

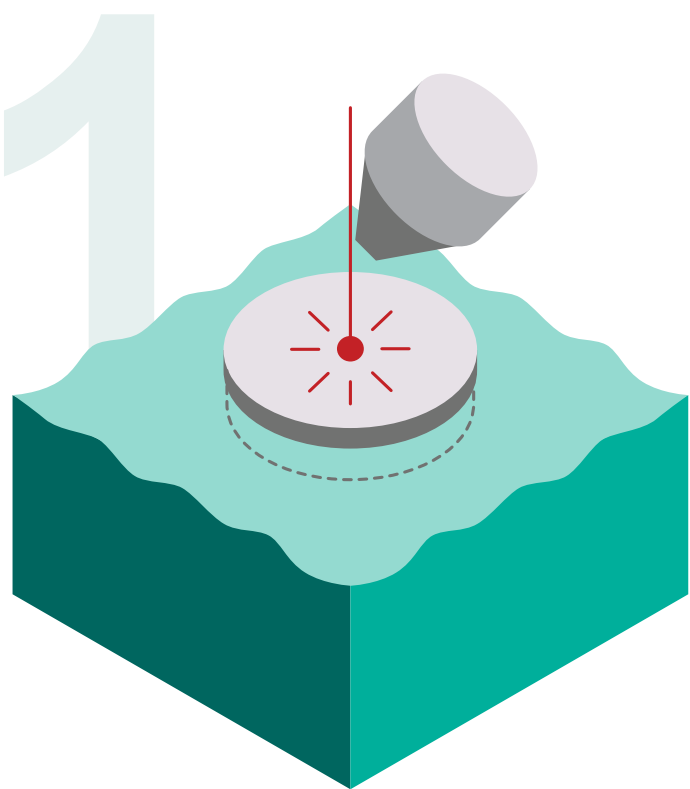
TECHNOLOGIES OF ADDITIVE MANUFACTURING

The term additive manufacturing encompasses a group of technologies with a common principle: **the production of parts with high complexity from a CAD model applying layer-by-layer of material.**

This group of technologies are constantly researched and further developed. In 2010, in order to standardize names and definitions, the American Society for Testing and Materials (ASTM) group “ASTM F42 – Additive Manufacturing” clustered the technologies into 7 main types.

The main differences between the groups lie mainly in the feedstock, bonding mechanism and layer application strategy. For each technology group, a diverse palette of materials is used, enabling multiple applications in industry sectors such as aerospace, automotive, medical, energy and construction.

VAT POLYMERIZATION

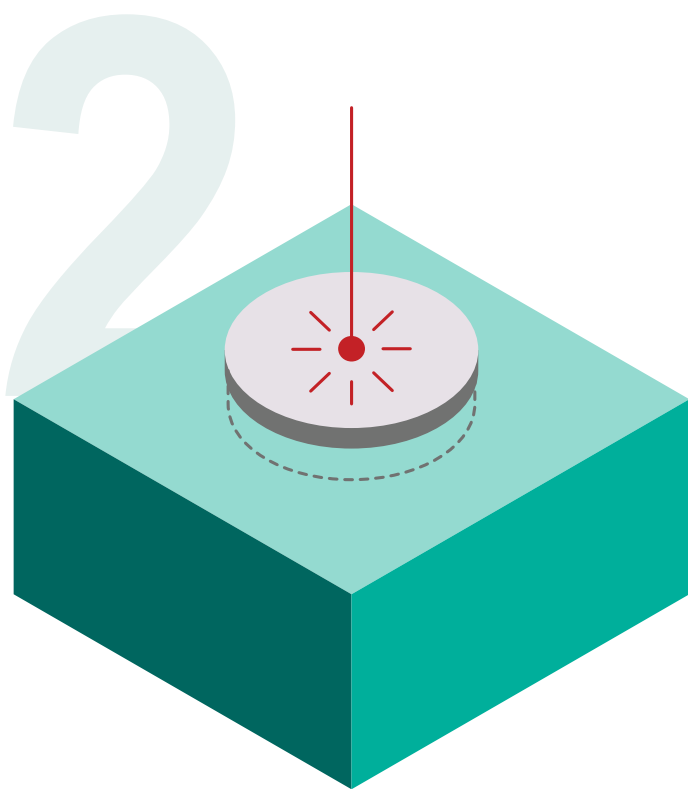


Liquid photopolymer is cured by exposure to light - from laser to projector - the exposed areas solidify by polymerization.

