Towards near field characterization of plasmonic and magnetoplasmonic nanostructures

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Most plasmonic devices are passive devices since their electromagnetic properties depend mainly on the shape of the structures, on the constitutive material of these structures and on the dielectric media. All those characteristics are generally fixed and the optical properties cannot be changed. A way to turn plasmonic devices into active ones is to use ferromagnetic metals, since the magneto-optical (MO) activity of these ferromagnetic metals is responsible for the modification of the optical response when applying an external low magnetic field. Unfortunately, plasmon resonances are critically broadened in ferromagnetic materials due to their important electromagnetic losses. An alternative is to combine ferromagnetic materials with noble metals. Recently, it has been demonstrated that Au/Co/Au nanodisks exhibit magnetoplasmonic properties such as a significant increase of the MO activity when the localized surface plasmon (LSP) resonance is excited[1,2].

Understanding the interplay between the LSP excitation and the MO activity is relevant from both fundamental and technological point of view. A path to this comprehension is to correlate the behavior of the LSP induced electromagnetic field and the MO activity. It has been clearly shown that the increase of MO activity is related to the enhancement of electromagnetic field penetrating into the Co layer[2]. In that way, the goal of this work is to characterize the distribution of the near field at the surface of the magnetoplasmonic structures as a function of their morphologies but also as a function of the position and the size of the ferromagnetic layer. This study will be achieved by combining the method of Scanning Near field Optical Microscopy in collection and illumination configurations with MO characterization. The lasers used to perform near field experiments and the LSP resonance of structures must have their wavelength close enough to couple efficiently the light with the LSP. Since the LSP wavelength is sensitive to the size of the nanostructures, the first step of this work has consisted in varying dimensions of the structures and carrying extinction spectrometry. Preliminary results have been obtained for Au dimers, nanorods and both Au and Au/Co/Au nanodisks, and then compared to other results presented by previous theoretical and experimental studies[3-5].

References:

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