B162 Evaluating the Application of Micro X-Ray Fluorescence (XRF) and Micro Raman Spectroscopy to the Analysis of Duct Tapes: Intra-Roll and Inter-Product Correlations

Sergey Mamedov, PhD, 3880 Park Avenue, Edison, NJ 08820*

After attending this presentation, attendees will better understand XRF and Raman microscopy in applications in the analysis of duct tapes; this analysis is an important element in forensic identification of these materials.

This presentation will impact the forensic science community by serving as key aspect of duct tapes analyses and as an example of a practical application of XRF and Raman spectroscopy in duct tape identifications.

XRF and Raman spectroscopies are useful tools for identification substances and confirming their identity with little or no sample preparation. XRF provides information about elemental composition of the material, whereas Raman spectroscopy supplies molecular information. Both techniques are able to record not only spectra of small particles, but also hyper-spectral images, as well as collect average spectra over certain areas. Multivariate Analysis (MVA) can produce chemical distributions of elements and/or material classification based on Principal Component Analysis (PCA), Partial Least Square Discriminative Analysis (PLSDA), in particular, with association between elements that can aid in the identification of bonded phases. The analysis of micro XRF and Raman data of duct tapes can be used to identify the source of a duct tape or the vendor of the product.

XRF and Raman analytical microscopes were used in this study. XRF spectra of the materials were collected using 30keV acceleration voltage and with an X-ray spot size of 1.2mm. Two excitation wavelengths (532nm and 785nm) were used to collect Raman spectra.

The spectra of duct tapes from different sources were collected and analyzed by micro XRF and Raman spectroscopy. XRF analysis was performed in the range of 1.00keV-40.96keV. There are no spectral features in the energy range above 15keV; spectra were truncated and analysis was performed in spectral range of 1.00keV-15keV. Some tapes contain elements Ti, Ca, S, and Al in a fiber substrate, which may be used for duct tapes differentiation. Classification of duct tapes-based PCA of the spectra will be shown. Small pieces of glue from the tapes were collected and Raman spectra of this material were measured in the range of $100cm^{-1}$-$3,500cm^{-1}$. MVA was applied to these spectra to extract differences in connection with different source of the tapes. The data demonstrates that MVA allows differentiation of the samples, for example, duct tapes #1020 and #1110 or #1230. PCA of duct tapes exhibits significant separation between duct tapes of different vendors and brands. Raman spectra of the materials note many common features with some differences, which may originate from the filler. Data fusion technology was applied to the set of XRF and Raman data to create PCA and PLSDA models. Misclassification in PLSDA models was studied using randomly selected samples from available data. Results of standard and data-fused analysis are compared and discussed. In conclusion, this study provides methods that allow one to differentiate duct tapes based on spectra analysis of micro XRF and micro Raman data.

Duct Tape, XRF, Raman Spectroscopy

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