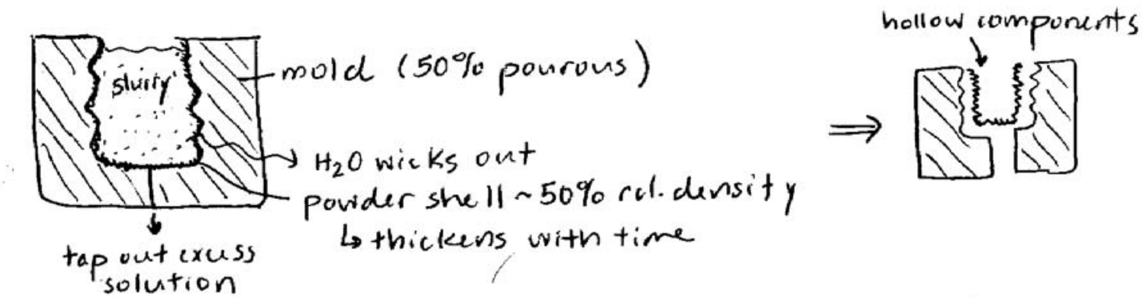
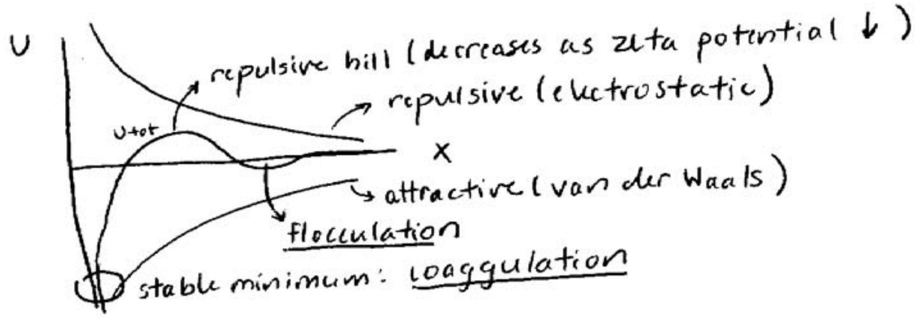
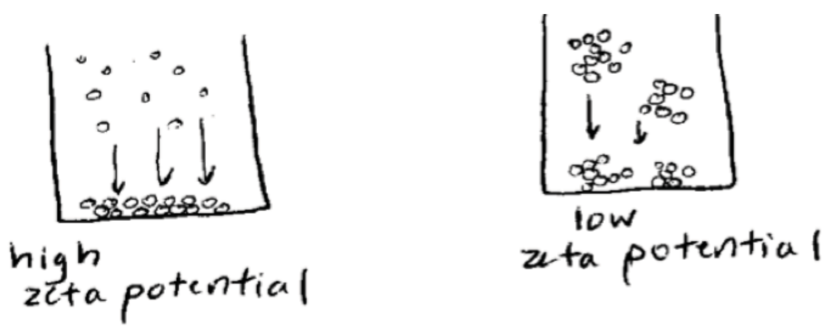
3.044 MATERIALS PROCESSING

LECTURE 22

Slip Casting







· **high ζ potential** ⇒ well separated particles in suspension ⇒ uniform packing when settled ⇒ sinters to a regular structure with uniform grains

Date: May 14th, 2012.

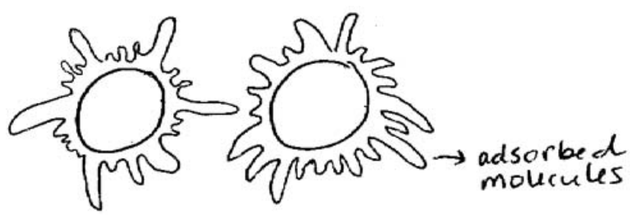
· **low ζ potential** ⇒ particles agglomerate in suspension ⇒ aggregates settle ⇒ larger voids, irregular structure in sintered body

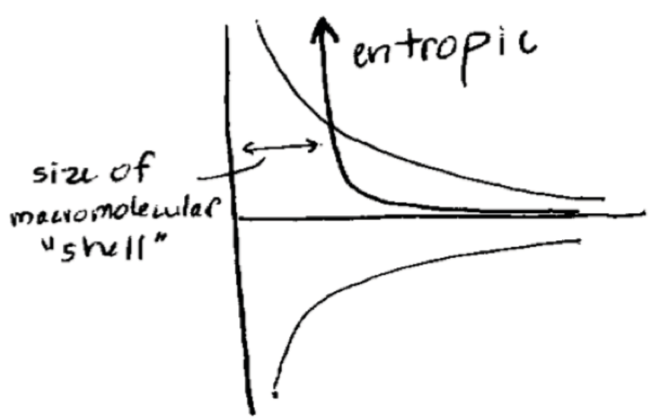
· **settling** ⇒ lower velocity settling ⇒ spend more time going over the "repulsive hill" ⇒ less flocculation, more uniform settling

