Supplemental information for "Microfluidic tailoring of the two-dimensional morphology of crimped microfibers"

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Results and Discussion

Effect of w_2/w_1 and α

To investigate the effect of opening angle, α, three devices with varying opening angles – 20°, 45° and 90° – were fabricated and fiber synthesis was studied at three UV positions (l_{res} = 1.5, 2.5, 4.5 mm) while all other experimental parameters were unchanged: $l_1 = l_2$ = 6 mm, w_1 = 260 µm, w_2 = 550 µm, Q_o = 75 µL/min and Q_m = 12 µL/min. There was no clear effect of α on the degree of waviness of the fibers as shown in Figure S1A. However, the effect of l_{res} on the degree of waviness, where increasing l_{res} results in a decrease in A/λ, was found to be consistent regardless of the magnitude of the opening angle, for the range investigated (Fig. S1B).

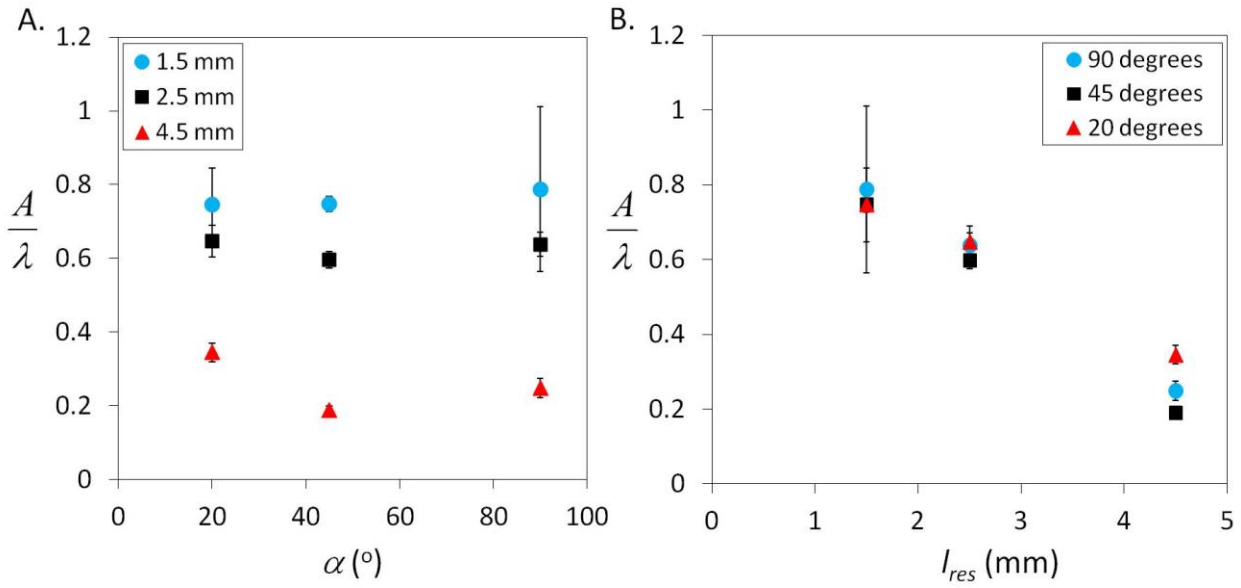

Fig. S1 Fiber morphology was studied as a function of opening angle, α. (A) Plot of A/λ as a function of α, and (B) Plot of A/λ as a function of l_{res}.

To investigate the effect of channel width ratio, w_2/w_1, three devices with varying width ratios – approximately 2, 3 and 4 – were fabricated and fiber synthesis was studied at three UV positions (l_{res} = 1.5, 2.5, 4.5 mm) while all other experimental parameters were unchanged: $l_1 = l_2$ = 6 mm, w_1 = 260 µm, α = 45°, Q_o = 75 µL/min and Q_m = 12 µL/min. Again, we observed no clear effect of w_2/w_1 on the degree of waviness of the fibers as shown in Figure S2A. Similarly, we observed the same trend of decreasing

A/λ with increasing l_{res} for each of the three devices, even though the width of the wider channel was changing.

