

**ABSTRACT**

The purpose of this paper is to review the recent trends in the Metal 3D Printing. Metal 3D Printing holds a unique position in modern-day product development. It allows for the direct manufacturing of complex end-use parts and facilitates tooling for conventional manufacturing technologies, reducing costs and lead times. 3D printing is a technology on the cusp, and therefore it is essential that you be fully prepared for its arrival. The only way to profit from great changes is to anticipate them in the very early stages and be ready to take advantages of the opportunities that they create. We are still at the beginning phase today, but major technical advances are already heralding enormous business opportunities. 3D printing is a technique that converts a digital design into tangible products by laying down consecutive cross sections of material in thin layers until it is built up. 3D printing has been widely used in aerospace, Bio-Printing and automotive industries to create prototypes of usually shaped components. The material here has been meticulously researched and combined with uniquely specialized knowledge of overseas manufacturing, niche markets and emerging economies.

**KEYWORDS:** 3D Printing, Metal, Aerospace, Organic Implants, Bio- Printing, Prosthetics and EBM.

**I. INTRODUCTION**

3D printing, also known as additive manufacturing, refers to processes used to create a three-dimensional object in which layers of material are formed under computer control to create an object. Can be of almost any shape or geometry and are produced using digital model data from a 3D model or another electronic data source such as an Additive Manufacturing File. Thus, unlike material removed from a stock in the conventional machining process, 3D printing or AM builds a three-dimensional object from computer-aided design (CAD) model or AMF file by successively adding material layer by layer. 3D printers take data from a computer generated model and translate that into a real, solid form. The two most popular methods are FDM and SLA. Fused Deposition Modeling (FDM) is a process where small amounts of plastic are heated and fused together layer by layer to create a three-dimensional structure. Stereolithography (SLA) works by using a laser to solidify a photopolymer (light reactive plastic) resin. The UV light is projected onto a point in the resin, causing it to become solid one layer at a time.

It is already making an enormous impact in prototype development by giving the designer the ability to go from an idea to a physical object within hours. In contrast, creating prototypes using conventional methods can take weeks and is often costly. This all adds up to a faster turnaround on projects, months shaved off the design cycle and a whole lot of money saved in the process. The potential applications for 3D printing cross a huge range of business sectors from interior set modeling, architectural design and dentistry to rapid product prototyping and scientific and structural.



The term “3D printing” originally referred to a process that deposits a binder material onto a powder bed with inkjet printer heads layer by layer. More recently, the term is being used in popular vernacular to encompass a wider variety of additive manufacturing techniques. United States and global technical standards use the official term additive manufacturing for this broader sense. ISO/ASTM52900-15 defines seven categories of AM processes within its meaning: binder jetting, directed energy deposition, material extrusion, material jetting, powder bed fusion, sheet lamination and vat photo polymerization.

Metal 3D Printing holds a unique position in modern-day product development. It allows for the direct manufacturing of complex end-use parts and facilitates tooling for conventional manufacturing technologies, reducing costs and lead times.

#### Common applications

- Production tools, molds and inserts
- Housings, ductwork and spare parts
- Fully functional prototypes

#### Materials

- Aluminum
- Titanium
- Stainless Steel

#### 3D Metal Printing Application

By using metal 3D printing, Aerospace companies can use the same materials (titanium, aluminum) as they do with traditional methods. This is crucial for these industries because they have qualified specific materials that can resist to the conditions of a flight. For instance, **3D printed titanium** has the same mechanical characteristics of strength, weight or solidity than forged titanium. It is indeed very important in this sector to have lightweight materials like **aluminum** or strong and resistant materials like titanium to build specific parts for spacecraft or engines. One of our favoring examples is also the *International Submarine Engineering's* (ISE) association. They built the AUV submarine vehicle using 3D printing to manufacture a ballast tank. They achieve it in a **shorter turnaround time than with traditional forging methods**. Metal 3D printing makes them realize that they can easily modify the shape of the ballast to fit better in their AUV



Sometimes, the Aerospace industry is leading to great improvements in other sectors. The powdered nickel super alloy was first developed for the aerospace industry but thanks to researches and design simulation software; this material is on the verge to be applied in mechanical parts in many other industries

#### Another domain where metal 3D printing is changing the game is the health sector:

3D printing is making great progress with bio-printing and organic implants but metal 3D printing is already widely used for prosthetics, implants and custom tools.

