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Rotation of the Polarization Plane by Double-Layer Planar-Chiral Structures. Review of the Results of Theoretical and Experimental Studies

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Abstract—This article provides examples that illustrate the search for different two-layer metamaterials that provide rotation of the polarization plane ("optical activity"). Selected objects show a twenty-year history of the search for a new principle of creation of polarization rotators based on planar metamaterials that were implemented in the form of thin-layered periodic structures. The manifestation of optical activity, presence or absence of satisfactory or perfect matching, the possibility of a multiband phenomena, the role of high spatial harmonics in "electromagnetics" such effect are explained by the features of the eigen-oscillations that are excited in the gap of the multilayer structure.

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1. INTRODUCTION

The first publication about the so-called metamaterials attracted a lot of attention due to their unexpected application in the microwave technology and optics. Researchers were primarily concerned with the new useful properties of 3D objects with complicated geometry. This became possible due to fast progress in electromagnetic modelling and new abilities to manipulate the 3D form of the objects.

The article focuses on the effect of rotation of the polarization plane that passed through planar-chiral composite structure and the corresponding waveguide iris[1]. The traditional synthesis of polarization transformers is based on creation of the required phase shift between two orthogonal components. This requires significant length of the corresponding transformer. The new transformers that are based on double-layer or multilayer metamaterials "work" using the resonance effects. Their longitudinal dimensions are significantly less than the wavelength. This provides the required transformation in the band up to several percentages.

2. BRIEF HISTORY

Most of the researched configurations are implemented in the form of planar two-dimensional periodic structures of thin metallic patches of different configuration, placed with less appearance frequency than the gaps in metallic screen that is placed in the dielectric layer. They can possess unusual properties, such as

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