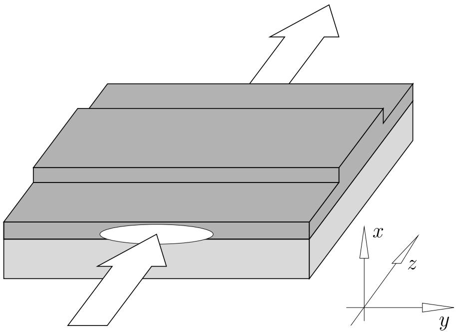
Bachelor project TET, academic year 2017/2018. 14.12.2017

Integrated optical cross-strip interferometers — modeling the lateral dimension

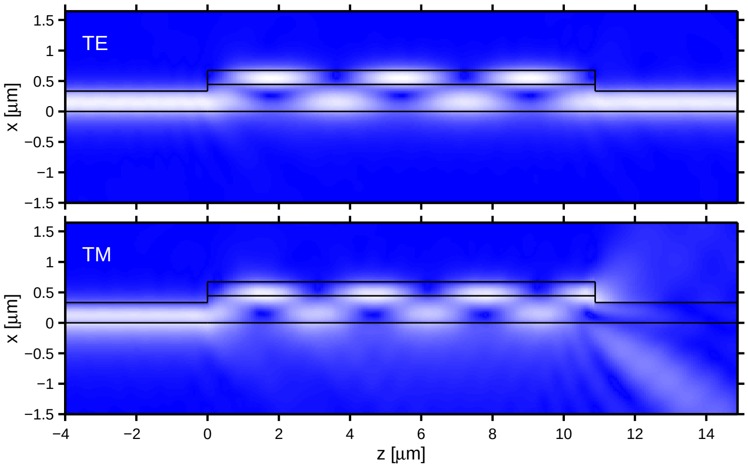
Candidate: — requested —
Supervisors: Manfred Hammer, Lena Ebers, Jens Förstner
Embedding: Theoretical Electrical Engineering (TET)



A wide, deeply etched rib is prepared using an air covered guiding dielectric film layer, the region indicated by the darker shading. Provided that the material and geometrical parameters are properly adjusted, this structure shows the characteristic properties of an interferometer, if — vertically guided, laterally unguided — light waves pass the structure in a direction *perpendicularly* to the rib.

In a two-dimensional setting, we have simulated structures of this kind, and found them to be quite promising for the realization of explicitely simple integrated optical devices [1, 2].

Consider a polarizer device: If the electrical field oscillates perpendicular to the figure plane, the optical power passes the device (TE, top). Orthogonally polarized light waves are scattered into the surrounding (TM, bottom). Our simulations predict a power throughput of 97% (TE) and 0.09% (TM), i.e. an extinction ratio beyond 30 dB and insertion loss of about 0.1 dB, achieved with a total length of less than 20 μm, without exotic materials or complicated processing.



So far so good. But what now about the third, the lateral dimension y ?

For this concept to become a real integrated optical device, the light should be confined in the y-direction as well. Hence we would like to consider a shallow, wide rib etched along the light path across the present strip, and determine the influence of this modification on the interferometer performance.

Tentative program, certainly negotiable and to be adapted according to the progress of the work:

- Make yourself familiar with the theoretical background of the problem in question.
- Repeat the simulations of Ref. [1] with the more recent 2-D Helmholtz solver (QUEP) of the Metric program collection, or with the online version of that solver.
- Formalize & implement a simple 2-D mode overlap model for the device, and compare with the rigorous 2-D solution.
- Formalize a mode overlap model for the 3-D device.
- Implement the model based on the VEIMS mode solver facilities included in the Metric library, or, alternatively, based on numerical solutions for guided modes computed with COMSOL.
- Run a series of 3-D simulations using that model, and identify an “optimized” configuration.
- Carry out a full 3-D simulation of the entire device with COMSOL or another suitable solver.

If you think that you could be interested in the concepts of optical waveguides, if you are aware that a computer can be programmed (and you are not afraid to do so; a little knowledge of C/C++ and Matlab would certainly help), and if you might like a theoretical task in between Applied Physics, Applied Mathematics, and Electrical Engineering, then don’t hesitate to contact us!

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[1] M. Lohmeyer, R. Stoffer, *Integrated optical cross strip polarizer concept*, Opt. Quant. Electr. **33** (4/5), 413-431 (2001),
[2] M. Lohmeyer et. al., Integrated magnetooptic cross strip isolator, Optics Communications 189 (4-6), 251-259 (2001)