National Workshop

On

Applications of Ion Beam in Device Fabrication and Nanotechnology

TECHNICAL PROGRAM

Date: 5th March 2012

Registration: 8:00-9:30

A. Inaugural Session (9:30-11:00)

KeyNote Address : Ajay Gupta (10:15-11:00), UGC DAE CSR, Indore
Title: “Nanoripple Formation on Si(100) Surface Using Low Energy Ion Irradiation”
Tea : 11:00 -11:30

B. Invited Lecture: (Chair : A.L. Sharma)
11:30-12:00 D.K. Avasthi, IUAC, New Delhi
Title: “Ion beam synthesis and engineering of nanostructures”
12:00-12:30 B. K. Panigrahi, IGCAR, Kalpakkam
Title: “Synthesis, characterization and photoluminescence studies of novel nanostructured materials using ion beams”
12:30-1:00 D.C. Kothari, Univ. of Mumbai, Mumbai
Title: “Low energy ion beam synthesis of embedded nanostructures for novel applications”

LUNCH : 1:00-2:00

C. Invited Lecture : (Chair : K. Rama Reddy)
2:00-2:30 Pratap K. Sahoo, NISER, Bhubneshwar
Title: “Role of amorphous and crystalline interface during MeV ion beam stimulated epitaxial crystallization of Si”
2:30- 3:00 Ratnesh Gupta, D.A. Univ, Indore.
Title: “Influence of Nitrogen ions on structural and magnetic properties of nanoscale exchange coupled Fe/Co bilayers”
3:00- 3:30 Sanjay Kher, RRCAT, Indore.
Title: “Micro and nano-structured optical fiber devices for detection of fuel adulteration and bio-chemical sensing”

TEA : 3:30-3:45
D. Tutorial Session (3:45-5:45) (Chair : B.K. Panigrahi)
   3:45-4:45 D.K. Avasthi, IUAC, New Delhi.
   Title: “Energy loss of ions in materials and consequent processes”
   4:45-5:45 Mukul Gupta, UGC-DAE CSR, Indore
   Title: “Self-Diffusion Measurements Using Secondary Ion Mass
   Spectroscopy”

E. Workshop Dinner and Cultural Program (6:00-10:30)
Date: 6th March 2012

F. Invited Lecture (9:00- 11:00) (Chair : Ajay Gupta)
9:00-9:30 K.G.M. Nair, IGCAR, Kalpakkam.  
Title: “Selforganized Patterns on Ion Irradiated Silica”
9:30- 10:00 K. Rama Reddy, Osmania Univ., Hyderabad.  
Title: “Correlation Methods for the improvement of S/N ratio in Stochastic Processes”
10:00- 10:30 S. I. Patil, Pune University, Pune.  
Title: “Effect of swift heavy ion irradiation on the physical properties of manganite thin films”
10:30-11:00 S.K. Deb, RRCAT, Indore.  
Title: “Indus Synchrotron Radiation Source”

Tea : 11:00-11:15

G. Tutorial Session (11:15- -1:30 ) (Chair : D. C. Kothari)
11:15-12:00 B.K. Panigrahi, IGCAR, Kalpakkam.  
Title: “Rutherford Backscattering Spectroscopy: SIMNRA”
12:00-12:45 Ajay Gupta, UGC- DAE CSR, Indore.  
Title: “X-Ray Reflectivity: Parrot Formalism”
12:45-1:30 N.P. Lalla, UGC- DAE CSR, Indore.  
Title: “Powder x-ray diffraction and Rietveld refinement”

LUNCH : 1:30-2:30

H Poster Discussion Session : 2:30 -5:00 (Chair : S.K.Deb, M.P.S. Chawla)

I. Concluding Session: 5:00-5:30
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Nanoripple formation on Si(100) surface using low energy ion irradiation

Ajay Gupta,

UGC-DAE Consortium for Scientific Research, Khandwa Road, Indore 452017

Low energy ion beam irradiation has been shown to be a powerful method for patterning of the surfaces of metals, semiconductors and insulators. Irradiation under appropriate conditions can result in formation of nanoripples at the surface, the period and the modulation depth of which can be controlled by controlling the energy, fluence and the angle of incidence of the bombarding ions. The structure of these ripples can strongly influence the functional properties of the films deposited on it.

Formation of nanoripples on the surface of Si(100) using surfactant assisted low energy ion bombardment at normal incidence has been studied. Detailed GISAXS and AFM measurements provide information about the mechanism of ripple formation.

The results of in-situ study of the growth behavior and magnetic properties of ultrathin Co films on nanoripped Si(100) substrate will also be discussed. It is found that magnetic films exhibit a strong uniaxial magnetic anisotropy with easy axis along the ripples. The anisotropy exhibits a monotonous decrease with increasing film thickness. In-situ resistivity measurements demonstrate a clear anisotropy in the growth behavior of the film along and normal to the ripple direction. Ex-situ AFM and synchrotron XRD measurements suggest that grain texture and morphology is significantly affected by the structure of the substrate surface. TEM measurements show columnar growth of the film with lateral dimensions of the columns equal to the ripple wave length. A correlation of the growth behavior, morphology and magnetic properties of the films will be attempted.
Correlation Methods for the improvement of S/N ratio in Stochastic Processes

K. Rama Reddy

Department of Physics, Osmania University, Hyderabad – 500 007

Particle counting measurements are made through recording the counting rates as a function of physical parameters like momentum, energy, angle, external perturbations etc. Specialized techniques were developed, suitable to each field of spectroscopy for the improvement of detection sensitivity for the enhancement of S/N ratio. In all the counting measurements the background radiation limits the precision to be achieved in physical parameters as the existing methods use the d.c. technique of relative variation of the count rate as a function of physical variables. The present talk deals with the development of Correlation methods coupled with Fourier technique, which are shown to evaluate physical parameters with better precision in all the photon/particle counting spectroscopy.
I3

Low energy ion beam synthesis of embedded nanostructures for novel applications

D. C. Kothari

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In recent years there are a few of studies indicating that low energy ion beam can provide control in producing surface modified layers with embedded nanoparticles. Many studies are devoted to using the effects of dielectric confinement of nanoparticles for optical switching, waveguides etc. When it comes to integrating an optical device with an electronic device, ion beam is a welcome technique, since it is a standard process step in integrated circuit manufacturing. Moreover, the structures remain chemically and mechanically stable. Recently it has been shown that ion beam can provide control in producing mono-dispersed nanoparticle embedded in glass with desired particle density. The author would indicate many novel applications of such materials made using ion beams. In addition to the above discussed bottom-up approach for synthesizing nano-composites, nano-structures can be sculpted by focus ion beam technique by the top-down approach. The author will also discuss the use of focused ion beams in making nano-structures for possible device applications.
Effect of swift heavy ion irradiation on the physical properties of manganite thin films

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In the perovskite manganites of the form $\text{R}_{1-x}\text{A}_x\text{Mn}_3\text{O}_5$ the spin, lattice, charge and orbital degrees of freedom are coupled to one another. Since interaction energies are also of the same order of magnitude, their properties are extremely sensitive to small changes in the material parameters or any post synthesis like heavy ion irradiation leads to very rich phase diagram. A detailed investigation of electron transport, magnetism, magnetoresistance and crystallographic modifications due to the heavy ion irradiation were carried out on epitaxial thin films of hole and electron doped manganites. The results are correlated with the type and concentration of doping elements, energy, dose and type of heavy ion, and existing theories of manganites. The work carried out at the University of Pune in collaboration with IUAC New Delhi will be discussed during the presentation.
I5

