Numerical Analysis and Optimization of a Multi-Mode Interference Based Polarization Beam Splitter

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Abstract

The progression toward smaller and faster photonic circuits has led to the development of nanophotonic platforms capable of compacting many devices onto an integrated chip. These devices, as well as the input and output grating couplers, are sometimes polarization dependent, which allows for a preferential treatment of different polarizations within the same circuit, especially since the waveguides are capable of supporting both transverse electric (TE) and transverse magnetic (TM) polarizations with manageable crosstalk. This introduces the growing need for reliable devices that can perform polarization conversion or rotation, and splitting or filtering, in order to test nanophotonic circuits that incorporate polarization diversity.

This paper characterizes the response of a fabrication tolerant multimode interferometer (MMI) based polarization beam splitter (PBS) for the C-band wavelength range, over different waveguide input/output configurations. It is found that the position of the input waveguide relative to the MMI-PBS plays a crucial role in the multimode interference pattern generated within the device. Light entering the PBS is separated based on polarization due to the fact that different polarizations experience a different effective refractive index. This is behavior can be exploited by collecting light differentially at the output using two separate waveguides - for TE and TM. The characterization results are optimized and as a result, a novel PBS geometry is proposed. A restraint has been considered regarding the feature size in order to maintain a small device footprint.

Through Finite Element analysis techniques in the Wave Optics module, a figure of merit is calculated for the clarity of the interference pattern and hence, efficiency of separation and collection of TE and TM polarizations. The simulation uses the Optimization module to determine ideal parameters for this new, fabrication tolerant geometry. The results are compared with Eigenmode Expansion (EME) and Finite Difference Time Domain (FDTD) methods to examine consistency and accuracy.

Figures used in the abstract

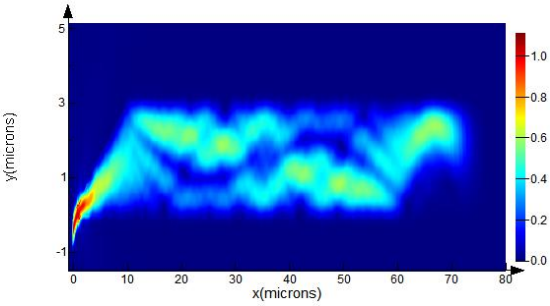

Figure 1: Multimode TE interference pattern generated in a compact yet fabrication tolerant 3x60 µm PBS design