

**ST. JOSEPH'S COLLEGE (AUTONOMOUS)**

**BENGALURU - 27**

**DEPARTMENT OF CHEMISTRY**

**SYLLABUS FOR POSTGRADUATE COURSE  
M.Sc. ANALYTICAL / ORGANIC CHEMISTRY  
FOURTH SEMESTER - DEPARTMENT ELECTIVE**

**2021-2024**



Re-accredited with 'A++' GRADE and 3.79/4 CGPA by NAAC  
Recognised as "College of Excellence" by UGC

**FROM 2021-2022 ONWARDS**

Semester	IV
Paper code	CHDE 0221
Paper title	Dept. elective: Chemistry of Materials
Number of teaching hours per week	4
Total number of teaching hours per semester	60
Number of credits	4

### 1. INTRODUCTION

1

h

Importance of solids in technological applications, solids as materials.

### 2. MATERIALS CHARACTERISATION TECHNIQUES

(14 +

1)h

Electron microscopy and related techniques: transmission electron microscopy, scanning electron microscopy, electron diffraction, electron energy loss spectroscopy, energy dispersive X-ray spectroscopy. Atomic force microscopy. Photoelectron spectroscopy and auger spectroscopy. *Particle induced X-ray emission spectroscopy*. Extended X-ray absorption fine structure. Porosity and surface area measurements by sorption-desorption – BET and BJH methods.

### 3. LAYERED SOLIDS AND POROUS MATERIALS

(8 + 2)

h

Layered solids: general structural features, classification, intercalation and deintercalation. Structure, composition, properties and applications of cationic clays, layered double hydroxides, layered chalcogenides and layered oxides. Polytypism in layered solids.

Microporous and mesoporous materials: structure, composition, synthesis, properties and applications of zeolites and zeotypes, metal organic frameworks.

*Macroporous solids: general methods of preparation, properties and applications.*

#### **4. SUPERCONDUCTORS**

**5 h**

Definition, Meissner effect, type 1 and type 2 superconductors, features of superconductors, Frolich diagram, Cooper pairs, theory of low temperature superconductivity, high T<sub>c</sub> superconductors.

#### **5. SOME MATERIALS OF RECENT INTEREST**

**( 5**

**+ 1) h**

Multiferroics, giant and colossal magneto resistance (GMR, CMR) materials, thermoelectric materials, topological materials, *conducting polymers*.

#### **6. NANOMATERIALS**

**(20 + 3)**

**h**

Nanoregime, properties at nanoregime- electronic structure of metals and semiconductors at nanoscale, quantum confinement, superparamagnetism of magnetic solids at nanoscale. Classification of nanomaterials.

Synthesis of nanocrystals: top-down vs bottom-up synthesis, dispersity, La Mer principle, capping agents, simple solution-based synthesis, inverse-micelle synthesis, spray pyrolysis, sol-gel, combustion, solvothermal and electrochemical synthesis.

*Synthesis of thin films: physical vapour deposition – pulsed laser deposition and atomic layer deposition, chemical vapour deposition, electrodeposition.*

Synthesis of 2D nanomaterials: mechanical, solvent-mediated, and chemical exfoliation.

Use of PXRD, UV-visible and Raman spectroscopy in the characterization of nanomaterials.

Nanocomposites: definition, different types, general methods of synthesis and applications.

Carbon-based nanomaterials: structure, synthesis, properties and applications of fullerenes, carbon onions, carbon nanotubes and graphene.

Applications of nanomaterials: nanomaterials in energy conversion and storage; environmental amelioration applications; electronic and optoelectronic applications; biological and theronastic applications.

*Nanotoxicity.*

**References:**

1. C. N. R. Rao and J. Gopalakrishnan, *New Directions in Solid State Chemistry*, Cambridge Univ. Press, 2ndEdn., 1997.
2. *Molecular Sieves*, Science and Technology Series, Volume 6, 2008.
3. Kenneth J Klabunde, *Nanoscale Materials in Chemistry*, John Wiley and Sons(2000).
4. C.N.R Rao, *Chemistry of Nanomaterials*, Wiley VCH (2007).
5. Clemens Bruda, *Chemistry and Properties of Nanocrystallites of Different Shapes*, Chem. Rev. 2005, 105, 1025
6. Recent advances in the liquid phase synthesis of inorganic nanoparticles, Chem.Rev. 2004, 104, 3893.
7. The biomolecule-nanoparticle interface, Vincent M Rotello, *Nano Today*, Vol 2, Number 3, June 2007.
8. *Biomaterial Science*, Buddy Ratner, Allan S Hoffmann, Jack E Lemons, Frederick JSchoen, B.D. Ratner, Academic Press (2004).
9. Guozhong Cao, *Nanostructures and Nanomaterials: Synthesis, Properties and Applications*, Imperial College Press (2004)
10. *Hybrid Nanocomposites for Nanotechnology: Electronic, Optical, Magnetic and Biomedical Applications*, Editor Lhadi Merhari, Springer Publications (2009)
11. Characterization techniques for nanoparticles: comparison and complementarity upon studying nanoparticle properties, *Nanoscale*, 2018, 10, 12871

Blue Print

**Code number and Title of the paper:** CHDE 0221: Chemistry of Materials

<b>Chapter Number</b>	<b>Title</b>	<b>Number of teaching hours (As mentioned in the syllabus)</b>	<b>Maximum marks for which questions are to be framed from this chapter (including bonus questions)</b>
1.	<b>Introduction</b>	1	2
2.	<b>Materials characterisation techniques</b>	15	26

3.	<b>Layered solids and porous materials</b>	10	17
4.	<b>Super conductors</b>	5	8
5.	<b>Some materials of recent interest</b>	6	10
6.	<b>Nanomaterials</b>	23	40
<i>Total marks excluding bonus questions</i>			70
<i>Total marks including bonus questions</i>			103