Electronic Supplementary Material (ESI) for Analyst.

Supplementary Information

Use of Electrospinning and Dynamic Air Focusing to Create Three-Dimensional Cell Culture Scaffolds in Microfluidic Devices

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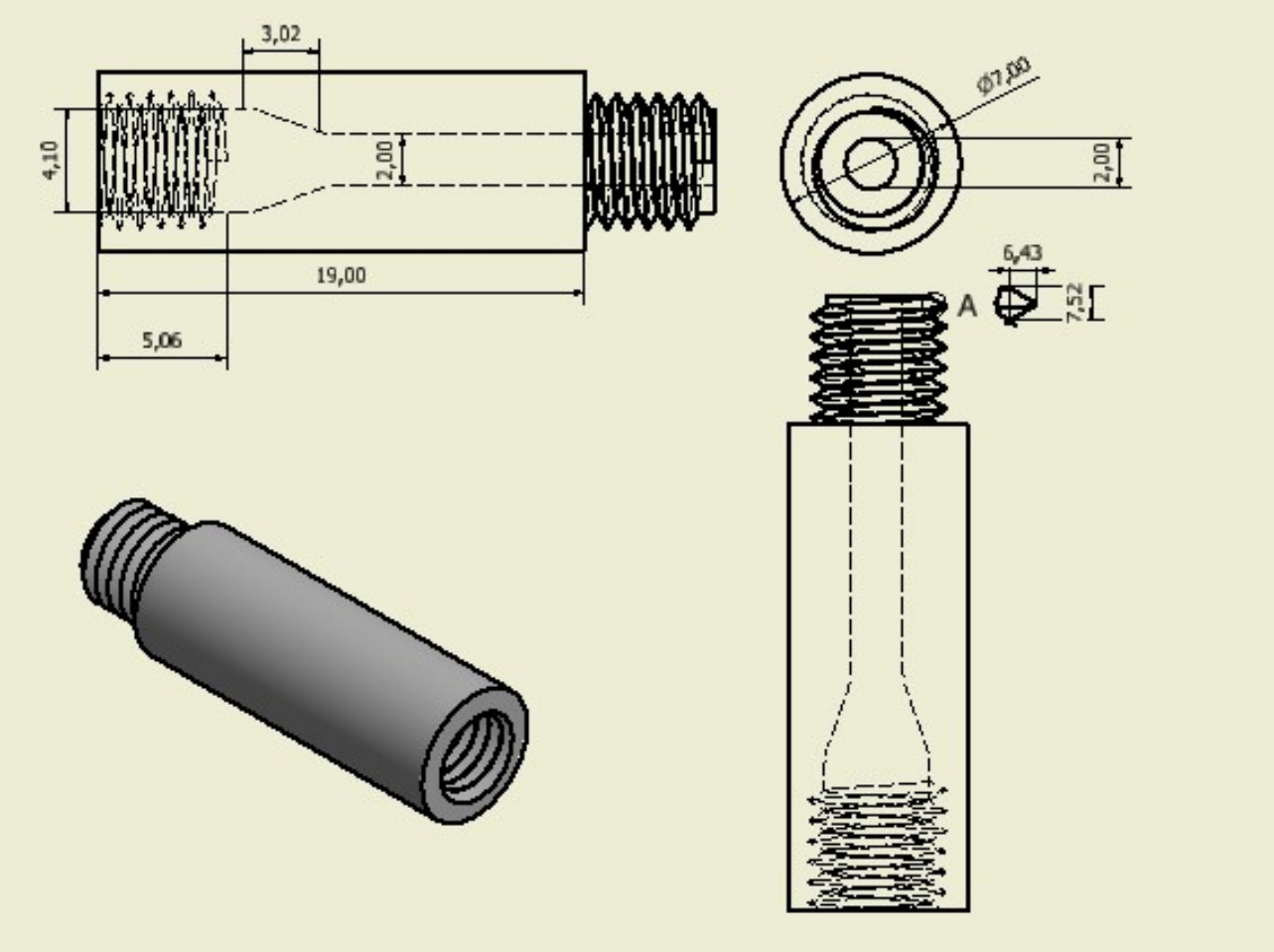

Figure S1. CAD drawing of the 3D-printed channel devices. Units are in mm.

