

# ABSTRACTS MATERIALS 2011

## 1. Phase, microstructural characterization and microwave dielectric properties of $\text{SrLa}_4\text{Ti}_{5-x}\text{Sn}_x\text{O}_{17}$ ( $x=0-3$ ) ceramics

Yaseen Iqbal and Abdul Manan

Materials Research Laboratory, Institute of Physics and Electronics, University of Peshawar Pakistan  
[dryaseeniqbal@yahoo.co.uk](mailto:dryaseeniqbal@yahoo.co.uk)

**Abstract:** The phase, microstructure and microwave dielectric properties of  $\text{SrLa}_4\text{Ti}_{5-x}\text{Sn}_x\text{O}_{17}$  ( $0 \leq x \leq 3$ ) were investigated in an attempt to tune their temperature co-efficient of resonant frequency ( $\tau_f$ ) to zero. The compositions sintered to single phase  $\text{SrLa}_4\text{Ti}_5\text{O}_{17}$  ceramics at  $x=0$ , and  $\text{SrLa}_4\text{Ti}_4\text{Sn}_x\text{O}_{17}$  along with a small amount of  $\text{La}_2\text{Ti}_2\text{O}_7$  at  $x=1$ . The major phase observed at  $x=2$  was  $\text{La}_2\text{Ti}_2\text{O}_7$  but along with  $\text{SrLa}_4\text{Ti}_4\text{SnO}_{17}$  and  $\text{SrLa}_4\text{Ti}_4\text{O}_{15}$ . At  $x=3$ , the major phases observed were  $\text{La}_2\text{Sn}_2\text{O}_7$  and  $\text{Sr}_2\text{La}_3\text{Ti}_3\text{SnO}_{15}$ . The observed variation in the chemical composition of the grains combined with the morphological change from rod-shaped grains to cubical and irregular-shaped grains with increase in Sn content appeared in agreement with the phase constitution of samples identified by X-ray diffraction.  $\tau_f$  decreased from 117 to 9.5 ppm/ $^\circ\text{C}$  with increase in  $x$  from 0 to 3 but at the cost of  $\epsilon_r$  and  $Q_{uf_0}$  which decreased from  $\sim 61$  to 23 and 9969 to 2084GHz respectively due to the formation of secondary phases.

## 2. Globalization of Science is pressuring us for Change in Chemistry Education in Pakistan

Fida Mohammad

Faculty of Materials Science and Engineering  
 Ghulam Ishaq Khan Institute for Engineering Sciences and Technology, Topi, Swabi, KPK

**Abstract:** The emerging global village and internationalization of science is pressuring us to bring about changes in chemistry education at home. In this article, I will discuss some of these changes such as: learning more Mathematics and English; involving ourselves in interdisciplinary areas such as materials science and chemical biology; switching to theory-based teaching and writing students friendly books both of which are said to have an enormous influence on students. Also, a modified scheme of studies at the higher secondary level will be proposed which will do away with premedical and pre-engineering streams of study. This proposal, if accepted, will not only improve the preparation of students for the newly introduced 4-year B.S program but will also provide these students opportunities for graduating in more science subjects than is possible under the current system.

## 3. Annealing effects on surface morphology, thickness and chemical phases of Sr-Cu-O thin film deposited by MOCVD

Afzal Khan<sup>1</sup>, Carmen Jimenez<sup>2</sup> and Jean-luc Deschanvers<sup>2</sup>.

<sup>1</sup>Institute of Physics and Electronics, University of Peshawar, Peshawar Pakistan.

<sup>2</sup>Laboratoire des Matériaux et du Génie Physique (LMGP), INP-Grenoble, Grenoble France.  
[afzal\\_stc@yahoo.com](mailto:afzal_stc@yahoo.com)

**Abstract:** We studied the annealing process for obtaining  $\text{SrCu}_2\text{O}_2$  out of the as-deposited Sr-Cu-O films by MOCVD. Whatever the deposition condition may be, the as-deposited films are always composed of  $\text{SrCO}_3$  and  $\text{CuO}$ . As-deposited films were annealed in various

gaseous atmospheres at different temperatures and for different annealing durations to obtain pure SrCu<sub>2</sub>O<sub>2</sub> phase. Annealing effects on the as-deposited film include; crystallization of the film, transformation of the chemical phases, sintering of the grains, formation of cracks, reduction of the film thickness and diffusion of film contents into the substrate. Transformations of chemical phases depend on oxygen partial pressure, temperature and duration of annealing and rate of cooling. Formations of cracks were found to depend on heating rate and duration of annealing. Diffusion of film content into the substrate depends on duration and temperature of annealing and on the nature of substrate. Duration of annealing for obtaining pure SrCu<sub>2</sub>O<sub>2</sub> phase depends on annealing temperature as well as heating and cooling rate.