MATERIALS

Curable photopolymer resins

POWDER BED FUSION



Powder materials are selectively melted with a heat source such as laser or electron beam. The powder bed composed by unfused powder surrounding that part can act as support material for overhanging features.

MATERIALS

Metals
Ceramics
Plastics

BINDER JETTING

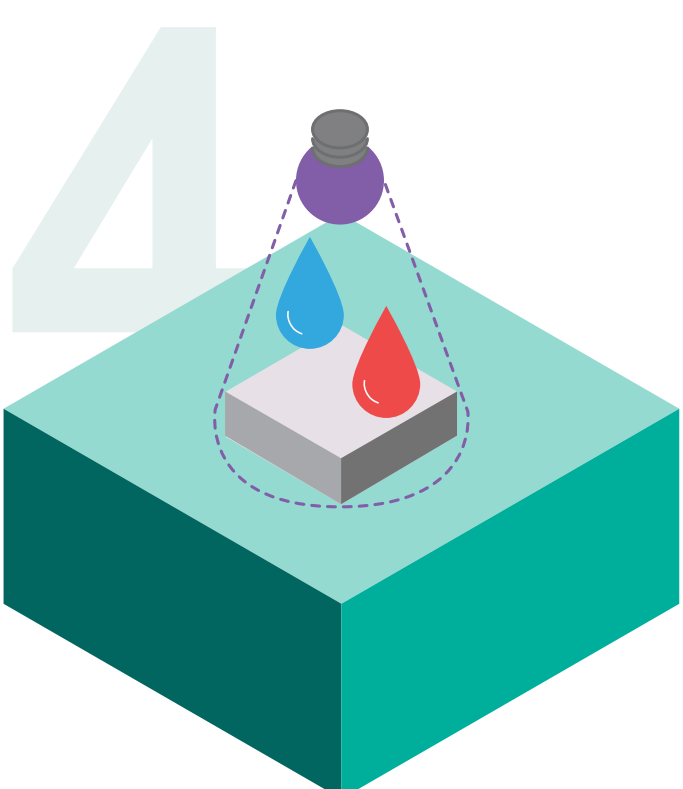


Powder material is selectively bounded by a binder agent to build up parts layer-by-layer. The binders can have organic or inorganic nature. The metal or ceramic parts must be sintered after a debinding process to reach the maximum mechanical properties.

MATERIALS

Metals
Ceramics
Plastics
Glass

MATERIAL JETTING

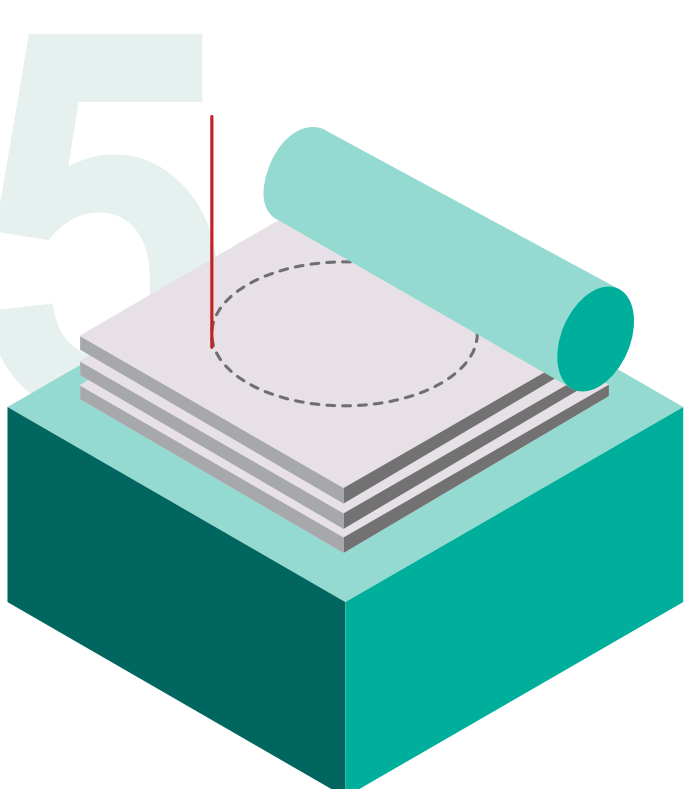


Droplets of material are deposited to conform parts layer-by-layer. Photocurable resins are applied and cured with UV light as well as liquid materials that solidify at ambient temperature.

