



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJIRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 11, Issue 6, June 2022

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.118



9940 572 462



6381 907 438



ijirset@gmail.com



www.ijirset.com

A Review on Desktop 3D Printer and its Process

Chandan P¹, Avanish M Kumar², Sheik Mohammad Arief³, Anish V⁴, Mamatha K M⁵

U.G. Student, Department of Mechanical Engineering, MITE, Moodabidri, Mangalore, India^{1,2,3,4}

Senior Assistant Professor, Department of Mechanical Engineering, MITE, Moodabidri, Mangalore, India⁵

ABSTRACT: Due to its ability to print extremely sophisticated geometrics, additive manufacturing technical advancement has a significant impact on today's advanced society. Because of its inherent mechanical and anisotropic properties, 3D-printed plastic components have a limited capacity for utilisation. The addition of fillers has improved its functionality in terms of flexibility and ease of usage. 3D printing provides several advantages, including customizable geometry, minimal slopes, low cost, and ease of material change. The general topics covered include electron beam melting, digital light processing (DLP), powder-liquid 3D printing (PLP), selective laser sintering (SLS), stereolithography (SLA), and fused deposition modelling (FDM). This study examines the effects of input parameters on output features, including diameter of the filament, temperature of extruder, feed rate, angle of the nozzle, raster angle, working material characteristic and separation between parallel faces. To optimize these parameters, certain ways are given. A description of the techniques developed is thought to aid in comparing their primary characteristics, as well as their benefits and limits, in order to select one of the most appropriate ways for a certain application.

KEYWORDS: 3D Printer, Robotics.

I. INTRODUCTION

3D printing, often known as fast prototyping, is one of the additive manufacturing technologies [1]. A three-dimensional transformation approach for digital models. Plastics, concrete, ceramics, and other materials are commonly used. Efforts to develop additive manufacturing processes began in the 1980s. Charles Hull invented stereolithography after decades of research [2,3]. The Computer-Aided Design (CAD) model of the necessary product or arrangement is the first step in the AM process. Additionally updated is the mesh CAD version. With the appropriate g codes for manufacturing, STL put the file into a 3D printing system. It is a layer-by-layer coating development that provides excellent precision and removes material obstructions [4]. A number of sectors are actively supported by fabrication. It enables the fabrication of lightweight regions such as movable components [5] that include angles and voids to handle extra weight in the automotive and aerospace markets. Simulating and evaluating configurations is simple [6]. 3D printing aids in the creation of kinds for development and concept [7]. The polymer has various physical characteristics that set it apart from tiny molecular compounds, including strength, durability, and viscoelasticity, which allows for deformation under external pressure. This is because polymer chains, which are repeating subunits, are easily transferable. Manufacturers typically pay attention to polymer systems because of their distinctive qualities, including light weight, simplicity of use, extended service life, low cost and possibly ductile efficiency. Conversely, polymers are weaker and have a lower modulus than ceramics and metals, which has historically overshadowed the latter's distinctive properties.