#### **4. Bulk nano-structured materials from severe plastic deformation: A technical review**

**Muhammad Daniel Saeed Pirzada**

Pakistan Institute of Nuclear Science & Engineering, Islamabad

**Abstract:** Severe Plastic Deformation (SPD) methods have been developed to produce nanostructured nanostructured materials. The refined microstructure offers set of mechanical and physical properties that are desired for many applications and provide an opportunity for superplastic forming. Among all the processes developed to date for the production of nanostructured materials, only severe plastic deformation processes exhibit a potential for producing relatively large samples suitable for industrial applications. SPD techniques are now finding applications in manufacturing of several commercial products, e.g. sputtering targets, fasteners and dental implants. Compaction of powders using SPD processing is yet another

spillover of this process. This paper provides an introduction in the field of severe plastic deformation and reviews the current capability of the process for producing bulk nano-materials of different alloys and materials. Special emphasis has been given to the recently developed techniques and equipment for this purpose.

#### **5. Comparative Study of Aluminum 6065 and 7075 in Hydrazine**

**M. Akram, Imran Reza, F. Karim, N. Hussain**

Materials Division, PINSTECH, PO Nilore, Islamabad

**Abstract:** The corrosion rate of Aluminum 6065 and 7075 was measured by using electrochemical techniques i.e. Polarization resistance and potentiodynamic polarization (Tafel test). Environment used for these tests was Hydrazine concentration 3%, 5% and 20% with and without aeration. The aeration time varied from 15 min to 1 hour. Surface studies were also carried out using optical microscope. Electrochemical techniques showed better corrosion resistance in Aluminum 7075 as compared to Aluminum 6065 in the investigated environments.

#### **6. Phase and microstructural analysis of the Nickel Phthalocyanine thin film**

**Mutabar Shah, M. R. Khan, Majid Khan**

Institute of Physics and Electronics, University of Peshawar

**Abstract:** Thin film of Nickel Phthalocyanine (NiPc) of 100 nm thickness was deposited at a base pressure of 10<sup>-5</sup> mbar by thermal vacuum evaporation technique. The effect of temperature on phase and microstructure of the thin film fabricated on cleaned glass substrates was studied using X-ray diffraction (XRD) and

scanning electron microscopy (SEM). The XRD graph shows that there is no change in the phase and crystal structure of the thin film before and after annealing. It is observed from the SEM that the pore size decreases after annealing.

## 7. Micrometer and nanometer scale patterning of functional ceramics and composite materials with soft-lithography

**Sajid U. Khan and Ibrahim Qazi**

Department of Materials Science and Engineering,  
Institute of Space Technology, Islamabad

**Abstract:** The miniaturization of objects and device components down to the micron and nanometer scale, and the development of methods to fabricate and register these, presents one of the main technological trends of the last decade. Among these methods, a number of alternative techniques to traditional photolithography for patterning a variety of materials have been developed. Photolithography is commonly used in the electronics industry and has been under development for many decades. At present, feature sizes  $\ll 100$  nm can be patterned on silicon in large scale. However, the drawbacks of the techniques are that high-end equipment and clean room conditions are required, and the methodology is applicable only to a narrow set of materials. In an attempt to overcome these restrictions, a family of related patterning techniques was developed by the Whitesides group at Harvard University in the 1990s. These so-called soft lithography techniques are mainly parallel patterning methods, so large areas can be patterned in a relatively short period of time. They may provide cheap alternatives for the much more costly photolithographic processes, and are able to process a wider range of materials, including polymers, biomaterials, ceramics, hybrids, and composites. At least with some of these

techniques, parallel patterning on sub-100 nm scale is possible. Since their development, soft lithographic techniques have achieved widespread use in academic and industrial laboratories for applications in diverse fields, e.g., photonics, biotechnology, microfluidics, and electronics. While most of these research efforts were focused on the patterning of polymers, biomaterials and self-assembled monolayers, it has also found application in the micrometer and sub-micrometer patterning of ceramics and organic-inorganic hybrid materials.

