CrystalWave Examples

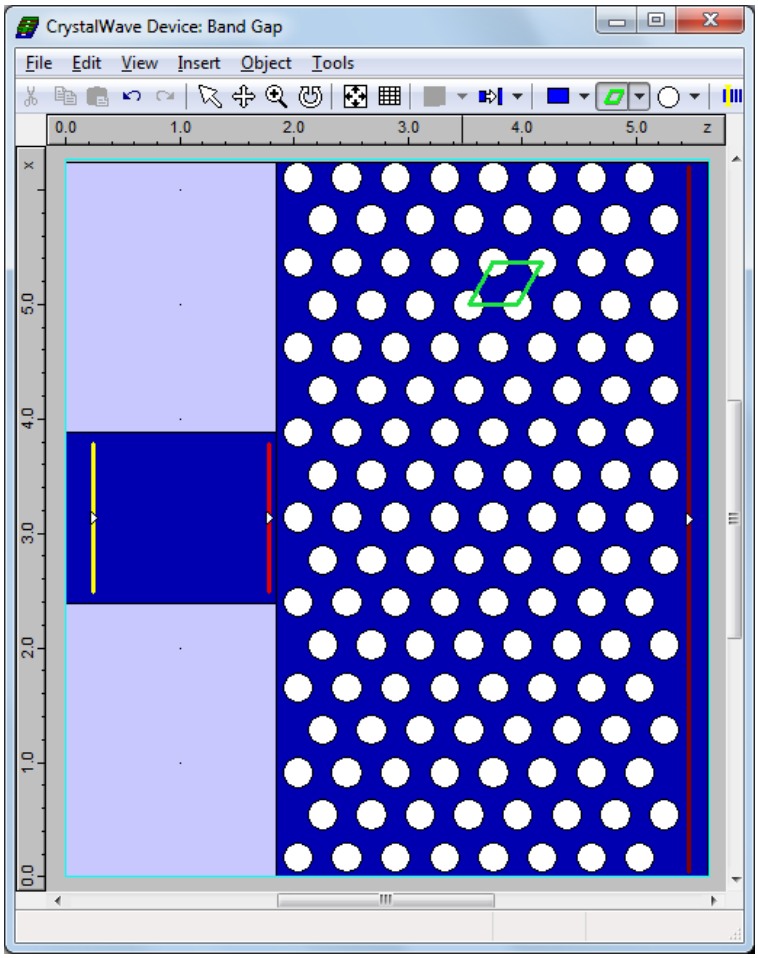
Calculating a Photonic Crystal Band Gap

PCBandGap.prj

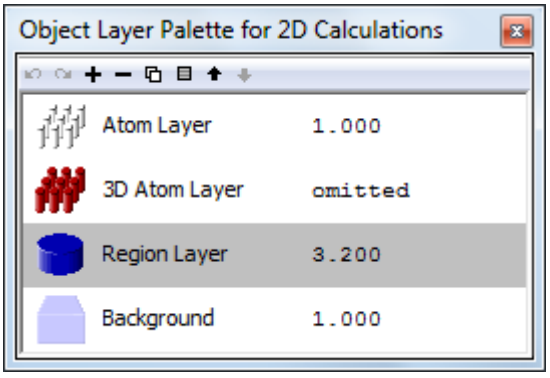
Calculating a photonic crystal band gap with Crystalwave

➢ Open the project PCBandGap.prj in CrystalWave and double-click on "Band Gap".

The CrystalWave Device will open. The structure is a photonic crystal to which a waveguide is attached. The lattice period is set to 0.4284um and the hole diameter to 0.25969um.



➢ Go to the menu and select /View/Object Layer Palette for 2D calculations.



This palette tells you how the structure is defined for 2D calculations. In this case the dark blue areas have a refractive index of 3.2 whilst the white holes and the pale blue background have a refractive index of 1.

The yellow line is a plane wave excitor from which a pulse of light centred on a wavelength of 1.55um will be launched. The red lines are sensors, which will monitor the field during the calculation.