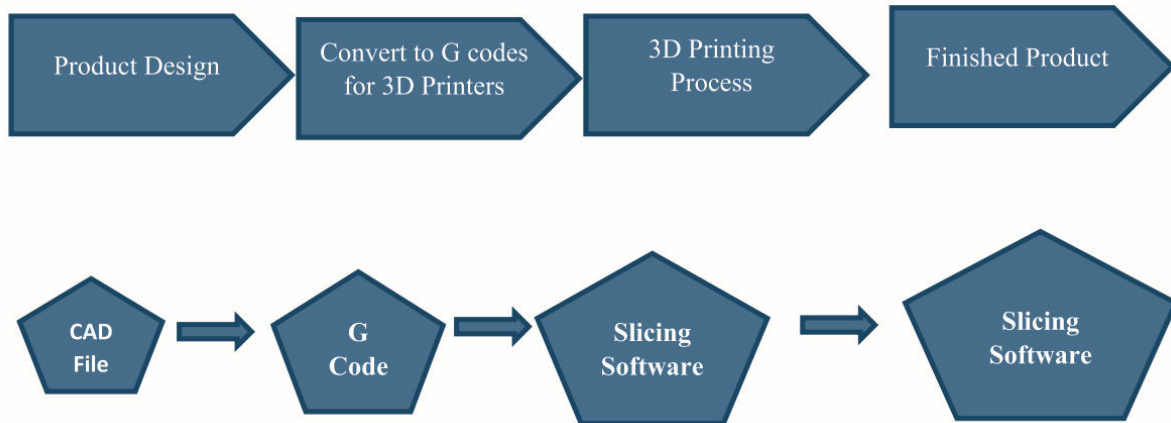


Fig. 1. General system of additive processes

II. TYPES OF ADDITIVE MANUFACTURING TECHNOLOGY

2.1 Fused deposition modelling (FDM) is a most common and cost-effective method of additive manufacturing..

Filament Extrusion Devices are the most widely used technique on the planet. Frequently, they Fused Filament Fabrication, or FFF, is another name for it. How does it work? Once a spool of filament has been loaded into the 3D printer, and then supplied directly into a printer's nozzle through an extrusion headset The nozzle of this printer has been preheated to the required temperature. Also, the motor allows it to break down and propels it around the house. The filament has a nozzle. The blackened material is placed on the plate by the extrusion nozzle following the specified coordinates. to re-establish and to re-energize the printer will not print if the sheet has been removed, a new sheet is placed [8-10].

2.2 Stereolithography

SLA has a long history as the first 3D printing method in the world. Chuck Hull invented stereolithography in 1986, filed a patent for the technique, and developed 3D printers to market it. Galvanometers are used in a SLA system, one in the X-axis and one in the Y-axis. Such galvos quickly aim towards a laser beam passing through a resin vat, curing, and solidifying the cross-section inside this building region layer by layer. Most SLA technologies use a dense-state laser to cure components [11,12].

2.3 Photopolymerization of VAT

Vat polymerization is just a three-dimensional method that involves selectively manufacturing a photopolymer resin in vat using a light source. SLA (Stereolithography) as well as DLP (Directed Polymerization) are two more common methods of vat polymerization (Digital Light Processing). These 3D printing methods would make a difference in the light source used to heal the resin. Those are compared to the method used by SLA printers, which use a point laser [13,14].

2.4 Masked stereolithography

The ultraviolet light is brightened by stereo using an LCD screen that displays a layer slice for a mask and uses an LED array. Like OLP, the digitally produced LCD image mask is composed of square pixels. The granularity of a display is determined by the LCD photomask number of pixels. The difference between Digital light processing and Masked stereolithography is that Masked stereolithography uses many distinct emitters rather than a single purpose emitter light like a laser diode or Digital light processing fluorescent bulb. Under some situations, MSLA may achieve print speeds that are quicker than SLA, which is equivalent to DLP. It's because the full layer, rather than the area, is displayed [15].

2.5 Digital light processing

For Digital light processing, this kind of additive manufacturing is equivalent to stereolithography. A single picture of each sheet is flashed by the DLP system simultaneously (or in multiple flashes for large parts). Each layer is composed of tiny rectangular blocks called voxels since each sheet's image is that of a digital screen. Compared to SLA, DLP can deliver faster print times. Light is projected onto the resin using a Digital Micromirror Device on a Light Emitting Diode (LED) display or a Ultraviolet light source (lamp). A Digital Micromirror Device is a group of small speakers that creates and controls the projected light pattern on the surface of the building [16].

2.6 Selective laser sintering

A laser cutter is used in the additive manufacturing (AM) process known as SLS (selective laser sintering). On the other hand, a resource is the ability to sinter powder content, organise the laser mechanically as indicated by a 3D model, and bind fabric together to create an amazing arrangement. Comparing to selective laser cutting in that they both represent the same idea, although they do it in somewhat different ways in terms of technical aspects. Similar in concept, selective laser melting (SLM) allows for a variety of characteristics because the materials are fully pumped rather than sintered. [17,18].

