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Research paper

A comparative study of 2d nanostructureds chiral photonic crystal connected and disconnected in terahertz (THZ) regime

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Abstract

The 2D nanostructureds Chiral Photonic Crystal (CPC) connected and disconnected in terahertz (THz) regime, on silicon oxide SiO_2 substrates, are comparatively studied via Comsol Multiphysics 5.0. Where properties of this nanostructureds are discussed based on transmission coefficient (S_{21}) and reflection coefficient (S_{11}).

Keywords:*Chiral Photonic Crystal Connected and Disconnected; Nanostructures.*

1. Introduction

In this paper, we will report on our simulation results obtained by COMSOL Multiphysics of connected and disconnected type 2D nanostructured Chiral Photonic Crystal (CPC). At first, we simulated the structures using COMSOL Multiphysics. In a second step, we modified them to visualize and confirm the variation of our results compared to the literature [1-8]. In parallel, we put the our CPC structure into arrays of four elements, in order to study the typical change, and effects connected compared to disconnected nanostructures. A 2D CPC crystal is a structure that (bianisotropic) presents a variation of the dielectric permittivity and the chirality parameter along two spatial directions, whereas they remain invariable along the other direction. There are two types of dielectric periodic structures [1]:

The "connected" structures (Fig.1) [1].

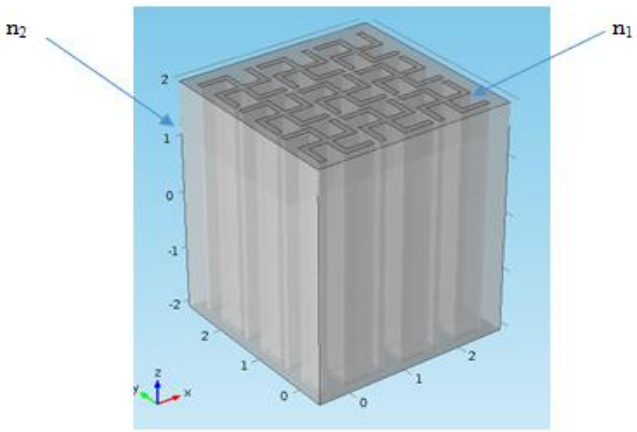

Fig. 1: Connected Periodic Structures 2D [1].

On the other hand, the "disconnected" structures (Fig.2).

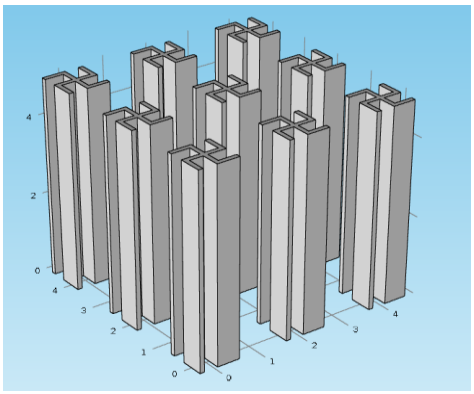

Fig. 2: Disconnected Periodic Structures 2D [1].

2. Results and comments

In the study of CPC nanostructures by COMSOL Multiphysics, we implemented our structures on a substrate, in a waveguide with two ports. Port 1 represents the excitation port by a right circularly polarized wave (RCP) wave, then by a left circularly polarized wave (LCP), and. The second port is kept inactive to prevent reflection of the wave. The same applies to the other faces of the waveguide; they are considered as perfect electrical conductors [1]. The chiral patterns are made of titanium dioxide with $n_g = 2.909$, and the substrate made of silicon dioxide SiO_2 with $n_h = 1.7$ (Fig.3).

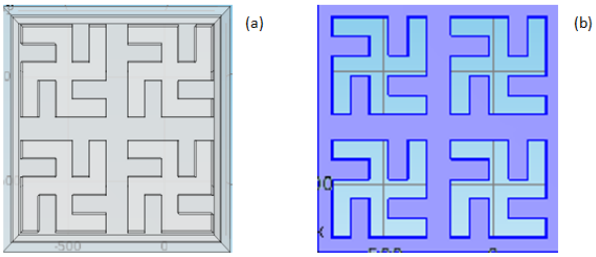

Fig. 3: Nanostructures Chiral Photonic Crystal 500nm Side, 100 Nm High, on A Square Substrate 600nm Side 100nm High where (A) Disconnected and (B) Connected.