Topic: Micro and nano-structured optical fiber devices for detection of fuel adulteration and bio-chemical sensing

Sanjay Kher
Fiber Optics lab, SSLD, RRCAT, Indore-452013

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Abstract:

Adulteration of petrol with kerosene is a common malpractice in India especially in public transportation system. Such adulteration results in increased pollution, reduced lifetime of engines and diversion of subsidized kerosene. There is no standard universal technique for detection of adulteration level so far and most current techniques can detect adulteration of about 20% or higher. We have designed specialty fiber gratings in single mode fibers that can detect the adulteration just above 5% and provide attractive platform for bio-chemical sensing. Such fiber gratings have been designed and fabricated using automated CO₂ laser system and Arc based fusion technique [1, 2]. In my presentation, I will cover design of specialty gratings and their applications for monitoring adulteration

Sensors based on Surface Plasmon resonance (SPR) have emerged as sensitive instruments for monitoring fuel and food adulteration. Recently, the use of modified optical fibers by use of nanometer thick metallic coatings and nano-structured coatings in conjunction with SPR have been studied to offer attractive advantages such as remote sensing, real time and in-situ monitoring of food and fuel adulteration[3]. These coatings have been made either by using thermal evaporation or by chemical route. We have designed and developed fiber optic based highly sensitive SPR sensors for refractive index sensing which can be used for adulteration sensing. I will describe the various techniques for interrogation of SPR based sensors and their applications for determination of adulteration and bio-chemical sensing.

References:


2. Sanjay Kher, Smita Chaube, Raman Kashyap, S.M.Oak, Tuernaround-point long period fiber gratings as high radiation dose sensors, rapid publication in IEEE-PTL (in-print for next issue 2012).

I6

Ion beam synthesis and engineering of nanostructures

D.K. Avasthi

Inter University Accelerator Centre, Post Box 10502, New Delhi-110067, India

Energetic ions, depending on their mass and energy, have different roles in synthesis and engineering of the nanostructures. The unique features of ion beams can be utilized in (i) synthesis of nanostructures (ii) engineering the size and shape of the nanostructures and (iii) tuning the surface plasmon resonance and non linear optical properties in noble metal nanocomposite thin films. Interesting results have been obtained in synthesis of metal-silica nanocomposites, ripples at surface and engineering the size and shape of particles embedded in silica matrix. Preliminary in-vitro experiments on applications of Au nanoparticles in radiosensitization of Hela cancer cells will be briefed.
Synthesis, characterization and photoluminescence studies of novel nanostructured materials using ion beams

B. K. Panigrahi

Indira Gandhi Centre for Atomic Research, Kalpakkam-603102, India

Abstract

The applications of nanodevices in novel electronic and optoelectronic fields have been increasing tremendously. The fabrication of nanomaterials with controlled size, shape and good crystalline structure, which are essential for device fabrications, is a challenging problem. For device fabrication a lower temperature synthesis is preferred and hence non-equilibrium process like ion implantation and pulsed laser deposition (PLD) method are preferred. 3C-SiC nanoparticles embedded in silicon matrix and Au nanoparticles embedded in silica and sapphire matrices were synthesized using ion beam synthesis method whereas ZnO/Au/Si hybrid structures were synthesized using pulsed laser deposition (PLD) method. For the first time, a large enhancement (14 times) in the PL emission of ZnO deposited on Au thin film was observed, which is in contrast to the earlier observation of poor enhancement in PL emission of ZnO thin film deposited on thick Au films. The enhancement in PL emission can be attributed to the interaction between the spontaneous recombination in ZnO and surface plasmon arising from Au nanoclusters.

Nanomaterials consisting of noble metal clusters on surfaces are of technologically important materials in vast areas ranging from plasmonics to chemical catalysis. A novel ion track etching method has been demonstrated for the synthesis of nanochain like gold aggregates in amorphous silica matrix. Au nanoparticles were also synthesized in sapphire substrates by direct ion implantation method without any post annealing procedures, which is in contrast to the synthesis of Au nanoparticles by post implantation annealing by earlier workers. The room temperature PL emission shows two major bands one in UV region and another in visible region. The observed temperature dependent PL behavior of Au nanoparticles is due to the PL enhancement induced by the local electric field of SPR and second harmonic SPR.

The talk will also cover our recent work on structural and electronic properties of nitrogen ion implanted ultra nanocrystalline diamond surfaces.
Role of amorphous and crystalline interface during MeV ion beam stimulated epitaxial crystallization of Si
Pratap K. Sahoo
School of physical sciences, National Institute of Science Education and Research (NISER) Bhubaneswar, Sainik School-751005, Orissa, India

When an amorphous layer is in contact with a single crystal substrate, it crystallizes epitaxially in the solid state by rearrangement of the atoms at the amorphous-crystalline (a/c) interface at elevated temperatures which are well below the melting point of the material. This is called Solid Phase Epitaxial Growth (SPEG). The typical SPEG recrystallization temperature for silicon is ³ 550°C. This process has found a wide applicability in device fabrication, as it does not involve very high temperatures and molten or gaseous states. Ion beam induced epitaxial crystallization (IBIEC), is one of the recent techniques among SPEG, used to stimulate the recrystallization of radiation induced damaged layers. In this process the amorphous layers can be epitaxially recovered by bombarding the amorphous layer with energetic ions of suitable ions at substantially lower substrate temperatures (200 to 400°C) compared to conventional SPEG. The annealing ions should have sufficiently high-energy, so that they pass through the a/c interface. In this discussion, I will explain our experimental results of three different epitaxial processes in Si using MeV Nitrogen ion beams. These are (i) IBIEC of thick amorphous silicon layers in the temperature range of 100 - 450°C. (ii) Synthesis of Silicon on insulator by dynamic epitaxy/annealing of crystalline Si in the temperature range of 200 - 450°C, (iii) a novel way of solid phase epitaxial recovery of deposited Si on the crystalline Si by ion amorphization followed by thermal annealing. The epitaxial recrystallizations have been characterized by means of RBSChanneling, Micro-Raman, AFM and TEM measurements. The mechanism of different epitaxial processes will be discussed.
Influence of Nitrogen ions on structural and magnetic properties of nanoscale exchange coupled Fe/Co bilayers

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Fe/Co bilayers were made using ion beam sputtering and then were subjected to nitrogen-ion irradiation to explore the influence of irradiation on their magnetic properties. The magnetization and coercivity of the as-deposited sample exhibited a two-fold uniaxial symmetry while the behavior for high temperature irradiated sample depicts a small shift in the two fold behavior. The magnetization data measured with the magnetic field perpendicular to the plane of the film exhibited a hysteresis in case of the irradiated sample while as-deposited sample has shown no well defined hysteresis loop in this geometry. The present talk deals with the effects of very low energy and low energy ions at different temperatures on the structural and magnetic properties of the bilayers.
Selforganized Patterns on Ion Irradiated Silica

