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Additive Manufacturing

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Abstract: Additive manufacturing uses data Computer-Aided-Design (CAD) software or 3D object scanners to direct hardware to deposit material, layer upon layer, in precise geometric shapes. As its name implies, additive manufacturing adds material to create an object. By contrast, when you create an object by traditional means, it is often necessary to remove material through milling, machining, carving, shaping or other means. While additive manufacturing seems new to many, it has actually been around for several decades. In the right applications, additive manufacturing delivers a perfect trifecta of improved performance, complex geometries and simplified fabrication. As a result, opportunities abound for those who actively embrace additive manufacturing.

Keywords: Additive Manufacturing, 3D Printer, 3D Objects, Filaments

I. INTRODUCTION

The term “additive manufacturing” references technologies that grow three-dimensional objects one superfine layer at a time. Each successive layer bonds to the preceding layer of melted or partially melted material. It is possible to use different substances for layering material, including metal powder, thermoplastics, ceramics, composites, glass and even edibles like chocolate. Objects are digitally defined by Computer-Aided-Design (CAD) software that is used to create .stl files that essentially "slice" the object into ultra-thin layers. This information guides the path of a nozzle or print head as it precisely deposits material upon the preceding layer. Or, a laser or electron beam selectively melts or partially melts in a bed of powdered material. As materials cool or are cured, they fuse together to form a three-dimensional object. The journey from .stl file to 3D object is revolutionizing manufacturing. Gone are the intermediary steps, like the creation of molds or dies, that cost time and money.

A Computer-Aided Design (CAD) is created and exported to Stereolithography (STL) file format that is read by the AM equipment. There are many techniques available, which can be categorized according to their raw material. They are: (1) powder-based, (2) liquid-based, and (3) solid based. Some examples of powder-based techniques include selective laser melting (SLM), Selective Laser Sintering (SLS), and electron beam melting (EBM). Liquid-based techniques include Stereolithography Apparatus (SLA) and polyjet while solid-based techniques include Laminated Object Manufacturing (LOM) and Fused Deposition Modeling (FDM). The strengths of AM compared to conventional manufacturing methods are listed further. Basically, any material can be produced by one or another AM technique today. These materials can be divided into four main categories: plastics, metals, ceramics, and composites.

II. ADDITIVE MANUFACTURING PROCESSES

A. Material Extrusion

Material extrusion is one of the most well-known additive manufacturing processes. Spooled polymers are extruded, or drawn through a heated nozzle mounted on a movable arm. The nozzle moves horizontally while the bed moves vertically, allowing the melted material to be built layer after layer. Proper adhesion between layers occurs through precise temperature control or the use of chemical bonding agents.

B. Direct Energy Deposition

The process of Directed Energy Deposition (DED) is similar to material extrusion, although it can be used with a wider variety of materials, including polymers, ceramics and metals. An electron beam gun or laser mounted on a four- or five-axis arm melts either wire or filament feedstock or powder.

C. Material Jetting

With material jetting, a print head moves back and forth, much like the head on a 2D inkjet printer. However, it typically moves on x-, y- and z-axes to create 3D objects. Layers harden as they cool or are cured by ultraviolet light.

D. Binder Jetting

The binder jetting process is similar to material jetting, except that the print head lays down alternate layers of powdered material and a liquid binder.

E. Sheet Lamination

Laminated Object Manufacturing (LOM) and Ultrasonic Additive Manufacturing (UAM) are two sheet lamination methods. LOM uses alternate layers of paper and adhesive, while UAM employs thin metal sheets conjoined through ultrasonic welding. LOM excels at creating objects ideal for visual or aesthetic modeling. UAM is a relatively low-temperature, low-energy process used with various metals, including titanium, stainless steel and aluminum.

F. Vat Polymerization

With vat photopolymerization, an object is created in a vat of a liquid resin photopolymer. A process called photopolymerization cures each microfine resin layer using Ultraviolet (UV) light precisely directed by mirrors.

