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# Magneto-Plasmonic Properties of Au/Fe/Au Planar Nanostructures: Theory and Experiments

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**Abstract**

The non-reciprocity of magneto-optical reflection response by surface plasmon excitation in the planar Au/Fe/Au/glass nano-systems with prism coupling is studied. In order to simulate diffraction response to external magnetic field theoretical matrix model based on rigorous coupled waves algorithm is applied that allows to simulate both the influence of metallic layer thicknesses and external magnetic field. The two new response factors related to response function are introduced and tested from the point of view of their applicability. Obtained theoretical results are compared with experiment realized using the measuring device Multiskop (Optrel GbR, Germany).


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*Keywords:* Magneto-Plasmonics; Planar nanostructures; Response factors

## 1. Introduction

The main attention in magneto-plasmonic research is focused to the enhancement of magneto-optical (MO) response regarding a chose of appropriate magneto-optically active material and/or architecture of designed system. Magneto-optical effect induced in various plasmonic nanostructures has been in recent time studied among other for

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sandwiched noble metal/ferromagnetic/noble metal optical system – see e.g. Armelles et al. (2009) or Ferreiro-Villa et al. (2009). The non-reciprocity of MO reflection response by surface plasmon excitation in a planar glass/Fe/Au/air system has been analyzed with aim to find the optimal thicknesses of metallic layers with regard to the reflectance sensitivity to an external magnetic field by Vlček et al. (2013).

In presented article we are concerned with MO response from three-layer planar system Au/Fe/Au that exhibit surface plasmon (SP) excitation by prism coupling in Kretschmann ordering (Fig. 1a). The effect in view is studied at fixed wavelength 632.8 nm in transversal MO configuration (Fig 1b) by varying angle of incidence by the use of introduced response function.

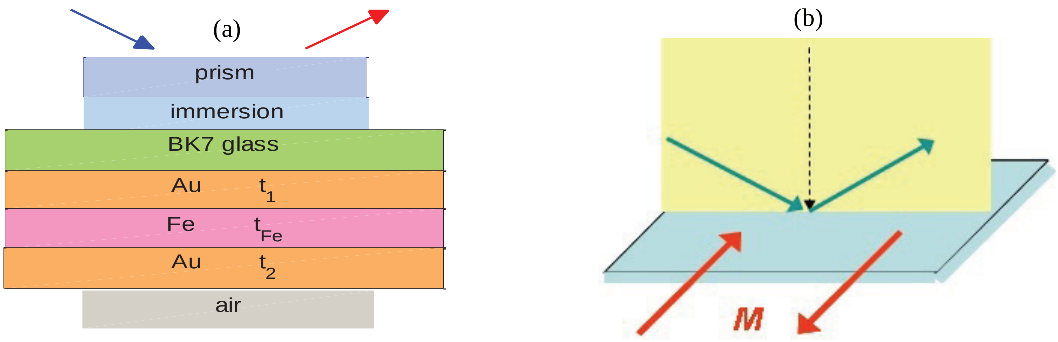


Fig. 1. (a) Sample scheme; (b) transversal MO configuration.

Besides optical functions of metallic materials the layer thicknesses and value of magnetic field exercise decisive influence to the MO-SPR response. In this paper, the last two factors are discussed by means of model simulations. The article is organized as follows: in the next section we deal with chose of appropriate response factor, for which the desired properties can be efficiently analyzed; sensitivity of selected factors is numerically tested in the Section 3, in the fourth part the result of realized experiment is described including the comparison with model computations; some concluding remarks are summarized in the Section 5.

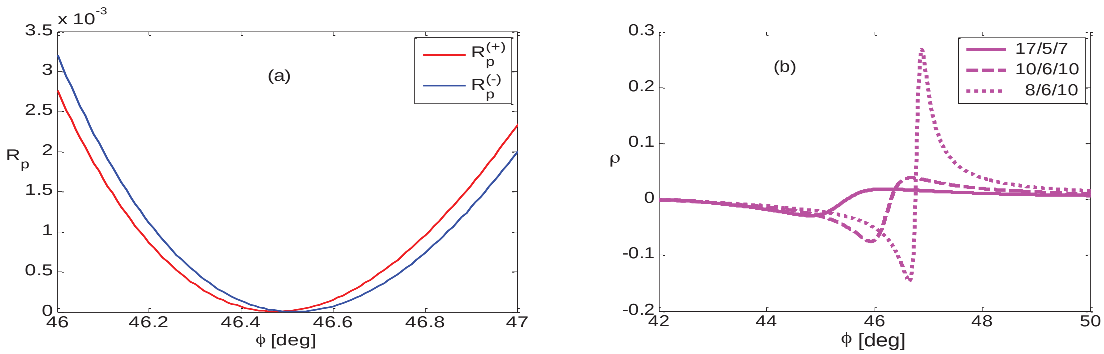


Fig. 2. (a) Reflectance minima shift; (b) response function by several combination of metallic layer thicknesses.

Presented numerical results were obtained using matrix form of rigorous coupled waves algorithm implemented in own Matlab code with the angular step $\Delta\phi = 0.01°$. Optical functions of isotropic materials were established at the wavelength 632.8 nm as follows. $n_g = 1.5146$ (BK7 glass plate), $n_{Au} = 0.1911\text{-}3.3577i$ by Johnson and Christie (1972). For the iron nano-layer, the values of refractive index $n_{Fe} = 3.53\text{-}3.66i$ and Voigt magneto-optical parameter $Q = 0.0341+0.0054i$ were extrapolated from the results referred by Buchmeier et al. (2008) with the use of tabled data in Višňovský et al. (1996).