

Leaky Modes in a Multilayer/Rib Waveguide

Introduction

Tool used: FemSIM

This example uses FemSIM to solve for the leaky modes supported by a multilayer GaAs and AlGaAs waveguide [1]. It discusses how to distinguish between highly lossy substrate radiation modes and the leaky guided modes of interest.

Structure Overview

This waveguide is a multilayer rib structure that is deep-etched on top of a GaAs substrate. The core and claddings of the device are composed of layers of AlGaAs with different alloy concentrations in order to provide confinement. Due to the large index of the substrate, we will see leakage into the substrate. We will solve for the modes of the waveguide at a wavelength of $1.064\text{ }\mu\text{m}$, where the index values at a wavelength of $1.064\text{ }\mu\text{m}$, along with AlGaAs alloy compositions as appropriate, are: $n_1 = 3.4804$ (GaAs), $n_2 = 3.3675$ ($x=20\%$), $n_3 = 3.4519$ ($x=5\%$), $n_4 = 3.3955$ ($x=15\%$), $n_5 = 3.4434$ ($x=6.5\%$). The cover material is air ($n=1$).

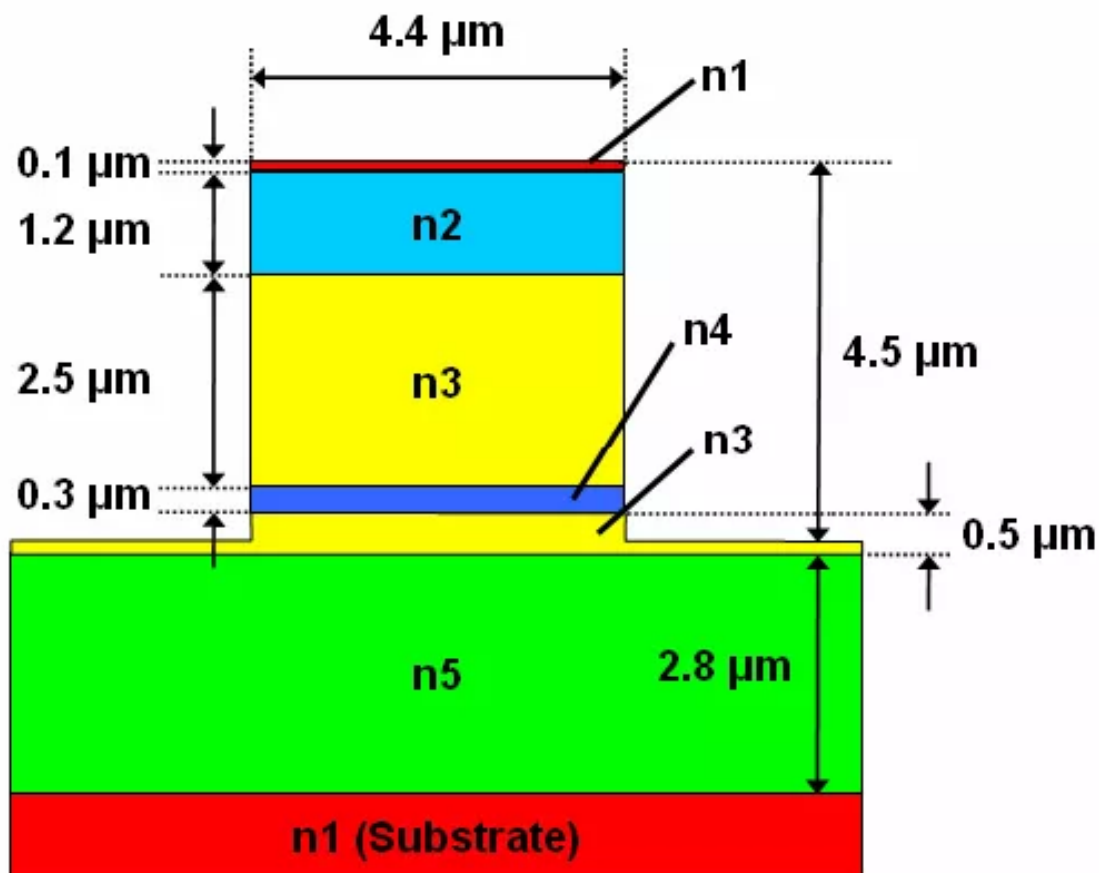


Figure 1. Waveguide structure overview

Calculating the First and Second Modes for Both TE and TM Polarizations

A nonuniform mesh and PML (perfectly matched layer) boundary conditions are used, since we are looking for lossy modes. Note that the polarization of the modes is found by looking at which field component is primary. RSoft's convention is that modes primarily defined along X are therefore TE, and modes primarily defined along Y are TM. At the end of the simulation, the modes found can be viewed using the buttons in the FemSIM simulation window toolbar. The first two modes are the same fundamental modes.