## 8. A new superstructure in $(\text{Li}_x\text{Ag}_{1-x})\text{NbO}_3$ ( $0.05 < x < 0.10$ )

**H. U. Khan<sup>1</sup>, I. M. Reaney<sup>2</sup> and I. Sterianou<sup>2</sup>**

<sup>1</sup>Institute of Physics and Electronics, University of Peshawar, Pakistan

<sup>2</sup>Department of Materials Science and Engineering, The University of Sheffield, Mappin St., S1 3JD, United Kingdom

**Abstract:**  $\text{Li}_x\text{Ag}_{1-x}\text{NbO}_3$  ( $0 \leq x \leq 0.10$ ) compositions have been fabricated by the mixed oxide route to study the effect of Li on the host material,  $\text{AgNbO}_3$ . The main X-ray diffraction (XRD) traces for ceramics with  $x < 0.10$  were single phase and could be indexed according to the orthorhombic,  $Pbcm$ , structure,  $\sqrt{2}a_p \times \sqrt{2}a_p \times 4a_p$  (where  $a_p$  = pseudocubic perovskite lattice parameter). For composition with  $x = 0.1$ , extra peaks, attributed to  $\text{LiNbO}_3$ , were observed, accompanied by phase transformation to the rhombohedral,  $R3c$ , structure. The same phase change was also revealed by Raman scattering and electron diffraction but the latter technique revealed reflections for  $x = 0.1$  at  $\pm^{1/6}\{001\}$  and  $\frac{1}{2}\{000\} \pm^{1/6}\{001\}$  (where  $o = \text{odd}$ ). Previous investigations (Nalbandyan *et al.* 1980, Sakabe *et al.* 2001, Fu *et al.* 2008) report that Li-content  $> \sim 0.06$  had rhombohedral,  $R3c$ , symmetry and  $\bar{a}\bar{a}\bar{a}$  tilt system evidenced by

reflections at  $\frac{1}{2}\{000\}$  positions. Nevertheless the present study supports the premise that Li doping  $0.05 < x < 0.1$  causes a new modulated tilt system with a  $\sqrt{2}a_p \times \sqrt{2}a_p \times 6a_p$ . This phenomenon is also reflected by the strong asymmetry in the  $M_3$ – $M_2$  dielectric anomaly. Slim polarisation versus field loops were observed indicating remanent polarisations that went up as a function of increasing Li-concentration albeit under subcoercive fields.

### 9. Phase and microstructural evolution of white bentonite from Peshawar valley Khyber Pukhtunkhwa, Pakistan

**Anwarul Haq, Yaseen Iqbal and Mohammad Riaz Khan**

Institute of Physics and Electronics, University of Peshawar, Pakistan

**Abstract:** White bentonite clay sample (BW) from Dag Ismail Khail Peshawar (KPK) were studied using X-ray fluorescence spectroscopy (XRF), thermo-gravimetric analysis (TGA), differential thermogravimetry (DTG), differential thermal analysis (DTA), X-ray diffractometry (XRD), scanning electron microscopy (SEM), energy dispersive X-ray electron spectroscopy (EDS) and transmission electron microscopy (TEM). The clay samples were fired at  $10^\circ\text{C}/\text{min}$  from  $400$ – $900^\circ\text{C}$  for 3h at  $100^\circ\text{C}$  temperature intervals. The measured chemical composition is different from the relevant reported values because of the presence of other clay- and / or non-clay minerals. The two-stage dehydroxylation of BW  $\sim 454$  and  $657^\circ\text{C}$  identified them as bentonite. The wt% loss in BW is  $\sim 22.4$  wt% from room temperature to  $900^\circ\text{C}$ . XRD analysis revealed that BW comprised montmorillonite, calcite and quartz. The breakdown of the montmorillonite crystalline structure occurred at some temperature below

$700^\circ\text{C}$ . At  $900^\circ\text{C}$ , mullite crystals were observed in an almost fused sample. The microstructure of as-received sample comprised convoluted rods of montmorillonite and sharp-edged  $\alpha$ -quartz grains which persisted up to  $\leq 700^\circ\text{C}$ . The only grains identified in fired sample at  $900^\circ\text{C}$  were calcite and quartz. TEM analysis revealed nano-scale cuboidal primary mullite  $900^\circ\text{C}$  in samples which could not be seen in SEM and confirm the XRD analysis.

### 10. The effect of processing conditions on the microwave dielectric properties of $\text{SrCa}_4\text{Nb}_4\text{TiO}_{17}$ and $\text{Ca}_5\text{Nb}_4\text{TiO}_{17}$ ceramics

**Abdul Manan<sup>1,2</sup>, Yaseen Iqbal<sup>1</sup>, I. M. Reaney<sup>2</sup>, Ibrahim Qazi<sup>3</sup>**

<sup>1</sup>Materials Research Laboratory, Institute of Physics and Electronics, University of Peshawar Pakistan

<sup>2</sup>Department of Materials Science and Engineering Materials, Sir Robert Hadfield Building, University of Sheffield, S1 3JD UK.

