UDC 621.396.676 (045)

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2D PHOTONIC CRYSTAL FILTER WITH HEXAGONAL LATTICE

Abstract. *Modified 2D hexagonally structured photonic crystal narrows the bandgaps of a standart comb filter.*

Solution of 3D optoelectronic problems is hard even today. It is very often still impossible to build a good 3D finite elements model (FEM), that can be treated with appropriate engineering software. So, how to get rid of this “modeling jam”, keeping the object’s 3D geometry for FEM processing and at the same time being able to overcome those huge (sometimes hundred thousands or even millions elements sized) matrices factorization crashes, when inverting them in order to find out a desired solution? The answer is clear – use 2D models of 3D material objects.

Physics. The differential equation in partial derivatives for this model is:

$$\nabla\times(\mu_r^{-1}\nabla\times E)-(\varepsilon_r - j\sigma/\omega\varepsilon_0)k_0^2E=0,$$

where μ_r - relative magnetic permeability; E - intensity of electric field at the monitoring point, (*V/m*); ε_r - relative dielectric permittivity; σ - conductivity of a proxy element, (*Sm/m*); ω - circular frequency of oscillations, (Rad/s); $\varepsilon_0 = 10^{-9}/36\pi$ - electric constant, (*F/m*); $k_0 = 2\pi/\lambda$ - wave number; λ - wavelength of oscillations, (*m*).

Results. This differential equation in partial derivatives for 2D photonic crystal PhC (Fig. 1, a) is derived from Maxwell’s equations. It is solved (Fig. 1, b) by Optiwave FDTD software with help of numerical methods (band gap tolerance 0.025). Input: plane wave, λ=2μm . Found 3 band gaps (BG): 0.0854, 0.0880, 0.0899 (Fig. 1, c). Original hexagonal lattice gave 0.1032, 0.1164, 0.0919. BG sharpening gave 1.78%, 2.84%, 0.2%. Average – 1.61%.

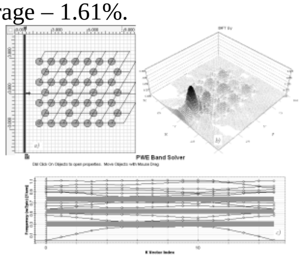

Fig. 1 Radiation patterns of 2D PhC

It was taken as many as 40 round pillars ($n_1 = 3.1$ and $n_2 = 1.0$) to build an appropriate FEM. Calculations were done in $\approx 21,6$ sec. using a modest laptop.