

Problem Set 13 Solution Sp'09Problem 15.1

$$\gamma_{\text{sput}} = 0.54 \text{ from Table 9.2}$$

$$n_s (\text{Ar}^+) = 10^{16} \text{ cm}^{-3}$$

$$\text{Guess/choose a } \Gamma_e = 3 \text{ V}$$

$$u_B = 2.7 \times 10^8 \text{ cm/s}$$

$$\text{Hence } \Gamma_+ = 2.7 \times 10^{16} \text{ cm}^{-2} \text{ s}^{-1}$$

$$n_{\text{Si}} = 5.0 \times 10^{22} \text{ cm}^{-3} \text{ (density of solid Si, p. 587)}$$

$$E_{\text{Si}} (\text{\AA}/\text{min}) = \frac{\gamma_{\text{sput}} \Gamma_+}{n_{\text{Si}}} \times 60 \times 10^8$$

(see p. 587)

$$E_{\text{Si}} = 1750 \text{ \AA}/\text{min}$$

(2)

Problem 15.3 (a)

$$\frac{d\theta_0}{dt} = K_{a1}(1-\theta_1-\theta_2)n_1 - K_{d1}\theta_1 = 0 \quad (1)$$

$$\begin{aligned} \frac{d\theta_F}{dt} &= K_{a2}(1-\theta_1-\theta_2)n_2 + \chi K_{a1}(1-\theta_1-\theta_2)n_1 - 4K_{d2}\theta_2 - 4K_{d1}\theta_1 = 0 \quad (2) \end{aligned}$$

(b) From (1),  $1-\theta_1-\theta_2 = \frac{K_{d1}\theta_1}{n_1 K_{a1}}$  and  $\theta_2 = 1-\theta_1 - \frac{K_{d1}\theta_1}{n_1 K_{a1}}$

Substituting these into (2), we obtain

$$\theta_1 = \frac{4 \frac{K_{d2}}{K_{d1}} n_1}{\frac{K_{a2}}{K_{a1}} n_2 + (\chi-4)n_1 + 4 \frac{K_{d2}}{K_{d1}} n_1 + 4 \frac{K_{d2}}{K_{a1}}}$$

Using this in (1), we solve for  $\theta_2$

$$\theta_2 = \frac{\frac{K_{a2}}{K_{a1}} n_2 + (\chi-4)n_1}{\frac{K_{a2}}{K_{a1}} n_2 + (\chi-4)n_1 + 4 \frac{K_{d2}}{K_{d1}} n_1 + 4 \frac{K_{d2}}{K_{a1}}}$$

(c)  $\bar{E}_{si}/n_2 = n_0' K_{d2} \theta_2 / (n_2 n_{si} F_2)$ . Using  $\theta_2$  above and plugging in the numbers given, with  $n_1, n_2 \ll K_{d2}/K_{a1}$  we find

$$\begin{aligned} \frac{\bar{E}_{si}}{n_2} &= 1.4 \times 10^{-22} \left(1 - \frac{n_1}{n_2}\right) \frac{\text{cm}}{\text{s}} - \text{cm}^3 \\ &= 8.4 \times 10^{-13} \left(1 - \frac{n_1}{n_2}\right) \frac{\text{\AA}}{\text{min}} - \text{cm}^3 \end{aligned}$$

