Theoretical study of the Faraday effect in Au-Co-Au membranes in conditions of extraordinary optical transmission

Blanca Caballero[1], Juan Carlos Cuevas[2], Antonio García-Martín[1]

[1]IMM-Instituto de Microelectrónica de Madrid (CNM-CSIC), Isaac Newton 8, PTM, Tres Cantos, E-28760 Madrid, Spain
[2]Departamento de Física Teórica de la Materia Condensada, Universidad Autónoma de Madrid, E-28049, Madrid, Spain
blanca.caballero@imm.cnm.csic.es

Abstract

In the context of Nanophotonics, Magnetoplasmonics is a field that has become more and more popular during the past few years [1]. It studies the magneto-optical properties of systems combining plasmons and magneto-optically active materials where both interact with each other, enhancing their properties. This kind of systems benefits from the ability of plasmons to localize light in reduced volumes, where the consequent field enhancement results in an amplification of the MO activity of the system. As another result of this synergy, one can also use the electric field to tune the plasmon properties. Those two qualities are very appealing for possible applications and give Magnetoplasmonic devices very promising perspectives.

The extraordinarily high transmission presented in periodically patterned plasmonic structures, when the holes are smaller than the wavelength, has been broadly studied [2,3]. Studies of the magneto-optical response in systems exhibiting extraordinary optical transmission have been carried out in the case of the Kerr effect, mainly considering perforated membranes made of ferromagnetic metals [4,5].

Therefore, it becomes natural to tackle the study of the magneto-optical effect of these systems but considering the transmitted field, rather than the reflected one. In this work we present an analysis of the Faraday polarization conversion through a Au-Co-Au perforated membrane. This combination of materials permits maintaining fairly good plasmonic properties while presenting magneto-optical response due to the presence of a ferromagnetic metal. We will present a systematic analysis of the polarization conversion as a function of the Co layer thickness as well as the Co layer position. Additionally, we will show the effect of the environment by studying the modification that the refractive index of both the incident media and the substrate introduces on the polarization conversion. Following this analysis, we will be able to put forward a clear correlation between the excitation of the SPPs and polarization conversion enhancement.

References

[1] G. Armelles, A. Cebollada, A. García-Martín, M. U. González, Adv. Opt. Mater., **1** (2013) 10.

[2] T.W. Ebbesen, H. J. Lezec, H. F. Ghaemi, T. Thio, and P. A.Wolff, Nature (London), **391** (1998) 667.

[3] F. J. García-Vidal, L. Martín-Moreno, T. W. Ebbesen, and L. Kuipers, Rev. Mod. Phys., **82** (2010) 729.

[4] B. Caballero, A. García-Martín, and J.C. Cuevas, Phys. Rev. B, **85** (2012) 245103.

[5] E. Melander, E. Östman, J. Keller, J. Schmidt, E.Th. Papaioannou, V. Kapaklis, U.B. Arnalds, B. Caballero, A. García-Martín, J.C. Cuevas, and B. Hjörvarsson, Appl. Phys. Lett., **101** (2012) 063107.