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Fabrication of Uniform Nanofibers Using Gas Dynamic Virtual Nozzle Based Microfluidic Liquid Jet System

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Abstract : Here we present a gas dynamic virtual nozzle (GDVN) based microfluidic jetting devices for spinning of nano/microfibers. The device is fabricated by soft lithography techniques and is based on the principle of a GDVN for precise three-dimensional gas focusing of the spinning solution. The nozzle device is used to produce micro/nanofibers of a perfluorinated terpolymer (THV), which were collected on an aluminum substrate for scanning electron microscopy (SEM) analysis. The influences of air pressure, polymer concentration, flow rate and nozzle geometry on the fiber properties were investigated. It was revealed that surface properties are controlled by air pressure and polymer concentration while the diameter and shape of the fibers are influenced mostly by the concentration of the polymer solution and pressure. Alterations of the nozzle geometry had a negligible effect on the fiber properties, however, the jetting stability was affected. Round and flat fibers with differing surface properties from craters, grooves to smooth surfaces could be fabricated by controlling the above-mentioned parameters. Furthermore, the formation of surface roughness was attributed to the fast evaporation rate and velocity (mis)match between the polymer solution jet and the surrounding air stream. The diameter of the fibers could be tuned from ~250 nm to ~15 µm. Because of the simplicity of the setup, the precise control of the fiber properties, access to biocompatible nanofiber fabrication and the easy scale-up of parallel channels for high throughput, this method offers significant benefits compared to existing solution-based fiber production methods.

Keywords : gas dynamic virtual nozzle (GDVN) principle, microfluidic device, spinning, uniform nanofibers
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