2.7 Material Jetting

Material Jetting (MJ) works in the same way as a typical inkjet printer. A huge variety of photopolymer droplets are spit out by the printer head, which are then fixed/cured in an infrared (Ultraviolet) environment. The development stage is lowered to one layer depth once one layer has been processed and injected, and the technique for producing 3D structures is repeated. MJ is distinct from other sorts. Material can be repaired or deposited to create a new structure. Rather than working with equipment that have a specific purpose, stick to a course that defines the components of a coat. Deposition is a technique for rapidly accumulating material. Rust has the advantage of allowing MJ printers in a single line to manufacture objects without causing damage.

2.8 Electron beam melting (EBM)

Solidification and melting is caused by a beam at a certain cross-sectional position. These areas are set up to provide a positive outcome. EBM, compared to SLM and DMLS types of additive manufacturing technology, has a much higher build pace due to its energy density.

2.9 Selective laser melting (SLM)

SLM and DMLS produce products in the same way as SLS does. SLS is a crucial part of any design and development process. It mainly differs because it can be used only for metal products. SLM employs a laser to completely melt the powdered material and create a homogeneous component. The portion that results will not create an alloy and just has one melting point. In compared to selective laser sintering, DMLS and SLM processes are structurally aided restrict the possibility of deformation

III. 3D PRINTING MACHINE PARAMETERS

A polymeric feedstock called 3D filament is used to produce fused deposition materials in 3D printers. Different printing temperatures are necessary for the various filaments since they each have unique qualities. 1.75 mm and 2.85 mm are the two standard sizes for the filaments. The term "3 mm" filament is widely used to refer to 2.85 mm filament.

The efficiency, precision and properties of the produced product are significantly influenced by the operating settings. Therefore, any functionally reliable parts production attempt using the Fused deposition modelling technology can incorporate fundamental research into process factors. The FDM production process includes a number of parameters that are listed and quickly explained.

These can be classified into three macro classes for simplicity:

1. Based on geometry
2. Based on process.
3. Based on structure.

1. Based on geometry

3.1 Size of nozzle

A component of a 3D printer that ejects the substance to create the item is called the nozzle. The nozzle's diameter spans from 1 cm to 10 cm. The most typical size of nozzle is 0.4 mm because speed of printing and accuracy are balanced well.

3.2 Size of filament

A polymeric feedstock called 3D filament is used to produce fused deposition materials in 3D printers. For the various materials different printing temperatures are necessary since they each have unique qualities. 1.75 mm and 2.85 mm are the two standard sizes for the filaments. The term "3 mm" filament is widely used to refer to 2.85 mm filament.

2. Based on process

3.3 Melting temperature

It's the temperature of the molten material when it exits the extruder.

3.4 Bed temperature

For additive manufacturing, heated beds are required. As not every machine has them, if used the temperature must be set every time.. For example, 55 to 70 °C is the ideal range of temperature.

3.5 Printing speed

For additive manufacturing, print speed is a very important setting. It affects the movement of the printer. The X- and Y-axis command electric motors, as well as the extruder motor, are all part of it.

3. Based on structure.

3.6 Layer thickness

One of the most essential technical elements of a 3D printer is the layer height, which is the vertical clarity of the z-axis. The three aspects of the three axes are dealt with when project creation using additions.

