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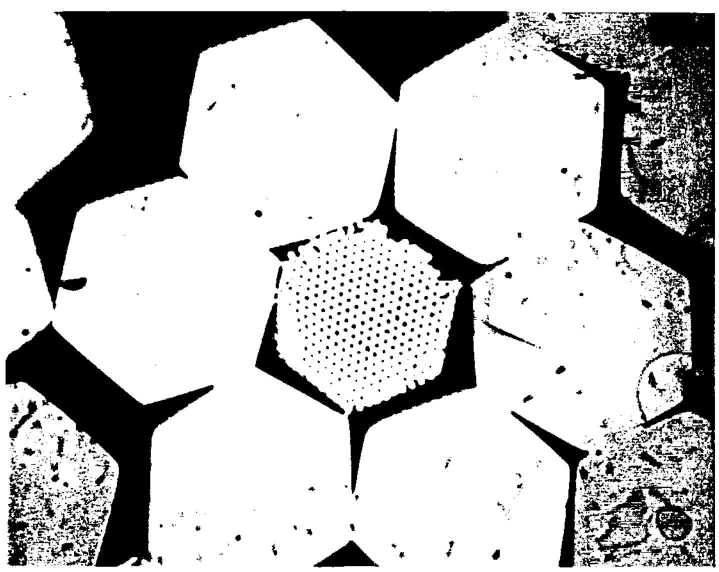
PROGRESS TOWARDS A PHOTONIC BAND GAP FIBRE

T. A. Birks, P. St.J. Russell, D. M. Atkin, G. Wylangowski
Optoelectronics Research Centre, University of Southampton, Southampton, U.K.

We are currently developing an entirely new type of optical fibre that guides light by Bragg reflection instead of total internal reflection. The fibre will be made from pure silica, using conventional fibre drawing techniques to give a longitudinally invariant structure kilometres in length. In cross-section the fibre will include a hexagonal array of air holes with a pitch of 1-2 μm. For a given optical frequency, there are ranges of axial wavevector β for which transverse propagation in this structure is forbidden: the photonic band gaps. It therefore acts as a totally reflecting "cladding" for such β values. A deliberate defect in the two-dimensional periodic structure (perhaps one hole is filled in, or is larger than its neighbours) provides a site for the localisation of light and so acts as the "core". The propagation of light along the defect can be engineered by modifying the unit cell and scale of the structure, giving rise to a number of unique applications.



A photomicrograph of the cross-section of a trial photonic band gap fibre in silica. The central element has an array of air holes with a pitch of 2.5 μm. Although the outer solid elements have not fused together, the figure clearly shows that close air-hole spacings are possible in a length of fibre, without any filling in.

The fibre is made by a repeated drawing and stacking process. Hexagonal silica rods with a central hole are drawn down and stacked, and the stack is then fused and drawn again to form a 1 mm cane with an array of air holes. This is jacketed with solid silica canes (to provide bulk, and to strip cladding modes), and this is drawn to form the final fibre. Our initial result is shown in the figure. Although the jacket material did not fuse properly, it is clear that the air holes did survive the drawing process without filling in. Having thus proved that the intended fibre can be made, we will repeat the procedure with a defect in the structure to act as a core. Silica with a higher OH content (and so a lower viscosity) will be used for the jacket, to ensure fusion without collapsing the air holes. We hope to report the success of this process, together with optical measurements, at the meeting. This work is supported by DRA Malvern.