Secondary Operation on Fusion Deposit Modeling

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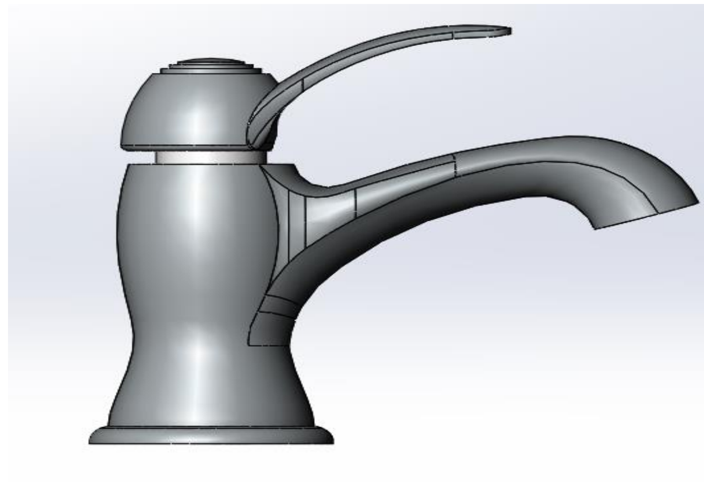
Abstract: Rapid Prototyping is a technology and apparatus for fabricating physical objects directly from parts created in CAD using additive layer manufacturing techniques without manufacturing process planning, tooling or fixtures. In rapid prototype machines were used to produce models and prototype parts. Rapid Prototype technologies now support microscopic manufacturing largely in microelectronics as well as in optoelectronics fabrication and several major areas of rapid prototyping are introduced in manufacturing, Medical, Automobile, Aerospace. The recent research and studies indicating extra layer of epoxy coating makes the RP products water proof. This document will provide through understand of RP technology and surface finishing method to overcome liquid leakage.

Keywords:Rapid Prototyping, CAD Model, epoxy coating

1. Introduction

Rapid Prototyping is defined as the tool less additive manufacturing process to convert CAD models directly into physical parts. It is a reverse Engineering process where CAD model is directly converted into physical virtual model. It is a layer by layer manufacturing process, it does not include tools, jigs and fixture and machining process. It involves solid, liquid and powder technology. Rapid Prototype technologies now support microscopic manufacturing largely in microelectronics as well as in optoelectronics fabrication and several major areas of Rapid Prototyping are introduced in manufacturing Medical, Automobile, Aerospace. A Prototype is original example of something that has been developed. It is a model or preliminary version. It is replica of original object.

Rapid Prototyping is a group of techniques used to quickly fabricate a scale model of a physical part or assembly using 3D (CAD) data. Construction of parts is usually done using 3Dprinting machine which is called as additive layer manufacturing technology. It uses a filament as working media in case of solid technology and it melts at a temperature of 270 degrees of temperature. Rapid Prototyping (RP) can be defined as a group of techniques used to quickly fabricate a scale model of a part or assembly using three-dimensional computer aided design (CAD) data. What is commonly considered to be the first RP technique, Stereo lithography, was developed by 3D Systems of Valencia, CA, USA. The company was founded in 1986, and since then, a number of different RP techniques have become available. Rapid Prototyping has also been referred to as solid free-form manufacturing; computer automated manufacturing, and layered manufacturing. RP has obvious use as a vehicle for visualization. In addition, RP models can be used for testing, such as when an airfoil shape is put into a wind tunnel. RP models can be used to create male models for tooling, such as silicone rubber molds and investment casts. In some cases, the RP part can be the final part, but typically the RP material is not strong or accurate enough. When the RP material is suitable, highly convoluted shapes (including parts nested within parts) can be produced because of the nature of RP.



