Lecture 2

Oxide growth

100 nm thick layer 10^{-7} m

wet Oxygen 1000 °C 1273 K

<100>

$C_1 = 2{,}14 \cdot 10^2$ µm/hr

$C_2 = \frac{8{,}95}{1{,}68} \rightarrow 5{,}327 \cdot 10^7$ µm/hr

$E_1 = 0{,}71$ eV $E_2 = 2{,}05$ eV

$B = C_1 e^{-E_1/kT} = 0{,}3308$ µm/hr

$k = 8{,}617339 \cdot 10^{-5}$ eV/K

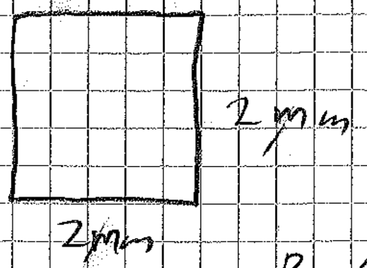
$\frac{B}{A} = C_2 e^{-E_2/kT} = 0{,}4080$ µm/hr

$x_i = 100$ nm $= 0{,}1$ µm

$\tau = \frac{x_i^2}{B} + \frac{x_i}{B/A} = 0{,}275$ hr $= 16{,}52$ min

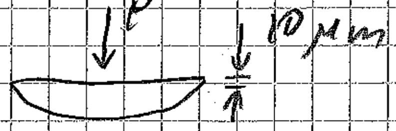
$= 16$ min 31 s

1 Lecture 4 Square membrane



$$D = \frac{Et^3}{12(1-\nu^2)} = \frac{190\cdot 10^9 \cdot (10\cdot 10^{-6})^3}{12\,(1-0{,}28^2)}$$
$$= 1{,}718\cdot 10^{-5}$$

$P = 1\,kPa$ max deflection



$$W_m = 0{,}001265\,\frac{P\cdot a^4}{D}$$

$$\underline{W_m} = 0{,}001265\,\frac{1000\cdot(2\cdot 10^{-3})^4}{1{,}718\cdot 10^{-5}}$$
$$= \underline{1{,}18\ \mu m}$$

Longitudinal stress max

$$\underline{\sigma_l} = 0{,}3081\,\frac{Pa^2}{t^2} = 0{,}3081\,\frac{1000\cdot(2\cdot 10^{-3})^2}{(10\cdot 10^{-6})^2}$$
$$= \underline{12{,}3\ MPa}$$

$$\sigma_t = 0{,}28\,\sigma_l$$

Lecture 5 ex 1

$N_D = 4 \cdot 10^{+14}\ cm^{-3}$

$N_A = 4{,}001 \cdot 10^{+14}\ cm^{-3}$

$p \approx N_A - N_D = 1 \cdot 10^{+11}\ cm^{-3}$

$n \approx 0$

$$\underline{R_H} = \frac{r_p}{qp} = \frac{0{,}7}{1{,}602 \cdot 10^{-19} \cdot 10^{11}} = \underline{4{,}4 \cdot 10^{7}\ cm^3/C}$$

ex2 $I = 10\ mA$ $B = 1 \cdot 10^{-2}\ T$

$t = 10\ \mu m$ $N_D \approx 10^{15} - 10^{16}\ cm^{-3}$

$nt_{min} = 1 \cdot 10^{12}\ cm^{-2} = 10^{16}\ m^{-2}$

$nt_{max} = 1 \cdot 10^{13}\ cm^{-2} = 10^{17}\ m^{-2}$

a)

eq 16 $R_H / t = -r_n / qnt$

$r_n = 1{,}15$ $q = -1{,}602 \cdot 10^{-19}$

$\underline{R_H} = 7180\ cm^3/C$ (assume weakest constant)

b)

eq 16 $V_H / IB = -r_n / qnt$

$$V_H = \frac{-r_n I B}{q n t}$$

$$V_{Hmax} = \frac{-1{,}15 \cdot 10 \cdot 10^{-3} \cdot 10^{-2}}{-1{,}602 \cdot 10^{-19} \cdot 10^{16}} = \underline{72\ mV}$$

$V_{Hmin} = \underline{7{,}2\ mV}$

Lecture 7 Floating membrane

a) Thermal resistance for one beam.

Beam: $R_{th} = \frac{L}{W} \cdot \frac{1}{kD} = \frac{2 \cdot 10^{-3}}{200 \cdot 10^{-6}} \cdot \frac{1}{150 \cdot 5 \cdot 10^{-6}}$

$= 1{,}33 \cdot 10^{4}$ K/W

Gas $R_{th} = \frac{L}{kA} = \frac{0{,}5 \cdot 10^{-3}}{18 \cdot 10^{-3} \cdot 2 \cdot 10^{-6}} = 1{,}39 \cdot 10^{4}$ K/W

Gas two ways $R_{th} = \frac{1{,}39 \cdot 10^{4}}{2} = 6{,}94 \cdot 10^{3}$ K/W

b)

Membrane capacity

$C = c_p V = 1{,}6 \cdot 10^{6} \cdot 5 \cdot 10^{-6} \cdot 2 \cdot 10^{-6} =$

$C = 1{,}6 \cdot 10^{-5}$ J/K

Time constant for membrane

$\tau_{beam} = C \cdot R_{th}^{beam} = 1{,}6 \cdot 10^{-5} \cdot 1{,}33 \cdot 10^{4}$

$= 0{,}21$ s

Time constant for membrane

$\tau_{gas} = C \cdot R_{th}^{gas} = 1{,}6 \cdot 10^{-5} \cdot 6{,}94 \cdot 10^{3} =$

$= 0{,}11$ s