International Journal of Scientific Research in Mechanical and Materials Engineering
© 2022 IJSRMME | ISSN : 2457-0435

A 3D Printing on Engineering and Medical Field

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Article Info
Volume 6, Issue 4
Page Number : 17-26
Publication Issue :
July-August-2022
Article History
Accepted : 05 July 2022
Published : 15 July 2022

ABSTRACT

Adding material layer by layer in successive way to create 3D component. In this paper we conclude some results on 3d printed manufacturing. Such materials are widely used in medicine, defense agriculture almost all fields. These will be future revolution. From CAD packages we can synthesis 3d material components. This paper deals with 3d smart materials used in 3d components.

Keywords: 3D printing Processes methods, 3D printers, bioprinters, 3D materials

I. INTRODUCTION

There are various AM processes such as stereolithography (SLA), selective laser sintering (SLS), fused deposition modeling (FDM), jet 3D printing (3DP), selective laser melting (SLM), direct ink writing (DIW), electron beam melting (EBM), etc.

1.1 Stereolithography (SLA)

It is the most widely used rapid prototyping technology. It works by using a low-power, highly focused UV laser to trace out repeated cross-sections of a three-dimensional object in a vat of liquid photosensitive polymer. As the laser traces the layer, the polymer begins to form shape, solidify, and the excess areas are left as liquid. When a layer of the three-dimensional object is completed, a leveling blade is moved across the surface to give it an even finish it before depositing the next layer. The platform which is hoisting the object is then lowered by a distance that is equal to the layer thickness, usually in the range of 0.003-0.002 in, and a consecutive layer is formed on top of the previously finished layers. The process described above, consisting of tracing and evening the surface is repeated until the object is finally completed. Once complete, the object is elevated above the vat and drained. Excess polymer is swabbed or lightly washed away from the surfaces. Many times the object is not completely solidified and is given a final cure is given by placing it in a UV oven. After the final cure, supports are cut off the object and surfaces are polished, sanded or otherwise finished.

