UNIT-1

INTRODUCTION

PART-A

1.What do you mean by nano?

The word "nano" means dwarf in greek language. If it is used as a prefix for any unit,it means a billionth of that unit.

Ex.A nano second is one billionth of a second.

2.What is Nano science ?

The study of objects and phenomenon at a very small scale ,roughly 1-100 nanometers(nm) is called nano scale science or nano science.

3.What is Nanotechnology?

Nanotechnology can be defined as the design, charecteristics, production& application of structure devide and system by controlling shape and size at a Nano meter scale

4.What presented classic lectures about nanotechnology and what was it ?

Richer Feynman, a physics nobel laureate presented the classic lectures entitled" There is plenty of room at the bottom"`

5.Define moore's Laws?

Moore's first law says that the amount of space required to install a transistor on a chip shrinks by roughly half every 18 months.

Moore's second law gloomily predicts that the cost of building a chip manufacturing plant doubles with every other chip generations or roughly every 36 months.

6.Define top down and bottom up approach.

Top down approach refers to slicing or successive cutting of a bulk material to get nano sized particles.

Bottom up approach refers to the building of a materials from the bottom; atom by atom, molecules or cluster by cluster.

7.What are the factors responsible for change of properties of nano scale material from that of the bulk materials?

1.Increased relative suface area.

2. Quantum confinement effect: electron can only exist at discrete energy levels. Quantum dots are nano materials

8.Write few chacteristics of nano scale materials.

Fibre that is stronger than spider web

Coating that are nearly frictionless –(Shipping Industry)

Materials thar colour chances and transparency on its demand.

9.What are the implications of nano science and technology for physics?

Nano scale materials mass is exteremely small and gravitational forces become negligible` Instead electromagnetic forces are dominant in determining the behavior of atoms and molecules.

10.What are the implications of nanoscience and technology for chemistry?

Nano scale particles exibits greater than vapour pressures, chemical potentials and solubility's relative to bulk materials .This is due to the high suface energy of such small particles.

11.What are nanoparticles.

Nanoparticles are particles between 1and 100 nanometers in size.

They exibit three-dimensional confinement. This structure does not permit free particles motion in any dimension.

12.What are the classificatios of nano materials.

0-D: All dimensions(x,y,z) are at nano metric scale.

1-D: Two dimensions (x,y) are at nano metric scale.

2-D: One dimension (x) is at nano metric scale.

3-D:All dimensions (x,y,z) are not at nano metric scale.

13.List the types of nanowires.

Metallic, semi-conductor, insulating, molecular.

14.What are ultra thin films?

System confined in one dimensions, or quasi 2D systems, include disc or platelets, ultra thin films on a surface and multilayered materials.

The films themselves could be amorphous , single crystalline or nano materials.

15.What are multilayered materials?

Multilayered materials are hetero structures composed of many alternating layers that are generally Stacked in a periodic.

16.What are quantum dots?

Quantum dots are extremely small semiconductor structures ,usually ranging from 2-10 nanometers (10-50 atoms) in diameters.

17.What are nanowires?

System confined in two dimensions, or quasi-1D include nanowires, nanorods , nanofilaments and nanotubes. These could either be amorphous, single-crystalline or poly crystalline. The term 'nano -ropes' is often employed to describe bundle of nanowires or nanotubes.

18.Define super lattices.

Multilayers composed of single-crystal layers that posses the same crystals structure and when the interfaces are in perfect atomic registry are called super lattices.

19.Mention some of the disadvantages of nano materials.

Instability of the particles.
Biologically harmful.
Recycling and disposal.

20.Define blue shift.

Blue shift phenomenon is a quantum size effect .It refers to a shortening of a transmitted signals wavelength and or an increases in frequency. The names coms from the fact that the shorter-wavelength end of the optical spectrum is the blue end , hence ,when visible light is compacted in wave length ,it is shifted towards blue or "blue shifted".

PART-B (16-Marks)

1.What are the implication of nano science and technology for biology?

2.Explain the properties synthesis method and application of quantum dots?

3.Explain the properties synthesis method and application of nanowires and nanoparticles?

4.Explain the properties synthesis method and application of multilayer materials ?

5.What are the effets of length scales of nano materials on magnetic, electronic properties?

6. What are the implication of nano science and technology for physics, chemistry?

7. What are the implication of nano science and technology for Engineering?

8. Explain the properties synthesis method and application of ultra thin films?

9. Explain the properties synthesis method and application of nanoparticles?

10.What are the effets of length scales of nano materials on mechanical ,optical and thermal properties?

