Nonreciprocal Magnetoplasmonic InSb Mirror for Mid-IR Isolation

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Isolation is a highly important passive functionality in optics. Notably, the optical isolators are necessary for protection of coherent sources from destabilizing feedback radiation. Creating an isolator demands breaking Lorentz reciprocity of Maxwell's equations [1], which can be achieved using gyrotropic phenomena. As an example, Faraday rotation is one of the well-known nonreciprocal (NR) magnetooptical (MO) effects, which is commonly used for fabrication of the optical isolators. However, contrary to the visible range of light, the Faraday rotators at mid-IR have serious drawbacks, such as a high applied magnetic field (~1 Tesla) necessary to achieve a reasonable polarization rotation, propagation losses, and bulky dimensions.

In current work, we propose a design of the mid-IR isolator based on NR transverse magneto-optical Kerr effect (TMOKE). Since TMOKE is related to the reflection of p-polarized light, the losses due to propagation through the material are no longer problematic. As for MO material choice, small band gap semiconductors with low effective mass of free carriers (n-type InSb is used in present study) allow achieving cyclotron frequencies ($\omega_c = eB/m^*$) in mid-IR at reasonable magnetic induction. We also use 1-D plasmonic grating on the surface of NR InSb mirror in order to enhance the isolation efficiency. [2]

The reflectivity of the n-doped InSb semiconductor grating in external magnetic field was calculated using Rigorous Coupled Wave Algorithm (RCWA). Results show that isolation over 20 dB with insertion loss 2.5 dB is achievable at room temperature and B=1 Tesla. Experimental reflectivity characterizations of NR n-type InSb mirror with plasmonic gratings are ongoing and results will be presented on the NanoTeraMIR meeting.

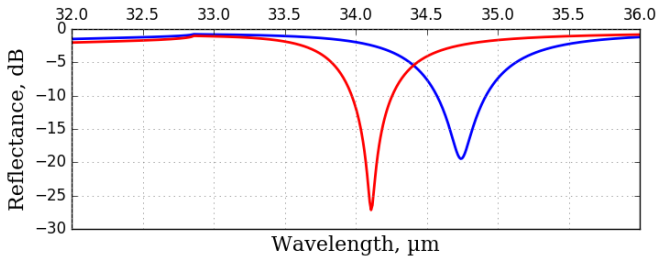

Figure 1: The reflectivity in forward (red) and backward direction (blue) of n-doped InSb grating with 20 μm period, thickness 1.4 μm and slit width of μm. The p-polarized wave is incident at 30°. Applied transverse magnetic field is B = 1 T.

[1] D. Jalas et al., Nature Photonics, vol. 7, pp. 579–582, July 2013.

[2] L. Halagačka et al., Op. Ex., vol. 21, pp. 21741-21755, 2013.