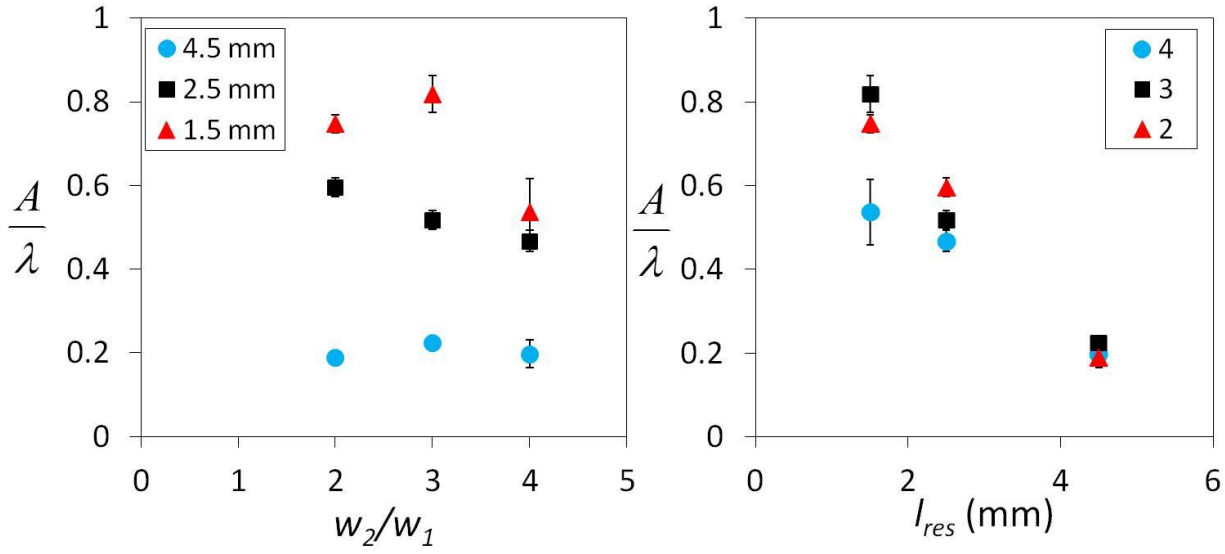

Fig. S2 Fiber morphology was studied as a function of channel width ratio, w_2/w_1. (A) Plot of A/λ as a function of w_2/w_1, and (B) Plot of A/λ as a function of l_{res}.

Modulus of PEG-DA hydrogels

Rheological experiments were performed to measure the shear storage modulus (G′) of crosslinked PEG-DA samples from oscillatory shear studies with an Anton Paar MCR 501 Rheometer using a parallel plate geometry at 25 ^{o}C. Crosslinked PEG-DA disks (25 mm diameter and 1 mm thick) were prepared by curing the monomer solution (54% PEG-DA, 42 % water, 4% Darocur 1173 photoinitiator) in a Teflon mold covered with a glass slide using a UV flood curing system (100 mW/cm^2, Intelli-Ray 400, Uvitron International). The gels were cured at three UV intensities: 50%, 75% and 100%. The PEG disks were tested immediately after curing, and water evaporation was prevented through the use of an environmental chamber on the rheometer. G′ was measured as a function of strain in the range 0.01 – 0.1 %, at a fixed normal force of 0.5 N and a frequency of 0.75 Hz.

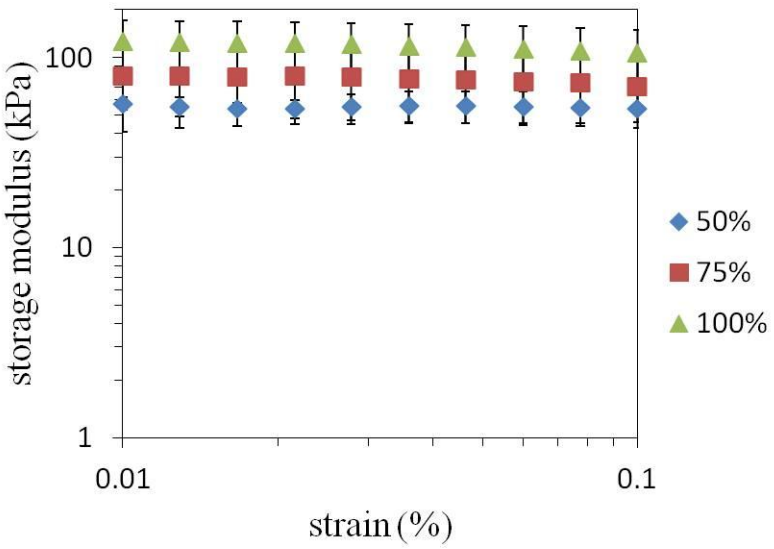

Fig. S3 Storage modulus (G′) of crosslinked PEG-DA samples as a function of strain at a frequency of 0.75 Hz.

Movies

Five movies are provided: 1-3 show the flow of the jet in the microchannel during polymerization, and 4-5 show the extension of fiber bundles.

1. Movie file, 75-14-8_5mm, shows the flow for the following conditions, $l_1 = l_2 = 12.5$ mm, $l_{res} = 8.5$ mm, $w_1 = 300$ µm, $w_2 = 600$ µm, $\alpha = 45^o$, $Q_o = 75$ µL/min, $Q_m = 14$ µL/min. Movie corresponds to $l_{res} = 8.5$ mm in Figure 8.
2. Movie file, 115-23-4_5mm, shows the flow for the following conditions, $l_1 = l_2 = 6$ mm, $w_1 = 300$ µm, $w_2 = 600$ µm, $\alpha = 45^o$, $l_{res} = 4.5$ mm, $Q_o = 115$ µL/min, $Q_m = 23$ µL/min. Movie corresponds to Figure 9A.
3. Movie file, 25-5-4_5mm, shows the flow for the following conditions, $l_1 = l_2 = 6$ mm, $w_1 = 300$ µm, $w_2 = 600$ µm, $\alpha = 45^o$, $l_{res} = 4.5$ mm, $Q_o = 25$ µL/min, $Q_m = 5$ µL/min. Movie corresponds to Figure 9B.
4. Movie file, extend1, shows 3 cycles of extension/relaxation for a pair of crimped microfibers
5. Movie file, extend2, shows 3 cycles of extension/relaxation for a large crimped fiber bundle