Fibre Grating Coupler

Last Updated: August 2019

Description

Fully-etched fibre-waveguide grating couplers with sub-wavelength gratings showing high coupling efficiency as well as low back reflections for both transverse electric (TE) and transverse magnetic (TM) modes. EBeam fabrication cost is reduced by ~2-3X when eliminating the shallow etch.

Model Name

ebeam_gc_te1550 & ebeam_gc_tm1550

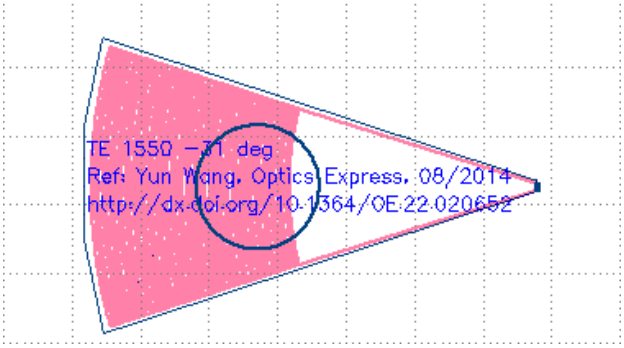

Fig. 1: Compact Model of Grating Coupler

Compact Model Information

- Support for TE and TM polarization using their respective models
- Operating at 1550 nm wavelength
- Performance:
  - TE – 4.1 dB loss, 30.6 nm 1-dB bandwidth
  - TM – 3.7 dB loss, 47.5 nm 1-dB bandwidth

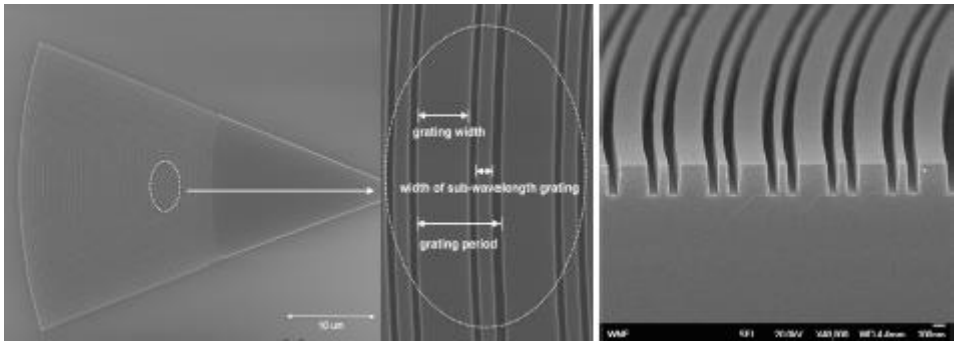

Fig. 2: SEM Picture of the Focusing Sub-wavelength Grating Coupler - Top View
Fig. 3: SEM Picture of the Focusing Sub-wavelength Grating Coupler - Sidewall View

Parameters

N/A

Simulation Results

From [Source]:

Extinction Ratios

- TE - 0.3 dB
- TM - 0.15 dB

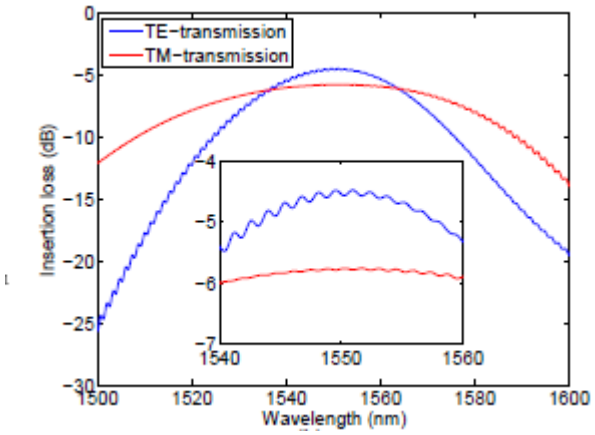

Fig. 4: Simulation Transmission Spectra of Input-Waveguide-Output Circuits for Sub-Wavelength Grating Couplers for TE (blue line) and TM (red line) Modes

Experimental Results

Coupler Type	Publication	Details
Uniform	Yun Wang, et al., "Focusing sub-wavelength grating couplers with low back reflections for rapid prototyping of silicon photonic circuits", Optics Express, 2014	• Fully-etched fiber-waveguide grating couplers with sub-wavelength gratings. • TE – 4.1 dB loss, 30.6 nm 1-dB bandwidth, -25° incident angle. • TM – 3.7 dB loss, 47.5 nm 1-dB bandwidth, 10° incident angle. • Repeatable results
Apodized	Yun Wang, et al., "Apodized focusing fully etched sub-wavelength grating couplers", Photonics Journal, 2015	• Reduced insertion loss. • TE – 3.2 dB loss, 36 nm 1-dB bandwidth, -24 dB back reflections, -31° incident angle • TM – 3.3 dB loss, 37 nm 1-dB bandwidth, -21 dB back reflections, 10° incident angle • Less repeatable results

Broadband	Yun Wang, et al., "Design of Broadband Sub-Wavelength Grating Couplers with Low Back Reflection", Optics Letters, 2015	• Increased bandwidth, but slightly lower coupling efficiency • TE – 3.8 dB loss, 90nm 1-dB bandwidth, -23 dB back reflections, 25° incident angle • TM – no performance information • Small Fabry-Perot ripples 0.08 dB due to the low reflections (-23 dB) • Repeatable results

Additional Details

- Incremental Fabrication Cost: $0.02 each on Layer 1
- Design Tools & Methodology: 2D & 3D FDTD (Lumerical Solutions), Scripted mask layout (Mentor Graphics Pyxis)
- Support for Monte Carlo using wafer map
- Model uses S-Parameters generated for 9 variations
- Number of fabrication iterations (separate runs) to get to published results: 6
- Number of variations fabricated: 100+

Reference

1. Yun Wang, et al., "Focusing sub-wavelength grating couplers with low back reflections for rapid prototyping of silicon photonic circuits", Optics Express, vol. 22, no. 17: OSA, pp. 20652-20662, 08/2014, http://dx.doi.org/10.1364/OE.22.020652
2. Yun Wang, et al., "Apodized focusing fully etched sub-wavelength grating couplers", Photonics Journal, 2015
3. Yun Wang, et al., "Design of Broadband Sub-Wavelength Grating Couplers with Low Back Reflection", Optics Letters, 2015
4. Yun Wang, et al., "Compact single-etched sub-wavelength grating couplers for O-band application", Optics Express, 2017