1 Profiles & Layout

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2 Process Procedures

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2.3

3 Calculations

a) Film Thickness

Layer	Theoretical calculation (nm)	Experimental (nm)	% Error	Linewidths (photoresist) (nm)	Linewidths (after PR Strip) (nm)	% Overetch
Field Oxide	505.8	477.2	5.65	?	3000	?
Polysilicon	?	?	?	?	?	?
Gate Oxide	80.1	86.5	7.40	3628	4000	?
Intermed Oxide	386.3	320	17.2	?	?	?
Aluminum	?	?	?	2088	2520	?

b) Sheet Resistance

4 Questions

1. The lab uses positive photoresist. The lithography machine uses a light that has g line wavelength. The I and G lines refer to the wavelength of the light coming off the light bulb that reacts with photoresist. G line is roughly xx wavelength and I line is xx wavelength.

5 Appendix

Film thickness calculation for oxide:

$$X_{ox} = \frac{0.5B}{B/A}\left[\sqrt{1 + \frac{4}{B}(\frac{B}{A})^2(t + \tau)} - 1\right] \tag{1}$$

$$\tau = \frac{X_i^2}{B} + \frac{X_i}{B/A} \tag{2}$$

where

$$B/A = D_o e^{\frac{-E_a}{kT}} \text{ (Use table 3.1 [1] to find } E_a \text{ and } D_o)$$
$$B = D_o e^{\frac{-E_a}{kT}} \text{ (Use table 3.1 [1] to find } E_a \text{ and } D_o)$$
$$t = \text{Time of oxide growth}$$
$$\tau = \text{Time of initial oxide growth already present}$$
$$X_i = \text{length of initial oxide growth}$$

Example: Calculated oxide thickness of Intermed Oxide:
Given: 5 min dry oxidation at 1050°C and 12 + 25 min wet oxidation and annealing at 1050°C, calculated oxide growth.

First we consider the 5 min dry oxidation. Using table 3.1 [1] for a < 100 > Silicon, and using dry oxidation, we see that for the linear rate constant (B/A), $E_A = 2.00$ eV and $D_o = 3.71 \times 10^6 \, \mu\text{m/hr}$. For the parabolic rate constant (B), $E_A = 1.23$ eV and $D_o = 772 \, \mu\text{m/hr}$.

Using an arrhenius equation where $k = $ Boltzmann's constant, and $T = $ temperature.

$$B/A = D_o e^{\frac{-E_A}{kT}} = 3.71 \times 10^6 e^{\frac{-2.00*1.602\times10^{-19}}{1.38\times10^{-23}(1050°C+273)}} = 0.0887\mu m/hr$$

$$B = D_o e^{\frac{-E_A}{kT}} = 772 e^{\frac{-1.23*1.602\times10^{-19}}{1.38\times10^{-23}(1050°C+273)}} = 0.0159\,\mu m^2/hr$$

Since there is no initial oxide here, $\tau = 0$,

$$X_{ox} = \frac{0.5B}{B/A}\left[\sqrt{1 + \frac{4}{B}\left(\frac{B}{A}\right)^2(t+\tau)} - 1\right] = \frac{0.5(0.0159)}{0.0887}\left[\sqrt{1 + \frac{4}{0.0159}(0.0887)^2\left(\frac{5\text{min}}{60\text{min/hr}} + 0\right)} - 1\right] \approx 7.11\,\text{nm}$$

Now after this dry oxidation, we have a 37 minute wet oxidation at 1050°C. Using table 3.1 [1] again, but this time using the constants that apply for wet oxidation,

$$B/A_{\text{wet}} = D_o e^{\frac{-E_A}{kT}} = 9.70 \times 10^7 e^{\frac{-2.05*1.602\times10^{-19}}{1.38\times10^{-23}(1050°C+273)}} = 1.50\mu m/hr$$

$$B_{\text{wet}} = D_o e^{\frac{-E_A}{kT}} = 386 e^{\frac{-0.78*1.602\times10^{-19}}{1.38\times10^{-23}(1050°C+273)}} = 0.411\,\mu m^2/hr$$

This time we do have an initial oxidation time τ because of the dry oxidation we did. Here X_i is the oxide length we calculated for the dry oxidation growth,

$$\tau = \frac{X_i{}^2}{B_{\text{wet}}} + \frac{X_i}{B/A_{\text{wet}}} = \frac{0.00711^2}{0.411} + \frac{0.00711}{1.50} \approx 0.00488\text{hrs}$$

And finally our oxide growth is,

$$X_{ox} = \frac{0.5B}{B/A}\left[\sqrt{1 + \frac{4}{B}\left(\frac{B}{A}\right)^2(t+\tau)} - 1\right] = \frac{0.5(0.411)}{1.50}\left[\sqrt{1 + \frac{4}{0.411}(1.50)^2\left(\frac{(12+25)\text{min}}{60\text{min/hr}} + 0.00488\text{hrs}\right)} - 1\right] \approx 386.3\,\text{nm}$$