K.G.M.Nair

Materials Physics Division

Materials Science Group

Indira Gandhi Centre for Atomic Research

Kalpakkam-603102

Ion beam sputtering is known to give rise to surface roughening and under certain conditions, can result in the formation of self organized surface morphological features such as ripples and periodic array of dots. Most of the studies on the surface pattern formation have made use of sputtering by low energy (~few keV) noble gas ions at off-normal incidence. In this paper the results on the pattern formation during MeV heavy ion irradiation in silica is reported. The formation of self-organised surface morphology was observed during irradiation of Silica with MeV Energy Metal Ions under both normal and off normal incidence. A dot pattern was observed during normal incidence whereas ripple like morphology was seen under off normal incidence. The spatial periodicity of the patterns was found be flux independent and varied linearly with ion energy. The most likely mechanism for pattern formation hence should be surface roughening by curvature dependant sputtering and surface relaxation by viscous flow. However the growth rate of the surface morphological features calculated assuming curvature dependent sputtering and irradiation induced viscous flow was found to be a few orders of magnitude lower than the experimentally observed growth rate. This suggests that the conventional models used in the context of pattern formation during low energy ion sputtering may not be adequate to explain the periodic surface morphology observed under the present experimental conditions. One important observation made during the study of surface morphology was that during irradiation with metal ions there is surface segregation of metal atoms. The presence of the metal atoms in the surface and near surface region is expected to modify the kinetics of surface roughening as reported in the case of ‘surfactant sputtering’. Surface stresses developed due to the accommodation of the metal atoms in the near surface region is expected play a major role in the formation of periodic surface morphology during ion irradiation.
I11

INDUS SYNCHROTRON RADIATION SOURCE

S.K. Deb

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Abstract

Raja Ramanna Centre for Advanced Technology at Indore, houses two synchrotron radiation sources: Indus-1 and Indus-2 respectively. Indus-1 is a 450 MeV and 100 mA source emitting primarily in VUV and soft x-ray region and Indus-2, with designed specification of 2.5 GeV and 300 mA emits in the hard x-ray with critical wavelength of 2Å. Indus-1 has been operational since 1999 at designed energy and current and five beamlines have been installed and operational. Two of these are for atomic and molecular physics experiments in the VUV region and remaining ones are for condensed matter studies. Indus-2 has been currently operating at 2 GeV and 100 mA and six bending magnet beamlines have been installed and are being used by several users. Two more beamlines namely ‘Grazing Incidence X-ray Scattering (GIXS)’ and ‘Protein crystallography’ beamlines are at advanced stage of installation. In this talk I will briefly discuss the specifications and capabilities the beamlines in Indus-1 and Indus-2 and discuss about a few interesting works which has been carried out recently using these beamlines. In particular I will specifically highlight works being carried out using the Indus-2 beamlines. These include Energy Dispersive EXAFS, Angle and Energy Dispersive XRD, X-ray fluorescence micro-focus, Soft and Hard X-ray Lithography and others. I will also discuss the several upgradation schemes in these existing beamlines and also insertion device based beamlines being planned in the next few years.
T1

X-Ray reflectivity : Parrot Formalism

Ajay Gupta
T2

Energy loss of ions in materials and consequent processes

D.K. Avasthi

Inter University Accelerator Centre, Post Box 10502, New Delhi-110067

Ion beams are capable of depositing a large energy density in materials. The processes of energy loss in during its traversal in materials will be discussed. The consequence of large energy density deposition will be discussed in terms of Coulomb explosion, thermal spike, pressure spike etc. The example of these will be briefed for understanding.
T3

Powder x-ray diffraction and Rietveld refinement

N.P. Lalla

UGC-DAE Consortium for Scientific Research, Indore

In the present lecture we will discuss regarding the technique of “Rietveld-refinement” of the powder XRD data for extracting useful structural informations related to the sample. In the beginning some very basics of x-ray diffraction in relation with the lattice-parameters (interplaner-spacings), atomic-arrangement in the unit-cell (space-groups), effect of temperature(Debye temperature factor) and effect of particle-size and its shape will be discussed in relation to a powder sample. Some instrumental factors affecting the peak-profile will also be discussed. Rietveld refinement is now a well developed area. It is capable of solving new crystal structures subject to the condition a proper starting model is selected for refinement. Very often it is used for refining known structural parameters as a function of some external variable like composition, temperature or some treatment condition under the constrain that the space-group remains unchanged. Performing a refinement basically means making a proper “input file” based on given structural model and then run this for the given data. Therefore during discussion we will describe how to make an input file based for some example powder XRD data.
T4

Self-Diffusion Measurements Using Secondary Ion Mass Spectroscopy

Mukul Gupta

UGC-DAE Consortium for Scientific Research, University Campus, Khandwa Road, Indore 452 001

Abstract. Secondary Ion Mass Spectroscopy (SIMS) is a technique that provides a unique combination of extremely high sensitivity for all elements from Hydrogen to Uranium (detection limit down to ppb level for many elements), high lateral resolution imaging (down to 40 nm), and a very low background that allows high dynamic range (more than 5 decades). This technique is "destructive" by its nature (sputtering of material). It can be applied to any type of material (insulator, semiconductor, metal) that can stay under vacuum. It allows molecular as well as elemental characterization of the first top monolayer in the static mode. It allows also the investigation of bulk composition or depth distribution of trace elements in the dynamic mode, with a depth resolution of few nanometers.

When a solid sample is sputtered by primary ions of few keV energy, a fraction of the particles emitted from the target is ionized. SIMS consists of analyzing these secondary ions with a mass spectrometer. Secondary ion emission by a solid surface under ion bombardment supplies information about the elemental, isotopic and molecular composition of its uppermost atomic layers. The secondary ion yields will vary greatly according to the chemical environment and the sputtering conditions (ion, energy, angle etc.). This can add complexity to the quantitative aspect of the technique.

In this tutorial first basic of SIMS technique will be presented. Thereafter depth profile of a three layer structure i.e. FeX(50 nm)/^{57}Fe(2nm)/Fe(50 nm) measured using SIMS will be discussed. After thermal annealing ^{57}Fe diffuses into natural Fe and the depth profile gets broadened. By doing careful experiment diffusivity and activation energy for diffusion can be measured precisely. Measurement of diffusivity and activation energy will be worked out during this tutorial session.
T5

Rutherford Backscattering Spectroscopy: SIMNRA

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HRBS and XRR analysis of HfO$_2$/SiO$_2$/Si samples


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Hafnium based high dielectric constant materials are critical for the state-of-the-art integrated circuit technology. As the size of the transistor decreases, the thickness of the gate dielectric should be reduced to maintain device capacitance at a desired level. This thickness reduction results in high OFF-state leakage current due to quantum tunneling (~ 100 A/cm$^2$ for 1 nm SiO$_2$). Eventually high-k materials, like HfO$_2$, have recently been introduced as gate dielectrics. However deposition of these high-k materials on Si wafers results in high concentration of interface defects due to their thermodynamic instability on Si. Introduction of thin inter layer (IL: Silicon oxide / nitrides) between Si and HfO$_2$ is expected to improve interface quality. Hence it is important to study the composition, thickness and intermixing effects to optimize the fabrication of Hafnium based MOS devices. Here we present High Resolution Rutherford Backscattering Spectrometry (HRBS) and X-Ray Reflectivity (XRR) studies of Atomic Layer Deposition (ALD) grown HfO$_2$/SiO$_2$/Si samples obtained from SEMATECH, USA. HRBS measurements and Synchrotron based XRR measurements were performed at National University of Singapore (NUS). The concentration profiles of Hf, O and Si were estimated using HRBS and film thickness and interface roughness was estimated using XRR. These results will be discussed in view of possible inter diffusion and straggling effects.