<sup>3</sup>Department of Materials Science and Engineering, Institute of Space Technology Islamabad, Pakistan  
[abdul\\_manan\\_sher@yahoo.co.uk](mailto:abdul_manan_sher@yahoo.co.uk)

**Abstract:**  $\text{SrCa}_4\text{Nb}_4\text{TiO}_{17}$  and  $\text{Ca}_5\text{Nb}_4\text{TiO}_{17}$  ceramics were processed through solid state mix-oxide route. The ceramics were characterized by using Raman spectroscopy, XRD and SEM for molecular vibrational modes, phase, and microstructural analysis respectively. LCR meter and vector network analyzer were used for dielectric properties at low and microwave frequencies. XRD results revealed the formation of a single phase for each ceramics and their microstructure comprised of elongated and plate-like grains with average grain size  $\sim 5\mu\text{m}$ . The optimum microwave dielectric properties i.e.  $\tau_f \sim -78$  ppm/ $^\circ\text{C}$ ,  $\epsilon_r \sim 47.2$  and  $Q_{uf0} \sim 11954$  GHz, and  $\tau_f \sim -137$  ppm/ $^\circ\text{C}$ ,  $\epsilon_r \sim 42$  and  $Q_{uf0} \sim 14800$  GHz achieved for  $\text{SrCa}_4\text{Nb}_4\text{TiO}_{17}$  and

Ca<sub>5</sub>Nb<sub>4</sub>TiO<sub>17</sub> sintered at 1475°C and 1450°C for 4h respectively.

### 11. Room temperature kinetic solidification of nanoconfined water layers

Shah H. Khan<sup>1</sup>, Peter M. Hoffmann<sup>2</sup>

<sup>1</sup>Institute of Physics and Electronics, University of Peshawar, Pakistan.

<sup>2</sup>Department of Physics, Wayne State University, Detroit, USA.

**Abstract:** Interfacial water plays an important role in many biological as well as man-made systems, e.g. protein folding in living organism, and fluid flow inside narrow channels in the Lab on a Chip device. However, the investigation of interfacial water has proven to be difficult due to technological problems as well as the anomalous nature of water. Controversial claims have been made about the elasticity and viscosity of nanoconfined water films. Using a special kind of home-built atomic force microscope, we have found a kinetically induced phase transformation in a few-molecules-thick-water-layers confined between two hydrophilic surfaces. Close to hydrophilic surfaces, water layers of less than 1 nm thickness seem to solidify above a critical compression rate of 0.8 nm/s at room temperature. This solidification leads to an elastic response of the water layers, accompanied by a sharp increase in mechanical relaxation time.

### 12. Temperature dependent structural and electrical analysis of Mn-Zn nano ferrites

Humaira Anwar, Asghari Maqsood\*

Thermal Transport Laboratory, School of Chemical and Materials Engineering (SCME),

National University of Sciences and Technology, H-12, Islamabad.

[merey\\_anwar@yahoo.com](mailto:merey_anwar@yahoo.com), [\\*tpl.qau@usa.net](mailto:*tpl.qau@usa.net)

**Abstract:** Mn-Zn ferrite powders (Mn<sub>0.5</sub>Zn<sub>0.5</sub>Fe<sub>2</sub>O<sub>4</sub>) were prepared by the chemical co-precipitation method. The effect of annealing temperature on the crystalline phase formation and dielectric properties were investigated by X-ray diffraction and impedance analyzer respectively. The DTA/TGA analysis was carried out to know decomposition mechanism. Ferrites decomposed to Fe<sub>3</sub>O<sub>4</sub> above 600°C annealing temperature. Particle size increased with increasing annealing temperature between 7-13 nm. The resistivity decreased with increase in temperature showing semiconductor like behavior. The measured dc resistivity for sample MZ4 at 573 K was found to be 2.86×10<sup>5</sup> Ω-cm and 4.02×10<sup>5</sup> Ω-cm for sample MZ5. The dc conductivity data was explained using Mott's variable range hopping (VRH) model and different related parameters were calculated. Dielectric constant decreased with increasing frequency and temperature. Relaxation peak occurred for loss tangent versus frequency curves at 1 kHz. Values of s parameter suggest that small polaron tunnelling (SPT) model fits for conduction mechanism in ferrites.

