Total No. of printed pages = 5

63/2 (SEM-3) PHY 309E

2021

(held in 2022)

PHYSICS

(Theory Paper)

Paper Code : PHY-309E

(Nano Science and Technology)

Full Marks – 80

Time – Three hours

The figures in the margin indicate full marks for the questions.

1. Answer the following questions : 1×5=5

(a) Which of the following is used in electron microscope ?

(i) Visible light waves

(ii) Electron beam

(iii) X-rays

(iv) All of the above

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(b) Transmission electron microscope is used to study the _____ of the material.

(i) Crystallinity

(ii) Chemical properties

(iii) Band gap

(iv) Morphology

(c) Blue-shift in the absorption spectra is observed due to

(i) Decreasing of the particle size

(ii) Increasing of the particle size

(iii) Higher electron density

(iv) None of the above

(d) In the chemical vapour deposition, the films are formed by decomposition of what kind of substances ?

(i) Liquid molecule

(ii) Gaseous molecule

(iii) Conducting polymers

(iv) Dielectric substance

(e) What does "critical thickness" mean in epitaxial films ?

(i) Minimum thickness of defect free layer.

(ii) Thickness of substrate needed for epitaxial growth of film on it.

(iii) Maximum thickness of defect-free layer.

(iv) Minimum thickness of films for smooth growth.

2. Answer the following questions : 2×5=10

(a) What is a quantum well and superlattice structure ?

(b) How does the band gap of a quantum dot vary with its size ?

(c) Explain the term *'super surface activity'* of the nano materials.

(d) Discuss the physical mechanism that occurs when energetic particle strikes on the surface of the material.

(e) Define thin film. Write the importance of thin film.

3. Answer any *five* of the following questions : 5×5=25

(a) Discuss the top-down and bottom-up approach with examples in nano material synthesis.

(b) What is quantum confinement ? Discuss the strong and weak confinement regime of nano materials. 2+3=5

(c) With schematic diagram discuss the atomic force microscopy characterization technique.

(d) Explain how to obtain continuous thin film from the initial nucleation stage.

(e) Explain the importance of vacuum in evaporation technique. Discuss the three different growth modes of thin film. 2+3=5

(f) Discuss the various properties of carbon nanotube.

4. Answer any *four* of the following questions : 10×4=40

(a) (i) Obtain the total energy expression of the two-dimensional nano structures and show that the energy level spacing increases with the increase of the quantum confinement.

(ii) Show that the density of states of two dimensional nano structure is independent of energy. 5+5=10

(b) What is lithography technique ? What are the different types of lithography ? Discuss the nano fabrication using photolithographic technique with suitable block diagram. Outline the advantages of lithographic techniques. 1+2+5+2=10

(c) (i) Explain how to deposit thin film by resistive thermal evaporation technique. Discuss the main drawback of this technique. 4+1=5

(ii) Discuss the Sol-gel technique for the preparation of nano material. Write its advantage and disadvantage. 3+2=5

(d) Discuss the various prenucleation processes with the help of schematic diagram. Explain the capillarity model of nucleation. 4+6=10

(e) Discuss the working principle of Molecular Beam Epitaxy (MBE). What is MBE used for ? What are the advantages of MBE ? 6+2+2=10