Broad band infrared modulation with spintronic-plasmonic metasurfaces

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Giant Magneto Resistance (GMR) materials have been incorporated into the list of candidates for active-control, demonstrating modulation of mid-IR response in spintronic-plasmonic platforms using very low magnetic fields [1, 2]. This is due to the change in the optical response induced by the magnetic field as a result of the change in electrical resistivity (Magneto Refractive Effect or MRE), which enables fast and contactless modulation of the optical properties of the spintronic material in the IR and longer wavelengths. We experimentally demonstrate and theoretically confirm that metasurfaces consisting of arrays of randomly distributed slits fabricated on $Ni_{81}Fe_{19}$/Au multilayers exhibiting 4.2% GMR, show spintronic modulation of their optical properties in the 2-17 μm range of the spectrum, using very low magnetic fields. We find a continuous increase of the modulation of the optical reflectivity with both the slit concentration and the slit length and a red-shift of the plasmon peak position at which the modulation takes on for longer slits. These results open a route to design active metasurfaces covering different spectral regions (mid-far IR, THz, GHz...), by simply adapting the size and shape of the building blocks and their spatial distribution.

References

[1] G. Armelles et al., Opt. Express 25, 18784 (2017).
[2] G. Armelles et al., ACS Photonics 5, 3956 (2018).

Figures

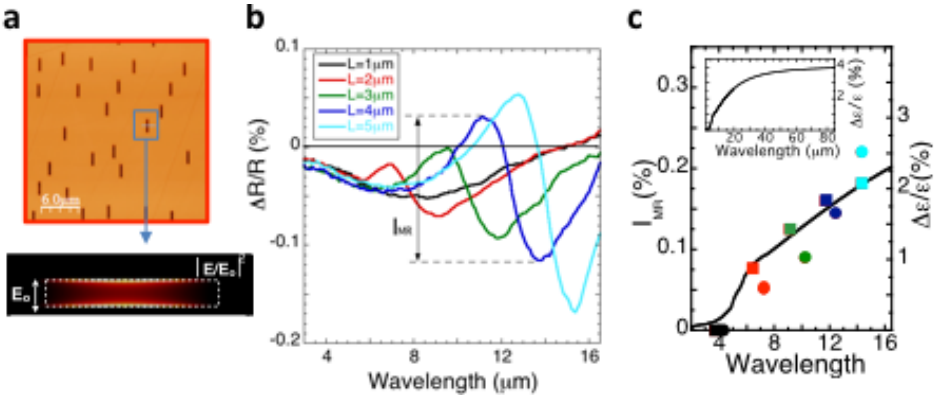

Figure 1. a) AFM image of slit metasurface (2.1% and L=2μm) and field enhancement, b) magnetic modulation for slits of different lengths and c) experimental (dots) and theoretical (squares) amplitude of magnetic modulation (I_{MR}). Black curve: magneto-induced variation of dielectric constant due to MR effect.