B20 Characterization of Electrical Tapes by Laser Ablation-Inductively Coupled Plasma/Mass Spectrometry (LA-ICP/MS) and Scanning Electron Microscopy With Energy-Dispersive Spectroscopy (SEM/EDS)

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After attending this presentation, attendees will better understand the versatility and utility of LA-ICP/MS for the characterization and comparison of tape evidence and its performance compared to SEM/EDS.

This presentation will impact the forensic science community by providing an assessment and validation of an LA-ICP/MS method for the forensic analysis of electrical tape evidence commonly found in murders, kidnappings, and improvised explosives, to mention a few. This technology has demonstrated its utility in other matrices such as glass, paint, soil, document examinations, and chemical taggants. The validation of this method for tape analysis will now expand the variety of forensic evidence that is currently characterized and analyzed by LA-ICP/MS, providing a more cost-effective solution that can be used across a large number of subdisciplines and materials, hence facilitating the incorporation of this useful tool into forensic laboratories.

Forensic examiners make use of chemical characterizations of both the organic and inorganic components in tapes to support other examinations including physical properties and even an apparent physical match. Current protocols used for electrical tape examinations may include the elemental analysis of backings and adhesives by SEM/EDS and/or micro X-ray fluorescence. Although these techniques have been shown to provide valuable elemental characterization of tapes, they have limited selectivity and sensitivity. The current study evaluated the forensic utility of LA-ICP/MS as an alternative method for the inorganic characterization of tape evidence.

The hypothesis of this research was that the superior sensitivity and selectivity of LA-ICP/MS methods could provide enhanced chemical characterization and improved discrimination between electrical tapes originating from different sources. To test that hypothesis, this study compared the performance of LA-ICP/MS to SEM/EDS data previously collected by another group on a collection set of 90 black electrical tapes. The overall discrimination for the 90 samples was found to be 93.8%, which was superior to the discrimination found using SEM/EDS (87.3%). Moreover, LA-ICP/MS detected a larger number of elements offering complementary information to the chemical characterization obtained by SEM/EDS. A second hypothesis was that the analytical performance provided by LA-ICP/MS was appropriate for the inherent chemical heterogeneity and the subsequent characterization of tape evidence. For this purpose, studies on the variation of the elemental composition within a roll were conducted for seven rolls. Each roll was split into six sections and each section was characterized in six replicates at different locations. Results demonstrated that the amount of material removed during analysis provided a representative characterization of the elemental composition of a number of tape rolls. Inter-roll variations were found to exceed intra-roll variations in all cases, making this technique viable as a comparison tool.

A set of 45 duplicate-control blind samples, each one originating from different locations of the same roll, were analyzed on different days and by different analysts to evaluate instrumental variations, inter-day variations, and false exclusion rates. A set of 100 electrical tapes originating from different sources was analyzed in four to six replicates to evaluate the false inclusion rates and the discrimination capability of the proposed method. False exclusion rates lower than 5% and false inclusion rates lower than 6% were observed for the selected collection sets, respectively. These results were evaluated to make informed decisions about sampling, chemical analysis, and interpretation of the data collected. A variety of statistical tools were evaluated to determine which one(s) are suitable to the particular sensitivity and precision level of the proposed method.

This work will also describe the optimization and examinations performed on electrical tapes using LA-ICP/MS to achieve ideal penetration into the tapes' backings and adhesives with minimal destruction to the evidence.

Electrical Tape, Trace Evidence, Elemental Analysis