

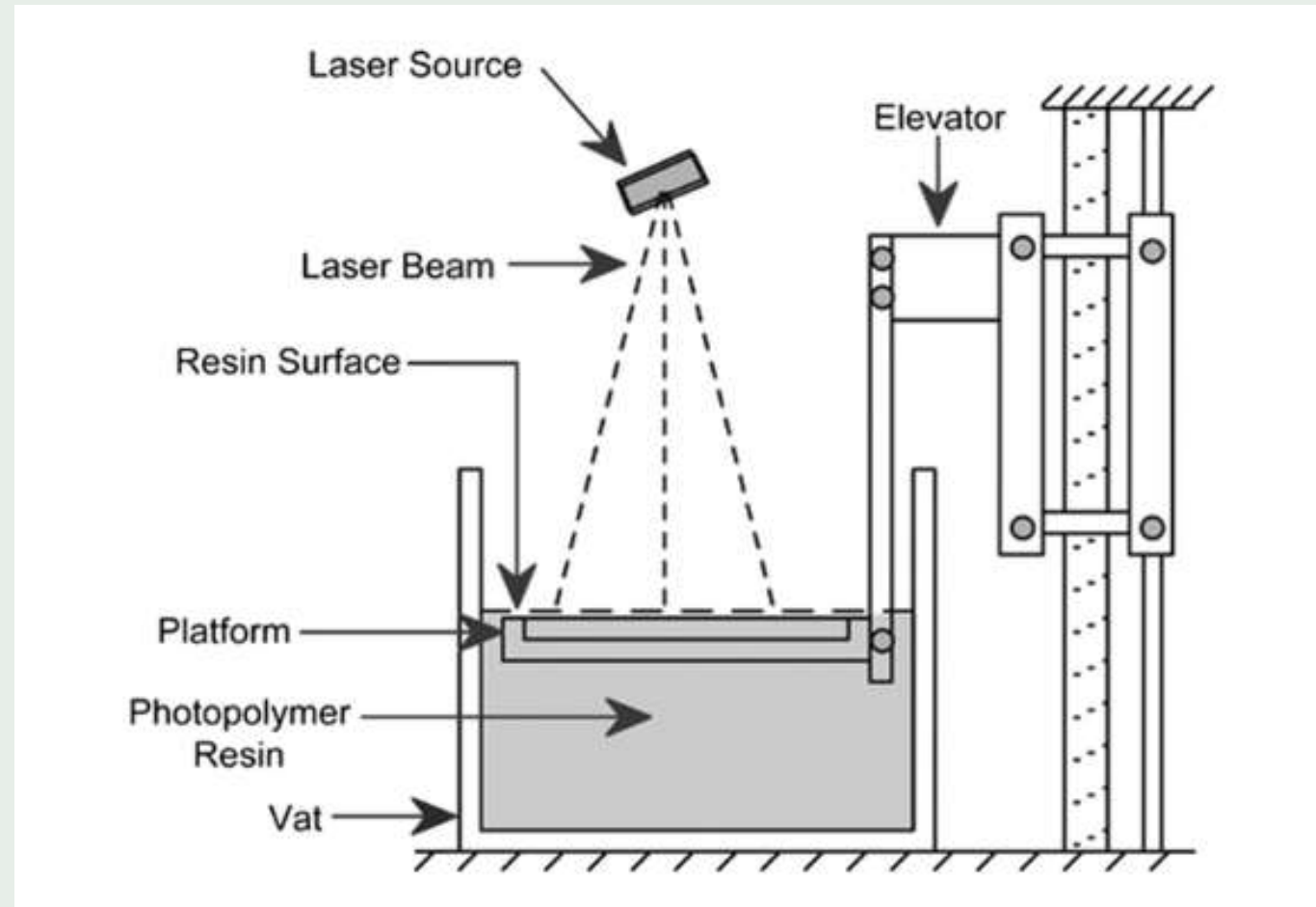
# ***Rapid Prototyping***

*Rapid prototyping is the fast fabrication of a physical part, model or assembly using 3D computer aided design (CAD). The creation of the part, model or assembly is usually completed using additive manufacturing, or more commonly known as 3D printing.*

# ***STEREOLITHOGRAPHY (SLA)***

*Stereo lithography (SLA) refers to a technology that uses ultraviolet light to photo-polymerise liquid resins. The material, in a photo sensitive liquid resin state, is placed within a bath and is exposed to UV light, creating a thin photopolymerised layer of solid material.*

# ***STEREOLITHOGRAPHY (SLA)***



# ***STEREOLITHOGRAPHY (SLA)***

## ***Components of an SLA printer***

- **Liquid Photopolymer Resin**

*This clear and liquid plastic material starts off in liquid resin form. It is contained within the resin tank and sensitively reacts to UV light. Popular resins used include epoxy, acrylic, and vinyl-based formulations. The resin must match the printer specifications.*

- **Moveable Build Platform**

*This platform is first lowered into the tank where it remains submerged in the liquid resin. The 3D printed object is built layer-by-layer on the platform. It can smoothly move up and down allowing fresh layers of liquid resin to flow beneath.*

