



INDIAN INSTITUTE OF INFORMATION TECHNOLOGY UNA
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School of Electronics

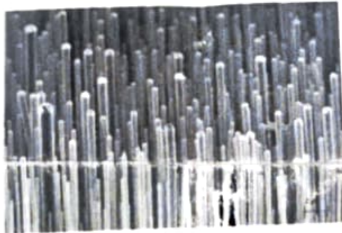
CURRICULUM: IIITUGECE22

Cycle Test – II

10, Oct. '23

Degree	B. Tech.	Branch	ECE
Semester	VII		
Subject Code & Name	ECPE61 / Nanoscience and Nanotechnology		
Time: 60 Minutes	Answer All Questions	Maximum: 20 Marks	

S. No.	Question	Marks
1.a	How many categories into nano materials can be classified? Based up on which parameter such classification is done?	1
1.b	Mention two significant differences between top-down and bottom-up technologies? Give one example of process technology belonging to both classes.	2
1.c	Write down two disadvantages of Gate-Last-Process, with reference to MOSFET fabrication process. For a Gate-Last-Process a 20 nm thick oxide (SiO_2) was grown on a p -type (100) silicon wafer by carrying out dry oxidation for 40 minute at a temperature of 1100 °C. The amount of positive charges trapped inside the grown oxide layer is found to be $6 \times 10^{-7} \text{ C/cm}^2$, extracted using C-V measurement of MOSFET. Calculate the shift in threshold voltage V_T of the fabricated MOSFET, as compared to V_T of a MOSFET without any trapped charges inside the gate oxide layer. Given dielectric constant for SiO_2 , $\epsilon_{\text{SiO}_2} = 3.9\epsilon_0$.	2
2.a	Why pulsed mode LASER is used to deposit a metal layer in PLD technique? What is the significant difference of this deposition technique as compared to Chemical Vapour Deposition (CVD) technology?	1
2.b	Describe the mechanism of an LPCVD process that leads reaction-rate-limited deposition rate, even at higher temperature. Justify using proper mathematical equation and deposition rate curve.	2
2.c	Write down two main advantages of a ball-milling technology. Mention whether ball-milling belongs to top-down technology or does it belong to bottom-up technology? What are the starting materials needed to manufacture superconducting nanomaterial YBCO using ball-milling technology?	2
3.a	What is difference between the working principle of a Scanning Tunnelling Microscope (STM) and Atomic Force Microscope (AFM) ?	1

3.b	Mention the major disadvantage of electro-deposition technique? A stainless steel plate of dimension $500\text{ }\mu\text{m} \times 500\text{ }\mu\text{m}$ is to be electroplated to enhance its corrosion resistive properties. The setup consists of nickel electrode as anode and the stainless steel plate to be electro plated, as cathode, in an electrolytic bath of NiSO_4 . If a dc current of 1 mA was passed through the solution for 30 minutes, calculate the thickness of nickel layer deposited on the stainless steel plate. Given, density of deposited nickel, $\rho_{\text{Ni}} = 6\text{ g/cm}^3$, atomic mass of Ni, $M_{\text{Ni}} = 59\text{ g/mol}$, Faraday's constant, $F = 96500\text{ C/mol}$.	2
3.c	Describe one way to reduce the Boundary layer problem usually encountered in a typical Chemical Vapour deposition (CVD) system. A CVD reactor of consisting of a quartz tube of length $L = 30\text{ cm}$ and diameter $d = 10\text{ cm}$, is used for silicon deposition. Silane gas is flowing inside the chamber with velocity of 0.5 L/min so that laminar flow is maintained with Reynold's number of $R_{\text{reactor}} = 1500$. Calculate the average length of boundary layer appearing throughout the reactor chamber.	2
4.a	Which material is used to generate ultrasonic shock waves incorporating mangetostriktion phenomena, for the production of gold nano-particles through sono-chemical technology ? Where are the reaction centres located in this process? Indicate the reaction centres by drawing suitable diagram.	1
4.b	Fig. 1 shows the Scanning Electron Microscope (SEM) image of an array of silicon nanowires. 	
	<p>Fig. 1: SEM image of silicon vertical nanowires.</p> <p>Identify the technique which is used for the growth of such nanowires? Which material is used as a catalyst in this process? Describe kinetics of the process by drawing a suitable phase diagram? What is the reactor temperature needed to be maintained mandatorily, for such growth of nanowires to take place?</p>	2
4.c	For a nano-particle, why surface is of much importance? Explain by drawing a suitable surface-to-volume versus size of nano-particle, diagram. For a cube shaped CdSe quantum dot, with side length of 5 nm , calculate the energy for quantum numbers $(n_x = 2, n_y = 1, n_z = 1)$, $(n_x = 1, n_y = 2, n_z = 1)$ and $(n_x = 1, n_y = 1, n_z = 2)$ in terms of E_0 , where $E_0 = h^2 / (8mL^2)$. What is the level of degeneracy for this energy level? Given effective atomic mass of electron in CdSe is $m_e^* = 0.13m_0$.	2

***** Best Wishes *****