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3D printed multiplexed electrospinning sources for large-scale production of aligned nanofiber mats with small diameter spread

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We report the design, fabrication, and characterization of novel, low-cost, and modular miniaturized nanofiber electrospinning sources for the scalable production of non-woven aligned nanofiber mats with low diameter variation. The devices are monolithic arrays of electrospinning emitters made via stereolithography; the emitters are arranged so each element has an independent line of sight to a rotating collector surface. Linear and zigzag emitter packing were evaluated using a PEO solution with the aim of maximizing the throughput of nanofibers with the smallest diameter and narrowest distribution. Current versus flowrate characterization of the devices showed that for a given flowrate a zigzag array produces more current per emitter than a linear array of the same emitter pitch and array size. In addition, the data demonstrate that larger and denser arrays have a net gain in flow rate per unit of active length. Visual inspection of the devices suggests uniform operation in devices with as many as 17 emitters with 300 μm inner diameter and 1.5 mm emitter gap. Well-aligned nanofiber mats were collected on a rotating drum and characterized; the 17-emitter device produced the same narrow nanofiber distribution (~81 nm average diameter, ~17 nm standard deviation) for all tested flow rates, which is strikingly different to the performance shown by 1-emitter sources where the average fiber diameter significantly increased and the statistics notably widened when the flowrate increases. Therefore, the data demonstrate that massively multiplexing the emitters is a viable approach to greatly increase the throughput of non-woven aligned nanofiber mats without sacrificing the statistics of the nanofibers generated. The production of dry nanofibers by the 17-emitter array is estimated at 33.0 mg min^{-1} (1.38 mg min^{-1} per mm of active length), which compares favorably with the reported multiplexed electrospinning arrays with emitters distributed along a line. © 2017 IOP Publishing Ltd.

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