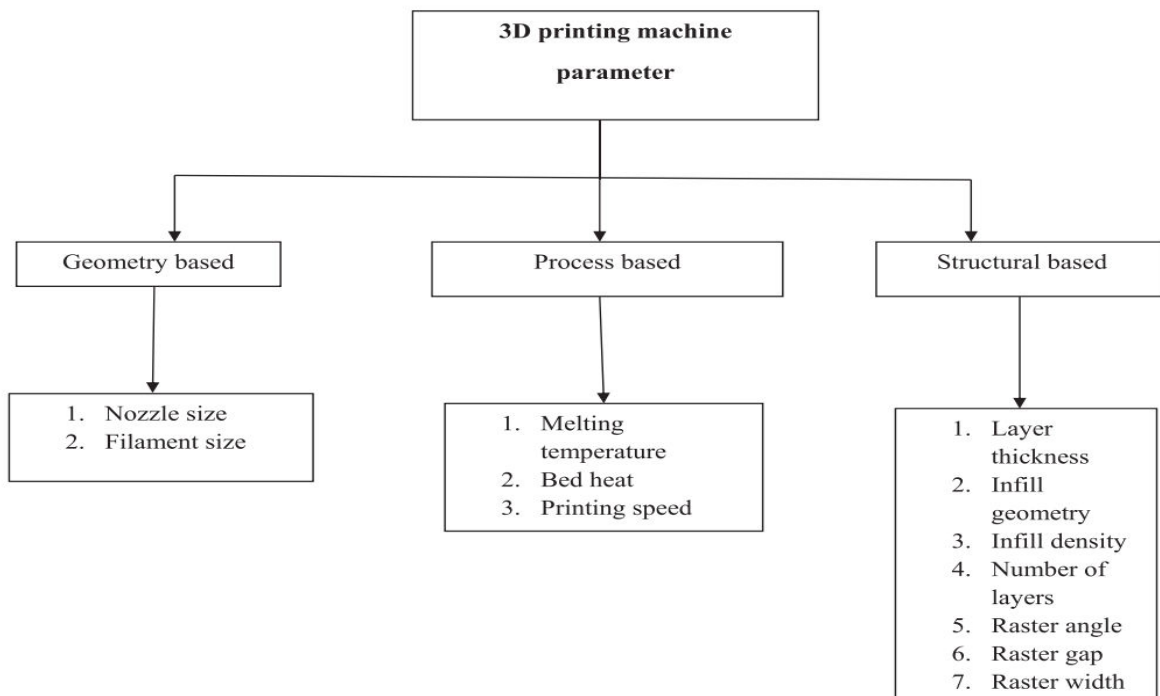


Fig. 2. Classification flow chart of 3D Printing Machine Parameters

3.7 Infill geometry

A design that has infill is also known as infill geometry. In 3D printing, pattern refers to this infill. The artwork was printed on the structure itself. Slice software can be used to define the sequence of infilling for an item in various proportions and forms. Duration of printing, print speed, mass, strength of object, and mechanical qualities are all affected by patterns. In general, infill patterns are divided into four categories: triangular, rectangular, hexagonal or honeycomb, and wiggly.

3.8 Infill density

The amount of filament that fills the piece's inside. Rolling programmes will commonly alter the amount of material from 0% (hollow part) to 100% (full part).

3.9 Raster angle

The X axis of the printer and nozzle path creates an angle which is known as the raster angle. Two subsequent layers' raster angles diverge by 90 degrees. The raster angle has an impact on the mechanical effectiveness and form accuracy of the object under production.

3.10 Raster gap

The air gap is the space between two neighbouring filaments placed in particular layers.

3.11 Classification of polymers

Polymers are categorized in various ways because they are frequently generated or discovered and have a large range of activities. The following are some of the methods that we use to classify polymers:

3.12 Poly lactic acid (PLA)

PLA Made from renewable resources including maize, corn, cane molasses, and sugar beet levels, PLA is a biodegradable, biocompatible, and compostable polyester. With the aid of the polymer industries carbon cycle breaks by thermoplastic, which will surely result in a decrease in their funding requirements. Acid is oligomerized to produce an oligomer and dimerized to produce the cyclic lactide monomer. High - molecular - weight polylactide is made from lactide monomer (ROP) by ring opening polymerization. Catalysts for the lactide process include tin and aluminium alkoxides [19].

3.13 Acrylonitrile butadiene styrene (ABS)

Acrylonitrile Styrene and butadiene polymers make up ABS, as its name suggests. Because it is easy to use with desktop printers and has many practical characteristics, this material is well-known. Thermoplastic ABS has amorphous characteristics. Because of its low cost, it is utilised for injection molding, and manufacturers also use it because of its impact resistance and insulating properties. Styrene, acrylonitrile, and butadiene were polymerized to make ABS. The percentages of acrylonitrile, butadiene, and styrene are 15-35 percent, butadiene is 5-30 percent, and styrene is 40- 60 percent [20]. It takes a lot of effort to become ABS-strong. The rubbery component gives acrylonitrile its strength, as well as resistance to heat and environmental damage.

