Indian Institute of Technology Patna

Patliputra Colony, Patna – 800 013, India

DEPARTMENT OF PHYSICS

MID-SEMESTER EXAMINATION DATE:16-09-2013

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

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

Attempt all Questions

1. A microscope has been built by using red light (wavelength (λ) = 400nm). The semi-angle (θ) of collection of the magnifying lens is 10^0. What will be the resolution of the microscope? How can you improve the resolution by using same red light? Also discuss how you can improve the resolution of microscope down to 1nm. **[3.0]**
2. How one can generate the magic numbers for nanoparticle in a cuboctahedral arrangement? Generate first 5 magic numbers along with fraction of surface to volume atom for the above system. **[2.0]**
3. 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, $m_0 \sim 9.1\times10^{-31}$kg, $\hbar = 1.054\times10^{-34}$J/s, $q=1.602\times10^{-19}$C). **[3.0]**
4. Make a flow chart of multi use MEMS/NEMS process with diagram. **[3.0]**
5. Draw a schematic diagram of a 200kV TEM. What will be the theoretical resolution of this TEM? **[2.0]**
6. Write short notes on PECVD. Give some nanomaterial examples which can be prepared by using above technique. **[3.0]**
7. Sections of 100-300nm poly vinyl chloride (toy materials, refractive index = 1.38) are floating on the silicon oil (refractive index = 1.52). If the oil is illuminated with white light, which colour/s will be radiate from the sections. **[3.0]**
8. What do you mean by super hydrophobocity of morpho butterfly's? How this concept can transfer to technology? **[2.0]**
9. What do you mean by resolution of a projection lithography? Calculate the resolution of a projection lithograph system that uses 400nm radiation. Assume constant k = 0.25, refractive index = 1.21 and half angle of the cone of light that can enter into the lens is 45^0. How one can optimize the resolution of this set up? Can one achieve 40 nm in this system by changing configuration? **[3.0]**
10. Write the different phenomena after interaction of electrons with the specimen in electron microscopy. **[2]**
11. Draw the force versus distance plot for AFM tip and specimen. Give an account of types of AFM. **[2]**
12. Discuss about the constant height and constant current operation mode of STM. **[2.0]**

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