

PAPER III: PH 811: MULTIFUNCTIONAL MATERIALS

Objective: To provide student with a fundamental understanding and working knowledge of functional ceramic materials.

Unit-I: Dielectrics and ferroelectrics

Basic definitions-properties of dielectrics- polarisation and polarisability-types of polarization- Debye equation-dielectric relaxation-ac and dc conductivity of solids- types of dielectrics-ferroelectrics-basic concepts-crystal structure and ferroelectricity-Theory of ferroelectricity-first and second order phase transition-domain theory-polarization reversal-poling-variation of dielectric constant with temperature-relaxor ferroelectrics.

Unit-II: Piezoelectrics

Direct and inverse piezoelectric effect-origin of field induced strain-piezoelectric constants-piezoelectric materials-Examples-Lead based and lead free piezoelectric materials-pyroelectric effect-piezo and pyroelectric measurements-ferroelasticity.

Unit-III: Magnetism

Basic concepts of magnetism-macroscopic view of magnetism-classification of magnetism-diamagnetism-paramagnetism-ferromagnetism-antiferromagnetism-ferrimagnetism-magnetic losses and frequency dependence-magnetic hysteresis-magnetic measurements-vibrating sample magnetometer-SQUID magnetometer.

Unit-IV: Multiferroism

Multiferroic materials-exclusive reason for existence of multiferroicity-types and general features of multiferroic materials - Examples- BiFeO_3 , BiMnO_3 - observation of multiferroic properties-requirement of multiferroic materials-magneto-electric coupling.

Unit-V: Applications

Pyroelectric detection-memories and display-electro-optic modulators-piezoelectric bimorph-elasto-optic cell-actuators-GMR-MERAMS.

Text books

1. Dielectrics, P.J.Harrop, Butterworth & Co.(Publishers) Ltd, 1972.
2. Ferroelectric materials, Kenji Uchino, Marcel Dekker Inc, (2000).
3. Principles and Applications of Ferroelectric related materials, M.E. Lines and A.M.Glass, Oxford University Press, 1977.
4. Introduction to Magnetic Materials, B.D.Cullity and C.D.Graham, John Wiley & Sons Publications, 2009.

Reference books

1. Functional Materials Preparation, Processing and Application edited by Dr.S.Banerjee and Dr.A.K.Tyagi, Elsevier, First Edition, (2012).
2. Piezoelectric Ceramics by Bernard Jaffe, William R. Cook and Hans Jaffe, Cleveland, Ohio,USA.

Ms. RB/BM
for Senate approval
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