mole fraction of DCS

$$y_{DCS} = \frac{Q_{DHS}}{Q_{NH3} + Q_{DCS}} = \frac{70\ sccm}{700\ sccm + 70\ sccm}$$

$$y_{DCS} = 0.0993$$

Concentration of DCS

$$750 \times 10^{-3}\ Torr \times \frac{133.322\ Pa}{1\ Torr} = 33.33\ Pa$$

$$\frac{n}{V} = \frac{P_g}{RT} = \frac{(0.0993)(33.33\ Pa)}{(8.314\ J/(K \cdot mol))(770+273)K}$$

$$C_{DCS} = 9.97 \times 10^{-4}\ mol/m^3$$

Kinetic Eq'n

$$J = k_0 \exp\left[\frac{-E_a}{RT}\right] C_{DCS}^{0.49}$$

$$= 82300\ s^{-1} \exp\left[\frac{-(169.4 \times 10^3\ J/mol)}{(8.314\ J/(K \cdot mol))(770+273)K}\right] (9.97 \times 10^{-4}\ mol/m^3)^{0.49}$$

$$= 9.14 \times 10^{-6}\ mol/(cm^2 \cdot s)$$ rate of change of C_{DCS}

Deposition rate

Stoichiometric coefficient $SiCl_2H_2 : Si_3N_4 = 3 : 1$

approximate deposition rate $\approx \frac{1}{3}(9.44 \times 10^{-6}\ mol/(cm^2 \cdot s)) \approx 3.05 \times 10^{-6}\ mol/(cm^2 \cdot s)$ by neglecting surface kinetics.

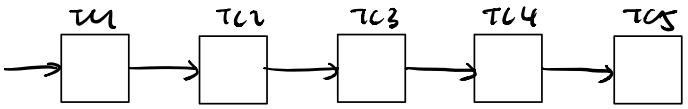
$MW_{Si_3N_4} = 140.28\ g/mol$

$\rho_{Si_3N_4} = 3000\ kg/m^3$

$$\frac{3.05 \times 10^{-6}\ mol}{m^2 \cdot s} \times \frac{140.28\ g}{mol} \times \frac{m^3}{3000 \times 10^3\ g} = 1.43 \times 10^{-10}\ m/s$$

Deposition rate = 1.43 Å/s = 85.8 Å/min

$$\frac{2000\ Å}{85.8\ Å/min} = 23.31\ mins \approx 25\ mins.$$



40 wafers each.

Volume of Si_3N_4 = (2)(200)(π)(0.15m)²(1000×10⁻¹⁰ m)

= 2.83×10^{-6} m³

$n_{Si_3N_4} = (2.83 \times 10^{-6}\ m^3)\left(\frac{3000\ kg}{m^3}\right)\left(\frac{1\ mol}{0.14\ kg}\right)$

$n_{Si_3N_4} = 0.061$ mol which is $n_{DCS} = 0.183$ mol

0.0813 mol Si_3N_4 for 30 sccm DCS flow
200 sccm Si_3N_4 flow

which is 0.244 mol of DCS

	n (mol)
Si_3N_4	0.0813
$SiCl_2H_2$	0.2439
NH_3	0.813

Material Balance on DCS

In − Out + ~~Gen~~ − Cons = ~~Acc~~

In − Out − Cons = 0

$0.244\ mol - Out - \left(\frac{0.183\ mol}{200}\right)(40) = 0$

Out = 0.2074 mol TC1

Overall chem eq'n

$3SiCl_2H_2 + 4NH_3 \longrightarrow Si_3N_4(s) + 6HCl + 6H_2$

At the end of TC1

	I	C	F
$SiCl_2H_2$	0.244	−0.0366	0.2074
NH_3	0.813	−0.0488	0.7642
HCl	0	+0.0732	0.0732
H_2	0	+0.0732	0.0732

$y_{DCS,TC1} = \frac{0.2074}{0.2074 + 0.7642 + 0.0732 + 0.0732}$

$y_{DCS,TC1} = 0.1855$

Concentration of DCS exiting TC1 / entering TC2

$\frac{n}{V} = \frac{P_A}{RT}$