· **slip casting** ⇒ highter velocity settling ⇒ spend less time going over the "repulsive hill" and enter the flocculation minimum ⇒ more flocculation, less uniform settling

Add Macromolecules

$U = H - TS$





⇒ adsorbed macromolecules add entropic repulsion effects

Vacuum/Vapor Deposition Processes

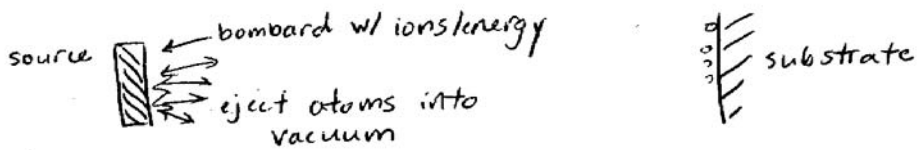
· semiconductor devices, integrated circuits, MEMS, etc.
· coatings for decoration (furniture, sports equipment, faucetry) or abrasion resistance (cutting/machining, tooling, blades)

Two main classes of processes

PVD physical vapor deposition	**CVD** chemical vapor deposition
vacuum process (low pressure)	vapor process (high pressure)
solid or liquid source	gas source
no chemical reaction, just adsorption	chemical reactions occur
geometry dominated	fluid flow and diffusion dominated

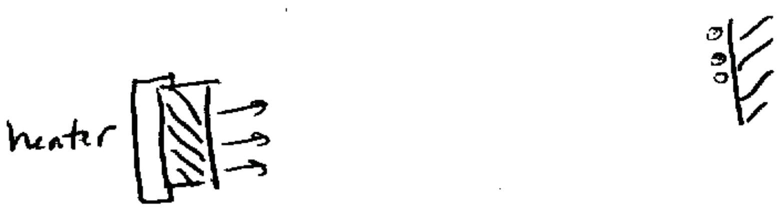
PVD

1. sputtering



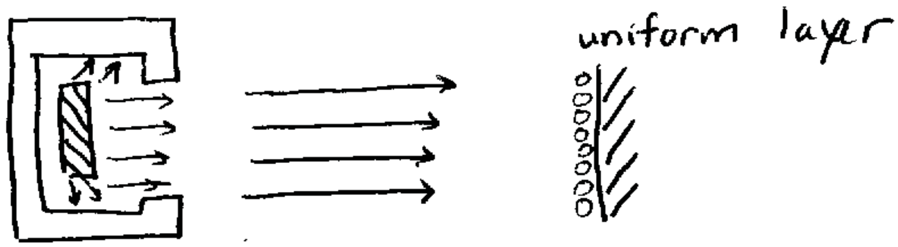
2. e-beam

3. evaporation



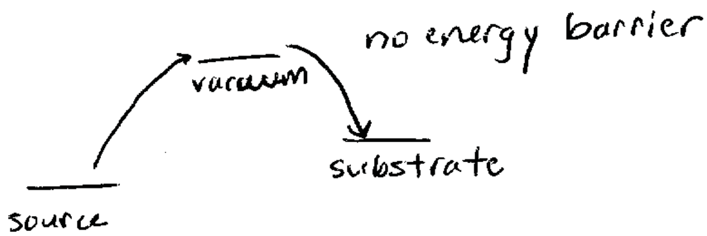
4. pulsed laser deposition

5. MBE - molecular beam epitaxy



6. plasma enhanced deposition

PVD Energy Diagram:



no chemical reaction: the deposition rate is as fast as atoms are supplied

$\Rightarrow$ geometry dominated, source limited

$\Rightarrow s \propto t \propto$ supplied flux, $J\ \frac{mol}{m^2 s}$

$\Rightarrow \frac{ds}{dt} = J \cdot V_m$, where V_m is molar volume, geometry factor

e.g. **Evaporation**

$$\boxed{J = \frac{P_e - P}{\sqrt{2\pi MwRT}}}$$

where P_e is equilibrium vapor pressure, P is pressure ≈ 0 (vacuum), and Mw is molecular weight

Next time: **CVD**

3.044 Materials Processing
Spring 2013