CHE323/384 Chemical Processes for Micro- and Nanofabrication
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Homework #6

1. Calculate the mean free path at room temperature for N_2, with a molecular diameter of 0.4 nm, at pressures of 1 atm, 0.01 atm, 0.0001 atm, and 10^{-6} atm. How do these distances compare to the size of typical semiconductor features (< 100 nm, called the feature-scale), the size of a wafer (~100 mm, called the wafer-scale), and the size of the vacuum chamber (~1 m, called the reactor-scale)?

2. Calculate the mean free path of a particle in the gas phase of a deposition system and estimate the number of collisions it experiences in traveling from the source to the substrate in each of the cases below. Assume that in each case the molecular collisional diameter is 0.3 nm and that the number of collisions is approximately equal to the source-to-substrate distance divided by the mean free path.
   a. An evaporation system in which the pressure is 10^{-5} torr, the source-to-substrate distance is 70 cm, and the temperature is 25˚C.
   b. A sputter deposition system in which the pressure is 3 mtorr, the source-to-substrate distance is 5 cm, and the temperature is 25˚C.

3. Why does the sputter yield have a maximum at some ion energy?

4. Campbell textbook, Chapter 12, problem 3.

5. Campbell textbook, Chapter 12, problem 7.