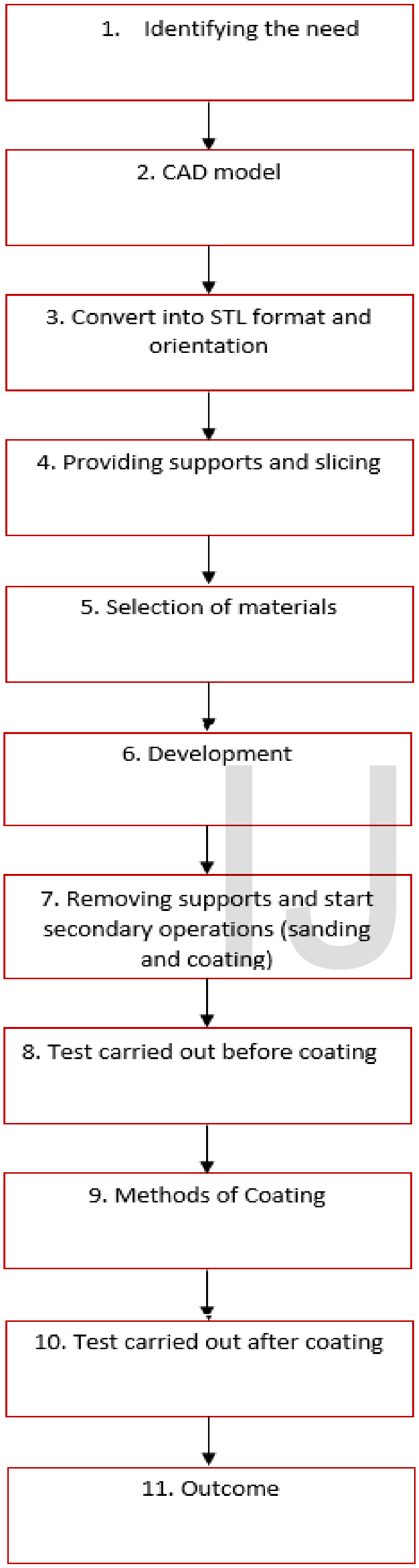


Fig1:Steps involved in rapid prototyping

Fig 2: 3D model

Fig3: STL format of assembled part

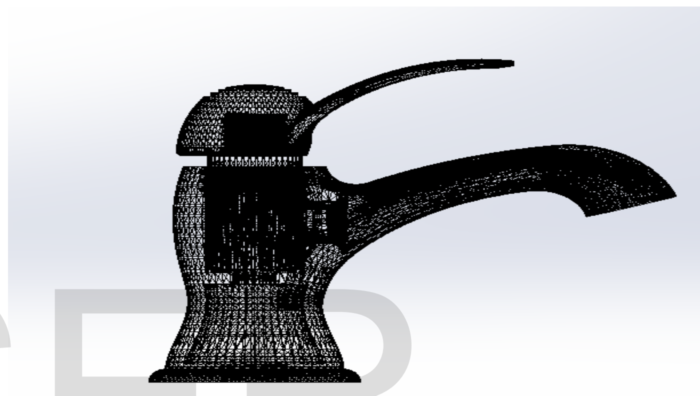


Fig 4: Body

Fig 5: Head

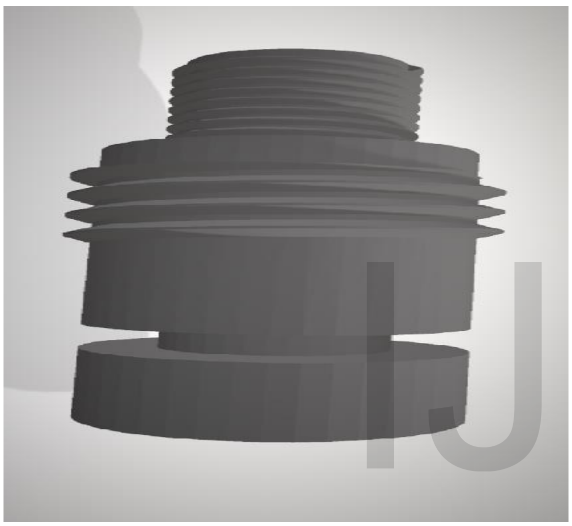


Fig 6: 3 –D Spindle

3-D prited Model

The software which is already inbuilt in 3D printer provides support to the CAD model the main types of software are fine support and curtain support.These are the pre-processing steps to be carried out before printing.Supporting structure is provided by the printer itself (micro-boat=name of the printer).The support has 2 types namely fine support & curtain support. In case of overhanging beam these support plays a major role in 3D printer. According to the geometry slicing is done based standard triangulation language

