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Product development for future using rapid prototyping techniques

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Abstract - *Rapid Prototyping is a process to develop the impeccable final product. This technique used to make a quick model from 3Dimensional computer aided design. Rapid prototyping technique is help to create different types of model. Rapid Prototyping Technique has two types: additive manufacturing and subtractive manufacturing. In the Subtractive type of rapid prototyping, material removed from the solid to shape the piece and in another type of rapid prototyping, material is added to make the geometry. These are opposite in the process while creating the prototype.*

Key Words: **3D printing, rapid prototyping, manufacturing, product development**

1. INTRODUCTION

In current era, industries are working to improve the quality of the product. Reduction in time and flexibility in manufacturing are important while developing the product. Rapid prototyping is process which helps to improve the quality of product and reduce the prototyping cost. It is the automated process. Initial step to make prototype is design. Prototype made by compiling the CAD files. Rapid prototyping takes less time to build model. There are some methods in the rapid prototyping which is used in industries for manufacturing the product. The Rapid prototyping techniques are given below -

Stereolithography (SLA), Laminated object manufacture (LOM), Selective Layer Sintering (SLS), 3D Printing (3DP), Fused Deposition Modeling (FDM), Solid Ground Curing (SGC).

1.1 RAPID PROTOTYPING PROCESS CHAIN

In the process of rapid prototyping first create a CAD model by using CAD software. When CAD model completed then converted it into Standard Tessellation Language format. Standard Tessellation Language format is focus on surface geometry. After CAD model then process of construction physical model starts by using additive or subtractive type of rapid prototyping techniques. Build 3D model from liquid photo sensitive polymers when exposed to UV rays.

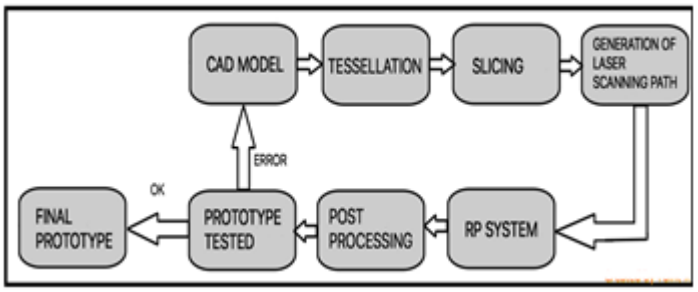

Fig- 1 Rapid prototyping process chain

1.2 STEREOLITHOGRAPHY

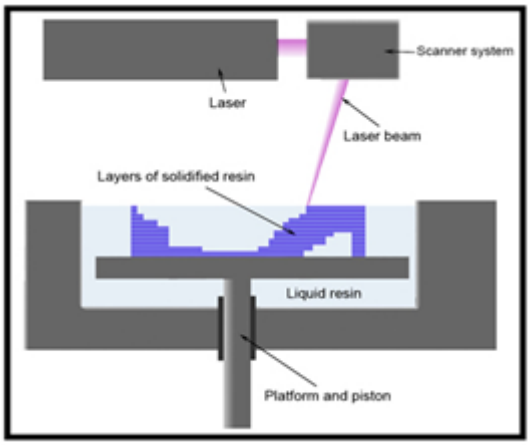

Fig 2 – Stereolithography

Layer of photopolymer uncovered on perforated platform. The UV laser is strike to perforated platform. Initial layer the object formed when UV-curable liquid hardens by UV laser when it is strike.

After initial layer hardened, the platform is lowered then new surface layer of liquid polymers exposed. The laser again traces a cross section of the object. This process is followed again and again. When object formed then it is drown in the tank. The platform is then lifted up to uncover object. It is free of excess resin by cleaning with the liquid solvent. The object is heated in an ultraviolet oven to further cure the plastic.

In this technique advantages of stereolithography are easy to obtain prototypes with a very good finish. It is to get complex geometric shapes. Prototype has good functional surface quality. Product has good finishing. Small parts with high details and up to one meter size of part can create. Its cost reasonable and about two day's parts can create with

good surface finish. In disadvantages it requires post curing. Limited material is also one of the disadvantages. Machine cost of stereolithography is high. It is very difficult to remove the support structures.

