## K44 Surface Enhanced Raman Scattering (SERS) Analysis for Synthetic Opioids

*Xuyang He*, University of Southern Mississippi, Hattiesburg, MS 39406*

**Learning Overview:** After attending this presentation, attendees will understand: (1) how sensitive and useful the SERS technique is in forensic drug/toxicological analysis, (2) how to optimize the signal enhancement to various degrees by using different metal substrate/solvent/aggregating reagents, and (3) how to do a quantitative measurement with SERS.

**Impact on the Forensic Science Community:** This presentation will impact the forensic science community by elucidating the application of SERS in forensic investigations regarding synthetic opioids. In most cases, SERS was deemed a rapid and sensitive screening test, but SERS can also work as a reliable confirmatory test if used properly.

Presented here is the study of identifying and quantifying certain synthetic opioids using SERS. In recent years, the abuse of opioids, especially the powerful synthetic opioids such as fentanyl and its analogs, has become America's leading cause of overdose deaths, which is the so-called opioids crisis. Hence the rapid detection, identification, and quantification of these psychoactive substances emerge as a critical need for forensic scientists. Usually it is not feasible to analyze fentanyl and its analogs using traditional techniques because of their superior potency, leading to very low concentration present in samples. As a valuable analytic tool for the detection and identification of various chemical compounds of forensic interest, Raman spectroscopy attracts increasing attention over the past decades due to its non-destructive nature, wide application range, and capability of providing rich structural information. The Achilles' heel of general Raman spectroscopy is its weak signal, resulting from the fact that only one scattered photon out of ten thousand is Raman active. One of the solutions to this is the SERS technique, which boosts the signal by placing the sample in the vicinity of or on rough metal/semiconductor substrates. The signal enhancement factor of SERS can reach up to $10^{-11}$, improving the detection limit to $10^{-12}$ M. In addition, SERS has proven to be a great means to quench unwanted luminescence for fluorescent molecules while enhancing the Raman signal at the same time.

This study analyzed synthetic opioids, especially those potent ones such as ohmefentanyl, tetrahydrofuranylfentanyl, etc. Multiple research efforts have been focused on qualitative detection and identification of forensic drugs by SERS. However, quantitative SERS measurements are scarce, owing to the complexity of the system and the spectra. Ideally, when SERS peaks of interest are unique and not overlapped with other peaks, quantification is possible by calculating peak areas/heights after appropriate calibration. In fact, an analyte is always within a complex background such as blood/urine/saliva plus metallic colloidal solutions and we often need to perform quantitation for multiple analytes simultaneously. One way to overcome these issues is the Standard Addition Method (SAM), by spiking the standard to both blank and real samples. Therefore, first this work systematically studied the dependence of SERS signal enhancement on difference experiment conditions. The results reflect how the signal enhancement varied with different substrates, solvents, and aggregating reagents. Also, the quantitative measurements of certain potent synthetic opioids under optimized SERS conditions are conducted using the standard addition method.

**SERS, Opioids, Quantitation**