Magneto-optical properties of nanostructured ferromagnetic films mediated by surface plasmon polaritons

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Magneto-optics offers unique possibilities to manipulate light by making use of an external magnetic field. Recently, this research area has benefited a lot from the connection to the field of plasmonics, producing novel ways of manipulating light at the nanoscale [1]. The main idea is based around using nanostructures made of magnetic materials that simultaneously support plasmon excitations. This can concentrate light in reduced volumes, resulting in an amplification of the electric field, which in turn enhances the magneto-optical response. This increase of the magneto-optical signals, in particular of the Kerr and Faraday effects, paves the way for new applications, for instance, in sensing and biosensing devices [2].

One particular case of interest is the transverse magneto-optical Kerr effect (TMOKE) in periodically patterned ferromagnetic nanostructures. We choose ferromagnetic metals for our research since they combine both, plasmon resonances and magneto-optical activity. In particularly, we focus on the study of hexagonal anti-dot array systems in transverse configuration for Fe [3,4] and Ni [5] (Figs. 1a and 2a). In both cases, experiments show an enhancement of the TMOKE signal, likely mediated by the excitation of surface plasmon polaritons (SPPs). We prove this to be the case, and reproduce quite accurately the experimental results by making use of the dedicated scattering matrix formalism aimed to describe magneto-optical systems for arbitrary orientation of the sample magnetization [4].

In Figs. 1b and 2b the calculated reflectivity and TMOKE are presented, where the dashed lines correspond to the resonant conditions for SPPs. A clear correlation between reflectivity minima and TMOKE maxima and plasmon excitations can be observed.

References

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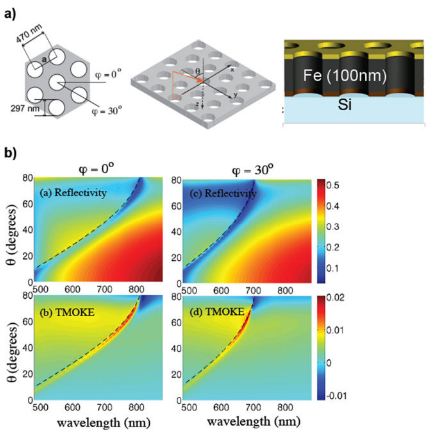

Figure 1: Fe

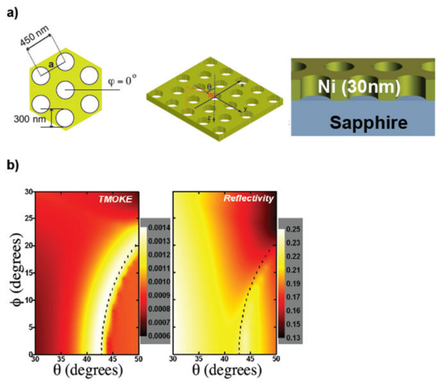

Figure 2: Ni