इलेक्ट्रॉनिक पदार्थ

इलेक्ट्रॉनिक सामग्री प्रभाव सरकारी तथा निजी संगठनों की रूप के विभिन्न प्रकार के अनुप्रयोगों के समन्वय में सामग्री, साधनों तथा प्रणालियों की यथायाित विविधता पर अनुसरण और विकास कार्य को आगे बढ़ाने में सक्रिय रूप से कार्यरत रहे हैं। प्रभाव में अनेक समूह विभिन्न प्रकार के कार्यक्षेत्रों में कार्यरत हैं जिनका विवेचन नीचे किया गया है:

**सामग्री का विभिन्न प्रकार समूह हाल ही में संस्थापित लेख आधारित दावा माप व्यवसाय का प्रयोग करके एम इ इ एम तथा संगठन अनुप्रयोगों के लिए बोटी (SiO₂) फिल्मों में दबाव के अध्ययन में कार्यरत है। यह एक प्रायोगिक सारणार्थक वाण निषेधान्त द्वारा माइक्रो तथा नैनो क्रिस्टल उत्पादन मूले के निषेधान्त तथा तैयार फिल्म सीरीज और लेखक तेंदु के अनुप्रयोग के लिए इक्सक्स अनुप्रयोग अनुसरण और विकास का एक निरस्तर अनुसरण क्षेत्र है। धावड़ोन, धावड़ोन और बीरोन समावेश सहित चुनौतीपूर्वक अभिलश्चेता कार्य का विकास और विशेषज्ञाताओं पर अनुसंधान कार्य जारी है।**

सिलिकान और सिलिकान साधन, एम इ एम एस (MEMS) तथा संगठन जूप यूट गायं तथा परिपूर्ण क्रिस्टलिक सिलिकान सेतु के विकास और अभिलश्च निर्देशन में कार्यरत है। इसमें एक अनुप्रयोग के लिए यूस्यू प्रणालियों विकसित करने के लिए सिलिकान में निरस्तर अनुप्रयोग धावड़ोन चैनल में अनुसंधान तैयार किया गया है।

नैनो संस्थान, प्रकाशीय बैंक्टकॉमिक तथा बहुल कार्यक्षेत्र सामग्री समूह ने निम्नलिखित क्षेत्रों में विभिन्न प्रकार के कार्य आरंभ किए हैं:

- नैनोक्रिस्टलिक कोयला फाराइट पाउंड्स और तुनी फिल्म के अनुप्रयोग।
- मेट संदर्भों में प्रयोग के लिए उत्तम फाराइट संलग्न द्वारा तैयार नैनो संस्थान।
- संक्रिया ब्रैड पार्स तुनी फिल्म फिल्टरों के विकास।
- प्रायोगिक बहुक्रिक्षण निषेधान्त प्रणालियों तथा विभिन्न प्रकार की बहुक्रिक्श फिल्मों के निषेधान्त की प्रक्रियाओं का विकास।
- नैनो संस्थान उत्तम रेंडरिंग आयकैड फिल्मों, जो ब्रैड गायंक हैं, का ब्रैड ओक्सिक स्मैट विद्युत में प्रयोग के लिए विकास।
- अनेक प्रकार के घोल - प्रकाशीय सुनिश्चित बहुलक और समस्याओं का बहुल कर सेटों के विकास में प्रयोग के लिए संलग्न और अभिलश्च निर्देशन।

उच्च तापमान वाले अतिसंगठन पदार्थ तथा उन्मत मूलक गिलिम समूह उच्च धारा परिवर्तन के लिए Bi2223 तथा Bi2212 टीन-टू चालकों, HTSC चुंबकीय फिल्मों तथा तात्त्यों के लिए Bi2223 प्रीलय लन्ड ह्वाली एकट-बहु तंतु घटनों और धारा तरीकों के विकास, टूप्सों को जोड़ने की एक नई पुद्धति के विकास, (B,PB) एक द्विएक्शन होस्ट के लिए मिन बजनें केन्द्रों की समायोजन के अधीन तात्त्यों का विकास, ये ब्रैड इलेक्ट्रॉमिन ल सुमात्रा-सामान्य आधारित उप-जी जी संदर्भों का विकास कार्य प्रारंभ है। जल प्रदूषण अनुसंधान के लिए सील जेल से प्राप्त प्रकाशीय जैव संबंधक का प्रस्ताव रखा जा रहा है।