# ***STEREOLITHOGRAPHY (SLA)***

## ***Components of an SLA printer***

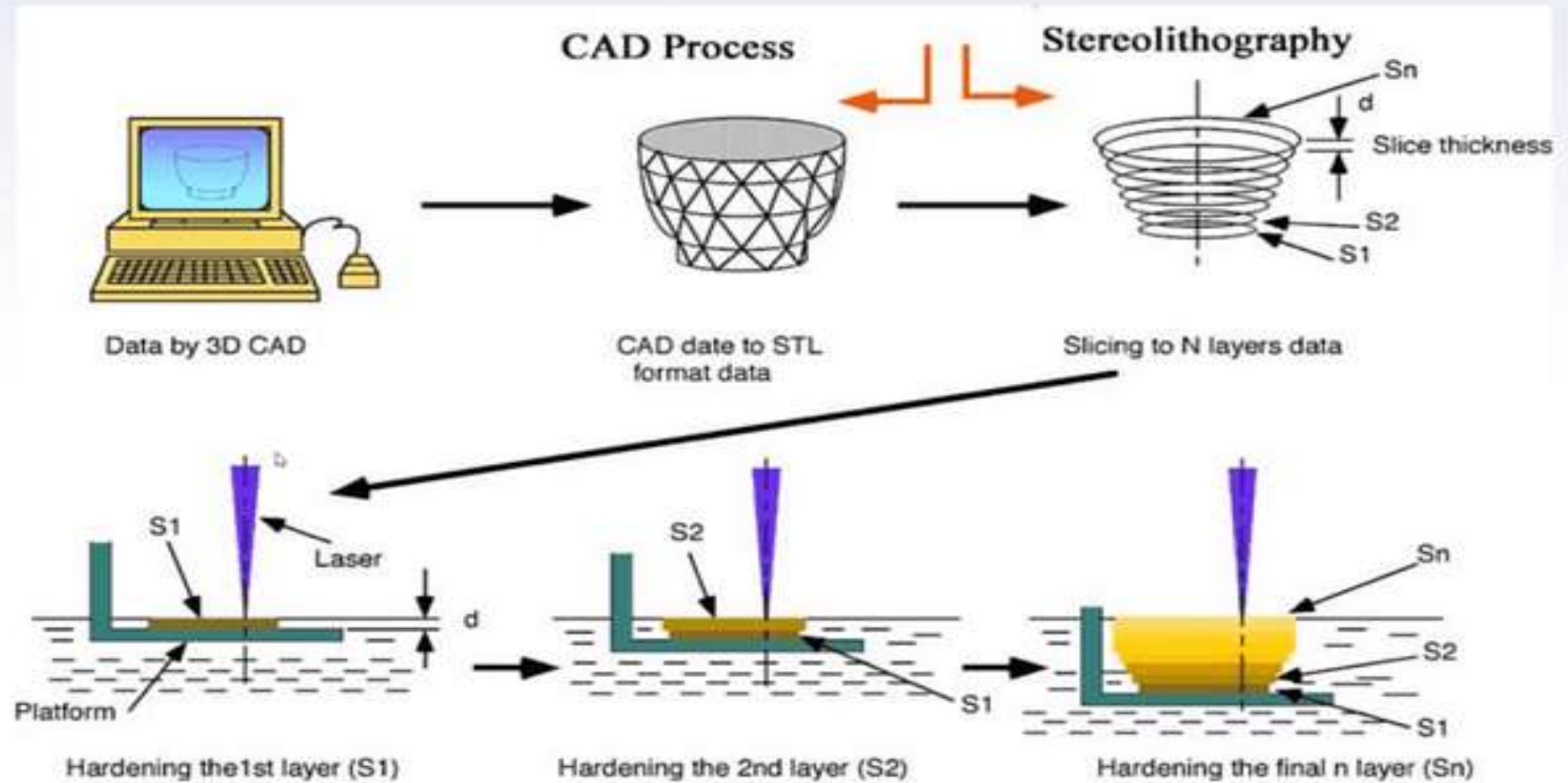
- **High-Powered UV Laser**

*The laser beam traces out each layer's cross section onto the resin surface based on coordinates provided by the software commands. As soon as the laser makes contact, the liquid resin solidifies through a process called photo polymerization.*

- **Computer Interface**

*Specialized software slices the 3D model into layers and generates the necessary laser paths to trace out each layer. The interface manages the laser controls and the build platform movement in a synchronized manner.*

# ***STEREOLITHOGRAPHY (SLA)***



# ***FUSED DEPOSITION MODELLING***

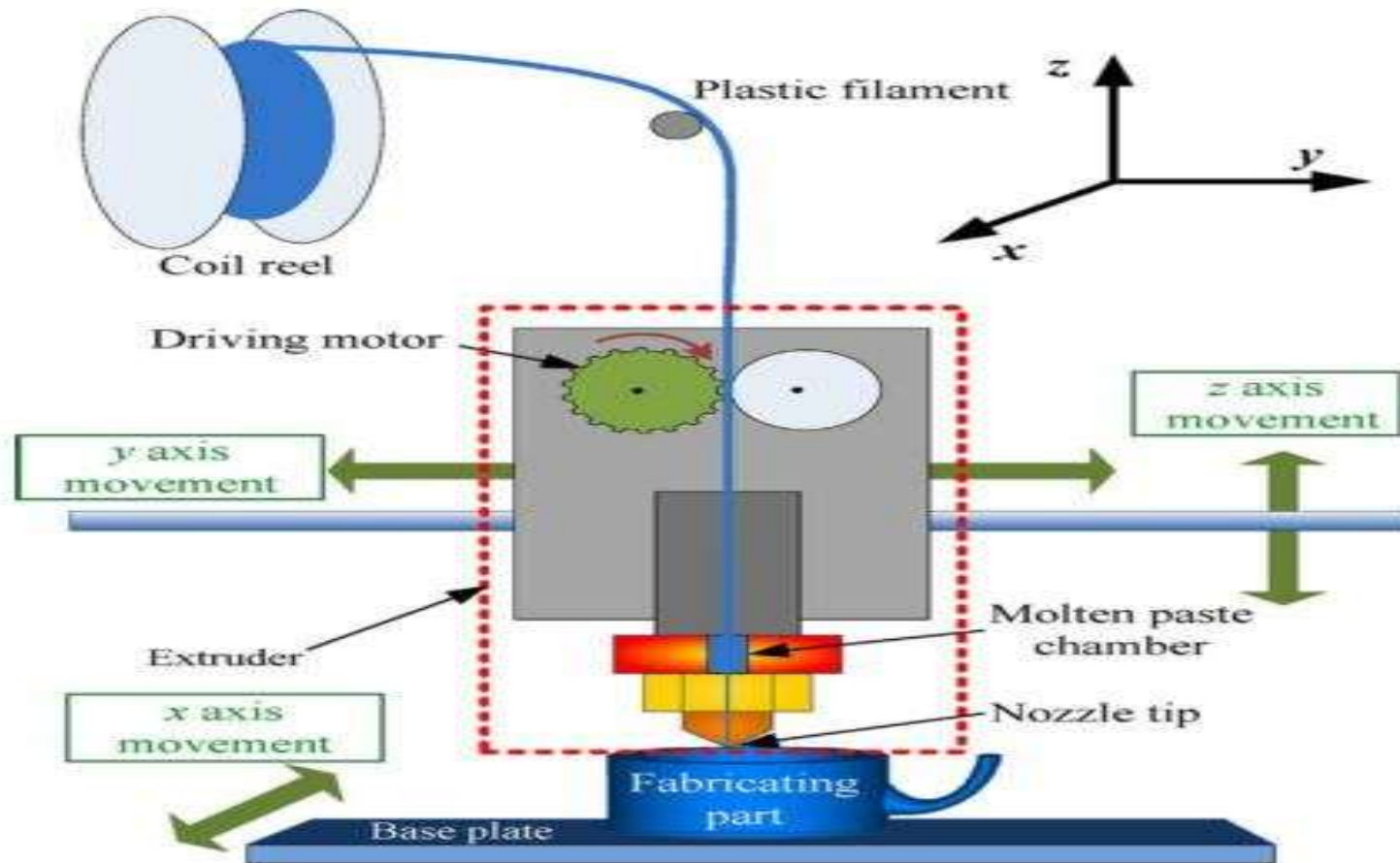
*Fused deposition modeling (FDM) is an extrusion-based 3D printing technology. The build materials used in FDM are thermoplastic polymers and come in a filament form. In FDM, a part is manufactured by selectively depositing melted material layer by layer in a path defined by the CAD model*

