



# A REVIEWS ON APPLICATION OF SMART MATERIALS IN ADDITIVE PRINTING

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**Abstract :** Computerized manufacture innovation, mathematical portrayal by progressive expansion of materials. 3D printing innovation is a quick arising innovation. These days, 3D Printing is generally utilized on the earth. 3D printing innovation progressively utilized for the mass customization, creation of any kinds of open source plans in the field of farming, in medical care, auto industry, train industry and flying enterprises. 3D printing innovation can print an article layer by layer statement of material straightforwardly from a PC supported plan (Computer aided design) model. This paper presents the use of 3D printing innovation and in conclusion, the materials utilized for 3D printing innovation in assembling industry.

**IndexTerms - smart materials, 3D printing , industrial manufacturing.**

## I. INTRODUCTION

3D printing can make actual articles from a mathematical portrayal by progressive expansion of material [1]. printing innovations into seven gatherings, including the limiting streaming, printing measures in year 1980 by Charles Hull [2]. At present, 3D printing essentially utilized for delivering counterfeit heart siphon [3], gems assortments [4], 3D printed cornea [5], PGA rocket motor [6], steel connect in Amsterdam [7] also, different items identified with the flying business just as the food business. 3D printing innovation has begun from the layer by layer manufacture innovation of three structures straightforwardly from PC helped plan (CAD) drawing [8]. 3D printing innovation is a really imaginative and has arisen as a flexible innovation stage. It opens new freedoms and offers desire to numerous opportunities for organizations hoping to improve fabricating effectiveness. Regular thermoplastics, pottery, graphene-based materials, and metal are the materials that can be printed now by utilizing 3D printing innovation [9].

3D printing innovation can possibly upset ventures and change the creation line. The reception of 3D printing innovation will speed up while decreasing expenses. Simultaneously, the interest of the shopper will have more impact over creation. Customers have more noteworthy contribution to the end result and can demand to have it delivered to accommodate their details. At the interim, the offices of 3D printing innovation will be found nearer to the buyer, taking into consideration a more adaptable and responsive assembling measure, just as more noteworthy quality control. Besides, when utilizing 3D printing innovation, the requirement for worldwide transportation is essentially diminished. This is on the grounds that, when assembling locales found closer to the end objective, everything dispersion could be finished with armada following innovation that saves energy and time. In conclusion, the selection of 3D printing innovation can change the coordinations of the organization. The coordinations of the organizations can deal with the whole interaction, offer more complete and beginning to end administrations [10]. These days, 3D printing is broadly utilized on the planet. 3D printing innovation progressively utilized for the mass customization, creation of any sorts of open source plans in the field of agribusiness, in medical services, auto industry, and aviation ventures [11]. For example, the impact of the utilization of 3D printing innovation is will decrease the utilization of assembling work so naturally will enormously influence the economy of nations that depend on countless low ability occupations. Moreover, by utilizing 3D printing innovation, clients can print various sorts of items like blades, firearms what's more, hazardous things. In this manner, the utilization of 3D printing ought to be restricted to just certain individuals to forestall fear based oppressors furthermore, hoodlums bring firearms without identified. Simultaneously, individuals who get it together of a diagram will actually want to fake items without any problem. This is on the grounds that, the utilization of 3D printing innovation is straightforward, simply outlining, and set the information in the machine-printed so 3D items can produce [12].

## 2. MATERIALS USED FOR 3D PRINTING TECHNOLOGY IN MANUFACTURING INDUSTRY

Like any assembling cycle, 3D printing needs top notch materials that meet reliable particulars to construct steady great gadgets. To guarantee this, methodology, prerequisites, and arrangements of material controls are set up between the providers, buyers, and end-clients of the material. 3D printing innovation is fit to create completely practical parts in a wide scope of materials including earthenware, metallic, polymers and their mixes in type of half breed, composites or practically reviewed materials (FGMs).

