SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
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DEPARTMENT OF AEROSPACE ENGINEERING

19ASZ401-3D Printing for Space Components

UNIT-I INTRODUCTION

TOPIC: Development of Additive Manufacturing Technology

NAME: Mr.N.Venkatesh., M.Tech.,(Ph.D)
Assistant Professor
Aerospace Engineering
SNS College of Technology

Introduction

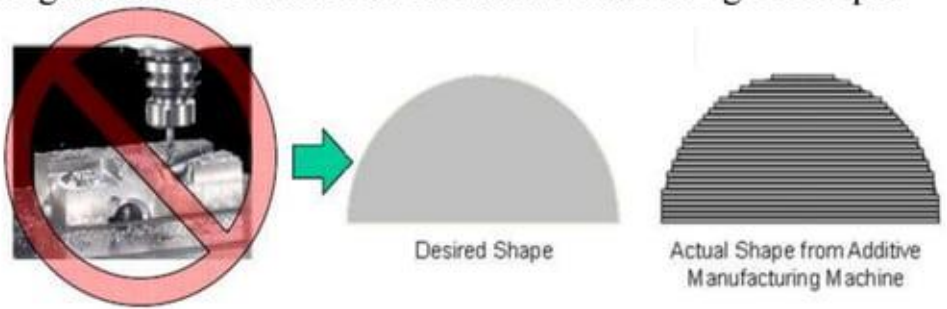
Manufacturing is a process in which raw materials are transformed into finished goods.

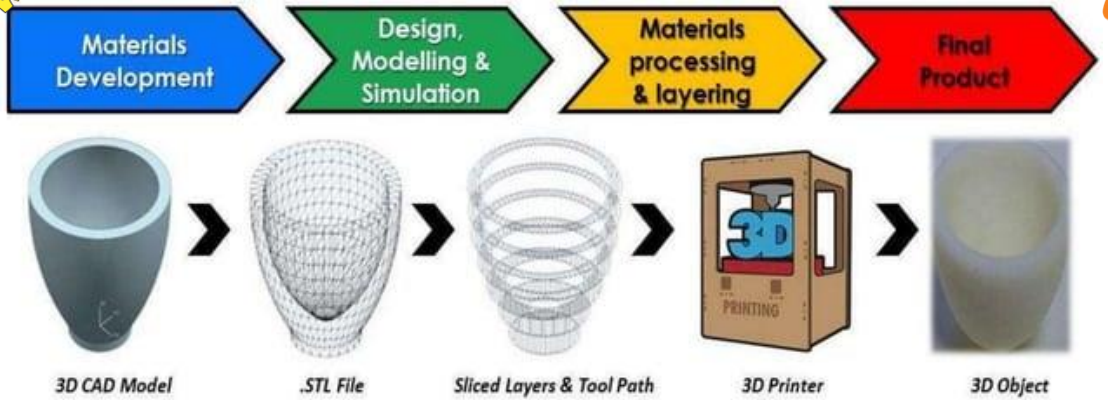
Additive Manufacturing

- Technology that can make anything.
- Eliminates many constraints imposed by conventional manufacturing
- Leads to more market opportunities.
- Increased applications such as 3D faxing sender scans a 3D object in cross sections and sends out the digital image in layers, and then the recipient receives the layered image and uses an AM machine to fabricate the 3D object.

What is Additive Manufacturing?

- *The process of joining materials to make objects from three-dimensional (3D) model data, usually* ***layer by layer***
- Commonly known as **"3D printing"**
- Manufacturing components with virtually no geometric limitations or tools.
- AM uses an ***additive process***
- *Design for manufacturing to manufacturing for design*
- Distinguished from traditional subtractive machining techniques





Functional principle

- ✓ 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.
- ✓ 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.

ADVANTAGES

- Freedom of design
- Complexity for free
- Potential elimination of tooling
- Lightweight design
- Elimination of production steps

DISADVANTAGES

- Slow build rates
- High production costs
- Considerable effort required for application design
- Discontinuous production process
- Limited component size.

