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Comparison and Selection of Suitable 3D Printing Technology to Replicate Plastic Material Properties for Rapid Prototyping

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Abstract: In R&D there is need of rapid prototyping to validate new concepts. 3D printing is widely used now a days For rapid prototyping of new concepts. As there are numerous 3D printing technologies are available now in market so it is always difficult to select correct 3D printing technology to replicate plastic material as per requirement in prototyping. Engineers in industry initially struggle or spend time to select best suited 3D printing technology for rapid prototyping of their concept or part. In this study we will be reviewing different available 3D printing technologies and its capabilities in terms of adding properties in printed parts. We will be selecting most common plastic which are being used in industry. For selected materials best suited 3D printing technologies will be compared on the basis of required material properties

Keywords: 3D printing, Plastics, RPT, Comparison, Product

I. INTRODUCTION

In early stage of new product development, selected concepts need to be validated before moving to manufacturing. In development stages manufacturing of parts directly in plastic is not feasible. But there is need to use Rapid prototyping method to validate concept which is best alternative for actual manufacturing process.. 3D printing is one of the well know rapid prototyping technique. It is recent trend in manufacturing sector. It has its unique advantages over conventional methods. 3D printing technology is widely used in R&D sectors of manufacturing industry such as automobile, medical, aerospace etc. But as different 3d printing technologies are available in market so there is always question on quick selection of right technology. In this paper we will be comparing different 3d printing technologies for replicating plastic material . we will list different cases as per requirement in product and we will list best suitable 3d printing technology for each case. This comparison will help user to select 3d printing technology which will be suitable for requirement in their product.

II. METHODOLOGY

Recent trend in 3D printing technology will studied. Most common 3d printing technology with their material which can replace plastic will be selected and compared. On the basis of industrial application most commonly used plastic materials will be selected for study. 3D printing technologies will be compared to replicate selected plastic materials

III. AVAILABLE 3D PRINTING TECHNOLOGIES FOR INDUSTRIAL APPLICATIONS

Following are the 3D printing technologies available in market for plastic

- 1) Stereolithography (SLA)
- 2) Selective Laser Sintering (SLS)
- 3) Fused Deposition Modeling (FDM)
- 4) Digital Light Process (DLP)
- 5) Multi Jet Fusion (MJF)
- 6) PolyJet

Following are the 3D printing technologies available in market for metals

- a) Direct Metal Laser Sintering (DMLS)
- b) Electron Beam Melting (EBM)

IV. TABLE SHOWS COMPARISON OF 3D PRINTING TECHNOLOGIES ON THE BASIS OF PROPERTIES

Properties	3D printing technology			
	SLA	SLS	FDM	Polyjet
Dimensional Accuracy	Good	Less	Poor	Good
Surface finish	Good	Poor	Poor	Good
Stiffness	Good	Poor	Good	Good
Elongation properties	Poor	Excellent	Good	Poor
Overmold compatibility or silicon / rubber material	No	No	No	Yes
Range of material	Wide	Limited	Wide	Limited

Scale : Excllent/ Good/ Poor

Yes/No

Wide /Limited

V. PLASTIC MATERIALS AND THERE EXPECTED PROPERTIES FROM 3D PRINTING

There are variety of plastic materials are being used for different applications.

Most common plastic materials are as follows

Polyethylene Terephthalate (PET), High-Density Polyethylene (HDPE), Polyvinyl Chloride (PVC), Low-Density Polyethylene (LDPE) ,Polypropylene (PP),Polystyrene (PS), polyamide (PA), Polycarbonate (PC),ABS

Table –I

Following are properties of plastics are expected from 3D printing technologies

Properties	Stiffness	Elongation	Surface finish	Dimensional stability
Material				
PP	Yes	Yes	Good	Good
ABS	Yes	Yes	Good	Good
HDPE	Yes	Yes	Good	Good
LDE	No	Yes	Good	Good
PET	Yes	Yes	Good	Good
PS	Yes	No	Good	Good
PC	Yes	No	Good	Good

VI. COMPARISON TO SELECT SUITABLE 3D PRINTING TECHNOLOGY FOR DIFFERENT PLASTIC MATERIALS

Based on requirement of properties in plastic materials, Suitable 3d printing technology can be selected as we know capabilities of selected 3d printing technologies to meet material requirement. Following table will show capabilities of 3d printing technology to simulate properties of plastic

Table-II

Selection of 3d printing technology based on combination of 3d printing parameters

Different materials which suits to requirements	Different cases of material requirement for prototyping				
	PP,ABS,LD PE, HDPE, PC, PS like	PP, ABS, LDPE like	PP,ABS,LDP E, HDPE, PS, PC, PTFE Like	PP,ABS, LDPE, HDPE like	TPE like
Surface finish	High	High	Low	Low	High or Low
Dimensional accuracy	High	High	Low	Low	High or Low
Stiffness	High	Low	High	Low	-
Elongation	Low	High	Low	High	-
Silicon/rubber like /overmoulding	-	-	-	-	Yes
Suitable 3D printing technology for given requirement	SLA, Polyjet	SLS	FDM, Polyjet	FDM, SLS	Polyjet

VII. CONCLUSION

With wide application range of plastic, each every product needs different plastic as per required plastic. But in stage of prototyping we use 3d printing technology to replicate plastic parts. Each 3D printing technology has its own feature make parts. User has to select machine as per requirement in parts. From comparison in this study we come across following findings

- 1) For case of high stiffness, low elongation with good finish and good dimensional accuracy SLA & Polyjet is preferred.
- 2) For case of low stiffness, high elongation with poor finish and good dimensional accuracy SLS is preferred
- 3) For case of high stiffness, OR high elongation with poor finish and dimensional accuracy FDM is preferred

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