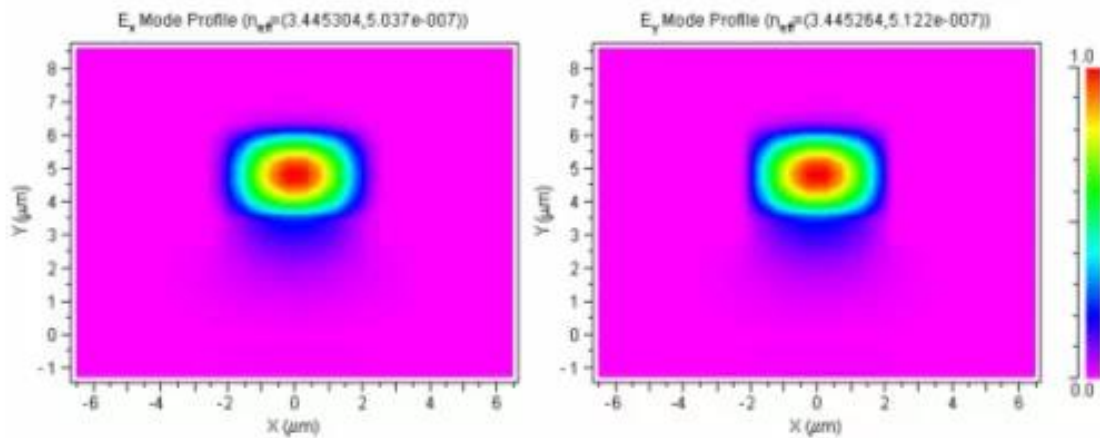


Figure 2. Left: Fundamental TE mode profile. Right: Fundamental TM mode profile.

The second order modes are:

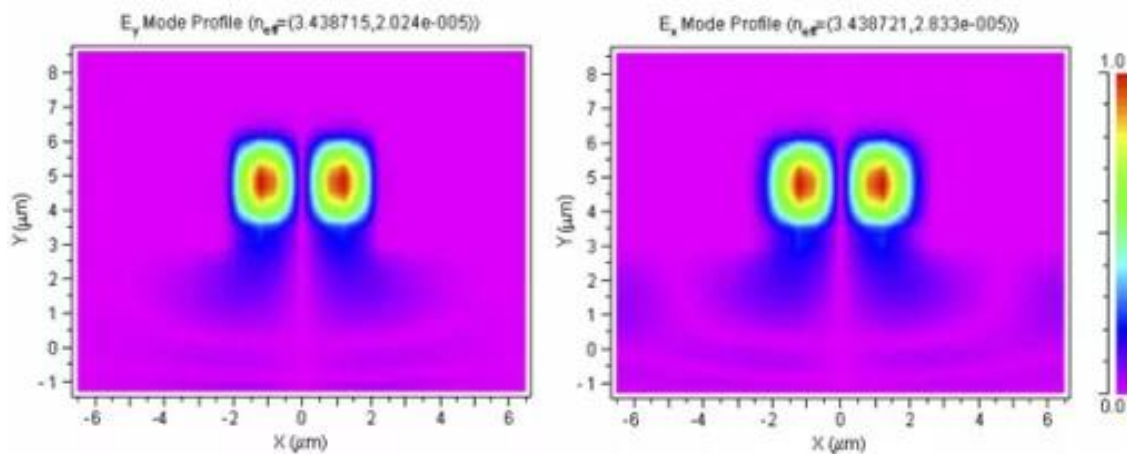


Figure 3. Left: TM mode profile. Right: TE mode profile.

References

- [1] J. Heaton, M. Bourke, S. Jones, B. Smith, K. Hilton, G. Smith, J. Birbeck, G. Berry, S. Dewar, and D. Wight, "Optimization of Deep-Etched, Single-Mode GaAs/AlGaAs Optical Waveguides Using Controlled Leakage into the Substrate," *Journal of Lightwave Technology*, 17, (1999) 267-281.