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Mid-Semester Question Paper – IC Fabrication Technology (MEL G 611)

Date: 01-11-2022 **Time: 11:00 hours to 12:30 hours**
Open Book **Full-Marks: 20**

Use the Tables (wherever values are not given in the question) given below suitably for solving the problems

1.
   a) A 110-keV Phosphorous implant is introduced on a 200 mm Silicon wafer at an ion dose of 6.5×10^{14} ions/cm^2. Calculate the peak concentration and the ion beam current for 30 seconds of implantation.

   1+1= 2-marks

   b) Assuming R = 3000Å, find out R_P, σ_P and σ_L if Arsenic is bombarded on Silicon wafer at 100 keV for 1 minute at an ion dose of 5×10^{14} ions/cm^2. Assume lateral straggle is within 20% of projected straggle and the collision is head-on and elastic.

   1+1+1= 3-marks

2. For a Boron diffusion in Silicon at 1000^0C, surface concentration is kept constant at 10^{19} cm^{-3}. The diffusion-time is 50 minutes. Find Q(t) and the gradient at x=0 and at a location where the dopant concentration reaches 10^{15} cm^{-3}. Given $Erfc^{-1}(0.0001)=2.75$.

   2+2 = 4-marks

3. From the solution of the governing equation defining the depth of oxidation d_0 in terms time, with rate constants A, B and τ (time coordinate shift to account for initial oxide thickness) derive

   a) $d_0{}^2 \cong Bt$, for long oxidation time, i.e., t>>τ and t>>$\frac{A^2}{4B}$

   and

   b) $d_0 \cong \frac{B}{A}(t+\tau)$, for short oxidation time, i.e., (t+τ)<<$\frac{A^2}{4B}$

   c) For wet oxidation at 1000^0C, calculate d_0 for t=0.01 hour and 100 hour using approximate equation and compute the error (in %) in results obtained from the governing equation.

   1+1+6×1= 8-marks

4. Define (a) grain boundary, (b) Frenkel defect and (c) intrinsic stacking fault with representative sketches.

   1+1+1= 3-marks

TABLE

Impurity in Si	**Al**	**B**	**O**	**P**	**As**
k_0	**0.002**	**0.8**	**0.25**	**0.35**	**0.3**

TABLE (Oxidation in Steam)

Oxidation Temp. (in ⁰C)	**A(μm)**	**B(μm²/h)**	**B/A(μm/h)**	**τ (h)**
1200	**0.05**	**0.72**	**14.4**	**0**
1100	**0.11**	**0.51**	**4.64**	**0**
1000	**0.226**	**0.287**	**1.27**	**0**
920	**0.5**	**0.203**	**0.40**	**0**

Partial Pressure of Gallium and Arsenic over Gallium Arsenide as a Function of Temperature (T)

	800^0C	900^0C	1000^0C
As_2(As-rich)	7×10^3	1.1×10^4	5.0×10^4
Ga (As-rich)	1.0×10^{-5}	7.0×10^{-4}	4.0×10^{-2}
As_2 (Ga-rich)	2×10^{-2}	1.1	6×10^1
Ga (Ga-rich)	6×10^{-3}	5.5×10^{-2}	6×10^{-1}

Constants

$E_a(Si)$	k	q (Coul)	μ_n (cm²/V-s)	μ_p (cm²/V-s)	ε_r of Ta_2O_5
2.48 *kCal/ mol*	1.38×10^{-23} J/K ($=8.617\times10^{-5}$ ev/K)	1.6×10^{-19}	1000	450	8.85×10^{-14}

$\xi_o = 8.85\times10^{-14}$(F/cm)

Molecular Weight/ Atomic Mass

Element	Si	B	P	Ga	As_2	GaAs
Molecular Weight	28.09	10.8	30.97	69.72	149.84	144.63
Atomic Mass	28.09	10.8	30.97	69.72	74.9216	-