ray diffraction (XRD) and microstructure using extended pressure scanning electron microscope (EPSEM).

The results indicated that the specimens carbonized at lower heating rates had an excellent carbon yield and fine microstructure than that carbonized at higher heating rates. The specimens carbonized at 1 ^{0}C/min showed a very good carbon yield and microstructure. The results further showed that that the specimens carbonized at heating rates in a range of 3-5 ^{0}C/min had moderate carbon yield, poor microstructure and bloating than that carbonized at lower heating rates.

The heating rate carbonization for the fabrication of C/C composite is an important criterean . lowering heating rates mean more power and time consumption whereas high heating rates and encourages cost effectiveness of C/C composites, which is important from industry point of view. Heating rate during carbonization of C/C compacts was optimized with respect to economy, carbon yield, microstructure and bloating.

MSP54 Nanostructured Heusler $Ni_{50}Mn_{25+x}Sn_{25-x}$ (13≤x≤18) alloys a potential magnetic coolant with structural magnetic transitions

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Nanostructured Heusler $Ni_{50}Mn_{25+x}Sn_{25-x}$ (13≤x≤18) alloys have been developed in devising magnetocalory in the structural magnetic transitions for possible magnetic cooling devices. The XRD pattern in a specific alloy at x = 18 describes an austenite phase of a $L2_1$ cubic crystal structure with the lattice parameter 0.6009 nm and crystallite size 7.7 nm. The FESEM images represent nanoplates (thickness 8 nm) sequenced one over others. The magnetostructural transition, characterized in terms of the caloric signal, occurs at 136 K upon cooling. The maximum values for the magnetic entropy change ~14 J/kg-K and the adiabatic temperature change ~28 K, which are the basic parameters to characterize the magnetocalory, are computed from the heat capacity measured by heating selective alloys at different magnetic fields varied up to 14 T.

MSP55 Sintering Effect of Nano crystalline ZnO

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Nanocrystalline Zinc oxide powder was synthesized by High Energy Ball Milling (HEBM) technique. The effect of sintering on the density and electrical properties of bulk and nanocrystalline ZnO were studied. The dielectric properties of nanocrystalline ZnO was higher than the bulk ZnO. The structure of the ZnO nano sample was found to be hexagonal. Bulk samples that were sintered at 1000°C has no colour change as compared to nanocrystalline (15nm) ZnO sintered samples. The nanocrystalline sintered samples turned green at 1000°C whereas the bulk samples remained white in colour. The color change in nanocrystalline ZnO was may be due to some surface defect concentrations.

MSP56 Structural and Electrical Properties of Nanocrystalline $CaTiO_3$

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$CaTiO_3$ is well known perovskite material with its unique structure, higher thermal stability and bio compatibility finds potential application in the field of communication, electronics, and in biotechnology. Here calcium titanate ($CaTiO_3$) powders were synthesized by using solid state reaction route and High Energy Ball Milling technique. Preliminary x-ray structural analysis for $CaTiO_3$ powders suggested the formation of orthorhombic structure. Detailed studies of dielectric and impedance properties of material in a wide range of frequency (100Hz –1MHz) and temperatures (30°C -300°C) shows that these properties are frequency independent. It was found that nanocrystalline $CaTiO_3$ shows better electrical properties than bulk.

MSP57 Impedance Spectroscopy of PZT Ceramics

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PZT nanoceramics were prepared by High Energy Ball Milling techniques. The electrical properties of nanocrystalline PZT were investigated by Impedance Spectroscopy. Rare earth Sm modified PZT shows less dielectric constant then the unmodified PZT. It was also observed that samarium dopants act as grain refinement of the PZT which clearly observed from TEM and SEM micrographs. It was found that Sm doped PZT had more grain boundary resistance than the unmodified PZT. The structural analysis shows that Sm doped PZT was cubic in 50h milled powder as well as sintered at 400^0C. The structural phase transformation from Cubic to Tetragonal takes place when it was sintered at $\geq 600^0$C.