Applications

AM has been used across a diverse array of industries, including;

- ✓ Automotive
- ✓ Aerospace
- ✓ Biomedical
- ✓ Consumer goods and many others

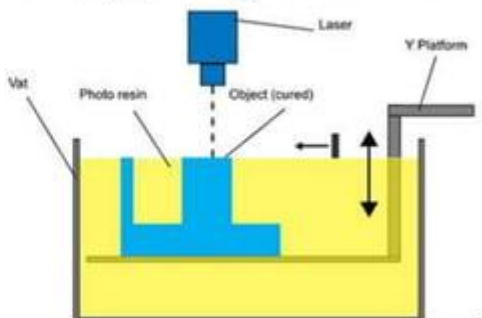
AM processes are classified into seven categories

1) Vat Photopolymerisation/Steriolithography
2) Material Jetting
3) Binder jetting
4) Material extrusion
5) Powder bed fusion
6) Sheet lamination
7) Directed energy deposition

Vat photopolymerization/Steriolithography

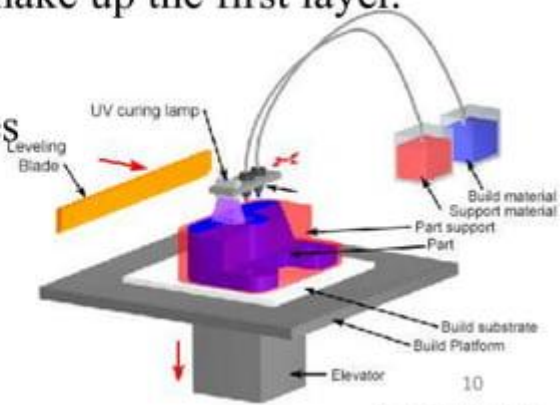
- Laser beam traces a cross-section of the part pattern on the surface of the liquid resin
- SLA's elevator platform descends
- A resin-filled blade sweeps across the cross section of the part, re-coating it with fresh material
- Immersed in a chemical bath

Stereolithography requires the use of supporting structures



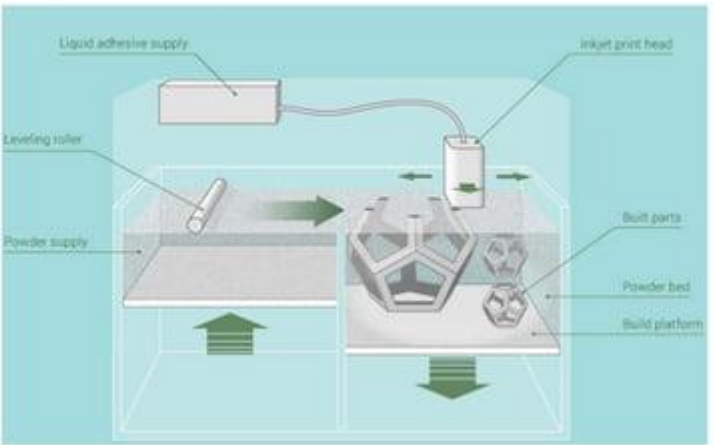
Material Jetting

- Drop on demand method
- The print head is positioned above build platform
- Material is deposited from a nozzle which moves horizontally across the build platform
- Material layers are then cured or hardened using ultraviolet (UV) light
- Droplets of material solidify and make up the first layer.
- Platform descends
- Good accuracy and surface finishes



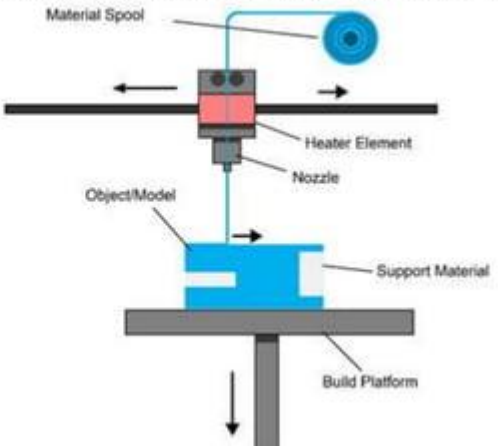
Binder Jetting

- A glue or binder is jetted from an inkjet style print head
- Roller spreads a new layer of powder on top of the previous layer
- The subsequent layer is then printed and is stitched to the previous layer by the jetted binder
- The remaining loose powder in the bed supports overhanging structures



Material Extrusion/FDM

- Fuse deposition modelling (FDM)
- Material is drawn through a nozzle, where it is heated and is then deposited layer by layer
- First layer is built as nozzle deposits material where required onto the cross sectional area.
- The following layers are added on top of previous layers.
- Layers are fused together upon deposition as the material is in a melted state.



