23CHT101-Engineering chemistry

UNIT-III NANOMATERIALS

Empathy questions

1. **What challenges are you facing in your current work that nanomaterials could help** address?
2. How do you see nanomaterials impacting engineering field in upcoming days?
3. What concerns do you have about integrating nanomaterials into your current projects?
4. What specific problems are you encountering in your projects where conventional materials fall short?
5. How do you think nanomaterials could enhance the performance or efficiency of your designs?
6. What factors would make you more comfortable or confident in using nanomaterials in your work?

Introduction

BASICS OF NANO CHEMISTRY

1. Nano-technology

- Nano-technology is a design fabrication, characterization and applications ofmaterials at nano-level (1-100nm) and converting them into useful devices.

2. Nano-science

- Nano-science is the study of phenomena and manipulation of materials between molecular and nanometer size.

3. Nano-chemistry

- Nano-chemistry is defined as the study of phenomena and manipulation of materials at atomic, molecular and macromolecular of nano scales.

DISTINCTION BETWEEN NANOPARTICLES, MOLECULES AND BULK MATERIALS

1. The sizes of nanoparticles are less than 100 nm in diameter, molecules are therange of Pico meter, but bulk materials are large in micron size.
2. Molecule is a collection of atoms, nanoparticles are collection of few moleculesthat is less than 100 nm but materials contains thousands of molecules.
3. Surface area of nanoparticles is more than the bulk the bulk materials
4. Hardness of Nano materials is 5 times more than the bulk materials
5. Strength of Nanomaterials is 3-10 times higher than the bulk materials
6. Nanoparticles possess size depended properties, but bulk materials possessconstant physical properties.
7. Corrosion resistant of Nanoparticle is more than the bulk material, hence localized corrosion in nano materials is stopped.
8. Behavior of bulk materials can be changed, but cannot enter inside the nanoparticles.
9. Nanoparticles due to its size, possess unexpected optical (visible) properties. Examples:
10.
    (i) Gold nanoparticle appear deep red to black color in solution compared toyellow color with gold.
    (ii) ZnO nanoparticles possess superior UV blocking property compared to bulk material.
    (iii) Absorption of solar radiation in photovoltaic cell containing nanoparticles are higher than the film (bulk materials).
11. Nanoparticles possesses lower melting point than the bulk materials. Example: gold nanoparticles melt at lower temperature (300 °C) for the size of 2.5 nm, but gold slab melts at 1064°C.
12. Sintering of nanoparticles takes place at lower temperature in short time than the bulk materials.

13. Electrical properties, resistivity of nanoparticles are increased by 3 times.
14. Suspension of nanoparticles is possible, because nanoparticles possess high surface area, but bulk materials cannot.
15. The wear resistance of nanoparticles is 170 times higher than the bulk materials.

Differences between molecules, nanoparticles and bulk materials

S.No	Properties	Molecules	NanoParticles	Bulkmaterials
1.	Size of the particles	Size is much smaller	Size is larger than molecules but smallerthan bulk materials.	Size is much larger than the molecules and nanoparticles.
2.	Magnitude of constituting particles.	Few Angstroms (A°) (10^{-10} m)	Angstrom to nano meter 10^{-10} m to 10^{-9} m	Micronsto millimeter
3.	Number of constituting particles.	Two atoms for molecules.	2 to several thousands.	Infinite
4.	Electronic structure.	Confined.	Confined.	Continuous.
5.	Geometric structure	Well-defined structure and predictable.	Well-defined structure and predictable	Crystal structure decides.