# ***FUSED DEPOSITION MODELLING***

- 1. After the CAD data is input, the already loaded solid build material filament is liquefied with the help of heat in the liquefier head.*
- 2. This molten liquid plastic is fed onto the foam build platform as a layer through the extrusion nozzle that moves in all directions as defined in the CAD data. This process of adding the liquid/semi-solid layers one above the other is repeated. If the design consists of over-hangs or structures that might potentially warp or bend, support structures are used. The support material can be the same as the build material or any other material according to the choice.*
- 3. In case support structures were used, they are later removed once the build is complete.*



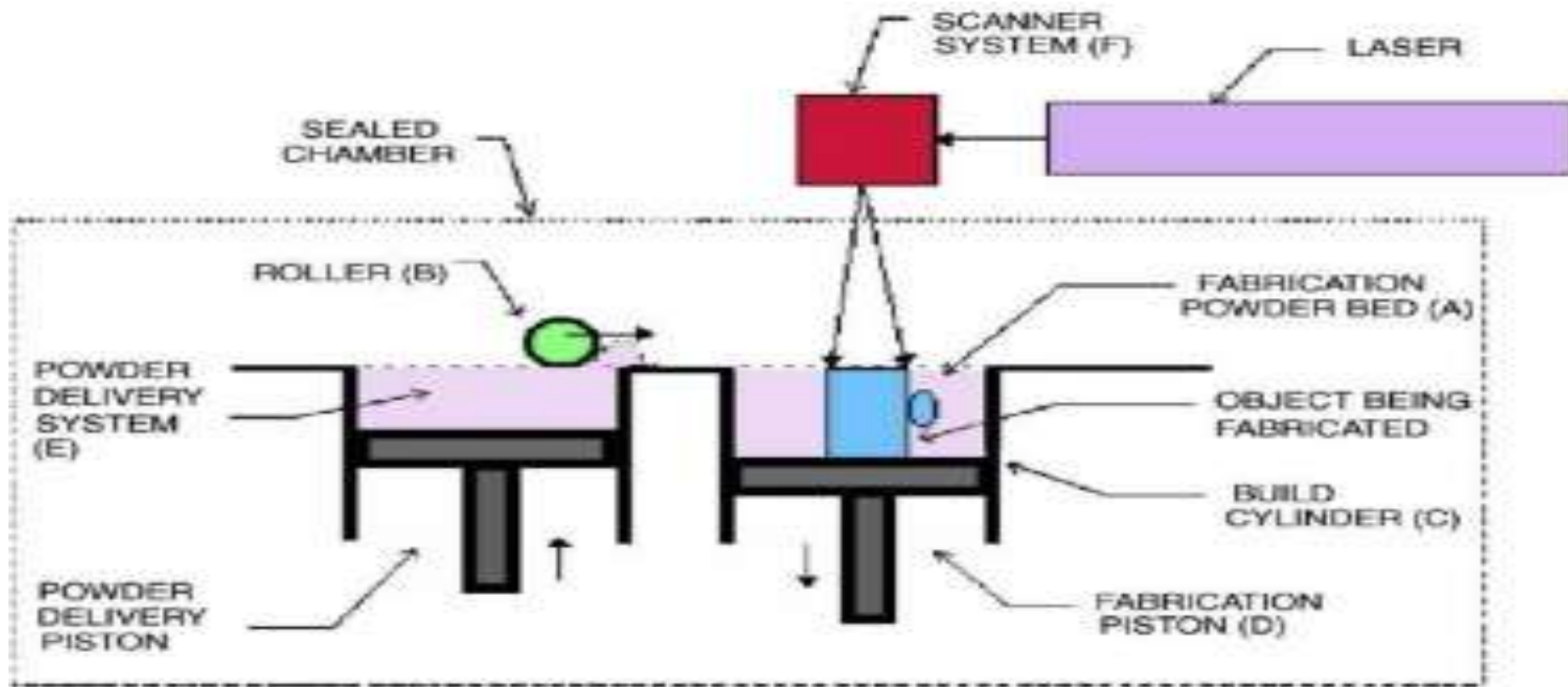
# ***FUSED DEPOSITION MODELLING***



# Selective Laser Sintering (SLS)

*Selective Laser Sintering, commonly known as SLS, is a powerful technique in the rapid prototyping arsenal. It utilizes a high-powered laser to sinter powdered material, layer by layer, to create a solid structure.*