Doctors and surgeons use 3D printing for their specific instruments. They can conceive their prototypes that will look very close to the final product. **Spine Vision**, one of our customers is making prototypes thanks to

Sculptor's 3D printing service. They consider using our metal 3D printing service to manufacture their tool in titanium or stainless steel.

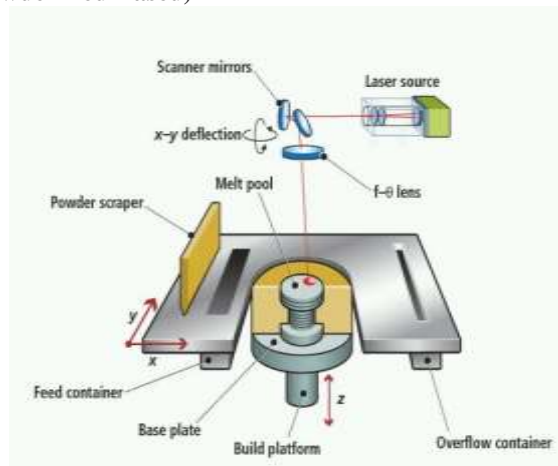
The metal 3D printing technology allows creating custom parts in a very short turnaround time that's why it is also used for surgical implants or prosthetics. With **biocompatible metals like titanium, some stainless steel alloys**, medical companies can achieve prosthetics and implants that perfectly fit the needs of the patient.



One great example is the recent success of a surgeon team from Hong Kong. They achieve to implement a titanium 3D printed talus bone to a motorcycle crash victim. It was easier for them to use this technology as it allows a short turnaround time and very precise dimensions that **perfectly fits the patient's body**. They are planning to expand the use of metal additive manufacturing to replace bones of patients suffering from bone cancer.

Metal 3D Printing is tantamount to the Holy Grail of additive manufacturing. Companies are in a full-scale arms race to establish the most effective means of molding metal into malleable forms and in accordance, sales have been rising annually. Metal 3D printing is poised to kick start a whole new renaissance in manufacturing. So far, there are multiple types of metal 3D printing that each have their own benefits and drawbacks. Here are some of the most common types used to digitally craft metal objects.

#### Selective Laser Melting (Powder Bed Based)



**Retrieved from:** Popular 3D Printers

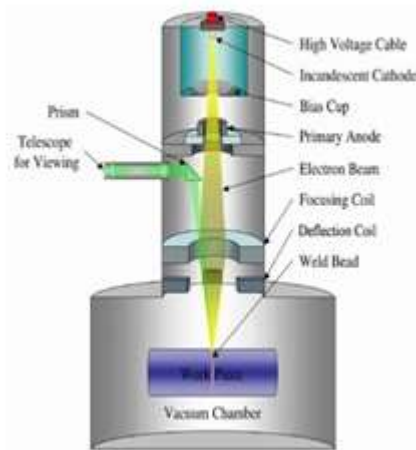
SLM refers to the metal 3D printing method of using lasers to melt and recombine powders. This method is fantastic for rearranging alloys. SLM is very similar to Direct Metal Laser Sintering and according to rumors the name difference is due a falling out between the parties developing the method and varying patents. Nonetheless, both methods make use of lasers to arrange a wide spectrum of alloys.

### Selective Laser Sintering (Powder Bed Based)

SLS, while mostly used for plastics, can also be used for certain types of metals. SLS and SLM are among the most common means by which metals are 3D printed, also known as Direct Metal Laser Sintering (DMLS) and Direct Metal Laser Melting (DMLM). These methods are quite similar to the point of being confused for each other very often. The difference lies in what materials they affect. SLM sinters powders making it useful for alloys as opposed to SLS which processes single element metals and certain alloys. SLS displays a far wider range of material powders that it can work with and it can achieve varying levels of density in creating structures. Another difference is that SLS requires the elements to be fully melted.

