Università degli Studi di Padova

Venerdì **20 Settembre 2019** alle ore **14:30** presso l'aula **H**

il **Prof. Francesco Pineider**

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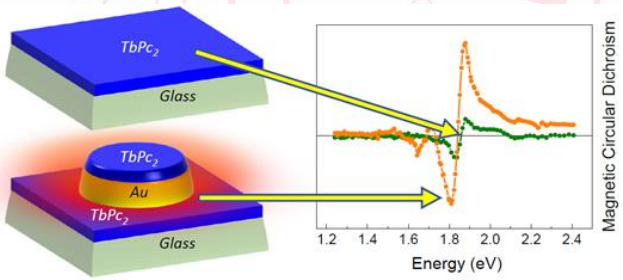
terrà il seminario dal titolo:

Magnets and Plasmons – A story of love and hate

Magnetoplasmonics is a form of active plasmonics in which an external magnetic field is used to modulate the resonance conditions of a plasmonic system.[1] The amplitude of the modulation is rather small in purely plasmonic resonators,[2,3] but it can increase significantly if a magnetic metal able to sustain plasmon resonance is used,[4] or by designing appropriate hybrid magnetic-plasmonic structures.[5] Fast modulation of the plasmonic response can be used to dramatically increase the figure of merit in refractometric sensing:[3,6] this is particularly appealing in view of localized plasmon resonance-based sensing.[7] The successful design and production of efficient magnetoplasmonic materials must abide by three intertwined criteria, which constitute the *magnetoplasmonic trilemma*: i) The magnetic component must be sufficiently strong and magnetically coupled; ii) The plasmonic component must give rise to sharp and well defined plasmon resonances; iii) The two components must be coupled. Satisfying each of the three conditions tends to have a negative effect on the other two. On the other hand, the requirement that the magnetic and plasmonic functions interact has generally has a negative influence on both magnetic and plasmonic functions.

Several reports have appeared in the literature using multilayer structures of plasmonic and magnetic metals, or by using the weak plasmonic properties of magnetic metals. An alternative approach consists in mixing noble metals and magnetic metals at the atomic level, by forming alloy nanostructures. This process strongly alters the electronic structure of the two species, forming a third phase, whose optical and magnetic properties can differ strongly from those of the starting materials. Here we show results on Au nanospheres doped with 10% Fe atoms by laser ablation,[8] which maintain good plasmonic properties and the Fe centres are magnetically coupled at low temperature, giving a relatively strong magnetic response.

Independently of magnetic doping, plasmon modulation can be significantly altered by modifying the features of charge carriers. In particular, the effective mass of charge carriers directly controls the magnitude of field modulation. These effects have been recently shown on heavily doped semiconductors of different types,[9] and can result in a tenfold enhancement of the magnetic field modulation efficiency in non-magnetic indium tin oxide nanospheres with respect to gold or silver nanoparticles.



Finally, in a slightly different topic, we will show what we believe is the first demonstration of plasmon-enhanced magneto-optics on single-molecule magnets. The significant boost in magneto-optical response afforded by the nanoantennas allows obtaining spectroscopic and magnetometric information of the molecular deposit.[10]

With this proof of concept, we suggest that with appropriate tuning of the plasmon resonance of the nanoantenna to the molecular absorption bands this could become a general method to study reduced amounts of magnetic materials on surface.

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References:
1) G. Armelles et al., Adv. Opt. Mater. 1, 10 (2013). 2) B. Sepúlveda et al., Phys. Rev. Lett. 104, 147401 (2010). 3) F. Pineider et al., Nano Lett 13, 4785 (2013). 4) N. Maccaferri et al., Phys.Rev. Lett. 111, 167401 (2013). 5) J. B. González-Díaz et al., Small 4, 202 (2008). 6) N. Maccaferri et al., Nature Commun. 6 (2015). 7) J. N. Anker et al., Nature Mater. 7, 442 (2008). 8) V. Amendola, et al., Nanoscale 5, 5611 (2013). 9) K.H. Hartstein et al., J. Phys. Chem. Lett. 8, 1831 (2017). 10) F. Pineider et al., Mater. Horiz. 6, 1148 (2019).

La presenza della S. V. sarà molto gradita

Sara Bonacchi

Il Direttore del Dipartimento
Michele Maggini