San Juan de Pasto, 03 de diciembre de 2019

Profesores
Departamento de Física
Universidad de Nariño

Asunto: Socialización de la comisión académica para el evento XVI Encuentro Nacional de Óptica y VII Conferencia Andina y del Caribe en Óptica y sus Aplicaciones.

Cordial saludo.

Por medio del presente documento hago la socialización de mi participación en el **XVI Encuentro Nacional de Óptica y VII Conferencia Andina y del Caribe en Óptica y sus Aplicaciones (XVI ENO VII CANCOA 2019)**, el cuál se llevó a cabo del 26 al 30 de noviembre del presente año en la ciudad de Montería efectuándose en la Universidad de Córdoba. En dicho evento presenté, en modalidad póster, el trabajo titulado "***Study of Switching of Ultrashort Pulses in Nonlinear Photonic Band Gap Materials***", el cual se presentó el día jueves 28 de noviembre. En dicho trabajo se analizó la respuesta de un cristal fotónico ante la incidencia de un pulso electromagnético con el fin de probar la existencia de brechas fotónicas de energía, encontrándose que existe una periodisidad de las mismas cada cierto intervalo de frecuencia, a la vez que una fuerte dependencia con la diferencia entre los índices de refracción. En el evento fuerón presentados trabajos relacionados con los siguientes tópicos:

- Desarrollo de equipos de instrumentación en óptica.
- Estudios teóricos y experimentales en fotónica y nanofotónica.
- Implementación de técnicas enfocadas a la didáctica de la óptica.
- Aplicaciones de la óptica y la fotónica a diversas áreas, se destaco su aplicación en la medicina.

La apertura del evento se llevó a cabo el día 26 de noviembre y desde esa fecha hasta el 30 de noviembre, se realizaron las diferentes actividades programadas en el cronograma del evento y llevadas a cabo por profesores investigadores en el área y estudiantes de pregrado y posgrado en ciencias, ingeniería y áreas de la salud. El evento fue aprovechado para generar relaciones de colaboración con pares académicos nacionales e internacionales.

Por la atención al presente, anticipo agradecimientos.

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Study of Switching of Ultrashort Pulses in Photonic Band Gap Materials

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XVI ENO VII CANCOA

Abstract

We reviewed the theoretical study by Scalora about the propagation of ultra-short electromagnetic pulses through one-dimensional Photonic Crystals, getting the transmission function of crystals. We found that the expression presented in Scalora's article corresponds to reflection function but not to transmission function. Also, we expanded the range of frequencies to know-how is the periodicity of the photonic band gaps. We saw that periodicity of the photonic band gap is holding for a wide range of frequencies and we calculated this periodicity for determined values of the refractive index. Likewise, we analyzed the affectation of refractive index change in at least one of the component materials of crystal.

Introduction

When a multilayer stack of dielectric material is made in such a way that it has alternating layers of different refraction index, i.e., the system has two materials with index n_1 and n_2, and also it has thickness $\lambda/4n_1$ and $\lambda/4n_2$ respectively, then the dielectric stack became a reflective dielectric coating, such structure is depicted in figure 1.

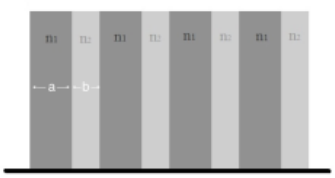

Figure 1: A 1-D periodic array of alternating dielectric layers.

Scalora et. al. calculated the dispersion relation of an ultrashort pulse through a photonic crystal[1], getting

$$cos[k(a+b)] = cos\left[\frac{\omega n_1 a}{c}\right] cos\left[\frac{\omega n_2 b}{c}\right] - \frac{n_1^2+n_2^2}{2n_2n_2} sin\left[\frac{\omega n_1 a}{c}\right] sin\left[\frac{\omega n_2 b}{c}\right] \quad (1)$$

They found, with the transmission function $T(\omega)$, that a larger index difference widens the gap, while a smaller difference narrows it, and so, they concluded that a change of index at least in one of the materials can produce a dynamical change on the gap, which is make in practice with a non-linear material.

Objetives and Methods

In this work, we did an analysis of this system to get the transmission function and expand the range of frequencies to know-how is the periodicity of the photonic band gaps and its properties.

Mathematical Section

According to Scalora's paper, the transmission function for the system described in figure 1 is[1]

$$T(\omega) = 1 - \theta\left\{1 - |cos[k(a+b)]|\right\} \quad (2)$$

which was plotted taking into account equation 1, to obtain the photonic band gaps and the frequency intervals at which they appear.

Results

The graphs of the equations 2 is shown in figure 2-a.

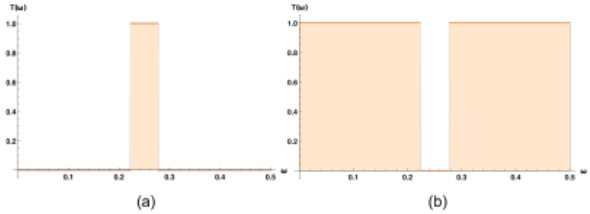

Figure 2: Graphics of transmission function to: (a) equation 2 and (b) equation 3.

The graphic 2-(a) is not the result showed per Scalora in his article, but the equation

$$T(\omega) = \theta\left\{1 - |cos[k(a+b)]|\right\}, \quad (3)$$

it does correspond to the expected, whose graph is shown in the figure 2-(b). Therefore, the graph shown by Scalora in his article does not correspond to the transmission function, so, it must be the reflection function. Also, a greater range of frequencies was analyzed and found that more band gaps exist with a non-dependent periodicity of the refractive index, as shown in figure 3.

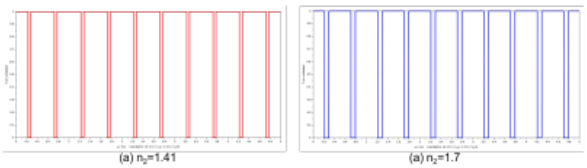

Figure 3: Graphic of transmission function to a greater range of frequencies to different values of refractive index.

Conclusions

- Equation 2 is the reflection function of the photonic crystal.
- Equation 3 is the correct transmision function of the photonic crystal.
- There are more photonic band gaps if we considered a greater range of frequency.

Acknowledgements

The authors of this work thank Universidad de Nariño for logistical and financial support for the presentation of this project into the XVI ENO XVII CANCOA.

Bibliography

[1] M. Scalora, J. Dowling, C. Bowden and M. Bloemer. Phys. Rev. Lett. **73**, 1368 (1994).