Fig 7: 3-D printed model

1.4 SELECTION OF MATERIAL

ABS has superior mechanical property but is harder to print when compared to PLA.PLA is ideal for 3D Prints where aesthetics are important. ABS is best suited for application where strength, ductility, machinability, and thermal stability are required.But PLA is less toxic when compared to ABS. melts the filament under 270-degree temperatures and it get solid when exposed to atmosphere.Properties of PLA are friendly bonding with epoxy & resin.

Fig 8: PLA white material

ORIENTATION

Designers often overlook the importance that part orientation plays in the final quality of a 3D printed part. Part orientation impacts on the part accuracy, manufacturing time, strength, and surface finish of 3D printed parts. Orientation plays a predominant role in developing model. Through this orientation we can decide number of slicing and development time. Usually vertical components are spaced horizontally in order to reduce number of slicing and development time. here the tap is placed horizontal direction by providing bed support. Orientation can be performed with in the view or an software. The object should be oriented to.,

- Minimize the distance between the parts and the CAD origin
- Minimizing the height of the support structure
- Minimizing the number of slanted or sloping surfaces
- Minimizing the overall height of the object which reduces the number of layers to built there by reducing the build time
- All the parts should be oriented along the z-axis for slicing to avoid confusion

1.5 DEVELOPMET

The 3D printing process builds a three-dimensional object from a computer-aided design model, usually by successively adding material layer by layer, which is why it is also called additive manufacturing. The term "3D printing" covers a variety of processes in which material is joined or solidified under computer control to create a three-dimensional object, with material being added together, typically layer by layer. Once providing support the development of the model is carried out on the tray. The tray is placed at a certain height based on the geometry length. As shown in fig 4.6. The model is developed using PLA White material which provides good strength and also PLA has friendly bonding nature with epoxy and resin. Also it has high plastic strength. Time taken to develop a model is 3hr 52min, using macro boat 3D printer. The area of the plate is 500*500*250. With single extruder both support material and build material come in the same extruder. The development of model is shown in the figure 9

Fig 9: Development of model

1.6 Removing Deposits And Start Secondary Operation

This step is known as post processing step. Once after the unwanted material is removed primary operation is carried out on the model. Primary operation is known as

1. Sanding paper
2. File tool etc.,

Table 1: Sanding

Medium grade	4 min 15sec	255sec
150 grade	6 min 10sec	370sec
220 grade	7 min 25sec	445sec
400 grade	7 min 40sec	460sec

Coating

FDM uses layer manufacturing technique which is very poor in surface quality. In this study aluminum filled epoxy resin is used as filler for improving the surface quality of FDM model.

Two methods of coating is implemented I this case they are

1. Slurry coating
    - Heat and coat technique
    - Coat and heat technique
2. Dipping coating
    - Heat and coat technique
    - Coat and heat technique

The coating is done using theses material

1. Araldite
2. HAKSONS

Fig 10: a slurry coating material

Fig 11: Material for dipping coating

Fig 12: Slurry Coating

DIP COATING

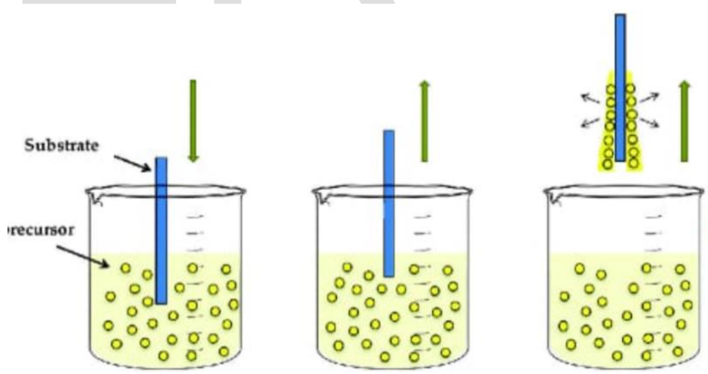


Fig 13: Dipping coat

Dip coating is an industrial coating process which is used, for example, to manufacture bulk products such as coated fabrics and specialized coatings for example in the biomedical field. Dip coating is also commonly used in academic research, where many chemical and nano material engineering research projects use the dip coating technique to create thin-film coatings.

