भारतीयप्रौद्योगिकीसंस्थानपटना

Indian Institute of Technology Patna

End Semester Examination (End-Sem) (Aug-Nov-2016)

COURSE NO: PH401 **COURSE TITLE: Introduction to Nanomaterials**

Duration: 3hours **Dt-24-11-2016** **Full Marks: 50**

(If you find question is wrong, mention in the answer book without asking in the exam hall)

1. Answer all the questions: **[5x2]**

(i) Give an account of physical properties of carbon nanotube.

(ii) Plot the energy versus DOS (Density of State) for (a) (11,11) metallic conducting CNT (Carbon nanotubes) and (b) (5,10) semiconducting CNT.

(iii) Why is the strength of nanocomposite more than the bulk materials?

(iv) Why is the ideal strength E/15, where E is the Young's modulus?

(v) Write a short note on class of material.

2. Answer all the questions: **[5x3]**

(i) Define the critical size below which particle exists as a magnetic single domain. Sketch the magnetic behavior (Saturation magnetization & coercivity) with the decreasing size for a bulk ferromagnetic material.

(ii) How can magnetic nanomaterials be used for hyperthermia treatment?

(iii) Discuss any three methods of preparation of nanocomposites.

(iv) Calculate the melting point of 1nm, 100nm, 200nm and 5μm gold nanoparticle and conclude your results. (Surface tension coefficient for liquid-solid interface is 1.162N/m, Bulk melting point of gold = 1064^0C, Particle density=1.25g/cm^3, Latent heat of fusion- 63kJ/kg or 15 Cal/g).

(v) How SAXS and GID techniques are used to characterized nanomaterials? Which technique is better for quantum dot (0-D material) and which is used for 2-D materials?

3. Answer all the questions: **[5x4]**

(i) XRD pattern of a nanocrystalline material have the following data. Three peaks have been observed at 38.52^0, 44.76^0 and 65.13^0 with FWHM at 1.8×10^{-3}, 1.2×10^{-3} and 1.6×10^{-3} radian respectively. The pattern has been recorded at 0.02 steps and scan rate is 1 sec per step. Calculate the crystallite size and maximum possible error on it. Take the instrumental broadening 0.015^0 for all peaks.

(ii) Determine the diameter for the following nanotubes (6,9), (14,21) and (34,97). Write the conductivity nature of nanotubes.

(iii) Calculate the melting point of 1nm, 100nm, 200nm and 5μm gold nanoparticle and conclude your results. (Surface tension coefficient for liquid-solid interface is 1.162N/m, Bulk melting point of gold = 1064 ^{0}C, Particle density=1.25g/cm^3, Latent heat of fusion- 63kJ/kg or 15 Cal/g).

(iv) What is the tensile strength (σ_s) of C-C (bond order = 1, Bond length = 0.154nm and bond dissociation energy = 348kJ.mol^{-1}) and C-C (bond order = 1.33, Bond length = 0.142nm and bond dissociation energy = 480kJ.mol^{-1})? How much mass under earth's gravitational pull are these bonds able to hold without breaking?

(v) What is the resistance of a 0.2nm copper nanoparticle? If an array is made up of 10 copper nanoparticles of 0.2nm, what will be resistance of the array? Make a block diagram for an engineering product by using this array. Suggest the method for making the electrical connection at the ends of the array of 100 numbers of Cu nanoparticles with 0.2nm diffuse and make a bigger nanoparticle. What is the size and electrical resistance of the bigger nanoparticle? [Atomic number of Cu= 29, plank's constant=6.62607 x 10^{-34} m^{2}kg/s , Mass of the electron =9.1×10^{-27} kg, Charge of electron =1.6 x 10^{-19} C]

4. Explain the working principle of recording media and magneto resistivity memory. What is the difference between these two devices? Write the engineering advantage and disadvantages for both the methods. **[5]**

----------BEST OF LUCK----------