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Selective Laser Sintering

Selective Laser Sintering (SLS) process was first developed by University of Texas; DTM; Austin, U.S.A. Here sintering of non-metallic and metallic powders are selectively carried out to form a prototype part (three-dimensional objects) through the application of a modulated laser beam.

Equipment Details

The process details and schematic representation are shown in Fig. 3.1. It consists of a process chamber, the bottom of which is equipped with two cylinders:

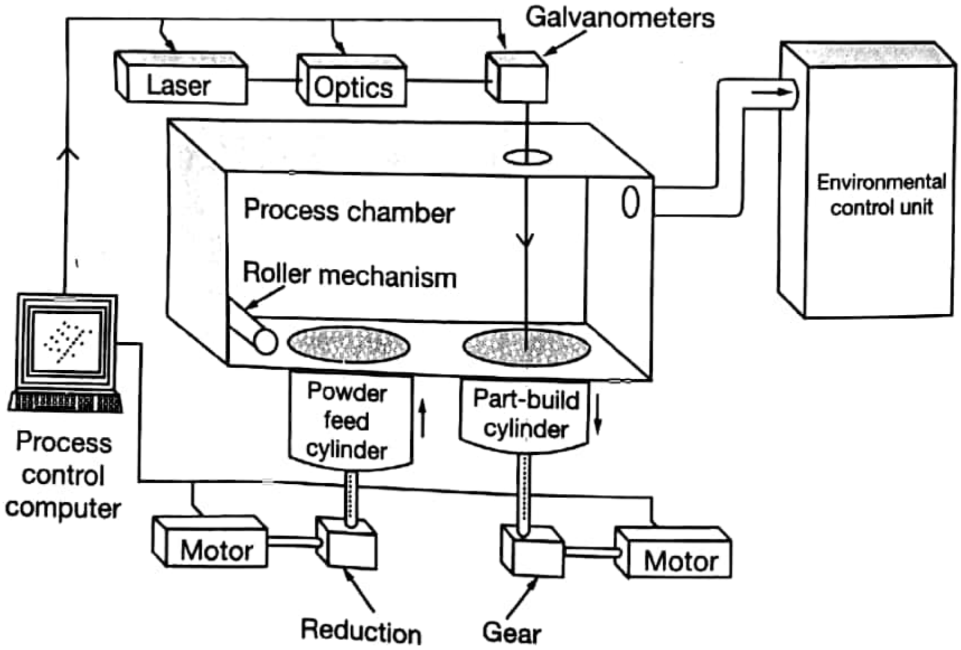

Fig. 3.1: Selective Laser Sintering (SLS) process. Laser beam sinters the powder

1. *Powder feed cylinder*, which is raised incrementally to supply powder to the part-build cylinder through a roller mechanism.

2. *Part-build cylinder*, which is lowered incrementally to where the sintered part is formed.

The equipment is also provided with a laser source with optical system. The laser beam is guided by the process control computer using the NC instructions generated by the 3D CAM programme of the desired part.

Pictorial view of SLS equipment is shown in Fig. 3.2.

