Electronic Supplementary Material (ESI) for Nanoscale.

Supplementary Information

Flexible and tensile microporous polymer fibers for wavelength-tunable random lasing

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PVA microfibers with different sizes can be fabricated by directly drawing from an aqueous mixture. Figure S1a shows the formation of a fiber created from an initial aqueous droplet. To study the fiber's cross-section, we embedded the fiber in Polydimethylsiloxane (PDMS, SYLGARD™ 184 Silicone Elastomer Kit, silicone base: curing agent = 10:1). When PDMS became solid, the fiber was cut vertically to its long axis and the cross-section was examined by using a microscope. The result shows that fabricated fibers have a nearly circular cross-section (Fig. S1b). Figure S2 shows that fibers with diameter from about 10 to 60 μm can be produced which is significant for the study of size-dependent lasing characteristics.

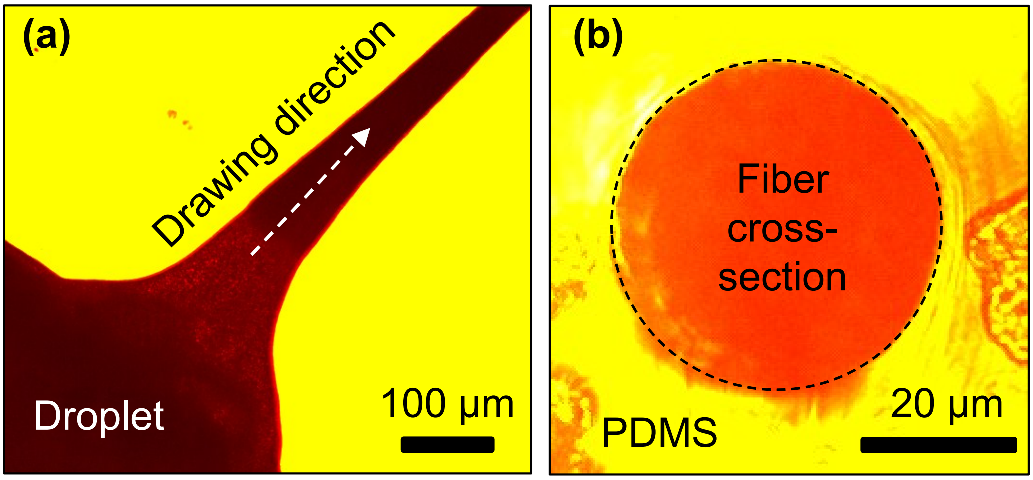

Fig. S1. Optical microscope image of (a) a direct drawing microporous fiber from a droplet and (b) a fiber's cross-section.

Microporous fibers were obtained by selective chemical etching in dimethyl carbonate. PS microspheres are completely removed, leaving round holes throughout the fibers. Figure S3 presents the

SEM image of the cross-section of a typical fiber. It can be seen clearly that microporous are visible from the surface to the center.

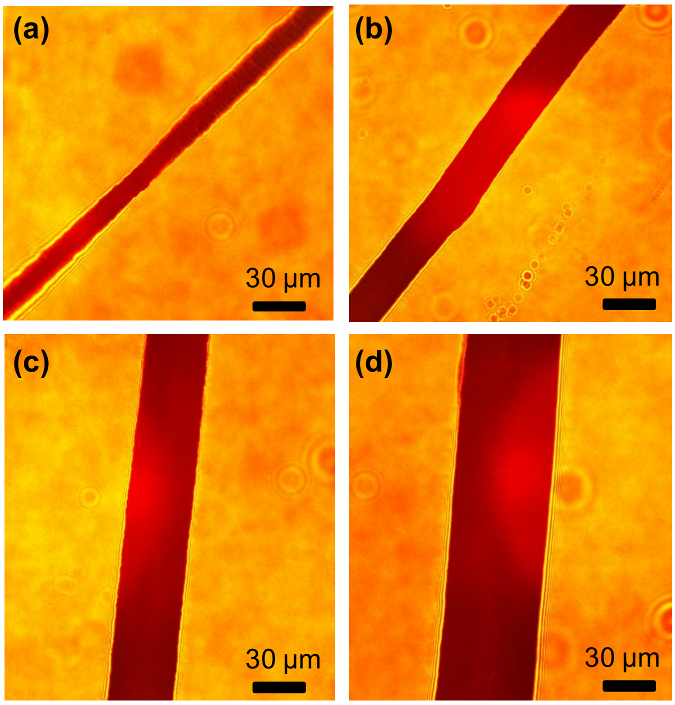

Fig. S2. Optical microscope images of different microporous PVA fibers. (a)-(d) Diameter of the fibers are around 14, 26, 38, 58 μm, respectively.

