Validation Report

Name of Report	A comparison of photonic bandgap microcavities calculated by OmniSim with published data.
Performance Date	15 th September 2004
Performed By	Stephen Day
Product Name	OmniSim
Product Version & Compile Date	Version 1.1.2, Compiled: 3rd September 2004
References	J. S. Foresi et al, Photonic-bandgap microcavities in optical waveguides, Nature v390, 13 Nov 1997 p 143-145
External Files	Microcavity.prj

A comparison of photonic bandgap microcavities calculated by OmniSim with published data.

1. Report Summary

This report compares the performance of three dimensional finite difference time domain with published literature. A high index waveguide containing an array of etched holes is simulated and the results compared.

2. Device Description

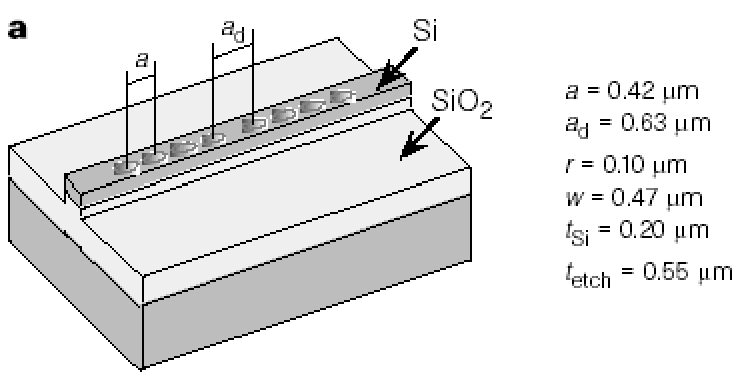

Figure 1: Waveguide microcavity.

Figure 1 above shows a microcavity based upon a silicon on silica waveguide. The dimensions of the waveguide are given in figure 1. A series of holes with a period of 0.42 um is etched into the silicon waveguide to create a photonic bandgap. A central defect is introduced into the periodic structure by having a gap of 0.63 um, between the two sets of holes. This structure then acts as a resonant microcavity.

Photon Design have two Finite Difference Time Domain tools that could be used to study this device. OmniSim is designed for studying waveguides and has a sophisticated editor for defining a wide range of waveguide shapes and joining shapes together whilst CrystalWave is designed for studying two dimensional photonic lattices and has sophisticated tools to allow the lattice to be simply defined and for defects to be introduced. Either program could be used to define the required structure, in this example OmniSim has been used. The diagram below shows a cross section of the waveguide device. The rectangular pink region is the silicon core where the light propagates, the green and blue are air and the darker pink is the silica.