G. Powder Bed Fusion

Powder Bed Fusion (PBF) technology is used in a variety of AM processes, including Direct Metal Laser Sintering (DMLS), Selective Laser Sintering (SLS), Selective Heat Sintering (SHS), Electron Beam Melting (EBM) and Direct Metal Laser Melting (DMLM). These systems use lasers, electron beams or thermal print heads to melt or partially melt ultra-fine layers of material in a three-dimensional space. As the process concludes, excess powder is blasted away from the object.

III. ADDITIVE MANUFACTURING TECHNOLOGIES

The system starts by applying a thin layer of the powder material to the building platform. A powerful laser beam then fuses the powder at exactly the points defined by the computer-generated component design data. The platform is then lowered and another layer of powder is applied. Once again the material is fused so as to bond with the layer below at the predefined points. Depending on the material used, components can be manufactured using stereolithography, laser sintering or 3D printing. EOS Additive Manufacturing Technology based on laser sintering has been in existence for over 20 years.

A. Sintering

Sintering is the process of creating a solid mass using heat without liquefying it. Sintering is similar to traditional 2D photocopying, where toner is selectively melted to form an image on paper.

B. Direct Metal SIntering (DMLS)

Within DMLS, a laser sinters each layer of metal powder so that the metal particles adhere to one another. DMLS machines produce high-resolution objects with desirable surface features and required mechanical properties. With SLS, a laser sinters thermoplastic powders to cause particles to adhere to one another.

C. Direct Metal Laser Melting and Electron Beam

By contrast, materials are fully melted in the DMLM and EBM processes. With DMLM, a laser completely melts each layer of metal powder while EBM uses high-power electron beams to melt the metal powder. Both technologies are ideal for manufacturing dense, non-porous objects.

D. Stereolithography (SLA)

Stereolithography (SLA) uses photopolymerization to print ceramic objects. The process employs a UV laser selectively fired into a vat of photopolymer resin. The UV-curable resins produce torque-resistant parts that can withstand extreme temperatures.

IV. ADDITIVE MANUFACTURING MATERIALS

It is possible to use many different materials to create 3D-printed objects. AM technology fabricates jet engine parts from advanced metal alloys, and it also creates chocolate treats and other food items.

A. Thermoplastics

Thermoplastic polymers remain the most popular class of additive manufacturing materials. Acrylonitrile butadiene styrene (ABS), polylactic acid (PLA) and polycarbonate (PC) each offer distinct advantages in different applications. Water-soluble polyvinyl alcohol (PVA) is typically used to create temporary support structures, which are later dissolved away.

B. Metals

Many different metals and metal alloys are used in additive manufacturing, from precious metals like gold and silver to strategic metals like stainless steel and titanium.

C. Ceramics

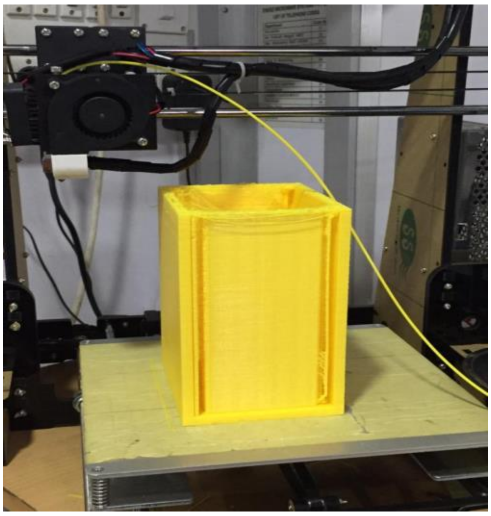
A variety of ceramics have also been used in additive manufacturing, including zirconia, alumina and tricalcium phosphate. Also, alternate layers of powdered glass and adhesive are baked together to create entirely new classes of glass products.

D. Biochemicals

Biochemical healthcare applications include the use of hardened material from silicon, calcium phosphate and zinc to support bone structures as new bone growth occurs. Researchers are also exploring the use of bio-inks fabricated from stem cells to form everything from blood vessels to bladders and beyond.

V. CONCLUSION

The cartesian cordinate 3D printer is used to print the shown object. It uses PLA plastic at the temperature of 180degree Celcius to melt and print. The heat bed is set to 80degree celcius to make the object stick to its place. The stipulated time taken by the printerto print this block is 1 hour 23 mins.



This object is 3D printed via FDM method

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