POWDER BASED SYSTEM

Selective Laser Sintering (SLS) :

The basic principle of selective laser sintering (SLS) process is similar to stereolithography (SLA) process. The difference is, in selective laser sintering (SLS) process, the material used is powdered polymer or powdered metal composite instead of liquid resin.

Hence, in selective laser sintering (SLS) process, the powdered polymer or metal composite layer is sintered by selective scanning of surface of powder bed, using laser.

1. Principle of Operation :

The selective laser sintering (SLS) process is based on the principle that powder of thermoplastic material, metals, composites or ceramics is sintered layer by layer, under the heat produced by CO2 laser to build the part.

The various Components of Selective Laser Sintering (SLS) System are

(i) Pre-processing computer

(ii) SLS system computer

(iii) Control unit

(iv) Optical scanning system

(v) CO_2, laser

(vi) Powder feed bed

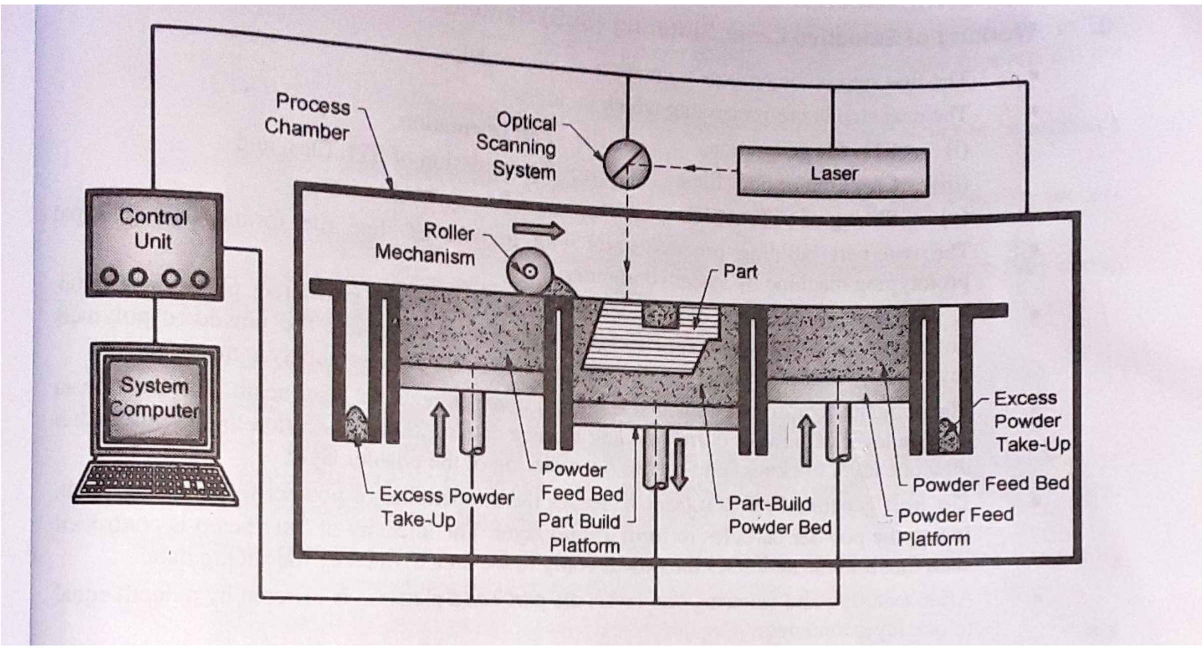
(vii) Part build power bed

(viii) Powder feed platform and cylinder

(ix) Part-build platform and cylinder

(x)Roller mechanism

(xi) Process chamber



Working of Selective Laser Sintering (SLS) System:

