Srinivas University

Course work syllabus for Nanotechnology

Nanomaterials Characterization techniques: 19SPHDNT01

Module 1

Introduction to characterization techniques: types of characterization techniques, Basics, Importance. Structural and compositional characterization tools, resolution, resolving power- abbe criterion, Rayleigh criterion. Different types of sources used, electron lenses, scan coils, lens aberrations. Electron diffraction-interference. Types of detectors.

Module 2

Basic characterization studies: Refractive index measurements. Photovoltaic cell - efficiency of a solar cell. Magnetic susceptibility studies. X-ray techniques: Laue, rotating crystal, Powder method. Density measurements, Viscosity measurements, Poiseullis equation. Laser diffraction analysis, Particle size analyzers, dynamic light scattering, CONTIN algorithm. Electro resistance particle size analyzers.

Module 3

Mechanical characterization techniques: micro and nanoindentation, Corrosion studies, tafel plots, cathodic and anodic polarization, corrosion rate, wear and friction studies, coefficient of friction (COF).

Module 4

Optical microscopy techniques: Optical microscopy, polarized light microscopy, Phase contrast microcopy, Interference Microscopy, hot stage microscopy, surface morphology, Etch pit density and hardness measurements

Module 5

Electron microscopic techniques: SEM - EDX, TEM, STEM, AFM. **Thermal analysis methods**: TGA, DTA, and DSC.

References:

1. D. John Thiruvadigal, S. Ponnusamy, C. Preferencial Kala, M. Krishna Mohan, “Material Science” Vibrant Publications, 2014.

2. Callister’s “Materials Science and Engineering” Adapted by R, Balasubramaniam, Wiley India Pvt. Ltd, New Delhi, 2011.

3. Dr. M. K. Muralidhara, “Material Science and Metallurgy”, Subhas Stores, 2011.

4. Edward L. Wolf, "Nanophysics and Nanotechnology - An Introduction to Modern Concepts in Nanoscience" Second Edition, John Wiley & Sons, 2006.

Applications of Nanoscience and Nanotechnology - 19SPHDNT02

Module 1

Photovoltaics: Ultrathin nanotechnology solar cells (plastic solar cells; Applications of CNTs in: photovoltaic diode, photo-active layer, transparent electrode, and dye-sensitized solar cells.

Batteries, and Fuel cells: Nanobatteries; Applications of NT in Hydrogen fuel cells, DMFC, and SOFC. Energy transmissions: General energy applications: lighting, heating, transportation, capacitors, power chips; NT for energy transmission development, transformers, substations, and sensors.

Module 2

Water purification: Nanooligodynamic metallic particles; Photocatalysis; Desalination: nanofiltration, NT in membrane process. NT in Defense: Smart helmets; Smart suits; Smart equipments. NT in agriculture applications: Nanoscale carriers, Microfabricated xylem vessels, Nanolignocellulosic materials, Clay nanotubes, Nanobarcode technology, Quantum dots for staining bacteria, Biosensors.

Module 3

Nanotechnologies in animal production and health care: Improving feeding efficiency and nutrition, Zoonotic diseases, Animal reproduction and fertility.

Module 4

NT in food processing applications: Nanofood, nanoencapsulation, nanocomposites in food packaging, smart food packaging. NT in civil engineering applications: NT for green building; Coatings: self-cleaning coatings, anti-stain coatings, De-polluting surfaces, Scratch-resistant coatings, Anti-fogging and anti-icing coatings, Antimicrobial coatings, UV protection, Anti-corrosion coatings, and Moisture resistance. NT in automobile applications: Functionalities (mechanical, geometric effect, electronic/magnetic, optical, and chemical); Applications of NT towards: car body shell, car body, car interior, chasis and tyres, electrics and electronics, engine and drive train. NT in aerospace applications: Potential space benefits: resources in space, technical difficulties, Space elevator.