### 13. Characteristics of dolomite from Swabi, Khyber Pakhtunkhwa (Pakistan) for its use as a raw material in fertilizer production

Muhammad Fahad<sup>1</sup>, Yaseen Iqbal<sup>1</sup>, Rick Ubic<sup>2</sup>

<sup>1</sup>Material Research Laboratory (MRL), Institute of Physics and Electronics, University of Peshawar 25120, Pakistan

<sup>2</sup>College of Engineering, Boise State University, 1910 University Dr. Boise, ID 83725, Idaho, USA

**Abstract:** The potential of dolomite [CaMg(CO<sub>3</sub>)<sub>2</sub>] from Swabi district of Khyber Pakhtunkhwa (Pakistan) as a raw material in fertilizer production was investigated in this

paper. Dolomite was found as a major mineral phase when investigated via X-ray diffraction (XRD). XRD results were fully supported by X-ray fluorescence (XRF) analysis. Thermo Gravimetric Analysis (TGA)/Differential Thermal Analysis (DTA) proved that the dolomite phase decomposes into MgO and CaO at 774°C. Further, the nitration of MgO leads to magnesium nitrite [Mg(NO<sub>3</sub>)<sub>2</sub>], a type of fertilizer widely used in agriculture. Due to high contents of magnesium in investigated dolomite, it is can be used as a raw materials for fertilizer production.

#### **14. Synthesis and characterization of completely soluble polypyrrole salts via inverse emulsion polymerization using a mixture of chloroform and 2- butanol as a dispersing medium**

**Mohammad Sohail<sup>1</sup>, Salma Bilal<sup>1</sup> and Anwar-ul-Haq, Ali Shah<sup>2\*</sup>**

<sup>1</sup>National Centre of Excellence in Physical Chemistry, University of Peshawar

<sup>2</sup>Institute of Chemical Sciences, University of Peshawar

**Abstract:** Polypyrrole (PPy) is one of the most promising candidates for possible technological applications. However, its insolubility in common organic solvents limits its range of applications. In the present study an attempt has been made to synthesize soluble polypyrrole salt via inverse polymerization pathway using benzoyl peroxide as oxidant and dodecylbenzenesulfonic acid (DBSA) as dopant as well as a surfactant. A mixture of chloroform and 2-butanol was used as dispersion medium for the first time for the synthesis of polypyrrole. The influence of synthesis parameters such as concentration of aniline, benzoyl peroxide and DBSA on the yield and other properties of the resulting PANI salt was studied. The synthesized PANI salt was found to be completely soluble in

DMSO, DMF, chloroform and in a mixture of toluene and 2-propanol. The synthesized polymer salt was also characterized with SEM, XRD, UV-Vis spectroscopy and viscosity measurements. The extent of doping of the PANI salt was determined from UV-Vis spectra. The activation energy for the degradation of the polymer was calculated with the help of TGA.

#### **15. Determination of thermal stability of polyaniline-dodecylbenzene sulfonic acid salt**

**Salma Gul<sup>1</sup>, Anwar-ul-Haq Ali Shah<sup>2</sup> , Salma Bilal<sup>1\*</sup>**

<sup>1</sup>National Centre of Excellence in Physical Chemistry, University of Peshawar

<sup>2</sup>Institute of Chemical Sciences, University of Peshawar

**Abstract:** Soluble polyaniline (PANI-DBSA) was synthesized by inverse emulsion polymerization. Dodecylbenzene sulfonic acid (DBSA) was selected as a surfactant because it also acts as a dopant. In this process a mixture of chloroform and 2-butanol was used as a dispersing medium for the first time. The synthesized polymer is found to be soluble in common organic solvents such as DMSO, DMF, Chloroform and in 2:1 mixture of toluene and 2-propanol. The conducting form of PANI was confirmed by X-ray diffraction and UV-Vis spectroscopy. The thermal stability was determined by thermogravimetric analysis. This technique was also used to calculate energy of activation (E<sub>a</sub>) for the degradation of polymer using Horwitz & Metzger, Coats & Redfern and Chan et al. methods.

### 16. Kinetic investigation of chromium (iii) removal by strong acid exchanger amberlyst-15(H<sup>+</sup>)

K. H. Shah\*, S. Mustafa, A. Naeem, M. Waseem, T. Ahmad.

National Center of Excellence in Physical Chemistry, University of Peshawar, 25120, Pakistan

\*khizar\_nce@yahoo.com

**Abstract:** Cr(III) sorption on strong acid exchanger Amberlyst-15(H<sup>+</sup>) is studied as a function of time and temperature using the basic chromium sulphate [Cr<sub>4</sub>(SO<sub>4</sub>)<sub>5</sub>(OH)<sub>2</sub>] solution. The temperature has a positive effect on Cr(III) sorption. The pH is observed to decrease during Cr(III) sorption with the passage of time. The film diffusion model is applied to explain the kinetic data and the exchange rate is found to be governed by the film diffusion process. From the rate constant values, the energies of activation are calculated using the Arrhenius equation. The low activation energy confirmed the diffusional nature of the sorption process.

