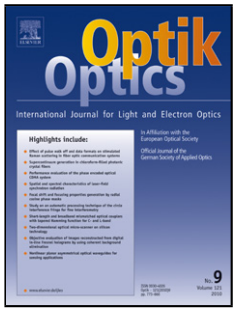

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Theoretical investigation of guided modes in planar waveguides having chiral negative index metamaterial core layer

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Abstract. In this work, a slab waveguide consisting of a chiral negative index metamaterial film surrounded by a dielectric medium was considered. The characteristics of both even and odd guided modes are investigated. The field profile, dispersion curves and power distribution for these configurations are also studied. A set of novel features were observed such as negative power in the chiral film and the existence of normalized frequencies less than the cutoff at which waves can propagate.

Keywords: slab waveguides, chiral materials, negative-index materials.

1. Introduction

Optical rotation phenomenon was the main property behind the last century investigation of chiral materials. It was shown that right- and left-hand circularly polarized waves have different velocities and hence different indices of refraction in these materials. Different polarized rotations correspond to different modes. At the boundary of isotropic chiral material, bi-refraction takes place because of the coexistence of two different modes caused by the material chirality [1]. Intensive investigations of slab waveguides including chiral media have been conducted by physicists and engineers due to their potential applications in many fields [2-7]. The characteristic equation of a chiral planar waveguide was presented in a very simple form [2]. The results showed the existence of two types of field distributions which were attributed to the working wavelength and chiral admittance. An asymmetric slab waveguide with anisotropic chiral guiding layer was examined [3]. The eigenvalue equation was derived in terms of a pair of parameters related to the eccentricity of the polarization ellipse. The dispersion equations and field profile distributions were investigated for a homogeneous chiral slab waveguide [4]. The energy flow distributions for guided modes of different orders were presented in chiral nihility, a chiral metamaterial in which the permittivity and permeability are simultaneously zero [5]. Characteristics of circular waveguides comprising uniaxial anisotropic chiral material and perfect conducting material were presented [6]. Planar chiral waveguide was numerically solved using the mixed-finite-element method [7].

Propagation of electromagnetic waves in planar waveguide structures containing negative refractive index materials (NIMs) has attracted an increasing interest because of NIMs unusual properties [8-20] and potential applications [21-29] such as absorbers, filters, couplers, antennas, and super prisms. Many peculiar properties of guided waves in NIM waveguides were presented. Among these novel properties, the absence of the fundamental mode, mode double degeneracy and the sign-varying energy flux were found. Surface waves in which the electromagnetic field exponentially decays on both sides of the interface between a normal medium and a NIM were found for both