Homework #5 — EE528

due 10/29/08

1. A 1000°C oxidation is performed on ⟨100⟩ lightly-doped silicon in an ambient of 1 part dry O_2 to 3 parts Ar_2 (an inert gas, $p_{O_2} = 0.25$).

   (a) Using the linear/parabolic model, determine the oxide thickness grown after a 1 hour oxidation and after a 2 hour oxidation. Assume $B/A \propto p_{O_2}^{0.75}$.

   (b) Compare your results to those given by a SProcess simulation and comment on the differences.

2. Run SProcess simulations for a LOCOS process using a viscoelastic model for oxide (default) with and without stress-dependent oxidation. Use the following process specifications:

   - Pad oxide thickness of 100 Å.
   - Nitride thickness of 400 Å.
     - Oxidation in steam at 1 atm and 1100°C for 10 minutes, or
     - Oxidation in dry O_2 at 20 atm and 900°C for 2 h.

   (a) From the simulations, determine the lateral encroachment of the bird's beak into the masked region (define limit as point where pad oxide thickness is increased by 20%).

   (b) Comment on the differences between the lateral encroachments calculated and other features of the shape of the bird's beak.

   (c) Also include contour plots of the normal and shear stresses in both the substrate and films.

   (d) Given that the stress-dependent model best represents reality, comment on the applicability of the other model. Are there circumstances where you might not want to use the stress-dependent viscous model for all simulations?

3. Using the experimental results given in the notes for phosphorus OED (Figure 11), determine the time-averaged interstitial supersaturation (C_I/C_I^*) during the first and second hours of oxidation under the conditions of Problem 1. Use these values to calculate the expected enhancements or retardations in antimony and arsenic diffusion (e.g., $\langle D_{As} \rangle / D_{As}^*$) under the same conditions. Assume $f_I = 0.95$ for phosphorus, $f_I = 0.4$ for arsenic and $f_I = 0.05$ for antimony and that the Frenkel reaction, $I + V \Leftrightarrow 0$, is near equilibrium in the bulk. Don't ignore antimony diffusion with interstitials since $C_I > C_I^*$.