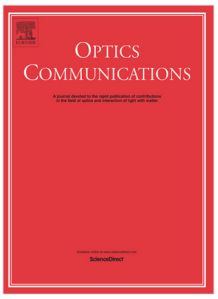
Accepted Manuscript



Hollow-core photonic crystal fibers for efficient terahertz transmission

H. Pakarzadeh, S.M. Rezaei, L.Namroodi

PII: S0030-4018(18)30854-X
DOI: https://doi.org/10.1016/j.optcom.2018.09.065
Reference: OPTICS 23504

To appear in: *Optics Communications*

Received date : 6 April 2018
Revised date : 31 July 2018
Accepted date : 26 September 2018

Please cite this article as: H. Pakarzadeh, et al., Hollow-core photonic crystal fibers for efficient terahertz transmission, *Optics Communications* (2018), https://doi.org/10.1016/j.optcom.2018.09.065

Transmission

H. Pakarzadeh [a,]*, S.M.Rezaei[a], L.Namroodi[a]

[a]*Physics Department, Shiraz University of Technology, Shiraz, Iran*

Abstract

Increasing applications of terahertz (THz) waves require design and fabrication of new waveguides with low transmission loss in THz region (0.1 ~10 THz). Hollow-core photonic crystal fibers (HC-PCFs) with their unique characteristics hold great promise for efficient THz transmission. Hence, in this article, HC-PCFs are designed and simulated based on the finite-difference-time-domain (FDTD) method to efficiently transmit THz radiation. Impacts of structural parameters such as background material, core diameter, air-hole rings and filling factor on the THz transmission window of HC-PCFs are investigated. The results show that as the number of air-hole rings and the core diameter are increased the transmission loss is decreased. Also, the suitable HC-PCF in the transmission window of 1.55-1.85 THz with simultaneously good dispersion properties is obtained when the background material is Teflon.

Keyword: hollow-core photonic crystal fiber; finite-difference time-domain; terahertz window; transmission loss

1. Introduction

Terahertz (THz) or T-ray radiation falls in the spectral region that is a connection between microwave electronics and infrared optics. The domain of the T-ray starts from the end of the microwaves and continues to midrange of the infrared waves. In fact, its frequency spans from 10^{11}Hz to 10^{13}Hz (similarly, the wavelength range is from 30μm to 3mm) as shown in Fig.1[1], [2]. The energy of optical photons in the THz region is less than the bandgap of non-conductive material; therefore, T-ray can penetrate to these substances. Moreover, THz radiation may be sent to materials for investigating their characteristics and can be regarded as a good alternative to the X-ray for obtaining high-resolution images of solid objects[3]–[6].

By increasing applications of THz waves, it is essential to design and fabricate new waveguides with minimum loss in THz region. Metallic waveguides were the first types which guided THz waves; and based on their geometry include four types known as circular, parallel plate, bare metal wire, and slit waveguide (see Fig. 2)[7]–[12]. Dielectric waveguides can also support THz waves and based on their guidance mechanism are divided into two main subgroups: index-guiding and photonic-bandgap (PBG) fibers. An Index-guiding fiber consists of a solid core with higher refractive index than the cladding where light is guided by total internal reflection in the core [13]. As shown in Fig.3, there are three types of index-guiding fibers with different cross sections known as: *step-index fiber, solid-core photonic crystal fiber and porous-core fiber* [14]–[17]. Since light mainly propagates in the solid core of the fiber, therefore, transmission of light is accompanied by the material absorption. However, by introducing porous-core, researchers are able to engineer and reduce the material absorption and consequently the transmission loss.

* Corresponding author. Tel :+98 913 6271392
E-mail address: pakarzadeh@sutech.ac.ir