B91 Toward Surface-Enhanced Raman Spectroscopy (SERS) -Active Forensic Evidence Swabs for Human Bodily Fluids

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After attending this presentation, attendees will better understand how SERS could be used in the forensics workflow for the confirmatory analysis of human bodily fluids.

This presentation will impact the forensic science community by providing results of the fabrication of SERS-active evidence swabs, identification of human bodily fluids by spectroscopic analysis, and the further extraction, quantification, and Short Tandem Repeat (STR) typing of the samples collected on the swabs. SERS-active evidence swabs are not currently available to the forensic science community.

The collection and identification of human body fluids at a crime scene can be a crucial aspect of an investigation. In the crime laboratory, evidentiary swabs that may potentially contain human body fluids are screened, using both presumptive and confirmatory tests. These tests, such as the Acid Phosphatase (AP) test and the Christmas tree stain for semen and the Kastle-Meyer and Takayama tests for blood, are quite time consuming, expensive, only test for one body fluid, and are prone to both false positives and false negatives; however, recent literature reports have indicated that Raman spectroscopy may have a far lower limit of detection than traditional methods and may allow investigators to perform one type of measurement for all body fluids, potentially leading to higher efficiency, more definitive results, and higher accuracy. Another recent report utilized SERS as a means to decrease the limit of detection of certain forensic samples. SERS, in which an analyte is placed on or near a nanostructured metal surface, has the potential to increase the Raman cross-section of the analyte by many orders of magnitude.

This presentation reports on the development of SERS-active forensic evidence swabs by attaching silver nanoparticles grown via the hydrogen reduction method to the fibers of commercially available swabs. For this study, SERS-active swabs were used to collect and measure the Raman spectrum of semen. Different swab fabrication parameters, such as reaction time (30 minutes-360 minutes), reaction temperature (40°C-100°C), and swab pretreatment protocols were varied in an effort to maximize the Raman signal of the semen. Integrated SERS intensity of semen-specific Raman bands were compared to silver particle size, silver concentration and spacing between particles on the swab fibers. Minimum volumes of semen that could be detected using the SERS-active swabs were also found. DNA extraction and quantitation was performed on semen samples collected on pristine swabs and SERS-active swabs, both those that had been exposed to laser radiation for Raman analysis and those that had not. Although extraction yields were higher for pristine swabs due to some dissolution of silver on the SERS-active swabs, STR typing was found to be possible.

Raman, SERS, Evidence Swab