MSP58 Experimental study on turning for surface roughness in CFRP material using tin coated tool

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Machining produces surface irregularities on the machined component, which affects the service life of components and other properties also. Carbon fiber reinforced polymer material has started replacing conventional materials a long back due to the excellent properties they possess for various applications. Fiber reinforced composite materials contain fibres of high tensile strength and modulus embedded in a matrix with distinct interfaces between them. Though fiber reinforced polymer composite materials are produced near net shape, further machining is required to achieve necessary surface properties. Machining of nonconventional materials is different from that of metals. It has matrix and reinforcement which are soft and hard in nature respectively, resulting in anisotropic properties. To understand the machinability of these materials, this experimental work has been undertaken. This experiment studies machining of carbon reinforced composite made in the form of tube. Turning operation was carried out using TiN coated cutting tool insert. Surface roughness was measured using TR200 handheld surface roughness measurement instrument. The measured parameters were analysed to determine better input parameters for getting better output. It uses various parameters like cutting speed, feed and depth of cut. Taguchi's concepts such as orthogonal array and ANNOVA were used to carry out experimentation and analysis.

MSP59 Breakdown characteristics of $GaInAs_xP_{1-x}$ SDRs/DDRs with different values of x

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The effect of different arsenic compositions in $GaInAs_xP_{1-x}$ on the breakdown characteristics of the corresponding p-n junctions of the form n^+npp^+ (DDR), n^+pp^+(SDR) has been studied using a sophisticated computer simulation method. Double iterative computer program has been framed to solve second order implicit device equations under static condition under usual boundary conditions. The analysis predicts better breakdown characteristics from the quaternary device. The performance of $GaInAs_{.76}P_{.24}$ devices (all three structures) are expected to perform the best amongst the lot considered in this paper.

MSP60 Study of $La(NO_3)_3$ doped PVA thin films

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In the present work, investigation of Lanthanum Nitrate doped Polyvinyl Alcohol thin films have been carried out. The dopant Lanthanum Nitrate [$La(NO_3)_3$] was added in PVA by weight percentage method. The percentage of $La(NO_3)_3$ in PVA were 0.05, 0.1, 0.5 and 1 by weight. Thin films were synthesized by solution cast method. The presence of $La(NO_3)_3$ in PVA thin film was confirmed from FTIR spectra of the sample taken on Shiamdzu IR

spectrophotometer in the wavenumber range 400 to 4000cm^{-1}. For determination of optical band gap UV-absorption spectra in the range 190nm-900nm was recorded on Elico spectrometer. Direct energy band gap was determined and found that E_g values decreases with increase in concentration of Lanthanum Nitrate in PVA. The optical band gap energy values varies in the range 3.19eV to 2.66V.

MSP61 Nano titania particles coated mesoporous silica for better phtocatalytic performance

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Mesoporous SBA-15 with high specific surface area were synthesized ysing nonionic surfactant as liquid template and Na_2SiO_4 as SiO_2 precursor. The synthesized SBA-15 served as the TiO_2 support to reduce the TiO_2 grain size and well-dispersed TiO_2 for enhancement of photocatalytic activity. A combination of XRD, FTIR, nitrogen adsorption–desorption isotherm measurement at 77 K, TEM as well as solid state UV–vis spectroscopy has been used to characterize the titania modified SBA-15 materials. These characterizations methods allowed the evaluation of the assembling modes of TiO2 inside SBA-15. TEM micrographs showed that the organic solute template method could prepare the titania-silica composite, and successfully embedded titaina in SBA-15 channel. The mesoporous structure restrained the titania grain size within 5 nm which caused blue shift identified by UV-Vis spectra. This is due to the formation of Si-O-Ti bonding which was identified by FTIR. The dispersion effect promoted by the support prevents the anatase to rutile phase transformation observed in monolithic TiO_2 materials upon identical calcination temperature. The activity test indicated that TiO_2/SBA-15 composite prepared by this method had better photocatalytic performance than pure TiO_2. The preparation method and the textural characteristics of mesoporous materials have great influence for the photocatalytic activity.

MSP62 Effect of solvents on electrophoretic deposition microstructure of mixed ceria

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Free standing films of mixed ceria powder were prepared by electrophoretic deposition in non-aqueous solvent. It has been found that uneven deposition occurred in ethanol, while in butanol deposition yield is low having very little variation with deposition time. On the other hand, good deposit obtained in acetyl acetone medium, but had a porous structure. The best result however was obtained in mixed solvent.