पूर्व चीनिया के लिए नैनो संरचना समूह दोस पट्टियाँ पर पूर्व घटना जैसे उच्च सुयुक्त Si (5512) एम एई (5512) पर एक अल्प प्रमाणों का निषेधान आयू, गैडिलिनियम नैनो क्षेत्र की स्विमर और हाइड्रोबाक्सनियन, SiO₂ फिल्मों में परिशोधित क्षूधक तथा प्रकाशीय CdTe सुमात्रा कणों की संस्थान के दौरान ओैसीफ्ले यूमक और XPS गाहार पर्यंपतिक तथा प्रकाशीय क्षेत्रों द्वारा अन्वेषित दोस (TOPO) आयूदित CdSe नैनो क्रिस्टलों पर अनु उद्योग अपने विभिन्न प्रमाणों के अध्ययन में कार्यरत था।
Mandate and Major Achievements

The Division of Electronic Materials has been actively engaged in pursuing R & D work on a large variety of materials, devices and systems, for multifarious applications of interest to government and private institutions. Several groups in the Division are involved in a host of different activities, enumerated below:

**Luminescent Materials and Devices Group** is engaged in R & D activities related to the development of a variety of inorganic phosphors and related devices, to meet the strategic demands of leading government and private organizations — sulfide phosphors for TV picture tubes, rare earth oxysulfides for fluorescent screens for high energy (1-15 MeV) X-ray imaging, colour TV phosphors and alkaline earth aluminates for special phosphors with enhanced phosphorescence characteristics. The group has developed electroluminescent phosphors and panels both in powder and in thin film form. It has also drawn up an extensive plan for development of nanophosphors and devices for industrial applications.

**Plasma Processing of Materials Group** has been engaged in studying the stresses in thick SiO$_2$ films for MEMS and sensors applications, using a recently installed laser based stress measurement set-up. The deposition of micro and nano crystalline silicon films by RF plasma enhanced chemical vapour deposition and their investigation for applications in thin film solar cells and white LED’s was an ongoing area of R & D. Investigations on the growth and characteristics of tetrahedral amorphous carbon with hydrogen, nitrogen and boron incorporation continued.

**Silicon and Silicon Devices, MEMS and Sensors group** has been engaged in the development and characterisation of surface-textured and improved crystalline silicon solar cells. Porous silicon has been grown in microchannels etched in silicon to develop microsystems for bioprocess monitoring. Growth of nano- and micro-structured porous silicon has also been undertaken.

**Development of Nanostructured, Optical, Electrochromic and Polymeric Materials group** has undertaken multifarious activities in

- Investigations of nanocrystalline cobalt ferrite powders and thin films
- Nanostructured materials prepared by hydrothermal powder synthesis for use in gas sensors
- Development of narrow bandpass thin film filters
- Development of plasma polymerization deposition systems and processes for the deposition of a variety of polymeric films
- Development of nanostructured mesoporous tungsten oxide films with fast kinetics for applications in electrochromic smart windows
- Synthesis and characterization of a variety of solution-processable conjugated polymers and composites for application in the development of polymer solar cells

**High Temperature Superconducting Materials and Advanced Ceramics group** is engaged in the development of Bi-2223 and Bi-2212 tube/rod conductors for high current transport, Bi-2223 long length mono/multifilamentary tapes and current leads for HTSC magnetic spools and cables, development of a novel method of joining (Bi, Pb) – 2223 tubes, exploring the possibilities of pinning centers for a d-band host, etc. Moreover, the microwave sintering of beta alumina and the development of a ceramic-based LPG sensor are in progress. Work on sol-gel derived optical biosensor for water pollution monitoring has been proposed.

