derivatives. Thermosets- phenolic, amino, epoxy, polyester, silicone, PEKK, and PEEK. Liquid crystal polymers, biomaterials, biomedical polymers, packaging materials, adhesives, and significances. Recent developments in polymer engineering. 14 hours

Unit III

Physical properties and characterization - free volume, viscosity, Mechanical properties- Tensile testing, stress-strain plots of different types of polymers. Viscoelastic behaviour, rubber like elasticity, factors influencing the strength of polymer. Electrical properties- dielectric relaxation, capacitance, CV measurement, applications.

Optical properties- refractive index, birefringence, UV, IR spectroscopy. Thermal properties - heat capacity of amorphous and crystalline polymers, polymer degradation, Thermal analysis – DSC, TMA, TG. Acoustic properties- dynamic modulus of elasticity, loss modulus, velocity of propagation and absorption coefficient of elastic waves in polymers. Experimental determination of modulus of elasticity. Properties and characterization of polymer blends. 14 hours

References

1. Polymer Science – V R Gowarikar, N V Viswanath, Jayadev Sridhar (Wiley Eastern, 1987)
2. Polymer Chemistry – Bill Meyer Fred (Wiley Interscience, 1984)
3. Polymer Chemistry – An Introduction – Raymond B Seymour & Charles E Carraher Jr (Marcel Dekker, 1987)
4. Polymer Chemistry – M Mishra (Wiley Eastern, 1993)
5. Physical Chemistry of Polymers – A Tager (Mir Pub., 1978)
6. An Introduction to Polymer Physics – I Perepechko (Mir Pub., 1978)
7. Principles of Polymer Science – F Rodrigues (McGraw Hill, 1974)
8. Acoustic Methods of Investigating Polymers – I I Perepechko (Mir Pub., 1975)
9. Polymer Science and Technology – Joel R Fried (Printice Hall, 1993)
10. Polymer Science and Technology – Premamoy Ghosh (McGraw Hill, 2011)
11. Developments in Polymer Degradation – Grassie N (Applied Science, 1984)
12. Experiments in Polymer Science – Hundiwale D G (New Age Int., 2009)
13. Applied Polymer Science – Arun Kumar Singh (Anmol, 2012)
14. Principles of Polymer Science – Bahadur P, Sastry N V (Narosa, 2005).

MSS 455 THIN FILMS (3 Credits)

Objectives: The objectives of this course are to (i) prepare the students with a strong foundation on thin film technology, its importance and applications. (ii) discuss various deposition techniques for the growth of thin films and their limitations. (iii) explain unique optical and electrical properties with suitable examples. (iv) relate their applications in new fields such as quantum well devices and spintronics.

Expected course outcomes: By the end of this course, (i) students will acquire a comprehensive knowledge of fundamentals of thin films. Students will be able to (ii) distinguish characteristic properties of thin films from thick films. (iii) describe various deposition parameters and their effect on structure and properties of thin film. (iv) undertake research on thin film growth and their characterization techniques and in academic/industries. (v) acquire the necessary knowledge and skills for placements in semiconductor, microprocessor industries.

Unit I

Preparation of thick and thin film materials: Definition of thick and thin films. Physical vapour deposition - thermal evaporation - Knudsen cosine law. Sputtering- DC glow discharge and low-pressure sputtering. Reactive sputtering. Chemical vapour deposition. MBE, MOCVD, ALD methods of preparing device grade films. Spray pyrolysis and other chemical methods of film preparation for large area applications. LB films and their applications. Thickness measurement techniques- electrical, and mechanical methods. Optical methods- spectrophotometric and interference methods. Microbalance methods – quartz crystal oscillator technique. Related problems and applications. 14 hours

Unit II

Nucleation and growth of thin films: Theories of nucleation-capillarity theory, effect of deposition parameters. atomistic theory and rate equation approach of nucleation. Growth of thin films- mechanisms and influence of deposition parameters. Epitaxial growth - theory of epitaxial nucleation. Durability of films - adhesion and internal stress.

Optical properties of thin films: Reflection and transmission at interface between isotropic transparent media. Reflectance and transmitance in thin films. Methods for determining optical constants - spectrophotometer and polarimetric methods. Antireflection coatings - theory and design of single layer coatings. Double and multilayer coatings - brief description. Related problems and applications. 14 hours

Unit III

Electron transport phenomena in thin films: Electrical conduction in discontinuous metal films - quantum mechanical tunneling model. Conduction in continuous metal films- size effect and specular scattering. Thermoelectric power in metal films. Electrical conduction in semi-conductor and insulator films - hybrid microcircuits, thin film resistors, thermopiles. Quantum Hall effect- quantum well devices. Spintronics-GMR and TMR. Related problems and applications. 14 hours

References

1. Handbook of Thin Film Technology – L I Maissel and R Glang (Ed) (McGraw Hill, 1970)
2. Vacuum Deposition of Thin Films – L Holland (Wiley, 1956)
3. Thin Film Phenomena – K L Chopra (Mc Graw Hill, 1969)
4. Physics of Thin Films Vol.1-4 – G Hass and R E Thun (Ed) (Academic, 1963)
5. Electrical Conduction in Thin Metal Films – T J Coutts (Elsevier, 1974)
6. Optical Properties of Thin Solid Films – O S Heavens (Dover, 1955)
7. Thin Film Technology and Applications – K L Chopra and L K Malhotra (Ed) (Tata Mc Graw Hill, 1985)
8. Materials Science of Thin Films- Milton Ohring (Academic, 2010)

MSS 456 QUANTUM MECHANICS (3Credits)

Objectives: This course introduces the concept of the language of Physics which makes use of the mathematical tools, learnt earlier, in abundance. As some of the concepts are far removed from the classical picture, they need to be understood well. The objectives of the course include (i) providing an enhanced level of understanding of the principles of quantum mechanics (ii) understanding the use of quantum mechanics to solve simple to not-so-simple textbook examples/problems.