

Course 17: Material Science

Course code: MSCPH552

Credit: 3

BLOCK -1: Introduction to different materials

Unit –1: Overview of materials: Basic idea about materials, structure of materials, Crystalline and amorphous materials, atomic bonding, properties, classification of materials, metals, ceramics, glasses, polymer, composite materials, semiconductors materials, semiconductors material, biomaterials, advanced materials, smart materials, nano-material.

Unit –2: Basic properties of metals: Classification of metals, base, noble, precious, heavy metals, properties of metals, Physical properties, mechanical properties, strengthening of metals, creep, Self Healing mechanism by Creep, Temperature effects on stress strain curve.

Unit –3: Ceramics: History of ceramics, Different types, Traditional ceramics, Whitewares, Clay Products, Bricks and Tiles, Abrasives, Refractories, Cements, Glasses or amorphous ceramics, Advanced ceramic materials, Preparations of ceramics, physical properties, Density, Porosity, Mechanical properties, Flexural strength, Elastic behavior, Strength, Plastic deformations, Brittle fracture, Hardness, Toughness, Thermal properties, Thermal expansion coefficient, Specific heat capacity, Thermal shock resistance, Electrical properties, conductivity, Super conductivity, Piezoelectric effect, Dielectric property, Magnetic properties, Chemical properties, Advantage, Applications.

Unit –4: Polymers: Basic idea, Classification, Natural polymers, Semi-synthetic polymers, Synthetic polymers, Polymer structures, Linear chain polymers, Branch chain polymers, Crossed Linked polymers, Elastomer, Fibres, Thermosetting, Polymerization mechanism, Addition polymerizations, Condensation polymerizations, Preparation of some important polymers, properties, Physical Properties, Thermal properties, Mechanical properties, Chemical properties, Polymer degradations, Comparisons of Polymer with metal and ceramics, Characteristics, Advantages and disadvantages, Application, Polymer recycling processes.

Unit –5: Nano-materials: Basic Idea about nano-materials, Nano-scale properties, Classification, Quantum dots and Quantum confinement, methods of Preparation, properties, Applications

BLOCK 2: Basics Techniques of synthesis

Unit –6: Synthesis and preparation of materials: Introduction to crystal growth, Basic idea about Single crystal, Single crystal growth theory and techniques, zone refining, doping techniques of semiconductors

Unit –7: Thin Film Preparation Methods: Methods of Fabricating Thin films, Synthesis of Nanomaterials; Top down and bottom up approach, physical and chemical techniques for nanomaterial synthesis, physical vapour deposition processes (PVD) and chemical vapour deposition techniques (CVD) processes, Sputtering.

BLOCK 3: Characterization of materials

Unit –8: Structure analysis tools: Defects in crystal, X-ray diffraction and structural analysis, Neutron diffraction, Low-energy electron diffraction, Thermal analysis: Differential Thermal Analysis (DTA), Thermogravimetric analysis (TGA), Differential Scanning Calorimetry (DSC).

Unit –9: Microscopy techniques: Introduction to microscopes, types of microscope, Light microscope, Electron Microscope: Tunnelling Electron Microscope (TEM) and Scanning Electron Microscope (SEM), Heat treatment Processes: quenching and annealing, Radiation damage.

Unit –10: Optical spectroscopy: Molecular spectroscopy, UV-Vis spectroscopy, Fourier Transform (FT-IR) spectroscopy, Raman Spectroscopy, Nuclear Magnetic Resonance Spectroscopy (NMR), Electron Spin Resonance Spectroscopy (ESR), Mossbauer Spectroscopy and Positron annihilation Spectroscopy.

Reference Books:

1. Kaushik Pal, NPTEL online course on Structural Analysis of Nanomaterials, Department of Mechanical & Industrial Engineering, Indian Institute of Technology Roorkee
2. R Balasubramaniam, Material Science and Engineering, Wiley India Pvt. Ltd. New Delhi.
3. C Kittel, Introduction to Solid State Physics 7th Edition, John Wiley and Sons, Singapore
4. V. Ragavan, Material Science and Engineering, Prentice Hall of India, New Delhi.
5. M. Arumugam, Materials Science, 3rd Edition, Anuradha Agencies.