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NONLINEAR INTERACTION MODELING IN PHOTONIC CRYSTALS

Dana Georgeta POPESCU,[1] Paul STERIAN[2]

Abstract. *This paper presents several methods for photonic crystals (PCs) characterization which are subsequently applied to realistic systems using specialized software. These methods are Finite Element Method, Plane Wave Method, Finite Difference Time Domain Method, Multipole and Bloch Wave Methods. Based on a full nonlinear system of equations, a nonlinear SHG (Second Harmonic Generation) problem in one-dimensional photonic crystals will be analyzed using Finite Element Method coupled with Fixed Point Iterations. The diagrams resulted after parameter variations are plotted using FlexPDE Professional software. As a result we obtained two maximum intensities of the second harmonic wave within each high index layer, contrasting to the fundamental wave peak. Also a representative band structure using the Plane Wave Method is given.*

Keywords: photonic crystal, finite element method, plane wave method, second harmonic, band structure

1. Introduction

Photonic crystals are periodic dielectric structures which have a band gap that forbids the propagation of radiation within a certain frequency range. This property allows an enhanced control of light effects, otherwise difficult to control with conventional optics.

Photonic crystals are described by Maxwell's equations:

$$\nabla \cdot \vec{E} = \frac{\rho}{\varepsilon_0} \tag{1.1}$$

$$\nabla \cdot \vec{B} = 0 \tag{1.2}$$

$$\nabla \times \vec{E} = -\frac{\partial \vec{B}}{\partial t} \tag{1.3}$$

$$\nabla \times \vec{B} = \mu_0 \vec{J} + \mu_0 \varepsilon_0 \frac{\partial \vec{E}}{\partial t} \tag{1.4}$$

[1]Eng., The Faculty of Electronics, Telecommunication and Information Technology, National Institute of Materials Physics, University "Politehnica" of Bucharest, Romania (dana.popescu@infim.ro).
[2]Prof., Ph.D., eng. University "Politehnica" of Bucharest, Romania; full member of the Academy of Romanian Scientists (sterian@physics.pub.ro).