Study on Biomolecules by Electrokinetic Concentration-based SERS Amplification

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Surface enhanced Raman scattering (SERS) of molecules can reach the dimensions making the detection of single molecules possible by the two main contributions. One is a locally amplified excitation of illuminated at sharp tips or on rough surfaces of some metals and is usually described as electromagnetic (EM) effect. The other contribution is a dynamic charge transfer (CT) effect from electronic states of the absorbed molecule to the metal.

We have developed a SERS substrate based on nanowell structured array showing the EM effect and amplified the enhancement by electrokinetically concentrating the absorbed molecules on the substrate to improve CT effect. The optimized nanowell was a uniformly patterned nanostructure in 150 nm diameter and down to 20 nm gap and was coated with island-shaped Au layer of 20 nm in thickness. The optimized nanowells showed a strong SERS of Adenine because the coupling on the rough surface has the EM effect and the uniformly fabricated structure improved the EM effect with the large number of uniform hot spots. Electro-kinetic concentration improved CT effect by increasing the concentration of the adsorbed molecules on the substrate. The enhancement by the concentration was characterized by measuring SERS of Adenine while increasing the duration and the magnitude of the applied voltage. The intensity of 1μM Adenine at 735 cm^{-1} was observed a consistent increase as the duration and the magnitude of the voltage increased.

We have demonstrated that the SERS of biomolecule can be enhanced by EM effect with the nanowell structure and CT effects can be amplified by the electrokinetic concentration. Thus we are planning to apply these techniques to observe the orientation information of biomolecule by the applying electrokinetics to the SERS-active nanowell structure.

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