Validation Report

Name of Report	Comparison of CrystalWave FDTD engine with Rosenberg et al
Performance Date	10th Aug 2006
Performed By	Dominic Gallagher
Product Name	OmniSim, CrystalWave
Product Version & Compile Date	
Files	Rosenberg-FDTDvalidation.prj
References	A. Rosenberg et al. *"Guided resonances in asymmetrical GaN photonic crystal slabs observed in the visible spectrum"*, Vol. 13, No. 17 / OPTICS EXPRESS 6564, 2005

Comparison of CrystalWave FDTD engine with Rosenberg

Report Summary

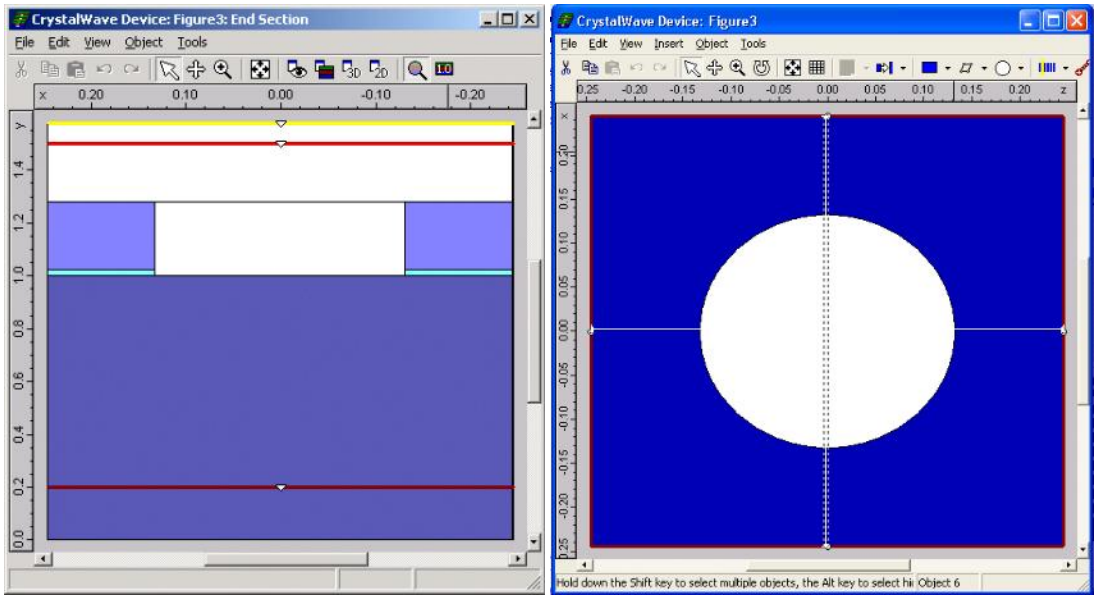
This study simulates the optical transmission through a photonic crystal membrane, using CrystalWave's FDTD engine and compares it with results published by Rosenberg et al.

1. Description of Test

This is a 3D FDTD simulation with periodic boundary conditions on 4 faces. The structure is a GaN membrane, perforated with a square lattice of holes. The simulation computes just one unit cell of the membrane, surrounding it by periodic boundary conditions. Light is launched from above and the transmitted light recorded.

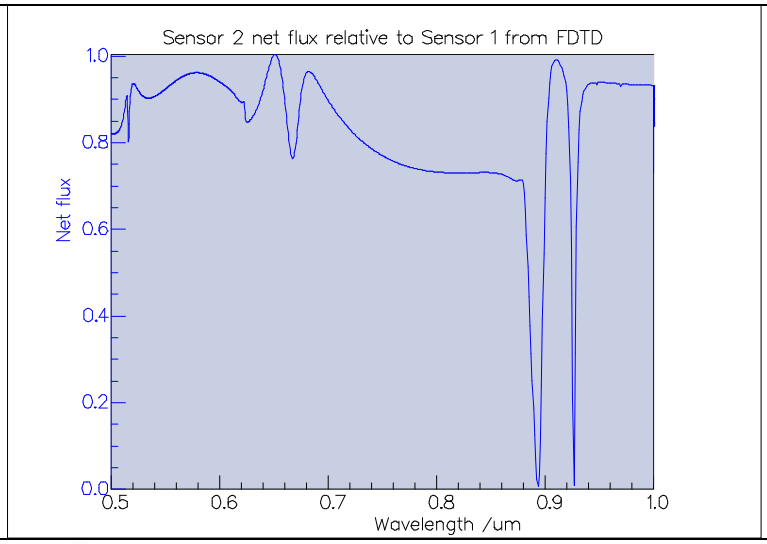
Simulations were done with the following parameters:
Lattice spacing (a): 0.49
FDTD Grid Size: a/50
FDTD run time: 2500fs
Sensor time undersampling: 12
Top/Bottom PMLs: 8 cells (default values)

Note: it is important to keep the bottom PMLs far away from the holes. The PMLs must not interact with the lateral propagating Bloch modes since they do not absorb light travelling parallel to them and in fact will slightly amplify parallel light (this is a known problem with PMLs).

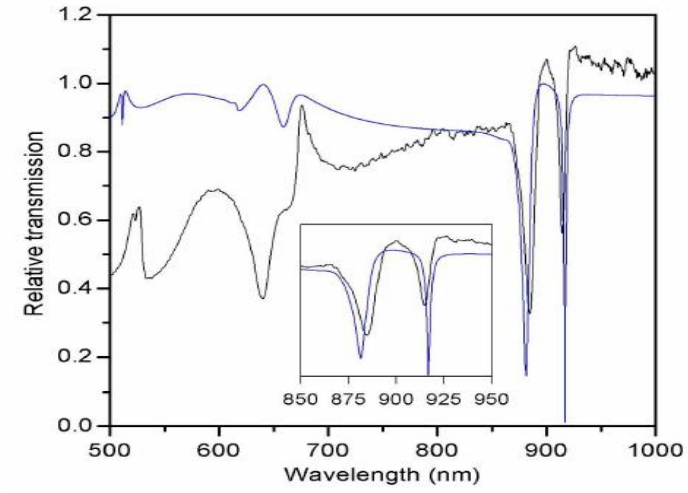


Above: (left) vertical section of structure showing position of excitor (yellow) and sensors (red). (right) plan view of structure, as constructed in CrystalWave.

2. Results



Left: CrystalWave result for transmission thru crystal. Plotted is the net flux through the lower sensor relative to the flux measured through the upper (reference) sensor.



Left: Figure 2 reproduced from Fig3 of [1]. The blue line (topmost for left half of the graph) is the theoretical result and the second line is the measurement.

3. Conclusions

The CrystalWave FDTD results bear a very close relationship to the Rosenberg published results. The simulation tests the following features:

- 3D-FDTD engine
- Sensors and time-to-frequency Fourier Transform algothms
- Periodic Boundary Conditions

4. References

[1] A. Rosenberg et al. *"Guided resonances in asymmetrical GaN photonic crystal slabs observed in the visible spectrum"*, Vol. 13, No. 17 / OPTICS EXPRESS 6564, 2005