Lecture 9

Chapter 18

Processing of Ceramics and Glass

• Uses of Ceramics and Glasses
  – Floor tiles
  – Dishes
  – Electrical Insulators
  – Spark Plugs
  – Ball Bearings
  – Thermal Insulation – Space Shuttle
**Techniques of Ceramic Processing**

**TABLE 17.7**

<table>
<thead>
<tr>
<th>Process</th>
<th>Advantages</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slip casting</td>
<td>Large parts, complex shapes; low equipment cost.</td>
<td>Low production rate; limited dimensional accuracy.</td>
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<tr>
<td>Extrusion</td>
<td>Hollow shapes and small diameters; high production rate.</td>
<td>Parts have constant cross section; limited thickness.</td>
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<tr>
<td>Dry pressing</td>
<td>Close tolerances; high production rate with automation.</td>
<td>Density variation in parts with high length-to-diameter ratios; dies require high abrasive-wear resistance; equipment can be costly.</td>
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<tr>
<td>Wet pressing</td>
<td>Complex shapes; high production rate.</td>
<td>Part size limited; limited dimensional accuracy; tooling costs can be high.</td>
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<tr>
<td>Hot pressing</td>
<td>Strong, high-density parts.</td>
<td>Protective atmospheres required; die life can be short.</td>
</tr>
<tr>
<td>Isostatic pressing</td>
<td>Uniform density distribution.</td>
<td>Equipment can be costly.</td>
</tr>
<tr>
<td>Jiggering</td>
<td>High production rate with automation; low tooling cost.</td>
<td>Limited to axisymmetric parts; limited dimensional accuracy.</td>
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<tr>
<td>Injection molding</td>
<td>Complex shapes; high production rate.</td>
<td>Tooling can be costly.</td>
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</tbody>
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**Slip Casting**

(a) Slip casting
- Slip
  - Colloidal suspension
- Absorption of water
- Removal of excess slip
- Trimming
- Removal of part
Extrusion and Jiggering

- A) Extrusion
- B) Jiggering

Shrinkage of Wet Clay

- Up to 20% shrinkage
  - High porosity
Forming of Glasses

- Glass products formed
  - Flat sheet / plates
    - $t = 0.8 - 10$ mm
    - Rods and tubing
    - Discrete products
      - Bottles
      - Vases
      - Headlights
  - Glass fibers
    - $T_m = 900 - 1000$ °C

- Drawing and rolling
  - Molten glass drawing between two rollers as it is solidified
Forming of Glasses

- Float Method
  - Excellent surface finish
  - Microscope slides

Forming of Glass

- Blowing of glass
  - Hollow and thin walled pieces
    - Tubing
    - Bottles
    - Bulbs – 2000 / min
Bullet Proof Glass?

- Bullet proof glass
  - Laminate structure
    - Glass – Polymer – Glass
    - Glass
      - Hard – good wear properties
    - Polymer
      - Tough – good energy absorption properties
Rapid Prototyping

Why?
- Full production of a part is expensive
  - Assurance of performance is necessary before a large capital investment
- Faster prototypes expedite full production and release of a product to the market
  - First-to-market products will usually be more lucrative

Examples of Rapid Prototyped Parts
Fused Deposition Modeling and Stereolithography

- Steps
  - CAD file generation
  - Pre-processing for implementation
  - Support build
  - Part build

Fused Deposition Modeling

Thermoplastic or wax filament
Heated FDM head moves in xy plane
Plastic model created in minutes
Table moves in z-direction

Support building
Stereolithography

- UV light creates parts from a UV curable liquid
  - Mers
  - Oligomers
  - Photoinitiator

Examples of RP
Integration of RP into other Processes
Integration of RP into other Processes

5. Roll drag over, place cope half of pattern and flasks.  Note: spines and risers are standard inserts.

6. Prepare cope half of mold; this step must be repeated for each half of the mold.

7. Separate flasks — remove all patterns. Place core in place, close flask.

8. Flask closed and clamped, ready for pouring of molten metal.

Remove excess sand