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Designing the Mode solving of the photonic crystal fiber via BPM and Exploring the Single-Mode Properties

Mohammed DEBBAL[1], Mohamed CHIKH-BLED[2]

[1] Electronic Department, Abou-Bekr BELKAID University, Telecommunication Laboratory Tlemcen, 13000, Algeria

[2] Electronic Department, Abou-Bekr BELKAID University, Telecommunication Laboratory Tlemcen, 13000, Algeria

Abstract

Microstructured optical fibers (MOFs) are one of the most exciting recent developments in fiber optics. A MOF usually consists of a hexagonal arrangement of air holes running down the length of a silica fiber surrounding a central core of solid silica or, in some cases air.
MOFs can exhibit a number of unique properties, including zero dispersion at visible wavelengths and low or high effective nonlinearity [3]–[17], By varying the size of the holes and their number and position, one can also design MOFs with carefully controlled dispersive and modal properties.
In this paper, we analyze and modeling the behavior of the photonic crystal fiber (PCF) by using in the first step a propagator method based on the BPM method.
With our BPM software, the electric field contour of the fundamental mode of PCF was demonstrated. We also used it to see the variation of the effective index; an effective index model confirms that such a fiber can be single mode for any wavelength.
It would make a study of photonic crystal fibers, and a study of the numerical simulation methods allow the simulation of optical properties and has modeled the propagation of light in this fiber type.
After that we use the V-parameter because it offers a simple way to design a photonic crystal fiber (PCF), by basing in a recent formulation of this parameter of a PCF, we provide numerically based empirical expression for this quantity only dependent on the two structural parameters, the air hole diameter and the hole-to-hole center spacing.

Keywords: *Optical Telecommunication, V-Parameter, BPM Method, Photonic crystals fibers, nanotechnologies.*

1. Introduction

Photonic Crystal Fibers (PCFs) [1]–[2], have been under intensive study for the past several years as they offer a number of unique and useful properties not achievable in standard silica glass fibers. PCFs fall into two basic categories.

The first one, an index-guiding PCF [3], [4], is usually formed by a central solid defect region surrounded by multiple air holes in a regular triangular lattice and confines light by total internal reflection like standard fibers.
The second one uses a perfect periodic structure exhibiting a photonic band-gap (PBG) effect at the operating wavelength to guide light in a low index core region, which is also called PBG fiber (PBGF) [5], [6].

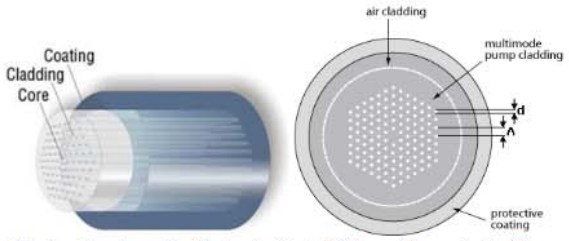

Fig. 1 : Structure of a Photonic Crystal Fiber with an air cladding.

A typical cross section of an index guided PCF is shown in Fig.1, The PCF consists of a triangular lattice of air holes where the core is defined by a "missing" air hole. The pitch is labeled Λ, and measures the period of the hole structure (the distance between the centers of neighboring air holes). The hole size is labeled d, and measures the diameter of the holes.

2. Beam Propagation Method (BPM)

The Beam Propagation Method (BPM) is a numerical modeling method to simulate the propagation of a wave in a guide of arbitrary geometry. It can predict from an incident field distribution within a structure. The main idea of this method is to divide a structure into "slices"