SS848 NANOMATERIALS SYNTHESIS AND CHARACTERIZATION TECHNIQUES 4-0-0-4

Unit I Nanomaterials Characterization

Tools for nanoscience: UV-VIS and IR Spectrophotometry, XRD, Photoelectron Spectroscopy (PES), Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Atomic Force Microscopy (AFM) techniques. Thermal methods of Analysis TG, DTA and DSC.

Unit II Nano dimensional materials

0D, 1D, 2D structures – Size Effects – Fraction of Surface Atoms – specific Surface Energy and Surface Stress – Effect on the Lattice Parameter – Phonon Density of States – the General Methods available for the Synthesis of Nano structures – precipitative – reactive – hydrothermal/solvo thermal methods – suitability of such methods for scaling – potential Uses

Unit III Physico-chemical methods of nanostructured materials

Solution growth techniques of 1D-2D nano structures:- Synthesis of metallic, semiconducting and oxide nanoparticles – homo- and hetero-nucleation growth methods – template-based synthesis (electrochemical, electrophoretic, Melt and solution, CVD, ALD) – Gas Phase Synthesis of Nano powders: – Vapor (or solution) – liquid – solid (VLS or SLS) growth – the Need for Gas/vapor State Processing – Main Stages of Gas Phase Synthesis – Applicability of the methods.

Unit IV Specific features of Nanoscale Growth

Thermodynamics of Phase Transitions – triggering the Phase Transition – fundamentals of nucleation growth – Controlling Nucleation & Growth – Size Control of the Nano metric State –Aggregation – Stability of Colloidal Dispersions – Spontaneous Condensation of Nanoparticles: Homogeneous Nucleation – Spinodal decomposition – Other undesirable Post-Condensation Effects – Nanoparticles' morphology

Unit V Nanoscale Properties

Magnetism:- Magnetic Moment in clusters/Nanoparticles – Magnetic Order – coercivity – Magneto crystalline Anisotropy – thermal activation and Superparamagnetic effects – Electronics and Optoelectronics:- Quantum Confinement of Super lattices and Quantum Wells – Dielectric Constant of Nanoscale Silicon – Doping of a Nanoparticle – Excitonic Binding and Recombination Energies – Capacitance in a Nanoparticle – Diffusion in 4 NT – 12–13 – SRM – E&T Nano crystalline Materials –Diffusion In Grain Boundaries Of Metals – Nano crystalline Ceramics – Correlation Between Diffusion and Crystallite Growth – Other properties: – brief overview of optical properties – mechanical properties including super plasticity phenomena – reactivity of nanoparticles

Unit VI Characterization of Nanophase Materials

Fundamentals of the techniques – experimental approaches and data interpretation – applications/limitations of X ray characterization: – X-ray sources – wide angle, extended x-ray absorption technique – Electron microscopy: SEM/TEM – high resolution imaging – defects in nanomaterials – Spectroscopy: – electron energy-loss mechanisms – electron

filtered imaging – prospects of scanning probe microscopes – optical spectroscopy of metal/semiconductor nanoparticles

TEXT BOOKS/ REFERENCES:

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2) C. Bre´chignac P. Houdy M. Lahmani, Nanomaterials and Nanochemistry, Springer Berlin Heidelberg, Germany (2006).

3) Guozhong Cao, Nanostructures & Nanomaterials Synthesis, Properties G;Z: Applications, World Scientific Publishing Private, Ltd., Singapore (2004).

4) Zhong Lin Wang, Characterization of Nanophase Materials, Wiley-VCH, Verlag GmbH, Germany (2004). 5) Carl C. Koch, Nanostructured Materials: Processing, Properties and Potential Applications, Noyes Publications, William Andrew Publishing Norwich, New York, U.S.A (2002).