Multistructured metallic substrate as a new SERS platform: experimental studies and electromagnetic modeling of localized plasmon surface

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Since the first observation of Surface Enhanced Raman Scattering (SERS) in 1974¹, a variety of methods have been developed to control physically the arrangement of metallic nanostructures onto a surface in order to enhance Raman signals. It is now generally believed that the magnitude of the SERS enhancement factor is mainly driven by the enhanced local electromagnetic field in nanostructured metal surfaces². Previous studies revealed that gaps between adjacent nanoparticles or roughness give rise to strong enhancement effects, often referred to as ‘hot spots’. In 2014, we patented a force-assisted Atomic Force Microscopy lithographic method³ allowing fabrication of reproducible metallic nanostructures with various shapes and sizes on the same substrate that can be solid or flexible.

Figure 1. SEM and AFM pictures of various gold nanostructures

In order to investigate the relationship between nanostructures network geometry and spectral dependency of the local field enhancement, plasmonic response of nanostructures has been simulated using COMSOL Multiphysics®. Localization of hot spot has been experimentally confirmed with Photoemission Electron Microscopy measures on different nanostructures and we also studied the SERS efficiency of our substrates by analyzing the Raman signal after immersion in diluted solution of Benzenethiol (10⁻⁶). This kind of multistructured substrate opens the way for new theoretical and experimental fields in order to study and optimize physical mechanisms involved in SERS phenomenon.

Figure 2. Raman spectra and local field calculation on various gold nanostructures

References
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