

A Review on Selecting the Best Rapid Prototyping Technique for Given Geometrical Object

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ABSTRACT

Rapid Prototyping is the technique which is used to convert the CAD file directly into functional prototype, which saves lead time between design to manufacturing phase. Various RP(Rapid prototyping) technique's such as Selective Laser Sintering (SLS), Sterolithography (SLA), Fused Deposition Modeling (FDM) are vastly used nowadays. The object or prototype produced by this technique require different mechanical properties according to its use. This review paper focuses on the proper selection of the rapid prototyping technique.

Keyword: - Rapid Prototyping (RP), Selective Laser Sintering (SLS), Sterolithography (SLA), Fused Deposition Modeling (FDM).

1. INTRODUCTION

A rapid growth has been seen in the field of RP technology, since the first commercialized Rapid prototyping and manufacturing machine was introduced. Recently research has been done on comparative study between SLS, SLA and FDM. The importance must be given to the functional working of a prototype, while selecting the RP technique. It can be considered by considering the mechanical properties, time, cost, for manufacturing the object for its effective working. Most of the RP technique also has limitation on use of different material at a time, which can rather be used to improve properties and functional working of prototype. Thus a comprehensive study of various process from the perspective of building mechanism, surface quality, surface finish, building time and cost has been done.

2. LITERATURE REVIEW

The Selective Laser Sintering (SLS) is a one of the rapid prototyping (RP) technology by which prototype or objects are created directly from CAD model using layer by layer deposition of extruded from material. The quality produced parts by SLS is affected by various parameters used in the process. Higher strength and surface finish metal object are produced by SLS. In this present work two important process parameters of the SLS process such as layer thickness and Orientation are considered. Influence of each parameter on responses such as change in Tensile Strength, Yield Strength and Surface roughness of the build part are essentially studied.[1].

The mechanical properties and surface finish of functional object are important consideration in rapid prototyping, and the selection of proper parameters is essential to improve the selection of manufacturing process. The purpose is to describe how parts manufactured by fused deposition modelling (FDM), with different part orientations and angles, were examined experimentally and evaluated to achieve the desired properties of the parts while shortening the manufacturing times due to maintenance costs[2].

Design of cellular structures based on a photosensitive resin with varied porosity content is performed. Finite element computation is considered to predict the behaviour of both 3D micro structures and CAD models up to the densification stage. The defects is proved to be related to the design of cellular structures. In addition, both experimental and numerical results show no evidence of anisotropic effect related to additive layering of resin.[3].

3. TYPES OF RAPID PROTOTYPING TECHNIQUE

3.1 Selective Laser Sintering (SLS)

Selective laser sintering is the most common additive manufacturing technology used for many industrial applications. SLS 3D printers has a high-powered laser to fuse small particles of polymer powder. The unfused powder supports the part during printing which indirectly eliminates the need for dedicated support structures. Due to which SLS is ideal for complex geometries, including interior features, undercuts, thin walls, and negative features. Parts produced by using SLS printing process have excellent mechanical characteristics, with strength resembling that of injection-molded parts. SLS produced object have a slightly rough surface finish, but almost no visible layer lines. The common material used for selective laser sintering is nylon, a popular engineering thermoplastic with excellent mechanical properties. Nylon is lightweight, strong, and flexible, as well as stable against impact, chemicals, heat, UV light. The combination of low cost per part, high productivity, and established materials make SLS one of the popular choice among engineers for functional prototyping, and a cost-effective alternative to injection molding for limited-run or bridge manufacturing.

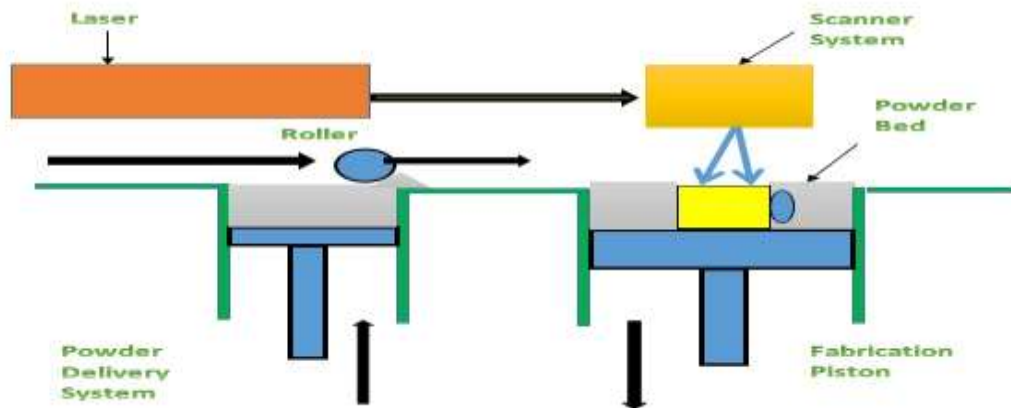


Fig -1: Selective Laser Sintering

3.2 Fused Deposition modeling (FDM)

Fused Deposition Modeling is the most widely used form of 3D printing at the consumer level. In FDM 3D printers build parts by melting and extruding thermoplastic filament, which a print nozzle deposits it layer by layer in the build area. FDM works with various range of standard thermoplastics, such as ABS (Acrylonitrile Butadiene Styrene), PLA (Polylactic acid) and their various blends of these thermoplastic. This technique is well-suited for basic proof-of-concept models, as well as quick and low-cost prototyping of simple parts, such as parts which might typically be machined.

