Probing the electromagnetic field distribution within a magnetoplasmonic nanodisk

D. Meneses-Rodríguez, E. Ferreiro-Vila, P. Prieto, J. Anguita, A. García-Martín, M. U. González, J. M. García-Martín, A. Cebollada, and G. Armelles

IMM-Instituto de Microelectrónica de Madrid (CNM-CSIC)
Isaac Newton 8, PTM, E-28760 Tres Cantos (Madrid), Spain.
david.meneses@imm.cnm.csic.es

It is well known that localized surface plasmon resonances (LSPRs) greatly influence the optical [1, 2] and magneto-optical [3] properties of metallic nanostructures. It has been reported an enhancement of the magneto-optical (MO) activity when these LSPRs are excited. The key factor for this phenomenon is the high intensity of the electromagnetic (EM) field inside the global nanostructure when a LSPR occurs [4, 5]. In this work we show how the EM profile related to the LSPR can be probed locally inside the nanostructure.

We have studied the MO activity upon plasmon excitation in magnetoplasmonic nanodisk arrays. Such arrays have been fabricated in large area onto glass substrates by combining colloidal lithography with deposition under UHV and lift-off techniques. Each nanodisk is a Au (45nm-X)/Co(7nm)/Au (X)/Cr(2nm) multilayer with height=54nm and diameter=140nm, and for the sake of comparison, continuous thin films with identical composition have been also prepared (see Fig. 1(a) left and right, respectively).

The MO activity has been obtained by measuring the MO Kerr effect in polar configuration upon normal incidence illumination. With the help of extinction spectra, it has been checked that the maximum MO activity is in the same spectral range than the LSPR excitation. Fig. 1(b) shows the maximum MO activity as a function of the Co position for the nanodisk arrays as well as for the continuous films. The MO activity in the nanodisks depends on the position of the Co layers. It exhibits maximum values when the Co layer is located near the top or the bottom of the disks and minimum values in-between due to the LSPR excitation. This behavior is in contrast with the MO activity exhibited by the continuous films, which increases monotonously as the Co layer becomes closer to the top surface. This indicates that the EM field inside the nanodisks exhibits a nonuniform distribution in plasmon resonance conditions. In fact, the Co layer acts as a probe sensing the EM field within the nanodisk, since the MO activity depends on the intensity of such field.

This information could be very relevant for the design of magnetoplasmonic systems offering optimum MO enhancement, for instance for sensing applications where maximum sensitivity is expected in the areas with higher EM field.

References

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Figures

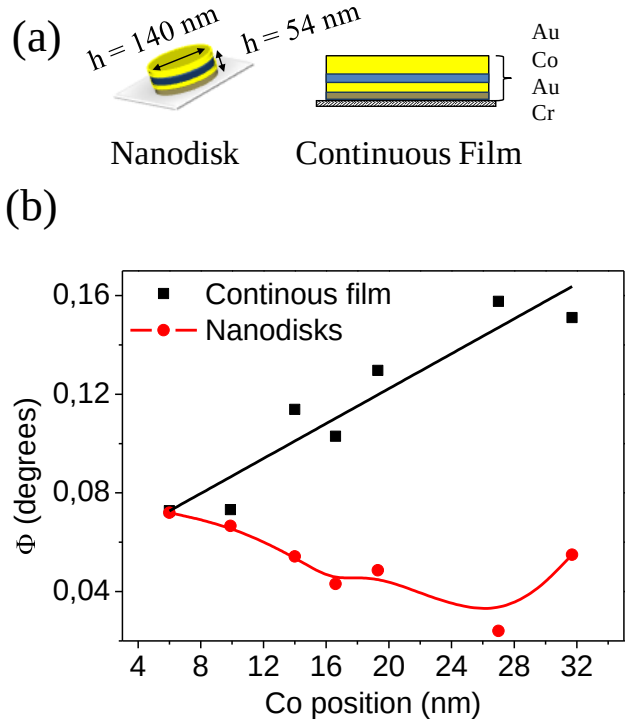

Figure 1: (a) Schemes of the Au/Co/Au/Cr magneto- plasmonic systems here studied: nanodisks and continuous films, respectively. (b) Maximum magneto-optical activity as a function of the Co position for both kinds of structures.