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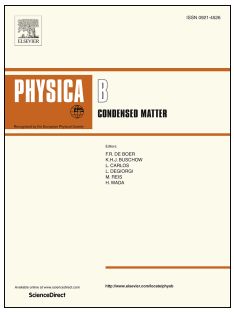

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Analysis of transmittance properties in 1D hybrid dielectric photonic crystal containing superconducting thin films

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Abstract

By means of two fluid model and transfer matrix method (TMM), we investigate theoretically the transmittance properties of a defective hybrid dielectric–dielectric photonic crystal that contains a superconducting material as a defect layer. The considered hybrid photonic structure is: $H(LH)^7(HLSLH)^P H(LH)^7$, where H is the high refractive index dielectric, L is the low refractive index dielectric, S is the superconducting material and P is the repetitive number. The results show that the variation of the number and the positions of the transmissions modes depend strongly on the repetitive number P, the temperature T and the thickness of the layer S. An improvement of the spectral response is obtained with the exponential gradation of layer thicknesses $d_j = d_0 + \beta e^{j\alpha}$, where d_0 is the initial thickness of the layer j, α and β are two particular constants for each material. In addition, the effect of the incident angle for both transverse electric (TE) and transverse magnetic (TM) polarizations on the transmittance spectrum is discussed. As a result, we propose a tunable narrow stop-band polychromatic filter that covers the visible wavelength.

Keywords: Photonic crystal, superconductor, temperature, TMM, exponential gradation.

1. Introduction

Photonic crystals (PCs) have received much attention over the past few years, because of the periodicity, they exhibit photonic band gaps (PBGs), which means that the photon can be controlled and manipulated effectively **[1-5]**. PC is an artificially fabricated structure with periodic, quasi-periodic and hybrid dielectric medium. One-dimensional periodic structure (PS) (also called the Bragg Mirror) is composed of alternating layers having a low and a high refractive indices (n_L and n_H respectively), the thickness of each layer is chosen to satisfy the Bragg quarter-wave condition **[6]**. Quasi-periodic structure (QPS) is another type of PC that can be considered by a simple deterministic generation as the Fibonacci, Thue-Morse, Cantor sequences **[7-9]**. The third type of PC is called hybrid structure (HS) designed as a combination of PSs and QPSs. This makes it possible to obtain important physical properties. Examples of such properties are the enlargement of the PBG **[10]** and the manipulation of the transmission peaks **[11-12]**. Many devices can be fabricated by these structures **[13-14]**. The