**Surface Physics and Nanostructures Group** was engaged in several studies regarding surface phenomena on solid surfaces, such as formation of Sb submonolayer phases on high index Si (5 5 12) surface, stability and hydrogenation of “bare” Gadolinium nanoparticles, role of Oxygen during sintering of cubic and hexagonal CdTe nanoparticles dispersed in SiO$_2$ films and low energy ion induced effects on TOPO capped CdSe nanocrystals probed by XPS depth profiling and optical measurements.
R & D ACTIVITIES
Advanced Luminescent Materials and Related Devices

Luminescent materials known as phosphors are able to convert absorbed (invisible) energy in the form of moving particles or quanta of radiation into visible light. The major and important applications of phosphors are in light sources, display devices and detection systems. The Luminescent Materials and Devices group continued its work towards developing phosphors, with special emphasis to nanophosphors, for applications such as solid-state lighting using blue LED, field emission and other display devices.

Nanophosphors have been synthesized during the last few years by many processes and techniques as these have demonstrated their application potential for various novel and efficient displays and devices. A brief review of different synthesis techniques employed all over the world for the development of industrially important nanophosphors was prepared and published for the benefit of the R & D community.

The field of solid-state white lighting has become very active globally as better energy efficiency can be achieved compared to present day light sources. YAG:Ce phosphor in nanophase has been synthesized for this purpose and studied. Fig. 4.1 shows excitation and emission spectra of the synthesized phosphor. Other phosphors with excitation in the range of 450-470 nm are being explored for use with blue light emitting LED for generation of white light. A Japanese company showed interest in developing this category of phosphors.

Development of long persistence phosphors is another important activity. These phosphors find applications in emergency escape route markings and for locating important objects in the dark. Green emitting phosphor is the most common, but to get full colours in the dark, phosphors emitting in blue and red are also needed. A process to prepare blue light emitting long decay/persistence phosphor excitable with ambient light has been developed, with a persistence time of 6-8 hrs (Fig. 4.2).

To achieve the goal of developing nanophosphor based devices, a simple methodology has been developed for dispersing the silica-capped ZnS:Mn nanophosphors with controlled particle density as two-dimensional (2D) layers. Size-controlled ZnS:Mn nanoparticles were capped with silica for their surface passivation, growth retardation, and stabilization against environmental attacks. Controlled particle density, uniform particle distribution, good room temperature photoluminescence, etc. were important achievements.

Plasma Processed Materials, Devices and Systems

A CSIR Network project on MEMS and sensors is being undertaken, whose major objective is to study the stress in thick SiO$_2$ films. A laser based stress measurement set-up has been installed and thick silica films were analysed for stress.
A physical vapor deposition technique known as “Filtered cathodic vacuum arc” (FCVA) for the deposition of tetrahedral amorphous carbon (ta-C) films has been set up and a reactor for the same custom designed and indigenously developed, perhaps for the first time in India. Fig. 4.3 is a photograph of the system developed under a DST sponsored project. The system consists of (a) water cooled cathode and anode (b) S bend magnetic filter on 6 inch duct to remove the macro particles and neutrals generated in the arc and (c) an 8 inch S.S. Cross deposition chamber with a provision of biasing the substrate. The system is evacuated by two turbo pumps backed by two rotary pumps and a base pressure of ~1x10^{-6} mbar is achieved in the system. The magnetic filters are energized by using three different D.C. power supplies. A mechanical striker initiates the arc. The film is deposited by condensation of highly ionized plasma on any substrate including low melting point plastic at room temperature. The cathodic vacuum arc offers the opportunity of growing various forms of carbon ranging from highly diamond-like to graphite-like and various intermediate materials like tetrahedral amorphous carbon (ta-C), hydrogen and nitrogen incorporated tetrahedral amorphous carbon, nanoclustered carbon, nanocomposite and carbon nano tubes.

