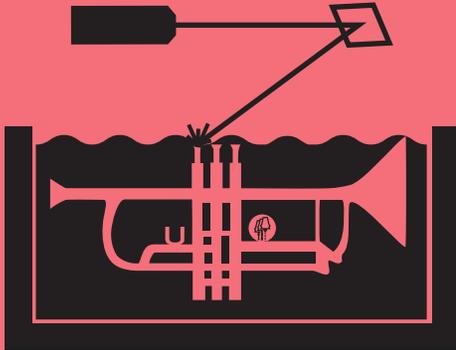
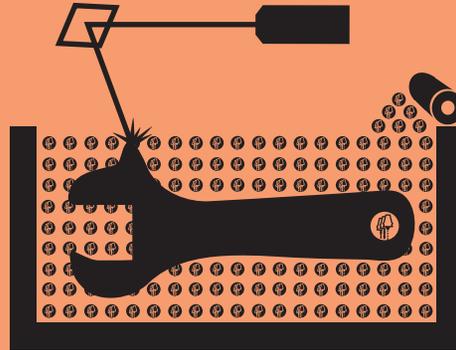


# 7 Families of Additive Manufacturing

According to ASTM F2792 Standards



**VAT  
PHOTOPOLYMERIZATION**



**POWDER BED  
FUSION (PBF)**



**BINDER  
JETTING**



**MATERIAL  
JETTING**

## Alternative Names:

SLA™ - Stereolithography Apparatus  
DLP™ - Digital Light Processing  
3SP™ - Scan, Spin, and Selectively Photocure  
CLIP™ - Continuous Liquid Interface Production

## Description:

A vat of liquid photopolymer resin is cured through selective exposure to light (via a laser or projector) which then initiates polymerization and converts the exposed areas to a solid part.

## Strengths:

- High level of accuracy and complexity
- Smooth surface finish
- Accommodates large build areas

## Typical Materials

UV-curable Photopolymer Resins (with various fillers)

## Alternative Names:

SLS™ - Selective Laser Sintering; DMLS™ - Direct Metal Laser Sintering; SLM™ - Selective Laser Melting; EBM™ - Electron Beam Melting; SHS™ - Selective Heat Sintering; MJF™ - Multi-Jet Fusion

## Description:

Powdered materials is selectively consolidated by melting it together using a heat source such as a laser or electron beam. The unused powder surrounding the consolidated part acts as a support material for overhanging features.

## Strengths:

- High level of complexity
- Powder acts as support material
- Wide range of materials

## Typical Materials

Plastics, Metal and Ceramic Powders, and Sand

## Alternative Names:

3DP™ - 3D Printing  
ExOne  
Voxeljet

## Description:

Liquid bonding agents are selectively applied onto thin layers of powdered material to build up parts layer by layer. The binders include organic and inorganic materials. Metal or ceramic powdered parts are typically fired in a furnace after they are printed.

## Strengths:

- Allows for full color printing
- High productivity
- Uses a wide range of materials

## Typical Materials

Powdered Plastic, Metal, Ceramics, Glass, and Sand.

## Alternative Names:

Polyjet™  
SCP™ - Smooth Curvatures Printing  
MJM - Multi-Jet Modeling  
Projet™

## Description:

Droplets of material are deposited layer by layer to make parts. Common varieties include jetting a photocurable resin and curing it with UV light, as well as jetting thermally molten materials that then solidify in ambient temperatures.

