## E38 Forensic Analysis by Raman Spectroscopy

*Aylin Yalçin Saribey, PhD*, Uskudar University, Istanbul 34662, TURKEY; Nurdan Kenan, MS, Istanbul, TURKEY*

**Learning Overview:** After attending this presentation; attendees will better understand the use of Raman spectroscopy to examine wide-ranging evidence.

**Impact on the Forensic Science Community:** This presentation will impact the forensic science community by offering new approaches for the fields of using Raman spectroscopy and for improving existing studies.

Raman spectroscopy is a valuable analysis method for not getting fluorescence from water-containing samples, having the possibility of non-destructive analysis as well as the ability to analyze solids, liquids and gases. There are various types of evidence, which are categorized as biological (DNA, body fluids, bone), physical-chemical (chemicals, explosives, dyes, cosmetic products, fiber, hair, gunshot residue, documents, environmental pollutants), and trace (fingerprint) evidence, in this study to examine using Raman spectroscopy. Wang et al. revealed the difference between human and non-human blood using Raman spectroscopy; results showed that the model provided 100% accuracy in its differentiation between human and non-human blood.[1] In a study that may play a critical role, particularly in rape cases, the separation of peripheral blood and menstrual blood was revealed by Sikirzhytskaya et al. in 2012 with Near-Infrared (NIR) Raman spectroscopy.[2] A condom-related DNA study by Raman spectroscopy was published in 2008 by Coyle et al.[3] In 2016, Delannoy et al. buried bone samples in the soil and included Raman spectroscopy into their work to measure bones' weight every day, over a three-month period.[4] As a result, they reported a decrease in bone mass that was determined by Raman spectroscopy over time. Kwok et al. determined the difference in the packaging of original and counterfeit samples of a drug using Raman spectroscopy and 2D Correlation Spectroscopy (2D CoS).[5] Edwards et al. used Raman Spectroscopy to examine dyes on a painting that was purported to belong to the Renaissance period painter Malatesta.[6] As a result, the pigments of dye that were found were compatible with the Renaissance period. Bianchi et al., in a study conducted with cotton, polyester, and polyamide fabric samples, revealed that the difference between fibers can be determined both in terms of dye and in terms of age.[7]

In addition, the development of portable Raman devices allows evidence to be quickly identified and analyzed during crime scene investigations. In this way, Raman spectroscopy allows the crime scene to be turned into a laboratory environment, which helps analysts and researchers in terms of safety and time. Pestle et al., in their study with the portable Raman spectrophotometer, developed a method to test the presence of sufficient collagen in bone samples found in the field.[8] This method is very valuable for forensic archaeologists as it provides a preliminary study of which sample is worth testing to obtain DNA.

It should not be ignored that Raman spectroscopy alone may be insufficient in evaluating evidence and giving information about victims, suspects, or objects, so it should be verified with an advanced technique. However, modified sample preparation steps and systems such as Surface-Enhanced Raman Spectroscopy (SERS) continue developing to remove these disadvantages in standard Raman analyses. Yu and White, who worked with SERS for the analysis of cocaine and heroin at lower concentrations, developed a paper swab in which they inkjet impregnated silver nanoparticles for sampling.[9] Fierro-Mercado and Hernandez-Rivera developed a substrate by spraying gold nanoparticles on a standard filter paper and reported that this swab could be used to take samples from the contact surfaces of explosives.[10] Becue et al. developed a method, by using a Multi-Metal Deposition (MMD) technique, for the detection of fingerprints from different substrates.[11]

As a result, along with a few disadvantages, standard Raman spectroscopy and SERS have proven to be remarkable and important techniques in the search for more accurate, fast, and portable analysis techniques for modern forensic science. The advantages of Raman spectroscopy over other analytical techniques makes it attractive and inevitable for use in multidisciplinary forensic science. In all aspects, Raman spectroscopy is a valuable universal tool to assist researchers in securing justice.

**Reference(s):**


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*Presenting Author

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**Raman Spectroscopy, Crime Scene, Forensic Science**



*Presenting Author