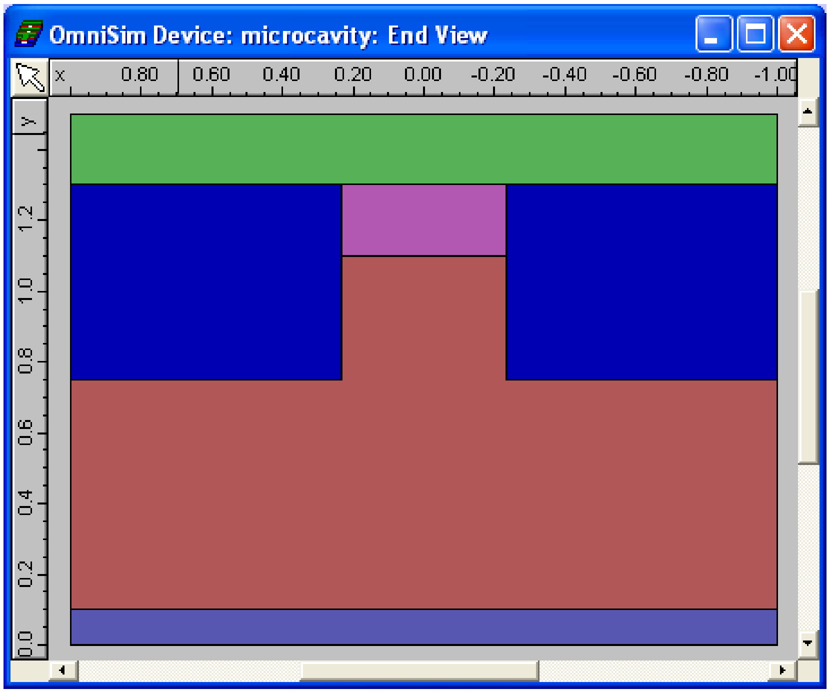

Figure 2: Cross section of Waveguide

The waveguide dimensions were taken from the paper as follows, width=0.47 um, silicon thickness=1 um, silica thickness =1 um, etch depth = 0.55 um. The refractive index was taken to be silicon=3.478 and the silica was 1.45. The microcavity was produced by etching holes 0.2 um diameter on a 0.42 um pitch, the gap between the two sets of holes. The diagram below shows a cross section of the waveguide through the centre of one of the etched holes. The red region represents the etching.

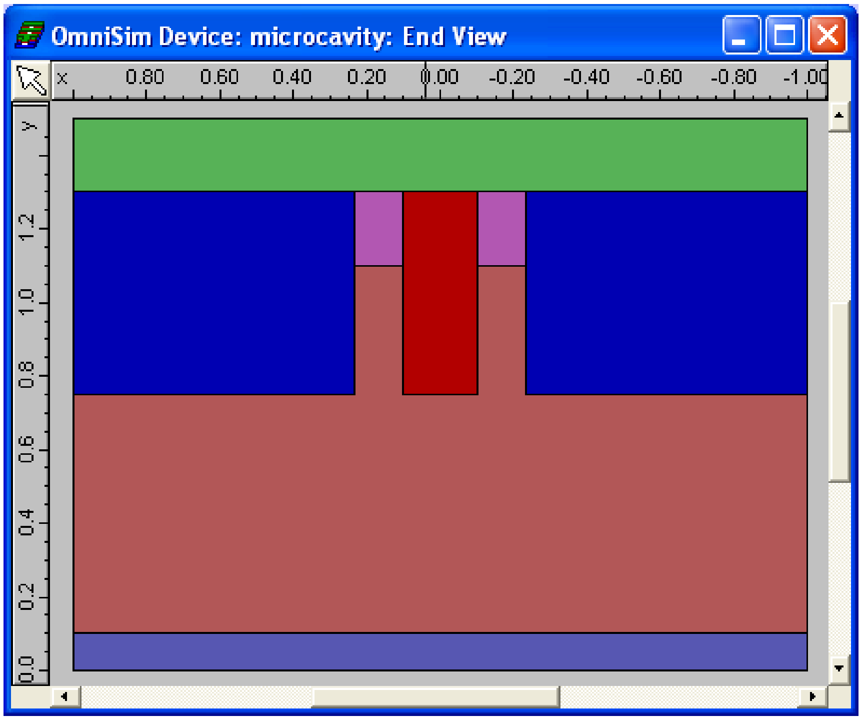

Figure 3: Cross section of waveguide including etched hole

The diagrams below shows a top view and a side view of the structure studied. These views are easily accessed and give a quick way of confirming that the structure has been correctly set up.