We will now run a 2D FDTD calculation on this structure.

- Go to the menu and select /Tools/Calculator/FDTD Calculator…

Notice that GridType has been set to "Match Lattice". This allows the FDTD Engine to use a grid that matches the crystal lattice, speeding up calculations significantly.

Also, notice that GridSpacing is set to 0.026775. To ensure that the grid matches the periodicity of the lattice the GridSpacing should be a fraction of the lattice period. Here it is 1/16th.

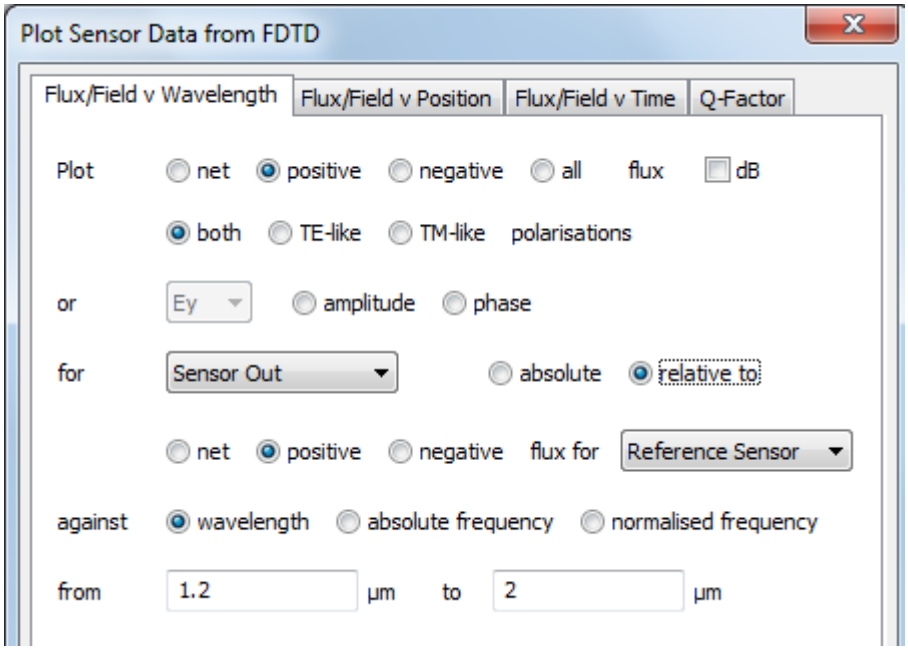
- If you are working on a computer with multiple CPU cores, go to the "SMP" or "Cluster/SMP" tab. Make sure that "SMP (No cluster)" is selected in the drop-down menu and select your computer in the list, then click on the "+" button until it is disabled to add enable as many CPU cores as available for the calculation.
- Before starting the calculation, go to the "Controls" tab.

CrystalWave allows you to plot the field and intensity evolving in the time domain during the calculation.

- Select "Show Hy every 16 steps".
- Click on **Calculate** to launch the FDTD calculation. The Hy field profile will be plotted every 256 steps, allowing you to see some of the light reflected by the photonic crystal and some of it travelling through.