# Selective Laser Sintering (SLS)



# Selective Laser Sintering (SLS)

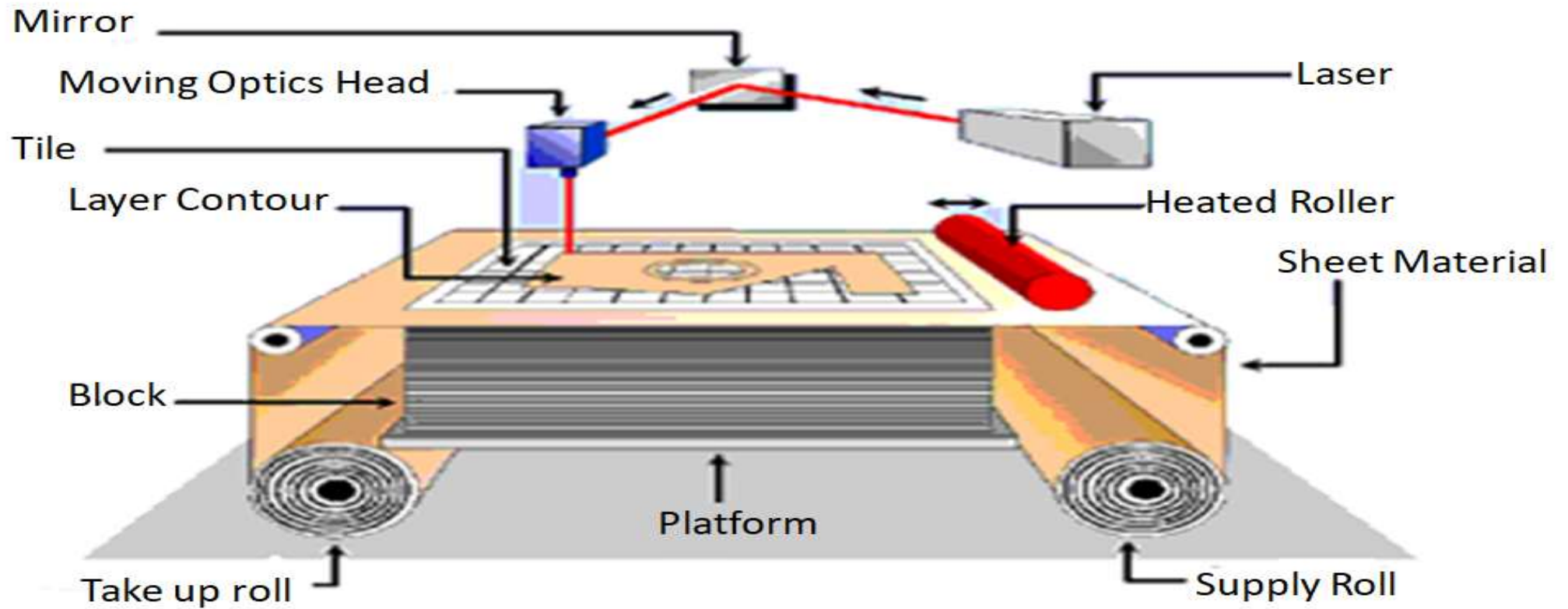
*The laser sintering process has **three** stages,*

- *Warm-up - where the powder in the build chamber and powder supply chamber is brought to the processing temperature.*
- *Build phase - where the parts are fabricated in the build chamber.*
- *Cool down - where the powder is brought down to room temperature after the process is complete*

# Laminated Object Manufacturing (LOM)

- *Laminated object manufacturing is a lesser known additive manufacturing process in which fabrication of objects is done by laying down layers over the layers of the build material sheets.*
- *These sheets are coated with heat activated adhesive materials, so when heat and pressure is applied these sheets get bonded together. This is done with help of Heated Roller, it is rolled over sheet material to activate the adhesive coating.*
- *3D CAD model is sliced in layers and converted into .stl file which contains the information about surface geometry of the model. Countours of 2D projections are cut on each layer using laser cutters or knives.*
- *First layer of sheet material is mounted on a retractable platform which lowers down after processing of each layer. This process is repeated until the final product is ready. Waste material is removed manually.*

# Laminated Object Manufacturing (LOM)



# ***METAL WORKING***

*Metalworking is the process of forming and shaping metals to create useful tools, objects, equipment parts, and structures.*

*Metalworking projects generally fall under the categories of forming, cutting, and joining, and may involve techniques such as cutting, welding, casting, and molding.*

*Materials used for metalworking include ferrous and non-ferrous metals such as steel, aluminum, gold, silver, bronze, iron, and more.*

# ***CUTTING***

*Cutting removes material from metal using milling, routing, turning, and technologies like CNC (computer numerical control) machines.*

*Metals must be cut and separated throughout the metalworking process to build structures, make tools, and more.*

*There are numerous metal cutting methods available for metalworking, from using simple handheld tools to a variety of more advanced machines and equipment.*



# ***MILLING***

***Milling is a type of machining process that uses a rotating cutter to remove material in a controlled manner from a work piece. This subtractive manufacturing technique aims to turn the work piece into the required shape.***

***A modern milling machine is often paired with Computer Numerical Control (CNC) for automated control over the whole process.***



# ***TURNING***

*Turning is a machining process in which a cutting tool moves linearly while the work piece rotates, strategically removing material from the piece. Material can be removed from both the depth and width of the work piece.*



## ***GRINDING***

*It's the process of creating a specific shape or finish by rubbing an abrasive disk or belt against the metal.*

*Grinding is often considered a process related to cutting and can be used to cut metal in certain cases. Typically, an abrasive disk is used for cutting, while belts and circular grinders are used to smooth a nearly finished piece or to create a specific finish on the metal*



## ***DRILLING***

*A cutting process that involves spinning a drill bit to create a circular hole in solid materials is known as drilling. The drill bit is typically a multi-point rotary cutting tool. The bit is pressed against the work piece and rotated at speeds between several hundred and several thousand revolutions per minute.*



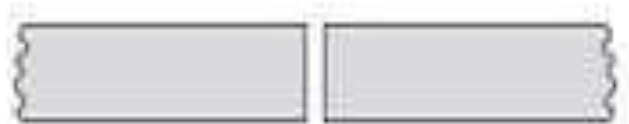
## ***JOINING PROCESSES & TECHNIQUES***

### **Welding**

*Welding is a fabrication process whereby two or more parts are fused together by means of heat, pressure or both forming a join as the parts cool. Welding is usually used on metals and thermoplastics but can also be used on wood. The completed welded joint may be referred to as a weldment.*

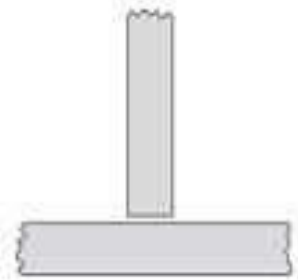
## Common Joint Configurations

### Butt Joint



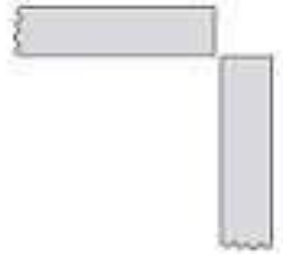
*A connection between the ends or edges of two parts making an angle to one another of 135-180° inclusive in the region of the joint*

## T Joint



*A connection between the end or edge of one part and the face of the other part, the parts making an angle to one another of more than 5 up to and including 90° in the region of the joint.*

## *Corner Joint*



*A connection between the ends or edges of two parts making an angle to one another of more than 30 but less than 135° in the region of the joint.*

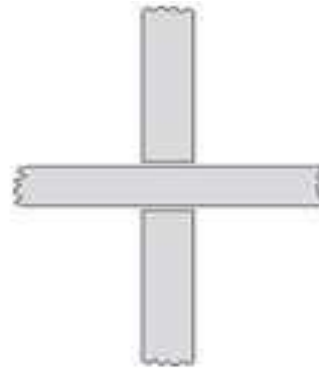


## *Edge Joint*



*A connection between the edges of two parts making an angle to one another of 0 to 30° inclusive in the region of the joint.*

