Slip Casting

- high $\zeta$ potential $\Rightarrow$ well separated particles in suspension $\Rightarrow$ uniform packing when settled $\Rightarrow$ 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** ⇒ higher 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

<table>
<thead>
<tr>
<th>PVD</th>
<th>CVD</th>
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</thead>
<tbody>
<tr>
<td><strong>physical vapor deposition</strong></td>
<td><strong>chemical vapor deposition</strong></td>
</tr>
<tr>
<td>vacuum process (low pressure)</td>
<td>vapor process (high pressure)</td>
</tr>
<tr>
<td>solid or liquid source</td>
<td>gas source</td>
</tr>
<tr>
<td>no chemical reaction, just adsorption</td>
<td>chemical reactions occur</td>
</tr>
<tr>
<td>geometry dominated</td>
<td>fluid flow and diffusion dominated</td>
</tr>
</tbody>
</table>

**PVD**

1. sputtering

![sputtering diagram](image)

2. e-beam

![e-beam diagram](image)

3. evaporation

![evaporation diagram](image)

4. pulsed laser deposition
5. MBE - molecular beam epitaxy

\[ \begin{array}{c}
\text{source} \\
\downarrow \\
\text{substrate} \\
\rightarrow \\
\text{uniform layer}
\end{array} \]

6. plasma enhanced deposition

PVD Energy Diagram:

**no chemical reaction:** the deposition rate is as fast as atoms are supplied
⇒ geometry dominated, source limited
⇒ \( s \propto t \propto \text{supplied flux, } J \frac{\text{mol}}{m^2s} \)
⇒ \( \frac{ds}{dt} = J \cdot V_m \), where \( V_m \) is molar volume, geometry factor

e.g. **Evaporation**

\[ J = \frac{P_e - P}{\sqrt{2\pi MwRT}} \]

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

Next time: **CVD**