B17 Forensic Soil Analysis by Morphologically Directed Raman Spectroscopy (MDRS)

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After attending this presentation, attendees will understand the advantages of using MDRS in the identification of the mineral components present in recovered soil samples. In addition, attendees will better understand how MDRS works and the benefits it can provide the forensic community.

This presentation will impact the forensic science community by demonstrating how MDRS can be used to obtain particle distribution and shape information as well as chemical identifications of minerals in soil samples in order to provide an objective and robust method for their comparison and characterization.

Forensic soil examination is often considered to be very complicated because of the complexity of soil, but such diversity and complexity can be useful as it allows for the differentiation of soil samples with high discriminating power. The complex nature of soil minerals provides a means for its characterization, classification, and comparison.

MDRS combines automated particle imaging and Raman spectroscopy in one instrument. Particle imaging is performed to determine particle size and shape distributions of components in a mixture. Raman spectroscopy is useful for determining molecular chemistry because it is rapid, reliable, does not require contact with the sample, and is non-destructive. Combining these two analytical techniques allows the individual components present within a mixture to be independently characterized and compared. Such a tool can be used to gain a better understanding of mixtures across many areas of forensic science, as it is applicable to a range of Raman active samples. This presentation demonstrates the application of MDRS to soil evidence.

The benefits of MDRS for forensic soil analysis are that not only are you able to non-destructively identify the types of mineral specimens in the soil sample by Raman spectroscopy, but you are also able to obtain morphological information about the individual mineral grains, particle size distributions for the entire sample as well as each of the minerals, and quantitative information on the relative number of each of the particles.

In this research, soil samples were collected from four sites along one road in Connecticut and mineral portions were separated by sieving and washing. The results showed that the morphologies of the mineral fractions were the same, as expected since they were collected along the same road. Prior research has shown that the morphology of quartz can be used to differentiate different mineral environments, which could be exploited with MDRS. Additionally, the particle size distributions of some minerals showed significant differences that can be used to distinguish between samples. Furthermore, the particle counts for each mineral were used for a quantitative comparison between soil samples. This revealed differences between the soil samples. Principal Component Analysis (PCA) was used for exploratory analysis to reveal patterns in the data. In three PCs, good separation was achieved between the four data sets, thus indicating the mineral counts achieved by MDRS can be used for sample discrimination.

In conclusion, MDRS has the potential to be a valuable tool for forensic soil analysis because it is a non-destructive, relatively fast, and automated way to collect particle morphology and chemical information.

Soil Analysis, Morphologically Directed Raman, Raman Spectroscopy

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