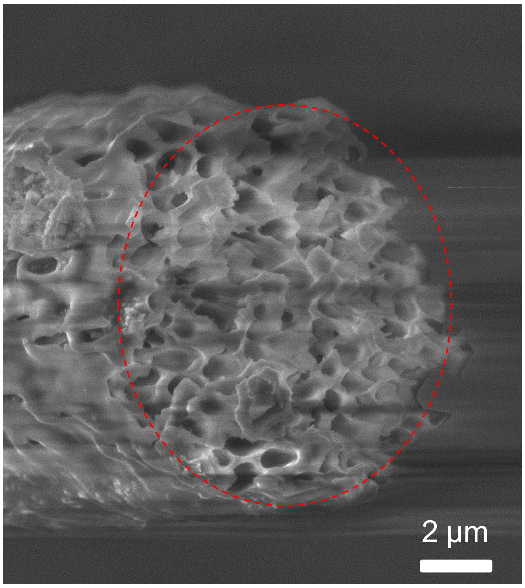

Fig. S3. SEM image of the cross-section of a microporous PVA fiber

Figure S4 shows size-dependent lasing spectra from microporous fibers. It can be seen that lasing spectra show a red-shift with the increase of fiber's diameter (*D*). The central wavelength of the 11 μm-diameter fiber is 587.7 nm (Fig. S4a). It gradually increases to 593 and 594.9 nm for 28 and 41 μm-diameter fibers, respectively (Figs. S4 b and S4c). When the diameter of fibers reaches 58 μm, a red-shift of 8.7 nm, from 587.7 nm to 596.4 nm, is recorded (Fig. S4d). Peak wavelengths of various fibers as a fuction of fiber diameter is shown in Fig. S5. The result suggests that if the diameter of a fiber is tuned then lasing wavelength can also be tuned in a specific range.

