MANGALORE UNIVERSITY

Department of Materials Science

MSc Materials Science

MSS 504: **NEW MATERIALS AND TECHNOLOGIES** (3 Credits)

Objectives: This course aims to provide a glimpse into the fascinating world of a few new unique materials like shape memory alloys, conducting polymers and nanoparticles – their properties, synthesis and applications.

Expected course outcomes: An appreciation of how manipulation of matter at the atomic level can result in materials with novel properties and how these properties can be applied for design of useful devices. It is also expected that it may provide in the students an urge to explore still newer discoveries in the field of materials science and an interest in research in the field.

Unit I

Super alloys and Smart Materials: Types of super alloys – iron based – nickel based – cobalt based super alloys –fabrication – their characteristic features – areas of application. Introduction to smart materials – shape memory effect and martensitic transformation – SME and Superelasticity. Ti - Ni SM Alloys – Cu - based SM Alloys. Ferrous SM alloys. Fabrication of SM Alloys. Characteristic fundamental properties – Shape memory ceramics and polymers. General applications of Smart materials – design of actuators – medical and dental applications. 14 hours

Unit II

Conducting Polymers :Introduction to conducting polymers. Structural features – factors affecting conductivity of polymers - (semiconducting, superconducting) – preparation of conducting polymers – band structures of polymers –charge transport in conducting polymers – nature of charge carriers (soliton, polaron, bipolarons) – models of charge transport – structure - property relationship. Mechanisms of conduction in doped polyheterocyclics, polyaromatics, conducting co-polymers. – molecular designing of Novel conducting polymers – substitution / fusion, ladder structure formation – copolymerisation – donar - acceptor polymer formation – practical applications of conducting polymers – electronic, electrochemical, photonic applications, sensors, medical applications. 14 hours

Unit III

Nano-materials :Introduction – nanostructural materials – metals, semiconductors and ceramics. Synthesis of nanoparticles– inert gas evaporation – laser pyrolysis –sputtering techniques, plasma techniques. Various Chemical methods of synthesis. Functionalized metal nanoparticles- synthesis, characterization, organization and applications. Semiconductor nanoparticles- synthesis, characterization and applications of quantum dots. Magnetic nanoparticles- assembly and nanoastructures. Manipulation of nanoscale biological assemblies. Carbon nanotubes and fullerene as nanoclustures. Nanostructured films.
Charaterisation of nanoaprticles and nanostructures– Optical spectroscopy, Electron Microscopy, Atomic Force Microscopy, X-Ray diffraction of nanoscale materials.

14 hours

References

1. The Science and Engineering of Microelectronic Fabrication, S. A. Campbell (Oxford,1996).
2. Intrinsically conducting polymers : An emerging technology, M. Aldissi (editor), (Kluwer, 1993).
3. Quantum Chemistry Aided Design of Organic Polymers, J. M. Andre, J. Delhalle & J. L. Bredas (World Scientific, 1991).
4. Electrical properties of polymers : Chemical principles, C. C. Ku and Leilpens, (Hanser, 1987).
5. Science and applications of conducting polymers, W. R. Salaneck, D. T. Clark, E. J. Samuelson, (Adam Hilger, 1991).
6. Special polymers for Electronics and optoelectronics, J. A. Chilton, M. T. Goosey, (Chapman and Hall, 1995).
7. Longmuir - Blodgett films - Gareth Roberts (Ed), (Oxford, 1989).
8. D. Chakravorty and A. K. Giri in Chemistry of Advanced Materials (C. N. R. Rao. ed), (Blaclwell, 1992).
9 . P. Jena, B. K. Rao and S. N. Khanna (eds). Physics and Chemistry of Small Clusters (Plenum Press, 1986).
10. Physics and Chemistry of Finite Systems : From Clusters to Crystals, (Kluwer, 1992).
11. Selection of Engineering Materials, G. Lewis, (Prentice Hall, 1990).
12. Engineering Materials and their applications, R. A. Flinn and P. K. Trojan, (Jaico,1998).
13. Fundamentals of Ceramics, M. W. Barsoum, (McGraw – Hill, 1997).
14. Shape Memory Materials, K. Otsuka and C. W. Wayman, (Cambridge, 1998).
15. Nanoscale Materials – (Ed) L.M. Liz-Marzan and P.V.Kamat, (Kluwer, 2003)
16. Nanostructured Materials and Nanotechnology, (Ed) H.S.Nalwa, (Academic, 2002).