DETERMINING THE EFFICIENCY OF SURFACE-ENHANCED RAMAN SPECTROSCOPY SUBSTRATES IN BODY FLUID IDENTIFICATION

Marsella Hatfield1,2, Jennifer Fore3, Ranjith Premasiri3, Jessica Irvine4, Cindy Pyles3 and Lawrence Ziegler3

1Department of Chemistry, Jackson State University, Jackson, MS 39217, USA
2Department of Chemistry, Alcorn State University, Lorman, MS 39096, USA
3Department of Chemistry, Boston University, Boston, MA 02215, USA
4Biomedical Forensic Sciences, Boston Medical School, Boston University, Boston, MA 02118, USA

Abstract: Body fluid identification is important to understand the nature of a crime and provide connections to any possible perpetrators. Methods such as Raman and surface-enhanced Raman spectroscopy (SERS) overcome current body fluid identification limitations. Raman spectroscopy is a molecular identification method in which molecules interact with light, yielding a spectral fingerprint due to the various vibrational modes of molecules present in a sample. A visible light source excites a molecule existing in a ground state to a virtual excited state. The molecule then either decays to its first vibrationally excited state, gaining energy, or its ground state, losing energy. These phenomena are referred to as Stokes scattering and Anti-Stokes scattering, respectively. In surface-enhanced Raman spectroscopy (SERS), noble metal nanoparticles (such as gold or silver) have surface plasmons which intensify the normal Raman signal. The surface plasmons of the nanoparticles experience an enlarged electromagnetic field when excited by a laser with a frequency which matches the plasmon resonance. Due to the enlarged electromagnetic field, any molecule that is in close proximity (~20Å) to the surface of the nanoparticle exhibits an enhanced Raman signal. SERS could allow forensic scientists to accurately identify body fluids in less than ten minutes, using minimal sample volume. The goal of this research were to determine the spectral-reproducibility, effects of varying sample volume, and the efficacy of two different SERS substrates, P-SERS® strips (Diagnostic anSERS) and gold nano-chips (synthesized in-house), for body fluid identification. Adenine was used as a calibration standard to test substrate efficiency prior to analyzing body fluids. The gold nano-chips exhibited a stronger signal compared to P-SERS® strips with 1 mL sample volumes. When sample volume was increased to 10 mL on the P-SERS® strips, a stronger signal was acquired, however did not achieve the enhancements observed on the gold nano-chips. Additionally it was determined that the P-SERS® strips yielded consistently reproducible signals, with minimal fluorescence backgrounds, compared to the gold nano-chips. Overall, the gold nano-chips proved to be more efficient that the P-SERS® strips in body fluid identification due to the smaller surface area and the smaller sample requirement.

Keywords: surface-enhanced Raman Spectroscopy, substrates, body fluid identification, forensics

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