Module 5

NT in Electronics, Computer Engineering, & Photonics: MOSFET, CMOS, DRAM, SRAM, FIFO, EPROM, and PROM. SETs, Coulomb blockade, miniature flash memory, and Yano type memory. Quantum mechanical tunneling: RTDs and Esaki diodes. Introduction to spintronics, molecular nanoelectronics, fault tolerant designs, quantum cellular automata, and quantum computing, MEMS and MOEMS, Introduction to: nanotechnology in photonics, photonic crystals, plasmonics, and spray-on nanocomputers.

References

1. Nanotechnology – Basic Science & Emerging Technologies: 2002 by Michael Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmons, and Burkhard Raguse.

2 Nanoparticles technology: Masuo Hosokawa, Kiyoshi Nogi, Makio Naito, Toyokazu Yokoyama, First edition, 2007, ISBN: 978-0-444-53122-3.

3 Nanotechnology, Importance & Applications, M.H. Fulekar, I.K. International Publishing House, New Delhi, 2011.

4. Nanotechnology Applications to Telecommunications and Networking, Daniel Minoli, Wiley Interscience, John Wiley & Sons, 2006, ISBN: 13-978-0-471-71-63-9-6.

5. Nanotechnology, Fundamentals and Applications, Manasi Karkare, I. K. International Publishing, New Delhi, 2008, ISBN: 978-81-89866-99-0.

Nanotechnology – 19SUPHDNT03

Module -1

Introduction to Nano science: Introduction to Nano science; History and Scope, Interdisciplinary nature, Structure of nanomaterials, Quantum wells, quantum wires, quantum dots, fullerenes, graphite, carbon nanotubes, inorganic nanowires, nanoparticles. Nano-optoelectronic materials and devices, medicine and pharmacology applications, thin-films, One Dimensional Nanostructures, Nano wires and nano rods, Spontaneous growth: Evaporation and condensation growth, vapor-liquid-solid growth.

Module-2

Template based synthesis: Electrochemical deposition, Electro-phoretic deposition. Two dimensional nano-structures, Fundamentals of film growth. Physical vapour Deposition (PVD): Evaporation molecular beam epitaxy (MBE), Sputtering, Comparison of Evaporation and sputtering. Chemical Vapour Deposition (CVD). Wet chemical synthesis methods: sol-gel, hydrothermal, coprecipitation and solution combustion methods.

Module -3

Nanomaterials and composites: Introduction, Nylon 6-clay hybrid (NCH) - Synthesis, Characterization; Epoxy nanocomposites, Epoxy layered silicate nanocomposites, Epoxy-nanocomposites based on other Nano fillers, Biodegradable polymer/layered silicate nanocomposites, Polymer/layered silicate nanocomposites technology, structure-property relationships, polypropylene layered silicate nanocomposites, Nanotubes, nanoparticles and inorganic organic hybrid systems, Single-walled carbon nanotubes in epoxy, Fullerene/carbon nanotube (CNT) composites, Filled polymer nanocomposites containing functionalized nanoparticles, Magnetic polymer nanocomposites, Polymer/graphite nanocomposites.

Module -4

Nano magnetic Materials: Basics of ferromagnetism, Effect of bulk structuring of Magnetic properties, Dynamics of Nano magnets, Nano pore containment of magnetic properties, Nano carbon Ferro magnets, Giant Magneto resistance, Applications in data storage, Ferro fluids, Band structure in magnetic fields, Parallel and perpendicular field. Thin films, Atomic layer deposition (ALD), electrochemical deposition (ECD), Sol-Gel films.

Module -5

Characterization of Nano-structured materials: Principle, instrumentation and applications of Powder X-ray diffraction, Fourier transform infrared spectroscopy, Scanning electron microscopy(SEM), tunneling electron microscopy(TEM), atomic force microscopy(AFM), magnetic-force microscopy (MFM), scanning near-field optical microscopy (SNOM).

REFERENCES: 1) Nanomaterials – AK Bandyopadhyay, Newage International (p) limited publishers.
2) Nanomaterials- J Dutta and H Hofmann
3) Nanostructured materials processing, properties and applications- Carl C Koch, Jaicopublishing house.
4) Nanotechnology- William Illsey Atkinson, Jaico publishing house.