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P2


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Iron nitrides (Fe-N) are interesting materials both from fundamental and application point of view. The magnetic iron nitrides (N at.%<25) are well-known due to their chemical inertness and mechanically hard surfaces [1-2]. On increasing the N at.% beyond 25%, non-magnetic iron nitrides are formed [3]. At about 50 at.%, iron mononitride (FeN) phase is formed which has been prepared in the form of thin films, only. Very recently non-magnetic iron mononitrides have emerged as a promising material in spintronics applications. Controlled annealing of FeN produces the γ-Fe₃N phase and thus provides a source of spin injection for semiconductors or diluted magnetic semiconductors [4]. Formation of such phases is a diffusion driven process and both Fe and N diffusion process are responsible for stability and nitride formation. During past decades improving the thermal stability of magnetic iron nitrides is an active area of research. In this respect it was suggested that addition of small amount of third element like Al, Ti, Zr etc. could suppress the iron and nitrogen diffusion and thus improves the stability of these compounds. However this has not been experimentally observed. Secondary ion mass emission spectroscopy (SIMS) is a versatile technique to measure diffusivity in nm range. In this work we have utilized SIMS technique to measure the diffusivity of iron and nitrogen in non magnetic iron mononitride prepared with small addition of Ti and Zr. For this purpose following tri layer samples were prepared: (i) Si(substrate)/FeTiN(100nm)/⁵⁷FeTi¹⁵N(2nm)/FeTiN(100nm) and (ii) Si(substrate)/FeZrN(100nm)/⁵⁷FeZr¹⁵N(2nm)/FeTiN(100nm)/Sub(Si). Diffusivity of iron and nitrogen was measured in both samples with isochronal annealing. It was found that nitrogen diffuses slowly as compared to iron as shown in Fig. 1. This result is counter intuitive as the atomic radius of iron (127 pm) is about 1.6 times larger than that of nitrogen (79pm). The obtained diffusivity can be understood in terms of formation of covalent bonds in this system.

Fig.1 SIMS depth profiling of FeN samples for ¹⁵N(a), ⁵⁷Fe(b) with Ti addition and ¹⁵N (c), ⁵⁷Fe(d) for Zr additions.
P3

120 MeV Ag$^{9+}$ Ion Irradiation Effects on Structural and Optoelectronic properties of ZnS/TiO$_2$ Core-Shell Quantum Dots

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Abstract

ZnS/TiO$_2$ core shell quantum dots (QDs) are synthesized by colloidal technique and are deposited on 1x1 cm$^2$ ITO (Indium Tin Oxide) coated glass substrate in the form of thin film of thickness of 500 nm. These films are irradiated at fluences $3\times10^{12}$ and $3\times10^{13}$ ions/cm$^2$ of 120 MeV Ag$^{9+}$ ions. The UV-visible absorption spectra of these ZnS/TiO$_2$ QDs shows strong absorption band edge at 234 nm in pristine sample, which is blue shifted from bulk ZnS absorption band edge (320 nm), which further shifted towards 240 nm at higher fluence $3\times10^{13}$ ions/cm$^2$. At higher fluence the band edge becomes sharp showing the uniform distribution of QDs. X-ray diffraction pattern shows increase in crystalinity of these QDs at higher fluence $3\times10^{13}$ ions/cm$^2$, which is further confirmed by electron diffraction patterns of pristine and irradiated samples observed in TEM measurement. Bright field TEM images of pristine and irradiated samples at fluence $3\times10^{13}$ ions/cm$^2$ show the nanoparticles of size distribution approximately 1-10 nm and analysis revealed that the size of QDs has increased at higher fluence which is confirm by red shifting in the UV absorption band edge at higher fluence compared to pristine. Thin film ZnS/TiO$_2$ QDs solar cell device performance under Ag$^{9+}$ ions of fluence $3\times10^{13}$ ions/cm$^2$ has been investigated. DC electrical conductivity of this device increases with the ion fluence. Photoconductivity measurements of pristine and irradiated ZnS/TiO$_2$ solar cell shows increase in conductivity at fluence $3\times10^{13}$ ions/cm$^2$ in response to 100 mW solar simulator spectrum. The photoluminescence optical emission spectra analysis shows increase in intensity with ion fluence. This can be attributed to thermal detrapping of charge carriers owing to enormous energy transfer during swift heavy-ion irradiation.

Key Words- Quantum dots, photoconductivity, photoluminescence, blue shift
Effect of SHI irradiation on optical properties of CVT grown ZnSSe single crystals

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Zinc sulpho-selenide (ZnS0.5Se0.5) is a solid solution of two binary compounds ZnS and ZnSe, where the band-gap energy changes continuously with the composition x. ZnS (Eg = 3.67 eV) and ZnSe (Eg = 2.67 eV) are direct and wide band gap semiconductors widely used in light emitting devices. The ZnSSe single crystals have been grown by chemical vapour transport (CVT) techniques with iodine as a transporting agent. The grown ZnSSe single crystals have been irradiated by Au9+ ion at 120 MeV in the room temperature with the fluence of 1x1012 and 5x1012 ions/cm2 using 15UD Tandem Pelletron Accelerator and current was maintained 0.6 pnA during irradiation. The UV-Visible absorbance shows the absorption cut off at 440 nm for as grown ZnSSe single crystal whereas for the irradiated samples the values are 444 nm and 447 nm with increasing ion fluences. The increasing the optical absorbance in the visible region with increase of ion fluences may be due to the formation of defects on the surface of crystals during irradiation. The photoluminescence studies of as grown ZnSSe show the emission wavelength at 590 nm whereas the irradiated samples emit at 584 nm and 583 nm. The decrease in intensity of the PL emission with increasing the ion fluence shows the loss of luminescence property and formation defects during irradiation. The Raman spectra show the three strong peaks at 177, 235 and 330 cm−1 correspond to the LO and TO modes of ZnSSe single crystals. The intensity of the Raman spectra decreases with ion fluences attributed to the decrease in the crystalline nature of ZnSSe single crystal during irradiation.
P5

Size controlled synthesis and magnetic properties of Ni-Zn ferrite nanoparticles by using Aloe vera extract solution

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ABSTRACT

NiₓZn₁₋ₓFe₂O₄ (x = 2.5, 4.5, 6.5, 8.5) ferrite nanoparticles were prepared by a modified sol-gel method using high purity metal nitrates and aloe vera plant extracted solution. Using of aloe vera extract simplifies the process, provide an alternative process for a simple and economical synthesis of nanocrystalline ferrite and controlled size of NiₓZn₁₋ₓFe₂O₄ ferrite nanoparticles were prepared. The structural characteristics of calcined sample of NiₓZn₁₋ₓFe₂O₄ (x = 2.5, 4.5, 6.5, 8.5) ferrite nanoparticles were determined by X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FT-IR) and transmission electron microscopy (TEM). All the prepared samples have spinel structure with particle size of ~9-20 nm. From XRD we observed that particle size decreases with increasing Ni content. Nano size of the particles was confirmed by TEM measurement. Magnetization measurements were obtained at room temperature by using Vibrating sample magnetometer (VSM), which showed that the calcined samples exhibited typical magnetic behaviour. Keywords: Sol-gel, Aloe-vera, Synthesis, Magnetic properties, Electron microscopy, Spinel.
Surfactant assisted sputtering: A new method of surface nano structuring by ion beams

