## B123 Forensic Analysis of Trash Bags: Part II — Fourier Transform Infrared (FTIR) Spectroscopy and X-Ray Diffraction (XRD)

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After attending this presentation, attendees will understand the use of FTIR and XRD to discriminate between various brands of trash bags. Trash bags are common in forensic investigations because they can be used to conceal victims, dispose of evidence, or transport controlled substances. Attendees will understand the potential for using FTIR and XRD to discriminate trash bags of different brands by identifying and quantifying crystalline additives.

This presentation will impact the forensic science community by providing forensic examiners with instrumental methods of analysis for the discrimination of trash bags from different sources. Additionally, this study provides data on trash bags used in the United States and Canada, while other publications on the forensic examination of plastic bags have examined samples used in other countries.

Trash bags are typically manufactured from virgin polyethylene pellets, pigments, and other particulate additives melted together to form a molten plastic. The melted plastic is extruded through a ring-shaped die and mandrel, which impresses tool marks into the bag surface, creating identifiable patterns. Such patterns can be useful in identifying sequentially manufactured bags, but would have less utility for the identification of the brand of trash bag. On the other hand, FTIR and XRD can provide information on the brand of trash bag and permit the comparison of trash bags when the questioned and known trash bags were not sequentially manufactured. These instrumental methods would also be of value when only fragments of bags are recovered at a crime scene.

This research investigated the discriminatory power of FTIR and XRD for the forensic examination of trash bags. Eighty-eight different samples representing 28 different brands were examined. Most of the samples were purchased in the Washington, DC, area; a few bags were purchased in the Midwest. While samples of national brands were collected, special emphasis was placed on "store brands." Features of the bags, such as color, odor, type of closure, dimension, thickness, and place of manufacture were recorded for each sample to create a database.

Square pieces of each trash bag were cut from the side-edge, approximately 5cm x 5cm in size. These pieces were cleaned with methanol, in order to eliminate possible interference of coatings on the surfaces of the bags. Two strips were then cut from each square, one for FTIR analysis and the other for XRD. The samples analyzed by FTIR were scanned in transmission mode from 525$cm^{-1}$ to 4,500$cm^{-1}$, 128 scans per sample. The samples used for XRD analysis were glued to a standard microscope slide. The samples were flattened on the slide using a rubber roller and left to dry before testing. The diffraction angle (2q) was scanned from 3° to 40° at 2° per minute.

The FTIR and XRD analyses of the trash bags provided basic information on their compositions. Most samples were composed of Low-Density Polyethylene (LDPE); a small number of samples were comprised of Linear Low-Density Polyethylene (LLDPE). Some bags had no additives; some contained either calcite or talc but not both; and some contained both calcite and talc. XRD revealed the presence of a low concentration of an additional additive, montmorillonite, which was not detected by FTIR. Based on their FTIR spectra, the bags could be placed into 14 groups based on the presence or absence of additive peaks and their relative intensities. Based on their XRD patterns, the bags could be placed into 18 groups based on reflections present in the diffraction patterns. The

discrimination of the trash bag samples in this research demonstrates the value of XRD for polymeric material containing a number of additives. Based on the results of this project, XRD should be preferred to FTIR for the analysis of trash bags.

**Trash Bags, FTIR, X-Ray Diffraction**