

# RSoft Application: Silicon-Based Optical Interconnect

## Design Optimization of a Vertical Grating Coupler

### Overview

*Technical University of Denmark, a leading research institute in silicon photonics, had a novel idea to maximize the coupling efficiency between a fiber and a silicon chip by apodizing a vertical grating coupler with meta-materials formed by nano-holes.*

### The Challenge

Very complex theories are needed to analytically determine the optimum size of the subwavelength nano-holes. With so many design parameters, it is hard to perform the simulation and optimization efficiently. Several RSoft™ products can handle this design challenge.

### The Solution

The complex optical interconnect model (figure 1) can be decomposed into several simpler design steps, each handled by a specific RSoft tool:

- ▶ ModePROP™ efficiently simulates the light propagation in the grating coupler
- ▶ MOST™ effectively optimizes the refractive indices of the metamaterials and determines the size of the holes in each period
- ▶ BeamPROP™ determines the optimum width of grating coupler
- ▶ FullWAVE™ validates the performance of the structure

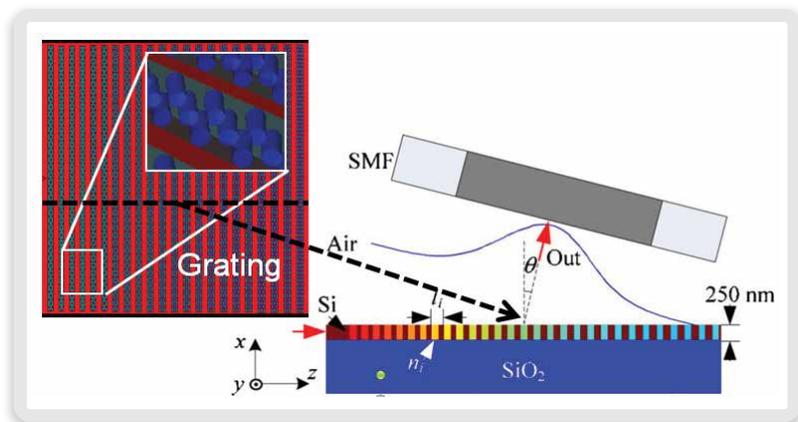


Figure 1. Silicon-based optical interconnect with vertical grating coupler. Image source (right): Ding, et al., *Optics Letters* 39.18 (2014): 5348-5350.

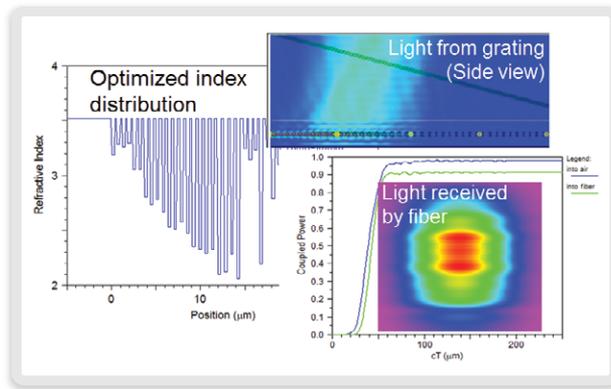


Figure 2. Optimized index distribution produced in MOST (left); FullWAVE validated the performance of the grating coupler's structure (right)

## The Result

The optimized distribution of refractive index of the metamaterial for each grating period is hard to imagine without the help of an optimization tool. Figure 2 shows the coupling efficiency and output field distribution. Validation of the final design by the FullWAVE simulation showed that -0.4dB coupling efficiency was achieved.

For more information, please contact Synopsys' Optical Solutions Group at (626) 795-9101, visit <http://optics.synopsys.com/rsoft/>, or send an e-mail to [rsoft\\_sales@synopsys.com](mailto:rsoft_sales@synopsys.com).