The system developed has been used so far to grow (i) ta-C films, (ii) hydrogen and nitrogen incorporated ta-C films and (iii) boron and phosphorous incorporated ta-C films. The investigations on undoped and doped ta-C films involving electrical conductivity, activation energy, stress, hardness, optical band gap, space charge limited conduction, electron paramagnetic resonance, spectroscopic ellipsometry, X-ray photoelectron spectroscopy, X-ray Auger electron spectroscopy, photoluminescence, SEM, AFM and field-emission measurements etc, have been carried out. The effect of varying substrate bias on the properties of as grown (undoped) ta-C films, varying amounts of hydrogen and nitrogen incorporation and the effect of varying the amount of boron and phosphorous dopants on the properties of ta-C have been studied.

Tetrahedral amorphous carbon (ta-C), relatively a new semiconductor, which is somewhat analogue to a-Si and a-Ge is of great technological importance due to its possible applications in displays and vacuum microelectronics etc. The system so developed will be used to grow a new form of amorphous carbon thin films having nanoparticle inclusions and nano tubes using novel modified arc based techniques in future and its application for field-emission type of display devices and tribological coatings will be explored.

**Silicon Devices, Mems and Sensors**

A silicon solar cell usually consists of a diffused p-n junction made in a thin silicon wafer. Texturization is one of integral parts of fabrication of crystalline silicon solar cell to enhance absorption of light in the cell. To achieve this, the reflectance of the solar cell has to be reduced as much as possible so that the weak incident light can be trapped on surface to get the maximum output. Anisotropic etching is a well-known technique in the field of silicon micro-machining or V-groove etching on <100> oriented silicon wafers to produce three dimensional structures. The texturization of the mc-Si for solar cell with alkaline or acidic solution has been investigated. It has been found that the reflectance of a mc-untextured silicon surface is reduced marginally by alkaline or acidic textured mc surface and so are not good enough. Hence a λ/4 coating of silicon nitride (λ about 600nm) can reduce the reflectivity to about 5%. Silicon nitride also serves as a surface and grain boundary passivator. This silicon nitrite coating also serves as a surface as well as grain boundary passivation to increase the efficiency of mc-Si solar cell. The SEMmicrographs of both alkaline textured and acidic textured mc-Si
are nearly same and a representative micrograph is shown in Fig. 4.4.

![SEM micrograph of textured mc-Si](image)

Fig. 4.4. SEM micrograph of textured mc-Si

In the development of microsystems for bioprocess monitoring, enzymes are commonly used to obtain biospecific detection. The enzyme is immobilized on the high surface area porous matrix. As the sample passes through the packed bed the substrate is covered by the enzyme, giving rise to reaction products that can be detected optically or electrochemically. Silicon surface when covered with PS provides a large enhancement in surface area (~200 m² cm⁻³) as compared to non-PS samples. The surface area could be enhanced further if the PS layer is grown on micro channels. In order to fabricate microchannels on crystalline silicon (c-Si) alkaline anisotropic wet etchants are used to have V (flat bottom) and U- grooves on <100> and <110> oriented wafers respectively. This is useful to make microelectromechanical systems (MEMS) in general and PS sensors in particular. The depth of the channels was measured and came out to be 100±10 µm. A representative micrograph is shown in Fig. 4.5. PS was grown in an electrochemical bath with Si was the anode while the counter electrode consisted of a Pt wire mesh that was positioned in the electrolyte at a distance of 2 cm from the anode. The resulting thickness of the PS layer was measured and found to be 250±15 nm.

