Advanced functionalities in subλ photonic and plasmonic structures

Ivan Richter, Pavel Kwiecien, Milan Burda, Vladimír Kuzmiak,* Jiří Čtyroký,*
Czech Technical University in Prague, Faculty of Nuclear Sciences and Physical Engineering, Břehová 7, 11519 Prague 1, Czech Republic, Email: ivan.richter@fjfi.cvut.cz
* CAS Institute of Photonics and Electronics, Chaberská 57, 182 51 Praha 8, Czech Republic

Recently, within our theoretical research projects, we have investigated various novel effects and functionalities, connected with subwavelength (SW) photonic and plasmonic (nano)structures. Based on the development and application of numerical methods for the analysis of the interaction of the electromagnetic field with such structures (mainly Fourier modal methods), we have recently studied several interesting and potentially perspective problems: subwavelength grating (SWG) waveguide-based structures, such as SWG Bragg and transmission narrow-band filters [1], novel magnetooptic (MO) plasmonic guiding structures with non-reciprocal properties [2], parity-time (PT) gain / loss symmetric guiding and resonant structures, resonant plasmonic nanostructures and metasurfaces for surface plasmon resonance sensing, plasmonic nanostructures with extraordinary optical transmission [3] and nonlocal and quantum response resonances [4]. In this contribution in particular, we present and discuss more in detail several results selected from these problems. Concerning activities on nonreciprocal structures, based on magnetooptic Fourier modal method (MOaRCWA) simulations, both in 2D in 3D, we have studied the one-way (nonreciprocal) propagation of magnetoplasmons in plasmonic nanostructures, such as highly-dispersive polaritonic InSb material, within the THz spectral region, under an external magnetic field (mainly in the Voigt configuration), see Fig 1 [2]. Further, concerning nonlocal activities, our recent results of both analytical and numerical approaches incorporating nonlocal behavior of plasmonic nanostructures, which characteristic dimensions of such structures have scaled down, will be discussed. In parallel to analytical approach based on the hydrodynamic model (with both radiative and viscosive damping), as an alternative (and more general) approach, based on our previous experience with Fourier modal methods, we have considered and developed the extension of the RCWA technique capable of treating nonlocal response numerically (NonLocRCWA), for more general structures. Finally, for even smaller characteristic dimensions, we have also adopted the Quantum corrected model. Funding by the CSF project (19-00062S) is gratefully acknowledged.

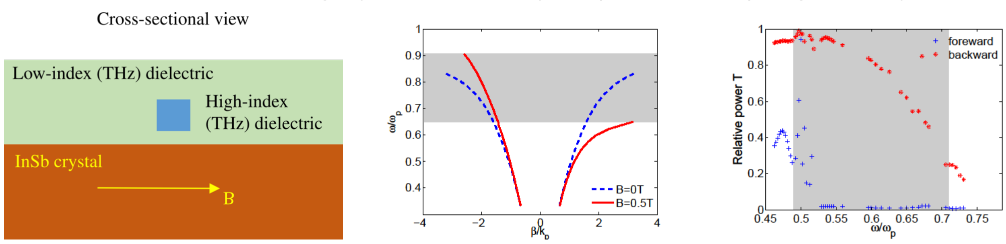

Fig. 1: Schematic of the 3D MO Si/InSb, dispersion nonreciprocal band diagram (B=0.5T), relative forward and backward spectral transmittances for L=300 μm (without losses).

[1] J. Čtyroký, J. G. Wanguemert-Perez, P. Kwiecien, I. Richter, et al., Optics Express 26 (2018), 179.
[2] P. Kwiecien, I. Richter, V. Kuzmiak, J. Čtyroký, JOSA A 34 (2017) 892.
[3] J. Fiala, I. Richter, Plasmonics 13 (2018)
[4] M. Burda, P. Kwiecien, J. Fiala, I. Richter, paper [10227-24], SPIE Optics+Optoelectronics 2017 (Prague, Czech Republic, April 2017).