High-Caliber 3D and Aerosol Jet Printing with Regenerated Silk Fibroin (RSF) (#8386)

A new aerosol jet printing method to efficiently fabricate RSF patterns for use in areas such as medicine, food production, and biosensors

Georgia Tech researchers have developed an innovative process to enable use of regenerated silk fibroin solutions with an aerosol jet printer. This method reliably processes silk fibroin material without the need for chemical additives that may negatively alter the mechanical properties of RSF. Additionally, it demonstrates a reduced likelihood for clogging the printer's nozzle—a typical challenge of other processes, like inkjet printing.

This procedure involves two phases of working with the RSF to print patterns: material preparation and material fabrication. The silk fibroin is first processed from its raw form into a printable liquid solution through a unique progression of degumming, dissolution, dialysis, and centrifugation. The solution is then atomized, and the final parameters are tuned before the printed pattern is finally deposited. In this method, the printer's focus ratio—composed of its sheath and ink rate—is customized to establish an operating window for optimum print quality.

Benefits/Advantages

- **High fidelity**: Preserves silk fibroin's advantageous mechanical properties by creating a printable RSF solution without the need for chemical additives
- **High quality**: Identifies the optimum parameters for producing printed patterns with minimal flaws
- **Efficient**: Reduces obstacles (e.g., clogged nozzle and overspray) normally encountered in other processes, like inkjet printing
- **Broadly applicable**: Expands potential use of silk fibroin material in an array of commercial contexts, including but not limited to medicine, food production, and biosensors

Potential Commercial Applications

- Medicine
    - Wound treatment
    - Surgery
    - Medical devices
    - Drug delivery and pharmaceuticals
- Food and beverage
    - Packaging
    - Sensors

- Electronics
- Photonics
- Filtration membranes

Background/Context for This Invention

Silk has been hailed as a multi-purpose material for centuries, thanks to its versatile mechanical properties, biocompatibility, and biodegradability. Its use in industries like medicine and food production, however, requires an efficient, non-contact printing method that can produce highly precise patterns. Aerosol jet printing has been identified as a promising technique for developing objects from RSF, as it can process drop volumes much smaller than inkjet printing and with a wider range of viscosity. To address the issues of RSF's low printability in aerosol jet printers, this technology prepares and fabricates RSF material in such a way that—when combined with particular parameters—it can print high-quality samples with more ease and adaptability.

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More Information

U.S. Application Filed - 62/977,449

Publications

Challenges and Advances in Aerosol Jet Printing of Regenerated Silk Fibroin Solutions, Advanced Materials Interfaces, Accepted 2020

For more information about this technology, please visit:
https://licensing.research.gatech.edu/technology/high-caliber-3d-and-aerosol-jet-printing-regenerated-silk-fibroin-rsf

Images:

The automated sequential delivery of multiple fluids. A varying number of delay gates imprinted in the branches are shown in the figure.

COVID-19 and flu saliva test on paper: (A) The automatic sequential delivery of multiple reagents required for virus test; (B) Water pouring into the device triggers the virus assay, allowing the presence of SARS-CoV-2 and influenza A & B viruses to be visually identified by the color changes in the corresponding detection spot