**NANOSTRUCTURE DEVICES, OPTICAL THIN FILMS, ELECTROCHROMIC DEVICES, POLYMER DEVICES**

**Thin Film Optical Coatings**

The Leybold L-560 vacuum coating plant was restored to operation and multilayer coatings of 35 layers were deposited, to serve as narrow bandpass filters in the 800 - 900 nm range. Narrowband filters had typical characteristics: Peak transmittance 68-83%, halfwidth about 16 nm, center wavelengths in 800-900 nm range, stopband range about 100 nm on either sides of the centre wavelength (Fig. 4.6). A glass block holder and calotte mount, monitor plate holder and test plate holder were designed and fabricated. A 17 layer high reflectance coating of TiO₂ and SiO₂ λ/4 layers at 850 nm was deposited on one face of a glass block for the fabrication of a WDM device.

![Spectral characteristics of fabricated narrowband filters](image)

Fig. 4.6. Spectral characteristics of fabricated narrowband filters

**Development of Plasma Polymerisation Systems and Thin Film Coatings**

Total integration of the plasma polymerisation deposition system for polymeric dielectric films has been completed with incorporation of the in-house designed and fabricated cold trap and the procured automatic pressure controller and mass flow controllers, along with the required couplings, adapters, valves, etc. A second deposition system for polymeric conducting films, consisting of deposition chamber with parallel plate electrodes, gas manifold, liquid vapour delivery system, rotary, roots and diffusion (turbo) pumps, has also been fabricated and assembled. Both systems are
operational (Fig. 4.7).

Good quality TiO2-like and SiO2-like polymeric films have been deposited and characterized for incorporation in antireflection coatings on polycarbonate substrates. Transparent conducting films of ITO with sheet resistances of about $40\Omega/\square$ with visible transparency of about 85% have been achieved. Efforts to optimize the deposition parameters for best film quality continue.

In a related study an unusual morphology in solution processable P3OT synthesized in our laboratory has been observed. The P3OT is comparable with high quality regio regular poly (3-alkyl thiophene), rr-P3ATs. Upon thermal annealing a rare well arranged corrugated-rod-type (CRT) morphology has been observed for the first time by SEM, supported by photoluminescence quenching, red shift of $I_{\text{max}}$ ($\pi-\pi^*$ absorption) in UV–vis spectra and increase in conductivity. These improvements in physical properties are perhaps due to the increase in the planarity and 3D-$\pi-\pi$ stacking of polymer chains by gradual soft-thermal annealing. The improvement in the quality of P3OT may induce self-assembly due to increased $\pi-\pi$ interactions. The surface morphology and electrical properties of P3OT films, in both their pristine and doped states, were studied by SEM and the variation of conductivity with temperature in the range 10–300 K. Pristine P3OT film exhibits a mat-type structure whereas ferric chloride doped P3OT film shows conducting domains in the range 40–80 nm (Fig. 4.8). The room temperature dc conductivities of pristine and doped P3OT films are $\sim 1 \times 10^8$ $\text{S cm}^{-1}$ and $8.2 \times 10^4$ $\text{S cm}^{-1}$, respectively. The temperature dependence of dc conductivity in the region 77–300 K, where hopping

**Polymeric Materials and Devices**

Solution processable conjugated polymers and their composites have been synthesized and characterized for application in the development of polymer solar cell. The important polymers of polythiophenes family such as poly(3-octylthiophene) (P3OT), poly(3-hexylthiophene) (P3HT) have been synthesized by chemical polymerization at low temperatures using ferric chloride (FeCl3) as an oxidant in an inert atmosphere. Development of composites of P3HT, P3OT with carbon nanotubes and fullerene and its derivatives is in progress.
conduction dominates, is well described by Mott’s three-dimensional variable range hopping transport. A new mechanism of chemical doping of p-conjugated polymer has been proposed. 