MSP63 CHARACTERIZATION STUDIES OF FIBRIN BASED BIOMATERIAL IMPREGNATED WITH SILVER NANOPARTICLES.

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There is an increasing commercial demand for nanoparticles due to their wide applicability in various areas such as electronics, catalysis, chemistry, energy, and medicine. Silver nanoparticles are traditionally synthesized by wet chemical techniques, where the chemicals used are quite often toxic and flammable. In this work, we describe a cost effective and environment friendly technique for green synthesis of silver nanoparticles from 0.5M $AgNO_3$ solution through the tea (*Camellia Sinensis*) extract as reducing as well as capping agent. The biological composites were prepared using Cellulose and Fibrin by employing regenerative technique. These biocomposites were impregnated with silver nanoparticles. The resulted product C-F-Ag were characterized for their physicochemical properties like Thermo gravimetric analysis (TGA), Differential Scanning Colorimetric analysis (DSC), Scanning Electron Microscopy (SEM), Energy dispersive X-ray analysis (EDX), Fourier Transform Infrared Spectroscopy (FTIR), Water absorption capacity and mechanical properties. The prepared bicomposites have shown good thermal property and the results have shown coating of Fibrin on the Cellulose fibers and incorporation of Ag-nanoparticles on its surface is also an evident. Based on the results obtained the biocomposites may be tried as a wound healing material on the wounds of experimental animals.

MSP64 Rapid thermal annealing studies on doped and co-doped ZnO deposited using DC sputtering

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Zinc Oxide (ZnO) is an attractive material for large variety of applications. ZnO films are used in particular for transparent contacts in photovoltaic solar cells. ZnO has emerged as one of the most promising materials, due to its optical and electrical properties associated with the high chemical and mechanical stability. In this study Al doped ZnO, Al-B & Ga-Al co-doped ZnO thin films were prepared on glass substrate by DC magnetron sputtering. Then the thin films were annealed in vacuum at 600^0C for 2 minutes. It was observed that the transmission of annealed samples of doped and co-doped ZnO thin films decreased as compared to pristine ZnO thin films. The X-ray diffraction (XRD) patterns of all the films showed a preferable growth orientation in the (002) phase. The crystallinity of annealed samples increased significantly to that of pristine ZnO thin films, as observed from XRD. The surface morphology was studied through SEM micrographs. The surface morphology show different growth structure and is discussed in detail. The electrical properties viz. resistivity, mobility and carrier concentration of both pristine and annealed ZnO thin films were measured using Hall Measurement System (Ecopia HMS3000) at room temperature. A detail comparative study of the role of thermal annealing on the structural, optical and electrical properties of doped and co-doped ZnO thin films will be discussed.

MSP65 Effect of B/Si ratio on Glass Forming Ability of $Fe_{54}Cr_{18}Ni_8B_{20-x}Si_x$ (x = 5, 10, 15, 20)

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Alloy $Fe_{80}B_{20}$ has a deep eutectic and glass forming ability (GFA) is easier at deep eutectic compositions. Metallic glasses are formed easier with multi-component systems. Fe (80 at %) was substituted by Fe (54 at %) and Cr-Ni (18-8 at %) which is austenitic stainless steel composition to form metallic glasses for corrosion resistant applications. Amorphous alloys $Fe_{54}Cr_{18}Ni_8B_{20-x}Si_x$ (x = 5, 10, 15, 20) were synthesized by planetary ball mill for 30 h. Samples were characterized by X-ray diffraction (XRD), differential scanning calorimetry (DSC) and transmission electron microscopy (TEM) techniques. Glass forming ability (GFA) seems to be better by replacing B with Si.

MSP66 Comparative study of wear behaviour of hot rolled and warm rolled $Ti_{13}Nb_{13}Zr$, $TiNb_{13}Z$ alloy for Biomedical Applications.

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The paper reports on the wear behaviour of hot rolled $Ti_{13}Nb_{13}Zr$ and Warm Rolled $TiNb_{13}Zr$ against a ceramic counter pin using a reciprocatory wear tester. An environment of Hank's Solution is used for the wear tests with the aim of using the substrates in Biomedical Applications. The microstructure and phases are analyzed using Scanning Electron Microscope (SEM) and X Ray Diffractometer (XRD). The relative compound wear and coefficient of friction have been measured and results are summarized in the paper.

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