Interaction between LSP and SPP in magnetoplasmonic structures

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Summary
In this work we study the effect of localized plasmon excitation on the response of a magneto-optically active system that also supports extended plasmons (magneto-plasmonic thin film). It is carried out using two different configurations for the applied magnetic field, and its influence on both kinds of plasmons is also analyzed.

Introduction
It is well known that the fundamental optical properties of hybrid structures conformed by arrays of metallic nanoparticles, sustaining localized surface plasmons (LSP), and metallic films, which support propagating surface plasmons (SPP), are strongly influenced by their mutual electromagnetic coupling [1,2]. On the other hand, the inclusion of ferromagnetic materials in nanoparticles or metallic films allow us to control the respective excitation LSP and SPP by an external magnetic field [3,4]. In this work we analyze a system presenting both situations: LSP on gold nanoparticles over a continuous metallic trilayer exhibiting magneto-optical (MO) activity.

Discussion

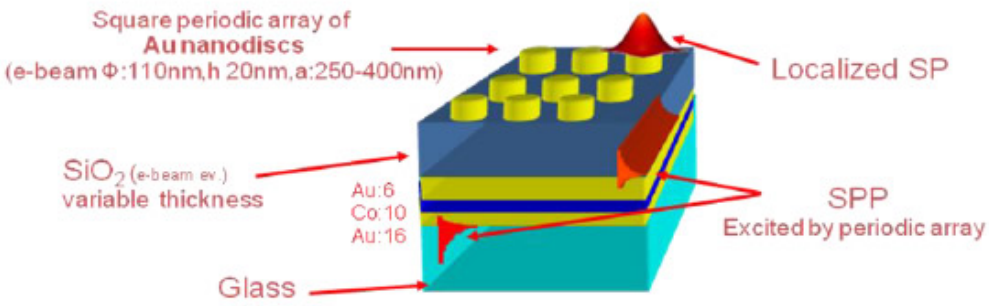

Figure 1. Configuration sustaining LSP, SPP and magneto-optical activity analyzed in this work.

Figure 1 shows the system under study: a Au/Co/Au trilayer film over a glass substrate and below a thin SiO_2 spacer that has an array of gold nanoparticles on top of it. The magneto-optical response of samples with different thicknesses of SiO_2 and different array periodicities have been measured in both the polar Kerr and the transverse Kerr configurations. In the polar Kerr configuration we analyze the polarization conversion (p-light into s-light) in the reflected light when a magnetic is applied perpendicular to the sample plane and parallel to the incident light plane; and in transverse Kerr measurement, we study the modification of the intensity of the reflected p-light when the magnetic field is applied parallel to the sample plane and perpendicular to the incident light plane.

The polar Kerr results show that the MO response differs from that of the trilayer alone due to the presence of LSP, even being physically separated. Moreover, we have determined that there is a redistribution of the electromagnetic field inside the trilayer when the LSP is excited, resulting in an enhancement of the MO signal only for those energies where the electromagnetic field is increased [5].
In the transverse Kerr configuration both the LSP and SPP plasmons are excited, and from the dependence on the angle of incidence of the TMOKE spectra, we can reconstruct the SPP dispersion relation. In this configuration the magnetic field introduces a modulation of the SPP wavevector allowing thus the use an external magnetic field as a tuning parameter of SPP properties. Furthermore, in the spectral region where both plasmon modes interact, this effect is reduced and partly transferred to the LSP.

Conclusions

We have studied the influence of the excitation LSP on the MO activity of the system, the effect of the magnetic field on both kind of plasmons, and the mutual interaction between them, finding an enhancement of the MO Kerr activity due to the plasmon excitation, and that the propagation of the SSP can be altered via modulation of its wavevector.

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