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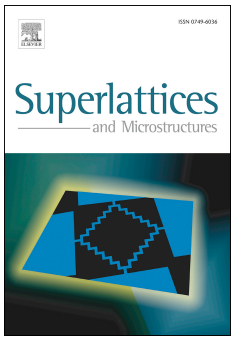

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Extension of energy band gap in ternary photonic crystal using left-handed materials

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Abstract
We investigate the extension of energy band gap in one-dimensional ternary photonic crystal. We assume one of the layers constituting the ternary photonic crystal to be left-handed material (LHM) of simultaneously negative electric permittivity and magnetic permeability. The photonic crystal has the structure dielectric / LHM / dielectric. We show in this work, the energy band gap in one-dimensional ternary photonic crystal can be dramatically enlarged with the increase of the LHM layer thickness. Moreover, it can also be enlarged with the decrease of both the negative permittivity and permeability of the LHM layer. The effects of the angle of incidence and the number of layers are also investigated.

Keywords: ternary photonic crystal, band gap, left-handed material, transmission.

1. Introduction

Photonic crystals are artificial media having a periodic structure stacked by alternating two different materials with distinct refractive indices. Binary photonic crystals have received an increasing interest in the last two decades [1-5]. A simple one-dimensional dielectric-dielectric photonic crystal is Bragg reflector also known as dielectric mirror. Bragg reflector is widely used in solid-state lasers [6]. These periodic multilayer structures form photonic band gaps in which propagation of light of certain wavelengths is not allowed. These photonic band gaps are also called stop bands whose extensions are critically dependent on the incidence angle of the wave, material thickness, and the index of refraction. The photonic band gap materials have arisen as novel optical materials in the optical applications. This generates a stream of papers in both the fundamental and applications of photonic crystals [7-10]. In dielectric-dielectric photonic crystal, a wide band gap is a requirement for the use in many applications. The band gap can be expanded by several techniques such as increasing the contrast of index of refraction of the materials constituting the dielectric mirror [11]. Utilizing chirped or disordered photonic crystals can also enhance the photonic band gap [12-14]. These techniques to expand the photonic band gap are mostly based on the binary dielectric-dielectric photonic crystals. A ternary photonic crystal can be designed to obtain an enlarged band gap [15]. The ternary photonic structures can be assembled by the repetition of three different