3.14 Thermoplastic Polyurethane

A thermoplastic polyurethane elastomer is TPU (thermoplastic polyurethane). Like other elastomers, TPU is flexible and melt- producible. Equipment for compression, blow, and injection moulding may also be used to treat. It can be solution-coated or vacuum formed, and it can be applied to numerous industrial processes. TPU can be coloured in many different ways. TPU is a very adaptable material since, more than any other elastomer, it can provide a variety of land mixes. This is so because TPU is basically a segmented block copolymer with soft and rigid parts. The segment may be either aliphatic or aromatic. Aromatic TPUs come from isocyanates like MDI, whereas aliphatic TPUs come from isocyanates like h-12 MDI [21,22].

3.15 Polybutylene terephthalate

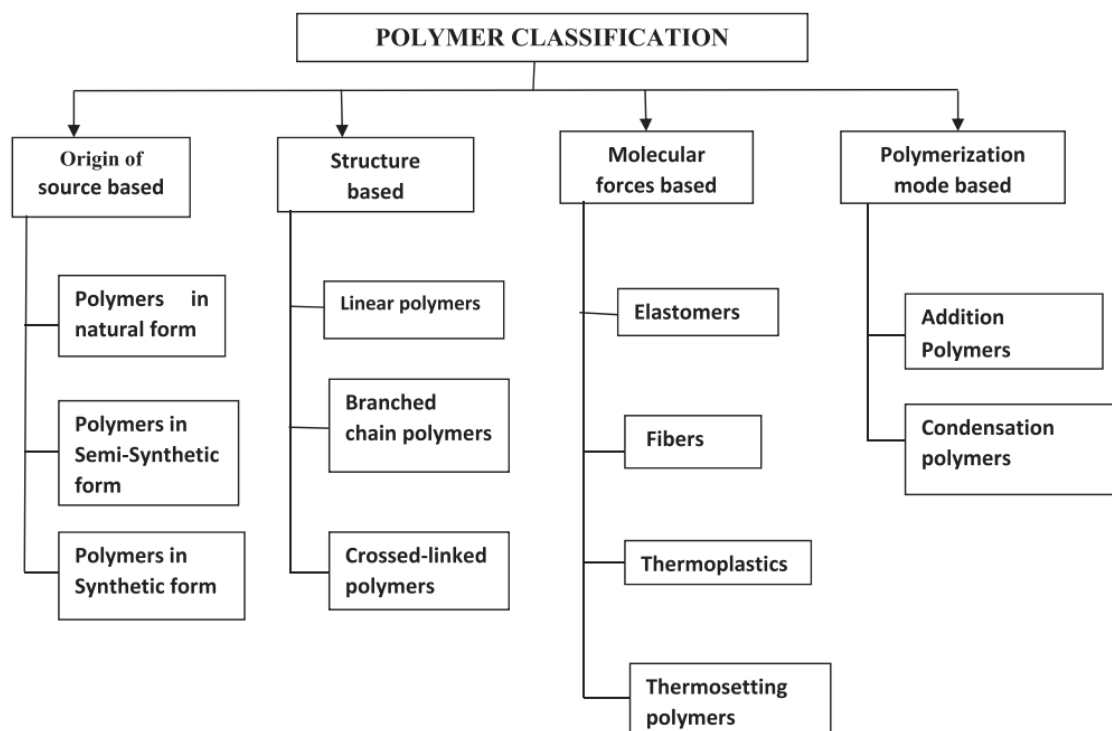
PolyEthyleneTerephthalate (PET) and why it's a good fit for so many software applications. Learn about its essential qualities, how it is combined with other thermosets and thermoplastics, processing requirements, and the advantages that make Polybutylene terephthalate the No. 1 plastic in the world that is recyclable. Polybutylene terephthalate is one of those aspects of one's activities that is equally important. It's a significant corporate plastic with a wide range of applications, including packaging, fabrics, photographs, moulded components for automobiles and electronics, and much more. This plastic can be found in the form of a pop jar container or a conventional water jar. PET is a thermoplastic polymer that may be used for a variety of applications [23].