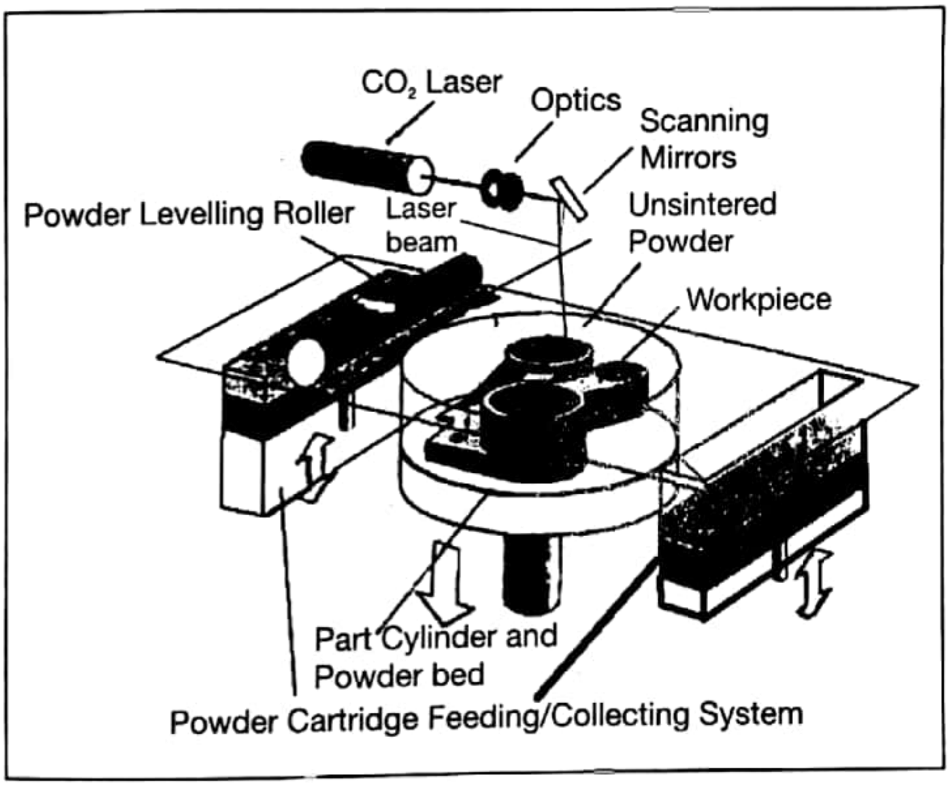

Fig. 3.2: Selective Laser Sintering (SLS)

Process Details

A thin layer of powder is deposited, spread out and levelled by the roller mechanism so that the requisite powder is kept over the top surface of the part-build cylinder.

The laser beam generated selectively scans and focuses on the layer of powder material, fuses (sinters) it on the areas defined by the geometry of the cross-section. The laser fuses the layers together to form a particular thickness which constitutes a solid mass.

The powder in other portions (i.e. unfused material) remains in place as a support for the sintered portion.

After each layer is deposited and formed, the platform lower's the part by the thickness of the layer and the next layer of powder is deposited and kept ready for fusing by the laser beam.

This cycle is repeated again and again till the entire thickness of 3D part is produced and the shape is completely built. The loose particles are shaken off, and the part is removed. The part has enough strength and need not be further cured or sintered.

Types of Materials Processed by Selective Laser Sintering (SLS)

- Plastics or polymers such as ABS (Acrylo Butadine Styrene), PVC (Poly Vinyl Chloride), nylons, polyester, poly styrene, poly carbonate and epoxy resins.
- Waxes (investment casting wax)
- Low melting temperature materials and metal alloys
- Ceramics (with appropriate binders).

Polymer materials are commonly processed. Since melting occurs easily, simple and less power, and less costly laser systems can be employed for fusing/sintering.

However, when ceramics and metallic powders are processed, only polymer binder materials (blended with ceramic and metal powders) alone gets sintered in the machine, forming "green" parts. Complete and full densification is done at the furnace later to give the "dry" strength.

If the laser used is sufficiently powerful, fusing of the metallic particles is possible in the first instance itself, in the processing chamber. Post-sintering and copper impregnation are not required.

Manufacturing of Small Lot Steel Die Parts by SLS (An Example)

Manufacturing of steel die parts for small lot production is possible. For making steel dies, the raw material is steel powder with steel particles coated with a polymer that acts as binder. In the processing chamber only binder coating is fused keeping the particles together. Thus, "green part" is obtained. The green part is put in a special oven to complete the sintering when the binder evaporates leaving it as a porous part.

The porous parts are put inside another chamber to impregnate pores with copper, to increase the density of the part and for good polishability.

Separate SLS machines have been developed to cater to different powder materials.

Advantages

- Any material that can be converted into powders and can be bonded together by fusing its particles at a reasonably low temperature (about 350-500°C) can be used for making the parts in SLS process (materials commonly used for making parts in this process are nylon, ABS and Investment Casting Wax).
- This is the only commercially available direct RP process to make prototypes out of metals. Hence, this is useful for tool and die makers.
- This can also produce ceramic mould cavities directly and hence there is no need for patterns.
- Parts obtained are tough.
- No external support structures are required.
- No post curing is required for non-metals. Only metal parts require sintering.
- Functional metal and ceramic parts can be obtained.
- There is no wastage of material.

Limitations

- This is one of the costliest processes.
- Surface finish of parts is grainy.
- Parts are porous in nature; further impregnation is required to get high density parts.
- The building operation needs to be monitored.
- Long time is required to heat up the material chamber before building the parts and to cool it down after the building the part is over.
- The parts are brittle.

EVALUATIVE QUESTIONS

1. Expand the term SLS.
2. What type of raw material is fed into the process and in what form?
3. What is the power source (heat source) used to heat up the material? How is the laser beam made to traverse?
4. Distinguish between the terms "green part" and "dry part" as used in sintering process.
5. Even though SLS is a process for making prototypes, it can be used for small lot production of steel/die parts. Justify this statement.
6. What are the advantages and disadvantages of Selective Laser Sintering process?
7. What is your concept of "Sintering"? What is the significance of the term "Selective" as referred to in "Selective Laser Sintering" process?