UNIT-2
GENERAL METHODS OF PREPARATION
PART-A

1. State the principle of atomic layer Epitaxy?

Atomic layer epitaxy or atomic layer chemical vapor deposition are mote generally called atomic layer deposition(ALD),is a specialized form of epitaxy that typically deposit alternating mono layer of two elements on to a substrate. The crystal lattice structure achieved is thin, uniform, and aligned with the structure of the substrate.

2. What is mean by Bottom up synthesis?

The bottom up approach first forms the nanostructure of building blocks such as atoms and molecules and assembles them into larger nanostructure material. This is a powerful approach of creating identical structures with atomic precision.

Types: Liquid solid reactions, laser ablation

3. What is MOMBE?

Metal Oxide Molecular Beam Epi taxy is a technique for the growth of epitaxial thin film, which also forms hetro-epitaxial growth of the n-type semiconducting oxides Ga2o3,Sno2etc.it is called MOMBE.

4. State the advantages of precipitation method?

1) Simple process
2) Relatively low process cost
3) High purity
4) Uniform nanostructure at low temperature

5. List the four products of vapour phase deposition?

Monocrystalline, Polycrystalline, Amorphous, and Epitaxial.

6. What is the type of sputtering?

dc sputtering

radio frequency sputtering

magnetron sputtering

high pressure oxygen sputtering

facing target sputtering

7. what are the advantage of bottom up synthesis?

One can get monosized nano particles by my bottom up approach.

A better method to obtain nano structures with less defects more homogeneous chemical composition.

8. what are the advantage of MOCVD?

MOCVD metal organic chemical vapor deposition is the most common fro growing high-quality III-compound layer with nearly atomic abrupt interfaces & it has fast gas switching capabilities.

9. what is chemical precipitation?

Removal of metal ions from solution by changing the solution composition, thus causing the metal ions to form insoluble metal complexes.

10. Definition patterning ?

The fabrication of a nanoscale patter, especially as part of an electronic component.

11. Give the advantage of patterning process and limitations of patterning?

Advantages:

No need for complex optics or high-energy radiation sources.

No need for finely tailored photoresists designed for both resolution and sensitivity at a given wavelength hence low cost.

Sheers simplicity.

Multiple layers of topography stacked vertically.

Disadvantages:

Overlay, defects, templates patterning and template wear.

12. List out the types of photoresists?

Positive photoresist.

Negative photoresist.

13. Write about vapour phase deposition?

Vapour phase deposition is a process widely used in the semiconductor and biotechnology industries for the deposition of a thin film of various materials in order to achieve precise surface modification.

14. What is meant by top down synthesis?

The top down approach involves the breaking down of large pieces of bulk material to generate the required nano structured material from them

Type: High energy ball milling.

15. State the advantage of mechanical process?

1. MA is more widely used than ever and continues to be applied to the formation of nanoparticles and nanocrystalline structures in an ever- increasing variety of metals, ceramics, and polymers.
2. High production rates of nano powders.

16.List the process to produce Nano powders?
TOP DOWN PROCESS

1. Milling

2. Lithographics

3. Machining

17. Define synthesis?

Synthesis is a process of creating new material in artificial manner. In Nano science synthesis meas creation or formation of nanoparticle or nanopowder from bluck, atoms available in nature.

18. What is meant by mechanical milling process?

Mechanical alloying is a simple and useful processing technique that is now being employed in the production of Nano crystals and/or nanoparticles from all material classes. The powder materials are crushed mechanically in the rotating drum by the hard balls. This repeated deformation can cause large reductions in grain size to form nanoparticles.

19. Write short notes on colloidal routes?

The inorganic colloidal route is a special case of a precipitation process with nucleation and growth to amorphous or crystalline particles. If the concentration of the feed is low and the pH value of the solution is in a range that surface charges are generated, colloidal particles with diameters in the lower nanometer range are accessible. This has been shown for many systems in very diluted solutions.

20.Define bottom up process?