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ABSTRACT

Ion beam sputtering-induced surface nanopatterns have received considerable theoretical and experimental attention due to the complex physical mechanism of self-organization, which has not been fully understood and their potential applications in fabricating large-area self-organized nanostructured surfaces on a variety of materials [1]. Recently, it has been found that presence of impurities also have a decisive role in the pattern formation [2]. In this work, self organized pattern formation on Si substrate using low energy ion beam sputtering (1000 eV) at normal incidence driven by Fe atoms has been studied for the better understanding of the role of impurities on the phenomena of pattern formation. Pattern transition from ripple to ripple-dot, ripple-dot to nanodot structure have been observed in different position of Si (100) irradiated in the presence of Fe. It has been observed that the ripples are always forming in a direction perpendicular to the Mo impingement. At different positions of the Si surface the Fe coverage is found to be different. Roughness of the ripple-dot pattern region is quite high and the transition from ripple-dot to dot structure is gradual and smooth. No ripple patterns were observed for the ion erosion at normal incidence without any surfactants. The evolution of patterns with ion fluence study shows that correlation length of the patterns increases with ion fluence.

μ-SQUID characteristics in the hysteretic and non-hysteretic branches

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A micron-size Superconducting Quantum Interference Device (μ-SQUID) consists of two superconducting dayem bridges or weak links (WL), of dimension of the order of the superconducting coherence length, in parallel, forming a loop with area in the μm² range. A single WL behaves very much like a Josephson junction with the super current approximately given by I = Icsinθ, where Ic is the critical current and θ is the phase difference across the junction. When two such junctions are fabricated in parallel in a SQUID, interference between the two current branches gives an oscillatory behavior of the critical current Ic with the external magnetic field. The flux period is equal to the flux quanta φ0= 2.05 ×10−15 T.m². This makes the SQUID a very sensitive device to measure magnetic field. μ-SQUIDs have been used to study the magnetization reversal of an isolated magnetic nano-particle, the persistent current in phasecoherent rings, and also in scanning SQUID microscopy.

Fabrication of non-hysteretic Micro-Superconducting Quantum Interference Devices (μ-SQUIDs) has been of importance for their easy operation and better performance. Insofar, most of the fabricated μ-SQUIDs are hysteretic in nature. Here, we report on the performance of both the hysteretic and the non-hysteretic niobium thin-film-based μ-SQUIDs. Especially, we show how one can play around the thin-film-morphology to control the hysteresis. Based on our experimental data, we propose certain methods to fabricate μ-SQUIDs for wider non-hysteretic regime and their possible use in a high magnetic field. We have fabricated Nb-based μ-SQUIDs by two different methods. One by using Focused Ion beam technique and other one by using Electron Beam Lithography technique. These μ-SQUIDs can be used in the temperature range between 2 and 9.3 K with the standard SQUID-read-out. For some of the SQUIDs, we have achieved non-hysteretic I-V characteristic with critical current more than 50 μA. The sensitivity of the μ-SQUIDs are comparable to the current state-of-the-art μ-SQUIDs. These μ-SQUIDs seem to be useful even in a high magnetic field.

References:
Role of grain size on magnetic properties of La0.7Sr0.3MnO3
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Abstract
The perovskite compound has the form ABO3, where A site is rare earth element and B site is occupied by Mn ions. Undoped perovskiteManganites like LaMnO3 is antiferromagnetic insulator. While divalent doped Manganites of the form R(1-x)AxMnO3 (where R: Trivalent rare earth ion, A: divalent alkali ion) exhibit properties like insulator to metal and paramagnetic to ferromagnetic transitions, colossal magnetoresistance, charge ordered behaviour, phase separation etc. Divalent doping (e.g. Ca, Sr, Ba) causes Mn3+ to change in Mn4+ state for charge compensation, depending on the doping concentration. During last decade, lot of work has been carried out on single crystal and polycrystalline perovskitManganites. But very few reports have been found on nanoparticles of hole doped Manganites (1-3).
Hence to study the effect of particle size on the properties of perovskiteManganites, we have synthesized the nanosized powder of La0.7Sr0.3MnO3 (LSMO) by using citrate-gel method. The samples are sintered from 600-1200°C by the step of 50°C for four hours. The size of particles was determined using X-ray diffraction and Field Emission Scanning Electron Microscopy technique. The average particle size is in the range 17-20 nm for sample prepared at 600°C. It was found that size of nanoparticles increased with increasing sintering temperature. Magnetization measurements of the sample were carried out with the help of Vibrating Sample Magnetometer (VSM) at room temperature. Saturation magnetization was found to be increased with increasing particle size giving evidence of formation of dead magnetic layer on the surface. The coercivity of nanoparticles follows the same trend as explained by Cullity (4). A.C. susceptibility measurements for these samples show systematic increase in magnetic transition temperature and approach the bulk value with increase in the particle size.

REFERENCES
P9

Application of spectroscopy for identification of counterfeit drug

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Abstract

The identification of counterfeit drug is based on the comparison of the NIR spectrum of a sample with typical spectra of the authentic drug using multivariate modelling and classification algorithms principle component analysis (PCA). Counterfeit medicines include drugs without sufficient active ingredient, without any active ingredients, or with fake packaging. This work was aimed at the investigation of the use of near-infrared spectroscopy (NIRS) for the identification of counterfeit drugs. The power of NIRS in distinguishing among similar pharmaceuticals was demonstrated and a protocol is proposed to construct a multivariate model and to include it in a library allowing testing for drug authenticity. The methodology was evaluated with real samples of counterfeit drugs and was able to recognize all those presenting changes in composition. The results show the potential of NIRS for rapid, on-site and non-destructive identification of counterfeit drug. It is important to determine the performance of the spectrophotometer which will be employed for drug classification. We have worked with the reflectance data and first preprocess the data and implement the multivariate methods. Data processing was done with Matlab 7. (The Math-Works inc. Natick, MA) and the standardization and normalization is done on the data using the Origin 7.5. Chemometric treatment of the spectral data, modelling and classification were performed by using the Unscrambler 7.5 software (CAMO, Oslo, Norway). This package provides PCA and more algorithms, used for modelling and classification, respectively. The instrument used for the data collection is Lambda 950 UV-VIS-NIR Spectrophotometer of Perkin Elmer

Keywords: Counterfeit drug, spectroscopy, Data Processing, principal components analysis (PCA)
P10

Tailoring of soft-magnetic properties of iron nitride thin film using ion and laser irradiation

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Abstract

Soft magnetic thin films are of great interest because of their potential applications such as memory devices, high frequency devices, sensors, TMR and GMR multilayers etc. Generally, as-deposited thin films possess defects and quenched-in stresses which may be developed during deposition and deteriorates their soft magnetic properties. Therefore post-deposition treatments are required in order to remove the stresses and improve the soft-magnetic properties. In the present work we have deposited iron nitride thin film using ion-beam sputtering. This film possesses high coercivity (140 Oe) and perpendicular magnetic anisotropy which may be due to presence of compressive stresses in the as-deposited state [1]. After, various post deposition treatments such as thermal annealing, heavy ion irradiation (Ag⁺ ions at 120 MeV energy) and laser irradiation at different energies (308 mJ and 220 mJ with 20 ns pulse width) an improvement in soft magnetic properties has been observed. However, when soft-magnetic thin films are integrated in a multilayer structure like tunnel magneto-resistance device, the post deposition treatment may also induce inter-diffusion at the interfaces. Therefore, it is also important to understand atomic diffusion in iron nitride thin film during several post-deposition treatments.

