Mechanical Engineering

VCU Innovation Gateway
Office of Research and Innovation

Device for Electro-Hydrodynamic Printing

A dual-channel jetting apparatus for Electro-Hydrodynamic printing

As an emerging printing technology, Electro-Hydrodynamic printing (EHD) has demonstrated the ability to fabricate micro/nano-scaled patterns because of its high resolution, good compatibility with ink variety and substrates, and all of the attributes of conventional inkjet printing. EHD printing has been successfully applied for direct 2D and 3D fabrication of micro/nano-scaled structures. However, different from conventional inkjet printing, ink droplets in the EHD printer are pulled out rather than being pushed out from the nozzle by an electric field.

As nozzle size decreases for increased resolution and functionality, nozzle clogging is inevitable. Mechanisms of clogging include, colloidal suspensions, agglomeration of primary particles, shear-induced gelation in liquid and solvent evaporation and/or ink polymerization during the printing. To prevent this, EHD printing uses extremely diluted ink, which affects quality of print features and throughput. A need therefore exists for a new printing nozzle design that enables the use of non-diluted ink and a circulating ink path, to prevent the nozzle from clogging.

The technology

Virginia Commonwealth University researchers have developed a dual-channel jetting apparatus for 2D/3D Electro-Hydrodynamic printing (EHD) on substrates. This new dual channel jetting design alleviates clogging issues commonly faced by EHD printers. During printing, ink is continuously injected into the nozzle through one flow channel and extracted from the other. A stable ink meniscus is established at the opening of the nozzle, where the ink bridges the two channels. When an electric field is applied between the nozzle and the substrate, the ink meniscus is activated and one single droplet is pulled out. The unconsumed ink is constantly recirculated to prevent solvent evaporation/ink polymerization. The unique nozzle design has jetting characteristics and meniscus dynamics different from those in the conventional EHD printing. Two alternative nozzle configurations are also presented. The dual-channel EHD printing provides a potentially high-resolution and reliable micro/nano manufacturing process enabled by continuous ink circulation and effective meniscus pinning.

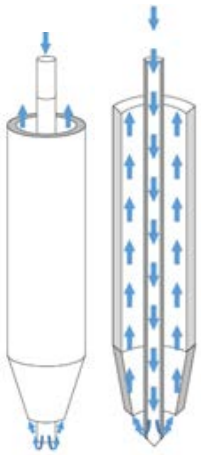

Figure 1: Schematic diagrams of the dual-channel nozzle with circulating ink path

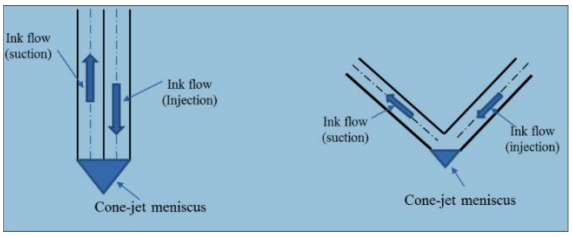

Figure 2: Alternative nozzle designs

Benefits

- Reduced colloidal particle agglomeration and flow channel clogging
- Robust jetting performance
- Improved ink flow & flow rates
- Minimized ink waste

Applications

- High resolution patterning of functional materials
- Fabrication of electronic devices
- Additive Manufacturing
- Fabrication of optical devices
- Hybrid additive micro/nano printing
- Micro-electronic manufacturing
- Pharmaceutics biomolecular patterning

Development Stage:
Functional lab prototype

Patent status:
Patent pending: U.S. and foreign rights are available.

License status:
This technology is available for licensing to industry for further development and commercialization.

Category:
Mechanical Engineering

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External resources:
Zhen Li et al 2019

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