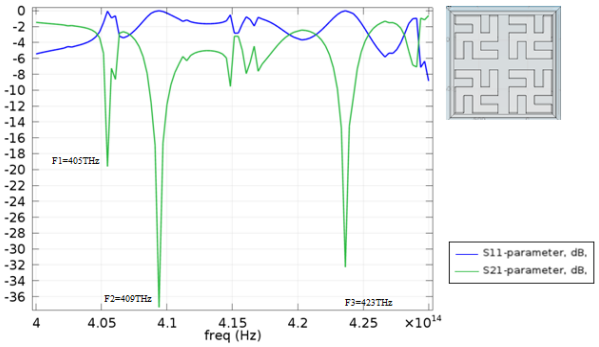

Fig. 4: Parameters S_{11}, S_{21}in Case of Disconnected Nanostructures Polarized by RCP Wave.

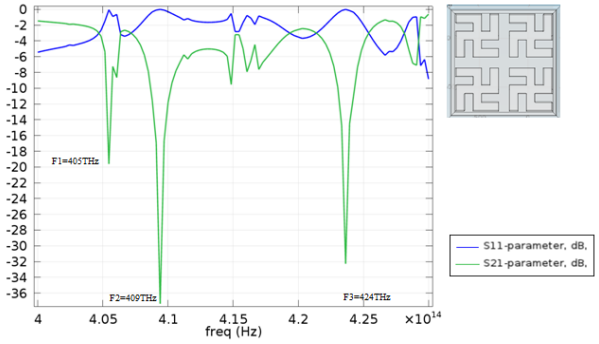

Fig. 5: Parameters S_{11}, S_{21}in Case of Disconnected Nanostructures Polarized by LCP Wave.

Figures 4 and 5 disconnected structures show, the plots of the parameters S_{11} (reflection coefficient) and S_{21} (transmission coefficient) present three clear peaks and dips respectively at the frequencies F_1, F_2 and F_3, with the presence of certain perturbations especially in the frequency window [F_2 , F_3].

On the other hand, the plots (Figures 6 and 7) of the connected structure are distinctly improved. They have windows of smooth transmission of the structure, distinctly separated, which is a good opportunity to investigate novel applications at those well defined frequency range.

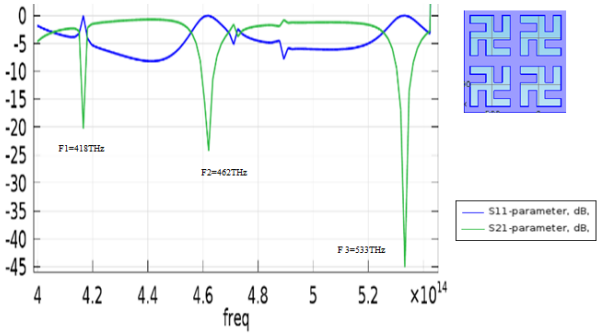

Fig. 6: Parameters S_{11}, S_{21}in Case of Connected Nanostructures Polarized by RCP Wave.

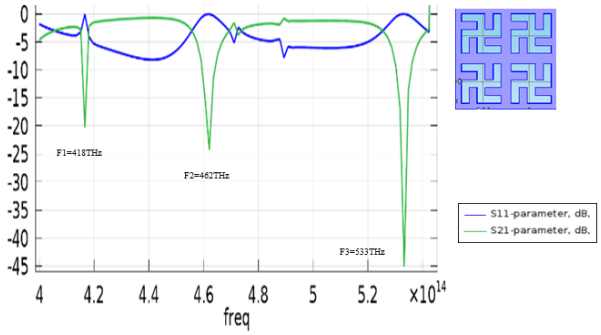

Fig. 7: The Curves of the Parameters S_{11}in Db and S_{21}in Db of Nanostructures Chiral Photonic Crystal Disconnected Polarized by LCP Wave.

Moreover, in the plots of figure 6, we have two interesting and exploitable peaks located at the frequencies F_1 = 462THz and F_2 = 533THz, and their respective quality factors are Q1 = 128 and Q2 = 197. Similarly, for the Arrays polarized by a LCP wave, the two peaks are located at the same frequencies.

3. Conclusions

The results obtained by simulation; have led us to highlight the difference between the effect of connected and disconnected 2D CPC types on the transmission coefficient (S_{21}), the reflection coefficient (S_{11}). Our perspective is to further study their optical properties for possible applications in the field of optical [6-8].

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