A Project Report
on
3D Printing

S.V. Ragul
2020PECME185

Panimalar Engineering College
Poonamallee, Chennai - 6000123

I N D E X

ABSTRACT

Digital fabrication technology, also referred to as 3D printing or additive manufacturing, creates physical objects from a geometrical representation by successive addition of materials.3D printing plays a vital role in our world.3D printing is used In many industries namely in mass communications, production of any types of open source designs in the field of agriculture, in healthcare etc. 3D printing technology can print an object layer by layer deposition of material directly from a computer aided design (CAD) model. This paper presents the overview of the types of 3D printing technologies, the application of 3D printing technology and lastly, the materials used for 3D printing technology in manufacturing industry.

1. Introduction

3D printing can create physical objects from a geometrical representation by successive addition of material. 3D printing experienced a vast expansion in the recent years. . First commercialised of the 3D printing processes in year 1980 by Charles Hull. 3D printing are mainly used for producing artificial heart pump, jewellery collections, 3D printed cornea as well as the food industry. 3D printing technology has originated from the layer by layer fabrication technology of three-dimensional (3D) structures directly from computer-aided design (CAD) drawing. 3D printing technology has the potential to revolutionize industries and change the production line.

The adoption of 3D printing technology will increase the production speed while reducing costs. the adoption of 3D printing technology can change the logistics of the company. The logistics of the companies can manage the entire process, offer more comprehensive and start-to-finish services. At the same time, there are several disadvantages the adoption of 3D printing technology in manufacturing Industry. For instance, the effect of the use of 3D printing technology is will reduce the use of manufacturing labour so automatically will greatly affect the economy of countries that rely on a large number of low skill jobs. To sum up, 3D printing technology has emerged during recent years as a flexible and powerful technique in advance manufacturing industry. This technology has been widespread used in many countries, especially in the manufacturing industry.

2. Types of 3D Printing

Varieties of 3D printing technologies have been developed with the different function. According to ASTM Standard F2792, ASTM catalogued 3D printing technologies into seven groups, including the binding jetting, directed energy deposition, material extrusion, material jetting, powder bed fusion, sheet lamination and vat photo polymerization. Nowadays, 3D printing technologies are no longer limited to prototyping usage but are increasingly also being used for making variety of products

2.1. Binder jetting

Binder jetting is a rapid prototyping and 3D printing process in which a liquid binding agent is selectively deposited to join powder particles. The binder jetting technology uses jet chemical binder onto the spread powder to form the layer. Binder jetting can print a variety of materials including metals, sands, polymers, hybrid and ceramics binder jetting also has the ability to print very large products.

2.2. Directed energy deposition

Directed energy deposition is a more complex printing process commonly used to repair or add additional material to existing components. Directed energy deposition has the high degree control of grain structure and can produce the good quality of the object. The process of directed energy deposition is similar in principle to material extrusion, but the nozzle not fixed to a specific axis and can move in multiple directions. The example of this technology is laser deposition and laser engineered net shaping (LENS). Laser LENS can exploit thermal energy for melting during the casting and parts are accomplished subsequently.

2.3. Materials extrusion

Material extrusion-based 3D printing technology can be used to print multi-materials and multi-colour printing of plastics, food or living cells. This process has been widely used and the costs are very low. Fused deposition modelling (FDM) is the first example of a material extrusion system. . FDM was developed in early 1990 and this method uses polymer as the main material.

2.4. Materials jetting

According to ASTM Standards, material jetting is a 3D printing process in which drop by drop of build material are selectively deposited. . In material jetting, a print head dispenses droplets of a photosensitive material that solidifies, building a part layer-by-layer under ultraviolet (UV) light. At the same time, material jetting creates parts with a very smooth surface finish and high dimensional accuracy. Multi-material printing and a wide range of materials such as polymers, ceramics, composite, biological and hybrid are available in material jetting.

2.5. Powder bed fusion

The powder bed fusion process includes the electron beam melting (EBM), selective laser sintering (SLS) and selective heat sintering (SHS) printing technique. The example of the materials used in this process are metals, ceramics, and polymers. Carl Deckard developed SLS technology in 1987. Selective laser sintering can used to create metal, plastic, and ceramic objects and lastly electron beam melting enhances an energy source to heat up the material.

2.6. Sheet lamination

According to ASTM definition, sheet lamination is the 3D printing process in which sheet of materials are bond together to produce a part of object. The example of 3D printing technology that uses this process are laminated object manufacturing (LOM) and ultrasound additive manufacturing (UAM). LOM is capable to manufacture complicated geometrical parts with lower cost of fabrication and less operational. UAM is an innovative process technology that uses sound to merge layers of metal drawn from featureless foil stock.

2.7. Vat Photo polymerization

The main 3D printing technique that frequently used is photo polymerization, which in general refers to the curing of photo-reactive polymers by using a laser, light or ultraviolet (UV). The example of 3D printing technologies by using photo polymerization is stereo lithography (SLA) and digital light processing (DLP). In the SLA, it was influenced by the photo initiator and the irradiate exposure particular conditions as well as any dyes, pigments, or other added UV absorbers. , digital light processing is a similar process to Stereo lithography that works with photopolymers. Light source is the major difference.