3.16 Nylon

Nylon's initial commercial breakthrough was in the 1940s, when it was used in women's sleeves. These were likewise a big hit, although some of them, like principles and parachutes, became difficult to understand after a while. The ny-lon product of earlier parachutes or lace was a vest made of bristles. DuPont (manufacturer of advertising nylon 6,6) struggled at first to figure out how to do it. Markets sprang up around the area as the trend got on. Nylon offers good qualities used in fishing lines and trimmer lines, as well as a variety of "vinyl" screws and push-in connections. Nylons may be found in your home as well as in automobiles if you look hard enough. Nylon is also used in clothes, such as windbreakers [24].

3.17 Polycarbonate

Amorphous thermoplastics with transparency include polycarbonate (PC) alloys. The raw material allows for the interior transmission of light in almost the same way as glass does, despite being commercially available in a variety of colours (both see-through and opaque). Numerous items are made from poly-carbonate polymers, which are especially useful where shock transparencies or resistance are needed. Polycarbonate has great heat resistance and may be assembled without causing material deterioration, which is common with fire retardant materials [25,26].



IV. CONCLUSION

The majority of issues that AM approaches encounter are based on the course of activity. FDM has evolved into one of the most used and cost-effective 3D procedures. The practice of emptiness development is remarkable throughout coating sediment & FDM extrusion owing to heating & heating. It also leads to anisotropic constructions and mechanical possessions declines. The repair of metals or powders has been accomplished layer by layer in the scorching mix, Printing methods including such SLM and SLA. Because of this variation in the temperature gradient, the lateral and vertical leads throughout healing processes may differ. It has the potential to cause anisotropic behaviour within the region. Other processes have quality topics and are rated throughout fab. Despite these numerous disadvantages and problems, its usage has considerably expanded. The researchers are presently striving to improve 3D printing processes in order to reduce the limitations. With the advancement of plastic composites in recent years, researchers have had the freedom to test and understand the performance and qualities of services and goods linked with their usage, resulting in the creation of a new area.

REFERENCES

- [1] G.N. Levy, R. Schindel, J.-P. Kruth, Rapid manufacturing and rapid tooling with layer manufacturing (LM) technologies, state of the art and future perspectives, *CIRP Ann. Manuf. Technol.* 52 (2) (2003) 589–609.
- [2] P. Tran, T.D. Ngo, A. Ghazlan, D. Hui, Bimaterial 3D printing and numerical analysis of bio-inspired composite structures under in-plane and transverse loadings, *Compos. Part B Eng.* 108 (2017) 210–223.
- [3] Q. Sun, G. Rizvi, C. Bellehumeur, P. Gu, Effect of processing conditions on the bonding quality of FDM polymer filaments, *Rapid Prototyp. J.* 14 (2) (2008) 72–80.
- [4] K.V. Wong, A. Hernandez, A review of additive manufacturing, *ISRN. Mech. Eng.* (2012).
- [5] O.A. Mohamed, S.H. Masood, J.L. Bhowmik, Optimization of fused deposition modeling process parameters: are view of current research and future prospects, *Adv. Manuf.* 3 (1) (2015) 42–53.
- [6] K.G. Cooper, *Rapid Prototyping Technology*, Marcel Dekker, New York, New York, 2001.
- [7] C.G. Mançanares, E.S. Zancul, J.C. da Silva, P.A.C. Miguel, Additive manufacturing process selection based on parts' selection criteria, *Int. J. Adv. Manuf. Technol.* 80 (5–8) (2015) 1007–1014.
- [8] Ferreira RTL, Amatte IC, Dutra TA, et al. (2017) Experimental characterization and micrography of 3D printed PLA and PLA reinforced with short carbon fibers. *Composites Part B: Engineering* 1Elsevier Ltd: 88–100.
- [9] N. Shahrubudin, T.C. Lee, R. Ramlan, An overview on 3D printing technology: Technological, materials, and applications, *Procedia Manufact.*, 35, Elsevier B.V., 2019, pp. 1286–1296.
- [10] L. Baich, G. Manogharan, H. Marie, Study of infill print design on production cost-time of 3D printed ABS parts, *Int. J. Rapid Manuf.* 5 (3/4) (2015) 308.
- [11] H. Li, L. Song, J. Sun, J. Ma, Z. Shen, Dental ceramic prostheses by stereolithographybased additive manufacturing: potentials and challenges, *Adv. Appl. Ceram.* (2019).
- [12] B. Thavornyutikarn, P. Tesavibul, K. Sitthiseripratip, et al., Porous 45S5 bioglass based scaffolds using stereolithography: effect of partial presintering on structural and mechanical properties of scaffolds, *Mater. Sci.Eng. C* 1 (75) (2017) 12811288.
- [13] W. Zhong, F. Li, Z. Zhang, L. Song, Z. Li, Research on rapidprototyping/partmanufacturing (RP&M) for the continuous fiber reinforced composite, *Mater Manuf Process* 16 (1) (2001) 17–26.
- [14] Davoudinejad A, Diaz Perez LC, Quagliotti D, et al. (2018) Geometric and feature size design effect on vat photopolymerization micro additively manufactured surface features. *Proceedings - 2018 ASPE and euspen Summer Topical Meeting: Advancing Precision in Additive Manufacturing* (July): 55–59.
- [15] A.J. Lopes, I.H. Lee, E. MacDonald, R. Quintana, R. Wicker, Laser curing of silverbased conductive inks for in situ 3D structural electronics fabrication in stereolithography, *J. Mater. Process. Technol.* 214 (9) (2014) 1935–1945.
- [16] I. Cooperstein, M. Layani, S. Magdassi, 3D printing of porous structures by UVcurable O/W emulsion for fabrication of conductive objects, *J. Mater. Chem. C* 3 (9) (2015) 2040–2044.
- [17] A. Takezawa, M. Kobashi, Design methodology for porous composites with tunable thermal expansion produced by multimaterial topology optimization and additive manufacturing, *Compos. Part B Eng.* 131 (2017) 21–29.
- [18] M. Nikzad, S. Masood, I. Sbarski, Thermo-mechanical properties of a highlyfilled polymeric composites for fused deposition modeling, *Mater. Des.* 32 (6) (2011) 3448–3456
- [19] J.L. Eguiburu, M.J.F. Berridi, J.S. Roman, Functionalization of poly(lactide) macromonomers by ring-opening polymerization of l-lactide initiated with hydroxyethyl methacrylate-aluminium alkoxides, *Polymer* 36 (1995) 173.