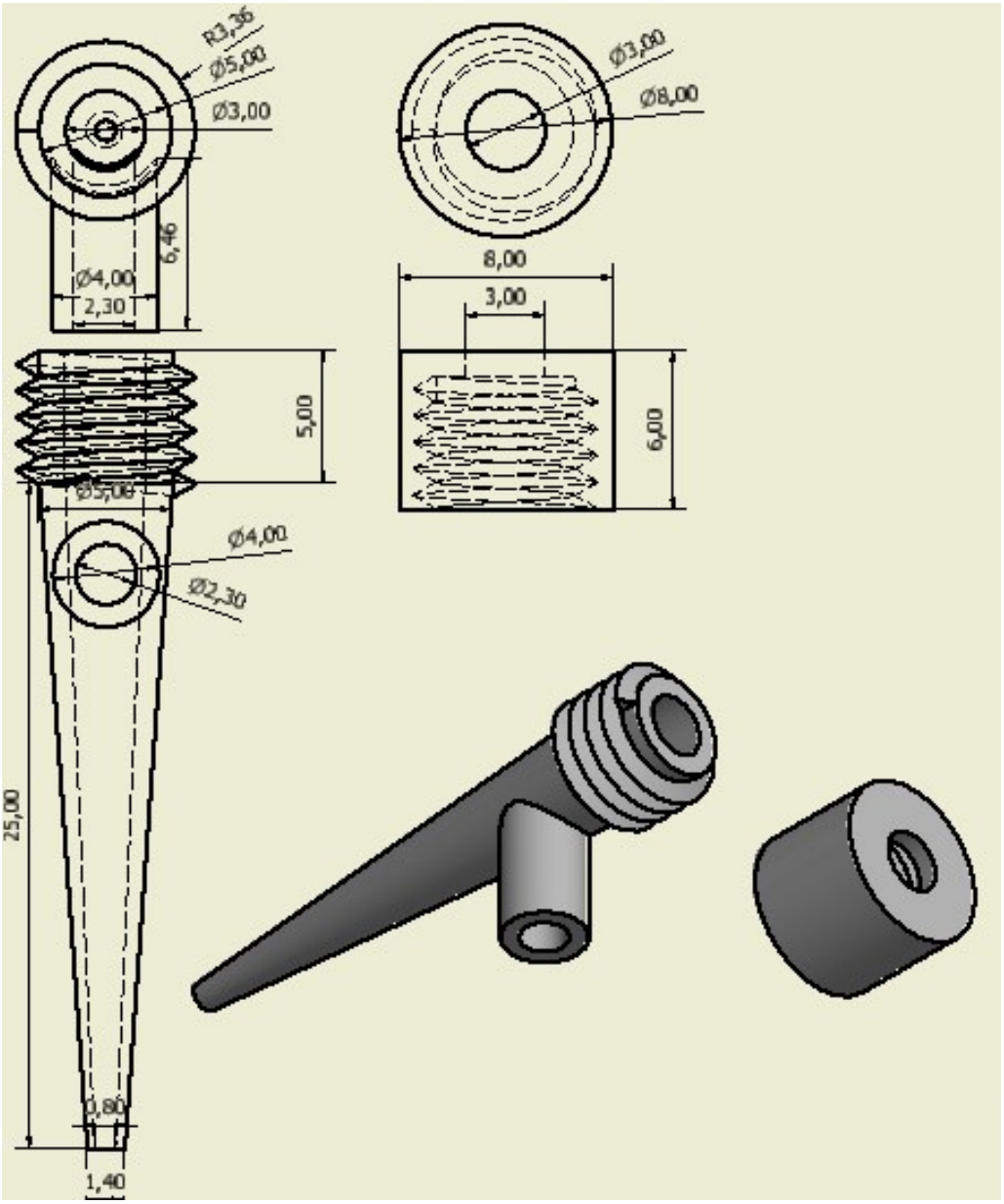

Figure S2. CAD drawing of the 3D-printed air sheath used for fiber creation. Units are in mm.