1. VAPOR PHASE DEPOSITION METHODS

a. Chemical vapor deposition

b. Physical vapor deposition

PART-B

1. Explain the bottom- up approach towards synthesis of nano structured material. Discuss in detail about any one method.
2. Explain the mechanical milling method with neat sketch and give the advantages , disadvantages.
3. Write a short notes on

i. Co-precipitation

ii. Ultra sonication

4. Explain the self-assembly process with suitable example.
5. What is mean by evaporation? Explain the types of evaporation.
6. Define vapor phase deposition and explain the types with suitable diagram.
7. What is MOCVD? State the working in detail.
8. Explain vapor condensation process for synthesis of nano powders with a neat sketch?
9. Explain detail about molecular beam epitaxy with neat diagram.
10. Elaborate the working of atomic layer epitaxy with neat sketch.

UNIT 3

NANO PARTICLES

PART A

1.What are quantum dots?

They are nanoscale semiconductor devices that tightly confine either electrons or electron holes in all three spatial dimensions. They can be made via several possible routes including colloidal synthesis, plasma synthesis or mechanical fabrication.

2. What are quantum wires?

Quantum wires, which confine electrons or holes in two spatial dimensions and allow free propagation in the third.

3. What are quantum wells?

Quantum wells, which confine electrons or holes in one spatial dimensions and allow free propagatiòn in the other two dimensions

4. What are the applications of quantum dots?

Computing, biology, photovoltaic devices, quantutn dot only solar cells quantum dot in hybrid solar cells, quantum dot with nanowire in solar cells

5.What are the applications of quantum wires?'

- Electronie devices
- Sensing using semiconductor nanowires

6.Describe the principle, construction and working of SEM and environmental SEM.

- A scanning electron microscope (SEM) is a type of electron microscope that produces images of a sample by scanning it with a focused beam of electrons
- The electrons interact with atoms in the sample, producing various signals that contain information about the sample's surface topography and composition.
- The environmental scanning electron microscope or ESEM is a scanning electron microscope (SEM) that allows for the option of collecting electron micrographs of specimens that äre "wet," uncoated, or both by allowing for a gaseous environment in the specimen chamber

7.Describe the principle, construction and working of TEM.

- Transmission electron microscopy (TEM) is a microscopy technique in which a beam of electrons is transmitted through an ultra-thin

specimen, interacting with the specimen as it passes through it.

- An image is formed from the interaction of the electrons transmitted through the specimen;
- The image is magnified and focused onto an imaging device, such as a fluorescent screen, on a layer of photographic film, or to be detected by a sensor such as a CCD camera.

8.Which mode of AFM is preferred to characterize delicate nano surfaces? Why?

- Tapping Mode AFM was developed as a method to achieve high resolution without inducing destructive frictional forces both in air and fluid.
- With the Tapping Mode technique, the very soft and fragile samples can be imaged successfully.
- Hence tapping mode of AFM is preferred to characterize delicate nano surfaces.

9.What is single electron transistor?

- The single electron transistor is type of switching device that uses controlled electron tunneling to amplify current.
- A SET is made from two tunnel junctions that share a common electrode.
- A tunnel junction consists of two pieces of metal separated by a very thin (1 nm) insulator

10.What is meant by nano-manipulation? Explain with one example using STM.

- Nano-manipulation is nothing but the manipulation of nanoscale objects using Nano technology
- Using an STM, individual atoms can be manipulated on surface Here the electron standing waves created inside the corral ate imaged by the STM tip.
- The probably demonstrates the highest resolution nano manipulation.

11.What do you mean by elastic and inelastic scattering?

Elastic scattering:

Elastic scattering is a fundamental scattering process in which the kinetic energy of a particle is conserved in the center-of-mass frame, but its direction of propagation is modified although the particle's kinetic energy in the center-of-mass frame is constant, its energy in the lab frame is not.

Inelastic scattering:

Inelastic scattering is a fundamental scattering process in which the kinetic energy of an incident particle is not conserved (in contrast to elastic scattering). In an inelastic scattering process, some of the energy of the incident particle is lost or increased

12. What is characterization in relation with materials?

Characterization refers to the broad and general process by which a material's structure and properties are probed and measured. It is a fundamental process in the field of materials science, without which no scientific understanding of engineering materials could be ascertained

13. What-is meant by surface analysis in nano characterization?

The surface analysis is defined as the set of techniques which allow us to identify the atomic structure and chemistry state and composition of a material, the elements or compounds that are located on the surface of the material, and the interactions that take place in the interfaces of materials. Eg.: SPM

14. List some material characterization techniques.

Transmission Electron Microscopy (TEM)
Scanning funneling Microscope
Atomic Force Microscopy (AFM)
Scanning Electron Microscopy (SEM)
X-Ray Diffraction (XRL)

15.What is TEM? Explain the principle behind it.

