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High-Efficiency Fiber-Chip Surface Grating Couplers

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***Abstract*— We report our latest advances in development of high-efficiency fiber-chip surface grating couplers with refractive index engineered subwavelength structures. We present different experimental demonstrations of high-performance grating-coupled optical interfaces, developed on the standard 220-nm silicon-on-insulator technology in the near-infrared wavelengths.**

Keywords—Grating couplers; refractive index engineering; subwavelength grating; silicon-on-insulator; silicon photonics

I. Introduction

The coupling of light to or from microphotonic circuits is still one of the major practical challenges of silicon technology. The surface grating couplers afford effective approach to interface silicon chips, with relaxed alignment tolerances, wafer scale testing capability, and compatibility with integration and packaging technologies [1-5].

II. Single-Etch Grating Couplers

We reported a set of subwavelength index engineered apodized grating couplers that desired only one fabrication step, while demonstrating the state-of-the-art fiber-chip coupling performance. In particular, we experimentally shown that by optimizing the thin film interference from the bottom oxide cladding, the peak efficiency of up to -2.2 dB and -2.5 dB are achieved near 1.55 µm and 1.3 µm wavelengths, as shown in Fig. 1 (red curves) [1-3]. The couplers are implemented on a standard silicon-on-insulator (SOI) wafer with 220-nm-thick layer. We also demonstrated the first sub-decibel fiber-chip coupling efficiency of -0.7 dB (blue curve in Fig. 1) in this platform by utilizing the backside wafer processing, followed by metal mirror deposition [2]. The optical micrograph and scanning electron microscope (SEM) images of fabricated couplers are shown in Fig. 1.

III. Dual-Etch Grating Couplers

We also developed a flexible dual-etch fiber-chip grating coupler with an extraordinary intrinsic directionality of 95%, independently on the buried oxide thickness [4]. The grating geometry comprises interleaved deep and shallow etched trenches and a short subwavelength index-matching section to reduce reflections [5]. The grating coupler was realized on regular SOI with 220-nm layer over 3-µm buried oxide. The measured coupling efficiency is -1.3 dB, as shown in Fig. 2, altogether with the SEM image.

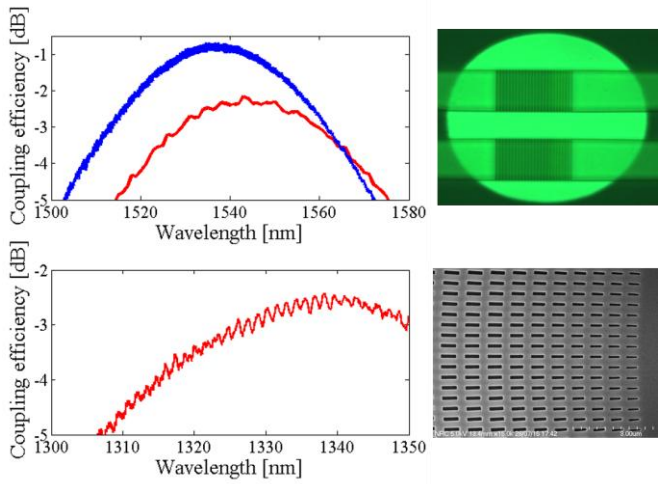

Fig. 1 Measured coupling efficiencies as a function of wavelength of single-etch apodized grating couplers, with and without metal reflector underneath. Optical micrograph and SEM images of fabricated structures.

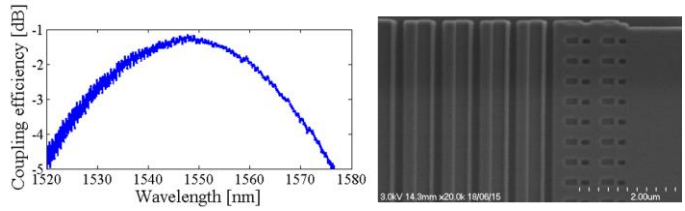

Fig. 2 Measured coupling efficiency as a function of wavelength of dual-etch coupler with interleaved deep and shallow etched trenches. SEM image of fabricated device.

IV. References

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