CVD Reactor $\delta_w := 1\cdot mm$ $gap := 20\cdot mm$ $nm := 10^{-9}\cdot m$ $mtorr := 10^{-3}\cdot torr$

$D_{reactor} := 150\cdot mm$ $D_{wafer} := 0.125\cdot m$ $n_{wafer} := 100$

$$L_{reactor} := 2\cdot 2\cdot cm + n_{wafer}\cdot\left(gap + \delta_w\right)$$

SiH2Cl2(g) + 2 N2O(g)<--> SiO2(s)+ 2 N2(g)+2 HCl(g)

$L_{reactor} = 2.14\,m$

$\rho_{SiO2} := 2.67\cdot\frac{gm}{cm^3}$ $Mw_{SiO2} := 60.06\cdot\frac{gm}{mole}$ $a := 1$ $c := 2$ $b := 2$ $d := 2$

A = SiH2Cl2

$F_{Ao} := 0.0368\cdot\frac{mole}{min}$

$T := 900\cdot K + 273.15\cdot K$ $P_{SiH2Cl2} := 157\cdot mtorr$ $P_{N2O} := 447\cdot mtorr$ $P_{tot} := 604\cdot mtorr$

$$\Theta := \frac{P_{N2O}}{P_{SiH2Cl2}}$$

$$\varepsilon := \left(\frac{d}{a} + \frac{c}{a} - \frac{b}{a} - 1\right)\frac{P_{SiH2Cl2}}{P_{tot}}$$

$\varepsilon = 0.26$

At 900C the reaction rate is given by

$$r'_A(X) := 3.16\cdot 10^{-8}\cdot\frac{mole}{m^2\cdot s}\cdot\frac{P_{SiH2Cl2}}{mtorr}\cdot\frac{(1-X)}{(1-\varepsilon\cdot X)}\cdot\left(\frac{P_{N2O}}{mtorr}\right)^{0.65}\cdot\frac{(\Theta - 2\cdot X)}{(1-\varepsilon\cdot X)}$$

$$A_{wafer} := 2\cdot\left(\frac{\pi}{4}\cdot D_{wafer}^{\ 2}\right)$$

$$V_{reactor} := \frac{\pi}{4}\cdot D_{reactor}^{\ 2}\cdot L_{reactor}$$

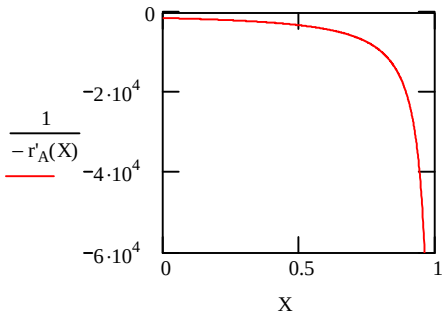
$$a := \frac{n_{wafer}\cdot A_{wafer}}{V_{reactor}}$$

$a = 64.901\,\frac{1}{m}$

$$V_{ReactorPerWafer} := \frac{V_{reactor}}{n_{wafer}}$$

$\frac{V_{reactor}}{n_{wafer}} = 3.782\times 10^{-4}\,m^3$

$$\frac{V_{reactor}\cdot a}{F_{Ao}} = \int_0^X \frac{1}{-r'_A(X)}\,dX$$

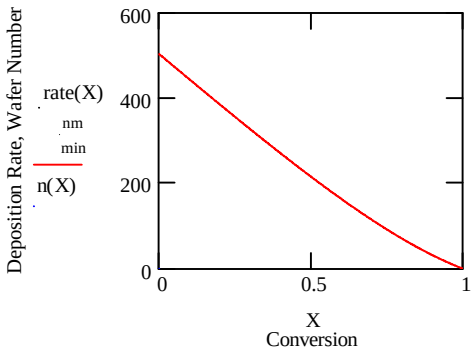


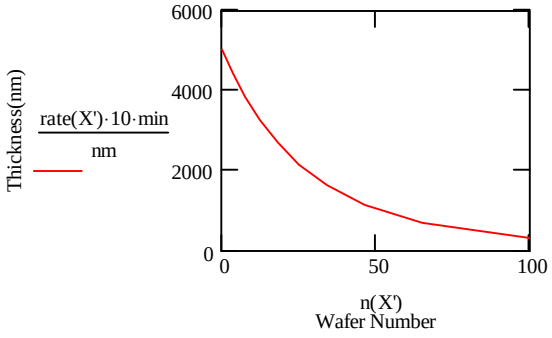
$X' := 0, 0.1 .. 1$

$$\frac{n_{wafer}\cdot V_{ReactorPerWafer}\cdot a}{F_{Ao}} = \int_0^X \frac{1}{-r'_A(X)}\,dX$$

