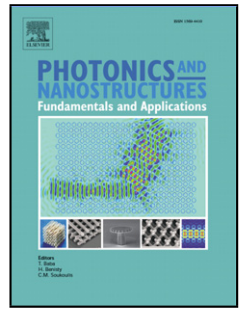

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PII:	S1569-4410(17)30389-9
DOI:	https://doi.org/10.1016/j.photonics.2018.08.004
Reference:	PNFA 677
To appear in:	*Photonics and Nanostructures – Fundamentals and Applications*
Received date:	16-12-2017
Revised date:	10-8-2018
Accepted date:	27-8-2018

Please cite this article as: Gorelik VS, Sverbil PP, Filatov VV, Bi D, Fei GT, Xu SH, Transmission spectra of one-dimensional porous alumina photonic crystals, *Photonics and Nanostructures - Fundamentals and Applications* (2018), https://doi.org/10.1016/j.photonics.2018.08.004

Transmission spectra of one-dimensional porous alumina photonic crystals

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Highlights

- Porous alumina photonic crystals can serve as narrow-band filters and sensors.
- Filling pores of porous alumina photonic crystal controls its transmission spectrum.
- Raman signal is greater when the substance is placed into a porous photonic crystal.
- The amount of substance needed for recording Raman spectra may be substantially decreased when it is placed into a porous photonic crystal.

The optical properties of a one-dimensional photonic crystal based on porous alumina with a crystal lattice constant of 460 nm were studied. The experimentally measured transmission spectrum of a one-dimensional photonic crystal film was compared with the theoretical spectrum in the spectral regions corresponding to the first, second, and third stop bands. The potential for using one-dimensional porous alumina photonic crystals as selective narrow-band filters and sensors was analyzed. Embedding a Raman-active medium into the voids of porous photonic crystal should provide an essential increase of spontaneous Raman scattering signal and low-threshold stimulated Raman scattering. The amount of substance needed for recording Raman spectra may be substantially decreased.

Key words: photonic crystal; porous alumina; stop band; narrow-band filter; Raman scattering enhancement; sensor.

1. Introduction

At present, it is very important to create new types of optical filters and sensors with controlled optical properties. In this connection, it is of great interest to study photonic crystal (PC) [1-4] media with spatial variation of dielectric permittivity. One type of PCs is the one-dimensional (1D) PC constructed from alternating layers with two different refractive indices. In the reflection spectrum of such crystal, there are spectral regions where strong reflection of electromagnetic radiation from the surface of the crystal is observed. Such areas are referred to as photonic bandgaps, or stop bands. The spectral positions of the stop bands depend on the parameters of the PC, i.e., the crystal lattice constant and the values of the refractive indices. PCs are used in various applications [5-9].

One of the kinds of PCs is a porous structure containing pores with a size of tens of nanometers [4, 10-11]. The optical properties of a porous globular PC constructed of close-packed silica globules (SiO_2) in the form of a face-centered cubic lattice have been previously studied [12-