FDM parts have visible layer lines and might show inaccuracies around complex features. Resolution is lowest for FDM and accuracy when compared to SLA or SLS and is not the best option for printing complex designs or parts with intricate features. Higher-quality finishes may be obtained through chemical and mechanical polishing processes. Industrial FDM printers use soluble supports to mitigate some of these issues and offer a wider range of engineering thermoplastics and also come at a steep price.

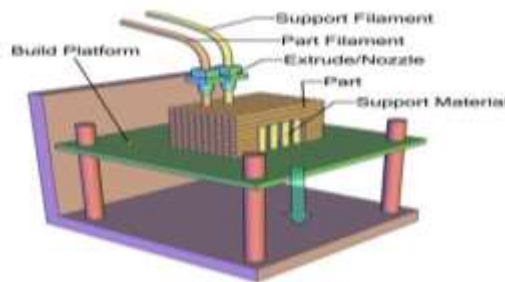


Fig -2: Fused Deposition modeling

3.3 Stereolithography (SLA)

Stereolithography was the world's first 3D printing technology, which was invented in the 1980s, and is still one of the most popular technology. SLA technology uses a laser to cure liquid resin into hardened plastic in a process called photo polymerization. SLA parts have the highest resolution and accuracy compared to SLS and FDM, the clearest details and the smoothest surface finish of all plastic 3D printing technologies, but the main benefit of SLA is its versatility. Material manufacturers have created innovative SLA resin formulations with a wide range of optical, mechanical, and thermal properties to balance those of standard, engineering, and industrial thermoplastics. SLA parts produced have sharp edges, a smooth surface finish, and minimal visible layer lines. SLA is a great option for highly detailed prototypes or object requiring tight tolerances and smooth surfaces, such as patterns, and functional parts. SLA finds wide range of application from industries to engineering and product design to manufacturing, dentistry, jewelry, model making and education.

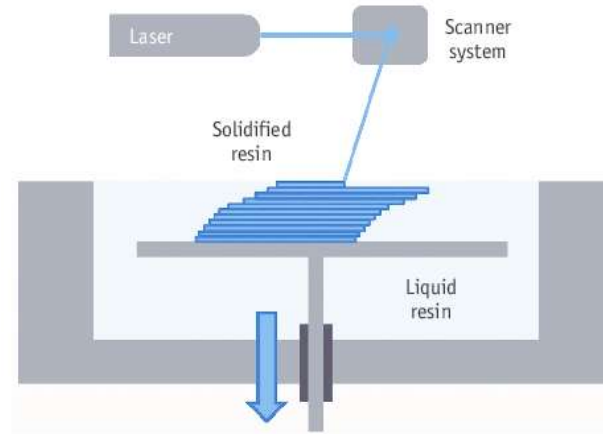


Fig -3: Stereolithography

4. COMPARISON OF SLS, SLA AND FDM

The following table compares FDM, SLA and SLS

Table -1: Comparison of SLS, SLA and FDM

PARAMETER	FUSED DEPOSITION MODELING (FDM)	STEREOLITHOGRAPHY (SLA)	SELECTIVE LASER SINTERING (SLS)
RESOLUTION	Average	Best	Better
ACCURACY	Better	Best	Best
SURFACE FINISH	Average	Best	Better
COMPLEX DESIGNS	Good	Better	Best
EASE OF USE	Best	Best	Better
MATERIALS	Standard thermoplastics, such as ABS, PLA, and their various blends.	Varieties of resin (thermosetting plastics), Standard, engineering (ABS-like, PP-like, flexible, heat-resistant)	Engineering thermoplastics. Nylon 11, Nylon 12, and their composites.
APPLICATIONS	Low-cost rapid prototyping Basic proof-of-concept models	Functional prototyping Patterns, molds, and tooling and casting Model making	Functional prototyping Short-run, bridge, or custom manufacturing

5. CONCLUSIONS

In this paper various conclusion regarding the selection of the rapid prototyping technique for the given object or prototype have been determined, which are enlisted below

- If the given object lack complexity in its geometry and has to be manufactured within less time and low cost of production having sufficient strength then Fused Deposition Modeling (FDM) method is the best option for its manufacturing.
- If the object to be manufactured has an intricate shape or possess complex geometry and also prime importance has to be given to the accuracy and best strength then Selective Laser Sintering (SLS) is the best available process in the market.
- If the final aim to achieve the best surface finish during manufacturing along with accuracy and complexity to some exten, then Sterolithography (SLA) is the best process to choose from.

6. REFERENCES

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