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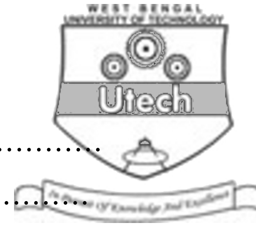


Name : ....

Roll No. : ....

Invigilator's Signature : ....

CS/M.Tech(ECE)VLSI/SEM-1/MVM-101/2009-10

2009

MICROELECTRONICS TECHNOLOGY

Time Allotted : 3 Hours *Full Marks* : 70

The figures in the margin indicate full marks.

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

Answer Question 1 and any *four* the rest.

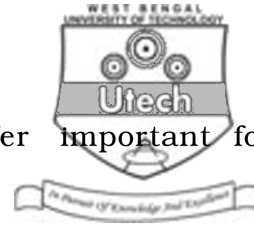
1. Answer all questions : $7 \times 2 = 14$

   a) Why Silicon Predominance in IC fabrication ?

   b) What is the difference betwen De-ionized and Distilled water ? What is the resistivity of De-ionized water ?

   c) You want to grow large diameter Silicon wafer. Which technique you should adopt and why ?

   d) You want to form the SiO_2 based age dielectrics for MOSFET device. What will be your technique and why ?



e) Why is cleaning of Silicon wafer important for microelectronics processing ?

f) *"To deposit the dielectric layers use DC sputtering system instead of RF sputtering system".* The statement is true or false ? Why ?

g) What is the Positive Photo-resist ?

2. You have a plan to design a CLEAN ROOM facility for fabricating of integrated circuits (VLSI technology). What kinds of clean room classification you should adopt and why ? What are the major process steps to obtain semiconductor grade silicon from metallurgical grade silicon ? Prior to do the microelectronic fabrication on silicon wafer RCA cleaning is necessary. What is the process of the RCA cleaning ? 1 + 3 + 5 + 5

Dia.

3. The impurity concentration in the electronic grade silicon is C_S , which can be expressed as the following equation :

$$C_S = k_o \; C_o \,(1 - X)^{k_o - 1}$$

Where X is the fraction of the melt solidified, C_o is the initial melt concentration, and k_o is the segregation coefficient.

a) Considering the above schematic and derive the above equation.

b) Using the above equation find the segregation coefficients value for Boron, Arsenic/Phosphorus and Antimony from the above curves.

You have a silicon wafer. What is the technique you will prefer to determine the carrier concentration and type of the wafer ? Explain. 6 + 4 + 4

4. You want to create a vacuum of 10^{-7} torr for a RF sputtering system to deposit insulating layers. Design the deposition system with proper pumping arrangement and the vacuum measuring (gauge) system.

What are the advantages of Turbo molecular pump over diffusion pump ?

What will be the time to achieve the vacuum of 1 μ Torr from 1 Torr pressure in a 2500 CC chamber using mechaical pump with pumping speed 100 CC/min. ? Derive the required expression. 6 + 3 + 2 + 3

5. What are the different film growth dynamics ? You want to deposit SiO_2 for LOCOS purpose. What deposition technique will you use and why ?

Mass deposition rate per unit area of source surface for a thermal evaporation system :

Dia.

Derive the uniformity condition for the system with the help of above expression and the figure :

$$\frac{W}{r_i^-} = \sqrt{2\sigma}$$

where σ is the degree of uniformity. 4 + 1

6. Define photolithography. You have a cleaned Silicon wafer. You want to make a pattern for metal-semiconductor Schottky contact. What will be the process flow using optical lithography ?

Dia.

Estimate the resolution and depth of focus (DOF) of a state-of-art eximer laser stepper using a KrF light source (λ = 248 nm) with a NA = 0·6. Assume K_1 = 0·75 and K_2 = 0·5. Do you think the state-of-art is suitable for SIA NTRS 0·25 μm generation ?

What are the different printing techniques used in photolithography ? Give the detailed schematic illustration for defect free mask at larger de-magnification technique.

2 + 5 + 3 + 1 + 3

7. Design a boron diffusion process (say for the well of a CMOS process) such that sheet resistance = 1000 Ω/square X_j = 5 μm, and N_{back} = 1×10^{17} cm^{-3} (substrate concentration) and x/x_j = 0·1. If the diffusion is done at 1100°C, then what will be the drive-in time ? The following Irvine curve will help you to extract the required parameter. Given : The boron diffusivity @ 1100°C is

$1 \cdot 5 \times 10^{-13}$ cm^2 sec^{-1} .

Dia.

What are the basic differences of dry and wet etching ?

Illustrate the Ion implantation process with proper schematic representation. 6 + 2 + 6

8. You want to measure 10^{-3} torr pressure using gauge system. What will be your preference ? Give the basic measurement set-up ?

   If you want to deposit dielectric materials (good quality as well as good step coverage) using physical vapour deposition system. Which technique should you follow and why ?

   What are the steps involved in a chemical vapour deposition process ? Discuss with a schematic representation.

   Why is Ion implantation the dominant method of doping for IC industry ? 1 + 3 + 1 + 3 + 4 + 2