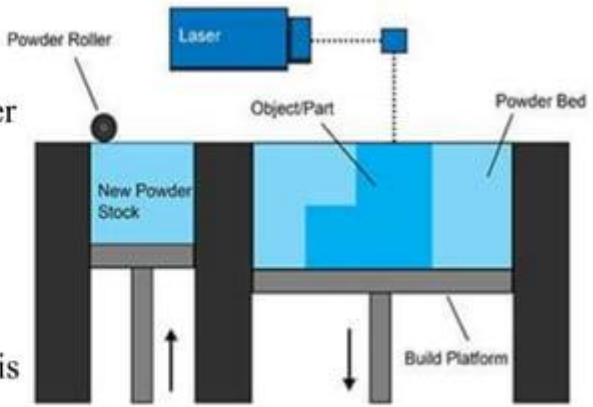
Powder Bed Fusion

- Selective laser sintering (SLS)
- Selective laser melting (SLM)
- Electron beam melting (EBM)

No support structures required

PROCESS

- A layer, typically 0.1mm thick of material is spread over the build platform.
- The SLS machine preheats the bulk powder material in the powder bed
- A laser fuses the first layer
- A new layer of powder is spread.
- Further layers or cross sections are fused and added.
- The process repeats until the entire model is created.

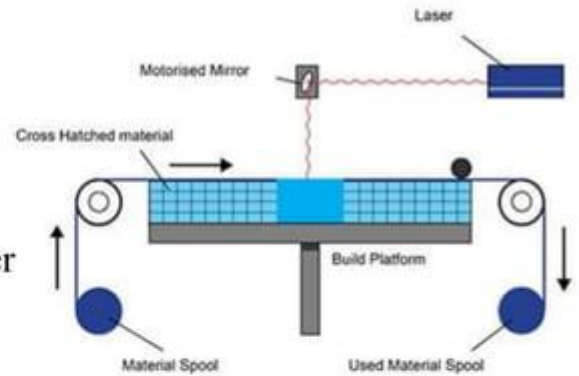


Sheet Lamination

- Metal sheets are used
- Laser beam cuts the contour of each layer
- Glue activated by hot rollers

PROCESS

1. The material is positioned in place on the cutting bed.
2. The material is bonded in place, over the previous layer, using the adhesive.
3. The required shape is then cut from the layer, by laser or knife.
4. The next layer is added.

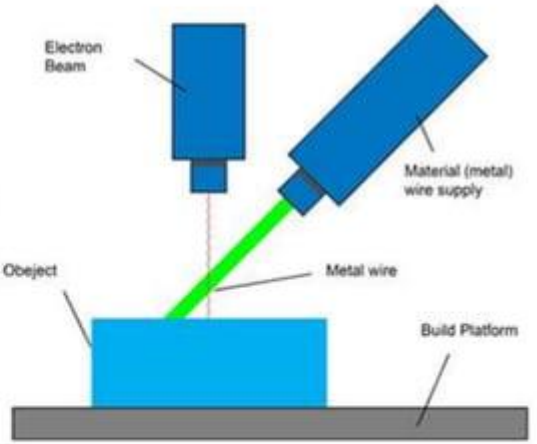


Directed Energy Deposition

- Consists of a nozzle mounted on a multi axis arm
- Nozzle can move in multiple directions
- Material is melted upon deposition with a laser or electron beam

PROCESS

1. A4 or 5 axis arm with nozzle moves around a fixed object.
2. Material is deposited from the nozzle onto existing surfaces of the object.
3. Material is either provided in wire or powder form.
4. Material is melted using a laser, electron beam or plasma arc upon deposition.
5. Further material is added layer by layer and solidifies, creating or repairing new material features on the existing object.



Present Condition & Trends

Technology And Research

- The model data, usually in ***stereolithography (STL)*** format, is first decomposed into a series of 2D, finitely thick cross sections, which are then fed into an AM machine.
- Used directly and indirectly to produce prototype parts
- Reduce manufacturing and product costs

University–Industry Collaboration and Technology Transfer

More and more companies have begun using AM technology to;

- Reduce time-to-market
- Increase product quality
- Improve product performance
- Costs

- Metal-based AM processes have recently emerged in industrial applications for manufacturing items such *as automotive engines, aircraft assemblies, power tools, and manufacturing tools including jigs, fixtures, and drill guides*

Education And Training

- Educating the general public about AM empowers people to build what they dream.
- Formal AM education has already been integrated into curricula at different levels.
- Educational materials on rapid prototyping have long been a part of manufacturing engineering courses

AM - Future Aspects

Technology And Research

- *" Third industrial revolution "*
- The cost effective mass customization of complex products
- Reduced material waste and energy consumption
- *Adapt new product designs without the additional expenses*
- In the *biomedical field*, AM can be used to fabricate tissue scaffolds that are biocompatible, biodegradable, and bio-absorbable

Education & Training

- AM holds great potential for promoting science, technology, engineering, and mathematics (STEM) education
- The availability of low-cost 3D printing equipment is creating the opportunity for AM-enabled, hands-on labs in primary, secondary, and postsecondary schools across the nation

THANK YOU