## *Cruciform Joint*



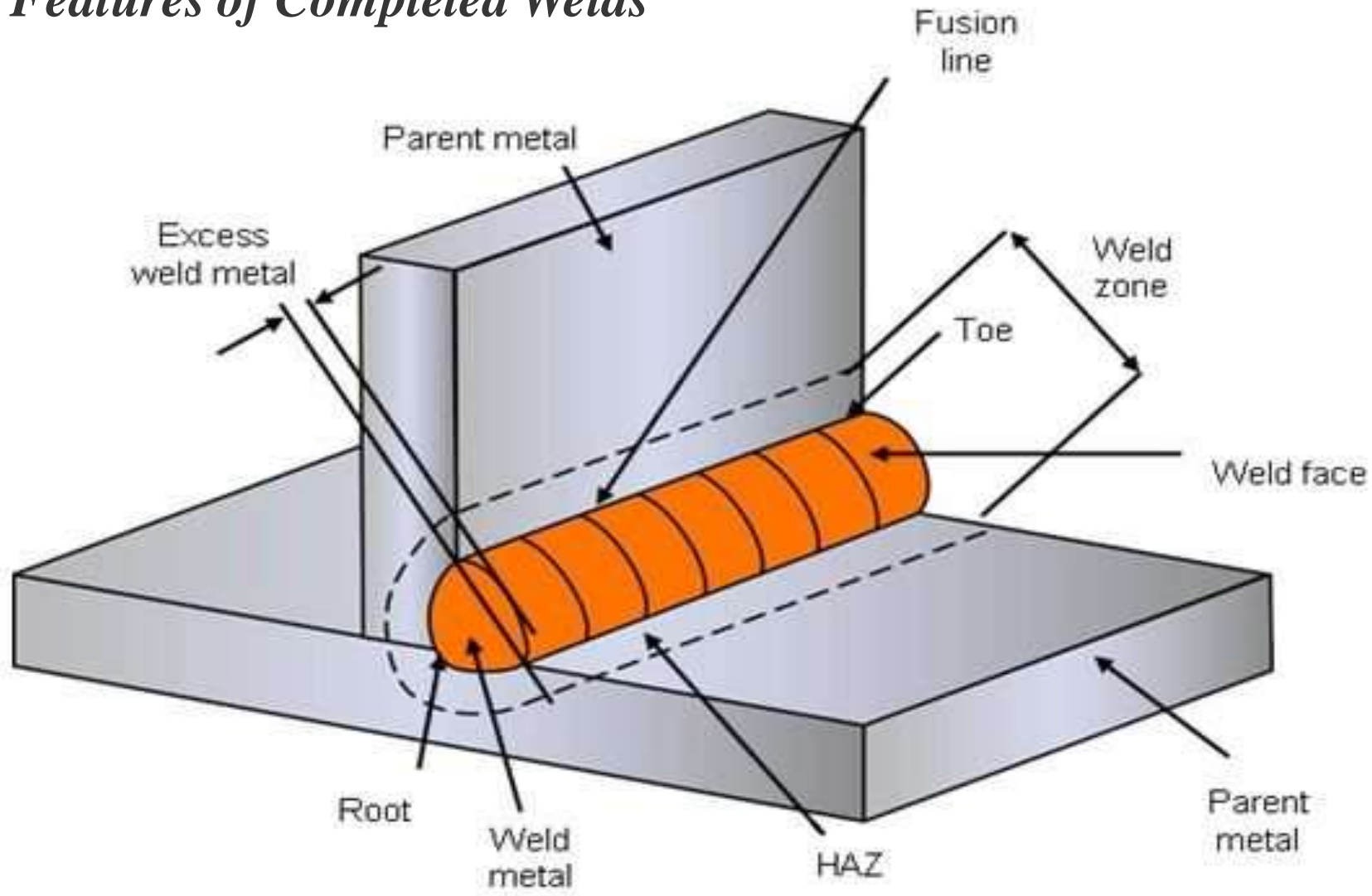
*A connection in which two flat plates or two bars are welded to another flat plate at right angles and on the same axis.*

## ***Lap Joint***



*A connection between two overlapping parts making an angle to one another of 0-5° inclusive in the region of the weld or welds.*

## *Features of Completed Welds*



**Parent Metal:** Metal to be joined or surfaced by welding, braze welding or brazing.

**Filler Metal:** Metal added during welding, braze welding, brazing or surfacing.

**Weld Metal:** All metal melted during the making of a weld and retained in the weld.

**Heat affected Zone(HAZ):** The part of the parent metal metallurgically affected by the weld or thermal cutting heat, but not melted.

**Weld Zone:** Zone containing the weld metal and the HAZ.

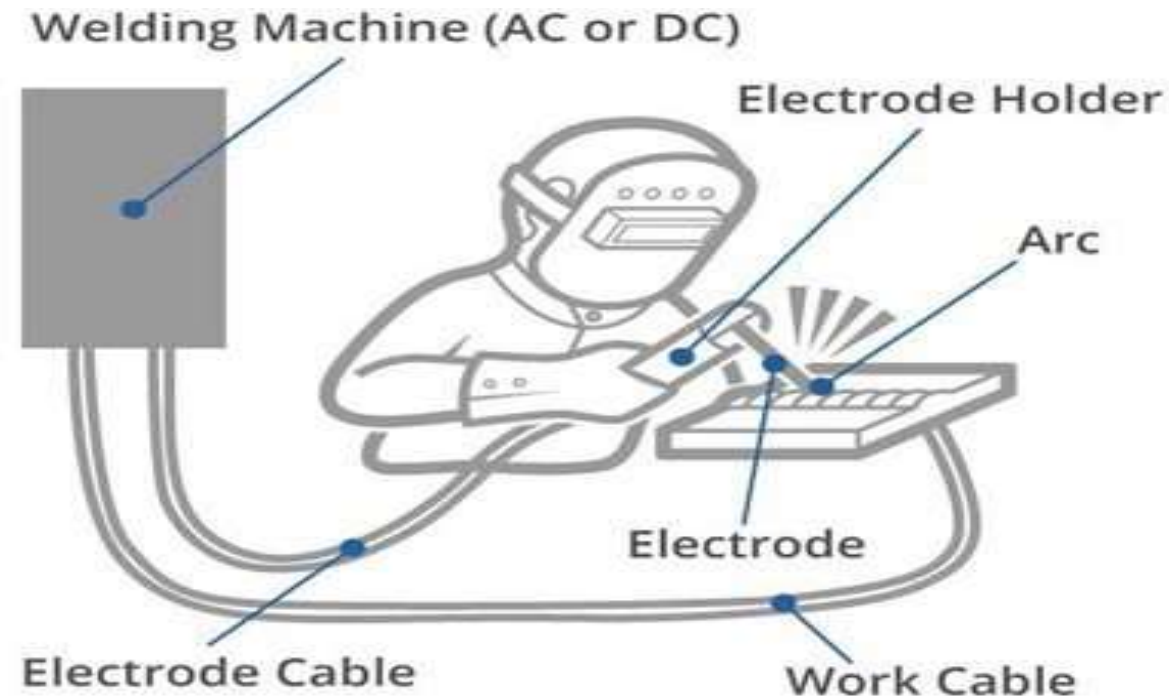
**Weld Face:** The surface of a fusion weld exposed on the side from which the weld has been made.

