

Nanochemistry

A graduate course of the Chemistry Subject Board

1. Basic Concepts of Nanochemistry

- 1.1. Introduction to nanoscience and nanotechnology.
- 1.2. Discussion on various phenomena at the nano-scale, such as size, shape, surface, surface energy, surface stabilization, characteristic length, self-assembly, defects, size quantization, surface plasmon, conductivity, etc.

2. Synthesis of Nanomaterials

- 2.1. Basics of nanofabrication method, top-down, bottom-up approaches, gas phase, liquid phase, solid phase synthesis, self-assembly, templated synthesis, sol-gel, electrodeposition.
- 2.2. Fundamentals of nanoparticle formation: thermodynamic approach, supersaturation-nucleation-growth, homo vs. hetero nucleation.
- 2.3. Synthesis of nanoparticles: metallic, semiconducting, quantum dots, oxides, hybrids. Micelles and microemulsion as templates for synthesis.
- 2.4. 0, 1, and 2D nanoparticles. Core-shell nanoparticles. Shaped nanoparticles.

3. Characterization Techniques

- 3.1. Discussion on various techniques available for characterizing the nanomaterials to analyze their size, shape, morphology, crystalline phase, oxidation states, textural properties (surface area, pore volume, pore size), thermal stability, light absorption, and band gap.
- 3.2. Scanning electron microscope (SEM) & Transmission electron microscopy (TEM).
- 3.3. X-ray powder diffraction (XRD) & X-ray photoelectron spectroscopy (XPS).
- 3.4. Scanning tunneling microscopes (STM) and atomic force microscopes (AFM).
- 3.5. Thermal analysis.

4. Applications of Nanomaterials

- 4.1. Nanocatalysis: fundamentals, homogeneous vs. heterogeneous catalysis, the effect of surface area, the effect of particle size, shape, and morphology. Effect of composition, bimetallic system, etc.
- 4.2. Nanomaterials for photo-catalysis [dye degradation, water splitting, organic transformations, plasmon-assisted photo-catalysis, etc.].
- 4.3. Nanomaterials for CO₂ capture and conversion [Synthesis of sorbents, characterization, their evaluation for CO₂ capture using gravimetric and volumetric techniques, stability, chemical conversion of CO₂ to fine chemicals, photocatalytic conversion of CO₂ to fuel, artificial trees].

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Days: Wednesday and Thursday

Venue: Lecture Room AG-80

Tutor: Mr. Rishi Varma

Course start date: 1st Feb 2023

Hours: 11:00 am – 12.30 pm