Semiconductor filled microstructured optical fibres with single mode guidance

N Vukovic, N Healy, F Poletti and A Peacock

Optoelectronics Research Centre, University of Southampton, Southampton SO17 1BJ, U.K.

Microstructured optical fibre (MOF) technology has generated new opportunities for the implementation of optical fibres with novel properties and functions [1]. It has been shown that silica MOFs make excellent 3D templates for semiconductor material deposition inside the capillary voids [2]. Recently a silicon MOF was designed and fabricated that had a high refractive index micron sized core, but yet only supported two guided modes [3]. This structure was realised via the complete filling of a hollow core photonic bandgap fibre (PBGF) with silicon so that the original air guiding PBGF was converted to a total internal reflection guiding fibre. Here, we extend the investigation by using a finite element method to model the optical properties of semiconductor filled MOFs of similar structures, with the aim to achieve broadband single mode guidance. Strategies to achieve single mode guidance both through the MOF template design and the selective filling of the voids of the original PBGF with semiconductor materials of different indices (silicon, silicon nitride, germanium) are proposed and investigated numerically. In particular, by selectively filling MOF templates with cladding rods that have a slightly raised index over that of the core, index guiding single mode operation can be observed in high index micron sized cores. Small index differences are achievable by controlling the nitrogen content in SiN_x and an example of a single mode semiconductor MOF is shown in Figure 1, where the confinement loss of the fundamental mode is ~10^6 lower than the lowest order cladding mode.

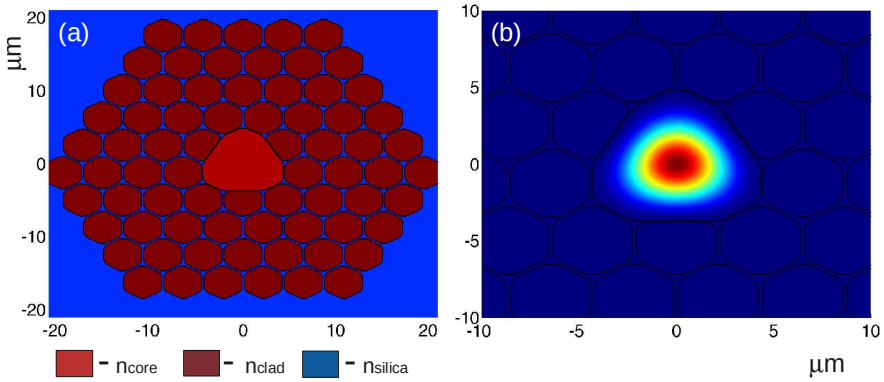

Figure 1 (a) Refractive index plot of the filled MOF showing slightly raised (~1%) index of the cladding rods over the index of the core (n~3). (b) The magnitude of the Poynting vector for the fundamental mode.

References

[1] P. Russell, “Photonic Crystal Fibers”, *Science*, 299, pp. 358-362, 2003.

[2] P. Sazio, A. Amezcua-Correa, C. E. Finlayson, J. R. Hayes, T. J. Scheidemantel, N. F. Baril, B. R. Jackson, D. J. Won, F. Zhang, E. R. Margine, V. Gopalan, V. H. Crespi, J. V. Badding, “Microstructured optical fibers as high-pressure microfluidic reactors”, *Science*, 311, pp. 1583-1586, 2006.

[3] N. Healy, J. R. Sparks, M. N. Petrovich, P. J. A. Sazio, J. V. Badding, A. C. Peacock, “Large mode area silicon microstructured fiber with robust dual mode guidance”, *Optics Express*, Vol 17, No. 20, pp. 18076-18082, 2009.