Department of Physics
Condensed Matter Physics
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UNIVERSITY OF OXFORD

CONDENSED MATTER SPECIAL SEMINAR

Thursday 5 May at 15.30

"Energy efficient single pulse switching of [Co/Gd/Pt]N metasurfaces using surface lattice resonances"

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Plasmonic surface lattice resonances, visible in periodic arrays of nanodisks, arise from radiative coupling between the localized surface plasmon resonance[1,2] of individual particles and diffracted orders[3]. Here, we study the impact of these optical modes on the magneto-optical properties[4] and energy absorption efficiency[5] of [Co/Gd/Pt]N nanodisks by measuring the response of different arrays to optical excitations as function of the light wavelength, the disk diameter, and the array period. We demonstrate that surface lattice resonances allow all-optical single pulse switching[6,7] of the nanodisks using much less energy than for the thin film, with an energy absorption enhanced by more than 4. Besides, these optical modes enhanced the magneto-optical Faraday effect by more than a factor of 4. The influence of the disk diameter and array period on the amplitude, width and position of the resonances is in qualitative agreement with theoretical calculations and opens the way to design magnetic metasurfaces for all-optical magnetic recording whose energy efficiency and magneto-optical read-back sensitivity are optimized for any given light wavelength.

[1] Liu, T.-M., et al. Nanoscale Confinement of All-Optical Magnetic switching in TbFeCo – Competition with Nanoscale Heterogeneity. Nanoletters, 15:6862 – 6868, 2015.
[2] Savoini, M., et al. Highly efficient all-optical switching of magnetization in GdFeCo microstructures by interference-enhanced absorption of light. Physical Review B, 86:140404, 2012.
[3] Kataja, M., et al. Surface lattice resonances and magneto-optical response in magnetic nanoparticle arrays. Nature Communications, 6:1 – 8, 2015.
[4] Freire-Fernández, F., et al. Magnetoplasmonic properties of perpendicularly magnetized [Co/Pt]N nanodots. Physical Review B, 101:054416, 2020.
[5] Kataja, M., et al. Plasmon-induced demagnetization and magnetic switching in nickel nanoparticle arrays. Applied Physics Letters, 112:072406, 2018.
[6] Radu, I., et al. Transient ferromagnetic-like state mediating ultrafast reversal of antiferromagnetically coupled spins. Nature, 472:205 – 208, 2011.
[7] Lalieu, M. L. M., et al. Deterministic all-optical switching of synthetic ferrimagnets using single femtoseccond laser pulses. Physical Review B, 96:220411, 2017

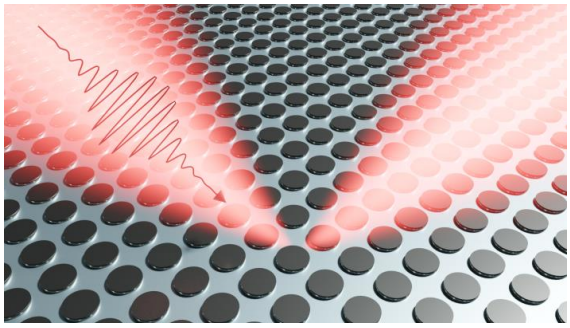

FIGURE. Magnetic $[Co/Gd/Pt]_N$ metasurface. Inset: SEM image of a $[Co/Gd/Pt]_2$ nanodisk array with D = 150 nm and P = 500 nm. The scale bar corresponds to 200 nm.

Host: Prof John Gregg
Audrey Wood room