**Weld Root:** Zone on the side of the first run furthest from the welder.

**Weld Toe:** Boundary between a weld face and the parent metal or between runs.

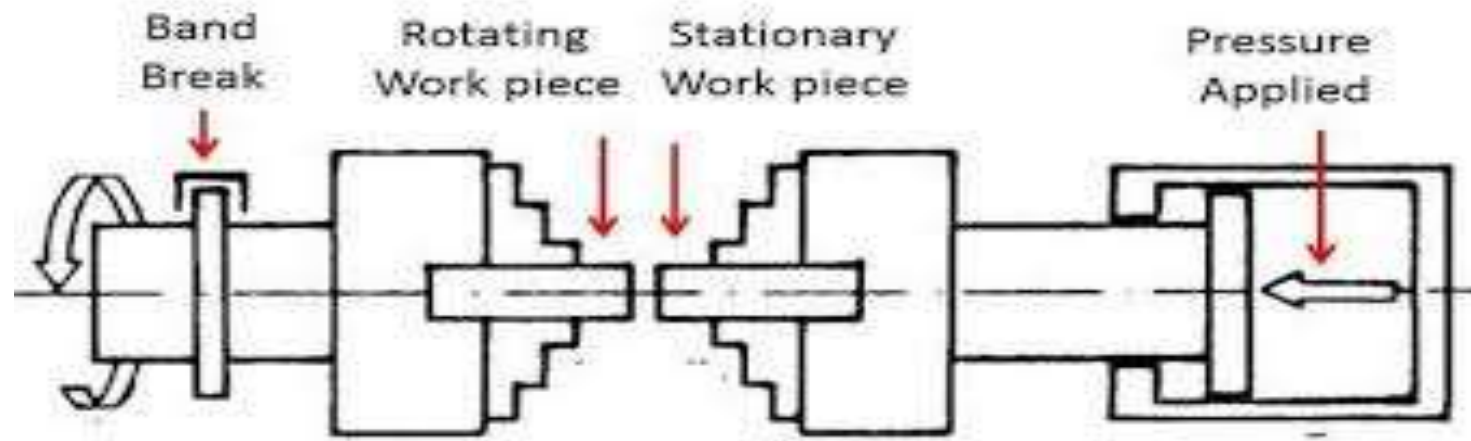
## *Different Types of Welding*

*Arc welding is a type of welding process using an electric arc to create heat to melt and join metals. A power supply creates an electric arc between a consumable or non-consumable electrode and the base material using either direct (DC) or alternating (AC) currents.*



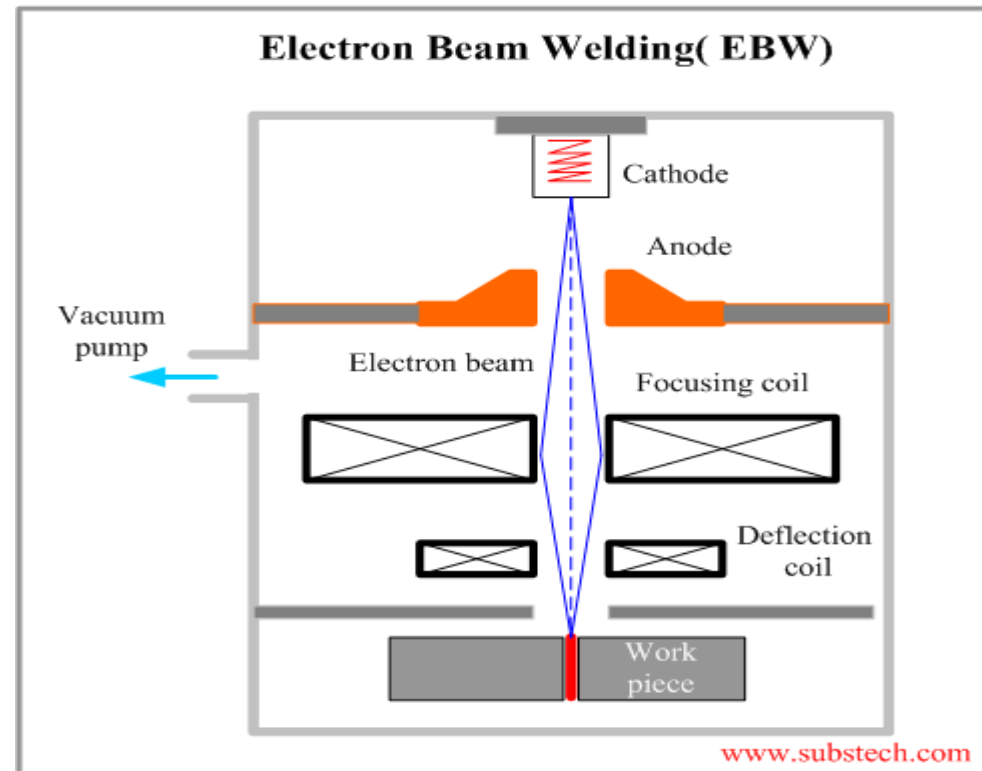
## *Friction welding*

*Friction welding is solid-state joining technique that welds work pieces by generating heat through mechanical friction.*