1. The first step in the process is creation of 3D-model.
2. The next step is pre-processing which includes:
   (i) STL file generation, (ii) Part orientation,
   (iii) Checking of STL files, (iv) Transmission of STL files, and
   (v) Slicing of STL model.
3. The real part building process starts with transfer of slice file format data to rapid prototyping machine by system computer.
4. A SLS system consists of powder feed bed containing powdered polymer, (nylon,polyamide, polycarbonate, etc.) metals, composite or ceramics. The powdered polymers (nylon, polyamides, polycarbonate used in this process are thermoplastic materials.
5. The computer controlled optical scanning system redirects the laser beam. The laser beam scans a layer of powder corresponding to slice data of 2D cross-section to a depth greater than one layer thickness and carries out sintering of the powder layer.
6. The heat generated by CO2 laser increases the temperature of powder to a melting point, fusing the powder particles to form a solid layer. The intensity of laser beam is controlled such that it melts and fuses the powder only in the area defined by the slicing data.
7. After scanning and sintering one layer, the part build platform is lowered by a depth equal to one layer thickness.
8. A roller mechanism convey a new layer of material from powder feed bed on top of the previously sintered layer for the next scanning and sintering process.
9. The process is repeated until the part is completely built.
10. As sintering operation is performed by high power CO2 laser, the build platform and the powder bed has to be preheated to certain temperature to avoid part deformation. Therefore, entire setup is kept in sealed and heated process chamber filled with nitrogen gas. Nitrogen gas prevents oxidation during sintering process.
11. Selective laser sintering process does not require supports. This is due to the fact that not melted and not fused excess powder in each layer during the process acts as a support.
12. After SLS process, the part is removed from process chamber and loose powder simply falls away.
13. The part or prototype is finished by post processing operation such as sanding, painting,etc.

Advantages of Selective Laser Sintering (SLS) Process:

(i) **Wide range of materials for parts :** The powders of wide range of materials like: nylon, polyamides, polycarbonates, metals, composites and ceramics can be used for making parts in selective laser sintering (SLS) process. This provides flexibility in using materials for parts in different applications.

(ii) **Capable of producing strong parts** : Due to process and type of material used, selective laser sintering (SLS) process can produce strong and tough parts. Therefore, functional parts can be built directly.

(iii)**No additional part supports :** In selective laser sintering (SLS) process, the part is supported by not melted and not fused excess powder. Hence, additional supports are not required. This saves time and material required for support building.

(iv) **High rate of production** : In selective laser sintering process, the parts can be produced in short time.

(v)**Minimum post processing required :** The parts produced by laser sintering process require only minimal post-processing such as sanding.

(vi)**No post curing :** The sintered parts produced by selective laser sintering are fully cured, and hence, does not required further curing.

Limitations of Selective Laser Sintering (SLS) Process:

(i) **Large physical size of unit:** The size of selective laser sintering unit is large.

(ii) **High running cost :** In selective laser sintering process, high power is required for sintering the powder. In addition, process chamber requires continuous supply of nitrogen. This increases the running cost.

(iii) **Poor surface finish :** There is limitations on the surface finish of the parts produced by selective laser sintering process due to size of the powder particles.

(iv) **Generation of toxic gases :** Toxic gases are generated during selective laser sintering process. This leads to pollution.

Applications of Selective Laser Sintering (SLS) Process :

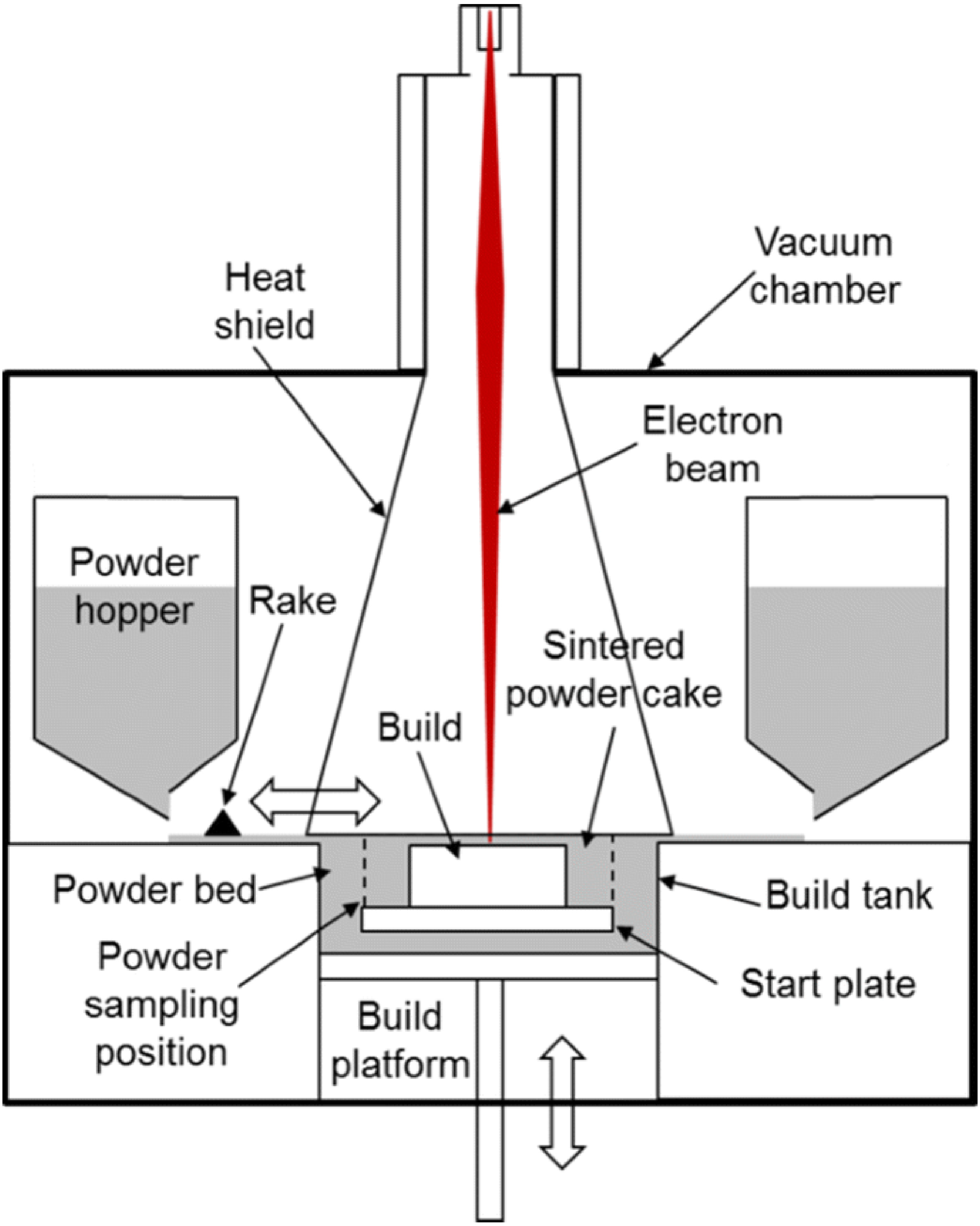
(i) **Concept models** : The selective laser sintering (SLS) process is used for making prototypes for concept models.

