3108

Comparison of lattice structures for air-guiding photonic band gap fibres

R. Amezcua, N.G. Broderick, V. Finazzi, D. J. Richardson

Optoelectronics Research Centre, University of Southampton, SO17 1BJ, UK

The optical version of a crystal, namely the photonic crystal, is a periodic distribution of a dielectric structure with a period on the order of an optical wavelength. According to Maxwell's equations, under certain circumstances a photonic band gap can appear, and therefore the propagation of light with particular frequencies is completely forbidden[1]. Photonic crystal fibres (PCF) composed of silica and air, have become very attractive for many new applications due to their special features such as large nonlinearity and adjustable dispersion and wave guidance by the photonic bandgap effect [2]. If in such fibre the photonic band gap expands above the air line, $k = \beta$, guiding of light in an air core can be possible.

In this poster we will focus on the modelling of a square photonic crystal which can be used as cladding of air-guiding photonic band gap fibres (PBGF). Air-guiding photonic crystal fibres with a triangular patter of air holes seem to be the most promising structure as air-guiding optical fibres. However, the design of new cladding structures with wide bandgaps is of great importance for future realization of low loss air-guiding fibres. Since the electromagnetic field of PBGF's cannot be separated in TE and TM polarizations, modelling of PBGF requires full-vectorial methods. For the bandgap and mode distributions we use a full vectorial plane wave expansion method[3].

Dispersion and polarization properties of solid-core square photonic band gap fibres have been extensively studied[4]. However, the possibility of air guiding in square lattice photonic crystals fibres, to the best of our knowledge, has not been studied. The basic square structure, a square arrangement of circular holes, presents very narrow gaps crossing the air line. Here, we study an arrangement of octagonal holes in a square pattern, see Fig.1. This structure presents wider bandgaps than the basic square lattice since isolated high-index regions are connected by very narrow veins. PBG regions extending above the air line begin to appear for air filling factors around 65%. For low air filling factors, 70 to 80%, the relative width of the gap crossing the air line is between 17 and 28% while triangular structures present gaps with relative widths of less than 13% for the same range of air filling factors. Numerical results demonstrate that such band gaps can be used to guide light in a properly chosen air core design.

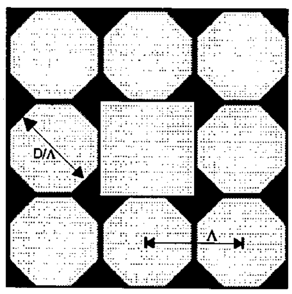

Fig.1: Square PBGF with hollow core formed by removing one unit cell. Black and white regions are silica and air respectively.

[1] J. D. Joannopoulos, J. N. Winn, and R. Meade, *Photonic Crystals: Molding the flow of light*. Pinceton University Press, 1995.
[2] P. Russell, *Photonic Crystal Fibers*, Science, 299, p. 358, 2003.
[3] S. G. Johnson and J. D. Joannopoulos, *Block-iterative frequency-domain methods for Maxwell's equations in a planewave basis*, Opt. Express, 8, p. 173, 2001.
[4] A. Ferrando and J. J. Miret, Single-*polarization single-mode intraband guidance in supersquare photonic crystal fibers*, Appl. Phys. Lett, 21, p. 3184, 2001