# Study on the Selective Laser Sintering In Additive Manufacturing

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***Abstract:-*** Additive manufacturing process, also popularly known as 3-D printing, is a process where a product is created in a succession of layers. Selective laser sintering (SLS) is one of the additive manufacturing technologies, which is used in the sintering process of powder metallurgical product. During SLS, tiny particles of plastic, ceramic or glass are fused together by heat from a high power laser to form a solid , three - dimensional product .The product printed with an SLS machine starts with CAD files which is converted to .STL format . Unlike other methods of 3D printing, SLS doesn't require the use of additional supports to hold an object together while it is being printed. The complexity factor of this process is almost 0% as in any shape and size can be manufactured except hollow enclosed shape.

***Keywords:-*** *Additive manufacturing, 3D printing, selective laser sintering, CAD, .STL.*

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## I. INTRODUCTION

Additive manufacturing is the process of making objects from 3D model data by joining materials layer by layer, as opposed to subtractive manufacturing methodologies, such as traditional machining. Additive manufacturing has the potential to completely redefine manufacturing in certain areas. The term Additive manufacturing includes a wide range of technologies, such as : selective laser sintering, fused deposition modelling, and many more. selective laser sintering(SLS) is an additive manufacturing technology developed under sponsorship by the Defence Advanced Research Projects Agency(DARPA) and acquired in 2001 by 3D systems. In SLS, plastic, metal (or) ceramic powder is heated by a high powered laser(CO2 Laser) at just below its melting point temperature . This causes the powders to sinter together layer by layer, forming the solid 3D model which was intended to be made. The SLS system consists of a Laser, part chamber, and control system.

The part chamber consists of a build platform, powder cartridge, and leveling roller. A thin layer of build material is spread across the platform where the laser traces a 2D cross section of the part, sintering the material together. The platform then descends a single layer thickness (usually 0.1mm) and the levelling roller pushes material from the powder cartridge across the build platform, where next cross section is sintered to the previous layer. The process is repeated one slice at a time until the part build height is completed.

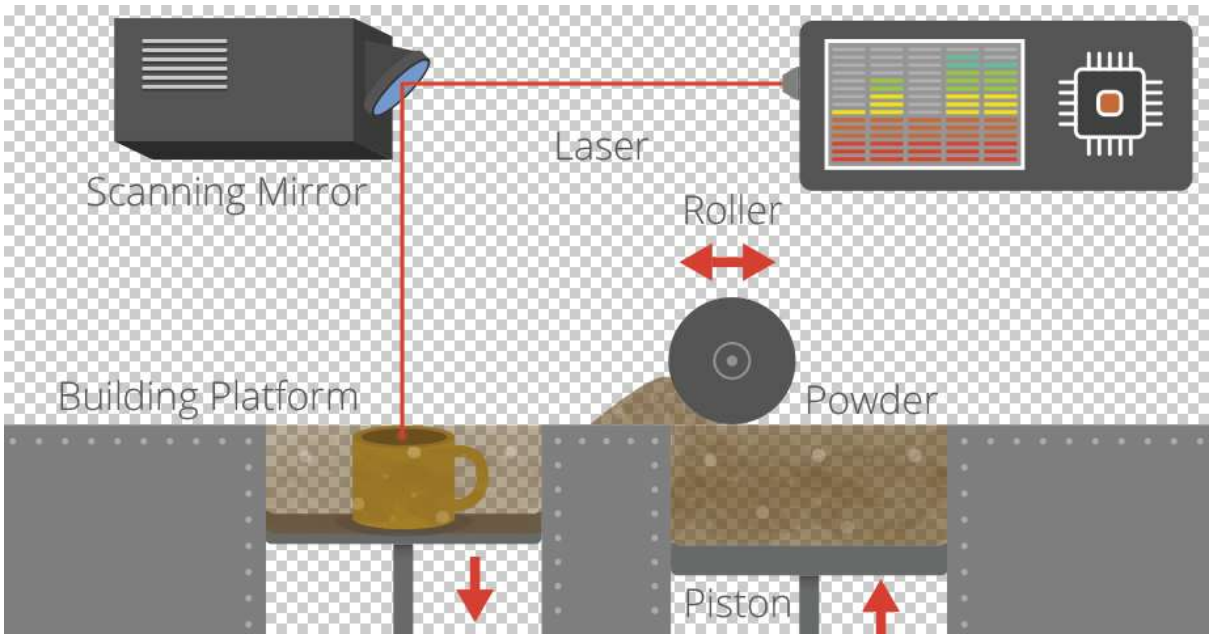


Fig1. Basic layout of SLS machine

## II. HARDWARE OF SLS MACHINE

The capabilities of a SLS machine is determined by its specifications. The specifications to be considered are:

