Optiwave

OptiBPM
Waveguide Optics Design Software

# Electro-Optic Modulator Design

Applications

Modelling, simulation, and design of

- Optical fibers
- Optical waveguides
- Photonic crystal fibers
- Mach-Zehnder interferometers
- AWG couplers
- Optical splitters and combiners

Overview

OptiBPM is a comprehensive CAD environment used for the design of optical waveguides. Based on the Beam Propagation Method (BPM) of simulating light passage through any waveguide medium, OptiBPM allows designers to observe computer-simulated light field distribution. The radiation field and the guided field are observed simultaneously. OptiBPM can improve a design engineer's productivity, reduce risk, and lower overall costs related to the design of waveguide solutions.

Electro-Optic Modulator Design
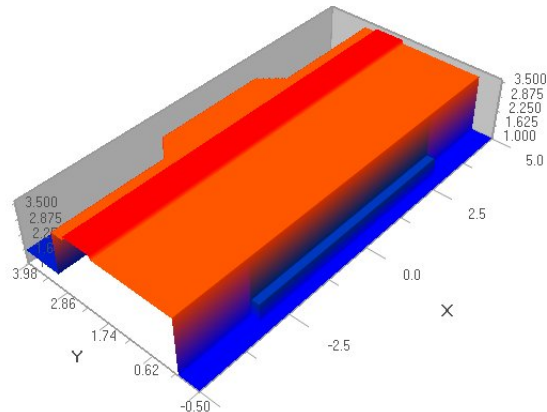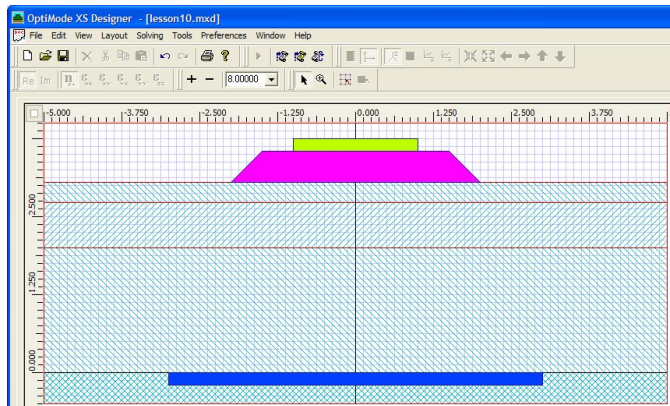
Benefits

- Significantly reduces product development costs and boosts productivity through a comprehensive design environment to help design, test, and simulate optical components.
- Interfaces with other popular design tools such as Code V, Zemax, and dw-2000

- Parameter scanning enables study of trade-offs with respect to parameters of interest and to choose an optimal design

Simulation Description

The material system for this example is AlGaAs. The ridge structure forms a waveguide and supports TE and TM waves, although only the TE mode will be focused on in this example.

The electrodes are metal and do not significantly intersect the guided mode. When the electrodes have a potential difference, a mostly vertical electric field appears in the material that supports the optical mode. The refractive index of the material is modified slightly by the electro-optic effect. The effect is small, but it can make a significant difference in the phase of the optical wave after propagation over a long distance, on the order of one cm.
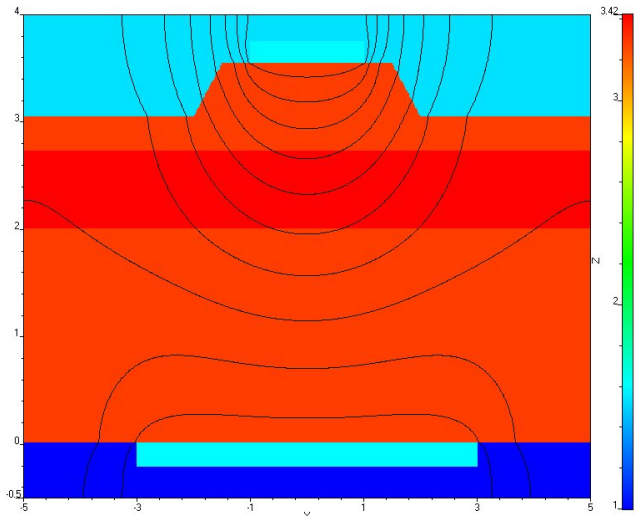

The electro-optic tensor (r) for GaAs has non-zero components $r_{41} = r_{52} = r_{63}$ in the crystal coordinate system. However, for this device the waveguide axis is rotated in the XZ plane by 45° relative to the crystal axis, so a vertical (parallel to Y) electrostatic field affects the TE mode by an electro-optic coefficient equal to r_{41}. In this example we will simulate a TE mode, so r_{41} is used as r_V, the vertical electro-optic coefficient:

The lines have constant potential. Basic electrical properties of the electrodes, such as capacitance and travelling wave impedance are estimated from this field pattern.

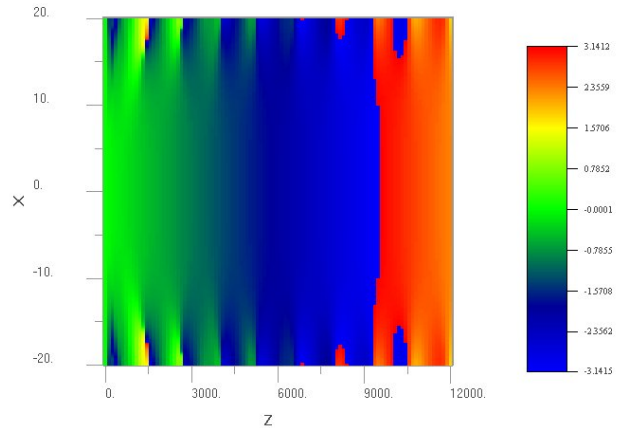$$n' = n + \frac{n^3}{2}\left(r_H E_H + r_V E_V\right)$$

The refractive index is changed by the horizontal and vertical components of the electric field according to the above equation.

To calculate the electric field, the electrodes (green and blue rectangles in the layout diagram) are set to the given potentials. OptiBPM finds the electric field with knowledge of the material permittivity by solving the Laplace equation:

The waveguide can be analyzed by the Beam Propagation Method. In the Optiwave display, one can watch the optical phase instead of optical amplitude. Under the influence of the electric field, the optical field is shifted 180 degrees within 9 mm of propagation.

$$\frac{\partial}{\partial x}\left(\epsilon_{XX}\frac{\partial V}{\partial x}\right) + \frac{\partial}{\partial y}\left(\epsilon_{YY}\frac{\partial V}{\partial y}\right) = 0$$

OptiSPICE
Opto-Electronic Circuit Design Software

OptiSystem
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OptiBPM
Waveguide Optics Design Software

OptiFDTD
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