High magneto-optical performance in metal-dielectric magnetoplasmonic nanodisks

Antonio García-Martín, Juan Carlos Banthí, David Meneses, Fernando García, María Ujué González, Alfonso Cebollada, and Gaspar Armelles

IMM-Instituto de Microelectrónica de Madrid (CNM-CSIC), Isaac Newton 8, PTM, E-28760 Tres Cantos, Madrid, Spain
a.garcia.martin@csic.es

The term magnetoplasmon, or magnetoplasma surface wave, was first introduced in the early 70's, motivated by a renovated interest in surface plasmons in metals and degenerate semiconductors [1,2]. Nowadays, the phenomenology associated to systems where plasmonic and MO properties coexist has become an active area of investigation. The so called magneto-plasmonic systems have opened new routes for the development for example of higher performance gas and biosensing platforms [3,4] as well as the exploitation of non-reciprocal effects [5] in devices with potential applications in the telecomunications area.

In magnetoplasmonic structures, magnetic and plasmonic properties are intertwined, allowing for example plasmonic properties to become tunable upon application of a magnetic field (active plasmonics) [6], or the MO effects to be largely increased by plasmon resonance excitation, as a consequence of the enhancement of the electromagnetic (EM) field in the MO active component of the structure [7].

In this last case, the study of the enhanced MO activity in structures with subwavelength dimensions is especially interesting since the properties of these systems upon plasmon resonance excitation bring as a consequence an enhanced EM field in its interior, and more interestingly in the region where the MO active component is present.

Unfortunately, it is not straightforward to experimentally determine the intensity of the EM field inside a nanostructure. Here we show (Fig.1) how the EM profile related to the localized surface plasmon resonance can be probed locally inside the nanostructure by measuring the MO activity of the system as a function of the position a MO active probe (a Co nanolayer) [8].

At this stage, optimizing the EM field distribution within the structure by maximizing it in the MO components region while simultaneously minimizing it in all the other, non MO active, lossy components, will allow for the development of novel systems with even larger MO activity with reduced optical absorption, becoming an alternative to state of the art dielectric MO materials, like garnets[9].

We will show how the insertion of a dielectric layer in Au/Co/Au magnetoplasmonic nanodisks induces an EM field redistribution in such a way to concentrate it in the regions of interest of the nanostructure. Figure 2 shows as an example experimental and theoretical optical extinction and MO activity for the system with the SiO_2 layer attached to the upper Au layer and for the fully metallic structure. The metallo-dielectric system ***exhibits large MO activity and low optical extinction*** in the high wavelength range (around 780 nm). It will be demonstrated how this is due to the specific EM field redistribution at this wavelength, controlled by the insertion of the dielectric layer.

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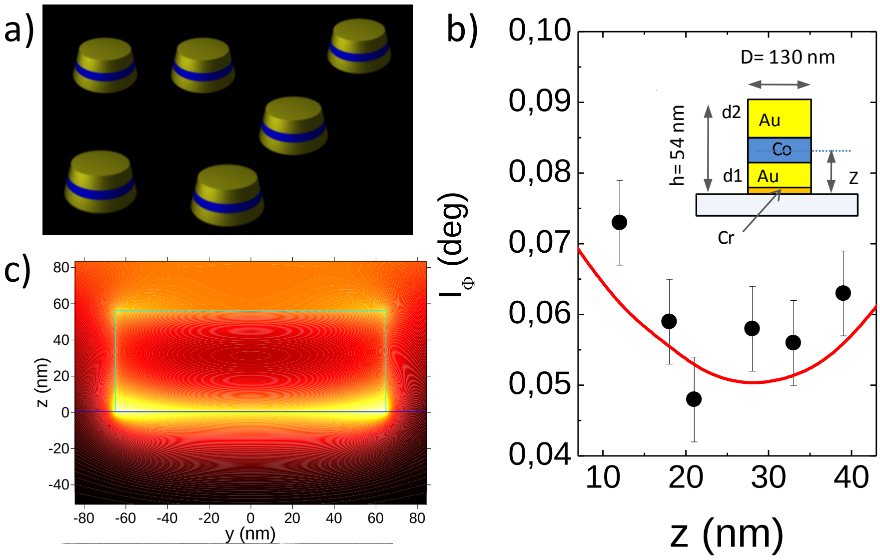

Figure 1: (a) Sketch of the fully metallic nanodisks (b) Maximum magneto-optical activity as a function of the Co position for fully metallic nanodisks (c) Electromagnetic field distribution inside a AuCoAu nanodisk.

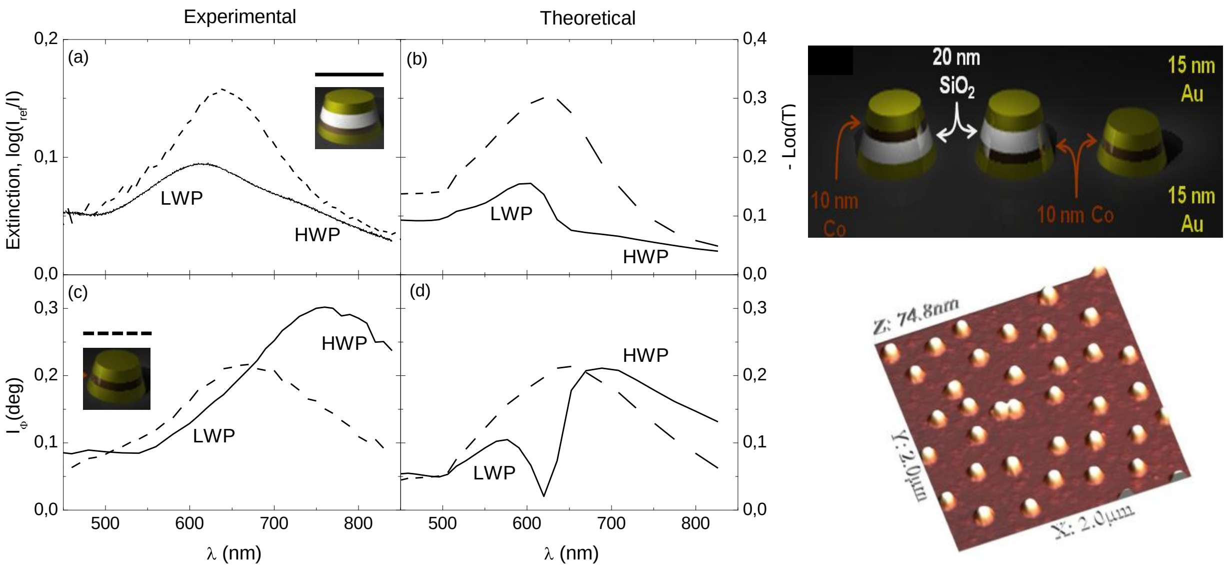

Figure 2: Left: Experimental and theoretical optical extinction and MO activity for the structure with the SiO2 layer attached to the upper Au layer (continuous lines) and for the fully metallic structure (dashed lines). Right: Sketch of the fabricated structures, and representative AFM image of one of them

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