



SNS COLLEGE OF TECHNOLOGY

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DEPARTMENT OF AEROSPACE ENGINEERING

19ASZ401-3D Printing for Space Components

UNIT-V PRINTING PROCESSES AND BEAM DEPOSITION PROCESSES

TOPIC: Droplet Formation in 3D printing

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Introduction



Definition of Droplet Formation in 3D Printing:

- Droplet formation refers to the controlled deposition of small droplets of material onto a substrate or previously deposited layers to build a three-dimensional object.
- It involves precise ejection or extrusion of material in a controlled manner to create layers, contributing to the additive manufacturing process.

Significance of Droplet-Based Techniques:

- **Precision and Accuracy:** Droplet-based techniques allow for precise placement of materials, contributing to high-resolution printing and intricate designs.
- **Material Versatility:** These methods accommodate various materials, including polymers, metals, ceramics, and biological materials, expanding the scope of applications.
- **Layer-by-Layer Construction:** The layering process enables complex geometries and intricate internal structures that traditional manufacturing methods might struggle to achieve.



Types of Droplet Formation Technologies



➤ Inkjet-based Printing:

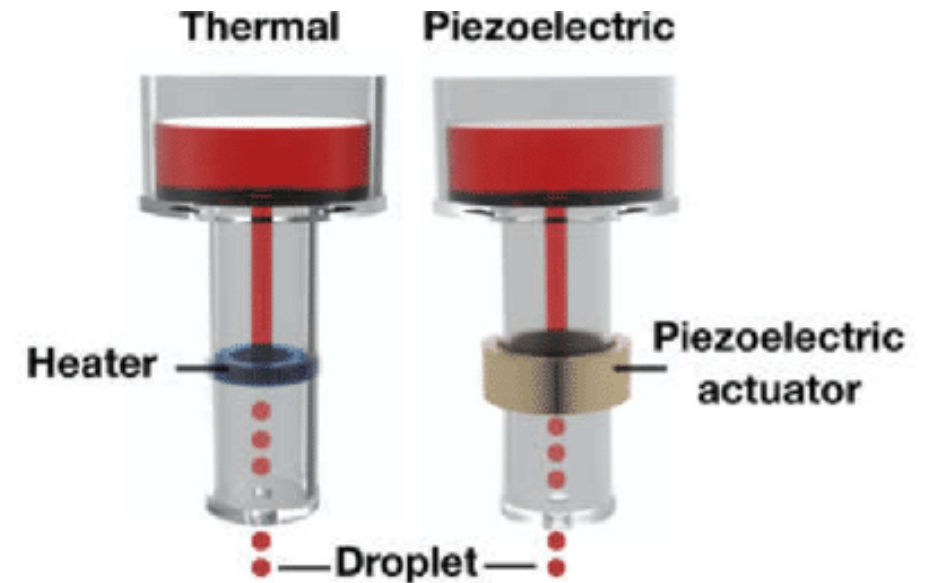
- Description: Inkjet-based 3D printing utilizes printheads that eject tiny droplets of liquid material onto the build surface.
- Mechanism: The printhead, using thermal or piezoelectric methods, expels droplets onto the substrate, where they solidify or cure.

Pros:

- High resolution and precision.
- Compatibility with a wide range of materials.
- Suitable for small-scale intricate designs.

Cons:

- Limited material viscosity.
- Slower compared to other printing methods for large-scale production.





➤ Extrusion-based Printing:

- Overview: Extrusion-based printing involves the controlled extrusion of materials, like filaments or pastes, through a nozzle.
- Process: Material is pushed through a nozzle heated to a controlled temperature, layering to form the object based on the digital model.

Pros:

- Compatibility with a broader range of materials, including thermoplastics, ceramics, and food materials.
- Faster printing speeds for larger objects.
- Cost-effective for bulk production.

Cons:

- Limited resolution compared to inkjet-based methods.
- Challenges with intricate designs due to layering.





Comparison of Droplet Formation Techniques



Aspect	Inkjet-based Printing	Extrusion-based Printing
Mechanism	Ejects liquid droplets	Extrudes material through a nozzle
Material Range	Limited by viscosity	Wide range of materials
Resolution	High	Moderate
Speed	Slower for large-scale	Faster for bulk production
Complexity of Designs	Suitable for intricate designs	Challenges with intricate details
Applications	Prototyping, small-scale production	Large-scale production, functional parts



Factors Influencing Droplet Formation:

- ✓ **Viscosity:** Material viscosity affects droplet size and flow rate, influencing the printing quality and resolution.
- ✓ **Surface Tension:** Determines the droplet's ability to maintain a cohesive shape upon deposition.
- ✓ **Nozzle Design:** The nozzle's size, shape, and internal structure play a crucial role in droplet formation and deposition accuracy.
- ✓ **Temperature and Pressure:** Control of temperature and pressure influences material flow and droplet consistency



Applications of Droplet Formation in 3D Printing

- Aerospace and Automotive:
 - ✓ Production of lightweight parts with complex geometries.
 - ✓ Rapid prototyping for testing and development.

- Healthcare Industry:
 - ✓ Manufacturing personalized medical devices.
 - ✓ Fabrication of tissue scaffolds.

- Consumer Goods and Electronics:
 - ✓ Customized manufacturing of products.
 - ✓ Integration of electronics during printing.