### 17. Comparative study of NiFe<sub>2-x</sub>Al<sub>x</sub>O<sub>4</sub> ferrite nanoparticles synthesized by chemical co-precipitation and sol-gel combustion techniques

I. H. Gul, Erum Pervaiz

Thermal Transport Laboratory, School of Chemical and Materials Engineering (SCME), National University of Sciences and Technology (NUST), H-12 Islamabad., PAKISTAN

[iftikhar\\_qau@yahoo.com](mailto:iftikhar_qau@yahoo.com)

**Abstract:** A series of aluminum substituted Ni-ferrite nanoparticles have been synthesized by chemical co-precipitation and sol-gel techniques. The samples were characterized by X-ray diffraction (XRD), Scanning Electron Microscopy (SEM), Atomic Force Microscope (AFM), Fourier Transform Infrared Spectroscopy (FTIR), DC electrical resistivity

and dielectric properties. Analysis of the X-ray diffraction pattern of all the samples confirmed the formation of single phase face centered cubic (FCC) spinel structure. The crystallite sizes ( $D_{311}$ ) have been calculated from most intense peak using the Scherrer formula. The particle size remains within the range 25-41 nm. The unit cell parameters decrease with the increase in Al<sup>3+</sup> concentration (x) in both techniques. FTIR measurements show two fundamental absorption bands, assigned to the vibration of tetrahedral (A-sites) and octahedral (B-sites), which were slightly changed with increasing Al<sup>3+</sup> concentration (x). DC electrical resistivity increases from  $6.60 \times 10^7$  to  $6.9 \times 10^{10}$  Ω-cm as the Al<sup>3+</sup> concentration (x) increases from 0.00 to 0.50. The results of DC electrical resistivity have been explained on the basis of polaron conduction mechanism. Activation energy calculated from the DC electrical resistivity versus temperature for all the samples ranges from 0.441 to 0.66 eV. The dielectric properties are studied as a function of frequency in the range 100Hz to 5 MHz at room temperature. The dielectric constant and loss tangent decreases with increasing Al<sup>3+</sup> concentration from 22 to 14, 0.354 to 0.27 respectively at 5MHz for all the samples. Impedance measurements as a function of frequency (1 KHz-5MHz) at room temperature further helped in analyzing the electrical properties of the prepared samples. Resistance of the grain boundary and grains can be separated using complex impedance analysis. Hence low values of dielectric constant increase the penetration depth of electromagnetic radiation which warrants their application at high frequencies.

## 18. An overview of osmotic power generation and its scope in Pakistan

Syed Waqar Hasan<sup>1</sup> and Syed Faraz Hasan<sup>2</sup>

<sup>1</sup>National Refinery Limited, Pakistan

<sup>2</sup>Department of Electrical Engineering, NED University of Engineering and Technology, Karachi

[waqar\\_hasan88@yahoo.com](mailto:waqar_hasan88@yahoo.com)

**Abstract:** The need of introducing innovative power generation methods is increasing rapidly worldwide. The conventional fuel driven methods not only require heavy financial investments, they have also been held responsible for many natural calamities faced by the human population. While the research on better utilizing the renewable resources such as wind, tidal and wave energy etc is underway, the Osmotic Power has been commercially introduced as a new fuel-free energy resource. The energy in the osmotic power is derived from the difference in salt concentration between the fresh water and the salt water. In this paper, we take an in-depth look into the technical details of the osmotic power generation. We identify some of the geographical locations alongside the country's coast that can be ideal for setting up an osmotic power station. We also evaluate the osmotic potential in the sea water on the coast of Karachi with the help of laboratory tests and mathematical estimation. According to our estimation, the osmotic potential in Karachi's sea water is comparable to that available in the first commercial osmotic power plant.