In case of heat and coat technique the model is initially heated to a different temperature as the temperature increases it absorbs the epoxy and resin. Epoxy is also called as a hardener when the model gets heated the filament gets melted and epoxy sit inside the surface so that it improves the hardness of the model. The hardness is tested before coating and after coating in order to see the difference, before coating the hardness number was 17 RHN with respect to 60kn load. Hardness test is done on ROCKWELL HARDNESS TESTING MACHINE Slurry coating is done using cotton brush; two layers is coated on the model coating thickness is around 1-2 mm approximately.

The model is heated at different temperatures as shown in below figures

Fig 14: hot air oven at 60 degree

Fig 15: hot air oven at 140degree

Hardness test

in order to find the hardness of the model ROCKWELL HARDNESS TEST fig 4.8a is carried out to find RHN number. Before coating the RHN number is 17 with respect to 60kn load.

Fig 16: Rockwell hardness test machine

I. Layer to layer gap level

Since FDM is a layer manufacturing technique it has layer to layer gaps at a micro level because of theses gaps FDM model cannot be used for further testing and leakage is unavoidable hence these gaps need to be filled by coating epoxy resin on the layer. It is necessary to know before coating how much the layer to layer has gap? Based on that thickness of epoxy and resin is calculated.
Layer to layer gap can be seen using travelling microscope with 50*magnification. Before coating the layer gap is approximately 200micron. Whereas after coating gap must reduce epoxy resin is filled between layer to layer refer fig 17.

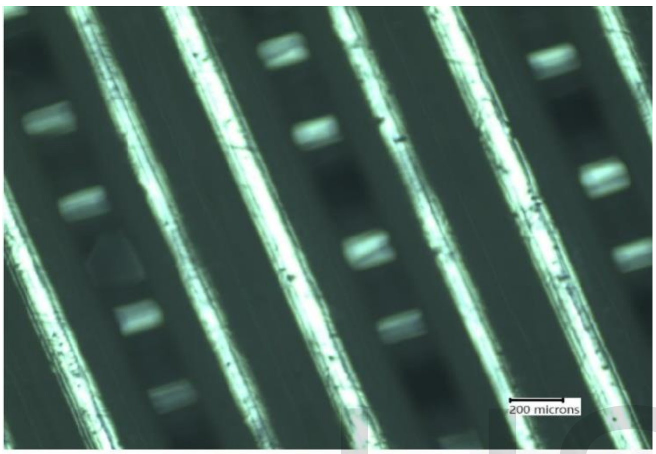
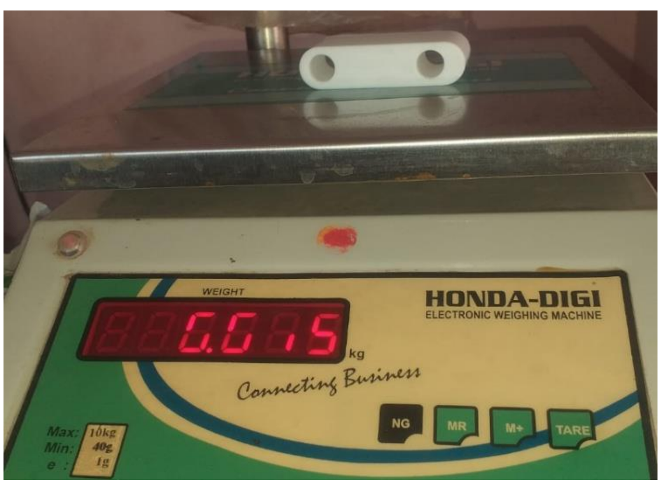


Fig 18: Layer to layer gap

II. Weight of the model

Once after coating the weight of the model should



not get increased if it does so it cannot be implemented in the case of aerospace. Before coating the weight of model is 15 gram when coating is done it absorbs the hardener inside since the hardener is weight and messy to handle there is a chance of increasing weight of the model. But when the model is heated with the epoxy coating it reduces the viscosity and thus reduces the weight.