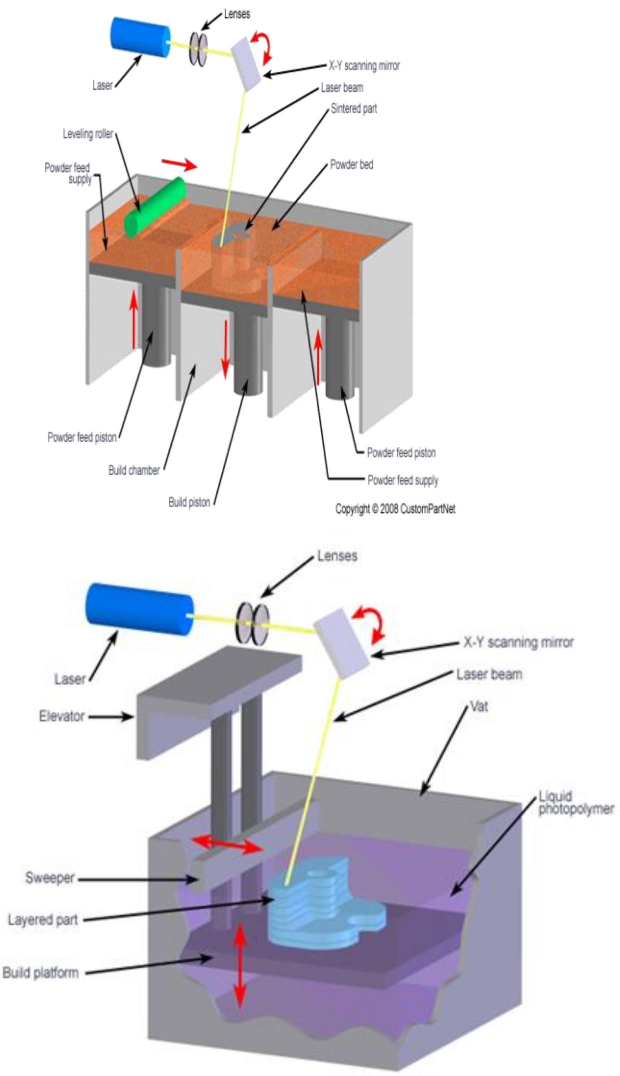


Fig 1. SLA

1.2 Fused Deposition Modeling (FDM)

Fused Deposition Modeling (FDM) was developed by Stratasys in Eden Prairie, Minnesota. FDM works by having a piece of plastic or wax material which is extruded through a nozzle that traces the objects cross sectional geometry layer by layer until it is completed. The material which the object will be constructed from is usually supplied in filament form, but some setups use plastic pellets fed from a hopper instead. The nozzle contains resistive heaters that keep the plastic at a temperature just above its melting point. This allows the plastic to flows easily through the nozzle and form consecutive layers and finally build a final object. The plastic hardens immediately after flowing from the nozzle and forms to the layer below. Once a layer is constructed, the platform lowers, and the extrusion nozzle deposits another layer. This process is continued until the object is completed. The layer thickness and vertical dimensional accuracy is determined by the extruder die diameter, which ranges from 0.013 to 0.005 inches. One of the strongest benefits to using FDM is the amount of different materials available used to construct an object. Some of the most widely used materials are ABS, polyamide, polycarbonate, polyethylene, polypropylene, and investment casting wax.

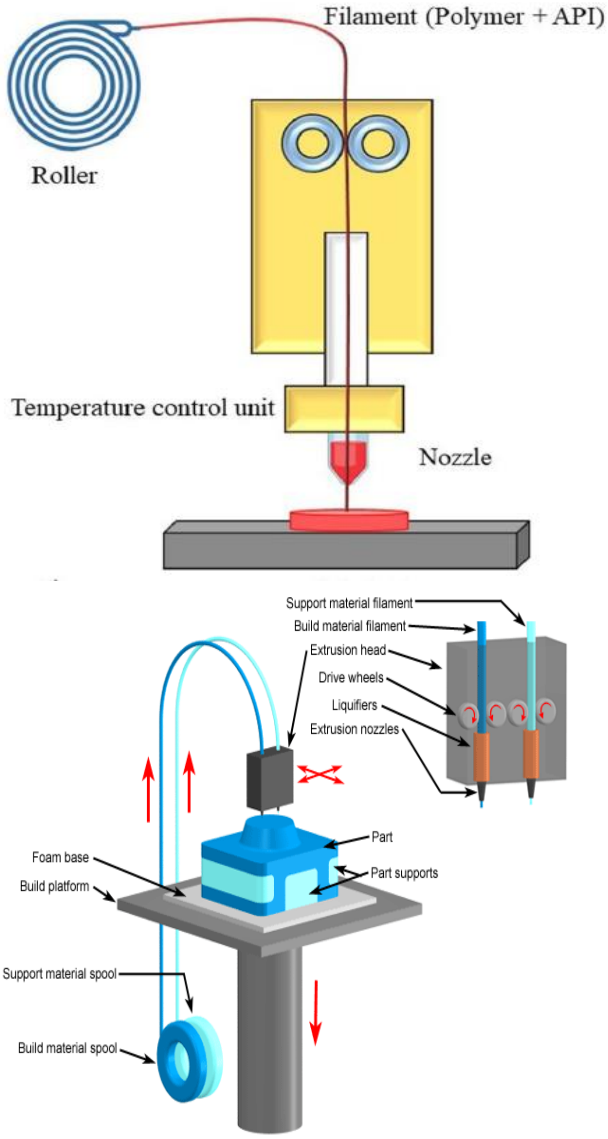


Fig 2. Fused Deposition Modeling (FDM)

1.3 Selective Laser Sintering

Selective Laser Sintering (SLS) was developed at the University of Texas in Austin, by Carl Deckard and colleagues. The technology was patented in 1989 and was originally sold by DTM Corporation. DTM was acquired by 3D Systems in 2001. SLS most closely resembles SLA in the way it is conceptualized and functions. It uses a moving laser beam to trace and selectively sinter powdered polymer and/or metal composite materials into successive cross-sections of a three-dimensional part. This is very much like the way SLA traces the ad forms the different cross-sections of an object. Just like the previous two techniques presented, the parts are built on a platform that adjusts in height equal to the thickness of the layer being built. To help the binding and curing process, additional powder is added on top of each solidified layer and sintered. The powder is then rolled onto the platform from a bin before building the layer. The powder is maintained at an elevated temperature so that it fuses easily upon exposure to the laser.