## 19. Pulsed DC plasma nitriding of AISI-316 stainless steel and mild steel in N<sub>2</sub>-H<sub>2</sub> mixture

A. Saeed<sup>1</sup>, A. W. Khan<sup>1</sup>, M. Khalid<sup>1</sup>, Z. Iqbal<sup>2</sup>, M. Shafiq<sup>3</sup>, M. Zakaullah<sup>\*3</sup>

<sup>1</sup>Department of Physics, Gomal University, D. I. Khan, 29050, Pakistan

<sup>2</sup>NS & CD, National Center for Physics, Quaid-i-Azam University, Islamabad 45320, Pakistan

<sup>3</sup>Department of Physics, Quaid-i-Azam University, Islamabad 45320, Pakistan.

**Abstract:** AISI 316 stainless steel and mild steel are nitrided in a 50 Hz pulsed-dc glow discharge for different treatment times of 4, 8, 12, 16 and 20 hours. The ion current density (3.3mA/cm<sup>2</sup>), filling pressure (5mbar), substrate temperature (450°C) and gas composition (30%N<sub>2</sub> and 70%H<sub>2</sub>) are kept constant. The treated and untreated samples are analyzed for changes induced in surface properties using X-ray diffractometer (XRD) showing the peaks of CrN and  $\epsilon$ -Fe<sub>2.3</sub>N for the sample treated for different treatment times, Scanning Electron Microscopy (SEM) showing the smoothing of the surface as the function of treatment time, Energy Dispersive X-ray Spectroscopy (EDS) showing an increasing trend in the nitrogen concentration and Vickers's micro-hardness testing. The surface hardness of AISI is increased 2.5 times while that of mild steel is increased 3 times of their bulk values due to the formation of Cr<sub>2</sub>N and  $\epsilon$ -Fe<sub>2.3</sub>N. The improvements in hardness and wear resistance are discussed considering micro-structural modifications in the treated samples.

## 20. Structural, magnetic and optical properties of undoped Co-evaporated ZnO thin films

Akif Safeen, Kashif Safeen, Shahzad Naseem and Saira Riaz

Centre of Excellence in Solid State Physics, University of the Punjab, Lahore Pakistan

[akifsafeen@gmail.com](mailto:akifsafeen@gmail.com)

**Abstract:** ZnO thin films have been deposited by co-evaporation at oxygen partial pressure of  $5.8 \times 10^{-4}$  and  $7.8 \times 10^{-4}$  torr. Different characterization techniques are employed to characterize the as-deposited and annealed (at 300 °C for 1 h) samples. X-ray diffraction (XRD) studies of the as-deposited samples



indicate the formation of amorphous ZnO thin films. After annealing no considerable change is observed in XRD pattern of both samples. For sample A, the variable angle spectroscopic ellipsometry (VASE) analysis shows that the post-deposition annealing causes a decrease in energy band gap ( $E_g$ ) from  $\approx 3.99$  eV to  $\approx 3.97$  eV, and the refractive index from 1.52 to 1.50. The film thickness also decreases in contrast to as-deposited sample. The same trend is observed for sample B. Vibrating sample magnetometer (VSM) was used to carry out magnetic characterization. Room-temperature ferromagnetism (RTFM) is observed in both categories A and B. Additionally, saturation magnetization enhanced after annealing.

## 21. Development of a dispersion process for co-ferrites nano-particles in an epoxy matrix and the resulting electrical, dielectric, Microwave and mechanical properties

**Ahmad Faraz, Nasir Mahmood Ahmad, Asghari Maqsood**

School of Chemical and Materials Engineering (SCME)  
National University of Sciences and Technology (NUST)  
H-12, Islamabad Pakistan.

**Abstract:** In the present investigation Co-ferrites nano particles are dispersed in epoxy (Araldite) matrix. The trapped air and reaction volatiles were removed from the mixture using high vacuum. The morphological, electrical, dielectric, microwave and mechanical properties of material are performed. The electrical and dielectric studies are performed to study the electrostatic charging of insulating matrix. Since to avoid electrostatic charging of an insulating matrix an electrical conductivity above  $\sigma=10^{-6}$  Sm<sup>-1</sup> is needed. At present, the most common practice to achieve this conductivity is to use filler such as co-ferrites nano-particles. The dielectric constant ( $\epsilon'$ ), dielectric loss ( $\epsilon''$ ) are found in frequency range of 5MHZ. The microwave properties of material

is studied in range 1MHz-3GHz, and further this materials is tested in X-band (11GHz-18GHz) frequency ranges, to analyze various parameter such as scattering, reflectance and absorption. Interesting microwave absorption behavior is obtained and it is observed that these materials can be useful for various strategic applications e.g. RAM. Tensile and fracture tests were performed on unfilled, 0.025wt.%, 0.050 wt.% , 0.10 wt.% and 0.5 wt.% Co-nano ferrites filled Araldite epoxy to identify the effect of adding ferrites nano-particles on the mechanical properties of epoxy. The highest improvement in strength was obtained with 0.5 wt% loading of Co-ferrites. The value of tensile strength was found in ranges 56.24-76.15MPa. So, the value of tensile strength increased with increase in dopant Co-ferrites nano-particles concentrations. The observed modulus values are found in range 2.52-3.42 GPa, confirmed the improvement in mechanical properties of the synthesized material.

