

- (c) Discuss the precipitation method for the synthesis of graphene nanomaterial using schematic diagram.

6 + 3 + 3 = 12

Group – E

8. (a) What are the major components of a photomask? Why is it important to use mask based lithography rather than direct printing?
- (b) With a schematic diagram, describe the process by which the mask pattern is transferred to the photoresist layer.

6 + 6 = 12

9. (a) What are conducting polymers? Describe any two methods for synthesizing two specific CP?
- (b) Homogeneous and heterogeneous nanocatalysts are available in certain forms. What are the two forms? Give details of two applications of homogeneous and heterogeneous nanocatalysts.

6 + 6 = 12

**NANOTECHNOLOGY
(CHEN 3231)**

Time Allotted : 3 hrs

Full Marks : 70

Figures out of the right margin indicate full marks.

*Candidates are required to answer Group A and
any 5 (five) from Group B to E, taking at least one from each group.*

Candidates are required to give answer in their own words as far as practicable.

**Group – A
(Multiple Choice Type Questions)**

1. Choose the correct alternative for the following: **10 × 1 = 10**
- (i) Nanosphere lithography
 (a) is a process by which a sphere is coated with a resist
 (b) uses nanospheres as masks
 (c) is a direct printing process using light
 (d) none of above.
- (ii) Atomic Force Microscope tips are generally made of
 (a) silicon (b) germanium
 (c) platinum (d) none of above.
- (iii) Langmuir-Blodgett process deposits monolayer films with the help of
 (a) gas phase precursors (b) metal oxides
 (c) amphiphilic molecules (d) chemical reaction.
- (iv) Electroluminescence is the process of
 (a) generation of electricity from light
 (b) generation of light by passing electric current
 (c) spontaneous flow due to radioactive nature of the material
 (d) flow under plasma discharge.
- (v) Epitaxial growth process is obtained when
 (a) a crystalline layer deposits on crystalline substrate
 (b) liquid layer deposits on crystalline substrate
 (c) amorphous layer on crystalline substrate
 (d) amorphous layer on amorphous substrate.
- (vi) A photoresist is a special type of polymer
 (a) that is sensitive to light
 (b) used to coat specimen sample in spectrophotometry
 (c) coated as a layer on to the photomask
 (d) solidifies in presence of air.

- (vii) Porous silicon is
- a different form of silicon
 - silicon dust obtained from mechanical grinding of polycrystalline silicon
 - formed on silicon substrate subjected to an etching process
 - formed through the sol-gel process.
- (viii) Silica gel is prepared through sol-gel process, the precursor being
- silicon dioxide
 - tetraethylorthosilicate
 - silicon nitride
 - none of above.
- (ix) The major advantage to this technique is that it provides a non-destructive method for identifying and quantifying trace elements; it is
- inductively coupled plasma emission spectrometry
 - x-ray diffraction
 - atomic absorption spectrophotometer
 - neutron activation analysis.
- (x) Stearic repulsion is observed by colloidal particles
- when macromolecules are attached to the particle
 - when the particles are suspended in an inorganic medium
 - due to breakage of hydrogen bonds
 - none of above.

Group - B

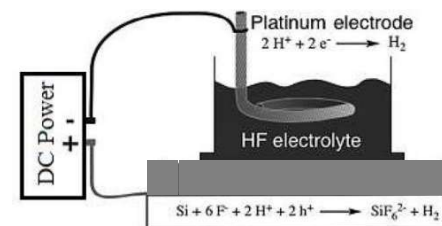
2. (a) Cite two material physical properties that change as its cluster dimension approaches atomic scale. What are Brillouin zones in a two-dimensional lattice?
- (b) Explain with appropriate graph the change in intermolecular potential energy as two particles are brought close to each other, the distance of separation between them being r .
3. (a) What is Bohr radius? Why do CdSe nanoparticles change color as the size of the particle is reduced from 6 nm to 2 nm.
- (b) What is a quantum well? Explain with a diagram the difference between a finite quantum well and an infinite quantum well.

6 + 6 = 12

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Group - C

4. (a) The figure below is a schematic of a setup used in generating P-Silicon. Draw the schematic and label in details all important features of this setup. Explain the usage of the labelled items.



- (b) Draw the II-Area curve for a typical L-B process identifying zones of compactness at different stages of the process.

6 + 6 = 12

5. (a) What are S layers? Give an example of a process where S-layers are used for growing ordered array of nanorods.
- (b) Explain the process of synthesis of carbon nano tubes with a diagram. State two important properties of carbon nano tubes.

6 + 6 = 12

Group - D

6. (a) Write the working principle of SEM and TEM analyses with schematic diagram. What is SAED?
- (b) What are the salient features attracted to the researcher for the use of graphene as an electrocatalyst support?
- (c) Describe the working principle of UV-Vis absorption spectroscopy.
7. (a) A cubic crystal was placed in an x-ray diffractometer using incoming x-rays with a wavelength $\lambda = 0.154$ nm. The various peak intensities recorded at different 2θ values are given in following table.

(4 + 1) + 3 + 4 = 12

2θ (deg)	40.3	58.3	73.2	154.2	131.2
$h k l$	110	200	211	400	321
Relative intensity	100	15	23	2	18

Determine the followings

- (i) Calculate the crystal size (Given, $k=0.9$; $\beta = 0.0098$)
- (ii) Calculate the value for the lattice constant (assuming first order diffraction with $n = 1$)
- (b) Describe the working principle of AFM with schematic diagram.