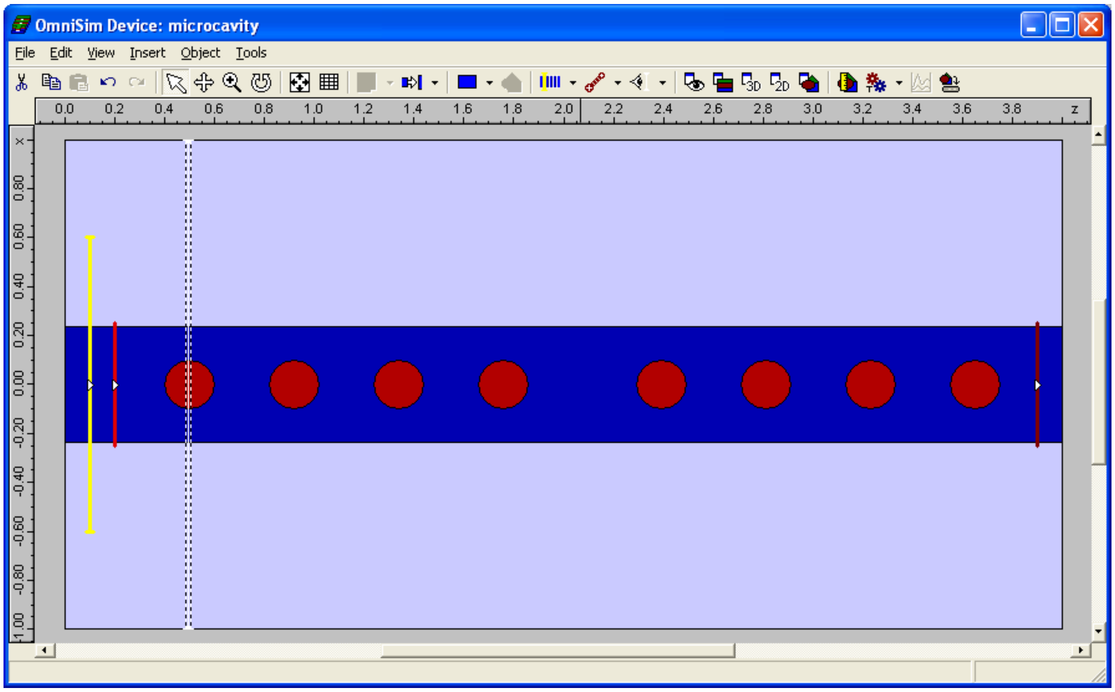

Figure 4: Top view of microcavity device

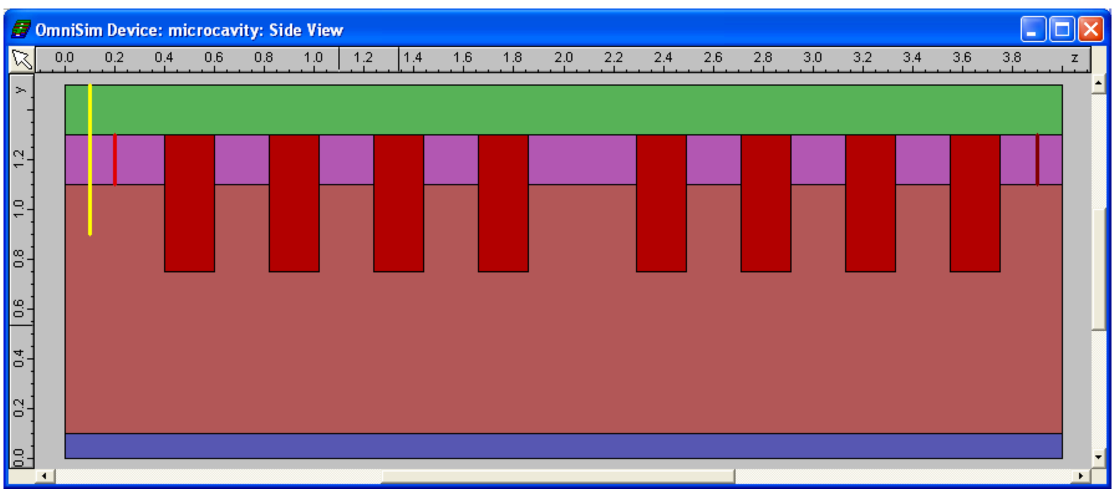

Figure 5: Side view of device

3. Results

The device was simulated in 3D using the OmniSim Finite Difference Time Domain engine. The simualtion was performaed using a 2 Ghz PC with 2 Gbytes of memory, with 32768 time steps and a grid resolution of 0.02 um. The simulation required 440 Mbytes of memory and took 2 hrs 20 minutes. Figure 6 shows the OmniSim result and figure 7 shows the result from the literature. There is very good agreement between the results. Not only does OmniSim accurately predict the position of the peak, but also the features at both the short and long wavelength regions are reproduced.