Atomic diffusion during the above post-deposition treatments have been measured either using neutron reflectivity (NR) [2] or nuclear resonance reflectivity (NRR) [3]. For this purpose the films have been prepared in the form of compositionally homogeneous isotopic multilayers. They have alternate layers of natFe-N and ⁵⁷Fe-N. Diffusion lengths after various post-deposition treatments have been measured by measuring the decay in the intensity of the Bragg peak in NR or NRR [3,4]. Both the techniques are capable of measuring diffusion lengths down to accuracy of 0.1 nm. The diffusion length of Fe is found to have a linear dependence on φ¹/², where φ is the fluence of Ag ions. The maximum diffusion length after irradiation of 2×10¹³ ions/cm², at which the magnetic anisotropy almost completely disappears, comes out to be only 12 Å. In the case of laser irradiation, the anisotropy is found to disappear completely after about 900 pulses of 308 mJ energy and 9000 pulses of 220 mJ energy. The diffusion lengths are found to be 4.2 Å and 9Å for 308 mJ and 220 mJ energies respectively. For a real application of soft-magnetic thin films, the diffusion occurring during post-deposition treatment is an important parameter, as it may obscure the sharpness of the interfaces. Therefore, a comparison of the diffusion length obtained after giving different post-deposition treatments (thermal annealing, heavy ion irradiation and laser irradiation) will help in deciding which technique is better suited for relieving defects and stresses in magnetic multilayers, without substantially affecting the interfaces.


P11

Study of Structural and Compositional depth profile of laser treated TiN and TiCN by non-Rutherford Backscattering Technique.

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Abstract

Ion beam can be used for surface processing applications such as ion implantation and ion beam mixing, this technique is also useful in the field of non destructive technique for the analysis of elemental compositions and depth profiles without standards and with high resolution. Ion beam analysis is based either on coulomb interaction between the ion beam and target nuclei or the nuclear reaction between the incident energetic ion and target nuclei. The former leads to the Rutherford backscattering spectroscopy (RBS), the later Nuclear Reaction Analysis (NRA). RBS is very powerful for the detection of the composition profile of heavy atoms in a light substrate. The detection of light elements in heavy substrates is normally difficult in RBS, due to the lower Rutherford cross sections of low Z elements. However in many cases, if the energy of the incident particles is in MeV range, resonant elastic scattering occurs for low Z target nuclei which enhanced scattering cross sections, it is easy to detect the depth profile of light elements in heavy matrix, it is called Non-Rutherford Backscattering (NRBS).

We have used the phenomenon of NRBS, to obtain the depth profile for the element N, C and O using 2.1 MeV proton beam. We have irradiated Ti specimen in controlled atmosphere of N or the mixture of N and CH₄ to obtain TiN or TiCN at the surface. In the present work, the composition profile of N, C, and O by NRBS technique has been correlated with its micro-structure as a function of depth using glancing angle X-ray diffraction.
P12

Synthesis and Properties of BaTi$_{1-x}$Cu$_x$O$_3$

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Abstract

A finest possible sample of copper doped micro particles of BaTiO$_3$ (BTO) with possible tetragonal structure via a solid-state route was prepared. Prepared samples of BaTi$_{1-x}$Cu$_x$O$_3$ ($x=0.02$) were structural characterized by X-ray diffraction, XRD patterns reports the single phase tetragonal crystal system of the space group P4mm (99) and pattern matched with the standard pattern JCPDS no. 79-2265. X-ray photoelectron spectroscopy technique used for determining the percentage area of elementary particle (Ba, Ti, O and Cu). Finally the dielectric constant measurements of the sample above and below the Curie temperature were carried out at 1 MHz, the Transition temperature is found shifted towards higher side from that of pure BaTiO$_3$. The Thermal Hysteresis is indicative of the fact that the transition is indeed of First Order.
P13

Effect of Swift Heavy Ion Irradiation on Mn/p-Si Interfacial Structure
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Abstract:
A study of morphological, electrical and magnetic properties have been done on unirradiated and swift heavy ion (SHI) irradiated manganese thin film (50 nm thickness) deposited on p-type silicon wafers, i.e., Mn/p-Si interfacial structure. Morphology of unirradiated Mn/p-Si structure shows the formation of nano-grains having several protrusions on it whereas, nice granular feature is observed after the irradiation having no protrusions. The protrusions may be due to the unreacted Mn, Si or their silicides. The nice granular feature after the irradiation is understood in terms of irradiation induced melting and recrystallization phenomena. Mn₅Si₂ and Mn₅Si₃ silicide phases are identified to be formed from x-ray diffraction pattern. Silicide phases are formed due to irradiation induced interfacial intermixing. Electronic transport across the interface shows that interface become ohmic after swift heavy ion irradiation and the current is increased by two orders of magnitude. Magnetic properties show the evolution of ferromagnetism after the irradiation whereas superparamagnetism is observed for the as deposited structures. Evolution of ferromagnetism at room temperature (RT) is a very significant finding which can be understood in terms of irradiation induced Mn-C-Si compound formation in which C atoms make modification of the local structure around the manganese sites. The observation of ferromagnetism and the magnetic field dependent electronic transport is a very significant element for spintronics.

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P14

Assessment of the quality of indian tea using spectroscopy

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Abstract

Due to more and more tea varieties in the current tea market, rapid and accurate identification of tea (*Camellia sinensis.*) varieties is crucial to the tea quality assessment. This study attempted the feasibility to use full range of the ultraviolet-visible and near infrared (uv-vis-nir) range for analysis for the qualitative and quantitative assessment of the tea quality. We have taken nine number of indian tea. We have taken upto the second derivative of the normalized tea data and anlyse them for the quality of the teas. The tea are measured is in powder form, we can say the destructive form of the tea is used in this analysis. The standard amount of powder are used. Twenty five readings for Each tea sample were taken and the data were stored. The spectrum were collected in the absorbance mode using UV 3600 spectrophotometer (Shimadzu, Japan.). The spectra used for the data analysis covered the range from 165 nm to 2600 nm, which resulted in 1181 variables. The principle component analysis (PCA) of multivariate technique is used for the characterization of the tea. Pattern recognition referred, principal component analysis (PCA) was firstly applied to the spectra. Experimental results showed that the tea quality could be accurately, rapidly, and identified via spectroscopy. Data processing was done with Matlab 7. (The Math-Works inc. Natick, MA) and the standardization and normalization is done on the data using the Origin 7.5. Using the Unscrambler 7.5 software performed Chemometric treatment of the spectral data, modelling and classification. This package provides PCA and more algorithms, used for modelling and classification, respectively.

