EECS 243 – Advanced IC Processing and Layout

Fall 2000	**Office Hours**	**Prof. A. R. Neureuther,**
Tu, Th 3:30-5	**M, Tu,Th, (F) 11am**	**510 Cory Hall, 2-4590**
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Homework Assignment # 6, Due Tu, Oct 17th, 00

Reading for Week #7: PDG Chapter 9; ARNL3-4 pp. 55-105, skip pp. 71-75.

6.1 Vacuum basics

A vacuum system at room temperature (21 C^o) contains only Ar at a pressure of 10^{-5} Torr. Assume that Ar has collision cross section that is circular with radius 0.3 nm. Also assume that whenever Ar forms a solid, it has a density of 1.78.

a) Determine the mean free path.
b) Determine the background impingement rate of Ar on the surface of a wafer and the velocity at which the wafer height would change if all the Ar atoms that struck the wafer surface remained (sticking coefficient of unity).
c) If Al were simultaneously being deposited at a rate of 10 nm/s, and if the impinging Ar were to get trapped in the Al what fraction of the film thickness would be Ar. (The real problem in practices is of course residual air or water vapor in the system that results in creating oxides.)
d) If all of the Al coating delivered to an 100 mm wafer at 10 nm/s were to come from a 1 cm^2 area on the Al evaporator source, what vapor pressure and temperature would be required at the source? (See Eq 9.24 and Figure 9.20 of PDG00.)

6.2 Chemical vapor deposition: transport and reaction regimes

Problem 9.7 PDG00 pp. 607. (Note $C_T Y$ remains constant.)

6.3 Physical vapor deposition

Use the LAVA application applet for "deposition and metalization" to explore and characterize the time-evolution of a trench profile under the following conditions. The trench is 400 nm wide by 1200 nm deep. Use a deposition rate of 6 nm/s and duration of 200 seconds so that the deposited film is three times higher than the width of the trench and equals the trench depth. (Use uniform flux and vertical walls.) Simulate the deposition using an axial symmetrical hemispherical source for four configurations of the source half-angle of a) 10, b) 20, c) 30 and d) 50 degrees. From the resulting profiles deduce the following four characteristics and plot them together versus angle on a design chart.

- Bottom fractional coverage = maximum height of the material on the bottom of the trench normalized to the deposition thickness for large flat areas.
- Side fractional coverage = thickness at the midpoint of the side of the trench normalized to the deposition thickness for large flat areas.
- Relative lateral encroachment factor = incremental lateral change of the initial profile normalized to the incremental deposition thickness for large flat areas.
- Void pinch factor = ratio of deposition thickness at which the trench opening becomes 50% of its initial width to the initial trench width.