The build process with metal composite materials is a little bit different than that of polymers. When working with metal composite materials, the SLS process solidifies a polymer binder material around steel powder one slice at a time, forming the objet. The part is then placed in a furnace, with temperatures over 900 °C, where the polymer binder is burned off. To help improve its density and structural integrity the part is infused with bronze. This previously described process usually takes roughly one day to complete. SLS, like FDM, also allows for a wide range of materials that can be used to create objects. For example some of the materials are nylon, glass-filled nylon, SOMOS (rubber-like), Truform (investment casting), and the previously discussed metal composite.

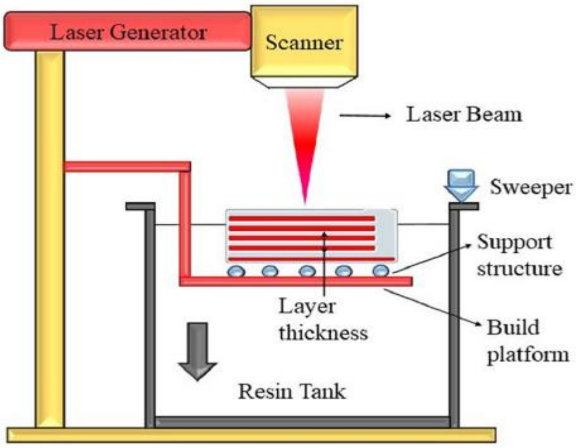


Fig 3. Selective Laser Sintering

1.4 Inkjet Printing

The additive manufacturing technique of inkjet printing is based on the 2D printer technique of using a jet to deposit tiny drops of ink onto paper. Where the two processes differ is in the additive process, the ink is replaced with thermoplastic and wax materials, which are held in a melted state. When printed, liquid drops of these materials instantly cool and solidify to form a layer of the part. Inkjet printing offers the advantages of excellent accuracy and polished finishes. On the downside, Inkjet printing has the disadvantages of slow build speeds, few material options, and fragile parts. Consequently, inkjet printing is most widely used for building prototypes of objects which are used for form and fit testing. Other applications include jewelry.

The inkjet printing processbegins with the build material (thermoplastic) and support material (wax) being held in a melted state inside two heated reservoirs. The materials are then each fed to an inkjet print head which moves in the X-Y plane and deposits tiny droplets to the specified area to form one layer of the object. Both materials instantly cool and solidify. After a layer has been finished, a milling head moves across the layer to smooth the surface and give it a finished look. The particles resulting from this cutting operation are vacuumed away by the particle collector. Much like the previous techniques described previous, once the layer is completed, the elevator then lowers the build platform and object so that the next layer can be constructed. This process is repeated over again until the object is completed. Once the object is completed, it can be removed and the wax support material can be melted away.

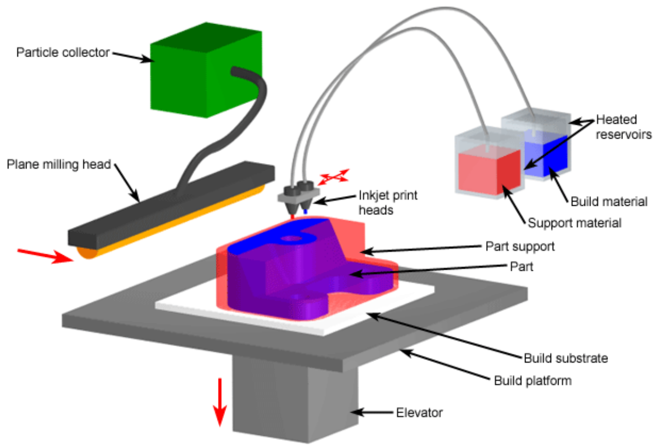


Fig 4. Inkjet printing

1.5 Microextrusion Bioprinters

The extrusion based bioprinting technique has a fluiddispensing system and an automatic robotic system in order to extrude the gel-form bioink and bioprint a model . Thebioink is located using a positioning system, with computer-aided design tools. The printed products are desired 3D custom-shaped structures that are formed with cylindrical filaments. These cylindrical filaments may contain cells and other biological materials. Such a better integrity on the structure can be provided by a rapid 3d printing for tissue engineering applications manufacturing method due to the continuous deposition of filaments. The fluid polymers can be dispensed using systems of the pneumatic, screw-driven, piston or solenoid-based system; however, the solenoid-based dispensers are not convenient to use for bioprinting. The pneumatic system uses pressured air with/without a valve configuration. The valve-free system has been widely used because of its simplicity. Therefore, the preferable configuration is the valve-based system can be because it has higher resolution than the other system due to its pressure control and pulse frequency control.

