

### 3D PRINTING TECHNOLOGY: METHODS AND MATERIALS

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#### ABSTRACT

Generally called as 3D printing, Additive Manufacturing has a very good potential to shorten the manufacturing processes, minimize material and energy use, and reduce waste. With the industrial revolution and the changing consumer buying behavior, companies are looking for ways to quickly transform the traditional model currently being used in production and logistics into advanced technologies to gain competitive advantage over their competitors. A wide range of the available 3D printing technologies and materials makes it necessary to choose among the followings: dimensional accuracy, surface quality and post-processing requirements. The aim of this study is to classify and summarize the differences between the production methods of the Additive Manufacturing Technology and the types of materials used in these technologies. In addition, advantages, usage fields and current challenges of the 3D printing technology are mentioned.

**Keywords:** 3D Printers, Additive Manufacturing, SLA, FDM

#### INTRODUCTION

With the industrial revolution and the changing consumer characteristics and demands, companies have been looking for ways to quickly transform the traditional model in production and logistics into advanced technologies to have advantages over their competitors. (Troselj, 2014).

The 3D printers make it possible to simplify manufacturing steps, modernize production processes, and reduce stocks. (Kleviet, 2015).

In the future, children will be able to do their toys with a three-dimensional toy data downloaded from the internet, and when any piece of home-use devices is broken, without feeling necessary for bringing the broken piece directly from factory, it will be enough to pay only for either necessary geometry or material information. (M.Ruffo, 2007). Additionally, It is strongly expected that the organs needed by people can be produced with the 3D printers. (Billiet, Vandenhaute, Schelfhout, & V, 2012).

In this study, classifying and summarizing the differences between the production methods of the Additive Manufacturing Technology and the types of materials used in these technologies will be explained in detail. Finally, advantages, usage fields and current challenges of the 3D printing technology are mentioned.

#### WHAT IS ADDITIVE MANUFACTURING?

Firstly produced in 1984 by Charles Hull (Ponsford & Glass, 2014 ), the 3D printers are one of the fastest growing industries in the world (Gruske, 2015). The technology, also called as additive manufacturing, is the process of producing any solid object from a digital computer model. The production of a three-dimensional shape is made by melting the 3D printing material into layers to form the desired shape (Campbell, Williams, Ivanova, & Garrett, 2011). Nowadays, it provides a real-time inventory management solutions for all industries. (Kietzmann, Pitt, & Berthon, 2015). Figure 1 exhibits some applications of the 3D printing technology in many sectors.



Figure 1: Usage fields of the 3D printing technologies in many sectors

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### 3. ADDITIVE MANUFACTURING METHODS

Although there are many applications in layered manufacturing technology, these applications are classified according to their method and materials. In 3D printers, many materials such as ABS (Acrylonitrile Butadiene Styrene), plastic, polyamide (nylon), glass filled polyamide, stereolithography materials (epoxy resins), silver, titanium, steel, beeswax, photopolymers and polycarbonate can be used as consumables (raw material). Otherwise, metal, wood, cement, chocolate or human cells may also be consumables (3ders.org, 2016). Table 1 shows some of the most common additive manufacturing technology application methods and materials used in these methods.

Table 1: Additive manufacturing methods and materials used in these methods

	Technology		Materials
Photopolymerization		SLA	Standard, robust, flexible, transparent and refillable resins
		DLP	
		CDLP	
Dust Bed Fusion		<b>Selective Laser Sintering (SLS)</b>	Nylon, alumite, carbon fiber filled nylon, PEEK, TPU
		<b>SLM ve DMLS</b>	Aluminum, titanium, stainless steel, nickel alloys, cobalt-chrome
		<b>Electron Beam Melting (EBM)</b>	Titanium, cobalt-chrome
		Multi Jet Fusion (MJF)	Nylon
Material Extrusion		<b>Fused Deposition Modelling (FDM)</b>	ABS, PLA, Nylon, PC, fiber reinforced Nylon, ULTEM, exotic filaments (wood filled, metal filled etc.)
Material Jet		Material Jet	Hard, transparent, multi-colored, rubber-like, ABS-like. Multi-material and multi-color printing available
		<b>Nano particle jet</b>	Stainless steel, ceramic
		<b>Drop On Demand (DOD)</b>	Wax
Connector jetting		<b>Connector Jetting</b>	Silica Sand, PMMA Particle Material, Gypsum Stainless steel, ceramic, cobalt-chrome, tungsten carbide

### CONCLUSION

The Additive Manufacturing Technologies have many advantages such as not having too many limits compared to classical manufacturing methods, not requiring special gauge / mold like tools and providing very fast solution especially in prototype applications. As it meets a wide range of material types and production needs, it should be accurately determined which method to use. In this study, The Additive Manufacturing

Technologies, which have become popular recently, have been examined and a detailed classification for them has been made. In order to guide the selection of the appropriate method, the methods used in different sectors are described and a Table, that explains these methods and the materials, is formed.

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