Transmission Electron Microscopy (TEM) is a microseopy technique whereby an electron source emits a stream of electrons. With the help of electromagnetic lances, the electron are focused into a very thin beam which are transmitted through
the specimen and inally projected on a tluorescent screen giving a"shadow image"

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PART B

1. Explain in detail about multi wall carbon tube?
2. Describe the preparation, properties and applications of zno in Nanoscience:
3. Describe the preparation, properties and applications of nio in Nanoscience:
4. Describe the preparation, properties and applications of cao in Nanoscience:
5. With neat diagrams, explain the preparation and properties of quantum wires?
6. Explain in detail about single wall carbon tube?
7. With neat diagrams, explain the preparation and properties of Quantum dots?
8. Briefly explain the sputtering and its types.
9. Write a short notes on evaporation.
10. Explain the vapour deposition method with its diagram?

UNIT-4
CHARACTERIZATION TECHNIQUES
PART A

1. Why is spatial resolution of STM better than AFM?

The electron current flowing between the surface and the tip is monitored in STM but the forces developed only is monitored in AFM. Hence physical and electron density maps of the surface can be generated with high spatial resolution in STM

2. Describe the basic principle, working of an STM?

A sharp tip is scanned over a conducting surface at a very small distance above the surface. The electron current flowing between the surface and the tip is monitored physical and electron density maps of the surface can be generated with high spatial resolution

3. Describe in brief some nano-technological applications of STM.

1. STM is particularly useful in nanoscalo chemistry labs, where the study of defects and physical structure of synthetic chemical compounds is of vital importance.
2. It is used to obtain images of conductive surfaces at an atomic scale 0.2 nm
3. It can also be used to alter the observed material by manipulating individual atoms
4. It can be used to study chargo transport mechanisms in molecules, surface domain formations defect sites in molecules and substrates

4. Deserибe the principle and working of AFNM.

Atomic force microscopy is similar to STM but applicable to non-conducting surfaces. In atomic force microscope a probe consisting of a Sharp tip located near the end of cantilever beam is raster scanned across the surface of the specimen using piezoelectric scanners

5. Describe the principle and working of SNOM.

Scanning near-field optical microscopy (SNOM) works on the principle that enables studying a sample's optical properties with resolution far beyond the diffraction limit. This is done by placing the detector very close to the specimen surface. Sample fluorescence, light emission, transmission, scattering etc., can be mapped with the spatial resolution down to tens of nanometers.

6. Describe the principle and working of ESCA.

Electron spectroscopy for chemical analysis works on the principle when X- ray photons of precisely defined energy bombard the surface, electrons are emitted from the orbitals of the component atoms enabling the measurement of electron kinetic energies and their binding energies to

determine the component atoms

7. Describe the principle and working of SIMS.

Secondary Ion Mass Spectroscopy (SIMS) works on the principle when beam of high energy (keV) primary ions bombards the surface, secondary atomic and cluster ions are emitted and analysed with a mass spectrometer

8. What is nanoindentation?

Nano indentation is a hardness test used to determine the hardness and elastic modulus of materials, including layers and coatings <100 nm thick. Hardness is the resistance to penetration of a hard intender.

6. What are the significants of nanoidentification?

- Nano indentation has developed machines that can record smal-Hoag and displacement with high accuracy and precision
- It has developed analytical models by which the load displacement data can be used to determine modulus, hardness and other mechanical Properties.

7. Describe the principle, construction and working of SEM and Environmental SEM.

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18. List some miterial charaeterization techniques.

- Tranismission Eleetron Mieroseopy (TEM)
- Beathning fiinieling Microseope
- Atvmic Fores Mierusetbpy (AFM)
- eanng Eleetron Mierostopy (SEM)
- V X-Ray Diffraction (XRL)

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20, what is SEMY Explain the principle behind it.

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- When a beam of electrons strikes the surface of the specimen and interacts with the atoms of the sample, signals in the form of secondary electrons, back scattered electrons and characteristic Xrays are generated.

PART B

1.Explain the scanning electron microscopy with neat diagram?

2.How do you characterize the material with transmission electron microscope?

3.Explain the working principle of TEM?

4.What are thypes of SEM?

5.explain the working condition of scanning tunnelling microscopy(stm)?

6.Explain the working principle of AFM?

