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nanoscience cooperative research center

RESEARCH PROJECT FOR UNDERGRADUATES | IKASIKER 2016

Nanostructured Magnetic Metamaterials for Light Manipulation

In the last decade, and driven by the strong development of nanotechnology, there has been an increased interest in the study of the optical properties of metallic nanostructures and nanoparticles and their ability to control and manipulate light. In particular, it was found that tailor designed nanostructured materials offers the possibility to control propagation, localization, and polarization of light at the nanoscale and beyond the intrinsic properties of the constituent material. A current focal point of research is, thereby, the development of novel nanostructured composite materials (metamaterials) with "designed" and tunable optical properties. These novel materials exploit the capability of metallic nanoparticles to confine the electromagnetic (EM) field beyond the diffraction limit when properly excited by the electromagnetic field of a light beam impinging on them (localized plasmon resonance).

In this project, we aim at the design and nanofabriation of composite metamaterials made of ferromagnetic nanoelements (magnetoplasmonic nanoantennas) because they combine the plasmonic behavior described above with intertwined optical and magnetic properties (magneto-optical activity). Which are activated by the application of an external magnetic field. Thereby, the use of magneto-optical -active nanostructures can open up the pathway to design new types of photonic devices and biosensors with enhanced performances, which can be remotely controlled by external magnetic fields.

In this project, the student will conduct laser-based spectrometric characterization of such magneto-plasmoinc metamaterials to measure light intensity/polarization and intensity/polarization changes with a very high degree of precision. The student will also participate to the nanofabrication of the samples, namely of metamaterials made of ferromagnetic-alloys and multilayered nano-structures of several sizes and shape deposited on a dielectric substrate, also prepared in our laboratory. The acquired data will then be analyzed using modeling tools based on standard electromagnetic theory, which has been specifically devised in our group to deal with nano-scale optical objects.

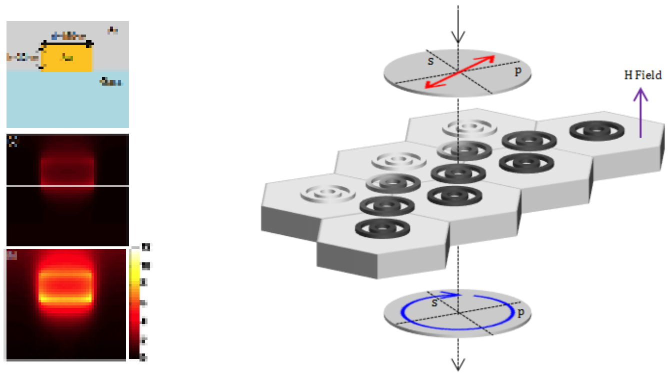

Figure: (left panel) electromagnetic field confinement effect due to the excitation of a localized plasmon in a metallic nanostructure; (central panel) example of a nanofotonic device for light polarization manipulation; (right panel) examples of ferromagnetic nanoscale optical objects implementing magneto-plasmonic functionalitites.

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SUITABLE FOR: physicists, materials scientists, engineers