Sensing Performance of Hybrid Magnetoplasmonic Systems

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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 two case studies showing how the use of hybrid magnetoplasmonic systems comprising in one case 2D crystals using ferromagnetic and noble metals and in the other bare noble metal nanoparticles, lead to a notable enhancement of the sensing performance plasmonic sensors. In particular, we present perforated Au−Co−Au films with a periodic array of subwavelength holes as transducers in magneto-optical surface-plasmon-resonance sensors and a random collection of Au nanoparticles supporting localized plasmon resonances deposited over a glass substrate, but using as transducer signal the measurements of the transverse magnetooptical Kerr effect (TMOKE). We demonstrate that this detection scheme results in (i) bulk figures of merit that are two orders of magnitude larger than those of any other type of plasmonic sensor [7], and an increase of ca. 300% in the refractive index sensing lowering at the same time the limit of detection in a ca. 200% [8]. 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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