Helmholtz solver with transparent influx boundary conditions and nonuniform exterior

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Background

In today's integrated optics design, many different simulation methods are employed. A common feature of these methods is the fact that the simulations are performed on a limited calculation window, enclosed by suitable boundary conditions. Beyond configurations where the exterior is uniform or where waveguides leave the domain through its boundary, this paper describes a quasi-analytical method that can handle problems with arbitrarily nonuniform exteriors. Figure 1 shows an example of a finite element frequency domain simulation window, where properties of the solutions on the exterior are incorporated into the boundary conditions. The solution on the exterior is represented by a different, efficient calculation method, Bidirectional Eigenmode Propagation (BEP).
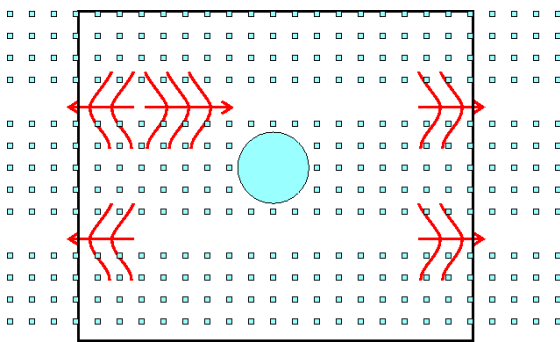
Results

When inserting light into the structure of Figure 1, the dependence of the amplitudes of the outgoing Bloch modes on the refractive index of the disk is as shown in Figure 2.
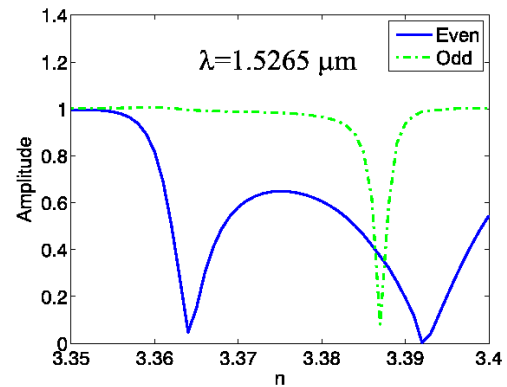

Figure 2: *Amplitudes of even and odd Bloch modes at the eastern boundary of Figure 1, vs the index of the disk*

At n= 3.388, both even and odd Bloch modes have low amplitude; nearly all light is routed to the bottom left output port, see Figure 3.
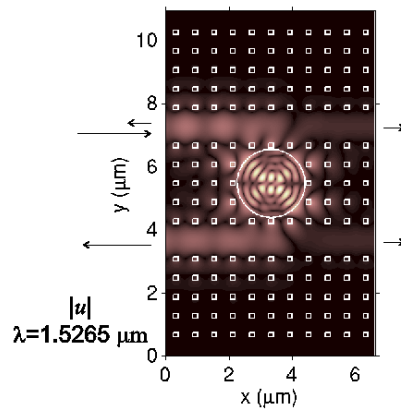

Figure 1: *Problem with nonuniform exterior. Outside the window, the refractive index is not homogeneous. The photonic crystal consists of silicon (n=3.4) pillars in air (n=1.0); the pitch is 600 nm, the pillars are 150 nm wide. The disk has a radius of 1075 nm.*

Figure 3: *Abs. value of field at n=3.388*