Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

FIRST SEMESTER M.TECH. (E & C) DEGREE END SEMESTER EXAMINATION
DECEMBER 2018/JANUARY 2019
SUBJECT: VLSI PROCESS TECHNOLOGY (ECE - 5124)

TIME: 3 HOURS **MAX. MARKS: 50**

Instructions to candidates

- Answer **ALL** questions.
- Missing data may be suitably assumed.

1A. A Si wafer has $10^{16}Cm^{-3}$ of boron is found to have a neutral vacancy concentration of $2x10^{10}Cm^{-3}$ at some processing temperature and a singly ionized vacancy concentration of $10^{9}Cm^{-3}$ at the same temperature. Determine the temperature and activation energy of charged vacancy with respect to intrinsic level.

1B. A melt contains 0.1 atomic percent P in Si. Assume well mixed approximation and calculate dopant concentration when 10% of crystal is pulled, when 50% of the crystal is pulled and 90% of the crystal is pulled. Comment on the result graphically. Given that k= 0.35 for P.

1C. A mixture of 30% Si and 70% Ge is heated to 1100 ^{o} C. If the melt is in thermal equilibrium, what is the concentration of Si in the melt? At what temperature will entire charge will melt? The sample temperature is raised to 1300 ^{o} C, then slowly cooled back down to 1100 ^{o} C. What is the concentration of Si in the melt?

(4+3+3)

2A. In delta doping methodology, a monolayer of p-type dopant material (Beryllium) is directly deposited between the gate electrode and GaAs with a surface coverage of $1.5x10^{15}$ Cm^{-2}. After gate patterning, the device is annealed at 800 ^{0}C for 10 minutes to activate the impurity. Assuming that there is no out diffusion, calculate the junction depth if the channel is doped $1x10^{17}Cm^{-3}$. Also calculate the surface concentration of Be under these conditions. Diffusivity of Be at 800 ^{o} C is $1x10^{-15}$ $Cm^{2}Sec^{-1}$.

2B. Design a constant dose diffusion of Antimony into p-type Si ($5x10^{16}Cm^{-3}$) that give a surface concentration of $5x10^{18}Cm^{-3}$ and junction depth of 1µm.

2C. How CV technique be utilized to find substrate doping concentration in Schottky contact? What are its limitations?

(4+3+3)

3A. A 250Å gate oxide is found to have 15mV temperature bias stress shift. Calculate the number of mobile ions per unit area in the oxide. Discuss various defects & impurities in SiO_2 which can alter the behavior of SiO_2/Si interface. Relative permittivity of silicon dioxide is 3.7.

3B. A 1000Å gate oxide is required for a technology. The oxidation is carried out at 1000^{o}C in dry oxygen. If there is no initial oxide thickness, how long should oxidation be performed.

Comment on the result. Given that B/A=0.899μm/hour and B=0.048 μm 2/hour. Consider the process is carried out in wet oxidation conditions what can be the time of oxidation. Given that B/A=15.86 μm/hour and B=0.829 μm ^{2}/hour.

(5+5)

4A. Discuss how the plasma etching and plasma deposition systems differ in an asymmetric RF electrode systems.

4B. What is meant by wasted electrons in a sputtering technique? Discuss various high density plasma techniques.

4C. Discuss the gas flow dynamics and determine the position of susceptor in the CVD system to fabricate the poly Si on Si substrate.

(3+4+3)

5A. Describe various wafer cleaning methodologies for epitaxial growth.

5B. What are source gases for Si epitaxy for IC fabrication? Justify

5C. Discuss the hetero-epitaxial processes

(3+4+3)

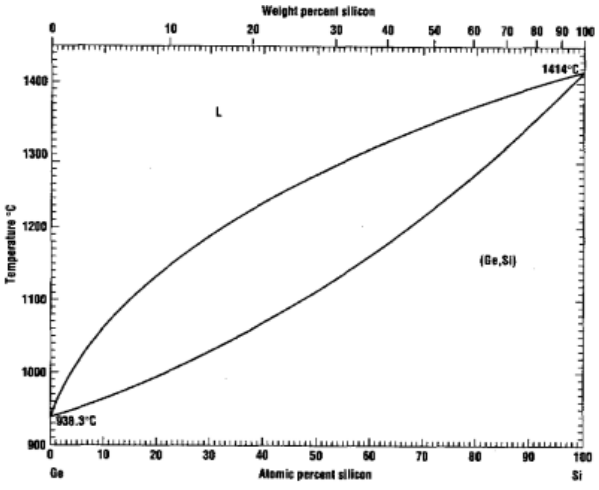

Figure 2.1 Phase diagram of Ge–Si. The dashed lines correspond to a heating process that remains in thermodynamic equilibrium *(courtesy of ASM International).*