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A Plasmonic nano device for spectroscopy, transport and imaging investigation of the nano world

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Abstract:

Nanoplasmonics, i.e. the way to control optical phenomena at the nanoscale, has greatly developed over the past decades, promoting the disclosure of many fundamental scientific breakthroughs pushing to a new level the knowledge and the use of nanoscale optoelectronic devices in material and life science.
We have recently introduced a new multidisciplinary investigation technique focused on hot electrons nanoscopy and spectroscopy, HENs, that relies on a multifunctional plasmonic device. The instrument allows topographical, electrical as well as Raman investigation at the nanoscale. The physical principle relies on the intrinsic electromechanical nature of Surface Plasmon Polaritons, SPPs, which are responsible for a local field enhancement at the nanoscale.
While propagating in metals, SPPs decay to form highly energetic “hot-“electrons in a process that is usually unfavorable for the lifetime and propagation of these electromechanical excitations. However, it is possible to take advantage of enhanced interaction of light with metallic nanostructures using a suitable 3D plasmonic probe. We review the main aspects that led to the squeezing of the electromagnetic energy, overcoming both limits, the fundamental optical diffraction, and the energy transport of the electrons in the metal, yet offering a nanometric spatial resolution for topography, optical spectroscopy, and hot electrons (he-) nanoscopy. We foresee that the concurrent application of such techniques will play a key role in relating the functional and structural properties of a tiny amount of matter down to the single molecule essay.
As an example, we report the use of HENs for the characterization of innovative semiconductors for applications in electronics: 2D MoS_2 single crystal and a p-type SnO layer. HENs reveals new features of local complexity at nanometric scale otherwise undetected with conventional techniques.

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