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Multiple hot spots 3D nanostructures: ultrasensitive substrates for surface-enhanced Raman spectroscopy

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Over the last few years, great efforts have been made in order to increase the performances of sensors down to ultralow concentrations (10-15 м) of analyte molecules, with exceptional consequences in the fields of photonics, nonlinear optics and imaging. Within this context, Surface Enhanced Raman Spectroscopy (SERS) provides label-free detection of analytes down to the single-molecule level with high specificity and sensitivity. Conventional and cost-effective approaches exploit bottom-up techniques for the realization of large SERS substrates with a random and high density distribution of active sites, also called hot spots. Complementary strategies employ top-down methods, which allow the realization of high uniformity SERS active surfaces with precise control over the position, size and shape of the hot spots. By taking advantage of the interaction between analyte molecules and enhanced optical near-fields in the vicinity of resonantly excited plasmonic nanostructures, plasmon-based devices represent a good candidate for SERS. Here, we present the realization and experimental characterization of 3D multi-branched nanostructures as a viable strategy for intense electric hot-spot generation and SERS applications. Our structures, arranged in isolated or coupled configuration, support intense localized surface plasmon resonances (LSPRs) with an associated giant electromagnetic (EM) field confinement and enhancement factors up to 108. Further developments of our 3D nanostructures have led to the realization of bimetallic Au/Ag nanostructures with a multi-branched geometry. This novel architecture integrates the advantages of extremely high EM field enhancement, owing to the plasmonic properties of Ag, with the excellent biocompatibility and chemical stability provided by the single metal Au analogue. Moreover, the present layout can support large hot spots densities comparable to those obtained with bottom-up techniques, although with greater reproducibility and precise control over the spatial location of the active areas.

Biography

Andrea Cerea is currently pursuing his PhD at University of Genoa and the Italian Institute of Technology. He is working in the Plasmon Nanotechnology Group, with focus on the development of photonic metamaterials for electromagnetic field manipulation.

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