Sensing Performance of Hybrid Magnetoplasmonic Nanohole Arrays

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Abstract

Plasmonic structures are widely used in low-cost, label-free biosensors, and the investigation of how to improve their sensitivity or to widen their range of applications is a central topic in the field of plasmonics.[1,2] The most commonly used plasmonic sensors are based on the concept of surface plasmon resonance (SPR) and, in particular, on the sensitivity of these resonances to changes in the refractive index of the medium surrounding a metallic structure.
In the search for an improved bulk sensitivity of SPR-based sensors, researchers have proposed different strategies. Thus, for instance, it has been shown that the use of the magneto-optical properties of layered systems containing magnetic materials can, in principle, enhance the sensitivity of these sensors.[3,4] Another possibility that is becoming increasingly popular is the use of nanohole arrays or perforated metallic membranes featuring arrays of subwavelength holes. [5,6] These sensors make use of the extraordinary optical transmission phenomenon, which originates from the resonant excitation of surface plasmons in these periodically patterned nanostructures.
We present here a theoretical study that shows how the use of hybrid magnetoplasmonic crystals comprising both ferromagnetic and noble metals leads to a large enhancement of the performance of nanohole arrays as plasmonic sensors. In particular, we propose using Au−Co−Au films perforated with a periodic array of subwavelength holes as transducers in magnetooptical surface-plasmon-resonance sensors, where the sensing principle is based on measurements of the transverse magnetooptical Kerr effect (TMOKE). We demonstrate that this detection scheme may result in bulk figures of merit that are two orders of magnitude larger than those of any other type of plasmonic sensor.[7] The sensing strategy put forward here can make use of the different advantages of nanohole-based plasmonic sensors such as miniaturization, multiplexing, and its combination with microfluidics.

References

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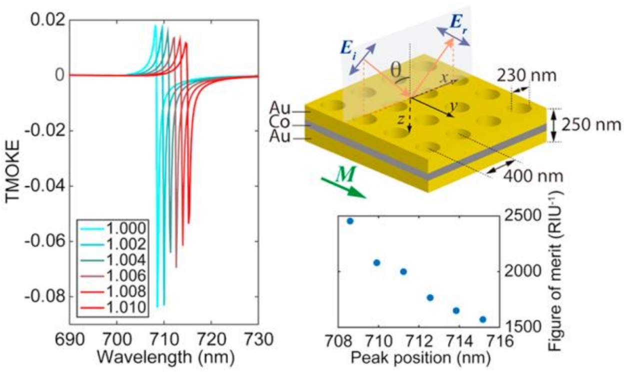
Figures



Left: TMOKE signal as a function of wavelength for varying values of the environment refractive index. Top-right: sketch of the structure used for the study. Bottom-right: figure of merit of obtained from the TMOKE curves.