

Simulation of Vector Mode Grating Coupler Interfaces for Integrated Optics

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Abstract

The use of grating couplers to couple conventionally phased and polarized light near vertically in and out of optical slab or film waveguides [1] represents an attractive method to interface optical fiber to photonic ICs. Previously developed grating coupler designs use transversely uniform grating structures matched to conventional scalar fiber modes. The performance of these geometries can be predicted and optimized with good accuracy using specialized 2D electromagnetic modeling tools [2]. In contrast, newly developed fiber technologies that exploit cylindrical vector modes [3] are inherently three-dimensional and grating interfaces for such beams require the solution of fully general 3D models.

In this work COMSOL Multiphysics® software was applied to the full 3D electromagnetic wave simulation of a novel forked grating coupler structures designed to interface with cylindrical vector beam modes of 1550 nm wavelength light. Full field frequency domain electromagnetic 3D models, such as shown in Figure 1, were solved for the radiating vector mode from a 3D grating emitter structure driven from a nanophotonic waveguide, as well as for the scattered field into a waveguide resulting from an incident free-space vector mode.

The results evaluated included vortex phasefront visualization (Figure 2), beam cross section studies (Figure 3), and amplitude profiles (Figure 4). Also modeled were vector modes in and out of fiber by means the fast and efficient beam envelope method available in the COMSOL Wave Optics Module. The Forked Grating Coupler invention described herein has been submitted for a provisional patent. The application number is 62/115,668 and the filing date was February 13th 2015.

Reference

[1] Taillaert, D., et. al. (2006). Grating Couplers for Coupling between Optical Fibers and Nanophotonic Waveguides. Japanese Journal of Applied Physics, 45(8A), 6071–6077. doi:10.1143/JJAP.45.6071

[2] Roelkens, G., et. al. (2007). SOI grating structure for perfectly vertical fiber coupling. In European Conference on Integrated Optics (pp. FC4:1–4). Copenhagen, Denmark. Retrieved from <http://www.ecio-conference.org/>

[3] Ramachandran, S., Yan, M. F. (2008). A new kind of PM fiber, using cylindrical vector beams. Lasers and Electro-Optics, 2008 and 2008 Conference on Quantum Electronics and Laser Science. CLEO/QELS 2008. Conference on.

Figures used in the abstract

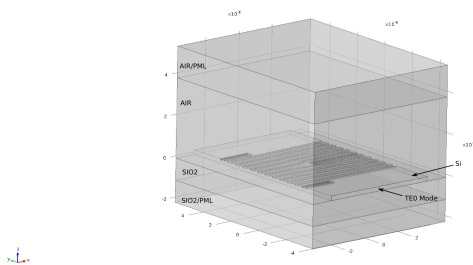


Figure 1: Geometry and materials for a 3D model of a forked grating coupler.

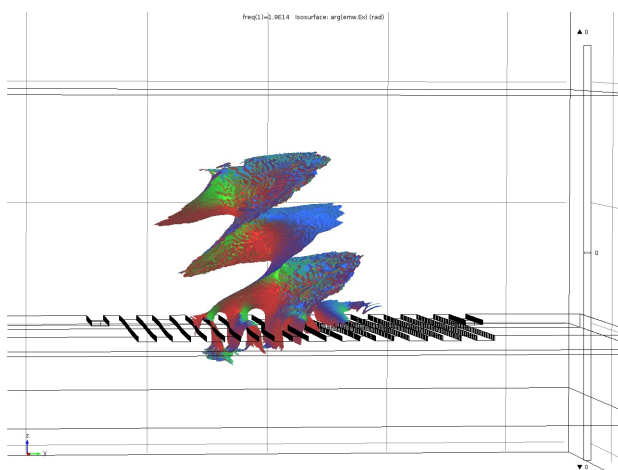


Figure 2: Optical vortex mode of charge=1 emitted by a forked grating coupler.

