3D printing technology industry

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Abstract: 3D printing has revolutionized various industries by enabling the production of complex designs and shapes. Recently, the potential of new materials in 3D printing has led to an exponential increase in the technology’s applications. However, despite these advancements, the technology still faces significant challenges, including high costs, low printing speeds, limited part sizes, and strength. This paper critically reviews the recent trends in 3D printing technology, with a particular focus on the materials and their applications in the manufacturing industry. The paper highlights the need for further development of 3D printing technology to overcome its limitations. It also summarizes there search conducted by experts in this field, including their focuses, techniques, and limitations. By providing a comprehensive overview of the recent trends in 3D printing, this review aims to provide valuable insights into the technology’s prospects.

Keywords: additive manufacturing; 3D printing; engineering applications; materials

1. Introduction

Three-dimensional printing technology has experienced unprecedented growth and is revolutionizing the manufacturing industry. This flexible technology provides the advantages of customization, prototyping, various fabrication techniques, and complex geometries at a low cost in a short timeframe. Additive manufacturing technology has come long way since its inception when Chuck Hull, co-founder of 3D Systems, developedthe first 3D printer in 1983 [1]. In the following years, there was a growing interest in this technology, and it became more affordable and accessible. In the late 1990s and early 2000s,the main focus shifted to new materials and uses, and additive manufacturing technology became more widely used in sectors such as aviation, healthcare, and automation. Today,3D printing technology is in high demand for the way it can create complex structureswith high precision and accuracy. Additionally, new techniques such as bio printing and 4Dprinting have opened new possibilities in the field of medicine [2]. Metals, thermoplastics, hydrogels, extracellular matrix materials, ceramics, fibre-reinforced composites, polymers,concrete materials, and even shape memory alloys known as smart materials can be 3Dprinted easily because the development in additive manufacturing is at its peak and has eliminated numerous issues [3]. Moreover, this technology has fortunately introduced

a new age of mass customization, where consumers have greater choices for the finalproduct, according to their specifications. Simultaneously, 3D printing facilities can be situated nearer to the customer or even at home for personal purposes, allowing for a moreadaptable and flexible manufacturing process as well as higher levels of quality control. Furthermore, the use of 3D printing technology has considerably reduced

Background

3D printing technology has been used in a variety of applications for over 30  years, including automotive, robotics, prototyping and chemical sciences [1]. Tis new industrial revolution will have a huge impact on the pharmaceutical industry. The pharmaceutical industry is currently using traditional methods to accept products into the market. 3D printing is the process of adding layers one on the other by using 3D printer. Because of the additional layers, it is also known as additive manufacturing. A file is created in a computer with all parameters such as infills percentage, geometry, printing speed, layer height, thickness, extrusion and platform temperature in the design by software and it is sent to a printer install format for printing where the desired product can be printed using the compatible excipients. 3D printing is a tailored formulation development technology that can cater to the needs of each individual patient. One of the most important factors in targeted drug delivery is administration dose accuracy. Currently, the industry follows a one-size-fits.

2. Types of 3D Printing

Varieties of 3D printing technologies have been developed with the different function. According to ASTM Standard F2792 [13], 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 photo polymerization. There are no debates about which machine or technology function better because each of them has its targeted applications. 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 [9]. The application of the binder jetting is would be producing the casting patterns, raw sintered products or similar large-volume products from sand. Binder jetting can print a variety of materials including metals, sands, polymers, hybrid and ceramics. Some materials like sand not required additional processing. Moreover, the process of binder jetting is simple, fast and cheap as powder particles are glued together. Lastly, binder jetting also

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 [17]. This process has been widely used and the costs are very low. Moreover, this process can build fully functional parts of product [8]. 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 . FDM builds parts layer-by-layer from the bottom to the top by heating and extruding thermoplastic filament. The operations of FDM are as follows:

I.

Thermoplastic heated to a semi-liquid state and deposits it in ultra-fine beads along the extrusion path .

II.

Where support or buffering needed, the 3D printer deposits a removable material that acts as scaffolding. For example, FDM uses hard plastic material during the process to produce 3D bone model [19].

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 printhead dispenses droplets of a photosensitive material that solidifies, building a part layer-by-layer under ultraviolet (UV) light [20]. 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, biologicals and hybrid are available in material jetting [8].

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. This method uses either an electron beam or laser to melt or fuse the material powder together. The example of the materials used in this process are metals, ceramics, polymers, composite and hybrid. Selective laser sintering (SLS) are the main example of powder based 3D printing technology. Carl Deckard developed SLS technology in 1987. SLS is 3D printing technology that’s functionally in fast speed, has high accuracy, and varies surface finish [21]. Selective laser sintering can used to create metal, plastic, and ceramic objects [22]. SLS used a high power laser to sinter polymer powders to generate a 3D product. Meanwhile, SHS technology is another part of 3D Printing technology uses a head thermal print in the process to melt the thermoplastic powder to create 3D printed object. Lastly electron beam melting enhances an energy source to heat up the material [22].

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 [20]. The example of 3D printing technology that uses this process are laminated object manufacturing (LOM) and ultrasound additive manufacturing (UAM) [8]. The advantages of this process are sheet lamination can do full-colour prints, it relatively inexpensive, easy of material handling and excess material can be recycled. Laminated object manufacturing (LOM) is capable to manufacture comp

4. Policies and Regulations in the Field of 3D Printed Drugs

As an emerging technology in the pharmaceutical industry, 3D printing has many industries. Advantages, and the 3D-printed drug industry is moving towards modern personalized medicines, which is directly related to the efforts of pioneering companies and the activesupport of government agencies, such as the Drug Review Centre. Spritam®, the world’s first 3D-printed preparation, received IND approval from theFDA in 2013. Subsequently, to encourage and facilitate the successful approval of newtechnology products in the pharmaceutical industry, the FDA established the ETT in

7. Conclusions and Recommendations

This paper critically reviewed the recent trends in 3D printing technology, including its major applications and the materials used. It also examined the direction of research, the methods, and their associated limitations in this field. To achieve greater success in theadditive manufacturing industry, further experimentation and innovation are needed to reduce costs, increase speeds, and develop high-strength and high-temperature materials that are more affordable. The ultimate goal is to generalize 3D printing technology to enable the manufacturing of essential items at home and in medical contexts, such as lowering the costs of surgeries for patients who cannot afford the current cost chain of manufacturers, sellers, hospitals, and doctors. Additionally, this technology can solve othersocietal challenges, such as food scarcity and homelessness, by enabling governments to

fund the production of free foods and homes for people in need, thereby reducing the

impact of poverty. The literature shows that there has been a rapid increase in research

on 3D printing. However, the limitations of the research have been acknowledged, as there are still numerous possibilities for conducting further experiments. In some cases, researchers did not provide sufficient explanations and details, and many studies focused only on a limited range of materials, with insufficient information, a lack of in-depth study, and a smaller number of samples, thereby reducing the overall understanding of the consistency of the experiments. Additive manufacturing is expected to continue advancing and improving, but it will take some time to overcome the challenges, particularly those related to the cost and speed of 3D printing. As technology becomes more efficient, faster,and cost-effective, it will become more accessible to a wider range of users worldwide. Additionally, the industry will focus on sustainability, developing eco-friendly materials, and adopting circular economy models. Overall, the future of additive manufacturing looks promising, and it will be fascinating to witness the emergence of innovations a.

Result.

It Plays a crucial role in the medical revolutionary.