Mechanical microextrusion systems use a piston or a screw-driven configuration; working principle. The piston-driven dispenser maintains more direct control over the bioink flow through the nozzle. On the other hand, the screw-driven dispenser may give more positional control and is more useful for processing the high viscous bioinks . However, the screw-driven dispenser can damage the loaded cells, because its mechanism exposes bigger pressure drops along the nozzle. Thus, the rotating screw gear of the dispenser must be carefully designed as an extrusion-basedbioprinter. Both piston and screw types of mechanical microextrusion can work synergistically. For example; the screw-driven dispenser melts polycaprolactone (PCL) before deposition while the piston-driven dispenser, having syringe pumping, extrudes hydrogel. Extrusion based bioprinters are simple to construct and affordable. High viscous biomaterials can be used as bioink for producing a tissue-specific scaffold or small tissues. Also, large constructs can be created. Cell spheroids, cell aggregates can be used as bioink and them self-assembled into complex tissues by this printing method. The drawback of these methods is that only high-viscous materials can be extruded. Low-viscous materials need high pressure for extrusion and this cause high shear stress, which tends to kill cells. Cell survival ratesdecrease with increasing pressure.

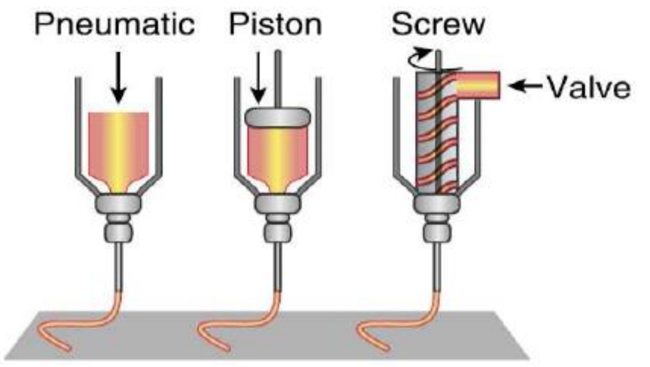


Fig 5. Microextrusionbioprinting systems

II. 3D PRINTER MATERIAL

1. Acrylonitrile Butadiene Styrene [ABS]

Temperature - 225°C Flow Tweak - 0.93• Bed Temperature - 90°C• Bed Preparation - apply glue stick 2 layer• & then abs glue 1 layer

2. Poly Lactic Acid [PLA], Material Properties of Poly Lactic Acid [PLA] Temperature - 180°C• Flow Tweak - 0.95• Bed Temperature - 60°C• Bed Preparation - apply glue stick 2 layer•
3. High Impact Polystyrene [HIPS]

Material Properties of High Impact Polystyrene [HIPS] Temperature - 225°C• Flow Tweak - 0.91• Bed Temperature - 90°C• Bed Preparation - apply glue stick 2 layer• & then abs glue 1 layer

