Magneto-optical studies in magneto-plasmonic nano-structured particles

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This work is devoted to the study of the magneto-optical properties of magneto-plasmonic particle based nanostructures. Magneto-plasmonic systems conjugate two materials, a magnetic one (e.g. transition metal) and an element exhibiting localized surface plasmonic resonance (typically noble metals: Au, Ag). By combining these features, it has been recently demonstrated the possibility of developing active magneto-plasmonics systems in which it is possible the modulation of plasmon resonance with an external magnetic field. [5] Moreover, plasmon-mediated enhancement of the magneto-optical response is possible. [6,7,8] In particular, the conjugation of magnetic and plasmonic properties in nanoparticulated structures offers a wide variety of applications in biomedicine: in theranostics, in which the gold shell acts as a protecting agent for the magnetic core, [1] as a highly functionalisable surface, [2] as an optical heater [3] or as an active optical beacon. [4]

The novel magneto-optical properties of the magneto-plasmonic systems are investigated measuring the magnetic circular dichroism (MCD), whereby the different absorption of right- and left-circular polarized light is used to probe the magnetization state of an absorbing sample. Our experimental configuration allows us to carry out room-temperature spectroscopic measurements in the Vis-nIR range (400-1000 nm). In addition, we carried out magnetization cycles at different wavelength, in order to resolve the magnetic contributions due to different electronic transitions or contributions.

We analysed hybrid systems containing gold and ferrites in different geometries, that exhibit different levels of conjugation, thus a variable extent of interaction of magnetic and plasmonic functions, ranging from no interaction (separate gold and ferrite particles), to weak (particle heterodimers) and strong interaction (gold-core@ferrite-shell particles).

The first results indicate that the single MCD responses of the ferrite and noble metal do not sum linearly (i.e. mix of separate particles), suggesting a plasmon amplified MO response and an energy shift of the plasmonic resonance in the MO spectrum . In addition, the MCD study of our hybrid systems allowed us to separate the single MO components of plasmonic and magnetic compounds and to evaluate their degree of hybridization with one another.

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