$$n(X) := \frac{F_{Ao}}{\left(V_{ReactorPerWafer}\cdot a\right)}\cdot \int_0^X \frac{1}{r'_A(X)}\,dX$$

$$rate(X) := \frac{r'_A(X)\cdot \frac{\pi}{4}\cdot D_{wafer}^{\,2}}{\frac{\rho_{SiO2}}{Mw_{SiO2}}\cdot A_{wafer}}$$





Effect down the stack of wafers

Effect across the radius of a wafer

$d_A := 0.3 \cdot nm$ $Mw_A := 100.8 \cdot \frac{gm}{mole}$ $\lambda := \frac{r}{R_w}$ $\phi_p := 1 - \frac{\delta_w}{gap}$ $\phi_p = 0.95$

$X_o := \frac{P_{N2O}}{P_{tot}}$ $C_{As} := \frac{P_{SiH2Cl2}}{R_g \cdot T}$

Pseudo First Order Rate Constant

$k_1 := 3.16 \cdot 10^{-8} \cdot \frac{mole}{m^2 \cdot s \cdot mtorr} \cdot \left(\frac{P_{N2O}}{mtorr}\right)^{0.65} \cdot \frac{(\Theta - 2 \cdot X_o)}{(1 - \varepsilon \cdot X_o)} \frac{1}{C_{As}}$ $k_1 \cdot P_{SiH2Cl2} = 0.206 \frac{m}{s}$

$D_{AB}(T) := \frac{2}{3} \cdot \left(\frac{R_g \cdot T}{\pi \cdot N_{Av}}\right)^{\frac{3}{2}} \cdot \frac{\sqrt{N_{Av}}}{P_{tot} \cdot \sqrt{Mw_A} \cdot d_A^{\,2}}$ $D_{AB}(T) = 0.083 \frac{m^2}{s}$

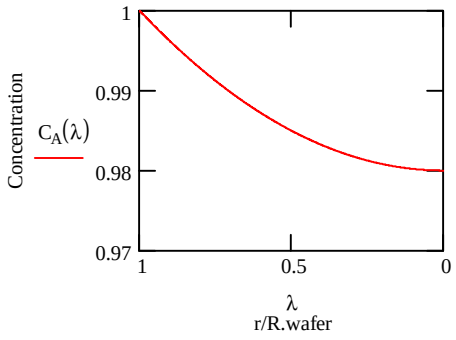
$D_e := D_{AB}(T) \cdot \phi_p$

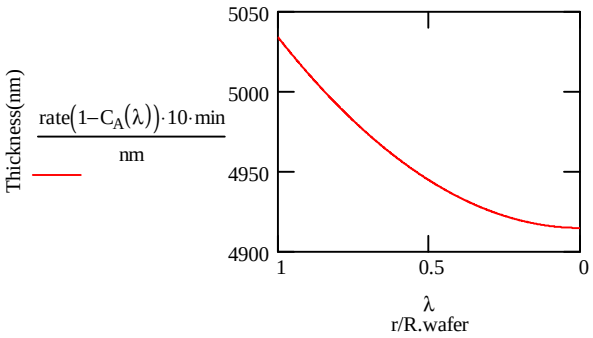
$\frac{A_{wafer}}{A_{wafer} \cdot (gap + \delta_w)} = 47.619 \frac{1}{m}$

$\phi_1 := \left(\frac{D_{wafer}}{2 \cdot 2}\right) \cdot \sqrt{\frac{k_1 \cdot P_{SiH2Cl2} \cdot \frac{A_{wafer}}{A_{wafer} \cdot (gap + \delta_w)}}{D_e}}$ $\phi_1 = 0.349$

Pseudo First Order Results

$C_A(\lambda) := \frac{1}{\lambda}\left(\frac{\sinh(\lambda \cdot \phi_1)}{\sinh(\phi_1)}\right)$





$x := 0.5$

$$\text{Rate}(\lambda, N) := \text{rate}\left[\, 1 - C_A(\lambda)\cdot(1 - \text{root}(n(x) - N, x))\,\right]$$