Nano-plasmonic devices: from fabrication to applications

Course at a Glance

Introduction to nanofabrication: top-down and bottom-up approaches for the realization of plasmonic devices.

Instructors

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Credits: 3

Synopsis

The fabrication of complex plasmonic nanostructures integrated in innovative device architectures represents a multidisciplinary key activity at the core of most research efforts in nanoscience and technology. In particular, the possibility to promote giant field enhancement has gained increasing attention over the last few years, enabling the detection of molecules in highly diluted liquids [1], and/or the spectral signature collection of single/few molecules concentrated in nanovolumes [2]. The "hot spot" concept, induced by localized surface plasmon resonances (LSPR), will be introduced as core idea behind the surface-enhanced infrared absorption (SEIRA) and the surface-enhanced Raman spectroscopy (SERS) [3]. Within this context, we will pay attention to the state of the art nanofabrication technologies, e.g. following top-down or bottom-up methods. In details, top-down fabrication refers to approaches such as electron beam lithography (EBL) or focused ion beam lithography (FIB) where focused electrons or ions are used to carve nanostructures into macroscopically dimensioned materials. Alternatively, in the bottom-up approach, one begins to assemble nanostructures from smaller units. Examples will include colloidal synthesis and unfocused ion beam sputtering.

Syllabus

The course develops in about 9/10 hours in the classroom.

- Nanofabrication technologies: top-down and bottom-up approaches for the realization of next-generation devices.
- Nano-plasmonic devices: design and realization of ultrasensitive biosensors.
- SEIRA and SERS: employing plasmonic devices for the ultrasensitive detection both in the visible and in the infrared range.

The examination consists in a journal club or a brief research project proposal.

Reading list

[1] F. De Angelis, F. Gentile, F. Mecarini, G. Das, M. Moretti, P. Candeloro, M. L. Coluccio, G. Cojoc, A. Accardo, C. Liberale, R. P. Zaccaria, G. Perozziello, L. Tirinato, A. Toma, G. Cuda, R. Cingolani, E. Di Fabrizio, *Breaking the diffusion limit with super-hydrophobic delivery of molecules to plasmonic nanofocusing SERS structures,* **Nature Photon. 5** (2011) 682.
[2] K. Kneipp, Y. Wang, H. Kneipp, L. T. Perelman, I. Itzkan, R. R. Dasari, M. S. Feld, *Single Molecule Detection Using Surface-Enhanced Raman Scattering (SERS),* **Phys. Rev. Lett. 78** (1997) 1668.
[3] R. Aroca, *Surface-Enhanced Vibrational Spectroscopy,* **Wiley** (2006).

Venue

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Course date

September-November 2015