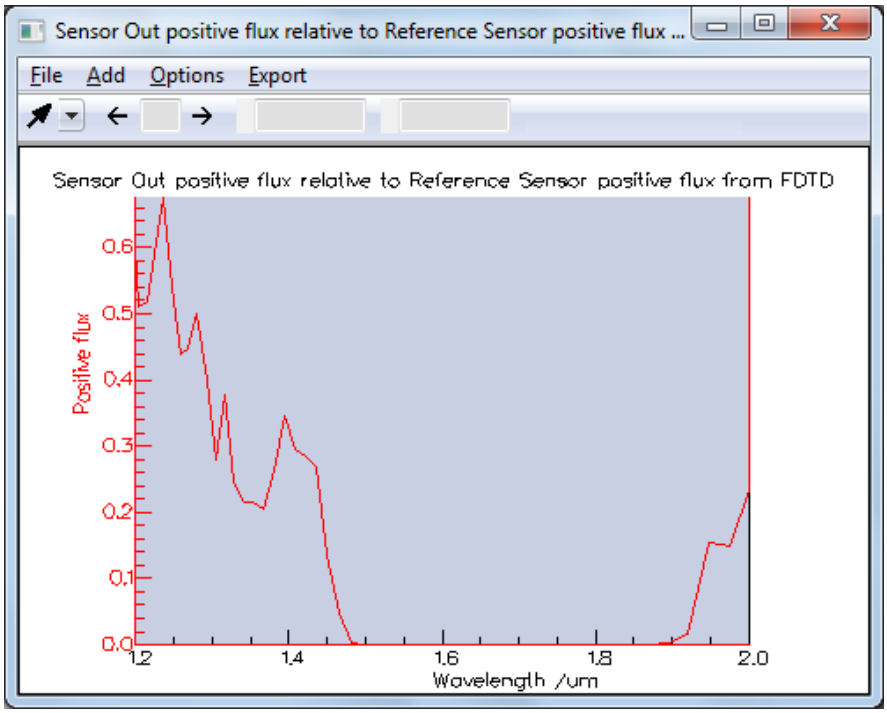
During the calculation you can select other field components or the intensity, adjust the brightness and the plotting rate. After a while you can set the plotting rate to "none" to speed up the calculation. From this panel you can also easily record videos of your FDTD calculation.

- Once the calculation is complete, click on **Close**.
- In the CrystalWave Device, go to the menu /Tools/Sensor/Plot Data…
- In the tab "Flux/Field v wavelength", select the "positive flux for both polarisations for Sensor Out relative to the positive flux for Reference Sensor against wavelength from 1.2 to 2um".



➢ Click on **Plot**.

The following plot will appear, showing a photonic crystal band gap between 1.5 and 1.9um.



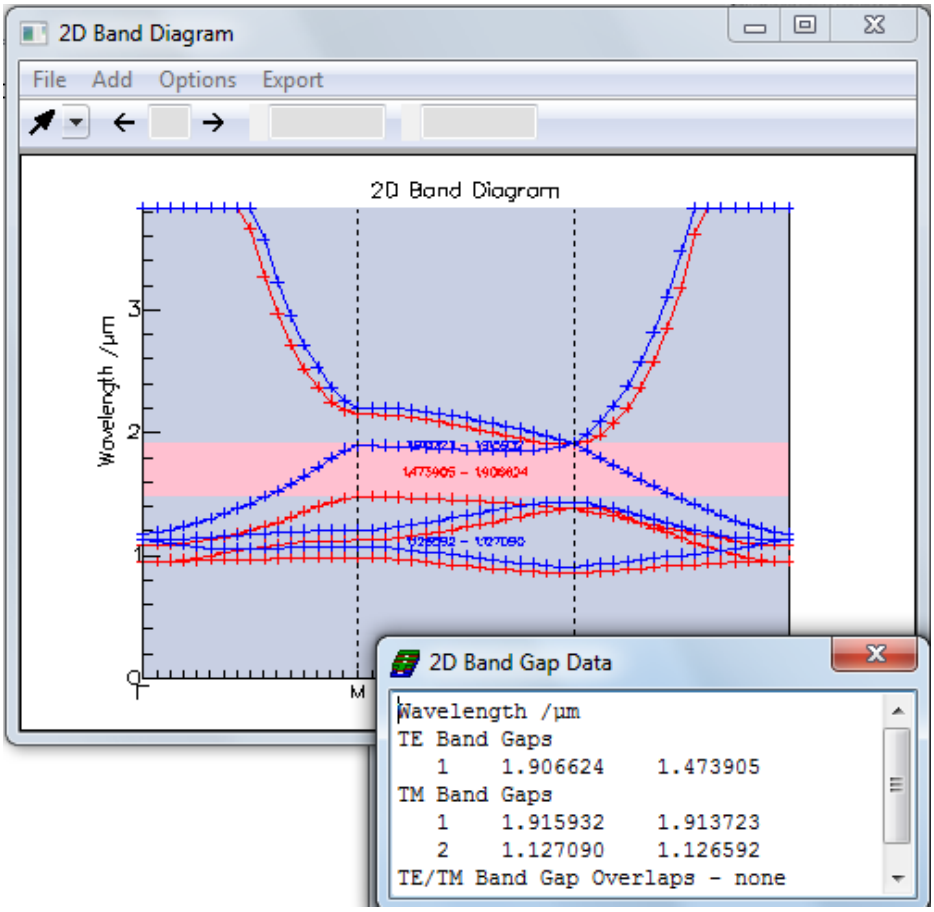
We will now characterise this further using the CrystalWave Band Solver.

