

- 10.4** Determine the metal–semiconductor work function difference  $\phi_{ms}$  in a MOS structure with p-type silicon for the case when the gate is (a) aluminum, (b)  $n^-$  polysilicon, and (c)  $p^+$  polysilicon. Let  $N_a = 6 \times 10^{15} \text{ cm}^{-3}$ .

From Table B.4,  $n_i = 1.5 \times 10^{10} \text{ cm}^{-3}$  &  $E_g = 1.12 \text{ eV}$   
for silicon @ 300 K.

$$V_t = \frac{k_B T}{e} = \frac{8.617333 \times 10^{-5} \text{ eV/K} (300 \text{ K})}{e} = 0.025852 \text{ V}$$

$$\text{Per (10.4), } \phi_{sp} = V_t \ln\left(\frac{N_a}{n_i}\right) = 0.025852 \ln\left(\frac{6 \times 10^{15}}{1.5 \times 10^{10}}\right) \\ = 0.33347063 \text{ V}$$

a) aluminum From Ex. 10.2,  $\chi' = 3.25 \text{ V} + \phi_m' = 3.20 \text{ V}$

$$\text{Per (10.15), } \phi_{ms} = \left[ \phi_m' - \left( \chi' + \frac{E_g}{2e} + \phi_{sp} \right) \right] \\ = 3.2 - \left( 3.25 + \frac{1.12 \text{ eV}}{2e} + 0.33347 \right) \\ \underline{\underline{\phi_{ms} = -0.9435 \text{ V}}}$$

b)  $n^+$  polysilicon

$$\text{Per (10.16), } \phi_{ms} = -\left( \frac{E_g}{2e} + \phi_{sp} \right) = -\left( \frac{1.12}{2} + 0.33347 \right) \\ \underline{\underline{\phi_{ms} = -0.89347 \text{ V}}}$$

c)  $p^+$  polysilicon

$$\text{Per (10.17), } \phi_{ms} = \frac{E_g}{2e} - \phi_{sp} = \frac{1.12}{2} - 0.33347 \\ \underline{\underline{\phi_{ms} = 0.22653 \text{ V}}}$$