Poster

THEORETICAL TREATMENT OF THE TMOKE IN MAGNETO-PLASMONIC PATTERNED NANOSTRUCTRURES: A SCATTERING MATRIX APPROACH

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The study of the Magneto-Optical (MO) properties of ferromagnetic metals is a topic under study since long ago. Nowadays, the study of the properties of nanostructures with magneto-optical activity is increasing due to the progress in miniaturization of optical devices. In this progress towards miniaturization of optical devices surface plasmons are playing an outstanding role [1]. These are excitations existing in the interface of a metallic medium and a dielectric one, whose associated electromagnetic field is spatially confined to that interface. Also, localized plasmon resonances in small particles are important since their spectral position strongly depends on a variety of parameters such as the size, the shape, the concentration of the metallic particles holding them. The vast majority of the studies have been so far devoted to study noble metal particles since their free electron contribution to the optical properties in the infrared and visible spectral range is predominant, exhibiting also a low damping constant. In ferromagnetic metals, relevant from the point of view of their MO activity, the free electron contribution to the optical properties is smaller, and has a higher damping constant; therefore their surface plasmon resonances appear broader and less defined [2]. Different works suggest that the proper combination of noble and ferromagnetic metals could lead to enhanced magneto-optical activity [3]. These kinds of structures are being currently studied on the basis of a scattering matrix (SM) approach in the so-called polar configuration [4] (magnetic field applied perpendicular to the sample plane and parallel to the polarization plane of the incoming light).

On another context, plasmon excitations are the basis of high sensitive biosensor devices. These devices are based on the dependence of the modification of the spectral location of the resonance with the refractive index of the dielectric side (Surface Plasmon Resonance -SPR-sensors). An evolution of the SPR lies in the introduction of MO elements. In this case the magnetic field must be applied lying in the sample plane and perpendicular to the incident light (Transverse configuration) [5]. The measured quantity is then the so-called Transverse Magneto-Optical Kerr Effect (TMOKE). To analyze this signal when nanostructuration of any of the components is present only approximate effective medium theories can be employed. Thus, an exact SM treatment is desirable. This is, however, not a trivial generalization of the polar case. In fact, in this work we show that SM treatment of the TMOKE for nanopatterned structures is only achievable if the magnetic component is homogeneous, remaining the rest free to be nanostructured on demand. We will present the theoretical method to tackle the aforementioned situation in detail and will apply it to a real system consisting on a homogeneous magneto-plasmonic trilayer (Au/Co/Au) coupled to a periodically patterned metallic layer (square array of Au discs) as it is shown in the figure.

References:

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Figures:

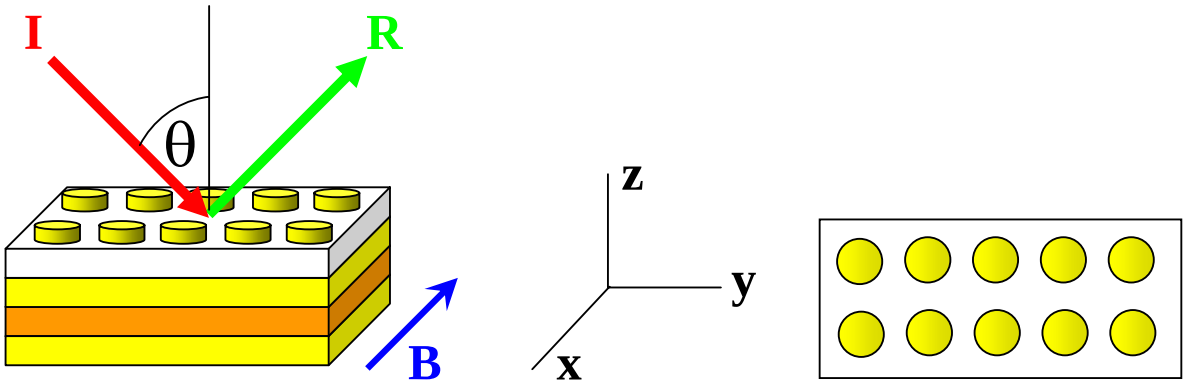

Figure: Schematical view of the system under consideration.