STUDIO 10

8. How long would you need to run the process to reach the desired semiconductor properties, and how much As has been loaded into the silicon at that time?

t when $C_A(0.5\times10^{-4}\ cm,\ t) = 2.065\times10^{20}$ atoms/cm^3.

$$\frac{C_{As} - C_A(z,t)}{C_{As} - C_{A0}} = \frac{(2.3\times10^{21}) - (2.065\times10^{20})}{(2.3\times10^{21}) - (2.3\times10^{17})} = 0.9103$$

$$\mathrm{erf}\left(\frac{z}{2\sqrt{D_{AB}\cdot t}}\right) = 0.9103$$

$$\frac{z}{2\sqrt{D_{AB}t}} = 1.2$$

$$t = \left(\frac{z}{(1.2)(2)\sqrt{D_{AB}}}\right)^2 = \left(\frac{0.5\times10^{-4}\ cm}{(1.2)(2)\sqrt{5.0\times10^{-3}\ cm^2/s}}\right)^2 = 868\ sec$$

$$= 14.5\ min.$$

total amount delivered/loaded [Flux integrated over time]

$$N_A\Big|_{z=0} = -D_{AB}\frac{dC_A}{dz}\Big|_{z=0}$$

$$= -D_{AB}\left(-\frac{C_{As}-C_{A0}}{2\sqrt{D_{AB}\cdot t}}\frac{2}{\sqrt{\pi}}\underbrace{e^{-\left(\frac{z}{2\sqrt{D_{AB}\cdot t}}\right)^2}}_{=1}\right)\Bigg|_{z=0}$$

$$N_A\Big|_{z=0} = (C_{As}-C_{A0})\sqrt{\frac{D_{AB}}{\pi t}}$$

$$W_A = S\cdot\int_0^t N_A\Big|_{z=0}dt = \pi r^2(C_{As}-C_{A0})\sqrt{\frac{D_{AB}}{\pi}}\,(2\sqrt{t})$$

$$W_A = 4.25\times10^{18}\ \text{atoms As}.$$

B. Time required to get $C_A(1.0\times10^{-4}, t) = 2.065\times10^{20}$ atom As/ cm^3

$$\frac{C_{As} - C_A(z,t)}{C_{As} - C_{Ao}} = 0.9103 \qquad \left(\frac{z}{2\sqrt{D_{AB}\cdot t}}\right) = 1.2.$$

for $z = 1.0\times10^{-4}$

$$t_{1\mu m} = (2)^2 t_{5\mu m} = 3472\text{ sec} = \underline{\underline{58\text{ min}}}.$$

Concentration at 5μm at 58 min

$$\text{erf}\left[\frac{0.5\times10^{-4}}{2\sqrt{(5.0\times10^{-13})(3472)}}\right] = \text{erf}(0.6) = 0.603.$$

$$\frac{C_{As} - C_A}{C_{As} - C_{Ao}} = 0.603. \qquad C_A = -(0.603)(C_{As} - C_{Ao}) + C_{As}.$$

$$\underline{C_A = 9.13\times10^{20}\text{ atoms As}/cm^3.}$$

$$\left(\frac{z}{2\sqrt{D_{AB}}\sqrt{t}}\right) = 1.2 \qquad z = \underbrace{(2)(1.2)\sqrt{D_{AB}}}_{\text{Slope.}}(\sqrt{t})$$

Straight line

c. Flux of As at 5min and 10min.

$$N_A(0, 5\text{min}) = (C_{As} - C_{Ao})\sqrt{\frac{D_{AB}}{\pi\cdot t}}$$

$$= 5.30\times10^{13}\ cm^2/s.$$

$$N_A(0, 10\text{min}) = 3.75\times10^{13}\ cm^2/s.$$