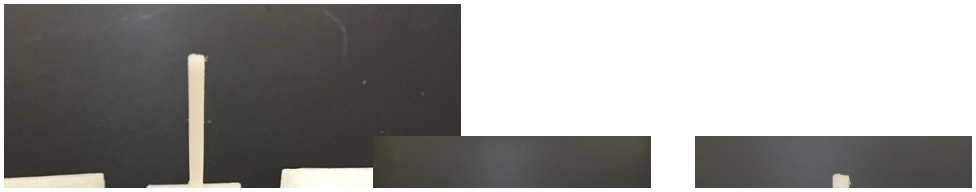

Figure S3. Fabrication of a PDMS device using a 3D-printed mold. (A) The 3D-printed mold consists of three separate parts; (B) The two side half walls were assembled onto the base part by inserting them into the groove. PDMS was poured into the assembled mold. Tape was used around the outside of the mold to minimize leakage of PDMS; (C) After curing of the PDMS in an oven, the side walls were separated from the base and the resulting PDMS device could be easily detached. The square channel is 2 × 2 mm and 15 mm in length.

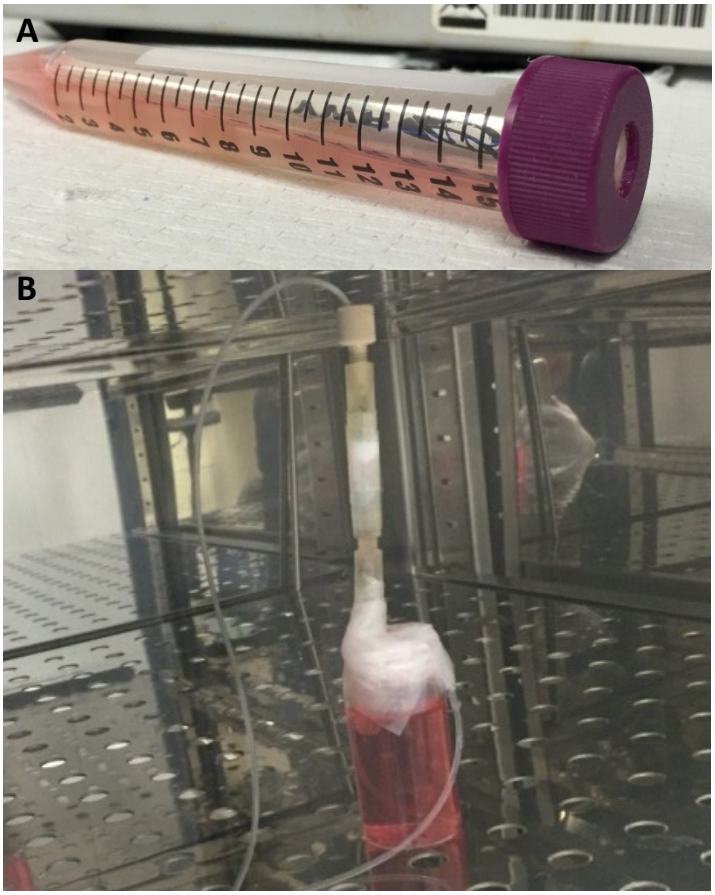

Figure S4. (A) Static seeding of cells on the fiber-coated devices. Three devices connected end to end by the integrated threads were placed in a sterile test tube, which contained 5 mL cell suspension (in media). A hole was drilled through the cap of the test tube and a piece of 0.4 µm pore size membrane was placed between the tube and the cap. This membrane enables CO_2 exchange for cell culture. The test tube was rotated periodically for a static culture time of 12 hours. (B), dynamic culture of cells on the devices. After 12-hour static culture, the devices were placed vertically over a glass vial filled with media. The end of the top device was connected via a commercial finger tight fitting to a piece of Tygon tubing, which was connected to a peristaltic pump (not shown). The other end of the Tygon tubing was immersed in the media in the vial. The peristaltic pump then circulated the media (at a flow rate of 400 µL/min) through the devices for 24 hours.

