5.2 April 29, 2005: Vapor phase transport, structure formation

Knudsen number is λ/L, λ is the mean free path. Derivation: volume of cylinder (approx. volume per particle) divided by area

$$\lambda = \frac{1}{\sqrt{2}\sigma^2 \rho_{atoms}} = \frac{kT}{\sqrt{2}\sigma^2 P}. \tag{5.9}$$

That was easy. But why the $\sqrt{2}$ in the denominator? I believe it has something to do with the velocity distribution.

Different value of L for different situations. To check continuum approximation validity, use chamber size; sometimes will need feature size; for cosine power deviation, use source diameter (and note the graphs use an inverse Knudsen number).

For low Knudsen number in the chamber, use mass transfer coefficients. Example: chemical vapor deposition chamber, uneven h_D leads to uneven distribution, ramp trick to even out the boundary layer.

Slides on the structure zone model... Basic principle: atoms arrive on one timescale, diffuse on another. Fast arrival with low substrate temperature means they can't diffuse well, shadowing and faceting lead to fibrous structure. Slow arrival and/or high substrate temperature means they diffuse very well, dense grains or even equiaxed structure.

Structure zone followup: textured films, preferential orientation by growth selection and by ion beam interactions.