(ii)**Functional models and working prototypes :** The selective laser sintering (SLS) process is used for making parts that can withstand limited functional testing.

(iii)**Polycarbonate patterns :** The selective laser sintering (SLS) process is used for making polycarbonate patterns for using in investment casting. The polycarbonate patterns are suitable for designs with thin walls and fine features. These patterns are durable and heat resistant.

(iv)**Metal tools (rapid tools) :** The selective laser sintering (SLS) process is used for making tools for low volume production.

[Electron Beam Melting Fabrication Process for Metal 3D Prints]()



- **Electron-beam additive manufacturing**, or **electron-beam melting** (**EBM**) is a type of additive manufacturing, or 3D printing, for metal parts.

- Electron beam melting or EBM is a type of additive manufacturing that is classified as a power bed fusion technique that was originally patented and developed by Arcam AB. EBM uses an electron beam as the power source instead of a laser .
- An electron beam melts metal powder layer by layer in a high vacuum and can achieve full melting of the metal powder. This method can produce fully dense metal parts and can retain the characteristics of the material.

- The Electron Beam Melting process can produce metal parts with 100% density and its material properties are much better than cast metals. The EBM process takes place in a vacuum which makes this process perfect for manufacturing reactive materials with a high affinity for oxygen. This process also operates at higher temperatures.

- Some of the materials used with this technology are Titanium Alloys which make it an excellent choice for medical implant market, copper, niobium, stainless steel, and titanium aluminide.
- A thin layer of metal powder is selectively melted by an electron beam. The parts are built up layer by layer the in the powder bed. Electron beam melting is similar to laser melting, but working with an electron beam instead of a laser.
- The machine distributes a layer of metal powder onto a build platform, which is melted by the electron beam. The build platform is then lowered and the next layer of metal powder will be coated on top.
- The process of coating powder and melting where needed is repeated and the parts are built up layer by layer in the powder bed.

Advantages

1. High scanning speed
2. Metals can be used
3. More efficient compare to laser
4. No support structure required
5. Compared to laser melting, EBM produces less thermal stress in parts and therefore requires less support structure. Further, it builds parts faster.

DISADVANTAGES

1. With EBM only metals can be used whereas with laser, metals, polymers and ceramics can be used.
2. Compared to laser melting, the technology does not achieve equally good surface finishes.

Application areas

- **Small series parts** down to one of a kind are produced directly by electron beam melting (post-processing to achieve better tolerances and surface finish might be required)
- **Prototypes** are produced for form / fit and functional testing
- **Support parts** (jigs, fixtures) are produced directly by EBM

- Used in Aerospace and Medical Industry