Key words: spectroscopy, classification, tea variety; identification, pattern recognition
Study of physical and optical pH sensing characteristics of functionalized nanostructured silica thin films

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The development of optical sensors for various applications has witnessed increased research interests owing to their flexibility for portability in various geometries, electrical isolation, interference immunity and low cost of optoelectronic & optical components. The optical sensor consists of an immobilized phase in the form of film that selectively interacts with the analyte to be interrogated. The interactions lead to modulation in optical properties like absorbance, fluorescence, luminescence and reflectance scaled in unit of interest.

The formation of select film underlines potential research thrusts for developments in materials chemistry and physics. The discovery of mesoporous materials in 1994 and subsequently the formation of mesostructured silica films added a new dimension in materials research. The mesoporous structures like worm-like disordered, lamellar, 2D-hexagonal (p6\text{\textit{m}}), 3D-hexagonal (p6\text{\textit{3}}\text{\textit{m}}\text{\textit{mc}}) and cubic (p6\text{\textit{m}}3\text{\textit{n}}) of varying pore dimensions have been obtained. These porous materials can host a vast variety of organic functionalities suited to chemical and biological applications like sensing, drug delivery and lasing. The local environment encountered by the occluded organic species in silica framework governs the physical and chemical characteristics of materials. The functional films are prepared by dip- or spin-coating of sol-gel chemistry processed sol on substrates like glass or on to a fiber optic cable by dip coating. The textural properties of the films are imparted owing to the physical chemistry of the surfactant by Evaporation Induced Self Assembly process (EISA). The surfactant present mesostructured materials have been exploited for synthesis of optical materials by dye-doping. The mesostructured silica films doped with cresol red dye were fabricated by spin coating on glass slides. The analytical instrumental techniques were employed to study their physical properties like film morphology, surface and optical transmission characteristics. The doped film mesostructure was retained where dye was confined between the hydrophobic tails of the self assembled surfactant micelles in a periodical manner within the mesostructured channel. The absence of characteristic IR absorption corresponding to dye molecules in template extracted films were attributed to the confinement and or shield effects of the inorganic walls of the host on the vibration of the dye molecules and implying that the organic dye was actually incorporated into the pores of the host material. The pH sensing properties of these film elements were explored and were found to be appreciable in 3-11 pH range.

Further research could be directed towards developing sol-gel films and patterned arrays assisted with ion-beam methods. The physicochemical properties of functionalized films and patterned sensor-arrays could be adopted for device fabrication in small form factor sensor system like on-chip detection of pH in microanalytical devices. The development of new and improved optical sensors calls for strategies to engineer tailor-made films with requisite porosity, thickness and stability and imparting these films with optical functionality to suit the desired application.
P16

Fabrication of nano ionic samarium doped ceria (Ce$_{0.8}$Sm$_{0.2}$O$_{1.9}$) thin films by pulsed laser deposition technique for solid oxide fuel cell applications

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Abstract

Uniform, adherent, single phase samarium doped ceria films have been successfully deposited by pulsed laser deposition technique for their application in solid oxide fuel cell. These films have been deposited at different substrate temperatures on Si and Alumina substrate and subsequently heat treated in tube furnace. Effect of substrate temperature and annealing temperature on phase formation was studied using scanning electron microscope and Atomic force Microscopy, and energy dispersive X-ray analysis techniques. These studies showed the formation of single phase Ce$_{0.8}$Sm$_{0.2}$O$_{1.9}$ films, at substrate temperature. This reveals the use of these films for making low temperature solid oxide fuel cells.
High-energy 120 MeV of Au$^{9+}$ ion induced surface and opto-electronic modifications in nano-composite CdS-Bi$_2$S$_3$ thin films

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Abstract:

The study of irradiation of 120 MeV Au$^{9+}$ ion with fluence 5 x 10$^{12}$ ion/cm$^2$ on CdS-Bi$_2$S$_3$ nano-composite thin films has been done. The structural and opto-electronic evolutions after irradiation were determined. Induced modifications were studied using XRD, AFM, UV spectroscopy and Raman Spectroscopy. XRD revealed decrease in the crystallite size. The subdivisional grain growth is studied by AFM. Increase in band gap from 1.75 eV to 1.80 eV was observed. I-V measurement showed enhancement in the electrical resistivity after irradiation. Irradiation of CdS-Bi$_2$S$_3$ nano-composite thin film was found to be effective to reduce the average crystallite size.
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SHI Irradiation induced Structural and Magnetic Evolution of Non-Stoichiometric Cobalt Doped Titanium Oxide Thin Films

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Non-stoichiometry cobalt doped titanium oxide (CTO) thin films were deposited by Pulsed Laser Deposition at various oxygen partial pressure and irradiated using 100 MeV Ag⁷⁺ ion at different ion fluence i.e. from 5 x 10¹⁰ to 1 x 10¹² ions/cm²'s. The composition and thickness of these films were measured by Rutherford backscattering (RBS). Phase, structure and morphology of the films were identified using GAXRD (Grazing angle x-ray diffraction), Raman spectroscopy and Field Emission Scanning Electron Microscopy (FE-SEM). The atomic percent of cobalt in all films were found to be 1.5. Lower is the oxygen partial pressure, thickness and nonstochimetric of the film is found to be higher. GAXRD pattern showed that highest non-stoichiometric CTO thin film deposited in vaccum correspond to non of the polymorphic phases of TiO₂. CTO film deposited at 0.1 mT showed a rutile phase with very high crystallinity. At 300mT, combination of both anatase and rutile phases were observed. However, in pure titanium oxide thin film deposited at same condition showed a rutile phase at 0.1mT and a pure anatase phase at 300 mT. The later observation is quite surprising in the sense that while TiO₂ thin film showed an anatase phase, CTO thin film showed both anatase and rutile phase at same deposition condition i.e. 300 mT. Raman spectra were well matched with the results obtained from GAXRD. After irradiation, from GAXRD, we observed that while film deposited at 0.1 mT showed radiation resistant behaviour with fluence, films deposited at 1mT and 300 mT, crystallinity degraded and approached amorphous phase with increase in ion fluence. Doped and undoped TiO₂ thin films showed room temperature ferromagnetic behavior. After irradiation, though the room temperature ferromagnetism retained, the magnetic moment was found to be reduced.

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Swift heavy ion (SHI) irradiation on pulsed laser deposited magnetite thin films on Si and MgO (100) substrates.