## *Electron Beam*

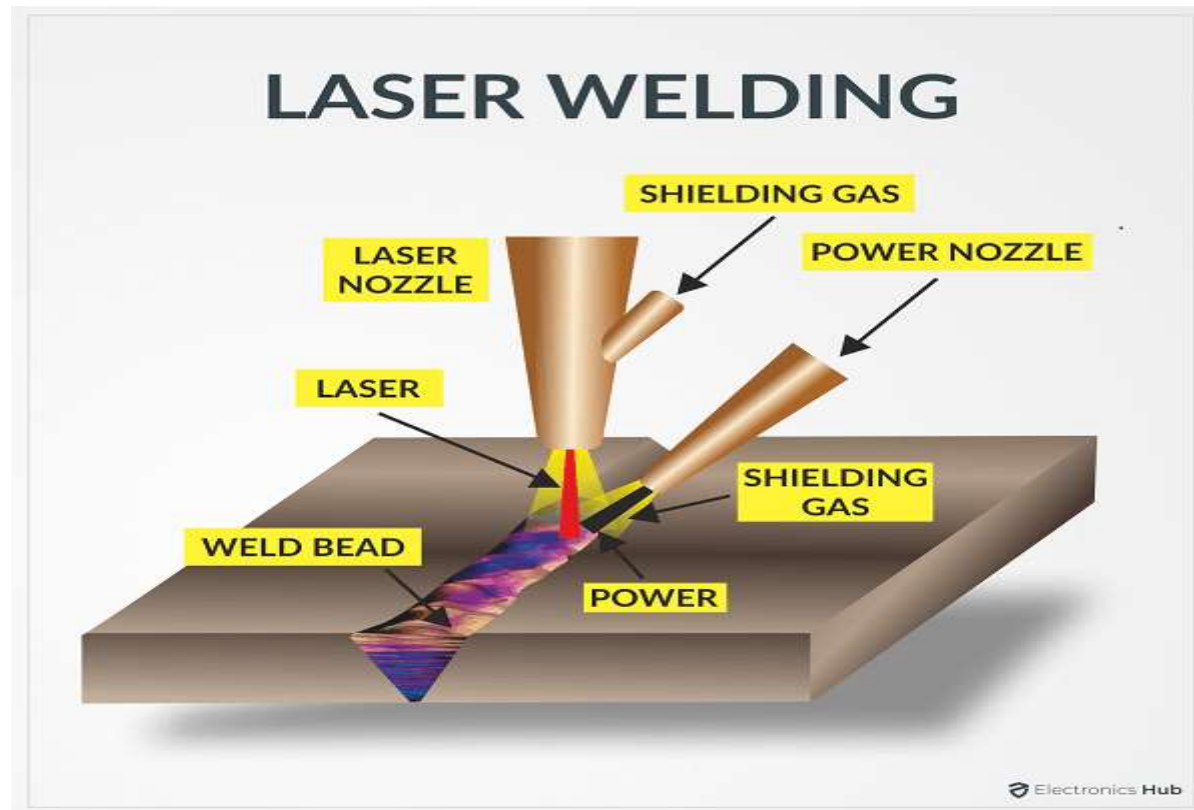
This fusion joining process uses a beam of high velocity electrons to join materials. The kinetic energy of the electrons transforms into heat upon impact with the work pieces causing the materials to melt together.





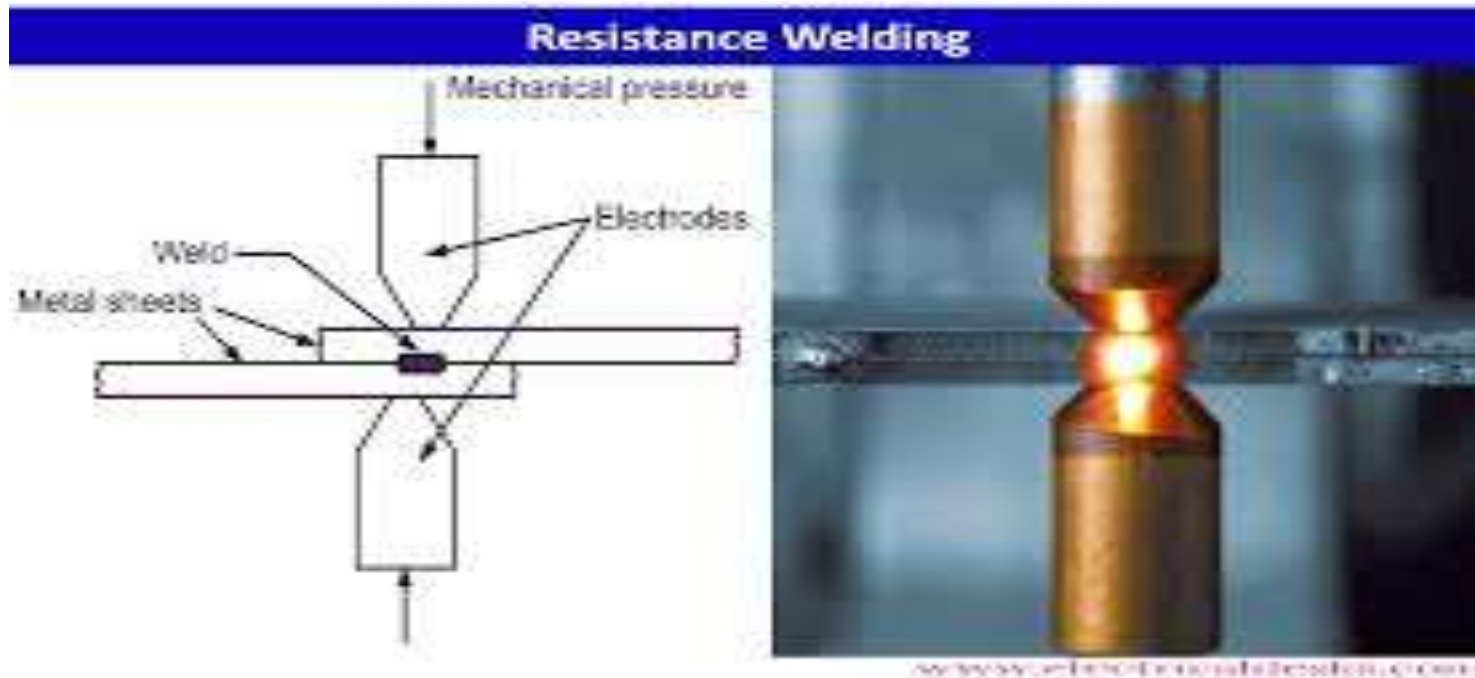
## ***Laser beam welding***

*Laser beam welding (LBW) processes is a unique welding technique used to join multiple pieces of metal through the heating effect of a concentrated beam of coherent monochromatic light known as LASER*



## *Resistance*

*Resistance welding is a cost-effective method of joining metals by applying pressure and passing a strong current through localized points. This pressure welding process involves placing the work piece between electrodes to melt the metals and create a welded joint without the need for additional materials.*

