RSOFT SOFTWARE IS USED IN THE MODELLING OF COMPUTATIONAL PHYSICS-BASED PHC WAVEGUIDES

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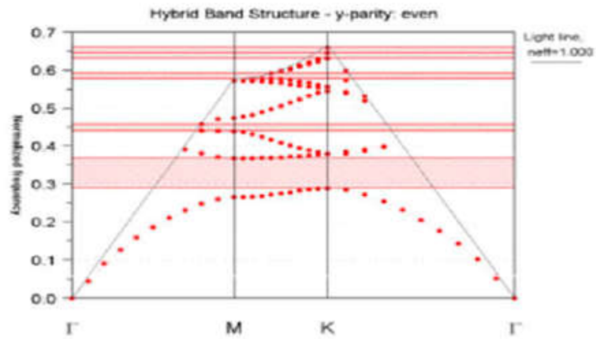
ABSTRACT

With the goal of using applied mathematics to create and research methods for stimulating and resolving physical issues, computational physics is a multidisciplinary field that combines elements of physics, applied mathematics, and computer science (CS). The modeling tools that have been employed for the simulation and study of the different photonic crystal waveguides are briefly described in the computational approaches used in photonic crystals.

Based on the displacement and narrowing methodology, a method for analyzing PhC structures has been devised to create photonic crystal waveguides. By moving narrowed rods into the waveguide's bending zones, the PhC waveguides were fine-tuned. The resulting wave propagation through the waveguide showed that relatively small design areas were enough to yield the wanted improvement in efficiency and the numerical results obtained have shown much improved transmission. The whole design and simulation process including PhC band gap simulation and wave propagation analysis is done using the software RSOFT.

INTRODUCTION

Because of how they interact with light, periodic dielectric structures known as photonic crystals (PhCs) are dubbed crystals. Light is insulated by photonic crystal formations, which have a photonic band gap. Without the need of additional colors or materials, photonic crystal materials may reflect colors with wavelengths that span the entire visible spectrum. Because of the photonic band gap, photonic crystals have the capacity to adjust the state density and group velocity, control spontaneous emission, and locate light via structural flaws (impurities).



Photonic band gap.

The main goal of Photonic crystals has the optical properties of materials. And the ability to prohibit light, direct light or even localized light in desired regions. All these are easily accomplish with the help of photonic crystals. Hence it is placed in science and technology advances today.

Waveguide Design in RSOFT

Waveguides

One of the application of PhCs is to improving the performance of waveguides. Guiding and trapping light using waveguides cavities are the two fundamental optical functions that enable a range of all-optical devices to be created. Waveguides not only perform the tasks of transferring light from one part of a circuit to another, but are used in many other devices such as couplers, junctions and interferometers.

There are various 20 methods for achieving efficient wave guiding and many others for producing high quality optical cavities, but very few single technologies allow both to be engineered in a single integrated structure. Two dimensional photonic crystals can provide just such a combination due to their versatile geometry that allows simultaneous fine tuning of a number of parameters. And the 3D PhCs could potentially provide even greater control over light and to achieve full 3D band gaps. hence waveguides in PhCs by introducing defects was recognized.

Design in RSOFT

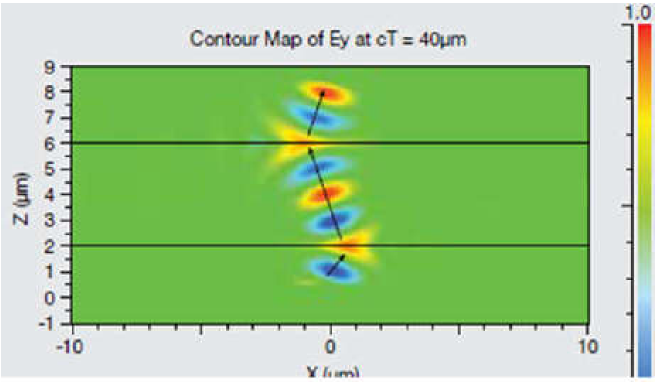
The RSoft CAD is the core program and acts as a control program for RSoft‟s passive device simulation modules. Such as FullWAVE. It is used to define the most important input required by simulation modules: the material properties and structural geometry of a photonic device. It is needed to first design a structure in the CAD interface and then use one or more simulation engines to model various aspects of the device performance. In this work, at first,

a. Band SOLVE: module has been used to calculate band gap regions of the desired photonic crystal waveguides. The band gap region gives the required operational wavelengths that can be used to execute. Band SOLVE can be applied to find the time-independent modes of any lossless photonic structure

