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# Polypropylene microfiber extrusion by hot melt rotary jet spinning for non-woven membrane manufacturing

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## Abstract

The COVID19 pandemic has highlighted the underlying challenges of supplying large quantities of medical masks needed to protect front-line workers and the population. The efficiency of such a mask relies on its filtration membrane, a ply of non-woven textile (NWT) compacted and electrostatically charged to capture 98% of larger than 0.1 micron diameter penetrating particles. To address the soaring cost and shortages of NWT filtration membranes, we are developing an inexpensive and high yield method based on the cotton-candy process: hot melt rotary jet spinning (RJS). This process harnesses the centrifugal force of a rotating spinneret containing a molten polymer to generate jets through several nozzles. Fibers are stretched and thinned during their extrusion to a collector, gradually forming an NWT mat.

We present a custom-designed cylindrical spinneret fitted on a commercial cotton-candy machine spinning at a fixed frequency. Two outlets fitted with interchangeable 3D printing nozzles on the spinneret allow to vary the extrusion orifice diameter between 0.2 mm and 1 mm. The fabrication process is instrumented with thermocouples, infrared imaging, and pyrometers for temperature monitoring. Optical and scanning electron microscopes are used to analyze the extruded fiber.

Our preliminary results show that higher melt temperature (i.e., lower polymer viscosity) facilitates jet formation and thinning, leading to lower average fiber diameter. Defects, such as beads and fiber inhomogeneities are mainly induced by aerodynamic cooling of the nozzle tip that quenches the polymer flow below the melt point. Orifice size is critical to reduce beads formation but is less influential on the final fiber diameter at sufficiently high process temperature. Detailed comparison with solvent-based RJS and other fiber spinning technologies are presented.

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