

Modeling Strain Effects in a Ridge Waveguide

Introduction

Tool used: Multi-Physics Utility

Strain can be an important factor in the performance of many types of devices. For example, it can induce birefringence in optical fibers, which can change the differential group delay (DGD) between polarization modes, and affect the behavior of fiber sensors or polarization-maintaining (PM) fiber amplifiers. Strain can result from the fiber fabrication process and may be intentionally introduced or naturally occurring. It can also result from (or be controlled by) the thermal environment in a waveguide device comprised of materials with different expansion coefficients.

The **Multi-Physics Utility** may be used to analyze the elasto-optic effects due to strain. While strain is the focus of the following example, it should be noted that the Multi-Physics Utility is also capable of simulating electro-optic, thermo-optic, and carrier-induced effects. Furthermore, all the material parameters for these physical processes may be found in the Material Library that is distributed with the software. Lastly, the effects resulting from Multi-Physics analysis may be utilized by any of the simulation engines in the device tool suite, such as **BeamPROP**, **FullWAVE**, or **FemSIM**.

Device Layout

In the following example, a buried ridge waveguide has been implemented with Si in SiO_2 . The waveguide dimensions are 2 mm wide by 2 mm high with a 1-mm-thick off-ridge layer thickness.

Simulations show the results of the anisotropic strain calculation along with the commensurate change in the refractive index profile. Subsequent mode calculations, with and without the effects of strain, indicate a change of about 0.0016 in the effective index of the fundamental mode.

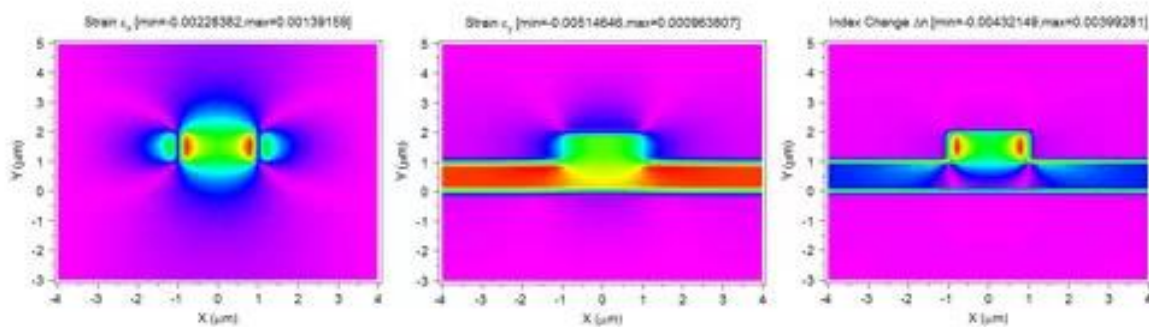


Figure 1. Strain calculation for a silicon ridge waveguide buried in SiO_2 . Shown here are the x (left) and y (middle) components of the strain profile, and the corresponding index perturbation (right).

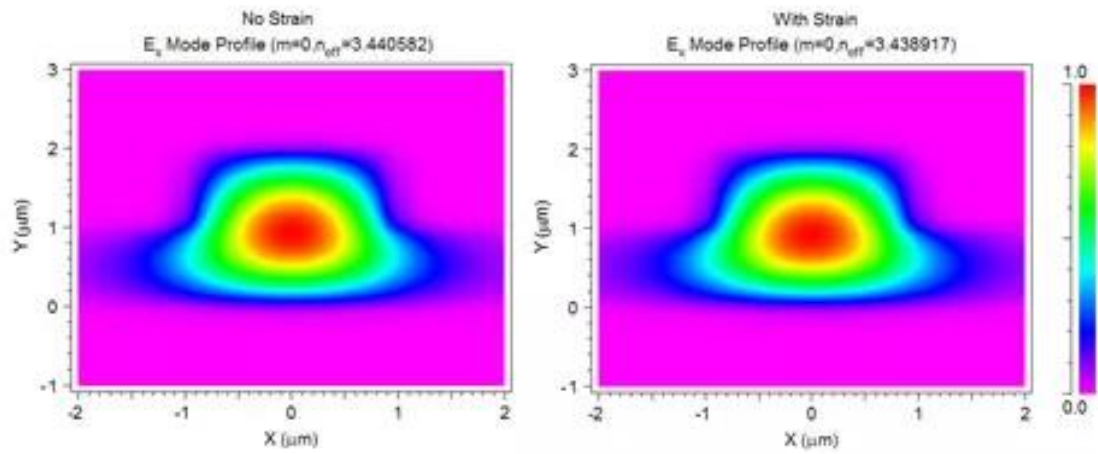


Figure 2. Mode calculations for the silicon-SiO₂ waveguide with (right) and without (left) strain. Note that the effective index of the mode has changed by ~ 0.0016 .

Keysight enables innovators to push the boundaries of engineering by quickly solving design, emulation, and test challenges to create the best product experiences. Start your innovation journey at www.keysight.com.



This information is subject to change without notice. © Keysight Technologies, 2025, Published in USA, October 20, 2025, 3125-1193.EN