UNDERSTANDING THE SURFACE ENHANCED RAMAN SPECTROSCOPY (SERS) SIGNALS OF AMINO ACIDS, PEPTIDES, AND PROTEINS FOR BIOSENSING APPLICATIONS

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One promising diagnostic tool for viral infection is surface enhanced Raman spectroscopy (SERS), which is a quick, sensitive light scattering technique that uses the energy of the bonds as a fingerprint to identify molecules. SERS yields enhanced Raman signals by positioning analytes near the surface of metal nanostructures and creating localized, electric fields around the metal with a resonant laser. Fundamentally, the vibrational signatures of peptides and proteins rely on their amino acid composition, secondary structure, and local environment. The SERS signals of these species are further complicated by interactions with the metal nanostructures. For instance, the SERS signals of a peptide can differ if the peptide is adsorbed to a gold nanostructured substrate versus a gold nanoparticle. As another example, tryptophan is an important aromatic residue within the binding domain of many proteins, but its SERS signal shows distinct differences from its Raman signal. These changes in tryptophan's signal can impact the overall signal from the peptides or proteins it comprises. Using SERS for biosensing requires determining the vibrational signature of the target molecule, which then allows for identification. In SERS sensing of viruses, a common concern is signal variability based on the orientation of these large species on the nanostructure surface. Fortunately, capture molecules can improve signal reproducibility by forcing the analyte into a consistent surface orientation, as well as by selectively targeting the analyte to avoid interference. Peptides can be used to bind the surface proteins of viruses and capture them on SERS surfaces to identify their SERS signatures. In this work, we investigate the SERS signals of a SARS-CoV-2 spike-binding peptide both before and after spike protein binding, along with those of tryptophan and tryptophan-containing peptides, on gold SERS surfaces. Understanding the origins of these signals will provide a basis for the design of a peptide-surface protein-based SERS assay for SARS-CoV-2, along with other potential viruses in the future.