2018

PHYSICS

PHY 309E

NANO SCIENCE AND NANOTECHNOLOGY

FULL MARKS: 80

TIME: 3 HOURS

Figures in the margin indicate full marks for the questions

1. Answer the following questions **5x1=5**

(a)Which of the following is the main parameter governing film nucleation?

(i) Substrate temperature and deposition rate

(ii) Particle density and source temperature

(iii) Particle mass and energy

(iv) Particle mass and deposition rate

(b) Graphene is a

(i) wide band gap semiconductor

(ii) narrow bang gap semiconductor

(iii) band gapless semiconductor

(iv) not a semiconductor but behaves like a graphite

(c) Which of the following is an example of top-down approach for the preparation of nanomaterials?

(i) Gas phase agglomeration (ii) Molecular self-assembly

(iii) Mechanical grinding (iv) Molecular beam epitaxy

(d) The broadening of X-ray diffraction peak is mainly due to

(i) Crystallite size (ii) Band gap

(iii) Electron density (iv) 0D fabrication process

(e) X-ray diffractometers are used to identify the ------of the material

(i) physical properties (ii) chemical properties

(iii) band gap (iv) morphology

2. Answer the following questions **5x2=10**

(a) Explain the importance of thin film technology. 2

(b) What are the factors that affect the growth and structure of thin films? Explain. 2

(c) What is quantum well and superlattice structure? 2

(d) Smaller the quantum dot greater the band gap. Explain 2

(e) Find the surface to volume ratio of a sphere and cube. 2

3. Answer the following questions (any five) **5x5=25**

(a) Explain the various pre nucleation process of the growth of thin film. What are homogeneous and heterogeneous nucleations? Give example for each type of nucleation. 3+2

(b) With schematic diagram, explain the working principle of resistive thermal evaporation technique for deposition of thin film. Explain the parameters that affect the growth of thin film in this technique. 4+1

(c) Discuss the various properties of carbon nanotube. What are the advantages and disadvantages of carbon nanotube? 3+2

(d) Discuss with block diagrams any one of the chemical methods for synthesis of metal oxide nanoparticles. 5

(e) Discuss the grain growth of crystals. Find the expression of average diameter of a grain at equilibrium 3+2

(f) What is lattice strain? Discuss the Williamson-Hall method to estimate the strain and crystallite size of nanomaterial. 1+4

4. Answer the following questions (any four) **4x10=40**

(a) Explain the physical phenomenon of sputtering when a surface of the material is impinged by an energetic particle. Explain the working principle of pulse laser deposition (PLD) technique with a proper block diagram. What are the advantages and disadvantages of this technique? 2+6+2

(b) (i) Discuss the atomistic model of nucleation. 5

(ii) Explain the steps for the formation of continuous thin film from the nucleation stage with the help of schematic diagram. 5

(c) What is quantum wire? Find the total energy expression for infinitely deep rectangular quantum wire. 2+8

(d) (i) Explain the three different growth modes of thin film. 3

(ii) With the schematic diagram of SEM explain the working principle of the technique. What are the uses of SEM? 6+1

(e) (i) What is SAED pattern? What information can be obtained from SAED pattern? 1+2

(ii) With schematic diagram discuss the atomic force microscope characterization technique. What is the difference between AFM and scanning tunneling microscope (STM)? 5+2

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