## Strengths:

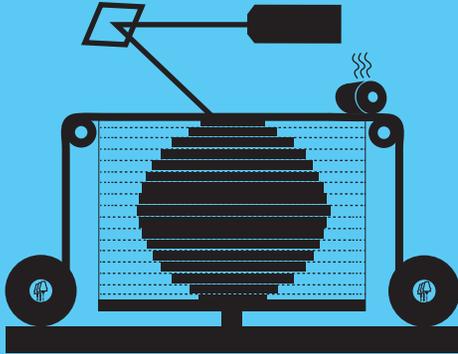
- High level of accuracy
- Allows for full color parts
- Enables multiple materials in a single part

## Typical Materials

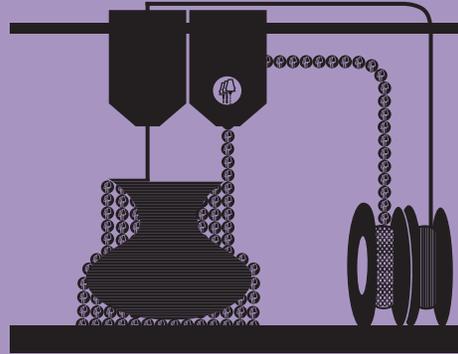
Photopolymers, Polymers, Waxes

# 7 Families of Additive Manufacturing

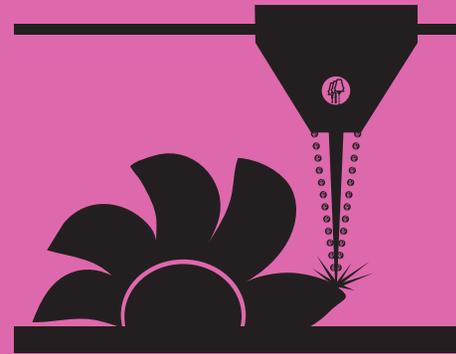
According to ASTM F2792 Standards



**SHEET LAMINATION**



**MATERIAL EXTRUSION**



**DIRECTED ENERGY DEPOSITION (DED)**



**HYBRID**

## Alternative Names:

LOM - Laminated Object Manufacture  
SDL - Selective Deposition Lamination  
UAM - Ultrasonic Additive Manufacturing

## Description:

Sheets of material are stacked and laminated together to form an object. The lamination method can be adhesives or chemical (paper/plastics), ultrasonic welding, or brazing (metals). Unneeded regions are cut out layer by layer and removed after the object is built.

## Strengths:

- High volumetric build rates
- Relatively low cost (non-metals)
- Allows for combinations of metal foils, including embedding components.

## Typical Materials

Paper, Plastic Sheets, and Metal Foils/Tapes

## Alternative Names:

FFF - Fused Filament Fabrication  
FDM™ - Fused Deposition Modeling

## Description:

Material is extruded through a nozzle or orifice in tracks or beads, which are then combined into multi-layer models. Common varieties include heated thermoplastic extrusion (similar to a hot glue gun) and syringe dispensing.

## Strengths:

- Inexpensive and economical
- Allows for multiple colors
- Can be used in an office environment
- Parts have good structural properties

## Typical Materials

Thermoplastic Filaments and Pellets (FFF);  
Liquids, and Slurries (Syringe Types)

## Alternative Names:

LMD - Laser Metal Deposition  
LENS™ - Laser Engineered Net Shaping  
DMD™ - Direct Metal Deposition

## Description:

Powder or wire is fed into a melt pool which has been generated on the surface of the part where it adheres to the underlying part or layers by using an energy source such as a laser or electron beam. This is essentially a form of automated build-up welding.

## Strengths:

- Not limited by direction or axis
- Effective for repairs and adding features
- Multiple materials in a single part
- Highest single-point deposition rates

## Typical Materials

Metal Wire and Powder, with Ceramics

## Alternative Names:

AMBIT™ - Created by Hybrid Manufacturing Technologies

## Description:

Laser metal deposition (a form of DED) is combined with CNC machining, which allows additive manufacturing and 'subtractive' machining to be performed in a single machine so that parts can utilize the strengths of both processes.

## Strengths:

- Smooth surface finish AND High Productivity
- Geometrical and material freedoms of DED
- Automated in-process support removal, finishing, and inspection

## Typical Materials

Metal Powder and Wire, with Ceramics