UNIVERSITY OF MYSORE
Syllabus for Ph.D. Entrance Exam
Materials Science

Unit I: Kinetic Theory and Laws of Thermodynamics

Kinetic Theory of Matter, Different States of Matter, Concept of Ideal or Perfect Gas, Kinetic Theory of Gases, Expression for the Pressure of a Gas, Kinetic interpretation of Temperature. Thermal Equilibrium Concept of Temperature (Zeroth Law of Thermodynamics), Concept of Heat-Heat: S Path Function Work; A Path Function, Comparison of Heat and Work – First Law of Thermodynamics, Isothermal Process, Adiabatic Process, Isobaric Process, Isochoric Process, Second Law of Thermodynamics, Entropy, Third law of Thermodynamics.

Unit II: Crystal Structure

Periodic Array of Atoms Crystal Lattice-Lattice translation Vectors – United-Basis-Symmetry Consideration- Bravis Lattice – Crystal Planes and Millers Indices- Simple Crystal Structure (HCP, FCC, BCC, SC, Diamond), Bragg's Law, Laue Equations, Reciprocal Lattice, Braggs Condition, Brillouin Zones, atomic Scattering, Geometrical Structure Factor, Experimental X-Ray Diffraction, Methods of Crystal Structure, Laue Method, Rotary Crystal Method, Powder or Debye Scherrer Method, Weber Feckner Method.

Unit III: Materials

Materials World, Materials classification, Functional materials, bulk materials, fine materials and nanomaterials. Crystal, Glasses, Metals, Polymorphism, Solid Solutions and Alloys: Phase Transitions: Overview of Crystal Structure – Property Relations: Neumann's Law: Thermal Properties: Optical Properties: Electrical Properties; Dielectric Properties: magnetic Properties: Mechanical Properties, Solar cells, ceramics, photonics, carbon nanotubes.

Unit IV: Polymers

Introduction and significance of polymer characteristics for property determination: Molecular modeling, Introduction: Definition, Reason for composites, classification of composites, Raw materials, classification, Chemistry, Properties and applications. Matrix: Thermoplastics-Raw materials, Physical and chemical properties, Thermal behavior and mechanical properties, Thermosets-Epoxy; Curing reactions, hardener, Gel time Viscosity Modifications, Prepreg making, Unsaturated polyester resin; catalyst, curing reaction, Viscosity modifier, Alkyd resin, Vinly ester, polyimides, Physical and chemical properties, Thermal behavior, Mechanical Properties and uses, Elastomeric composites.

Unit V: Biomaterials

Common biomaterials and their applications, Protien adsorption in biomaterials; surface modification of biomaterials; biocompatibility testing; cell-biomaterial interaction; inflammation hypersensitivity, carcinogenesis; cardiovascular grafts, orthopedic applications; drug delivery and gene therapy; microencapsulation; cardiovascular tissue engineering. Biosynthesis, Bioimaging, Hypothermia, Biomaterials and gene therapy – in vivo imaging of quantum dots, biophotonics.

Unit VI: Materials Preparation

Solid states routes; mechanical mixing; grinding; solution techniques, seeded growth of crystals, Evaporations, precipitation; Top seeded solution growth; sol-gel techniques; high temperature solution; hydrothermal solvothermal methods; Melt methods- super cooling, Czechorlskii methods; Skull melting. Vapour phase methods, CVD; CVT; MBE; Plasma; Laser ablation. Crystal growth of selected functional materials – quartz, diamond, chalcogenides, GaAs, Si, Graphene.

Unit VII: Materials Characterization

Thermal analysis: TGA; DTA; DSC; dilatometry; (Thermal expansion) Principles and applications. Electron imaging techniques; SEM; TEM; FESEM; STM; AFM; SPM; HRTEM; HRSEM, Particle size measurement, surface area measurement, DC polarization, AC impedance measurements.

Unit VIII: Nanomaterials

Defining nanodimensional materials-size effects in Nanomaterials-Application and technology development–supramolecular machines-Fundamentals of energy transfer and photon motion manipulation-Solar energy harvesting–Fundamentals of electron motion manipulation-Electron pumping and molecular wires-General methos available for the synthesis of nanomaterials-Manipulation of Nanopartices-Nanofabrication-Methods-Bottom up methods-Photolithography-Scanning probe methods-Soft lithography. Quantization effect.

Unit IX: Functionalization of Nanomaterials

Chemical functionalization-Recent advances in Thiol-Au and Silane Chemistry-Layer-by-Layer synthesis of multilayer assemblies Applications-Quantum dots-nanocores and applications. Detailed description of the fabrication of functionalised Gold Nanocores and their application in cancer therapy. Devices, Nanodevices.

Unit X: Environmental Effects on materials

Materials for high performance renewable energy production, storage, conversion and usage. Materials for concentrated solar power, Fule cells. Atmospheric Corrosion, Oxidation in Gaseous Environments, Ellingham Diagrams, Role of Protective Scale, Molten Salt Corrosion, Environmental degradation of ceramics, Degradation of Polymeric Materials, Microbial corrosion, Corrosion of Bio-Implants, Corrosion Prevention methods. Environmental effects from the chemical processes industry (like Pulp mill operations, bleach plants, boilers, paper machine, water treatment plants in the pulp and paper industry and others), infrastructure, and transportation industry.