High magneto optical activity and low optical losses in metal–dielectric Au/Co/Au-SiO_2 magnetoplasmonic nanodisks

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Magnetoplasmonics deals with the study of systems where the plasmonic and magneto-optical (MO) properties coexist and show a distinct interaction between them. In this kind of systems, the plasmonic properties can become tunable upon application of a magnetic field [1,2], or the MO effects can be largely increased by plasmon resonance excitation, as a consequence of the enhancement of the electromagnetic (EM) field in the MO component of the structure [3].

The study of the enhanced MO activity in structures with subwavelength dimensions is especially interesting since they may be viewed as nanoantennas in the visible range with MO functionalities. The light harvesting properties of these systems upon plasmon resonance excitation brings as a consequence an enhanced EM field in its interior, and more interestingly in the region where the MO active component is present. In fact, it has been recently demonstrated that the MO enhancement can be directly linked with the amount of EM field inside the MO layer, in such a way that this layer can be used as a probe to determine the EM field distribution inside a nanostructure [4].Therefore, optimizing the EM field distribution within the structure by maximizing it in the MO regions while simultaneously minimizing it in all the other, non MO active, lossy components, will allow for the development of novel systems with larger MO activity and reduced optical absorption, becoming an alternative to state of the art dielectric MO materials, like garnets.

Here we will present our approach to face this problem, based on the insertion of a dielectric layer in Au/Co/Au magnetoplasmonic nanodisks. The resulting nanostructure consists of two metallic nanodisks coupled through the dielectric layer, with one of the nanodisk being purely Au and the other one Au/Co (see Figure 1(a)). This kind of systems presents two hybridized localized plasmon resonance modes [5], showing two peaks in both the extinction and the MO spectra (see Figure 1(b)). Moreover, the EM field inside the nanostructure is strongly redistributed, being strongly concentrated in the nanodisk composed only of pure noble metal (Figure 1(c)). By optimizing the internal architecture (position of the Co layer), a configuration where the system exhibits large MO activity and low optical extinction in the same wavelength range can be obtained, as it can be seen in the right side of Figure 1(b) for the high wavelength peak [6].

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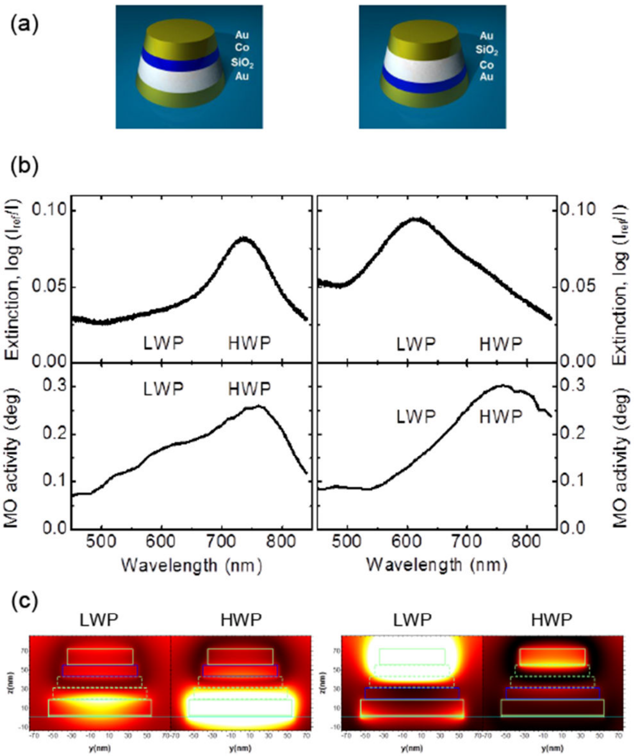

Figure 1: (a) Sketch showing the two kinds of fabricated magnetoplasmonic metal-dielectric nanodisks. (b) Extinction and magneto-optical (MO) activity spectra of the two kinds of nanodisks. (c) EM field distribution at the two resonance peaks, low wavelength (LWP) and high wavelength (HWP), for both kinds of nanodisks.