1.3 LAMINATED OBJECT MANUFACTURING

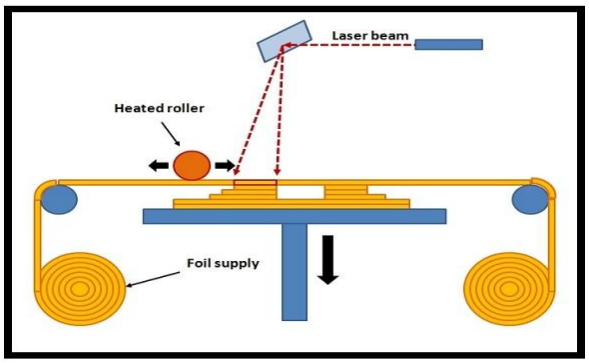

Fig 3 Laminated object manufacturing

In Laminated Object Manufacturing, materials such as plastics, paper, or composites are attached to a stack and laser then traces out the outline of the layer. It cuts away the unused portions.

In this technique the process roll which provides the material to the machine and a stepper motor placed the material on platform. Then a heated roller moves on the material & bonds it to the stack after that it is cut to the required profile by tracing the COR2R laser beam. The excess material which is left in the building block it moves as a support structure for the next layer. Advantage of this technique is that it is not limited by the complexity of the part. Also no internal stresses so the parts have no deformation.

1.4 SELECTIVE LASER SINTERING

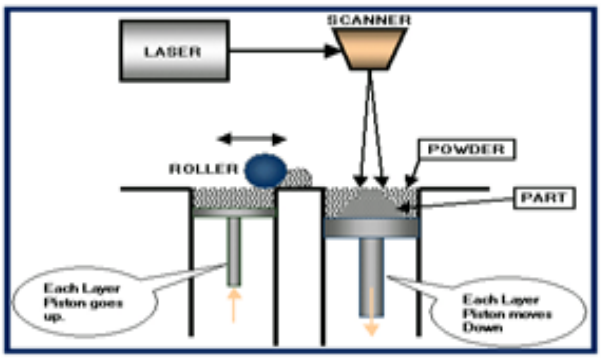

Fig -4 Selective laser sintering

In the selective layer sintering, laser beam used to fuse powdered materials into solid object. Nylon, elastomeric, metal these type of materials used in this type of prototyping technique to transfer it to solid.

A laser beam trace out to the pattern of the first layer. The platform is down then it is applied by powder. This process repeated until model is build. Powder is help to build the physical model. It is solidify by the laser.

Selective laser sintering does not require post curing as compare to stereolithography. Its dimensional accuracy is high. Design changes and modification can be easily done in selective laser sintering. Material selection is flexible.

1.5 3D INK JET PRINTING

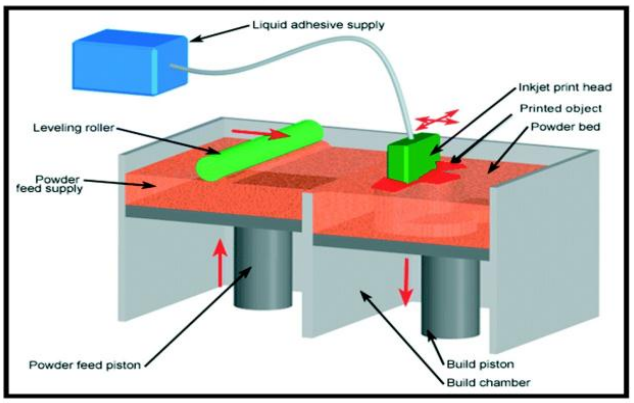

Fig 5- 3D ink jet Printing

Initially when powder supplied by piston then roller used to leveling it. A thin layer of powder covered on build chamber. Liquid adhesive deposited by ink-jet print head to targeted the area of the powder bed and make one layer of the part. When layer is built then built platform goes down and again layer of powder is added and followed remaining process. Powder removed when object completed. This process is very fast. It is more accurate in the process. Physical prototype can make in different materials. Disadvantage of this technique is high cost. Surface finishing is not good. Limitation in the size while developing the product.

