Nano structured materials-synthesis, properties, self assembly and applications

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Module 1 (LECTURE 1 & 2): INTRODUCTION TO NANOTECHNOLOGY

Problem:

1. Define materials.
2. What is the resolution of human eye
3. What is an electromagnetic spectrum
4. 1 micron = …….nm
5. What do you understand by amorphous and crystalline material.
6. X-rays have wavelength of the order of…..nm
7. What is a) SEM b) TEM
8. What are fullerenes.
9. Give examples of a) 1D b) 2D and c)3D nanostructured materials
10. Define nanomaterials.
11. How the size of particle effects the properties of a material
12. Role of surface area in catalysis
13. What are the different methods of synthesis of nanomaterials
14. Applications of nanotechnology in different field.
15. What are the two basic approach for the synthesis of nanomaterials

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Solution:

1. Material – made up of matter, constituted of one or more substances. Materials are categorised into natural e.g. garnet, quartz, gold, silver marble etc and man-made materials like cement, silicon for IC chip.
2. Resolution of human eyes = 0.07 mm
3. Electromagnetic spectrum- range of all possible frequencies of electromagnetic radiation. Extends from below the low frequencies used for modern radio communication to gamma radiation at the short-wavelength (high-frequency) end.
4. 1 micron = 1/1000 mm
5. Amorphous- solids that lack long-range order
   Crystalline - solid material whose atoms, molecules, or ions are highly repetitive and are arranged in a specific regular pattern
6. Wavelength of x-rays : 1-2Å
7. SEM – scanning electron microscope
   TEM – Transmission electron microscope
8. Fullerene - molecule composed entirely of carbonin the form of a hollow sphere, and resemble the balls used in football. The first fullerene molecule "buckminsterfullerene (C_{60})" was discovered and prepared in 1985 by Richard Smalley, and Harold Kroto at Rice University.
9. 1D – nanowire, nanotube
   2D – nanosheet
   3D – nanoparticles
10. Nanomaterials - have one dimension on the nanoscale, i.e., between 0.1 and 100 nm
11. As size of particle decreases disorderness in the material increases. As we enter to nanometer region quantum confinement effect comes to play.Electronic properties changes(these are seen when electron are confined)
12. Greater the surface area greater number of active sites per unit area thereby increases rate of catalysis reaction.
13. Synthesis of nanomaterials:
    Physical:
    Mechanical(ball milling, melt mixing), Vapour(physical vapour deposition, laser ablation)
    Chemical:colloidal route(sol-gel), microemulsion route, co-precipitation
    Biological:green synthesis(use of micro organisms like fungi, plant extracts, enzymes for nanoparticle synthesis),
14. Applications: Information technology(Internet,IT based systems), Energy(solar cells, batterie, fuel cells),Medicine(drug delivery, medical tools, diagnostic tests, Imaging), Consumer goods(food and beverages), textile industry, cosmetics etc.
15. top down and bottom up approach