### 2.1. Metals

Metal 3D printing technology gain many attentions in aerospace, automobile, medical application and manufacturing industry because the benefits existing by this process [26]. The materials of metal have the superb physical properties and this material are often went to complex manufacturer from printing human organs to aerospace parts. Cobalt-based alloy is suitable to use within the 3D printed dental application. this is often because, it's high specific stiffness, resilience, high recovery capacity, elongation and heat-treated conditions [28] Furthermore, 3D printing technology has capability to supply aerospace parts by using nickel base alloys [29]. 3D-printed object produces using nickel base alloys are often utilized in dangerous environments. this is often because, it's high corrosion resistance and therefore the heat temperature can resistant up to 1200 °C [26]. Lastly, 3D printing technology can also print out the thing by using titanium alloys. Titanium alloy with have very exclusive properties, like ductility, good corrosion, oxidation resistance and rarity . it's utilized in high stresses and high operating temperatures and high stresses, for instance in aerospace components [31] and biomedical industry [32].

### 2.2. Polymers

3D printing advances are generally utilized for the creation of polymer segments from models to utilitarian constructions with troublesome calculations [33]. By utilizing intertwined affidavit displaying (FDM), it can shape a 3D printed through the statement of progressive layers of expelled thermoplastic fiber, for example, polylactic corrosive (PLA), acrylonitrile butadiene styrene (ABS), polypropylene (PP) or polyethylene (PE) [33].

### 2.3. 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 [37]. Ceramic is strong, durable and fire resistant. Due to its fluid state before setting, ceramics are often applied in practically any geometry and shape and really suitable on the creation of future construction and building [37]. According to [38], they said ceramics materials is beneficial within the dental and aerospace application. The samples of this materials are alumina [39], bioactive glasses [40] and zirconia [41]. Alumina powder as an example has the potential to be processes by 3D Printing technology. Alumina is a superb ceramic oxide with a really wide selection of applications, includingcatalyst, adsorbents, microelectronics, chemicals, aerospace industry and another high-technology industry [42]. Alumina has great curing complexity [38]. By using 3D printing technology, complex-shaped alumina parts with features a high density after sintering and also has high green density are often printed [39]. Furthermore, in successiveexperiment, Stereolithographic (SLA) machine was used to process glass-ceramic and bioactive glass into dance part. It significantly improving the bending strength of this materials. The increasing of the mechanical strength will open up the potential for apply bioactive glass relevant clinical structure like scaffolds and bone. By usingStereolithographic Ceramic Manufacturing (SLCM), it is probable to produce solid bulk ceramics with high densities, very homogeneous microstructure, high compression strength and bending [40]. Meanwhile, zirconia arethe main construction materials in atomic power sectors, using for element tubing. Hafnium-free zirconium is extremely suitable for this application because it's low suscepiability to radiation and also has low thermal neutron absorption [41].

### 2.4. Composites

Composite materials with the exceptional versatility, low weight, and tailorable properties are revolutionizing high-performance industries. The samples of composite materials are carbon fibers reinforced polymer composites [43] and glass fibers reinforced polymer composite [44]. Carbon fiber reinforced polymers composite structures are widely used in aerospace industry because of their high specific stiffness, strength, goodcorrosion resistance and good fatigue performance [43]. At the same time, glass fibers reinforced polymer composites are widely used for various applications in 3D printing application [44] and has great potentialapplications due to the cost effectiveness and high-performance [45]. Fiberglass have a high thermal conductivity and comparatively low coefficient of thermal expansion. Furthermore, fiberglass cannot burn, and it not affected bycuring temperatures used in manufacturing processes, therefore, it is very suitable for use in the 3D printing applicant [45].

### 2.5. Smart materials

Smart materials are defined as this material have the potential to change the geometry and shape of object, influence by external condition like heat and water [46]. The example of 3D printed object produces by usingsmart materials are self-evolving structure and soft robotics system. Smart materials can also be classifiedas 4D printing materials. The samples of group smart materials are shape memory alloys [47] and shape memory polymers [48]. Some shape-memory alloys like nickel-titanium [47] are often utilized in biomedical implants to micro- electromechanical devices application [37]. In the production of 3D printed

products by using nickel-titanium, transformation temperatures, reproducibility of microstructure and density is that the important issue. Meanwhile, Shape memory polymer (SMP) may be a quite functional material that responds to a stimulus like light, electricity heat, some types of chemical then on [48]. By using 3D printing technology, the complicated shape of shape memory polymer might be easily and conveniently to supply. The quality evaluation of this material is performed supported the dimensional accuracy, surface roughness and part density [48].

