3D PRINTING

PRODUCT REALISATION TECHNOLOGY PRACTICUM (IC-141P)

CENTRAL WORKSHOP

INDIAN INSTITUTE OF TECHNOLOGY MANDI

3D PRINTING

1. Introduction

3D printing or additive manufacturing is a process of making three dimensional solid objects from a digital file. The creation of a 3D printed object is achieved using additive processes. In an additive process, an object is created by laying down successive layers of material until the object is created. Each of these layers can be seen as a thinly sliced horizontal cross-section of the eventual object.

3D printing is the opposite of subtractive manufacturing which is cutting out / hollowing out a piece of metal or plastic with for instance a milling machine. 3D printing enables you to produce complex shapes using less material than traditional manufacturing methods.

2. Process of 3D Printing

The process of 3D printing for plastics is known as Fused Deposition Modeling (FDM). FDM is a popular AM method used to produce three-dimensional objects by depositing a molten thermoplastic material layer-by-layer. FDM is an extrusion-based process (constant cross-section area). The material must fully solidify and must be bonded to material that has already extruded. The extruder is vertically mounted on a plotting system. The extruder head is moved along the required trajectory using computer control. The material is melted using resistance heating at temperature 1°C greater than its melting temperature. The filament is fed from a large coil through a moving, heated printer extruder head, and is deposited on the growing work. The print head is moved under computer control to define the printed shape. Usually, the head moves in two dimensions to deposit one horizontal plane, or layer, at a time; the work or the print head is then moved vertically by a small amount to begin a new layer. The speed of the extruder head may also be controlled to stop and start deposition and form an interrupted plane without stringing or dribbling between sections.

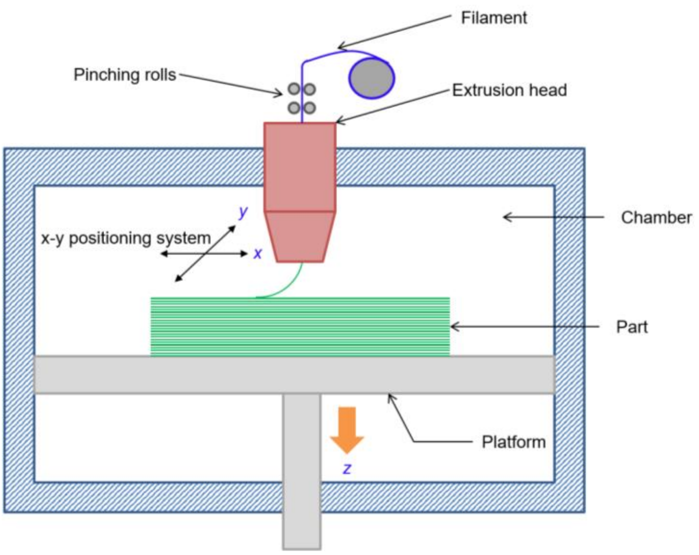

Figure 1: Process schematic of Fused Deposition Modelling

3. Physics of the Process

During extrusion, the thermoplastic filament is introduced by mechanical pressure from rollers, into the liquefier, where it melts and is then extruded. Flow geometry of the extruder, heating method and the melt flow behaviour of a non-Newtonian fluid are of main consideration in the part. The rollers are the only drive mechanism in the material delivery system; therefore, the filament is under tensile stress upstream to the roller and under compression at the downstream side acting as a plunger. Therefore, compressive stress is the driving force behind the extrusion process.

The force required to extrude the melt must be sufficient to overcome the pressure drop across the system, which strictly depends on the viscous properties of the melted material and the flow geometry of the liquefier and nozzle. The melted material is subjected to shear deformation during the flow.

4. Typical Materials that can be used

Various polymers may be used, including acrylonitrile butadiene styrene (ABS), polycarbonate (PC), polylactic acid (PLA), high-density polyethylene (HDPE), PC/ABS, polyethylene terephthalate (PETG), polyphenylsulfone (PPSU) and high impact polystyrene (HIPS).

5. Advantages

- Increased design freedom (versus conventional casting and machining)
- Lightweight structures made possible
- New features such as complex internal channels or several parts built in one stage
- Net shape process → less raw material consumption (up to 25 times less versus machining)
- The net shape capability → reduces the number of assembly operations such as welding, brazing
- No tools needed, unlike other conventional processes which require molds and metal forming or removal tools

6. Limitations

- Part size → limited. For example, in powder bed technology, the part size is limited to 250x250x250 mm
- Due to the low thickness of powder layers, it can be very slow and costly building high parts or massive parts.
- Production series: the AM not relevant for mass production. (25000 parts/year are already possible).
- Part design: Removable support structures are needed when the overhang angle is below 45°.

3D Printing

Aim	To create objects used fused deposition modelling
Drawing	[MAKE DRAWING AS PER THE OBJECT]
Material required	Polylactic acid (PLA) Spool
Equipment and tools required *(Please illustrate equipment and tools using appropriate drawings)*	3-D Printer Scrapper
Sequence of operations	To make an object as per solid model
Procedure	1. To make a drawing by Solid works / Auto cad 2. Save the file in STL format 3. Generate code with Cora-Software 4. Give the command to 3D Printer
Precautions	Avoid touching hot bedplate of 3D Printer Do not disturb the 3D printer, while the object is made