

## CAS 514: ANALYTICAL CHEMISTRY OF POLYMERS

### Course Outcomes

- Student will be able to understand fundamentals of polymers, polymerization processes, T<sub>g</sub> and T<sub>m</sub>.
- Gather knowledge about advanced polymeric materials, polymer processing techniques, stability and testing.
- Describe the different methods of molecular weight determination, thermal characterization, and measurements of mechanical and electrical properties of polymeric materials.

### UNIT-I: Fundamentals of polymers

[12 Hours]

Basic concepts-Monomers, repeat units, degree of polymerization; Linear, branched and network polymers; Polymerization-Condensation, addition, free-radical, ionic, co-ordination, Ring-opening and Electro chemical. Polydispersion, average molecular weight and size concept-number average, weight average, viscosity average and Z-average molecular weights. Average end to end distance and radius of gyration, Practical significance of molecular weight, Geometrical structure. Glass transition and melting transitions, Effect of polymer structure on T<sub>g</sub> and T<sub>m</sub> temperature, T<sub>g</sub> transitions and associated properties, importance of T<sub>g</sub>, effect of crystallinity on the properties of polymers and T<sub>g</sub>.

### UNIT-II

[12 Hours]

**Advanced polymeric materials:** Polymer blends interpenetrating networks & composites—Types, preparation techniques, properties & applications.

**Polymer Processing:** Processing of plastics, elastomers and fibers; Compounding and processing techniques-Calendering, casting, moulding, foaming, fiber spinning and reinforcing techniques. Identification of commonly used thermoplastics (ABS, Teflon, Acrylics, PE, PP, PVC) and thermosets (epoxy and formaldehyde based polymers).

**Environmental stability and testing:** Photo, oxidative and biodegradation. Solvent resistance testing, Polymer additives and roles-Fillers, plasticizers, antioxidants, coloring agents, UV stabilizers, heat stabilizers and flame retardants.

### UNIT-III

[12 Hours]

**Determination of molecular weight:** End group analysis, viscosity, light scattering, osmometry, cryoscopy, ebulliometry and ultra-centrifugation method.

**Thermal characterization:** Thermal properties, Techniques of measurement of transition temperatures and stability, Dilatometry, DSC, DTA, DTG, TGA. Measurement of thermal conductivity, thermal expansion and heat deflection temperature.

**Mechanical properties:** Tensile impact and flexural strengths; Deflection temperature, Dynamic mechanical thermal analysis and Flammability test-Limiting oxygen index;

**Electrical properties:** Measurement of dielectric strength, dielectric constant and arc resistance. Characterization and structural property relationship of polymers (phthalocyanine polymers, conducting polymers, flame retardant polymers, bio-medical polymers) with special interest. Special techniques-UV, IR, NMR, ESR, X-Ray Diffraction and Scanning Electron Microscopy methods of analysis.

## References

1. Polymer Science, 4<sup>th</sup> edn., V. R. Gowariker, N. V. Viswanathan and J. Sridhar, New Age International (2021).
2. Textbook of Polymer Science, F. W. Billmeyer, 3<sup>rd</sup> edn., John Wiley and Sons (2007).
3. A Text Book of Polymer Science, P. L. Nayak and S. Lenka, Kalyani Publishers (2001).
4. Introductory Polymer Chemistry, G. S. Mishra, New Age international (2008).
5. Fundamental Principles of Polymer materials, 3<sup>rd</sup> edn., C. S. Brazel and S. L. Rosen, John Wiley and Sons (2012).
6. Polymer Science and Technology, J. R. Fried, Printice Hall (2014).
7. Functional Monomers and Polymers: Procedures, Synthesis and Applications, K. Takemoto, Marcel Dekker (1987).
8. Polymer Characterization-Physical Techniques, 2<sup>nd</sup> edn., D. Campbell, R. A. Pethrick and J. R. White, Chapman and Hall (2000).
9. Plastics Chemistry and Technology, 1<sup>st</sup> edn., W. E. Driver, Van Nostrand Reinhold Co. (1979).
10. Composite Materials: Engineering and Science, F. L. Matthews and R. D. Rawlings, Woodhead Publishing (1999).
11. Composite Materials: Science and Engineering, 4<sup>th</sup> edn., K. K. Chawla, Springer-Cham (2019).