Magneto-optics and Magneto-plasmonics

VAVASSORI PAOLO
CIC nanoGUNE and IKERBASQUE, the Basque Foundation for Science, Spain
p.vavassori@nanogune.eu

The rapidly developing field of magneto-plasmonics merges concepts from plasmonics and magnetism to realize novel and unexpected phenomena and functionalities for the manipulation of light at the nanoscale.

These two lectures will cover recent advances in this emergent field, which contributed to broaden the understanding and control of optics at the nanoscale in ferromagnetic nanostrucutres owing to the intertwined optical and magneto-optical properties.

The first lecture focuses on the magneto-optic Kerr effect (MOKE) [1]. MOKE is widely used in studying technologically relevant magnetic materials since it profits from high surface sensitivity, material and depth sensitivity, its nondestructive character, and the possibility to measure all components of the magnetization vector (vector magnetometry) in an easy and straightforward fashion [2]. Real time measurements in the sub-ns range and stroboscopic measurements in the sub-ps range have also been demonstrated [3]. Thanks to these unique features, MOKE instruments have steadily improved and the technique continues to be a key experimental tool of magnetic nanostructure research. The lecture will provide with an introduction to the physics underlying magneto-optical properties of materials, their modeling, as well as to the techniques and tools utilized for their measurement [1]. Examples of relevant applications to advanced magnetometry and magnetic imaging will be also provided [4-7].

In the second lecture, I will start with introducing the fundamental physical aspects at the base of the excitation of localized and propagating surface plasmon excitations in metallic nanostructures and films [8]. Then, I will move to the effects arising from the intertwined optical and magneto-optical properties occurring in magneto-plasmonic structures [9, 10]. I will show how such materials can be engineered to offer a smart toolbox for actively tunable optical and magneto-optical ultrathin surfaces and metasurfaces.

Finally, applications of such multifunctional optical metamaterials to a variety of emerging technologies will be surveyed as an example of their broad scientific and technological perspectives [11-13].

References

[1] - A K Zvezdin A. K. and Kotov V. A. *Modern magnetooptics and magnetooptical materials*. New York: Taylor&Francis Group (1997).
[2] - Vavassori P., *Appl. Phys. Lett.* **77**, 1605 (2000).
[3] - Acremann Y. et al., *Science* **290**, 492 (2000).
[4] - Grimsditch M. and Vavassori P., *J. Phys.: Condens. Matter.* **16**, R275 (2004).
[5] - Verduci T., Rufo C., Berger A., Metlushko V., Ilic B., and Vavassori P., *Appl. Phys. Lett.* **99**, 092501 (2011)
[6] - Nikulina E., Idigoras O., Vavassori P., Chuvilin A., and Berger A., *Appl. Phys. Lett.* **100**, 142401 (2012).
[7] - McCord J, *J. Phys. D: Appl. Phys.* **48**, 333001 (2015).
[8] – Mayer S. A. *Plasmonics: Fundamentals and Applications*. Springer (2007).
[9] – Bonanni V. et al., *Nano Lett.* **11**, 5333 (2011).
[10] – Maccaferri N. et al., *Phys. Rev. Lett.* **111**, 167401 (2013).
[11] - Lodewijks k. et al., *Nano Lett.* **14**, 7207 (2014).
[12] - Maccaferri N. et al., *Nature Commun.* **6**, 6150 (2015).
[13] - Zubritskaya I., Maccaferri N., Inchausti X., Vavassori P., and Dmitriev A., *Nano Lett.* **18**, 302 (2018).