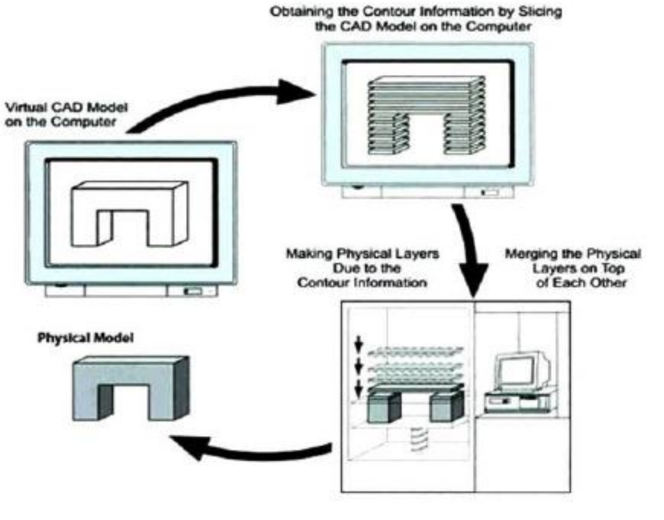


Fig 6. Printing procedure

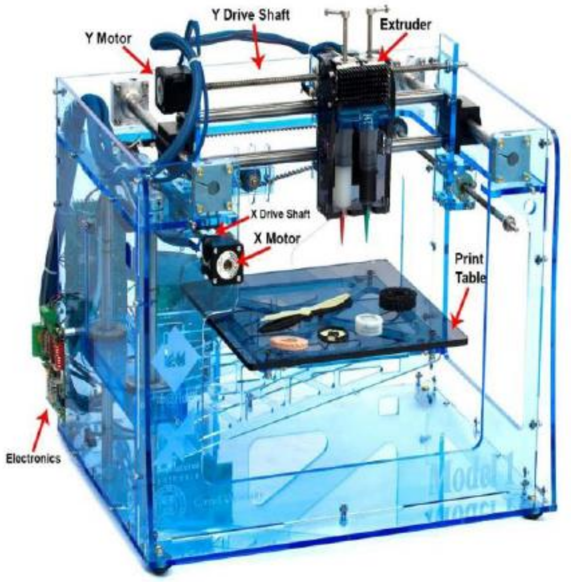


Fig 7. 3D-printer

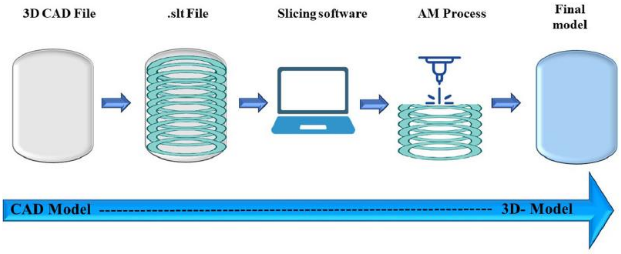


Fig 8. AM steps

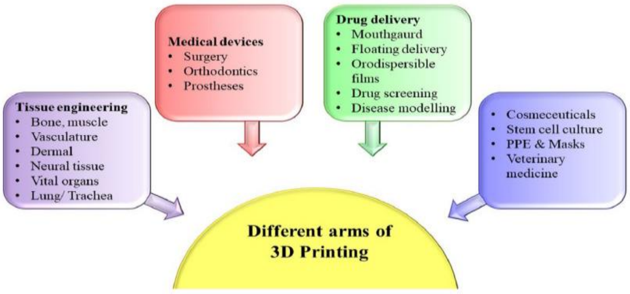


Fig 9. Application of 3d fields

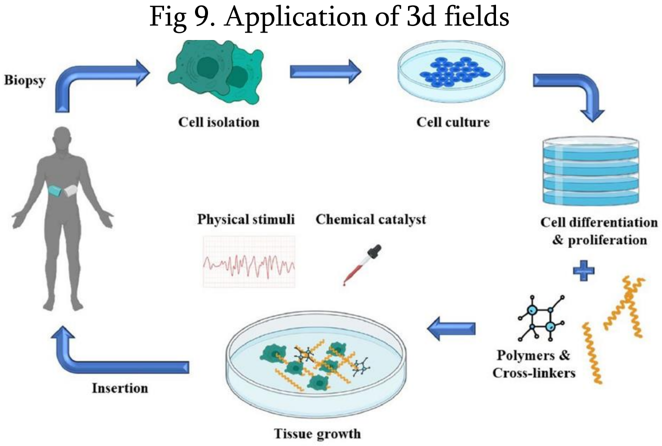


Fig 10. applications of 3d in Tissue growth

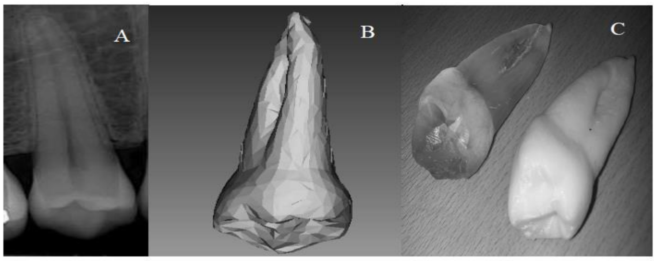


Fig11. Showing A) an example of a micro CT (computer tomography) image of human tooth with B) a digitized model and C) 3D printing models using SLA by Formlabs printer (transparent) and FDS by Maker Boot (white). The length of the tooth is about 20mm