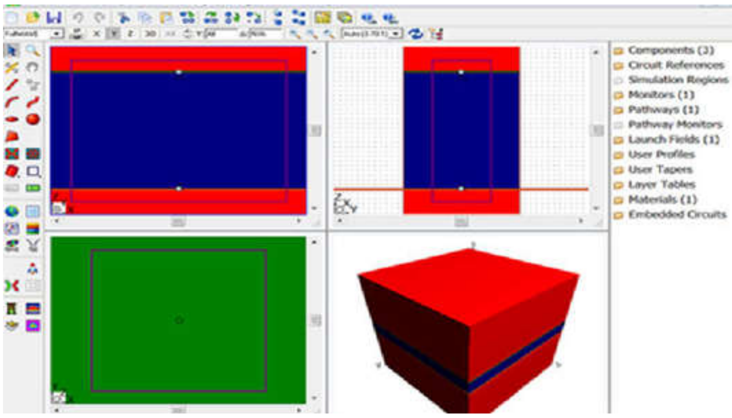
b. Full Wave simulation and allow the propagation of light waves transpire throughout the desired waveguides. Secondly, Full WAVE simulation program is used to compute the propagation of light waves through Z bend, Y bend and Z bend photonic crystal waveguides. It is a simulation package for computing the propagation of light waves in arbitrary waveguide geometries. This simulation is based on the well-known finite-domain time difference (FDTD) technique. This technique is based on direct numerical integration in time of Maxwell‟s equations.

FullWAVE device simulation tools

Demonstration of negative refraction with propagation of a beam



FULLWAVE stimulation in RSoft Cad



This structure is composed of three segments, all of which are defined using the same base TN anisotropic material. The crystal axis of this material is rotated around the Z axis to produce the Photonic crystal structure, and is matched between the segments to create a uniform material. The crystal axis of each segment is rotated around the Z axis (Psi) as follows:

Input Segment (bottom red)

This segment is defined via the material with a constant Crystal Axis orientation (Psi = 0 degrees).

Photonic Segment (dark blue)

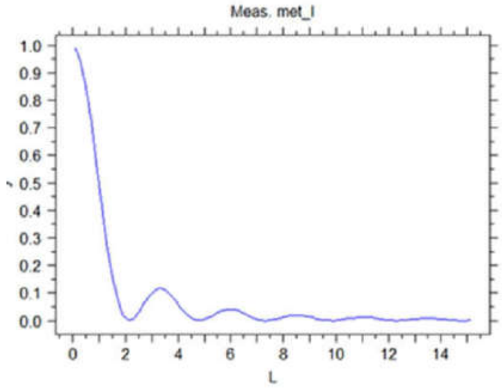
This segment is defined via the Photonic material with a linearly tapered Crystal Axis orientation (0 → Psi → 90). Later, we will study the transmission of the device as a function of the length of this segment.

Output Segment (top red)

This segment is defined via the Photonic material with a constant Crystal Axis orientation (Psi = 90 degrees).

The excitation field is a plane wave with a wavelength of 0.6328µm. Our aim is to measure the transmitted power in the Photon segment.

Using RSoft to calculate FullWAVE measure and the transmittance of the device



In this work, a number of photonic crystal waveguide structures and devices have been designed and analyzed and identified the basic physical effects that determine their behavior.

Conclusion

Designing Z- and Y-shaped photonic crystal waveguides as well as introducing displacement and narrowing processes are the key goals. Using the programmed RSOFT Cad, the waveguide's design and analysis were carried out. Interesting results have come from simulations that include adding x, y, and z flaws to an otherwise flawless lattice.

The measured transmission spectrum has been standardized to a transmission spectrum for a straight PhC waveguide of the same length while Z flaws are introduced. RSOFT software has been used to complete the work utilizing a trial-and-error methodology. The employment of advanced methods for optimization, such as simulated annealing fabrication technology, geometry projection optimization method using COMSOL, and topology optimization method using MATLAB, has become popular in recent years. Now-a-days in different structures, PhC is added to suppress the multimode output signal. So, the ultimate goal to design such PhC for the different device structure likes Semiconductor Laser

References

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