Design of advanced nanoplasmonic sensors

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Today, there are several well-established research directions in which plasmonic detection is used extensively, namely food and water quality monitoring, the study of viruses, pathogenic bacteria and hazardous toxins for theranostic applications and other purposes. The combination of vibrational spectroscopy and surface nanoengineering has established itself as a powerful tool for the rapid and accurate determination of sub-molecular quantities of nanoanalytes known as SERS (Surface Enhanced Raman Scattering). Signal enhancement through the use of various metallic nanoparticles and nanostructures is significantly increased due to the confinement effect of the electromagnetic field. Localised surface plasmon waves responsible for this phenomenon promote light absorption in the nanovolume and create 'hot spots' with an incredibly intense and confined electromagnetic field near the nanoscale metal surface.

However, the formation of the hot spot network strongly depends on the morphology, size and spatial arrangement of the plasmonic nanomaterials. Under optimal excitation conditions, the interaction between the optically induced electromagnetic field in the hot-spot region and an analyte bound to the nanoscale metal substrate increases the scattering cross-section of the photons, increasing the signal intensity by 10^6-10^{10}. This enables rapid recording of single-molecule vibrational fingerprints. Here, plasma fabrication of such nanoplasmonic surfaces has been used due to its versatility compared to other nanofabrication techniques, its reliability and its fast and one-step processing.

This talk will highlight our recent research in the design of advanced nanoplasmonic surfaces with high surface-to-volume ratio (nanocarbon structures, metal-oxide nanotrees, coupled nanogold) with different plasma setups (low-pressure and atmospheric pressure) that excel in everything from cancerogenic toxic molecules detection at ppb level to ultrafast recognition of other chemicals at trace level. Furthermore, even the detection of the bacterial DNA and its analysis with nanogram sample amounts is possible.

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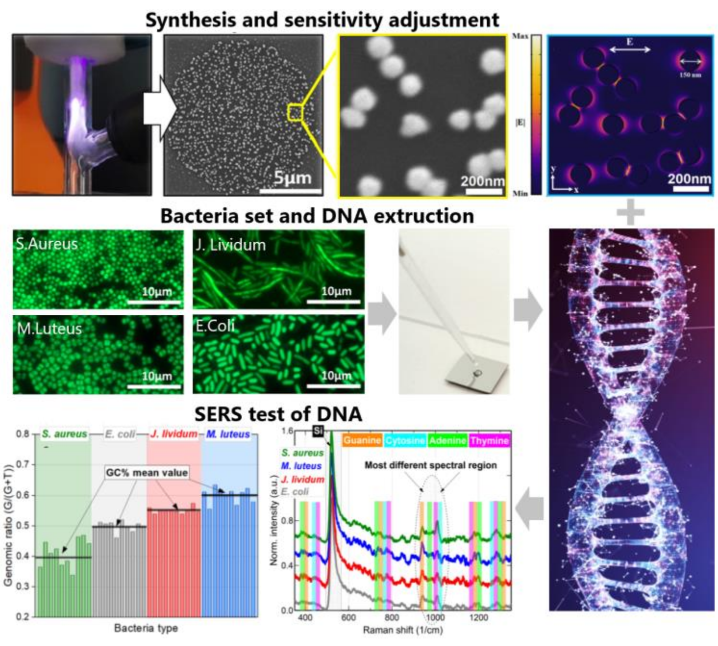

Fig-1. An example of distinctive DNA SERS sensing with plasma-made nanogold plasmonic chip.