### Electronic Beam Melting (EBM)

EBM is another type of additive manufacturing for metal Parts. It was originally coined by Arcam AB Inc. in the beginning of this century. The same as SLM, this 3d printing method is a powder bed fusion technique. While SLM uses high-power laser beam as its power source, EBM uses an electron beam instead, this is the main difference between these two methods. The rest of the processes are pretty similar.



The Material used in EBM is metal powder that melts and forms a 3D part layer by layer by means of a computer that controls electron beam in high vacuum. Contrary to SLS, EBM goes for full melting of the metal powder. The process is usually conducted under high temperature up to 1000 °C.

Currently the most well spread materials that are used for EBM are commercially pure Titanium, Inconel 718 and Inconel 625. The application of EBM is mainly focused on medical implants and aerospace area

## II. CONCLUSION

In this Paper, Metal 3D Printing is referred to a process that deposits a binder material onto a powder bed with inkjet printer heads layer by layer. More recently, used in popular vernacular to encompass a wider variety of additive manufacturing techniques. Metal 3D Printing is widely used in lightweight like **minimum** or strong and resistant materials like titanium to build specific Parts for spacecraft or engines. It was easier for them to use this technology as it allows a short turnaround time and very precise dimensions that **perfectly fits the patient's body**. They are planning to expand the use of metal additive manufacturing to replace bones of patients suffering from bone cancer. The material used in EBM is metal powder that melts and forms a 3D part layer by layer by means of a computer that controls electron beam in high vacuum. The metal 3D Printing using in bio - Printing and organic implants with **biocompatible metals like titanium, some stainless steel alloys**, medical companies can achieve prosthetics and implants that perfectly fit the needs of the patient.

## III. REFERENCES

1. <http://www.vision-experts.com/57-1-Decorated-metal-sheet-inspection.html>
2. [https://en.wikipedia.org/wiki/Type\\_metal/10/07/2017](https://en.wikipedia.org/wiki/Type_metal/10/07/2017)
3. <http://3dprintingfromscratch.com/common/types-of-3d-printers-or-3d-printing-technologies-overview/10/07/2017>
4. <http://www.materialise.com/en/manufacturing/3d-printing-technology>



5. [https://www.simpli.com/web?qsrc=999&qo=semQuery&ad=semD&o=604695&l=sem&askid=3d3a4729-a3bb-4cff-9142-63c50e19a2f1-gsb&q=3d%20printing%20in%20metal&dqi=&am=broad&an=google\\_s/10/07/2017](https://www.simpli.com/web?qsrc=999&qo=semQuery&ad=semD&o=604695&l=sem&askid=3d3a4729-a3bb-4cff-9142-63c50e19a2f1-gsb&q=3d%20printing%20in%20metal&dqi=&am=broad&an=google_s/10/07/2017)
6. <http://uk.rs-online.com/web/generalDisplay.html?id=i/3d-printing/-11/07/2017>
7. <https://www.livescience.com/topics/3d-printing/11/07/2017>
8. [https://www.google.co.in/search?q=3d+metal+printing&hl=en-IN&gbv=2&prmd=ivnsp&source=lnms&tbm=isch&sa=X&ved=0ahUKEwjuwau58o3VAhUNNpOKHUt0BqkQ\\_AUIBQ/-11/7/2017](https://www.google.co.in/search?q=3d+metal+printing&hl=en-IN&gbv=2&prmd=ivnsp&source=lnms&tbm=isch&sa=X&ved=0ahUKEwjuwau58o3VAhUNNpOKHUt0BqkQ_AUIBQ/-11/7/2017)
9. Image Retrieved from: <http://www.custompartnet.com/-10/07/2017>
10. <https://3dprinting.com/metal/types-of-metal-3d-printing/10/7/2017>.

#### CITE AN ARTICLE

**Singh, Azad . "AN ANALYSTICAL REVIEW OF METAL 3D PRINTING." *INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY* 6.7 (2017): 756-60. Web. 25 July 2017.**