1.6 FUSED DEPOSITION MODELING

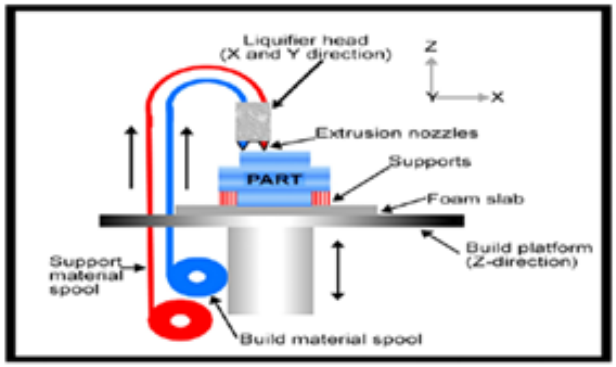

Fig -6 Fused deposition modeling

In fused deposition modeling technique from the tip filaments of heated thermoplastic are force out. The controlled extrusion tip force out the material to make thin layer. The base is controlled by low temperature to harden the thermoplastic. Extrusion head force out the material from tip it is layered on first thin layer. Polycarbonate, elastomeric, etc. are materials used in this type technique.

FDM is a very clean in the procedure. This technique is very simple to use. Materials make it possible to produce complex shape.

1.7 SOLID GROUND CURING

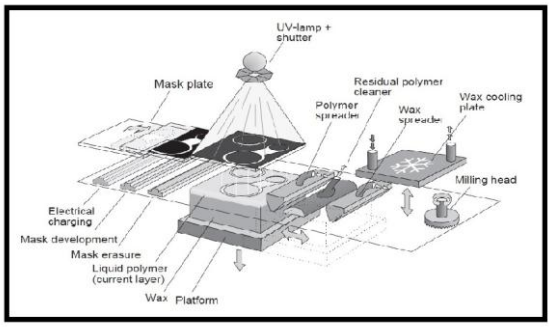

Fig -7: Solid Ground Curing

In Solid Ground Curing photopolymer Harden by lightning using masks. In SGC process, each layer of the prototype is uncovering by an ultra violet (UV) lamp. This technique does not require post curing process. Thickness of the layer and the cross section of each slice layer calculated. Cross section checked by optical mass then thin layer of liquid photopolymer spread on the platform. The mask is positioned over the liquid resin, and the resin is uncovered. Melted wax is spread on the work piece to fill space. The wax is solidified by cold plate. The layer surface is cut by a milling disk. Then work piece is covered by liquid polymer and steps repeated for upper layer until the topmost layer final. In final stage wax is melted. In the SGC process is not needed support structure. The Process of production is not dependent. Damages layers can be milled. Its cost is very high and it produces more waste.

2. FUTURE OF PRODUCT DEVLOPMENT

Product development procedure is starting to change the way. Design and building the product is changing by rapid prototyping. High cost, complex design that difficult to build, more time consumption etc. types of problems are going to decrease by using the various types of rapid prototyping techniques. These techniques are revolutionizing manufacturing. Manufacturing of micro design is possible in minimum time. Varieties are available in development of product. Industries are developing more products in less time by improving speed.

Another Future development is to make large size part. Currently maximum marines are developing limited object. Topographic Shell Fabrication (TSF) uses sand in building material. After that it is bound by wax. This technique is build models up to about 3.6 x 2 x 1.3 meters which is heavy and it melted by sun because of using wax.

Impeccable product development is possible by developing small prototype to check error in design before finalize it. It helps to minimize cost of the product. Another future development is improved accuracy and surface finish. Laser optics should be improved in accuracy in all direction. New materials like non polymers represent expected the development. These are expecting to expand more in future. Industries are now focusing on new materials like produce ceramic matrix composites by laminated object in manufacturing to develop the product.

Development in size, more surface finish and using more materials are the improvement that helps to improve rapid prototyping techniques. Rapid prototyping techniques will continue good growth to build the model.

3. CONCLUSION

This paper focuses on overview of rapid prototyping techniques. Future of the product development is improving fast by these advance technique. Make large size of the product and good surface finishing are the improvement. Focus on the using various materials are also important.

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