## 22. Thermal analysis and encapsulation of spent ion exchange resin in borosilicate glass

**N. Hamodi\*, K. Papadopoulou\*\* and Y.Iqbal**

School of Mechanical, Aerospace and Civil Engineering,  
the University of Manchester, Pariser Building,  
Manchester, M13 9PL, UK

\*[Nasir.Hamodi@postgrad.manchester.ac.uk](mailto:Nasir.Hamodi@postgrad.manchester.ac.uk)

\*\*[Kassandra.Papadopoulou@manchester.ac.uk](mailto:Kassandra.Papadopoulou@manchester.ac.uk)

**Abstract:** The underground disposal of waste arising from water treatments needs constant evaluation in order to improve upon it through minimizing the volume and cost by reducing the amount of glass used without compromising the safety of any leakage from the radioactive waste when disposed. The immobilization of the spent resin (NRW-40) in borosilicate glass was investigated to meet the acceptance criteria for disposal of nuclear waste. The organic mixed bed resin in granular form was used as a waste target. The analysis of surrogate resin

doped with radioactive and non-radioactive cesium and cobalt was carried out to investigate their thermal and chemical properties and their compatibility with an alkaline borosilicate glass. The thermal analysis indicates that the structural damage caused by 1 mSv gamma radiation to the radioactive resin has altered its properties in comparison with the non-radioactive resin, same amount of doping cesium (8.88wt%) and cobalt (1.88wt%) were used in both resins. The encapsulation of residue shows that the excess sulfur in the residue caused phase crystallization in the final glass matrix. It was found that the volatilization of Cs-137 and Co-60 from the successful radioactive resin-glass matrix (HG-3-IER-500) were more than that in the non-radioactive resin-glass matrix (HG-3-IEX-500). The study demonstrates comprehensive experimental and analytical works and shows that it is possible to minimize the volume of the glass while keeping the required safety levels, however more research needs to be carried out.

### 23. Hydrothermal synthesis and characterization of nanosized zinc cobaltite spinel ceramic

**Shahid Khan Durrani<sup>1\*</sup>, Anam Asif<sup>2</sup>, Ubaid ur Rehman<sup>2</sup>, Nazir Hussain<sup>1</sup> and Shahid Naveed<sup>2</sup>**

<sup>1</sup>Materials Division, Directorate of Technology, PINSTECH, Islamabad, Pakistan

<sup>2</sup>Chemical Engineering Department, University of Engineering and Technology Lahore.

[\\*durransk@gmail.com](mailto:durransk@gmail.com)

**Abstract:** Zinc cobaltite ( $ZnCo_2O_4$ ) spinel nanocrystals are important technological materials because they have a wide range of applications ranging from ultra high magnetic data storage, magnetic resonance imaging, sorbents, battery materials, catalysts, biosensing to nanoelectronic materials. Zinc cobaltite ( $ZnCo_2O_4$ ) spinel nanocrystals have been

synthesized via hydrothermal process at low temperature (180°C) and pH 11.5 for 4 h using stainless steel PTFE lined autoclave. The synthesized oxide material was characterized by a variety of techniques, including X-ray diffraction (XRD), scanning electron microscopy (SEM) and thermogravimetric analysis and differential thermal analysis (TG/DTA). The powder diffraction patterns and SEM observation of as-synthesized and calcined samples indicate that hydrothermal reactions yield good crystalline products. XRD data revealed the formation of a well-crystallized spinel structure of  $ZnCo_2O_4$  (~98%) by heating the precursor between 350°C and 750°C for 4 h.

The TG/DTA analysis results revealed that  $ZnCo_2O_4$  crystalline phase is thermally stable in the range 750-800°C. The physicochemical and XRF analysis showed that synthesized zinc cobaltite has high percentage of desire cobaltite spinel phase. Various crystal sizes were observed depending on reaction conditions ranging from 100 to 120nm. The hydrothermal method provides a practicable and effective route for the synthesis of the spinel nanocrystalline  $ZnCo_2O_4$  at elevated temperature and pressure using aqueous medium with improved control of size and morphology.