7.Explain the types of AFM?

8.Write the short notes about SPM?

9.What are the types of SPM?

10.Explain the XRD with its diagram?

UNIT-5
APPLICATIONS
2 MARKS

1. What are nano computers?

It is the logical name for the computer smaller than the microcomputer, which is smaller than the minicomputer. The term nanbcomputer is ihcreasingly used to refer to general computing devices of size comparable to a credit card

2. What is Nauo-RAM?

It is a proprietary computer memory technology from the company Naîtero.It is a type of non-volatile random access memory based on the position of carbon nanotubes deposited on a chip-like substrate.

3.What is a molecular switch?

A molecular switch is a molecule that can be reversibly shiftcd between two or more stable states. The molecules may be shifted between the states in response to environmental stimuli, such as changes in pH, light, temperature, electric circuit, microenvironment or in the presence of ligand.

4. What are the types of molecular switch?

- Photochromic molecular switches
- Host-guest molecular switches
- Mechanically-interlocked molecular switches

5.What is a nanocrystal?

It is a material particle having atleast one dimension smaller than 100 nanometres and composed of atoms in either a single or polycrystalline arrangement

6. What are the applications of nanocrystals?

Nanocrystals made with zeolite are used to filter crude oil into diesel fuel at an Exxon Mobile Oil refinery in Louisiana at a cost less than conventional methods

7.What are nanosensors?

Nanosensors are any biological, chemical or surgical sensory points used to convey information about nanoparticles to the macroscopic world.Their use mainly include various medical purposes and as a gateways to building other nanoproducts

8. What is a nanoprobe?

A nanoprobe as existing in the real world in an optical device. It was

developed by tapering m oplical fiber to a tip measuring 100nmi - 1000 angstroms wide.

9. What are the applications of targeted drug delivery?

It can be used to treat many diseases, such as cardiovascular diseases, diabetes to treal cancer tumors, stem cell therapy,

10.What is bio imaging?

Medical imaging is a technique and process of creating visual representation of the interior of a body for clinical analysis and medical intervention as well as visual representation of the function of some organs or tissues.

11. What is microprinting?

It is the production of recognizable patterns or characters on a printed medium at a scale which requires magnification to be read.

12. What are nanocrystal solar cells?

It is solar cell based on a substrate with a coating of nanocrystals. The nanocrystals are typically based on silicon, CdTe or CIGS and the substrate are generally silicon or various organic conductors

13. What are nanobatteries?

They are fabricated batteries employing technology at the nanoscale, a scale of minuscule particles that measure less than 100 nanometers or 10' metres.

14. What are the applications of nanobatteries?

- Increasing the available power in the battery
- Drecreasing the time required to recharge.
- Reducing the possibilities of batteries catching fire by providing less flammable electrode material

15.What are MEMS?

It is the technology of very small devices; it merges at the naroscale into nanoelectromechanical systems and nano technology. MEMS are made up ocomponents between I to 100 micrometres in size.

16. What are NEMS?

Nanoelectromechanical systems are a class of devices integrating electrical and mechanical lunctionality on the nano scale. NEMS form the logical next miniaturization step frotn so-called MEMS

17. What is nano indentation?

Nanoindentation is a variety of indentation hardness iests applied to small volames, Indentation is the most commonly applied means os tpsting the mechanical properties of materials. This technique was developed to mcasure the hardness of small volumes of material

18. What are the factors affecting nano indentation?

Thermal drift, Initial penetration depth, Instrument compliance, Tip rounding Residual stress, Specimen preparation

19.What are the limitations of nano indentation?

- Piles up & Sink in
- Nano indentation on soft material
- Tip dependency

20.List soume umsteriad characteriration techaiques

- Transmission Electron Microseopy (TEM)
- Scanoing tueneling Misroscops
- Atomic Force Microscopy (AFMD)
- Saming lectron Micosopy(SE)
- X-Ray Diflfraction (XRD)

PART B

1.Discuss the role of nanostructures in the information storage with example.

2.What are nano sensors?

3.Describe the fabrication of MEMS with neat sketch.

4.Explain the Targeted drug delivery and its methods.

5.Describe the principle, construction and working of solar cell with neat sketch

6.Write short notes

1. Nano Sensors
2. Batteries.

7. Discuss the sensors application in biotechnology.

8.Explain the fabrication of NEMS

9.Explain the application of nano technology in printers

10.Explain photoshot with nano application?