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Surface-Enhanced Raman Spectroscopy-Based Detection of SARS-CoV-2 Through In Situ One-pot Electrochemical Synthesis of 3D Au-Lysate Nanocomposite Structures on Plasmonic Au Electrodes

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Abstract : The ongoing COVID-19 pandemic, caused by the SARS-CoV-2 virus and is gradually shifting to an endemic phase which implies the outbreak is far from over and will be difficult to eradicate. Global cooperation has led to unified precautions that aim to suppress epidemiological spread (e.g., through travel restrictions) and reach herd immunity (through vaccinations); however, the primary strategy to restrain the spread of the virus in mass populations relies on screening protocols that enable rapid on-site diagnosis of infections. Herein, we employed surface enhanced Raman spectroscopy (SERS) for the rapid detection of SARS-CoV-2 lysate on an Au-modified Au nanodimple(AuND)electrode. Through in situone-pot Au electrodeposition on the AuND electrode, Au-lysate nanocomposites were synthesized, generating3D internal hotspots for large SERS signal enhancements within 30 s of the deposition. The capture of lysate into newly generated plasmonic nanogaps within the nanocomposite structures enhanced metal-spike protein contact in 3D spaces and served as hotspots for sensitive detection. The limit of detection of SARS-CoV-2 lysate was 5 x 10-2 PFU/mL. Interestingly, ultrasensitive detection of the lysates of influenza A/H1N1 and respiratory syncytial virus (RSV) was possible, but the method showed ultimate selectivity for SARS-CoV-2 in lysate solution mixtures. We investigated the practical application of the approach for rapid on-site diagnosis by detecting SARS-CoV-2 lysate spiked in normal human saliva at ultralow concentrations. The results presented demonstrate the reliability and sensitivity of the assay for rapid diagnosis of COVID-19.

Keywords : label-free detection, nanocomposites, SARS-CoV-2, surface-enhanced raman spectroscopy
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