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Fe$_3$O$_4$ thin films were deposited on Si (100) and MgO (100) substrates by pulsed laser deposition technique and irradiated by 200 MeV Ag ion in the fluence range of $5 \times 10^{10}$ ions/cm$^2$ to $1 \times 10^{12}$ ions/cm$^2$. Before irradiation, X-ray diffraction study of pristine samples shows the spinel cubic structure of the films with preferential (111) orientation on Si (100) and (100) orientation on MgO (100) substrate. The films on Si substrates do not show any appraisable change in the lattice parameters of Fe$_3$O$_4$ films with ion irradiation, indicating that Fe$_3$O$_4$ films on silicon substrates do not have strain in the deposited films. The resistivity measurements reveal that after irradiation Verway transition temperature ($T_V$) does not change much for films on Si substrates while films on MgO substrates show change in $T_V$ from 120 K to 127 K. The structural effect of SHI irradiation on these films reveal that at low irradiation fluence, the film is relaxed and at the fluence of $1\times10^{12}$ ions/cm$^2$ some indication of phase transformation of Fe$_3$O$_4$ to $\gamma$-Fe$_2$O$_3$ is observed.
Effect of annealing on structural, optical and electrical properties of TiO$_2$ thin film

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Abstract: Titanium oxide (TiO$_2$) thin films were deposited on quartz and silicon $<100>$ substrates by RF magnetron sputtering method at room temperature. These films were annealed in air at three different temperatures viz. 500°C, 800°C, 1000°C for tuning the structural, optical and electrical properties. Pristine and annealed films have been characterized using X-ray diffraction (XRD) for structural analysis, UV-Vis spectroscopy for optical properties and current-voltage (I-V) characteristics for resistivity measurement. As deposited film is crystalline (on Si substrates) as inferred from XRD spectra. Annealing at the lowest temperature (500°C) has changed the crystal structure of the as deposited film due to rearrangement of crystal lattice. Higher temperature annealing lead the film towards amorphization because of lattice distortions. Annealing at lowest temperature increases the bandgap and higher temperature annealing reduces the bandgap. Resistivity measurements show that the resistivity is decreased at lowest temperature annealing and increased on further annealing. The modifications in these properties are investigated due to the thermal energy deposition in the crystal lattice.
Development of Fiber Optic Temperature Radar with fast Instrumentation and Improved Spatial Resolution

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Abstract: Raman scattering based optical fiber distributed temperature sensing has received recent attention as a means of temperature monitoring of power cables, gas pipe lines, tunnels and critical installations etc. [1]. The advantages offered by such sensors are remote measurement in hazardous environments or in environments suffering from electromagnetic noise. The other advantage of using such a system is that it permits spatial temperature distribution over very long distances with just a single optical fiber. A typical optical fiber distributed temperature sensor system provides us with temperature verses distance (along length of fiber) curve.

The basic principle of Fiber Optic Temperature Radar is based on optical time-domain reflectometry (OTDR) [2-4] in conjunction with Raman scattering, in which sensing fiber is coupled to short interrogating laser pulses and the backscattered anti-stokes and stokes components are monitored for signal changes. These anti-stokes and stokes components are caused by inelastic nature of Raman effect in which change in incident light takes place due to vibrational properties of a substance. The Raman effect is inherently weak and needs amplification by several orders (~10^7) of magnitude. The anti-stokes signal carries signature of temperature corresponding to hot zone of fiber while stokes signal remains unaffected by heat throughout the fiber length. The continuous spatial variation of temperature along the fiber length can be obtained directly from the ratio of backscattered anti-stokes and stokes signals because it is a direct function of absolute temperature of scattering point.

Our group has carried out initial experimental studies on Raman–based optical fiber distributed temperature sensor [5-7]. In this paper, we report development of fast instrumentation based on photo multiplier tube (PMTs) with fast data acquisition using GPIB (General Purpose Interface Bus) on a high performance digital storage oscilloscope (DSO) of band-width more than 500 MHz to obtain spatial resolution better than 3 meters along fiber length of 220 meter in the temperature range of 250 - 250°C. The low level signals of amplitude 80 μV pp are amplified (Gain ~ 25) with high performance amplifier of band width 300 MHz. The system has been tested with a especially made heating facility with heating tape and a P-I-D controller having temperature stability of about 5°C.

References:
Comparative Study of Ion Beam Mixing in Amorphous and Crystalline Silicon (a-Si/Mn/c-Si) by swift Heavy Ions

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Abstract: Metal/semiconductor systems (a-Si/Mn/c-Si) were deposited on silicon substrate using electron beam evaporation method. These samples were irradiated by 100 MeV Ag ions different fluences ranging from \(1 \times 10^{13}\) to \(2 \times 10^{14}\) ions/cm\(^2\). Pristine and irradiated systems have been characterized using Rutherford backscattering spectroscopy (RBS) for depth profile analysis, atomic force microscopy (AFM) for surface morphological study and current-voltage (I-V) characteristics for resistivity measurements. A mixed region of \(~30\text{nm}\) at amorphous silicon (a-Si) interface and \(~10\text{nm}\) at crystalline silicon (c-Si) interface with Mn was estimated at higher fluence of \(2 \times 10^{14}\) ions/cm\(^2\). However there is no significant change at the interfaces has been observed at the lower fluences irradiation from RBS analysis. The roughness of the surface has been increased as investigated from AFM. Modifications in depth profile, surface morphological and electrical properties due to the electronic energy loss have been explained in the framework of thermal spike model. In the present paper, a comparative study of the contribution of crystalline and amorphous nature of the interface to the ion beam induced mixing has been studied.
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100 MeV Ag ion irradiation of tin oxide thin films

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Thin films of tin oxide (SnO₂) were deposited using thermal evaporation method and pulsed laser deposition (PLD) method. These as-deposited films were irradiated by 100 MeV Ag ions at different fluences. Pristine and irradiated films have been characterized using X-ray diffraction (XRD) for structural analysis, atomic force microscopy (AFM) for surface morphological studies and Current voltage (I-V) characteristics for electrical properties. Thermally evaporated films are amorphous and after irradiation nanocrystallization has occurred. PLD grown films are polycrystalline and irradiation has induced the amorphization. The surface of the as deposited thermally evaporated films is featureless and irradiation has induced nanograins due to surface diffusion mechanism. PLD grown films have nanograins and after irradiation their shape and size has modified. Modifications in electrical properties due to irradiation are also discussed [1, 2].

[1] R.S. Chauhan et al., Accepted in NIM B.
STUDY OF SIZE AND SHAPE DEPENDENT DIFFUSION COEFFICIENT OF TIN DIOXIDE NANOPARTICLES

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Abstract

In the present paper, the diffusion coefficients of nitrogen and platinum doped SnO\textsubscript{2} nanoparticles, with different sizes ranging from 1 to 20 nm, have been studied using Arrhenius relation and Lindemann’s criteria under their dynamic limit. The shape dependence has also been reported with 0-, 1- and 2 dimensions. It is found that as the size of nanocrystals decreases, the diffusion activation energy of atoms decreases. The SnO\textsubscript{2} diffused with metal and nonmetal gives rise to (meta-) stable structure and mid-gap state helps to increase surface to volume ratio and quantum confinement effects, and results in the increase of diffusion coefficient. The calculated results show good agreement with available experimental data.
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Soft Sensors: A new measurement tool for complex experimental conditions

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Abstract

Soft sensors are innovative tools for the acquisition of measurements in complex experimental conditions due to unavailability of a sensor. A soft-sensor may be used for interpolation and prediction of measurements. Soft sensors are especially useful in data fusion, where measurements of different characteristics and dynamics are combined. It can be used for fault diagnosis as well as control applications. Soft Sensors also known as virtual sensors, are software tools capable of calculating quantities that are hard to be measured. They are based on technologies that provide an estimation of measurements by creating a mathematical model from real data. The core of a soft-sensor is a partial model of a plant allowing the generation of a estimated measurement to replace missing actual measurements. This approach allows the computation of a given variable value from other measurements that are related to it. Soft sensors make use of secondary variables, easily measured in real time and a mathematical model that correlates these parameters and the variables that must be monitored. More recent implementations of soft sensors use neural networks or fuzzy computing.

Keywords: Soft sensors, complex experiment, virtual sensors, mathematical tool