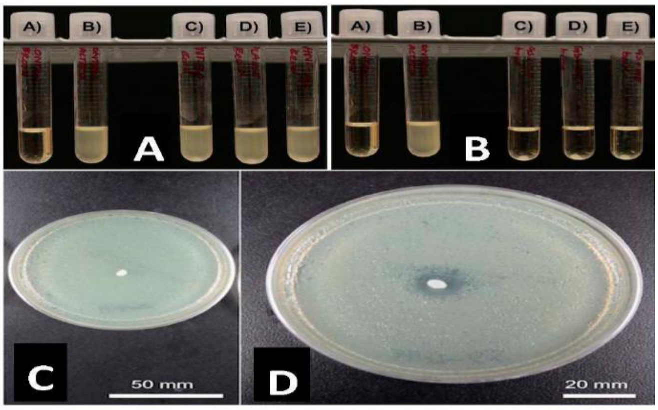
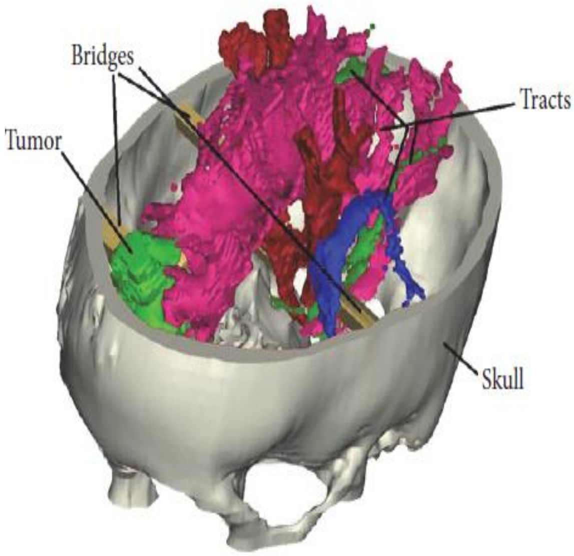
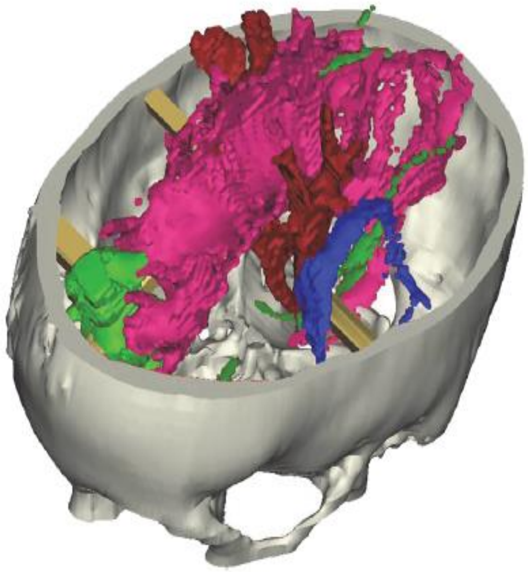


Fig 12. Doped Halloysite Nanotubes for Use in the 3d Printing of Medical Devices





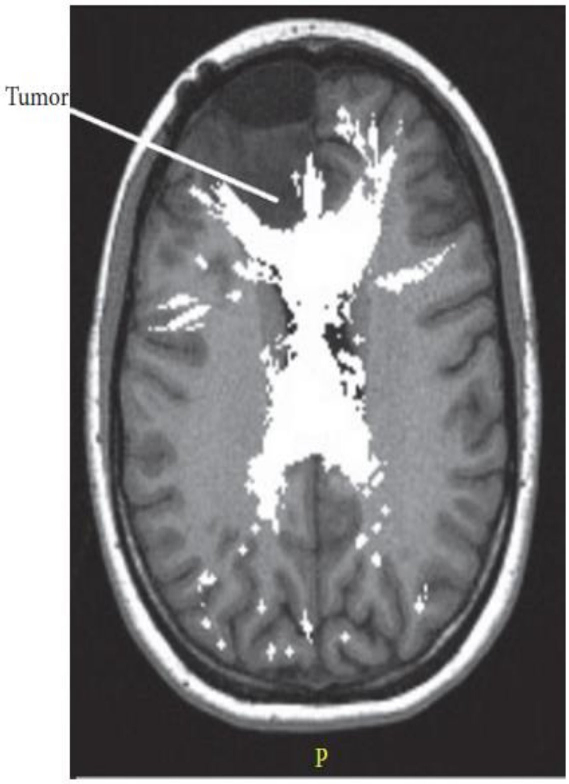


Fig13. skull as 3d tumor etc.

