CML102: Chemical synthesis of functional materials (3-0-0)

2018-19 Semester I, July –Dec 2018

Course Contents

1. Introduction to the course : Lecture 1
2. Introduction to Materials (inorganic, organic, polymeric, composite, alloys,bulk, films, nano, single crystals) : Lecture 2
3. Introduction to crystal chemistry of solids : lectures 3-4 : types of packing, lattices, point and space groups, structure types of rock-salt, fluorite, rutile, perovskite, spinel etc,
4. Introduction to characterisation of solids by XRD/microscopy : Lectures 5-6 : Generation of X-rays, lattices, space groups, Bragg's law, Miller indices, principle of x-ray diffraction (instrument) , `powder & single crystal(brief),
5. Chemical routes of synthesis (Lectures 7 to 12): Ceramic (Solid State) , coprecipitation, sol-gel, precursor, microemulsion, solvothermal/hydrothermal, ion –exchange , Chemical Vapour Deposition(CVD), growth of single crystals (vapour phase transport, Czochralski, Bridgman) :
6. Phase diagrams and its applications to synthesis ; Lectures 13-14:
7. Synthesis of carbon based and polymeric materials : Lectures 15-16
8. Synthesis and properties of magnetic materials : Lectures 17 -18 : types of magnetic materials, Curie-Weiss law , synthesis of gamma-Fe_2O_3, $NiFe_2O_4$, etc
9. Synthesis and properties of Superconducting materials : 19-20 : Synthesis and properties of Nb_3Sn, La_2CuO_4, $YBa_2Cu_3O_7$,etc.
10. Defects in solids and related materials and applications: point defects, extended defects, twins, disclocations, vacancies, relevance in batteries, solid electrolytes, mechanical properties, electrical conductivity, color centres and optical properties, creation of defects and vacancies in solids: Lectures 22-24
11. Electronic materials(including dielectrics and thermoelectric materials): overlap of orbitals, molecular orbitals, bands, band gap, metal, semiconductor, insulator, synthesis of BaTiO3, GaAs: Lectures 25-27
12. Optical materials: absorption, fluorescence, plasmonic absorption, synthesis of lasing materials, Nd:YAG, gold nanoparticles and nanorods: Lectures 28-29.
13. Nanomaterials : synthesis, facets, surface energy, La Mer growth mechanism, characterization using AFM/STM/DLS/TEM, quantization effects 3D, 2D, 1D, 0D, quantum dots, photonic, magnetic, catalytic, mechanical: Lectures 30-38
14. Nanosensors : functionalization with biomolecules, Langmuir-Blodgett technique, electrochemical sensors, superhydrophobic surfaces , Dip Pen nanolithography: Lecture 39-41

Lectures 21 and 42: Classes for discussion

AKG : S. Nos. 1-9 : SS : 10 - 14

Books recommended

1. Solid State Chemistry, A. R. West , Wiley – India
2. Solid State Chemistry: L. E. Smart and E. A. Moore, Taylor & Francis
3. Materials Chemistry, Bradley D. Fahlman, Springer (2007).
4. Introduction to Materials Science & Engineering, W D Callister and D G Rethwisch , 8th Edition , John Wiley & Sons (2009).
5. Nanostructures and Nanomaterials, Guozhong Cao and Ying Wang, World Scientific
6. Nanoparticles, G. Schmid, Wiley-VCH

Instructors:

Prof. A. K. Ganguli (AKG), MS 709, #1511, ashok@chemistry.iitd.ac.in, web.iitd.ac.in/~ashok

Prof. Sameer Sapra (SS), MS 717C, #1561, sapra@chemistry.iitd.ac.in, web.iitd.ac.in/~sapra

Grading

Minor 1: 20 marks

Minor 2: 20 marks

Major: 40 marks

Surprise quizzes: 20 marks (there will be a few surprise quizzes during lectures)

GRADE POLICY: Those who secure >80% will be awarded ‘A’ Grade. Minimum 30% mark is required to obtain ‘D’ GRADE.

Attendance:

As per Institute rules, 75% attendance is compulsory. Anyone who falls short of 75% attendance will be awarded ONE GRADE LESS than what they actually deserve as per their obtained marks.