Electric-field-driven Jet Deposition Based Micro-and Nano-scale 3D printing and Its Applications

Hongbo Lan[1,2]

[1]Shandong Engineering Research Center for Additive Manufacturing, Qingdao University of Technology, Qingdao 266520, China
[2]Qindao Engineering Research Center for 3D Printing, Qingdao 266520, China

E-mail: hblan99@126.com

Micro- and nano-3D printing is a new frontier in next-generation multifunctional additive manufacturing (AM) and micro/nanofabrication technologies. A variety of micro/nano-AM processes which include the microstereolithography, two-photon lithography, electrohydrodynamic (EHD) jet printing, aerosol jet printing, micro laser sintering, electrochemical fabrication (EFAB), nanoscale offset printing, etc., have been proposed and developed in recent years. This talk will present a novel micro-and nano-scale 3D printing technique based on electric-field-driven jet deposition and its typical applications. The basic principle of the proposed micro/nano-3D printing utilizes the single potential induced electric field and EHD cone-jetting behavior, as well as charges self-alignment effect. Furthermore, taking into account both the printing accuracy and the printing efficiency, three novel working modes, the micro-extrusion mode, pulsed cone-jet mode and continuous cone-jet mode, are introduced for implementing the multi-scale manufacturing of large-area macro/micro structures with high throughput. The mechanism and law of the formation for the proposed process are systematically investigated and revealed by combining with the theoretical analysis, numerical simulation and experimental verification. And, many typical applications including the transparent electrodes, transparent conductive heater, transparent EMI shielding, tissue engineering scaffolds, paper electronics, are provided to demonstrate the capability and advantages of the micro/nano-scale 3D printing which involve generating high resolution features for super viscosity materials, patterning on the non-conductive and non-planar substrate, conformal printing over 3D structure or surfaces, macro/micro-scale 3D printing. In addition, a method of mass producing large-area microstructures combining the micro/nano-scale 3D printing (fabricating the large-size microscale mold without stitching) and large-area hybrid nanoimprinting is also reported. As a result, the electric-field-driven jet deposition based micro-and nano-scale 3D printing provides a novel and prospect solution for mass producing large-area micro/nano-structures. It also offers a feasible approach for fulfilling multi-scale and multi-material 3D printing at low cost and good universality as well as high resolution.

Reference:

[1]Zhu, X.Y.; Xu, X.; Li, H.K.; “Fabricating Transparent Electrodes by Combined Electric-field-driven Fusion Direct Printing and the Liquid Bridge Transfer Method” J. Phys. D: Appl. Phys. 2019 52 245103.
[2] Qian L.; Lan H.B., Zhang G.M; “A Theoretical Model for Predicting the Feature Size Printed by Electrohydrodynamic Jet Printing” Applied Physics Letters. 2018 112 203505.

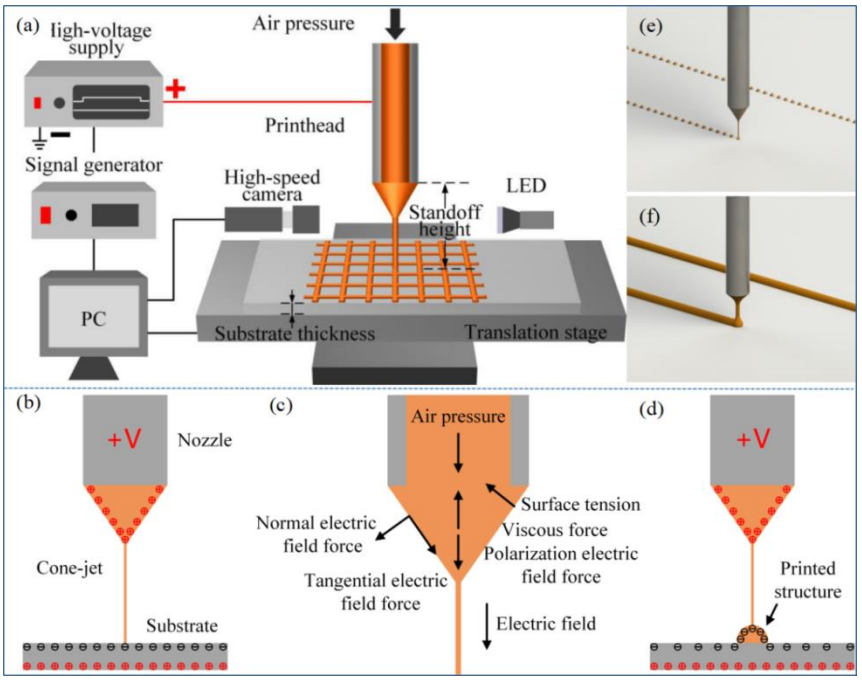

Figure 1. The basic principle of the micro-and nano-scale 3D printing based on electric-field-driven jet deposition