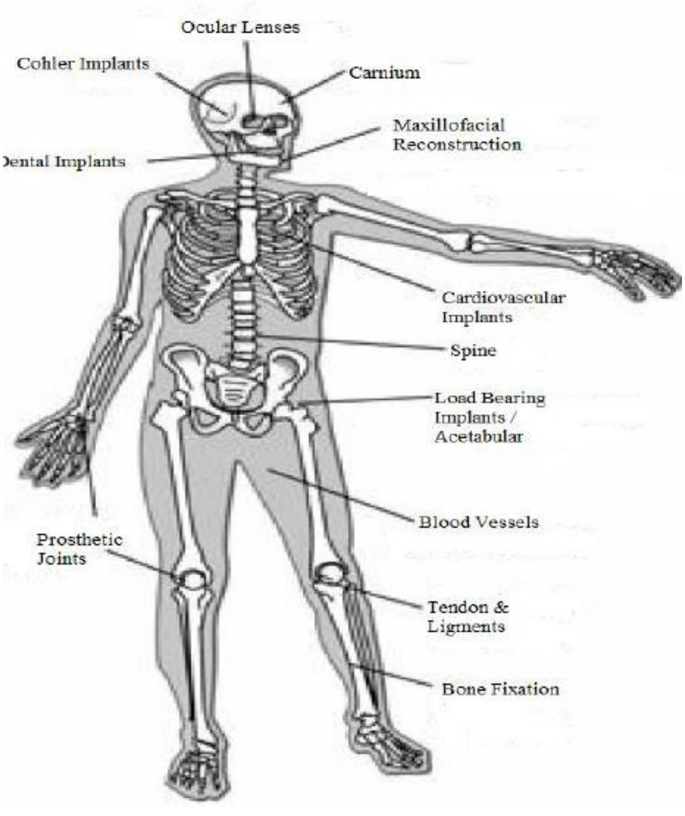


Fig 14. Possible implants in human body

III. Applications of 3d

Medical applications:

Organ printing, Smart multi-material printing, Dyspnea (Breathing problem), Smart medical implants and tissue engineering

Application in soft robotics: soft robots may be also used in autonomous surgeries, laparoscopy, and endoscopy, soft robots during manufacturing,

Application as self-evolving structures:

Application as active origami

Application in aerospace: to manufacture aerospace components that rely on aesthetics over function, such as door handles and light housings to control wheels and full interior dashboard designs

Application in sensors and flexible electronics: 3D printed circuit boards, 3D-printed supercapacitors, 3D-printed sensors, 3D- rinted actuators, Printed photovoltaics

Manufacturing-applications:Cloud-based-additive-manufacturing,Mass customization,Rapidmanufacturing.,Rapid prototyping,.Research.,Food.,Agile tooling

Educational Materials: Three-D printing technology may be used in education to spark pupil creativity and enhance mastering and collaboration. It can deliver items out of textbooks and off laptop monitors to offer gaining knowledge of advantages that cannot be finished in any other case. For example, college students may want to print out 3-d topographical models to research geography or 3D organic artifacts to study technology.

On-Demand, Tailored Clothing

The apparel enterprise generates a exquisite quantity of waste, which results in landfills. I currently bought a pair of three-D-printed footwear, and they're first-rate! Imagine if garb can be printed on-call for, to our measurements. We would get more of what we want with little waste. I’m also interested in the utility of three-D printing to cope with housing shortages

Pharmaceuticals: 3-D printing may want to facilitate the local production of drugs on demand. That could dramatically effect drug distribution and allow local geographies to rapidly address infectious illnesses

IV. Advantages of 3d

1. Time-to-Market: three-D printing permits ideas to increase faster. Being able to print a idea at the equal day it changed into designed shrinks a improvement procedure from what could have been months to some of days, helping companies stay one step beforehand of the other.

2. Save Money: Prototyping injection mold tools and manufacturing runs are expensive investments. The 3-d printing process permits the introduction of components and/or gear via additive manufacturing at rates a whole lot decrease than traditional machining.

Three. Mitigate Risk: Being capable of verify a layout before investing in an pricey moulding tool is worth its weight in three-D revealed plastic, after which a few. It is far less expensive to 3-d print a test prototype than to remodel or modify an current mold.

