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Scalable Additive Manufacturing of Polymeric Material with Metallic Structures in a Room Environment

Background

Heterogeneous material systems consisting of metallic structures and polymer matrices are important for applications including integrated circuits, microelectromechanical (MEMS) devices, antennas, sensors, actuators, and metamaterials. Recently, different multi-material structures have been fabricated with metal deposition using multiple manufacturing processes, including stereolithography, fused deposition modeling, direct ink writing, and traditional additive manufacturing. However, using these complicated hybrid processes is challenging to construct complex 3D structures of heterogeneous material with enhanced properties, high resolution, and time efficiency. Only certain types of metals and metal/polymer hybrid structures can be printed using current photochemical deposition-based 3D printing.

Invention Description

Researchers at Arizona State University have developed a novel electrical field-assisted heterogeneous material printing (EF-HMP) method to fabricate polymer materials with metallic structures using polymer-based photocurable and conductive composites in a room environment. This EF-HMP process provides a novel manufacturing tool for the fabrication of scaly-foot snail-inspired polymer/metal structures at room temperature using a single step process.

A polymer matrix-based composite invented in this technique acts as an electrolyte, facilitating the transportation of metallic ions and promoting metal deposition onto the photocured polymer matrix. The metallic structures can grow on the cured polymer matrix with complex patterns during the photopolymerization based printing process by regulating the electrical field. The process parameters can be optimized based on physics-based modeling, simulation, and testing.

Potential Applications

- 3D integrated circuits
- Flexible sensors
- Energy harvesting
- Healthcare (e.g., biosensors)
- Actuator, Robotics

Benefits & Advantages

- Enhanced functional characteristics (e.g., thermal conductivity, light weight, resistance)

- Lower cost than current printing methods
- High speed printing capabilities
- Enables printing of complex and high-resolution polymer and metallic material
- Can be easily scaled up for mass production
- Sustainable (more environmentally friendly than current approaches)

Related Publication: Multi-Material Additive Manufacturing of Bioinspired Polymeric Material with Metallic Structures via Electrically Assisted Stereolithography