Module Materials Science

Materials Science I

Learning objectives: Student should be able to

- classify metallic, ceramic and polymeric materials based on their structure on the atomic scale, microstructure and macroscopic properties.
- analyze different materials with respect to mechanical strength.
- understand the physical basis for thermal, electrical and magnetic properties of solid materials.

Syllabus:

- Classification of materials with respect to chemical bond and structure.
- Crystal structure: Symmetry classes, lattices, reciprocal lattice, diffraction.
- Defects in solids: Point defects, dislocations, grain and phase boundaries.
- Characterization of the microstructure: Microscopic methods (optical, SEM), diffraction techniques (XRD, TEM),scanning probe techniques (introduction).
- Phase diagrams: Thermodynamics of solutions, chemical potential, phase equilibrium, basic types of phase diagrams, important examples.
- Transport: Diffusion (macroscopic and microscopic description), diffusion at surfaces and interfaces, electromigration, thermotransport.
- Phase transformations: Thermodynamics and kinetics, diffusive transformations, non-diffusive transformations.
- Mechanical properties: Elasticity, plastic deformation, viscous flow and creep, fracture.

Literature:

- Ashby M. F. and D. R. H. Jones: Engineering Materials 1. 2nd ed., Butterworth-Heinemann, Oxford, 1996.
- Ashby, M.F. and D. R. H. Jones: Engineering Materials 2. 2nd ed., Butterworth-Heinemann, Oxford, 1998.
- Callister, W.D.: Materials Science and Engineering: An Introduction. 6th ed., Wiley, London, 2003.
- Ohring, M.: Engineering Materials Science. Academic Press, London, 1995.

Materials Science II

Learning objectives: Students should be able to

- interpret the influence of the processing of a metallic alloy, ceramic and polymeric substance on its microstructure and properties.
- relate the structure of a composite material to improved strength and toughness.
- select appropriate materials and processing routes for the realization of an engineering design goal, based on properties and performance characteristics.

Syllabus:

- Application of basic concepts introduced in part I of the lecture to different classes of materials: Metallic alloys, ceramics, glasses, polymers.
- Processing/optimization of materials, heat treatment
- Electrical properties of materials
- Semiconductors
- Magnetic properties of materials
- Optical properties of materials
- Micro- and nanostructure of materials: preparation, characterization and stability of micro- and nanostructures, relationship between structure and properties.

Literature:

- See above