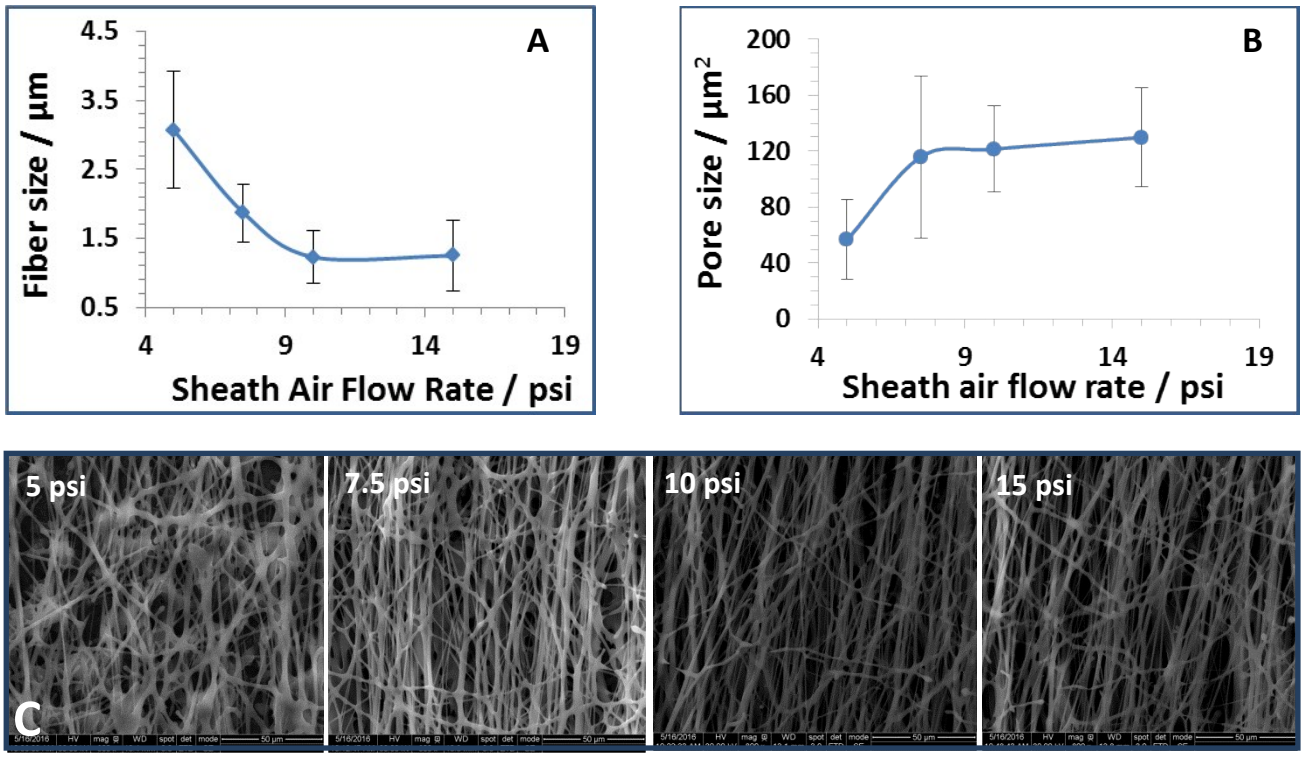

Figure S5. (A) Fiber size vs. sheath air flow rate. With increased sheath air flow, the fiber size tends to decrease and then plateau (n=3, error bar=standard deviation). (B) Pore size vs. sheath air flow rate. At a higher sheath flow rate, the pore size tends to be larger (n=3, error bar=standard deviation). (C) SEM images of fibers coated on the inside of a microfluidic device under different sheath flow rates. At a 5 psi sheath flow, the fibers are chaotically distributed and beaded. The deviation of fiber sizes is also large. At 7.5 psi, the fibers are orientated along the channel direction, and fibers are smaller and more uniform. At 10 and 15 psi, the fibers are more uniform and smaller than the 7.5 psi sheath flow.