MATERIALS

Photopolymers
Waxes

SHEET LAMINATION

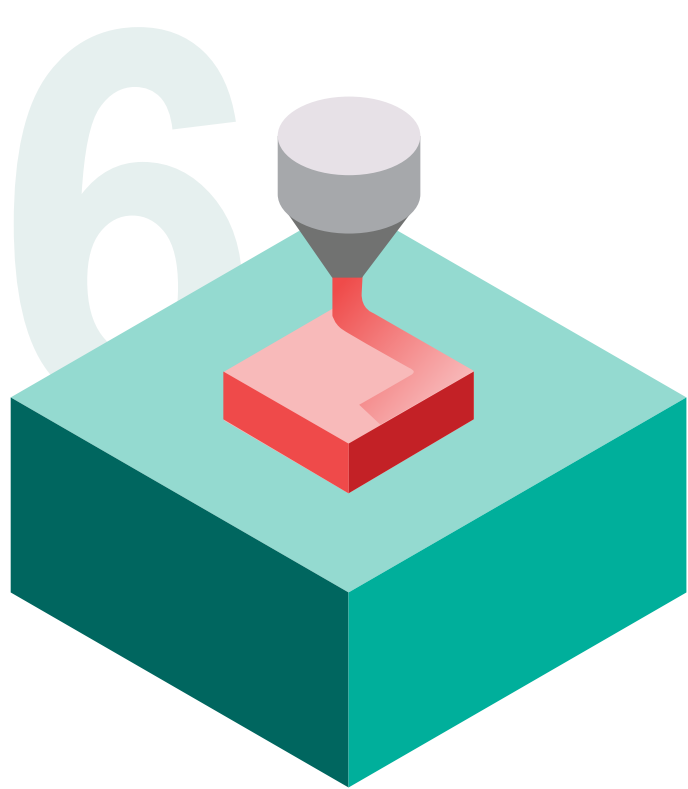


Sheets of materials are stacked together to form parts applying layer-by-layer. This process uses adhesive or chemical bonding for paper and plastics, and ultrasonic welding or brazing for metals. The regions that are not part of the final geometry are removed after the process.

MATERIALS

Foils
Plastic sheets

MATERIAL EXTRUSION

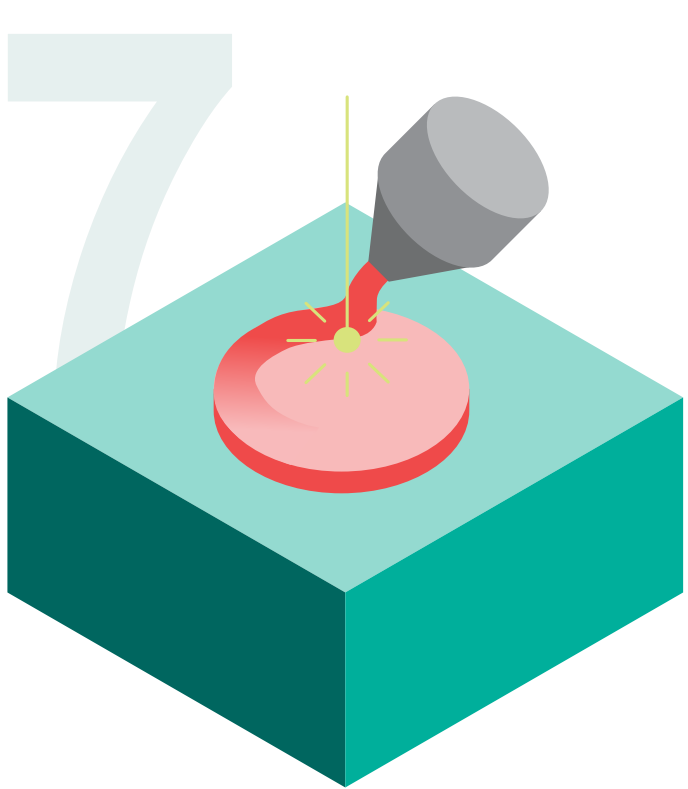


Filament of material is extruded through a nozzle forming tracks which form layered structures. Commonly thermoplastic filament is heated through the nozzle. A variety of this process includes syringe dispensing.

MATERIALS

Thermoplastic filaments

DIRECTED ENERGY DEPOSITION



Material is added simultaneously with the heat input via a laser, electron beam, or plasma arc to form a melted or sintered layer on a substrate. These processes require a vacuum system and inert gases to reduce oxidation rate.

MATERIALS

Metal powder
Wire