**Nanocrystalline Cobalt Ferrite Powders and Thin Films**

Cobalt ferrite, CoFe$_2$O$_4$, is unique among cubic spinel ferrites with a cubic magnetocrystalline anisotropy as high as that of hexagonal barium ferrite and has been well studied for possible magnetic recording applications. Nanoparticles prepared by low temperature chemical methods and thin films often show magnetic properties and cation distributions that are different from bulk. Stoichiometric cobalt ferrite nanoparticles in the 5-20 nm size range were prepared from a citrate precursor by a self-ignition reaction initiated at near dryness, to form fine brown flakes of ferrite. XRD pattern of the self-ignited powder shows typical inverse spinel structure with broad lines characteristic of nanoparticles. Particles in the of 5-20 nm size range were observed at different stages of nucleation and growth by TEM. The hysteresis loop shows a relatively low magnetization of 30 emu/g and a coercivity of 800 Oe. The magnetization does not saturate in 10 kOe. Thin films (100 nm thick) were deposited by a spray pyrolysis method. Films annealed at 700°C and above showed single spinel phase and coercivity of 1000 Oe. Improvements have been made in the deposition procedure and conditions to grow more than 10 microns thick films of barium ferrite, for applications in microwave circulators.

**Nanostructured Mesoporous Tungsten Oxide Films With Fast Kinetics for Electrochromic Smart Windows**

A potential driven self-assembly of sodium dodecyl sulfate/ tungsten oxide aggregates at the electrolyte-electrode interface followed by template extraction and annealing yielded mesoporous thin films of electrochromic tungsten oxide (WO$_3$). SEM images revealed a hitherto unreported hybrid structure comprising nanoparticles and nanorods, with a tetragonal crystalline phase of WO$_3$. This resulted in coloration efficiency and switching kinetics higher and faster than previously reported. Repetitive cycling between the clear and blue states has no deleterious effect on the electrochromic performance of the film, indicating its potential as cathode in practical electrochromic windows. A simple and inexpensive strategy has been employed to synthesize mesoporous tungsten oxide films with a hybrid structure comprising nanoparticles and nanorods with a tetragonal crystalline phase, not been reported so far. Such a microstructure aided ion-movement resulted in coloration efficiency and color-bleach kinetics higher and faster than previously reported for mesoporous nanostructured WO$_3$. The films also sustain 1000 color-bleach cycles without any degradation, which hints at their suitability for smart electrochromic windows.

As-deposited sol-gel derived amorphous tungsten oxide films transform into nanostructured films with an interconnected framework of grains and pores and a dominant triclinic crystalline phase upon annealing at 250°C. Microstructural changes on annealing were studied by TEM, SEM, XRD, etc. The effect of lithium ion intercalation on the chemical composition of the WO$_3$ films was studied in detail using X-ray Photoelectron Spectroscopy for the first time. Typical mesoporous WO$_3$ films in blue and clear states are shown in Fig. 4.9.

![Fig. 4.9. Mesoporous WO$_3$ films in blue and clear states](image-url)

**Nanostructured Materials for Gas Sensors**

Hydrothermal powder synthesis has been known as a powerful technique for the preparation of fine, high purity and homogeneous powders of various single component and multi-component powders. Hydrothermal reactions are usually performed in moderate conditions, do not require expensive precursors or equipments. The temperature, pH, dilution can be controlled to obtain powders of required size. The synthesis of SnO$_2$, ZnO and ZnS
powder using the hydrothermal synthesis route under a variety of synthesis conditions was carried out. The solvents, additives and dopants were varied. Powders were characterized using XRD, TEM for their particle size and morphology. The optical properties of synthesized powders were investigated by optical absorption and photoluminescence studies. Nanocrystalline powders of various sizes and morphologies obtained depended on the synthesis conditions.

HIGH TEMPERATURE SUPERCONDUCTING MATERIALS/DEVICES & ADVANCED CERAMICS

High Temperature Superconducting (HTS) Materials/Devices

The core component for majority of the high energy applications of HTS are HTS tube/rod conductors and long length wires/tapes, which can transport very high electrical current (>KA), can provide high fields and can withstand very high fields. This is the main object of applied work on Bi-2223 & Bi-2212 HTS.