Four. Feedback: With a prototype, you may take a look at the market with the aid of unveiling it at a tradeshow, showing it to buyers or raising capital through pre-promoting on Indigo or Kick-starter. Getting purchaser's reaction to the product earlier than it without a doubt is going into manufacturing is a treasured manner to confirm the product has marketplace capacity.

5. Get the Feel: One component you cannot get a photo or digital prototype on the pc display screen is the manner something feels for your hand. If you want to ensure the ergonomics and healthy of a product are just proper, you must without a doubt keep it, use it and check it.

6. Personalize It: With trendy mass-production, all parts come off the assembly line or out of the mildew the same. With three-D printing, you could customize, customize a element to uniquely in shape their desires, which allows for custom suits inside the clinical industries and helps set humans to problematic their idea in new international.

7. Build your Imagination: In the modern boom of digital art and layout, the possibilities aren't best accelerating however endless. One can now three-D prints almost the whole thing they believe after drawing it up sincerely or by means of different. In a incredibly short time, an idea, concept, dream or invention can go from a easy thought to a produced element.

8. Square Holes? No Problem: The boundaries of widespread machining have restricted product layout for years. With the improvements in AM, now the opportunities are infinite. Geometry that has been traditionally tough to construct; like holes that exchange route, unrealistic overhangs is now possible and actually simple to construct.

Nine. Fail Fast, Fail Cheap: 3-d printing allows a product developer to make breakthroughs at early stages which might be enormously cheaper leading to better merchandise and less luxurious lifeless-ends.

5. Disadvantages of 3d

1. Intellectual assets troubles: The ease with which replicas may be created using 3-D technology raises troubles over intellectual belongings rights. The availability of blueprints on line freed from fee may additionally trade with for-earnings businesses looking to generate profits from this new generation.

2. Limitations of size: 3-D printing technology is presently constrained by means of size constraints. Very massive objects are still no longer

viable while built using three-D printers.

Three. Limitations of uncooked fabric: At gift, 3-d printers can work with about a hundred one of a kind uncooked substances. This is insignificant while as compared with the tremendous variety of uncooked materials utilized in traditional production. More studies is required to plan methods to allow 3D revealed products to be extra durable and sturdy.

4. Cost of printers: The value of buying a three-D printer nevertheless does now not make its buy by the average householder possible. Also, distinct three-D printers are required so that it will print one-of-a-kind varieties of gadgets. Also, printers that may manufacture in colour are dearer than those that print monochrome objects.

5. Fewer Manufacturing Jobs: As with all new technology, production jobs will lower. This drawback will have a big effect to the economies of 0.33 global countries in particular China, that depend upon a large number of low skill jobs.

6. Unchecked production of threat items: Liberator, the sector's first 3-d revealed purposeful gun, showed how easy it

become to produce one's personal guns, furnished one had get entry to to the design and a 3D printer. Governments will need to plan ways and method to test this dangerous tendency.

V. CONCLUSION

Introduction part is set the quick records of 3-D printing, inside the next segment we have depicted the 3-d-printing and the techniques utilized in 3D-printing and the houses of the 3Dprinter materials. In the 0.33 section, we've highlighted the primary blessings and limitations of the 3-d printing generation. One can conclude that the three-D printing generation's significance and social effect increase regularly every day and affect the human's life, the financial system, and modern-day society. Three-D Printing era could revolutionize the world. Advances in 3-D printing generation can considerably exchange and enhance the way we manufacture products and convey goods international. An item is scanned or designed with Computer Aided Design software program, then sliced up into skinny layers, which could then be revealed out to form a strong threedimensional product. As shown, 3D printing could have an software in nearly all of the categories of human wishes as described via Maslow. While it could not fill an empty unloved coronary heart, it will offer agencies and people fast and clean production in any size or scale restricted only by their imagination. 3D printing, on the other hand, can permit fast, reliable, and repeatable method of producing tailored merchandise that could nonetheless be made inexpensively because of automation of techniques and distribution of producing wishes.

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Cite this article as :

Jitendra Sunte, Jagdish Rathod, "A 3D Printing on Engineering and Medical Field",International Journal of Scientific Research in Mechanical and Materials Engineering (IJSRMME), ISSN : 2457-0435, Volume 6 Issue 4, pp. 17-26, July-August 2022.
URL : https://ijsrmme.com/IJSRMME22643