- [20] Z. Weng, J. Wang, T. Senthil, L. Wu, Mechanical and thermal properties of ABS/montmorillonite nanocomposites for fused deposition modeling 3D printing, *Mater. Des.* 15 (102) (2016) 276283.
- [21] T. Tilford, S. Stoyanov, J. Braun, J.C. Janhsen, M. Burgard, R. Birch, C. Bailey, Design, manufacture and test for reliable 3D printed electronics packaging, *Microelectron. Reliab.* 85 (109–117) (2018) 185.
- [22] H. Qiao, Y. Zhang, Z. Huang, Y. Wang, D. Li, H. Zhou, 3D printing individualized triboelectric nanogenerator with macropattern, *Nano Energy* 50 (2018) 126–132.
- [23] G. Chen, J.A. Cuculo, P.A. Tucker, Effects of spinning conditions on morphology and properties of polyethylene terephthalate fibers spun at high speeds, *J. Appl. Polym. Sci.* 44 (3) (1992) 447–458.
- [24] K. Boparai, R. Singh, H. Singh, Comparison of tribological behaviour for Nylon6- Al-Al₂O₃ and ABS parts fabricated by fused deposition modelling: this paper reports a low cost composite material that is more wear-resistant than conventional ABS, *Virtual Phys Prototyp* 10 (2) (2015) 59–66.
- [25] T. Artham, N. Mohanalakshmi, P.P. Paragi-Vedanthi, M. Doble, Mechanistic investigations of lipase-catalyzed degradation of polycarbonate in organic solvents, *Enzyme Microb. Technol.* 48 (2011) 71–79.
- [26] G. Montaudo, C. Puglisi, R. Rapisardi, F. Samperi, Further studies on the thermal decomposition processes in polycarbonates, *Polym. Degrad. Stab.* 31 (1991) 229–246.



INNO SPACE
SJIF Scientific Journal Impact Factor
Impact Factor: 8.118



ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 **9940 572 462**  **6381 907 438**  **ijirset@gmail.com**



www.ijirset.com

Scan to save the contact details