BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE PILANI,
RAJASTHAN - 333031, INDIA
MEL G611: IC FABRICATION TECHNOLOGY
MID SEMESTER EXAM (**CLOSED BOOK**)
SEMESTER I: **2023-2024**, MARKS: **30**, TIME: **90 MINUTES**

Date: 13/10/2023

Instructions:

a. This question paper contains two parts.
b. Part A is short answer type and part B is long answer type.
c. All the questions are compulsory in both sections.

Part A **10×1.5**

1. What are the effects of halogen gases in the dry oxidation process? Explain in brief.
2. Why it's not possible to follow up with Moore's law anymore?
3. List down the VLSI processing steps in the correct sequence for Si based Schottky diode fabrication.
4. What is the basic difference between RCA1 and RCA2 process? List down the key chemicals used in both processes.
5. What do you understand by quantum confinement? Draw the density of states (DOS) for 0D, 1D, 2D, and 3D materials.
6. In a foundry, silicon wafers of 4" and 12" dia were grown by the CZ process using the same growth parameters. Out of these two wafers, which may be the best fit for the fabrication of advanced VLSI devices and why?
7. Two silicon wafers (one n-type and one n+-type) are subjected to dry oxidation under similar operating conditions. Draw a comparative oxide growth characteristics in linear and parabolic regimes for both the wafers on the same scale and explain it.
8. What may be the consequences if we carry out the CZ process in a vacuum instead of an inert ambient? Explain in brief.
9. What are the shallow and deep trap levels? Use the band structure of silicon as a reference to indicate energy levels of n/p type shallow and deep traps. Comment on the usefulness of deep traps
10. A compound semiconductor (with constituent atoms *A* and *B*) was grown by FZ process having Zinc blend structure where atom A is present at the corners and faces of the unit cell, however, atom B has occupied tetrahedral voids. If each atom's atomic radius and molar mass is provided ($r_A = 1.22$ Å$, r_B = 1.25$ Å$, M_A = 70u,\ M_B = 75u$) along with Avogadro's number (N_A)=6.023×10^{23}, then calculate the density of the grown semiconductor.

Part - B

1. An optimized dry oxidation process was used to grow gate oxide on a p-type (100) silicon substrate in 90 nm technology node. In this process, 2 μg of silicon is consumed. Calculate the thickness and mass of SiO_2 layer grown on the top of the Si wafer, provided that the surface area of the wafer is 1 cm^2. **(Density of silicon=2.33 g/cm^3, Density of silicon dioxide=2.27 g/cm^3, Atomic mass of silicon= 28)** **4**

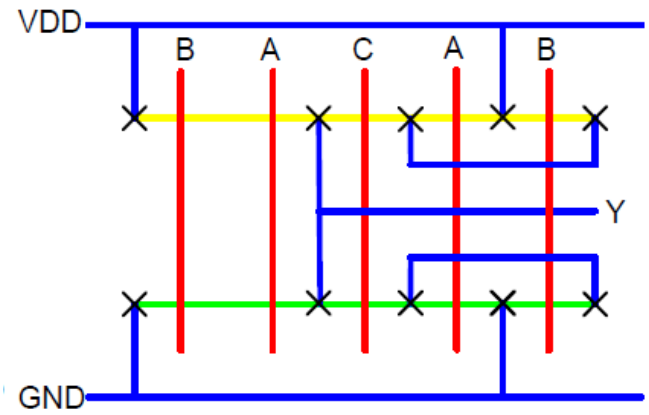
2. Assume that a wafer of a hypothetical compound semiconductor (with constituent atoms A and B) was grown by the CZ process. Further, XRD analysis revealed the crystallographic characteristics of the grown wafer. From the XRD data, it has been observed that it's lattice is cubic with a lattice constant of 4.50 Å and the crystal is side-centered. If, one of the face-centered atoms is present at the (100) plane. Consider the hard-sphere model of the unit cell and the diameter of both the constituent atoms are equal. Now answer the following questions. **6**

   (i) Out of (100), (110), and (111) planes which will oxidize fast if subjected to thermal oxidation.

   (ii) Out of (100), (110), and (111) planes which one is difficult to etch using a generic chemical etchant sensitive towards this semiconductor?

   (iii) Out of (100), (110), and (111) planes which one would be a preferred choice for MOSFET fabrication?

3. Sketch and label the crossectional diagram of the MOSFETs across the p-diffusion region. Use arbitrary scaling in your drawing to represent different regions of the MOSFETs. Also identify number of NMOS and PMOS in the circuit. **5**



************The End************