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Ultrasound-guided 3D Printing of Conductive Polymers for Bioelectronics in Tissue

Stanford researchers have developed a novel ultrasound-guided technique to 3D print conductive polymers directly within optically opaque biological tissues.

This advancement enables precise, non-invasive fabrication of bioelectronic structures deep inside the body.
Conventional additive manufacturing methods such as photopolymerization and extrusion are limited by poor light penetration and the need for invasive access, making it difficult to fabricate materials in deep or opaque biological tissue. While focused ultrasound-based "sonoprinting" has emerged as a potential solution, previous techniques have been unable to produce electroactive materials like conductive polymers for bioelectronics.

To address the challenges, Stanford researchers developed two sonoprinting methods that enable in situ polymerization of conductive materials. The temperature-based method uses focused ultrasound to locally heat tissue and trigger polymerization of PEDOT via thermal decomposition of an initiator. The pressure-based method utilizes acoustic droplet vaporization to mix chemical components and initiate polymerization at biocompatible temperatures. Both approaches allow for precise spatial control and are compatible with soft materials, including hydrogels and live tissue. This invention offers a powerful new tool for constructing implantable electronics and tissue interfaces.

Applications

- Electroactive tissue engineering
- Implantable bioelectronics

Advantages

- High spatial precision
- In situ bioelectronics printing
- Deeper penetration in optically opaque material

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