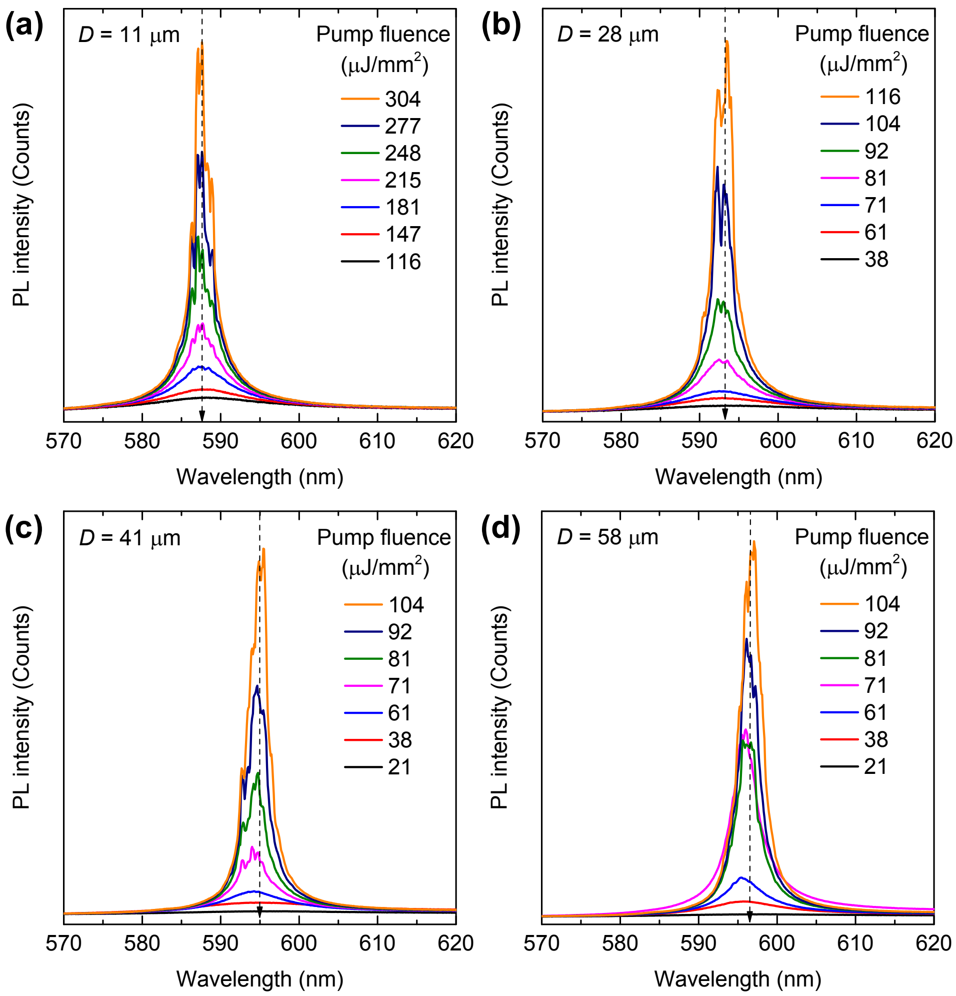

Fig. S4. Emission spectra of four different fibers under various pump pulse fluences. The dashed line denotes the center of the lasing spectrum.

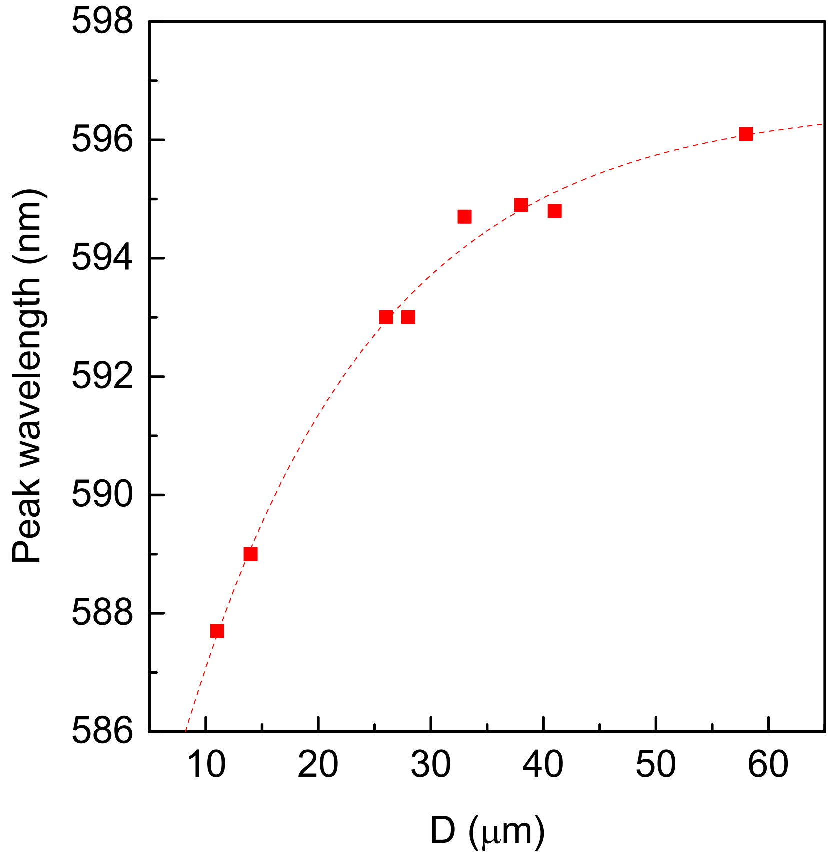

Fig. S5. Peak wavelength as a fuction of fiber diameter.

Figure S6 presents the simulation modes (using FDTD by Lumerical Inc.) for scattering cross-section of a single ellipsoid air void in polymer, considering all three different orientations with respect to the incident plane wave and the results are shown in Figure S7. It can be seen that the scattering resonance is red-shifted when the light is propagating parallel to the stretched direction and blue-shifted when it is transverse to the stretched pore. Overall, the average scattering cross-section changes with the stretching as shown in Figure S8 which would affect the output laser wavelength.

