Plasmonic hot spot engineering for reliable SERS biosensors: from reproducible detection, quantitative analysis to single-molecule sequencing

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Abstract

Plasmonic resonance in noble metal nanostructures can generate enhanced electromagnetic fields, so-called plasmonic hot spots, which find broad applications in surface-enhanced Raman scattering (SERS) biosensing. While the hot spots can be reproduced on ordered nanostructures on solid-state SERS substrates, analyte molecules' access to the hot spots become the key to produce reproducible and strong SERS signals. For example, although the hot spot of 2-nm nanogap between 2 nanoparticles exhibits a 10^8 enhancement factor, <1% of analyte molecules could enter the nanogap.

In this talk, I will present several works in my group and collaborators in plasmonic hot spot engineering for reliable SERS biosensing systems. They include the gap-free nanopillar system[1] with open hot spot that allows easy access by large biomolecules to produce reproducible SERS signals. Due to the reliable SERS signals, the nanopillar system achieved quantitative multiplexing SERS of mixed solution of 3 analytes[2], and real-time SERS monitoring of chemical reactions on a microfluidic chip[3]. On the other hand, we also generated a single hot spot on a single nanogap sensor that has demonstrated reproducible single-molecule SERS detection of 4 DNA bases[4] and 20 proteinogenic amino acids[5]. By reading single base in single RNA[4] and single amino acid in single peptide[6], our works have paved a ground-breaking way to single-molecule Raman sequencing. The talk will be concluded by summarizing general practices to use averaging effects for improving signal reliability in gap-free and gap-based SERS systems [7].

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