THz Isolator Using Nonreciprocal Magnetoplasmonic InAs Mirror

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Isolation is an important passive functionality in optics that helps to block any 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 the best known nonreciprocal (NR) magnetooptical (MO) effect commonly used for optical isolators. However, Faraday rotators at mid-IR and THz ranges have serious drawbacks, such as the need for a high applied magnetic field (~1 Tesla) necessary to achieve a reasonable polarization rotation, but more importantly high propagation losses, and bulky dimensions.

In the present work we demonstrate a NR magnetoplasmonic InAs mirror for THz and mid-IR isolation based on the transverse magneto-optical Kerr effect (TMOKE). This manifests itself as nonreciprocal reflection of p-polarized light from a transversally magnetized surface. By combining it with a surface plasmon resonance, TMOKE (which is commonly weak on a bare MO substrate) is greatly enhanced [2]. By using a reflective configuration for the nonreciprocal function, the problem with propagation losses through the gyrotropic material is avoided. The low effective mass of free carriers of a small gap semiconductor such InAs ($m^*=0.024m_e$) allows both to realize a plasma frequency in the THz range and a cyclotron frequency ($\omega_c=eB/m^*$) in the same range with a reasonable value for the magnetic induction. By carefully designing 1D plasmonic gratings on the surface of the NR InAs mirror, TMOKE can be enhanced by 3 orders of magnitude. Chemically etched gratings have been fabricated in undoped InAs substrates (Fig.1a). Comsol calculations of the NR p-reflectivity on the obtained profiles predict isolation ratios close to 20 dB at room temperature and under an applied magnetic field of 1 Tesla (Fig.1b). Experimental reflectivity characterizations of NR n-type InAs mirror with plasmonic gratings are ongoing and results will be presented on the conference.

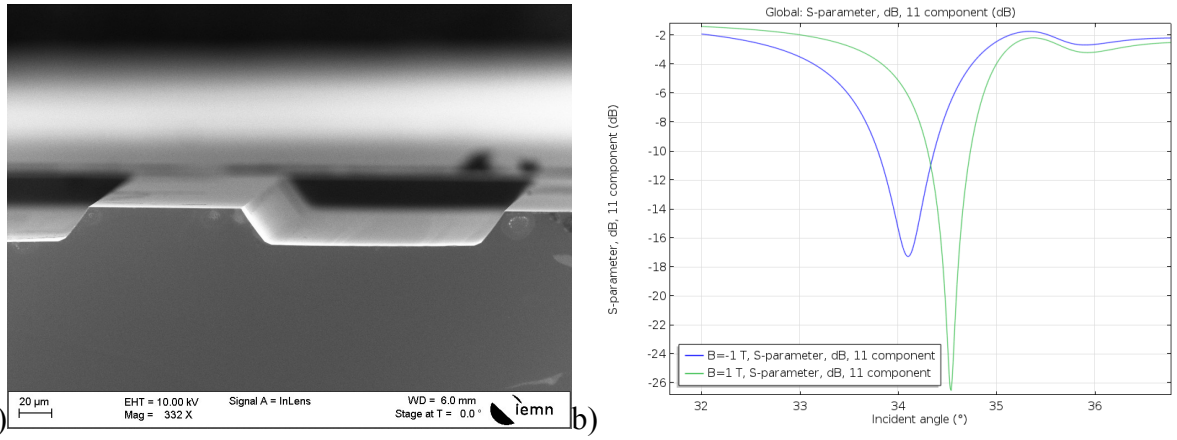

Fig.1. (a) - InAs grating with 250 µm period and 20 µm depth, using H_3PO_4:H_2O_2 etching solution.(b) – Calculated reflectivity at 761 GHz (HCOOH THz laser line) vs incidence angle.

References

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