High-sensititive magnetoplasmonic label-free sensing using Ni nanodisks

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Abstract

Plasmonic sensors based on the environment sensitivity of localized surface plasmon resonances (LSPRs) excited in metallic nanoparticles are attracting a lot of attention. Pure ferromagnetic (FM) nanostructures are not usually considered for sensing purposes, due to their highly damped plasmonic behavior [1]. FM nanostructures show intrinsically higher LSPRs refractive index sensitivity ($S_{RI}=\Delta\lambda_{LSPR}/\Delta n$) than noble metals. However, the broad and low intensity plasmonic peak result in a figure of merit (FoM, defined as S_{RI} normalized to the FWHM of the LSPR peak) much lower than that for noble metal nanostructures. Pure FM plasmonic nanostructures supporting LSPRs and magneto-optical (MO) activity [2-4] have been investigated. By taking advantage of the magneto-optical Kerr effect (MOKE), phase-sensitive measurements of LSPRs are enabled by looking at the spectral position of the Kerr ellipticity ε_K vanishing point (zero crossing) [4]. Using this concept we show that pure FM nanostructures provide unprecedented sensitive detection capabilities, having significantly higher SRI than standard noble metals [5]. In addition and more important, the high precision tracking of the ellipticity vanishing point results in FoMs exceeding 10^2, even higher than the maximum values measured for noble metal nanostructured systems based on LSPRs reported in literature [6]. This really opens the pathway to an entirely unused class nanostructured materials for sensing applications.

References

[1] J. Chen et al., Small **7** (2011) 2341.
[2] V. Bonanni et al., Nano Lett., **11** (2011) 5333.
[3] N. Maccaferri et al., Optics Express **21** (2013) 9875.
[4] N. Maccaferri et al., Phys. Status Solidi A, in press (2014).
[5] N. Maccaferri et al., Phys. Rev. Lett. **111** (2013) 167401.
[6] N. Maccaferri et al., submitted (2014).
[7]Y. Shen et al., Nat. Comm. **4** (2013) 2381.

Figures

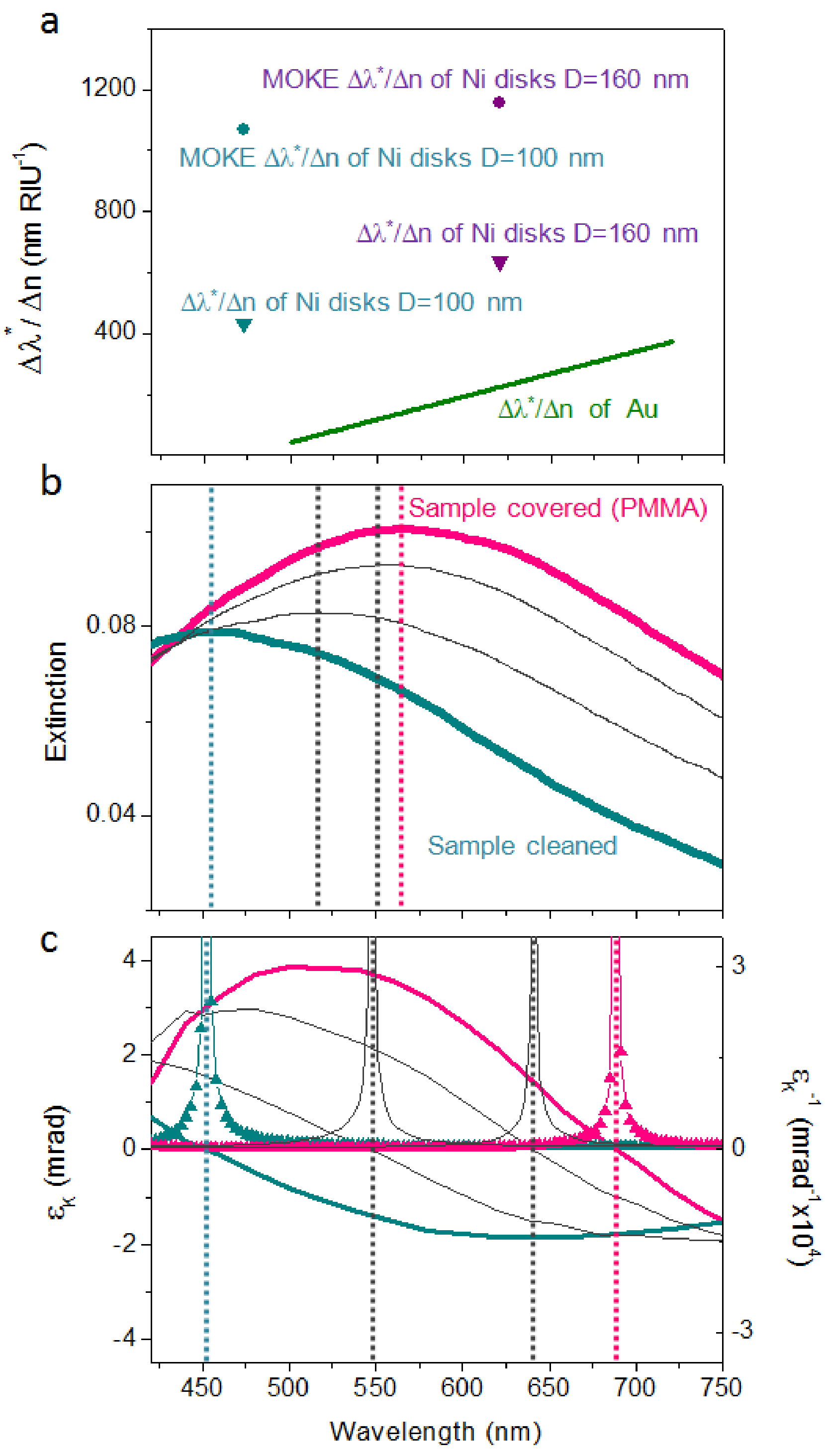

Figure 1. a Comparison between the optical sensitivity of Au nanostructures and the optical and magneto-optical sensitivities of Ni nanostructures. **b** Extinction spectra of Ni nanodisks before and after PMMA spin-coating (grey lines correspond to intermediate steps of covering). **c** Magneto-optical Kerr effect (MOKE) measurements of the Kerr ellipticity ε_K and of its inverse ε_K^{-1} before and after PMMA spin-coating.