INTERTWINED EFFECTS IN NANOSTRUCTURES WITH SIMULTANEOUS PLASMONIC AND MAGNETO-OPTIC PROPERTIES

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Subwavelength composite materials constitute an interesting path towards the development of materials with "on demand" optical properties. We will present our latest results on systems composed of both noble and ferromagnetic metals, which we denote as magnetoplasmonic systems. While noble metals have intense and narrow plasmon resonances they lack magneto-optical (MO) activity at reasonable magnetic field intensities. On the other hand, ferromagnetic metals are MO active but their plasmon resonances are weak and broad. By combining both kinds of materials in smart structures we intend to obtain systems which simultaneously exhibit plasmon resonances and MO activity. Even more, we will show that in such systems it is possible both to enhance the magneto-optical activity of the system via surface plasmon excitation, and to modulate the plasmon properties via application of a magnetic field[1].

First we will concentrate on the effects of plasmon excitation on the MO response, starting from the analysis of Au/Co/Au nanodiscs[2] where it will be shown how the excitation of a localized surface plasmon (LSP) leads to an enhancement of the electromagnetic field within the MO active layer, which in turns produces an enhancement of the system MO activity (a factor of two at specific wavelengths). This latter effect has also been observed in pure Ni nanowires and membranes, characterized though by a much broader plasmon resonance [3]. The same influence of the LSP on the magneto-optical properties can be observed in systems where the constituents responsible for plasmon excitation and MO activity are spatially separated. This has been shown in structures formed by Au nanodiscs and Au/Co/Au continuous trilayers separated by layers of SiO2[4]. Here the LSP excitation on the nanodiscs induces a redistribution of the electromagnetic field at the Co layer, and an enhanced magneto-optical activity occurs at those energies where the electromagnetic field in the magnetic layer is increased.

The same system will allow the analysis of the effect of the MO activity on the plasmon properties. In this case the application of a magnetic field in the transverse configuration affects the LSP and the surface plasmon polariton (SPP) excitation differently [5]. We will show that the wavevector of the SPP is the physical magnitude which is modified upon application of a magnetic field in the transverse configuration. That modification can be used in a wide variety of scenarios. Here we will discuss its application in active nanointerferometry and biosensing.

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