➢ In the CrystalWave Device, right-click on the green unit cell and select \Band Solver…

The "Band Solver for 2D Lattices" will open.

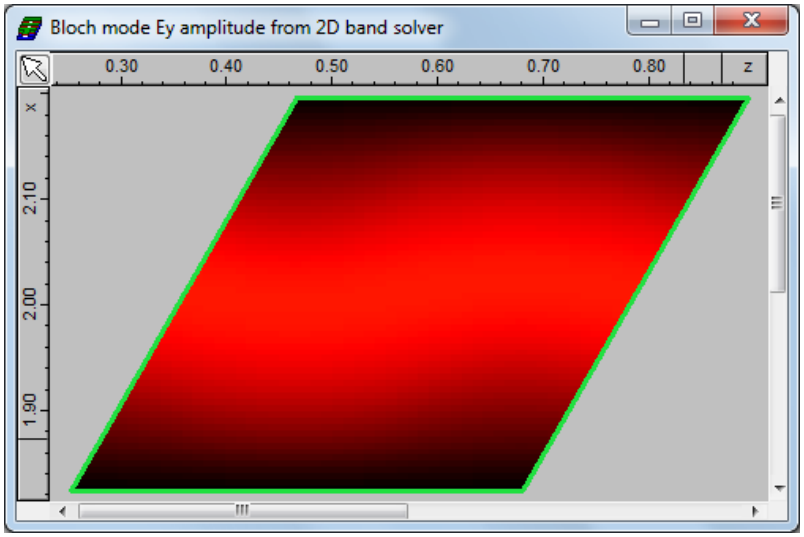
➢ Click on "Calculate".

After a little while, a 2D Band Diagram will appear, showing a TE band gap (pink area) between 1.47um and 1.90um.



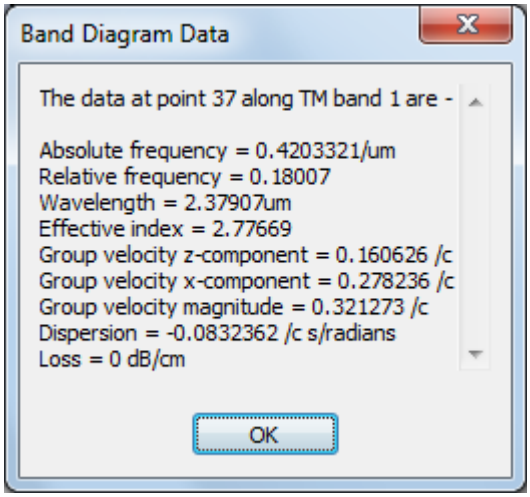
➢ Click on the Band Diagram to select a band. Then right-click on a point of the band and select \Show Bloch mode.

This will display the Bloch mode for this point in the band.



➢ Right-click on a point of the band and select \Show All.

This will display the optical properties of the mode at this point.



Band diagrams and FDTD calculations can also be performed in 3D. To repeat this simulation in 3D simply open the FDTD Calulator or the Band Solver for 2D Lattices again and set NumDimension to "3D" before clicking **Calculate**. Depending on the specifics of your PC this could take significantly longer.