Magneto-plasmonic nanoantennas based metamaterials

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The rapidly developing field of magneto-plasmonics merges the concepts from plasmonics and magnetism to realize novel and unexpected phenomena and functionalities for the manipulation of light at the nanoscale. Ferromagnetic nanoantennas support localized plasmons and exhibit magneto-optical activity under external magnetic fields. In this talk I will show recent advances in the field of magneto-plasmonic nanoantennas, and introduce the fundamentals aspects of the physics underlying their peculiar optical behavior [1-3].
Metamaterials based on magneto-plasmonics nanoantennas open a clear path towards applications to variety of emerging technologies as, e.g., ultrasensitive molecular sensing [4,5] and optical metadevices [6,7]. An overview of potential applications will be briefly presented as an example of the broad scientific and technological perspectives enabled by such multifunctional optical metamaterials. Amongst them, the present talk will focus on the potential of such magneto-plasmonic metamaterials as ultrasensitive sensors for biotechnological applications. Systems allowing label-free molecular detection are expected to have enormous impact on biochemistry and biomedicine, and are therefore subject to intense investigation. We propose an innovative and alternative route based on magneto-plasmonic nanoantennas, which enables radically improved sensitivity, clearly outperforming recently reported plasmon based sensors [4,5]. In particular, we show how designed phase compensation in the electric response of these nanostructures enables them to act as ultrasensitive label-free molecular sensors (see Fig. 1). Most remarkably, we achieved a local surface sensitivity of two orders of magnitude higher than the best values reported for nanoplasmonic sensors. Such sensitivity corresponds to a mass of ~0.8 attog/nanoantenna of polyamide-6.6 (n=1.51), which is representative for a large variety of polymers, peptides and proteins.

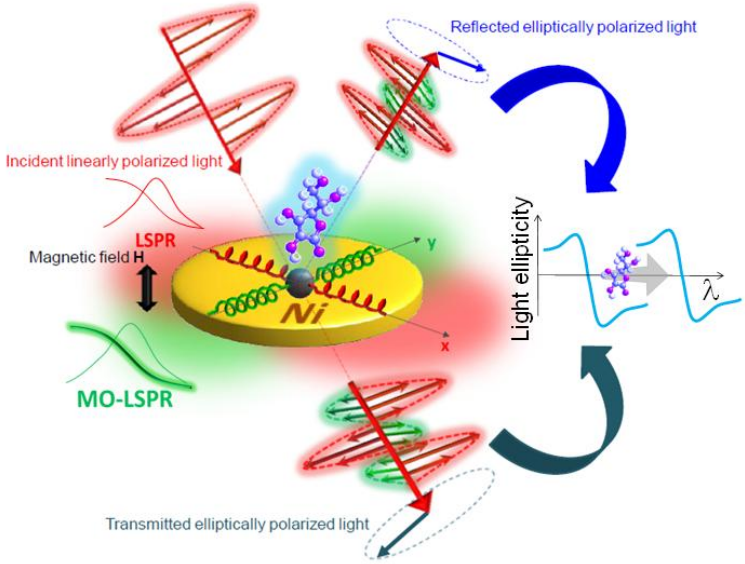

Fig. 1 Light polarization manipulation enabled by phase compensation in the electric response of a magneto-plasmonic nanoantenna controlled through precise design of the LPRS resonance induced by the magneto-optical activity (MO-LSPR) of the ferromagnetic constituent material (Ni) and exploitation of the effect for ultrasensitive molecular sensing.

References

[1] J. Chen et al. Small **7** (2011) 2341
[2] N. Maccaferri et al., Phys. Rev. Lett. **111** (2013) 167401
[3] N. Maccaferri et al. Opt. Express **21** (2013) 9875
[4] V. Bonanni et al. Nano Lett. **11** (2011) 5333
[5] N. Maccaferri et al., Nature Commun. **6**, 6150 (2015)
[6] K. Lodewijks et al., Nano Lett. **14** (2014) 77
[7] I. Zubritskaya et al. submitted to Nano Lett.