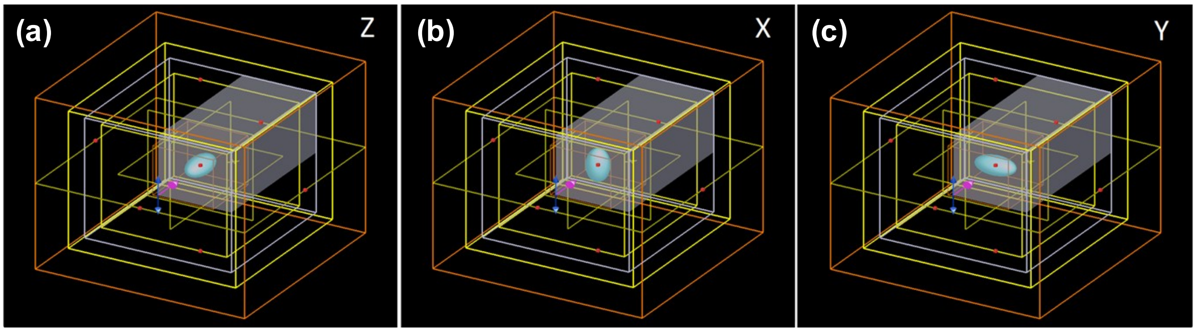

Fig. S6. Simulation geometry for calculating scattering cross-section of a single ellipsoid air void in polymer, considering all three different orientations with respect to the incident plane wave. The plane wave is propagating parallel to (a) the stretched direction and (b), (c) in transverse to the stretched pore. The incident light is polarized and the polarized direction is vertically shown by blue arrows.

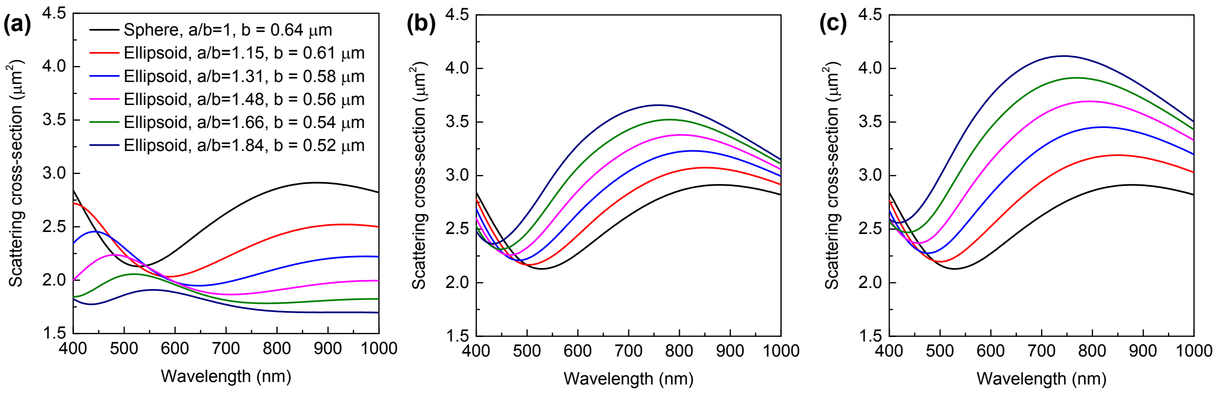

Fig. S7. Scattering cross-section of a single ellipsoid air void in polymer, considering all three different orientations concerning the incident plane wave. The plane wave is propagating: (a) parallel to the stretched direction and in (b), (c) transverse to the stretched pore.

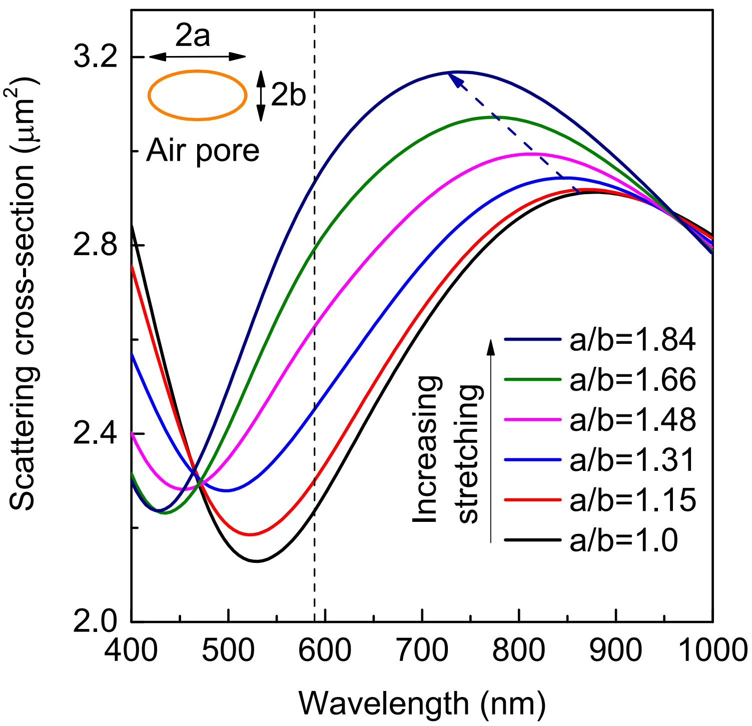

Fig. S8. Average scattering cross-section of air pore with various deformations in a polymer medium versus wavelength. The dashed line highlights the wavelength of 590 nm.