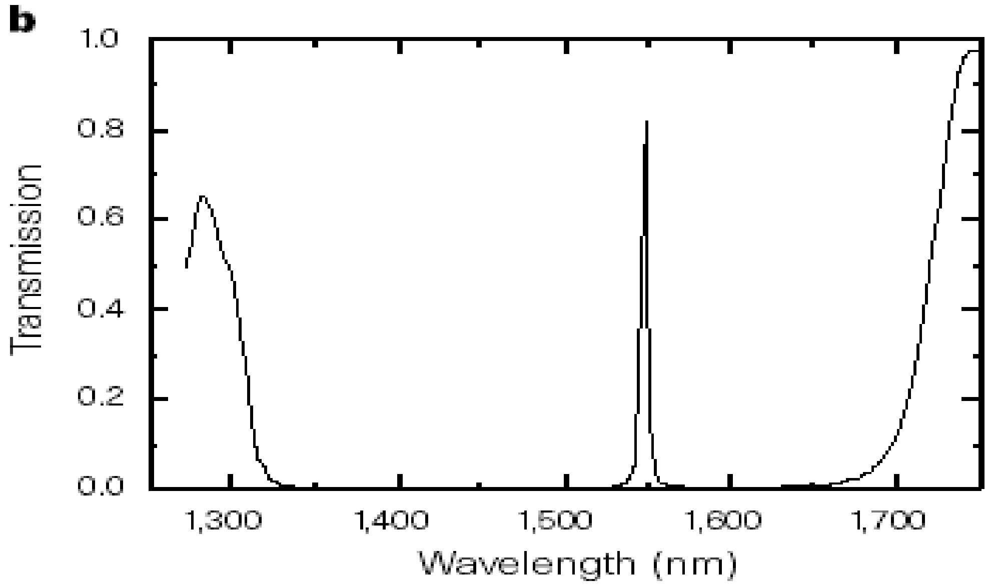

Figure 6: Results from reference 1

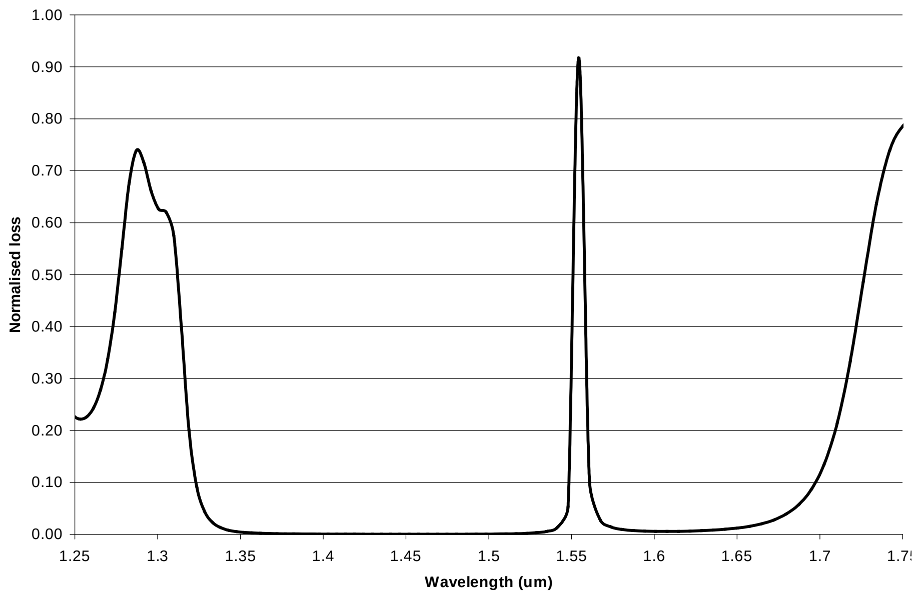

Figure 7: Response of microcavity calculated with OmniSim

References

1) J. S. Foresi et al , Photonic-bandgap microcavities in optical waveguides, Nature v390, 13 Nov 1997 p 143-145