3. Materials used for 3D printing in Manufacturing Industry

Like any manufacturing process, 3D printing needs high quality materials that meet consistent specifications to build consistent high-quality devices. 3D printing technology is capable to produce fully functional parts in a wide range of materials including ceramic, metallic, polymers and their combinations in form of hybrid, composites or functionally graded materials (FGMs).

3.1. Metals

Metal 3D printing technology gain many attentions in automobile, medical application and manufacturing industry because the advantages existing by this process. Cobalt-based alloy is suitable to use in the 3D printed dental application. This is because, it has high specific stiffness, resilience, high recovery capacity, elongation and heat-treated conditions. 3D printing technology also can print out the object by using titanium alloys. Titanium alloy with have very exclusive properties, such as ductility, good corrosion, oxidation resistance and low density. It is used in high stresses and high operating temperatures and high stresses, for example in aerospace components and biomedical industry.

3.2. Polymers

3D printing technologies are widely used for the production of polymer components from prototypes to functional structures with difficult geometries. Thermoplastics filaments with higher melting temperatures such as PEEK and PMMA can already be used as materials for 3D printing technology. 3D printing polymer materials in liquid state or with low melting point are widely used in 3D printing industry due to their low cost. the materials of polymers played important role in biomaterials and medical device products often as inert materials, by contributing to the efficient functioning of the devices as well as providing mechanical support in many orthopaedic implants.

3.3. Ceramics

Nowadays, 3D printing technology can produce 3D printed object by using ceramics and concrete without large pores or any cracks through optimization of the parameters and setup the good mechanical properties. Ceramic is strong, durable and fire resistant. Due to its fluid state before setting, ceramics can be applied in practically any geometry and shape and very suitable on the creation of future construction and building. Alumina powder for instance has the potential to be processes by 3D Printing technology. Alumina is an excellent ceramic oxide with a very wide range of applications, including catalyst. Stereo lithographic Ceramic Manufacturing (SLCM) is a process to produce solid bulk ceramics with high densities, very homogeneous microstructure, high compression strength and bending.

3.4. Composites

Composite materials with the exceptional versatility, low weight, and tailor able properties have been revolutionizing high-performance industries. The examples of composite materials are carbon fibres reinforced polymer composites and glass fibres reinforced polymer composite. Fiberglass have a high thermal conductivity and relatively low coefficient of thermal expansion. Hence it is very suitable for use in the 3D printing applicant.

3.5. Smart materials

Smart materials are defined as this material have the potential to alter the geometry and shape of object, influence by external condition such as heat and water. The example of 3D printed object produces by using smart materials are self-evolving structure and soft robotics system. Smart materials also can be classified as 4D printing materials. By using 3D printing technology, the complicated shape of shape memory polymer could be easily and conveniently to produce. The quality evaluation of this material is performed based on the dimensional accuracy, surface roughness and part density.

4. The application of 3D printing in manufacturing Technology

4.1. Automotive industry

In the automotive industry, 3D Printing technique have made phenomena to bring new shines, allowing for lighter and more complex structures in the fast time. Local Motor had printed the first 3D-printed electric car in 2014. Not only cars, Local Motors also extended the wide range application of 3D printing technology by manufacturer a 3D-printed bus called OLLI. OLLI is a driverless, electric, recyclable and extremely smart 3D printed bus. BMW uses 3D printing technology to produce hand-tools for automotive testing and assembly. Meanwhile, in 2017, AUDI was collaborated with SLM Solution Group AG to produce spare parts and prototypes.

4.2. Architecture, building, and construction industry

3D printing technology can be considered as environmentally friendly derivative and it give unlimited possibilities for geometric complexity realization. In the construction industry, 3D printing technology can be used to print entire building or can create construction components. With 3D printing technology, companies can design and create the visual of the building in the fast time and inexpensively as well as avoid delays and help pinpoint problem areas. The examples of 3D printed building are Apis Cor Printed House in Russia [67] and Canal House in Amsterdam.

4.3. Electric and Electronic Industry

Nowadays, various 3D printing technologies have already been used broadly for structural electronic devices like active electronic materials, electrode and devices with mass customization and adaptive design through embedding the conductors into 3D printed devices. The production process for the 3D electrode by utilizing the Fused Deposition Modelling of 3D printing technique provides low-cost and a time efficient approach to mass producing electrode materials. Compared to commercial electrodes such as aluminium, copper and carbon electrodes, the design and surface area of the 3D electrode can be easily customized to suit a particular application. In addition, active electronic components are any electronic devices or components capable of amplifying and controlling the flow charges of electric.

5. Summary

In the manufacturing industries, it offers many benefits to the people, company and government. Therefore, more information is needed to progress on ways to enhance the adoption of 3D printing technology. The more information in this review, there are rich landscape of 3D printing in manufacturing industry. At present, 3D printing technology is beginning about 3D printing technology will help the company and government to upgrade and improve the infrastructure of 3D printing technology. Thus, this paper is to overview the types of 3D printing technologies, materials used for 3D printing technology in manufacturing industry and lastly, the applications of 3D printing technology. In the future, researchers can do some study on the type of 3D printing machines and the suitable materials to be used by every type of machine