Uniform Fiber Bragg Grating modeling and simulation used matrix transfer method

Abdallah IKHLEF, Rachida HEDARA, Mohamed CHIKH-BLED

Laboratoire de Télécommunications, Département de Génie Electrique et d'Electronique
Faculté de Technologie, Université Abou-Bekr Belkaïd -Tlemcen
BP 230, Pôle Chetouane, 13000 Tlemcen- Algeria

Abstract

This paper presents the modeling and simulation of an optical fiber Bragg grating for maximum reflectivity, minimum side lobe. Gating length represents as one of the critical parameters in contributing to a high performance fiber Bragg grating. The reflection spectra and side lobes strength were analyzed with different lengths .The side lobes have been suppressed using raised cosine apodization while maintaining the peak reflectivity. Such simulations are based on solving coupled mode equations by transfer matrix method.

Keywords: Fiber Bragg grating, Reflection, Apodization, simulation Transfer Matrix Method.

1. Introduction

Optical fiber gratings are important components in fiber communication and fiber sensing fields. For normal fiber gratings, by properly choosing the period, length, index modulation amplitude, chirp and apodization function, one can flexibly design and optimize grating reflection or transmission spectra to satisfy many applications [1]. Although optical fibers have been used for many decades, the last 10 to 20 years have shown a lot of further development. The introduction of FBGs, photonic crystal fibers and new plastic optical fibers, to name only the most important new fields, has dramatically widened the range of possible applications.

The FBGs are used extensively in telecommunication industry for dense wavelength division multiplexing, dispersion compensation [2,3], laser stabilization, and Erbium amplifier gain flattening, simultaneous compensation of fiber dispersion , dispersion slope and optical CDMA [4,5]. By exploiting the characteristics exhibited by these gratings, numerous areas have been marked in which their usage has brought drastic advancements and continues to do the same. The FBG works on the principle that when ultraviolet light (UV) illuminates a certain kind of optical fiber, the refractive index of the fiber is changed permanently, this effect is called photosensitivity. Alternatively, the refractive index will last for several years if it is followed by proper annealing [6].

The optical fiber with germanium doped core remains the most important material for grating purposes. The first in-fiber Bragg grating was demonstrated by Ken Hill in 1978 [7].

Initially, the gratings were fabricated using a visible laser propagating along the fiber core. In 1989, Gerald Meltz and colleagues demonstrated the much more flexible Transverse Holographic Technique [6] where the laser illumination came from the side of the fiber. This technique uses the interference pattern of ultraviolet laser light to create the periodic structure of FBGs. Since this discovery, the development in the field of Bragg gratings has experienced a tremendous growth. FBGs offer ample advantages but the most important is the flexibility in spectral characteristics. Many researchers have been work done in this field also [1, 8].
There are a number of parameters on which the spectra of FBG has shown dependency such as change in refractive index, bending of fiber , grating period, mode excitation conditions, temperature and fiber Bragg grating length [9,10,11,12].

In this paper, the effect on the Reflection spectra of FBG is analyzed at the varied grating length. The paper is divided into following sections. Section 2 covers the theory and modeling (coupled mode theory and transfer matrix method) of FBGs as well as the working principle of FBGs. Section 3 deals with the results and discussion about the modeling and simulation work done on FBGs at typical specifications using MATLAB. Lastly, section 4 draws the conclusion of the work done.

2. Theory

The propagation of light along a waveguide can be described in terms of a set of guided electromagnetic waves called the modes of waveguide. In optical fibers the core-cladding boundary conditions lead to coupling between the electric and magnetic field components.

Copyright (c) 2012 International Journal of Computer Science Issues. All Rights Reserved.