## 2.6. Specials materials

The examples of special materials are:

- Food

3D printing technology can process and produce the desired shape and geometry by using food materials like the chocolate, meat, candy, pizza, spaghetti, sauce and so on [49]. 3D-food printing can produce healthy food because this process allows customers to regulate the ingredients of materials without reducing the nutrients and taste of the ingredients [50].

- Lunar dust

3D printing has the potential to directly produce multi-layered parts out of lunar dust, which has potential applicability to future moon colonization [51].

- Textile

With 3D printing technology, jewellery and clothing industry will be shine with the development on 3D- textile printing. Some advantage of 3D printing technology in apparel industry are short time interval to form the merchandise, reduced costs related with the packaging and reduce supply chain cost [16].

## 3. THE APPLICATIONS OF 3D PRINTING IN MANUFACTURING TECHNOLOGY

### 3.1. Aerospace industry

3D printing innovation gives unparalleled opportunity plan in segment and creation. In aviation industry, 3D printing innovation can possibly make lightweight parts, improved and complex calculations, which can diminish energy necessity and assets [52]. Simultaneously, by utilizing 3D printing innovation, it can prompt fuel reserve funds since it can decrease the material used to deliver aviation's parts. Besides, 3D printing innovation has been generally applied to create the extra pieces of some aviation segments like motors. The motor's part is effortlessly harmed, which require normal substitution. Hence, 3D printing innovation is a decent answer for the acquirement of such extra parts [53]. In aeronautic trade, nickel-based compounds is more liked due to the malleable properties, oxidation/consumption obstruction and harm resilience [54].

### 3.2. Automotive industry

These days, 3D printing innovation have quickly changed our industry to configuration, create and fabricate new things. In the auto business, 3D Printing strategy have made marvels to bring new sparkles, considering lighter and more perplexing constructions in the quick time. For example, Local Motor had printed the principal 3D-printed electric vehicle in 2014. Not just vehicles, Local Motors likewise expanded the wide reach use of 3D printing innovation by maker a 3D-printed transport called OLLI. OLLI is a driverless, electric, recyclable and amazingly brilliant 3D printed transport. Besides, Ford is the pioneer in the utilization of 3D printing innovation additionally apply 3D printing innovation to deliver model and motor parts [55]. Moreover, BMW utilizes 3D printing innovation to deliver hand-devices for auto testing and get together. Then, in 2017, AUDI was teamed up with SLM Solution Group AG to produce spare parts and models [56].

Therefore, by utilizing 3D printing innovation in auto industry empower organization to attempt different options and underscore directly in the improvement stages, provoking ideal and compelling car plan. At the same time, 3D printing innovation can diminish the wastage and utilization of the materials. In addition, 3D printing innovation can decrease expenses and time, in this way, it permits to test new plans in an extremely quick time [57].

### 3.3. Food industry

3D printing technology open the doors not only for aerospace industry, but also for food industry. At present, there is a growing demand for the development of customized food for specialized dietary needs, such as athletes, children, pregnant woman, patient and so on which requires a different amount of nutrients by reducing the amount of unnecessary ingredients and enhancing the presence of healthy ingredients [58]. However, the development of customized foods must be conducted in a very detailed and inventive way, which is where the adoption of 3D-food printing appears. Food layer manufacture also known as 3D-food printing fabricated through the deposition of successive layers by layer derived directly from computer-aided design data [49]. By using 3D printing technology, specific materials can be mixed and processes into various complicated structures and shape [59]. Sugar, chocolate, pureed food and flat food such as pasta, pizza and crackers can be used to create new food items with complex and interesting designs and shape.

### 3.4. Healthcare and medical industry

3D printing technology can used to print 3D skin [60], drug and pharmaceutical research [61], bone and cartilage [62], replacement tissues [63], organ [22], printing for cancer research [64] and lastly models for visualization, education, and communication. There are several advantages of 3D Printing technology for biomedical products which are:

- 3D printing innovation can recreate the characteristic design of the skin with the lower cost. 3D printed skin can be utilized to test drug, beautifying agents, and compound items. Along these lines, it is superfluous to utilize the creature skin to test the items. Thusly, it will assist the scientist with getting exact outcome by utilizing reproduce the skin [65].
- By utilizing 3D printing innovation to print medication can expand productivity, precise control of dropped size and portion, high reproducibility and ready to deliver dose structure with complex medication discharge profiles [22].
- 3D printing innovation can print ligament and unresolved issue hard voids in the ligament or bone that brought about by injury or sickness [66]. This treatment is various alternatives from utilizing auto-unions and allografts since this treatment centers around to create bone, keep up, or improve its capacity by utilizing in vivo.
- 3D printing innovation additionally can be utilized to supplant, reestablish, keep up, or improve the tissues work. The substitution tissues delivered by 3D printing innovation have the interconnected pore organization, biocompatible, suitable surface science and has great mechanical properties [63].
- 3D printing innovation additionally can be utilized to print out comparable organ disappointment brought about by basic issues such as infection, mishaps, and birth deserts.
- 3D printing advancements can frame exceptionally controllable malignancy tissues model and shows incredible potential to speed up malignancy research. By utilizing 3D printing innovation, the patients can get more dependable furthermore, precise information.
- 3D printout models can use in the learning cycle to help neurosurgeons rehearsing careful methods. By utilizing 3D model, it can improve exactness, can set aside the short effort to the coach when performing clinical strategy, and gives freedoms to preparing specialists active, as the 3D model is a recreation of a genuine patient's obsessive condition.

### 3.5. 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. The emergence of the Building Information 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. At the same time, with 3D printing technology, construction-engineer and their clients can communicate more efficiently and clearly. Much of a customer's expectations come from an idea, and 3D printing makes it simple to appear that idea beyond the dated method of paper and pencil [68]. The examples of 3D printed building are Apis Cor Printed House in Russia [67] and Canal House in Amsterdam [68].

### 3.6. Fabric and Fashion Industry

At the point when 3D printing innovation enters the retail business, 3D printed shoes, gems [4], purchaser products and attire [69] are rise into the market. The mix of style and 3D printing may not seem like the most normal fit, yet it is beginning to turn into an ordinary reality everywhere on the world. For example, large organizations like Nike, New Balance and Adidas are endeavoring to improvement the large scale manufacturing of 3D printed shoes. These days, 3D printed shoes are delivered for competitor's shoes, uniquely designed shoes and shoes [70]. Also, 3D printing innovation can spread imaginative opportunities for style plan. In reality, it makes it conceivable to makes shapes without molds. In style industry, by utilizing 3D printing innovation, it can plan and deliver pieces of clothing by utilizing network framework and furthermore can print trimmings for conventional material. Besides, the utilization of 3D printing innovation not restricted to the design business, yet additionally can print cowhide merchandise and frill. For occurrences, jewellery, watchmaking, adornments, etc [71].

### 3.7. Electric and Electronic Industry

As 3D printing becomes more and more accessible to sciences, technology and manufacturing fields, the manufacturers are beginning to see its potential realized altogether kinds of interesting ways. 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 [74].

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 like aluminium, copper and carbon electrodes, the planning and area of the 3D electrode are often easily customized to suit a specific application. Furthermore, 3D printing for the 3D electrode is fully automated, with a high degree of precision, made it possible to finish the printing for eight 8 electrodes in only half-hour [75].

In addition, active electronic components are any electronic devices or components capable of amplifying and controlling the flow charges of electrical. Besides, active devices also include people who can generate power. Examples of active electronic components include silicon-controlled rectifiers, transistors, diodes, operational amplifiers, light-emitting diodes (LEDs), batteries then on. These components normally require highly elaborate fabrication processes compared to those used for passive components thanks to their complex functionalities [76]. 3D printing technology provides advantages for processing of product along side its electronics. With multi-material printing technology, the efficiency of electronic system could be adopted in Industry Revolution 4.0, enabling more innovative designs created in only one process [37]. the event of a green device with low-manufacturing cost, good safety, high reliability and rapid production, is urgently in demand to deal with environment pollutions in today's society [75].

#### 4. DISCUSSION

In this survey, there are rich scene of 3D imprinting in assembling industry. As of now, 3D printing innovation is starting in the assembling ventures, it offers numerous advantages to individuals, organization and government. Along these lines, more data is expected to advance on approaches to upgrade the appropriation of 3D printing innovation. The more data about 3D printing innovation will help the organization and government to redesign also, improve the foundation of 3D printing innovation. Hence, this paper is to outline the sorts of 3D printing innovations, materials utilized for 3D printing innovation in assembling industry and ultimately, the utilizations of 3D printing innovation. Later on, scientists can do some examination on the kind of 3D printing machines and the appropriate materials to be utilized by each kind of machine.

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