भारतीय प्रौद्योगिकी संस्थान पटना

Indian Institute of Technology Patna

पाटलिपुत्र कालनी पटना & 800 013] भारत

Patliputra Colony, Patna – 800 013, India

MID-SEMESTER EXAMINATION DATE:10-09-2012

Time: 2hours **Full Marks: 30**

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

Attempt all Questions

1. How many 50 nm nanocubes are required to produce the same surface area as a one cubic meter cube? How much volume do they occupy? **[2.0]**
2. Calculate the ratio of surface atoms to volume atoms by a simple procedure for a $R = 25$nm gold colloid. Assume that the surface atoms occupy a thickness of one atomic diameter ($d_{gold} = 0.288$ nm) and that the packing fraction for gold is at a volume efficiency (V_{volume}/Total volume ($\frac{4}{3}\pi R^3, R = 10nm$)) of 0.740 and surface efficiency (=Volume available for surface gold atoms/V_{layer}) of 0.91. **[2.0]**
3. Explain the following nano-phenomena and give one example: (i) Super hydrophobicity, (ii) Self cleaning, and (iii) Localized surface Plasmon. **[3.0]**
4. A microscope has been built by using a yellow light (wavelength (λ) = 590nm). The semi-angle (θ) of collection of the magnifying lens is 40^0. What will be the resolution of the microscope? How can you improve the resolution by using same yellow light? Also discuss how you can improve the resolution of microscope down to 1nm. **[3.0]**
5. What do you mean by magic numbers in nanoscience? **[2.0]**
6. A nanoparticle with mass $5x10^{-27}$g exists in a 1-nm one dimensional box. What is the wave length of radiation that is emitted when the nanoparticle loses energy from the n = 2 level to the n = 1 level? **[2.0]**
7. A material (melting point =2000^0C) has been milled (ball milling) to make a 5nm size particle. Calculate the melting point of nano particle. (particle density = 11340kg/m^3, Latent heat of fusion = $67x10^3$J/kg, Surface tension coefficient for a liquid – solid interface = 2.2 N/m). **[2.0]**
8. Calculate the de-Broglie wavelength and Bohr radius of electron and hole in GaAs (III-IV) semiconductor. Give an account of semiconductor at nanoscale from the results. ($m_{e\sim}$ $0.067m_0$, $m_h \sim 0.5m_0$, $v_e \sim 10^5$m/s, $v_h \sim 10^5$m/s, $m_0 \sim 9.1x10^{-31}$kg, $\hbar = 1.054x10^{-34}$J/s, $q=1.602x10^{-19}$C). Explain weak, strong and intermediate confinement for a semiconductor. **[5.0]**
9. Make a flow chart of multi use MEMS/NEMS process with diagram. **[4.0]**
10. Draw a schematic diagram of a 200kV TEM. What will be the resolution of this TEM? Write the working principle of magnetic lenses. What is the typical field range of TEM magnetic lenses? **[3.0]**
11. Write short notes on LASER ablation method for deposition of nanomaterials. **[2.0]**

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