A SYSTEM FOR ADDITIVE MANUFACTURING OF CONTINUOUS FIBRE REINFORCED THERMOSET POLYMER COMPOSITES BY LIQUID DEPOSITION MODELING AND METHODS

IITM Technology Available for Licensing

Problem Statement

- **Conventional manufacturing of Fiber-Reinforced Polymer (FRP) parts is expensive and prone to defects due to the nonhomogeneous and abrasive nature of FRPs** and difficulties in joining and machining to fabricate complex components.
- Additive manufacturing (AM) offers advantages in fabricating complex structures but faces challenges in ensuring proper mixing and curing of matrix materials in continuous fiber-reinforced composites.
- **Existing AM methods lack control over the ratio of matrix components** and can result in improper curing, making them unsuitable for aerospace-grade polymers.
- There is a need for **an innovative Liquid Deposition Modeling system** to address these setbacks and enable the additive manufacturing of continuous fiber-reinforced thermoset polymer composites effectively.

Technology Category/ Market

Category - Additive Manufacturing

Applications- Applications include aerospace, automobile, defense, and marine sectors, where high mechanical properties and corrosion resistance are crucial.

Industry- Aerospace, automotive, defense and marine sectors.

Market - Global additive manufacturing market is expected to grow from $13.16 billion in 2022 to $16.06 billion in 2023 at a **CAGR of 22.%.**

TRL (Technology Readiness Level)

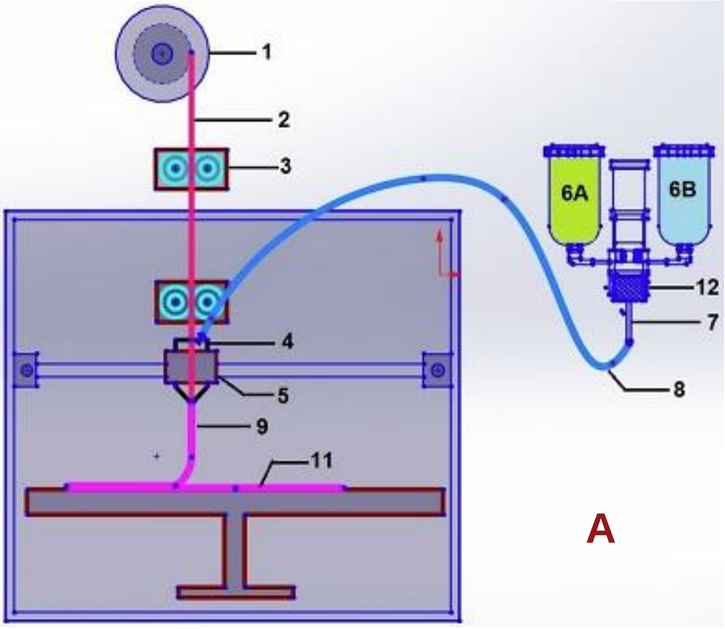
TRL - 4: Technology validated in lab scale.

Research Lab

Prof. Soundarapandian S,
Dept. of Mechanical Engineering

Intellectual Property

- IITM IDF Ref. **2011**
- **IN 443495 - Patent Granted**



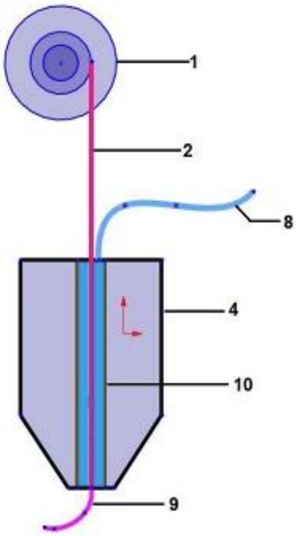


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FIG.1. A) Depicts the overall 'Liquid Deposition Modeling' of FRP, illustrating the following components of the system;
1-Fibre spool
2- Continuous fibre
3- Yarn rollers
4- Nozzle
5- Movable printer head
6A- Resin
6B- Hardener
7- Static stirrer
8- Hose pipe
9- Fibre coated with matrix
10- Matrix reservoir in nozzle
11-Cured FRP
12-Dispensing valve

B) Nozzle with matrix reservoir

CONTACT US
Dr. Dara Ajay, Head
Technology Transfer Office,
IPM Cell- IC&SR, IIT Madras