Applied Research Studies

- HTS (Bi, Pb)-2223 tube current leads of large size (43 cm long, 4.8 cm diameter, 3 mm wall thickness) have been developed (Fig. 10). Work on joining of a pair of such tubes is in progress.
- A patent on a novel method for joining of a pair of tubes of (Bi, Pb)-2223 HTS of lower dimensions has been submitted. The joint is not only superconducting but also stable for carrying critical currents. There are no reports so far on joining of superconducting tubes.
- Seven monofilamentary Ag clad (Bi, Pb)-2223 tapes (Fig. 4.10) of length varying from 30 m to 35 m, which all are superconducting end to end and can carry critical transport current of 50 A at 4.2 K have been developed. A small magnet has been assembled by stacking two pancakes in series made by wind & react method and has been tested. The optimization of wind & react parameters and another magnet assembled by stacking four pancakes in series is under testing.

Basic Research Studies

The only parameter at HTS compounds which limits their use at 77 K in their low upper critical field and which can be improved upon by a proper understanding of the nature and mechanism of electron/hole pairing and pinning of flux lines as microscopic and macroscopic aspects of the HTS compounds are highly interwoven and this is the focal point of basic research.

Ionic Conductors

Work on microwave sintering of beta alumina was initiated. Initial studies reveal microwave sintering is superior to conventional sintering methods, which was substantiated by microstructural studies. Scanning Electron Micrograph of beta alumina processed at 1300 - 1600°C shows gradual grain size variations. As a part of LPG sensor development the effect of Pb incorporation, operating temperature, morphology, and sensitivity were studied. Out of various sensor compositions, sintered Pb doped SnO$_2$ has shown high sensitivity towards LPG.

Surface Physics And Nanostructures

- **Formation of Sb submonolayer phases on high index Si(5 5 12) surface**
  Sub-monolayer antimony nanostructures using the highly trenched high index (5 5 12) surface have been formed as templates for the growth of single atom nano-wires for the first time. Temperature treatment relaxes this one-dimensional structure to form a zig-zig chain due to strain relaxation. Chemical and structural aspects are probed by surface sensitive electron spectroscopies & Low Energy Electron Diffraction.
- **Synthesis of cubic and hexagonal CdTe nanoparticles dispersed in SiO2 films: Role of oxygen during sintering**
  CdTe nanoparticles formed by co-sputtering
the constituent elements are sequestered in a SiO2 matrix. It has been observed that annealing this film in oxygen ambient leads to formation of hexagonal core due to formation of oxide and defects in the shell structure. Vacuum annealed films resulted in defect-free cubic CdTe core, demonstrating the influence of the nature of the shell on the properties of the core in the nanoparticle form.

- **Stability and hydrogenation of 'bare' gadolinium nanoparticles**
  
  Gadolinium formed by Activated Reactive Evaporation in the nanoparticle form (5 nm) has been observed to show very high stability towards oxidation by x-ray photoelectron spectroscopy. Since Gd can be used in this form for hydrogen sensing and storage without the Pd cap layer, the sensitivity of such devices can be greatly enhanced and can be used for applications such as optical-mirrors with hydrogen sensing switches.

**SPECIAL ACHIEVEMENTS**

- **Low energy ion induced effects on TOPO capped CdSe nanocrystals probed by XPS depth profiling and optical measurements**

  CdSe nanoparticles were formed by using tri-octo-phosphonic oxide (TOPO) organic molecules to limit the size during synthesis by the chemical route. The pre-cursor ratio was optimized to obtain monodisperse and well-defined CdSe nanoparticles of various sizes showing size-induced optical property variations. X-ray photoelectron spectroscopy in conjunction with Argon ion sputtering was used to reveal the core-shell structure formed. From this study it was observed that a 2:1 Cd:Se precursor ratio provided optimal conditions for the formation of high quality CdSe nanoparticles of 5 nm. The depth profile also showed the compositional changes from the optimal conditions when ratios in the range (0.5:1 to 3:1) were used. The study enabled the derivation of a structural model for the various compositional regimes that can be classified as a) selenium rich, 2) stoichiometric and 3) cadmium rich. The study graphically demonstrates the dynamics of CdSe synthesis by the chemical route and also the role of the organic cap layers.