Fig 19: weight of the model

REFERENCES

Sai Prasanna Pokala and Madhukar samatham: This paper provides a platform for researchers, new learners and product manufacturers to create an awareness of rapid prototyping and manufacturing technology for creating the complicated and different contour products in various field of applications. The various points are discussed in this paper for the researchers to insight the challenges associate in rapid prototyping. However, some of the factors are given for developing the RP techniques in Indian scenario[1].

I. Gibson, D.w. Rosen, B. Stucker and P. Dudek, J. Cieśli, in this paper discussed about despite certain limitations, it is possible to use some composite materials in rapid prototyping technologies. This paper presents, in brief, different RP methods and the potential for the use of complex materials to enhance mechanical, physical or chemical properties. The development of special mixtures of powders is the easiest way to make composites using 3DP or SLS/SLM. It must be mentioned, that SLA and LOM have vast potentials for the fabrication of continuous and short fibres reinforced composites, but for fast and accurate parts production the techniques need to be further developed. Another field in which additive manufacturing has dis-

tinct advantages over conventional techniques is the production of scaffolds for bio composites.[2]

Yembadi Koushik Varma, Samatham Madhukar, Bootla Akhil and Pokala Saiprasanna Kumar: FDM applies a LM process to develop 3D physical model that exhibits low surface quality. In this study, aluminium filled epoxy resin was used as a filler for improving surface quality of model. The practical implementation experiments show that this technique is an economic process and easy of handing. The results and findings reported in this paper are important in the field of rapid prototyping. This technique exhibits industrial value and offers substantial time and cost saving in the development of a new wax injection too .[3]

D.V. Mahindru A and Priyanka Mahindru: Rapid Prototyping is turn refers to as a group of techniques used to quickly fabricate a scale model of a physical part or assembly using 3D(three-dimensional) computer aided design (CAD) data. It is also known as a class of technologies and is defined, for the purpose of primer, as a 'diverse' set of technological tools and resources that can automatically construct physical models from (CAD) data. As on data RP techniques are being increasingly used in prototyping application, these techniques are often collectively referred to as Solid free-from fabrication, computer automated manufacturing or layered manufacturing. FDM in this technique, filaments of heated thermoplastic are extruded from a tip that moves in the x-y plane, the controlled extrusion head deposits very thin beads of material onto the build platform to form the first layer. It maintained at a lower temperature, so that the thermoplastic quickly hardens. Supports are built along the way, fastened to the part either with a second, weaker material or with a perforated junction. [4]

Heechang Kim, Eunju Park, Suhyun Kim, Bumsoo Park, Namhun Kim & Seungchul Lee: Acrylonitrile butadiene styrene(ABS) and polylactic acid (PLA) specimends were created according to the ASTM standards D-638 to determine which factors affect the tensile strength. Materials in the x-direction with fill rate of 100% using PLA exhibited the best **mechanical** properties, and it was also possible to use these factors to print products with **improved** mechanical properties. The 3D printer used in this research was capable of printing products using multiple **materials**. PLA is the mostly used filaments to find the difference in tensile strength, for an **additional** layer with multiple material printing material printing, the horizontal interface **were** expected to have better adhesive forces than the vertical interface. The structural **arrangements** design for multiple material in FDM can affect the mechanical properties. This **means** that the operator should consider the structural design when printing for a fixed **material** ratio. Based on such consideration, the efficiency can be enhanced in terms of mechanical properties even with the same ratio of materials.[5]