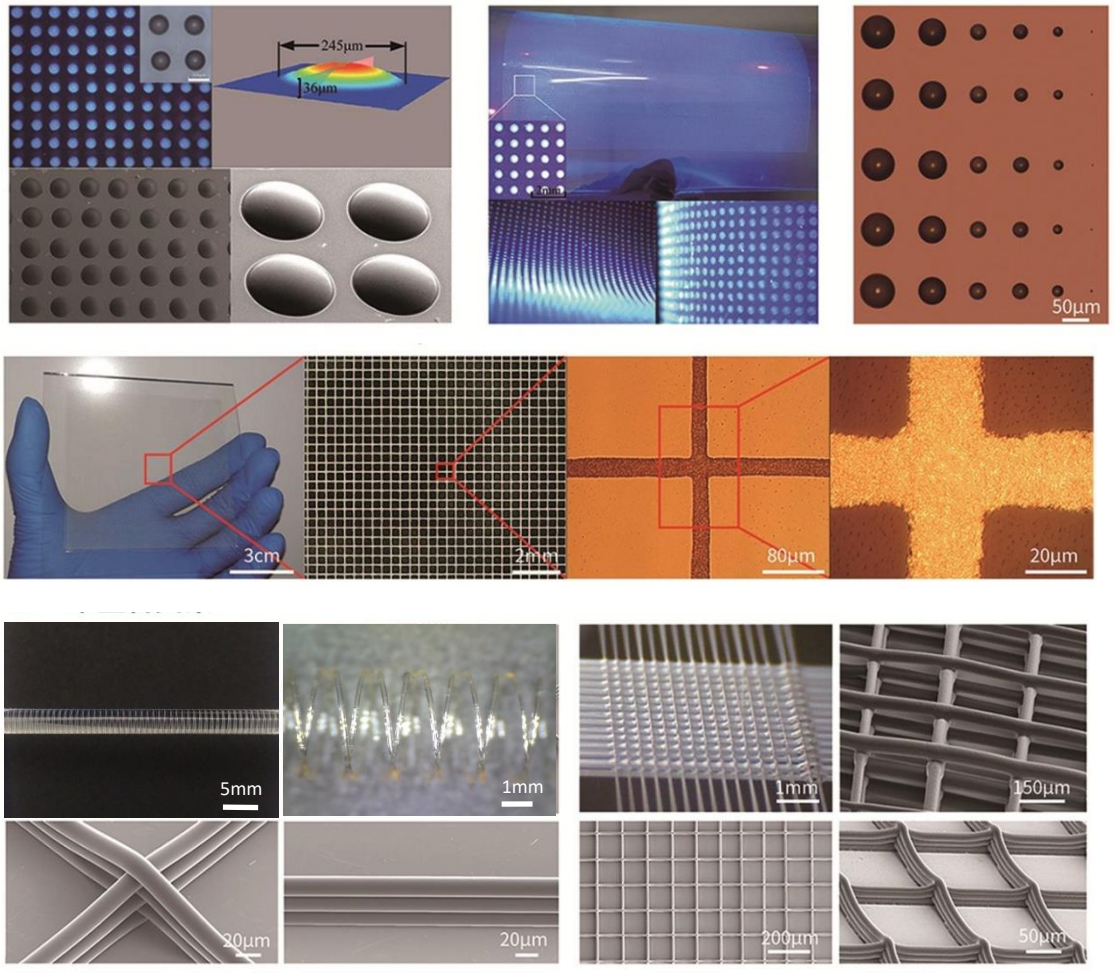

Figure 2. Printed results: microdroplets; transparent electrodes; tissue engineering scaffolds