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Fabrication and characterization of porous-core honeycomb bandgap THz fibers

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We have fabricated a porous-core honeycomb fiber in the cyclic olefin copolymer (COC) Topas® by drill-draw technology [1]. A cross-sectional image of the fabricated fiber is shown in the left Panel of Fig. 1. Simulation of the electromagnetic properties of the fiber shows two wide bandgaps within the frequency range 0.1 to 2 THz, and numerous sharp resonant features are visible in the core power ratio, indicative of resonant coupling between the reflected field from the outer interface of the fiber and the core mode. The fiber is experimentally characterized with a commercial fiber-coupled THz-TDS system (Picometrix T-Ray 4000). The reference pulse before coupling into the fiber is shown in Fig. 1(a) and the time trace of the THz pulse after propagation through a 5-cm long segment of fiber is shown in Fig. 1(b) (blue curve). After adding some water on the outside of the fiber surface, the transmitted pulse experiences less pronounced oscillations at times later than 20 ps (red curve in Fig. 1(b)). Figs. 1(c) and (d) show the short-time Fourier transforms of the two time-domain traces in Fig. 1(b), overlaid with the calculated group delay in the two bandgaps (black squares). The frequencies below approximately 0.6 THz are attenuated by adding a layer of water on the outside of the fiber surface, while the transmission in the two band gaps in the 0.7-1.1 THz and 1.3-1.7 THz regions are unaffected by the water, This observation demonstrates that the absorptive water layer effectively strips the cladding modes from the fiber. The propagation loss is measured in a cut-back experiment. The fundamental bandgap at 0.75-1.05 THz is found to have losses lower than 1.5 dB/cm, whereas the loss is below 1.0 dB/cm in the reduced bandgap 0.78-1.02 THz, as shown in Fig. 1(g).

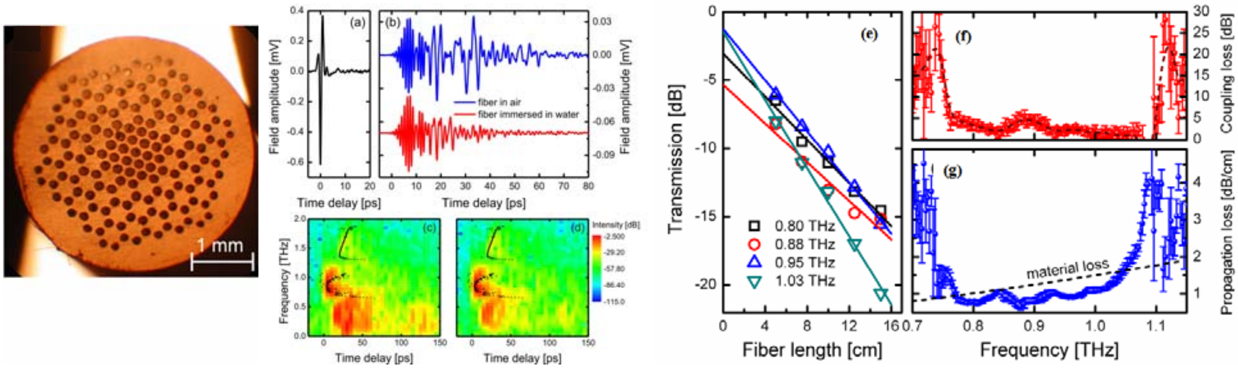

Fig. 1. (left side) Image of the end facet of the fabricated fiber. Measured (a) THz reference signal and (b) transmitted pulse through a 5 cm long honeycomb fiber with air (blue curve) and water (red curve) surrounding the outer surface. Short-time Fourier transforms of the transmitted waveforms in (b) are shown in (c) and (d), respectively, with simulated group velocity arrival times of the spectral components overlaid. (e) Relative transmission of the fiber with different lengths together with linear fits at four frequencies. Measured frequency dependent propagation loss (g) and coupling loss (f) of the fiber.

References

[1] K. Nielsen *et al.*, Optics Express, **17**, 8592-8601 (2009).