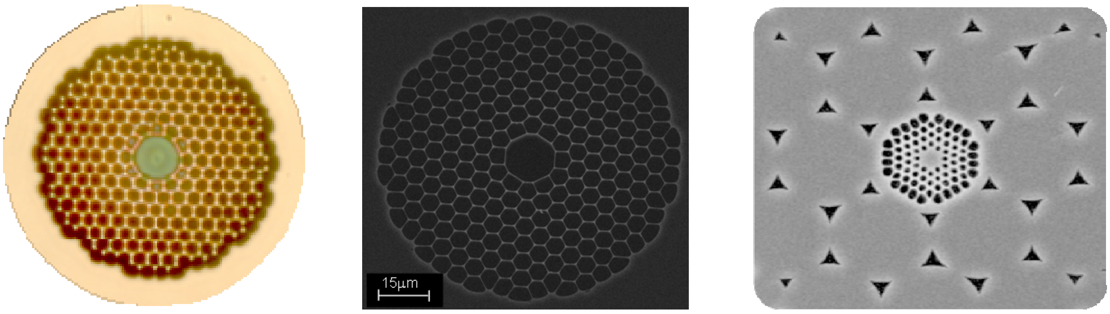
PHOTONIC BAND GAP FIBRES: THE NEW WAY OF GUIDING LIGHT

Rodrigo Amezcua-Correa, N. G. Broderick, M. N. Petrovich, D. J. Richardson
Optoelectronics Research Centre (ORC), University of Southampton, Southampton SO17 1BJ, UK.

Photonic Bandgap Fibres (PBGFs) are a radically new class of optical fibres whose guiding properties rely on the existence of photonic bandgaps. These fibres can guide light within an air-core thanks to a periodic array of micrometer-size holes running along the fibre length [1], see Fig 1a,b. PBGF have opened up numerous possibilities in photonics, largely through their ability to overcome the limitations of conventional optical fibres, for example by permitting guidance of light at wavelengths where silica fibres present high loss. They offer great prospects for communications due to the potential for low loss that results from the light being guided in air. In addition, these features make them ideal for sensors since there can be a large overlap between the light and gases, liquids, or nanoparticles introduced into the central hole. Such fibres could then be used wherever high sensitivity detectors are needed such as in the bio-medical field, or even for homeland security applications.

PBGFs are fabricated by stacking and fusing arrays of glass capillaries into a tube of 2-3 centimetres diameter which is then drawn at high temperatures to fibre form. This approach allows the complex preform structure to be scaled down to the size of a human hair, see Fig. 1b. By appropriately designing the stacked preform, the air holes within the PBGF can have a wide range of shapes and sizes in highly controlled microgeometries. By tuning the geometrical properties of the holes, the optical properties of the fibre can be engineered; here at the ORC we have demonstrated the fabrication of complex structures with incredible precision, Fig 1b,c.



(a) (b) (c)

Fig. 1. *(a) Green light propagating in the air core of a PBGF. Cross-sectional SEM images of: (a) a hollow-core photonic band gap and (b) other microstructured fibre fabricated at the ORC, (c) green light propagating in the air core of a PBGF.*

A key obstacle in the development of this fibre technology is the presence of modes guided at the core-cladding interface which reduces the fibre's low-loss operational bandwidth (normally limited to around 100nm). Recently, we have addressed this problem and proposed new fibre designs that eliminate the presence of these undesirable modes and which maximize the fibre's operational bandwidth. Fabrication of a PBGF with the optimum design structure was undertaken. Detailed structural analysis was performed by scanning electron microscopy (SEM), which allowed us to verify that the fabricated fibre had the target structural parameters. The measured transmission properties are in very good agreement with the predictions of our modelling. In this poster, we report on the design, fabrication and characterization of hollow-core PBGFs with a wide operational bandwidth.

References

1 P. Russell, Science, **299** (2003), 358.