IITM TTO Website:
https://ipm.icsr.in/ipm/

Email: smipm-icsr@icsrpis.iitm.ac.in
sm-marketing@imail.iitm.ac.in
Phone: +91-44-2257 9756/ 9719

Technology

1. The technology involves additive manufacturing of continuous fiber-reinforced thermoset polymer composites using liquid deposition modeling. (Fig. 1)
2. It is designed for 3D printing of composite parts with fiber reinforcement (carbon, glass, kevlar) and a thermoset polymer matrix (e.g., epoxy resin with a specific hardener).
3. The method allows for varying the percentage of reinforcement and matrix based on specific requirements. (Fig. 2)
4. The system can lay fibers in different orientations based on the design to achieve desired mechanical properties in different directions.
5. The process is rapid, with curing times reduced from 24 hours in conventional manufacturing to about 30 minutes at room temperature, followed by a post-cure at higher temperature of 200-220°C for 2-3 hours for proper bonding between matrix and fiber.

Key Features / Value Proposition

- **High-Performance Applications:** The technology enables the production of composite parts with exceptional mechanical properties, making it ideal for aerospace, automobile, defense, and marine industries.
- **Customizable Material Composition:** The method allows for flexible control of the percentage of reinforcement and matrix, tailoring materials to specific applications.
- **Versatile Fiber Orientation:** The system can lay up fibers in various orientations, ensuring that mechanical properties align with the desired direction of stress.
- **Rapid Curing Process:** Significantly reduces curing time from 24 hours to just 30 minutes at room temperature, enhancing production efficiency.
- **Enhanced Bonding:** Post-curing at elevated temperatures (200-220°C for 2-3 hours) ensures proper bonding between the matrix and fiber, guaranteeing the quality of the final composite part.

Methodology:

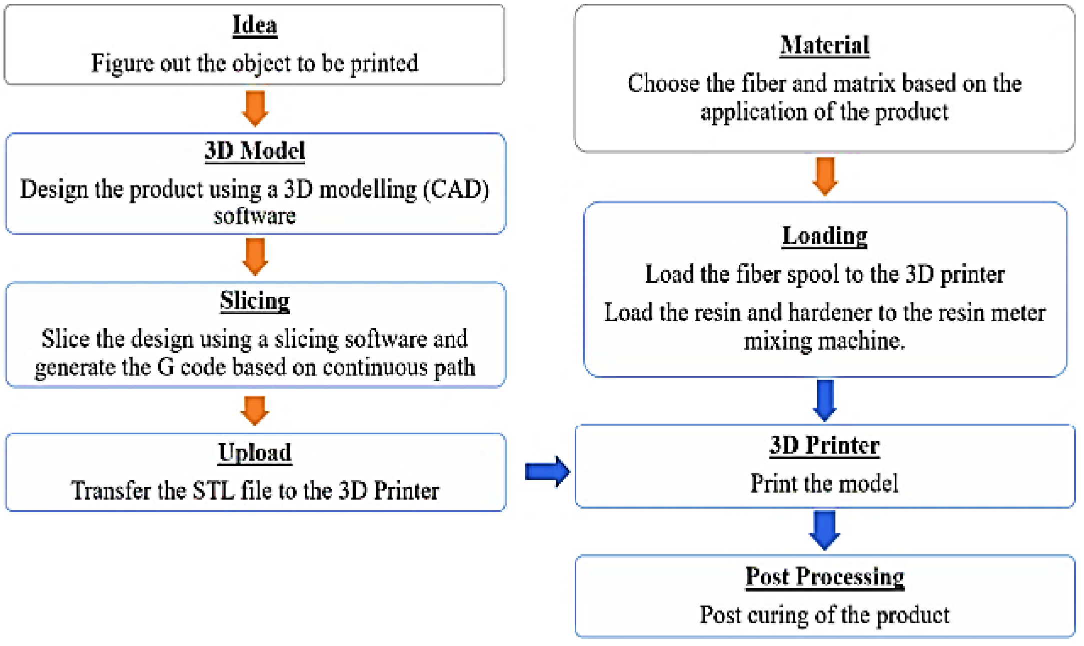

FIG. 2. Depicts the methodology used in the research.

CONTACT US
Dr. Dara Ajay, Head
Technology Transfer Office,
IPM Cell- IC&SR, IIT Madras

IITM TTO Website: https://ipm.icsr.in/ipm/

Email: smipm-icsr@icsrpis.iitm.ac.in
sm-marketing@imail.iitm.ac.in
Phone: +91-44-2257 9756/ 9719