Orientation-dependent bending properties of selectively-filled photonic crystal fibres

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Abstract text: A selective-filling technique was demonstrated to improve the optical properties of photonic crystal fibres (PCFs). Such a technique can be used to fill one or more fluid samples selectively into desired air holes. The technique is based on drilling a hole or carving a groove on the surface of a PCF to expose selected air holes to atmosphere by the use of a micromachining system comprising of a femtosecond infrared laser and a microscope. The exposed section was immersed into a fluid and the air holes are then filled through the well-known capillarity action [1, 2]. Provided two or more grooves are fabricated on different locations and different orientation along the fibre surface, different fluids may be filled into different air-holes to form a hybrid fibre. As an example, we filled half of a pure-silica PCF by a fluid with n=1.480 by carving a rectangular groove on the fibre (Figure 1). Consequently, the half-filled PCF became a bandgap-guiding structure (upper half), resulted from a higher refractive index in the fluid rods than in the fibre core [3], and three bandgaps were observed within the wavelength range from 600 to 1700 nm. Whereas, the lower half (unfilled holes) of the fibre remains an air/silica index-guiding structure (Figure 1(b)). When the hybrid PCF is bent, its bandgaps gradually narrowed, resulted from the shifts of the bandgap edges. The bandgap edges had distinct bend-sensitivities when the hybrid PCF was bent toward different directions. Especially, the bandgaps are hardly affected when the half-filled PCF was bent toward the fluid-filled region. Such unique bend properties could be used to monitor simultaneously the bend directions and the curvature of the engineering structures.

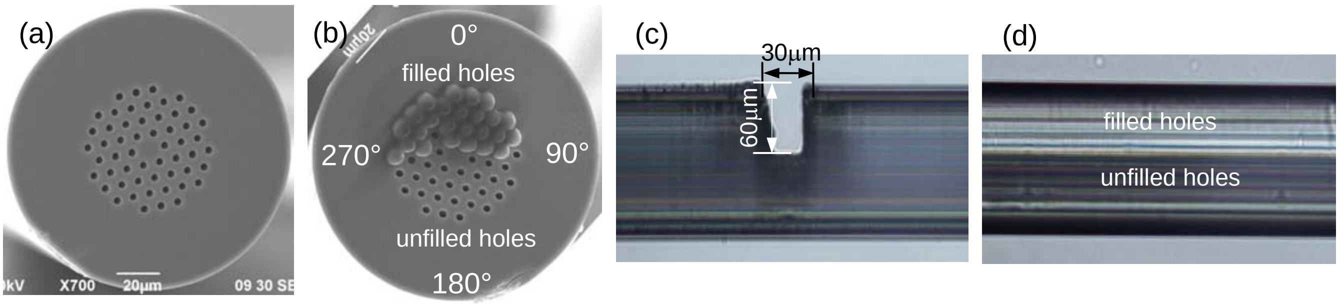

Figure 1 Scanning electron micrographs of (a) the unfilled PCF and (b) the half-filled PCF; Side images of (c) the PCF with a rectangular groove, and (d) the half-filled PCF.

References

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