**CHE323/384 Chemical Processes for Micro- and Nanofabrication**
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Homework #7 Solutions

1. For CVD deposition of a film, it is found that the mass transfer coefficient $h_G$ = 10.0 cm/s and the surface reaction rate coefficient $k_S$ = 1 x $10^7$ exp(-1.9 eV/kT) cm/s. For a deposition at 900˚C, which CVD system would you recommend using: (a) a cold-walled, graphite susceptor type: or (b) a hot-walled, stacked wafer type? Explain your answer.

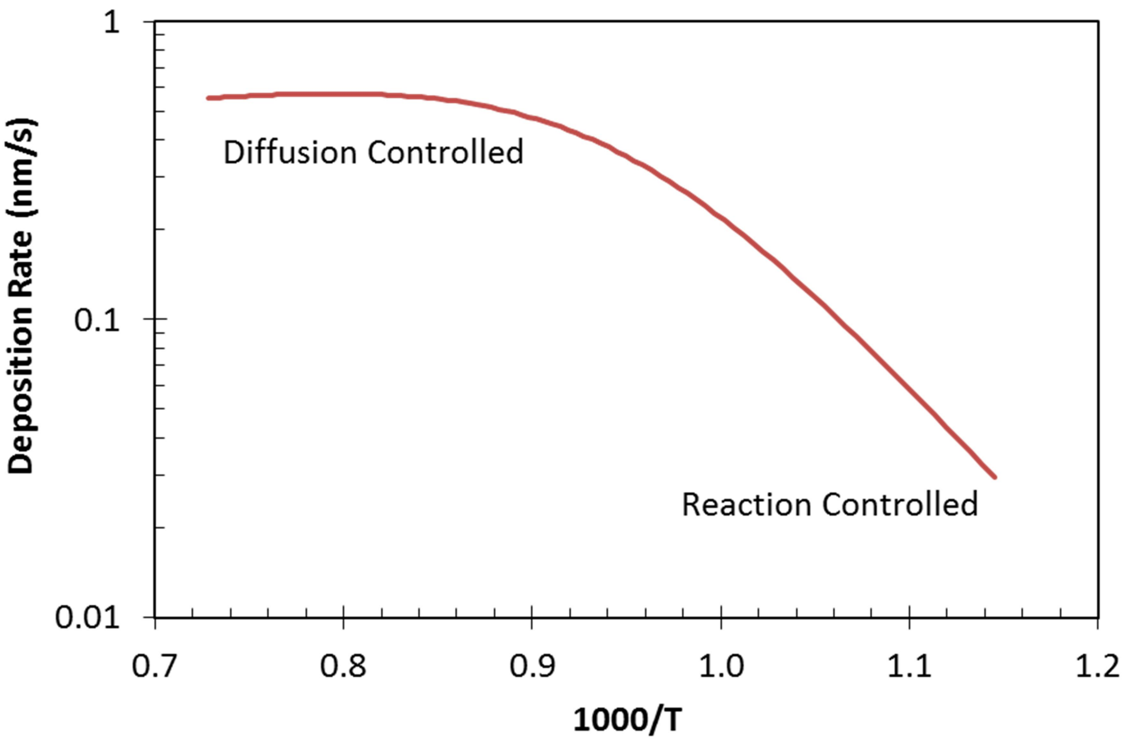
At 900˚C, $k_s = 1\times 10^7 \exp\left(\frac{-1.9eV}{kT}\right) cm/s = 1x10^7 \exp\left(\frac{-1.9eV}{(8.62x10^{-5} eV/K)(1173K)}\right) = 0.069 cm/s$

This is much less than $h_G$ (10.0 cm/s), so that $k_S \ll h_G$. This means that the system will be in the reaction controlled regime. Thus you should recommend using (b) a hot-walled, stacked wafer type system since in the reaction-limited regime we are very sensitive to temperature variations but not too sensitive to gas flow variations.

2. Plot the deposition rate (on a log scale) versus 1/T (Kelvin), for 600-1100˚C, for an atmospheric CVD system with the following parameter values:

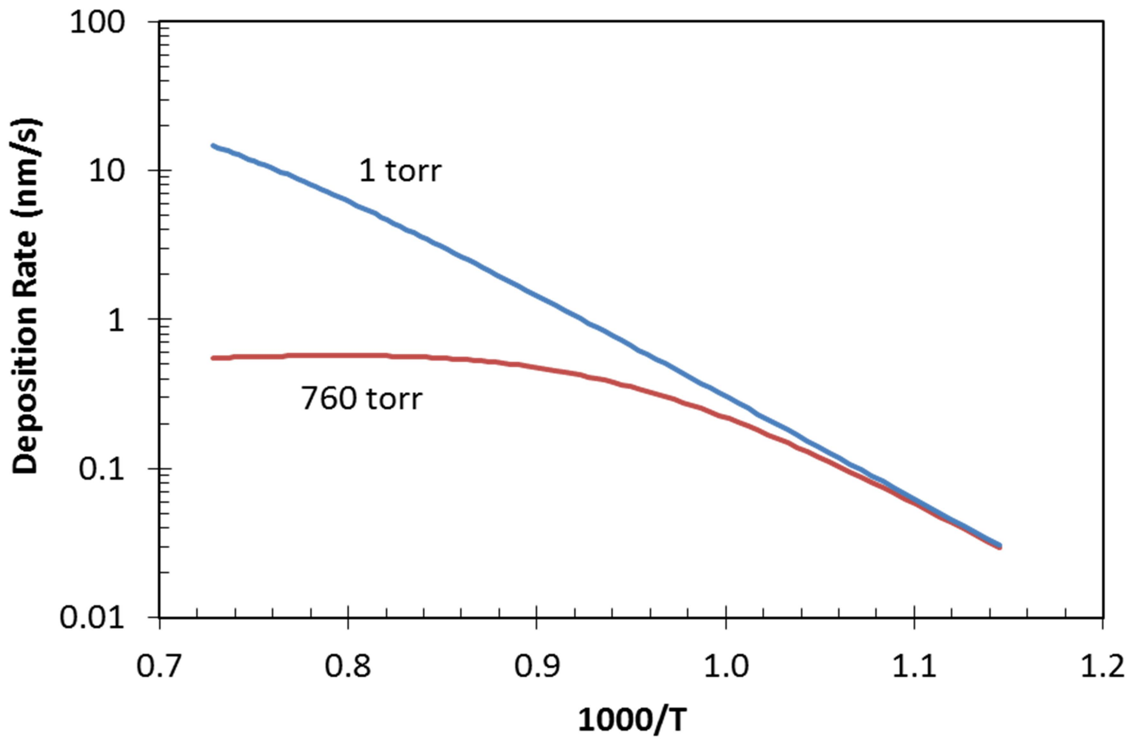
   $h_G$ = 0.5 cm $sec^{-1}$ (assumed independent of temperature)
   $k_S$ = 4 x $10^6$ exp(-1.45 eV/kT) cm/s
   Partial pressure of incorporating species = 1 torr
   N = 6.2 x $10^{22}$ $cm^{-3}$

   Identify the reaction and mass transfer limited regimes.




The reaction-limited regime is roughly below 750 $^oC$. The diffusion limited regime is roughly above 900 $^oC$.

3. Repeat problem 2 when the total pressure is decreased to 1 torr, so that $h_G$ increases by 100 times. Assume that the partial pressure of the incorporating species remains the same.




4. Campbell textbook, Chapter 13, problem 5.

No solution provided for this one. You are on your own!

5. Campbell textbook, Chapter 13, problem 6.

No solution provided for this one. You are on your own!