B2 Raman Microspectroscopy of Body Fluid Traces: Intrinsic Method Selectivity

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After attending this presentation, attendees will have a better understanding of the recent advancements of a particular application of Raman spectroscopy. The implementation of advanced statistics for automatic analysis of spectroscopic data and the evaluation of the accuracy and reliability of the conclusions made will be discussed.

This presentation will impact the forensic science community by potentially having a great effect on the accuracy and effectiveness of biological stain analysis for forensic purposes.

The identification of traces of body fluids discovered at a crime scene is a major part of forensic investigation today. The three most common fluids found are blood, semen, and saliva, and there are several methods used currently to distinguish one from another. Blood can be presumptively tested by using different color spot tests, but these tests are destructive to the sample and can also result in false positives. Semen is similar in that there are destructive presumptive tests as well as confirmatory tests; however, saliva has no confirmatory tests. Most presumptive tests can be performed in the field, but some sample preparation such as extraction is often necessary. Most confirmatory tests must be done in the laboratory. The main problem with these tests is the destruction of the sample. The forensic community is in great need of a reliable, non-destructive, on-field method for identification of all common body fluids.

Raman spectroscopy is a technique that is increasing in popularity among the different disciplines of forensic science. Some examples of its use today involve the identification of drugs, lipsticks, and fibers, as well as paint and ink analysis. The theory behind Raman spectroscopy is based on the inelastic scattering of low-intensity, non-destructive laser light by a solid, liquid, or gas sample. Very little or no sample preparation is needed and the required amount of material tested with a Raman microscope can be as low as several picograms or femtoliters. A typical Raman spectrum consists of several narrow bands and provides a unique vibrational signature of the material. Typically, non-resonance Raman spectroscopic measurements do not damage the sample. The stain could be tested in the field and still be available for further use in the laboratory for DNA analysis. A portable Raman spectrometer is a reality that should now allow for identification at the crime scene.

The latest development of a new method for identification of body fluid traces using Raman spectroscopy combined with advanced statistics is reported in this study. Multidimensional Raman spectroscopic signatures of dry traces of sweat, vaginal fluid, semen, saliva, and blood have been reported earlier. The dry blood signature has been upgraded to eliminate possible photodamage.1 The method was expanded for the application to semen stains on common substrates.2 The differentiation of menstrual and peripheral blood with high confidence was demonstrated.3 Raman spectroscopy has also been shown to be effectively applied as a non-destructive technique for differentiating human blood from a wide survey of animal blood.4 A Partial Least Squares Discriminant Analysis (PLSDA) model was built from a training set of the near infrared Raman spectra from 11 species. Various performance measures, including a blind test and external validation, confirmed the discriminatory performance of the chemometric model, which demonstrated 100% differentiation. Most importantly, a satisfactory differentiation between 11 individual animal classes was demonstrated.5

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