Polarization-insensitive multimode interference coupler based on bricked subwavelength gratings

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***Abstract*—The recently proposed bricked patterning enables enhanced performance in integrated photonics devices based on subwavelength gratings, including polarization insensitivity. We report on the design of a polarization-agnostic 2×2 multimode interference coupler for the 220 nm silicon-on-insulator platform using the bricked SWG metamaterial, operating in telecom O-band.**

***Keywords*—subwavelength gratings, on-chip metamaterials, multimode interference, polarization insensitivity, silicon-on-insulator.**

Silicon-on-insulator (SOI) is a mature integrated photonics platform, leveraging the well-established CMOS manufacturing processes [1]. However, SOI waveguides suffer from high birefringence which typically limits the operation of devices to either Transversal Electric (TE) or Transversal Magnetic (TM) polarizations [2].

Conventional subwavelength grating (SWG) metamaterials enable effective index, dispersion and anisotropy engineering of silicon waveguides modes [3]. Recently, a new bricked-patterned SWG topology has been proposed [4]. It was shown that the optical properties of TE modes are highly dependent on the bricked shifting, while TM modes are barely affected. Thus, by judiciously designing the bricked SWG geometry, it is possible to achieve devices with polarization independent performance [5].

In this work, we propose to use bricked SWG metamaterials to design a polarization independent 2×2 multimode interference (MMI) coupler operating in the O-band. The multimode waveguide geometry was designed so that the beat lengths L_π for TE and TM polarizations nearly identical for a wide spectral bandwidth. Fig. 1 shows the wavelength and polarization dependence of L_π for a conventional SWG waveguide and the bricked SWG waveguide. The performance of the device was evaluated by means of rigorous 3D full-vectorial FDTD electromagnetic simulations. Computation results are shown in Fig. 2. The polarization dependent loss is below 1 dB in the wavelength range from 1.24 µm to 1.45 µm. The device also exhibits imbalance less than 1 dB from 1.19 µm to 1.42 µm and phase errors lower than 5° from 1.26 µm to 1.50 µm, for both polarizations simultaneously. This is the first design, to the best of our knowledge, of a polarization-insensitive 2×2 MMI coupler in 220 nm SOI platform. We believe that these results open promising prospects for the development of advanced polarization-insensitive photonic devices in silicon waveguides.

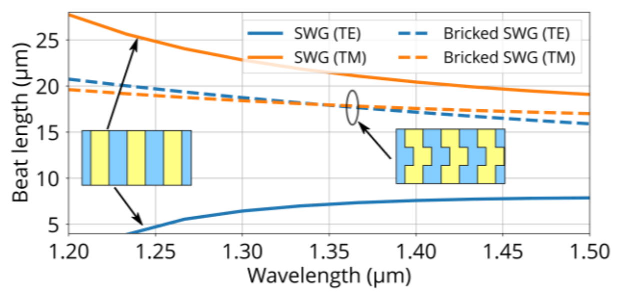

Fig. 1. The wavelength and polarization dependence of the beat length for bricked and conventional SWG engineered MMIs.

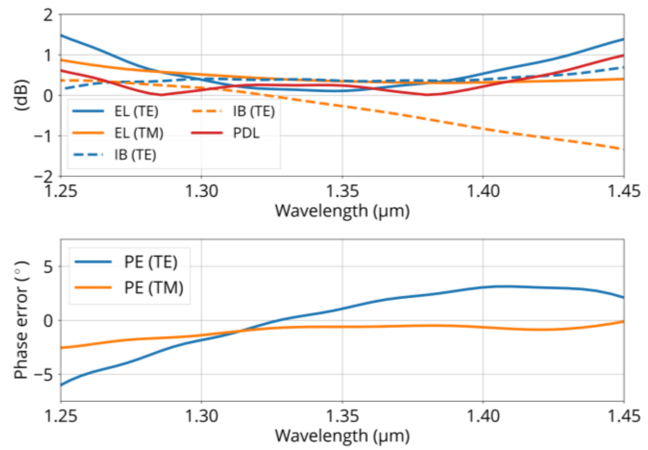

Fig. 2. Simulated performance of the polarization-independent 2×2 MMI coupler.

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We acknowledge funding from Ministerio de Economía y Competitividad (PID2019-106747RB-I00), Junta de Andalucía (P18-RT-1453, UMA-FEDERJA-158), Ministerio de Ciencia Innovación y Universidades (FPU16/06762, FPU19/02408) and Universidad de Málaga.