Semiconductor Devices

18.D7 (a) In this portion of the problem we are asked to determine the time required to grow a layer of SiO_2 that is 100 nm (i.e., 0.100 μm) thick on the surface of a silicon chip at 1000°C, in an atmosphere of O_2 (oxygen pressure = 1 atm). Thus, using Equation 18.37, it is necessary to solve for the time *t*. However, before this is possible, we must calculate the value of *B* from Equation 18.38a as follows:

$$B = 800 \exp\left(-\frac{1.24 \text{ eV}}{kT}\right) = (800) \exp\left[-\frac{1.24 \text{ eV}}{(8.62 \times 10^{-5} \text{ eV/atom-K})(1000 + 273 \text{ K})}\right]$$

$$= 0.00990 \ \mu\text{m}^2/\text{h}$$

Now, solving for *t* from Equation 18.37 using the above value for *B* and that $x = 0.100$ μm, we have

$$t = \frac{x^2}{B} = \frac{(0.100 \ \mu\text{m})^2}{0.00990 \ \mu\text{m}^2/\text{h}}$$

$$= 1.01 \text{ h}$$

Repeating the computation for *B* at 700°C:

$$B = (800) \exp\left[-\frac{1.24 \text{ eV}}{(8.62 \times 10^{-5} \text{ eV/atom-K})(700 + 273 \text{ K})}\right]$$

$$= 3.04 \times 10^{-4} \ \mu\text{m}^2/\text{h}$$

And solving for the oxidation time as above

$$t = \frac{(0.100 \ \mu\text{m})^2}{3.04 \times 10^{-4} \ \mu\text{m}^2/\text{h}} = 32.9 \text{ h}$$

(b) This part of the problem asks for us to compute the heating times to form an oxide layer 100 nm thick at the same two temperatures (1000°C and 700°C) when the atmosphere is water vapor (1 atm pressure). At 1000°C, the value of *B* is determined using Equation 18.38b, as follows: