Contribution ID: **33** Type: **Poster**

Key Building Block Upgradation and Optimization for High-performance Transceivers: Multimode Interferometers from Conventional to Sub-wavelength Regime

Thursday, 5 September 2019 16:55 (20 minutes)

Multimode interferometers (MMI) are key components for high-bandwidth transceivers in upgrading the data transmission of future detector systems. We present 2 conventional high-performance MMIs fabricated on a 250nm SOI platform with different splitting ratios which operate as 50:50 power splitter for Mach-Zehnder modulators and as 86:14 power splitter for loop control in future transceiver designs, respectively. Besides, we present novel MMIs based on sub-wavelength gratings. By engineering the refractive index of relevant sections with sub-wavelength structures, fabricating many-port MMIs with low phase error becomes feasible and also the on-chip footprint of 50:50 MMIs can be decreased dramatically.

Summary

In this paper, we present the complete design process of MMIs starting from theoretical calculation to numerical simulation. According to the phase difference and the power splitting ratio between output ports, MMIs can be used in different scenarios. We fabricated two conventional 2 × 2 MMIs using e-beam lithography on a 250nm SOI platform at IMS Stuttgart. They are used in a p-n depletion Mach-Zehnder modulator (MZM) design and a feedback control circuit design, respectively. The on-chip footprint of 50:50 MMI in our MZM is 4.5 µm × 24.5 µm and the footprint of the 86:14 MMI is 2.8 µm × 14.1 µm. For either device, there is very good agreement between measurement and simulation results with a power splitting ratio deviation of less than 3 percentage points over the entire C band, and the measured maximum insertion loss is 0.7dB.
A conventional symmetric 50:50 MMI with the same width of the asymmetric MMI would require a length of 28.6 µm. By engineering the refractive index of the central part of MMI, the modal phase of even modes is altered while odd modes remain unaffected, by which the required length of the MMI can be shortened dramatically. The refractive index is engineered by using a sub-wavelength structure consisting of 56 square holes etching down to the substrate with a dimension of 60 nm × 60 nm. The resulted footprint of the subwavelength MMI is 2.8 µm × 14 µm, only 36% of our fabricated conventional 50:50 MMI. The simulated insertion loss of the subwavelength MMI is less than 0.15dB in the C band and the power splitting ratio is 50:50 with a power splitting ratio deviation of only 1 percentage points.
As the modal phase error increases quickly with mode number, the output images are not perfectly focused for MMIs with more than 4 output ports. We design subwavelength gratings at the lateral cladding region to lower the refractive index contrast between the core and the lateral cladding and therefore decreasing the modal phase error. The simulated 2 × 4 MMI has a footprint of 7.2 µm × 96 µm and phase error is as low as 16°. This high-performance device enables constructing compact receivers for advanced modulation formats with very high data transmission bandwidths.

Primary authors: Mr ZHANG, Yunlong (IPE, KIT); SCHNEIDER, Marc (Karlsruhe Institute of Technology); KARNICK, Djorn (Karlsruhe Institute of Technology (KIT)); Mr EISENBLÄTTER, Lars (IPE,KIT); KÜHNER, Thomas (Karlsruher Institut für Technologie KIT); Prof. WEBER, Marc (IPE,KIT)

Presenter: Mr ZHANG, Yunlong (IPE, KIT)

Session Classification: Posters

Track Classification: Optoelectronics and Links