Materials Used in Additive Manufacturing Processes

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Types of Materials

- Starch based powders (proprietary/non proprietary)
- Sand
- Wood
- Ceramics
- Carbon Fiber
- High-end Cement
- Plaster
- Paper
- Metal Powders; stainless steel, bronze, cobalt
- Polyamide-powder
Properties

- Powder
- Solid
- Liquid
Processes

- 3-D Printing
- FDM (Fused Deposition Modeling)
- SLS (Selective Laser Sintering)
- SLA (Stereolithography)
- DMLS (Direct Metal Laser Sintering)
- SLM (Selective Laser Melting)
- EBM (Electron Beam Melting)
Fused Deposition Modeling (FDM)

Materials

- Thermoplastics
- Polycarbonates
- ABS --- acrylonitrile butadiene styrene
- Polyetherimide
- Polyphenylsulfone
Selective Layer Sintering (SLS)

- Materials
  - Photo-polymer powder
Stereolithography (SLA)

- Materials
  - Photo-polymer liquid
Direct Metal Laser Sintering (DMLS)
Selective Laser Melting (SLM)
Electron Beam Melting (EBM)

- Materials
  - Stainless Steel
  - Bronze
  - Titanium
  - Aluminum
  - Vanadium
  - Various Alloys
Uses

- Prototyping
- Modeling
- Production Parts
<table>
<thead>
<tr>
<th>Material</th>
<th>Properties (Type)</th>
<th>Process(es) (3-D Printing, FDM, SLS, SLA, DMLS, SLM, EBM)</th>
<th>Strength (Brittle, Strong)</th>
<th>Production Time (1 in³) (Minimal=1-4 hrs, Moderate=3-5 hrs, Lengthy=&gt; 5 hrs)</th>
<th>Uses (Prototyping, Production Part, Modeling)</th>
<th>Post Processing Requirements (Sanding, Hardening, Painting)</th>
<th>Cost (Inexpensive, Expensive)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starch</td>
<td>Powder</td>
<td>3-D Printing</td>
<td>Brittle</td>
<td>Minimal</td>
<td>Prototyping</td>
<td>Addition of hardener (Super Glue, Wax, etc..)</td>
<td>Inexpensive</td>
</tr>
<tr>
<td>Stainless Steel</td>
<td>Powder</td>
<td>3-D Printing</td>
<td>Brittle</td>
<td>Minimal</td>
<td>Prototyping, modeling.</td>
<td>Infused with additional metals</td>
<td>Expensive</td>
</tr>
<tr>
<td>Stainless Steel</td>
<td>Powder</td>
<td>DMLS, SLM, EBM,</td>
<td>Strong</td>
<td>Minimal</td>
<td>Prototyping, modeling, Production parts</td>
<td>Sanding</td>
<td>Expensive</td>
</tr>
<tr>
<td>ABS (Acrylonitrile Butadiene Styrene)</td>
<td>Solid</td>
<td>FDM</td>
<td>Relatively Strong</td>
<td>Moderate</td>
<td>Prototyping, Modeling, Production parts</td>
<td>Light Sanding, Support Removal, Painting</td>
<td>Inexpensive</td>
</tr>
<tr>
<td>Photo-polymer</td>
<td>Powder, Liquid</td>
<td>SLS</td>
<td>Strong</td>
<td>Lengthy</td>
<td>Prototyping, Modeling, Production parts</td>
<td>Light Sanding, Painting, Support Removal</td>
<td>Expensive</td>
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<tr>
<td>Aluminum</td>
<td>Powder</td>
<td>DMLS, SLM, EBM,</td>
<td>Strong</td>
<td>Lengthy</td>
<td>Prototyping, Modeling, Production Parts</td>
<td>Sanding</td>
<td>Expensive</td>
</tr>
<tr>
<td>Nylon</td>
<td>Solid</td>
<td>FDM</td>
<td>Relatively Strong</td>
<td>Moderate</td>
<td>Prototyping, Modeling, Production Parts</td>
<td>Sanding</td>
<td>Inexpensive</td>
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<tr>
<td>Plastic Ceramics</td>
<td>Solid</td>
<td>FDM</td>
<td>Relatively Strong</td>
<td>Moderate</td>
<td>Prototyping, Modeling, Production Parts</td>
<td>Sanding</td>
<td>Expensive</td>
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<tr>
<td>Titanium</td>
<td>Powder</td>
<td>DMLS, SLM, EBM,</td>
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