1. Build volume - l x b x h

2. Layer thickness - mm

3. Build speed - mm/ hr

4. Laser spot - mm

5. Maximum scanning speed - mm/ sec

### *Hardware Specifications of a ELITE SLS P3200:*

| | | |
|---|---|---|
| Build volume | : | 320 x 320 x 600 mm |
| Layer thickness | : | 0.13/0.15/0.18 mm |
| C02 laser power | : | 60 w |
| Build speed | : | 10 to 25 mm/hr |
| Laser spot | : | 0.25 mm |
| Maximum scanning speed | : | 13,000 mm/sec |
| Slicing Software | : | VISCAM |

Averagely an SLS machine can cost upto $ 250,000, making such machines expensive to both business and home owners. The good news though is that the core patents for SLS are said to expire this 2014. With those limiting patents out of the way , many more manufactures will now be able to access the SLS technology. consequently cheaper , more improved SLS machines are likely to be developed in the near future.

## III. SELECTIVE LASER SINTERING METHOD

SLS is the rapid prototyping technology with a wide range of functional prototype applications, including those with snap fits, living hinges and other mechanical joints. The accuracy of the final part is based on factors like the material used, how the layers are created and how they are bonded to each other.

steps involved in selective laser sintering :

1. Design of the product in a CAD software

2. Conversion to .stl file ( stereo lithography file format)

3. Printing the product

(i). Design of the product :

The product to be printed is initially designed in a CAD software like CATIA, PRO-E. The parts of the product are designed in the part design workbench using sketch based tools and drafting tools. The parts so designed are saved with the file extension ".CAT part ". Once the parts are designed in the part design, they are assembled in the assembly work bench. The tools used include Manipulation tools and constraint tools. The individual parts are to be constrained in order to avoid undesired translation or rotation of individual parts. Once the assembly is finished , the files get saved with the file format ".CATproduct".

(ii). Conversion to .stl format:

The ".CATProduct" files are not recognised by SLS machine. As such, these files are to be converted to ".stl" file extensions. This is achieved by a pre processing program. It slices the design into many layers and creates a systematic path as per which the product will be printed.

(iii). Printing the product:

The ".stl" extension file is now transmitted to the SLS machine via a connecting cable. At this stage, the printing process can begin. But all 3D printing materials to be used in the SLS process have to be powdered. Before printing starts, the powdered materials must be dispersed above the build platform in a thin layer. The next step will now be to direct a laser down to platform. The laser normally is controlled by a computer and therefore through the computer the designer can easily determine what will be fabricated using the laser. The laser main purpose is to heat the powder and fusing tiny particles together forming a solid object. The process repeats itself over and over again until the entire object has been fabricated.

## IV. COMPARISION WITH OTHER ADDITIVE MANUFACTURING METHODS

Other methods of 3-D printing deployed are :

1. Stereolithography (SLA)

2. Fused Deposition modelling ( FDM )

| Sl No. | Method of printing | Type of input material | Method of treatment |
|---|---|---|---|
| 1. | Fused Deposition Modeling | Solid | Heat treatment |
| 2. | Stereolithography | Liquid | Ultraviolet light |
| 3. | Selective Layer Sintering | Powder | Laser |

The following is a graph showing the market cost having a product manufactured by third .party dealer for different kinds of additive manufacturing. The cost per kilogram of product is considered.


## CONCLUSIONS

The SLS process is a viable time and money saving method for generating complex prototype parts in the plastics and metal industries, based on the materials employed in the system. The benefits of using the system includes: the ability to utilise a variety of materials and future ability to expand the variety of materials. The obstacle with this process is presence of micro-structural defects like voids, impurities or inclusions in final product. Some of the research concluded that powder with smaller size particles distribution could be easily melted and yields high density, superior mechanical strength and productivity.

## REFERENCES

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