

Introduction and classification of materials: metals and alloys, ceramics, polymers and composite. Atomic bonding, crystal structure and grain morphology. Defects in metals. Plastic deformation mechanisms of metals: dislocation slip, deformation twinning, martensitic transformation. Strengthening mechanism of metals. Failure mechanisms: fracture, fatigue and creep. Phase diagrams (Fe-Fe₃C phase diagrams), TTT and CCT diagram. Heat treatment. Powder metallurgy. Coating techniques. Composite fabrication: metal matrix, polymer matrix and ceramic matrix composites. Introduction to advanced materials: shape memory alloys, piezoelectric materials, biomaterials, superalloys, high entropy alloys.

Mechanical characterization: tensile test, hardness test, impact test, fracture/fatigue/creep test; X-ray diffraction (XRD) technique: characterization and analysis; Microscopy techniques and analysis of results: optical microscopy (OM), scanning electron microscopy (SEM), energy-dispersive X-ray spectroscopy (EDS/EDX/EDAX), electron backscatter diffraction (EBSD), transmission electron microscopy (TEM), atomic force microscopy (AFM), scanning tunneling microscopy (STM); Principles and applications of thermal analysis: differential thermal analysis (DTA), differential scanning calorimetry (DSC), thermogravimetric analysis (TGA), thermomechanical analysis (TMA), dynamic mechanical analysis (DMA/DMTA).

Texts/ References

1. W. D. Callister, Material Science and Engineering: an Introduction, Wiley, 2002.
2. G. Dieter, Mechanical Metallurgy, Mc-Graw Hill, 1996.
3. R. F. Speyer, Thermal Analysis of Materials, Marcel Decker, 1994
4. B. Fultz and J. M. Howe, Transmission Electron Microscopy and Diffractometry of Materials, Springer 2008.
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7. C. R. Brundle, C. A. Evans Jr., S. Wilson, Encyclopedia of Materials Characterization, Butterworth-Heinemann, 1992.
8. R. W. Cahn, and E. Lifshin, Concise Encyclopedia of Materials Characterization, Pergamon, 1993.
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