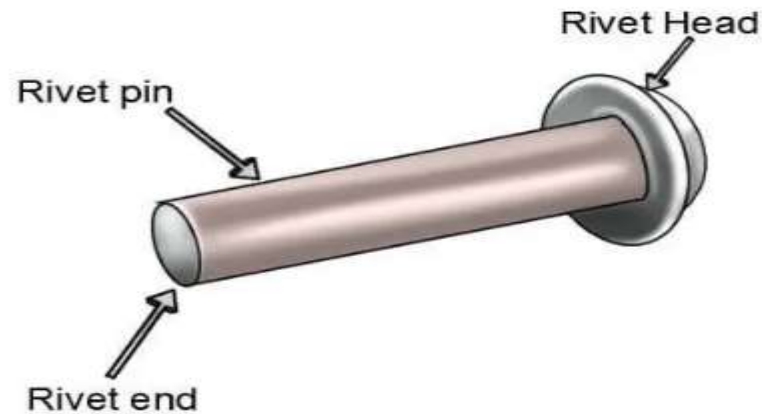


## *Soldering*

*Soldering is a process that joins metals using a **filler metal**, typically an alloy of tin and lead, which **melts at lower temperatures** compared to the base metals.*

## *Riveting*

*Riveting is a forging process that may be used to join parts together by way of a metal part called a rivet. The rivet acts to join the parts through adjacent surfaces. A straight metal piece is connected through the parts.*



## *Sheet Metal Fabrication*

*Sheet metal fabrication is a manufacturing technique that involves making products from flat metal sheets. The various sheet metal fabrication process is compatible with many metal materials. These include stainless steel, aluminum, copper, brass, zinc, and steel.*

# ***SHEET METAL FABRICATION TECHNIQUES TYPES***

- Cutting Sheet Metal*
- Forming Sheet Metal*
- Joining Sheet Metal*

## *Cutting Sheet Metal*

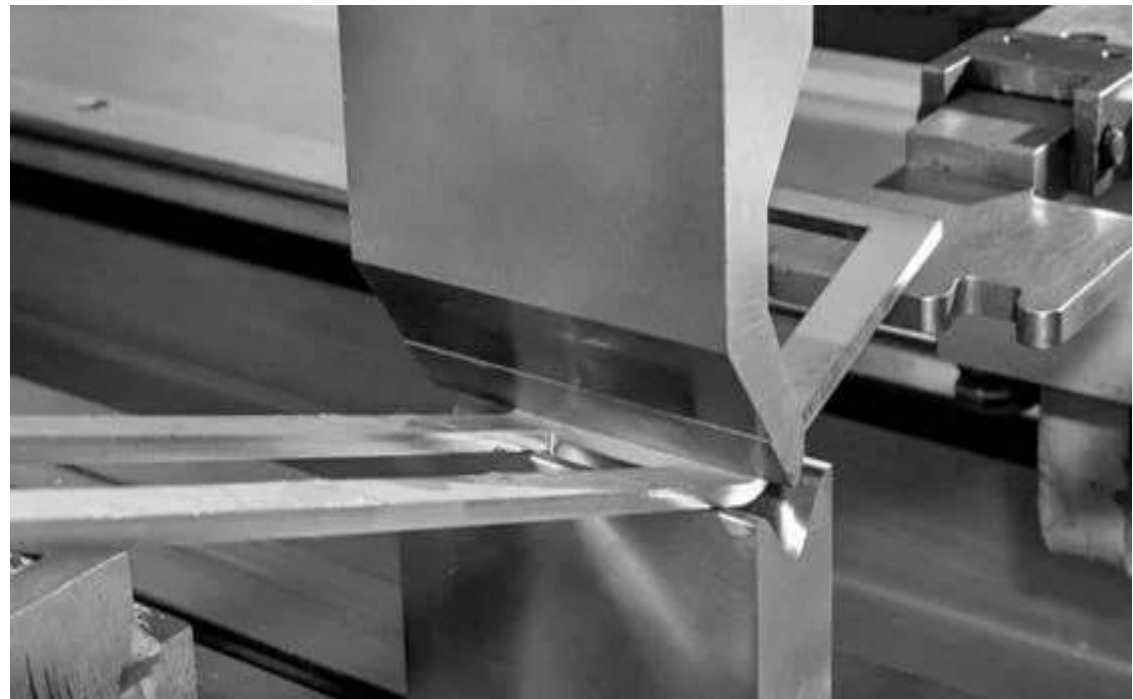
- *Laser Cutting*
- *Plasma Cutting*
- *Waterjet Cutting*
- *Punching*
- *Sawing*



## *Forming Techniques*

### **Bending**

*Sheet metal bending is highly cost-effective in low to medium-scale production. It involves deforming the metal's surface with force and bending it at the required angle to create the preferred shape.*





## *Forming Techniques*

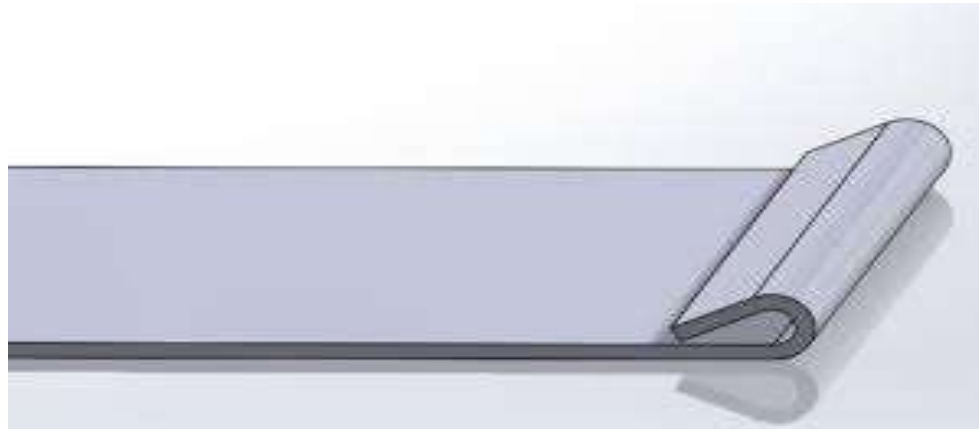
### **Rolling**

*Rolling involves passing a metal piece through a pair of rollers to gradually reduce the thickness of the metal or get a balanced thickness. Cold rolling and hot rolling are the two major rolling processes. Cold rolling often occurs at room temperature, while hot rolling occurs at a temperature beyond the material's re-crystallization.*

## ***Forming Techniques***

### ***Hemming***

***Hemming** is a custom sheet metal fabrication process that occurs when you roll over a sheet metal's edge onto itself to form an area with two layers*



# **Metal sheet Joining Techniques**

- Welding
- Riveting

Thank you