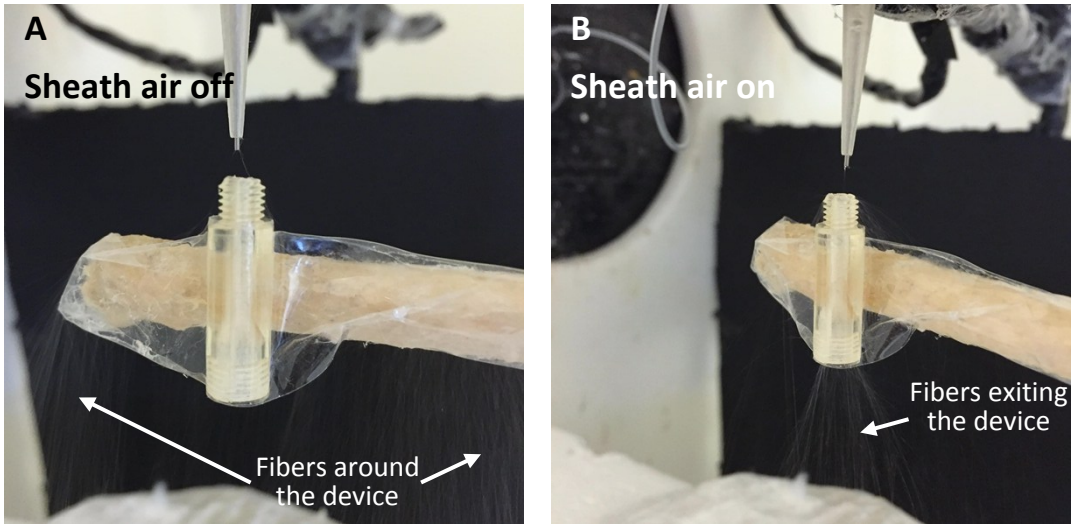

Figure S6. Demonstration of the role of the sheath air in focusing fibers into the channel. (A), the movement of fibers with the sheath air turned off. The fibers tend to go around the device, without entering the fully closed channel. (B), the movement of fibers with the sheath air turned on. Although some fibers were seen around the device, most of the fibers were focused through the channel, which can be indicated by the exiting fibers from the other end of the device.

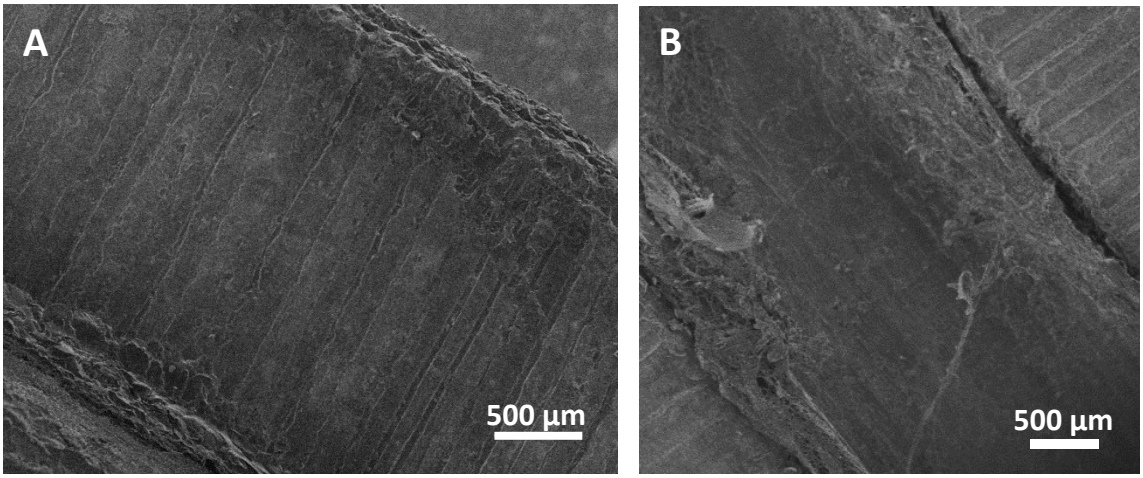

Figure S7. (A) SEM image of a bare channel 3-D printed. The ridges in the channel area resulted from the resolution (~200 µm) of the 3D-printer; (B) SEM image of a channel coated by a thin-layer of PCL (instead of a fiber scaffold). It was coated by pumping 15% PCL solution through the channel, followed by drying in a fume hood at room temperature for 24 hours. It can be seen that the ridges in the channel area were covered with a relatively smooth layer of PCL. Compared with a fiber coated device (Figure 3), no porous structures can be generated on such a device.