Proposal of new modulation schemes of the propagating light in plasmonic SI MZI

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Introduction

Currently in most plasmonic Mach-Zehnder Interferometers (MZI) where plasmonic metal structures such as gratings, slit-hole structures or other are used, measured signals are transmitting horizontally through the waveguide and the transmitted signals are then modulated.[1-3] In this work we propose a novel SI MZI with an interaction of surface plasmonic wave.

Device structure and analytic results

The proposed device is schematically shown in Fig. 1 (a) a plane view of the whole MZI and (b) a cross section of the modulation region. In the modulation region, it is equipped with an asymmetric Au grating to an Au film on the top where a signal light is propagating through a Si core and is modulated with the help of excited surface wave. With this element being under plasmonic (SPR)-wavelength external excitation (λ=550nm) a clear image of energy flow difference between to the left and right sides is seen compared to a symmetric structure, as shown in Fig. 2. By placing the elements in the MZI in the modulation region and exciting them with the same excitation wavelength as the input signal an 8% difference of the output signal compared with the case under no excitation modulation was seen as shown in Fig 3 for the long wavelength range. It is expected that since the flow difference from up to the sides show difference in plasmonic regions the characteristics for those wavelengths would give also difference. Additionally the device shows to be dependent on the refractive index of surrounding medium. Thus this device can be used as a refractive index sensor for surrounding media while under excitation. All simulations were done with Comsol 5.3a RF module.

Acknowledgements

The authors appreciate the permission to use of Comsol in University of Tartu

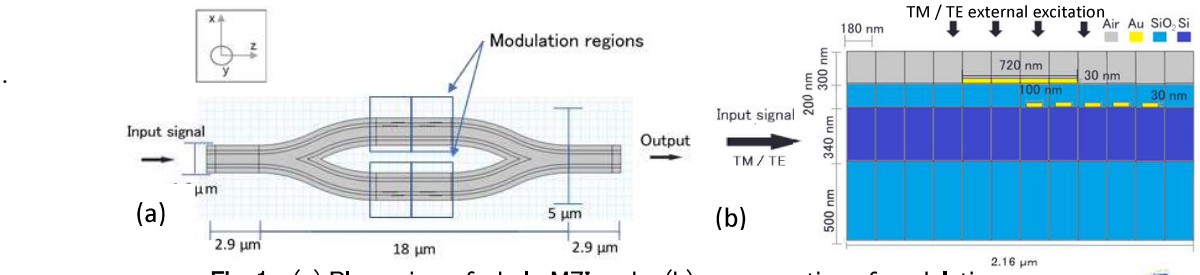

Fig. 1 (a) Plane view of whole MZI and a (b) cross section of modulation.

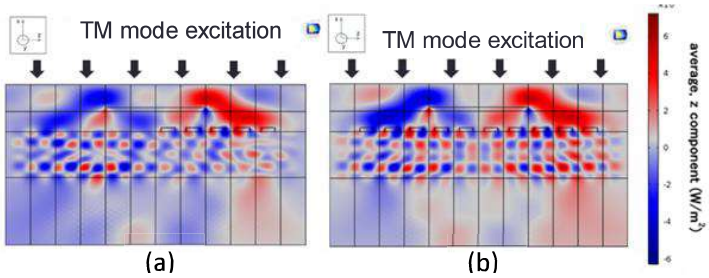

Fig. 2 TM mode excitation through the (a) asymmetric and (b) symmetric structure at 550nm excitation.

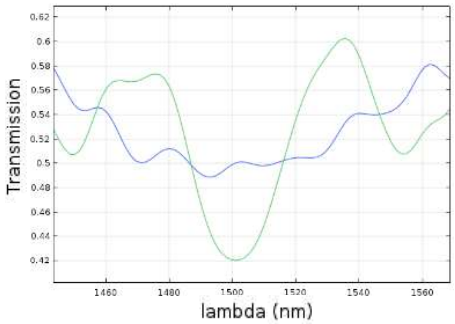

Fig. 3 Proposed scheme for setup for input signal (blue) with and without modulation (green).

References:

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[2] Yongkang Gao, Zheming Xin, Qiaoqiang Gan, Xuanhong Cheng, and Filbert J. Bartoli, "Plasmonic interferometers for label-free multiplexed sensing," Opt. Express 21, 5859-5871 (2013)
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