A31 Forensic Analysis of Carpet Fiber Samples Using Direct Analysis in Real Time Coupled to an Accurate Time-of-Flight Mass Spectrometer

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After attending this presentation, attendees will understand how the analysis of carpet fiber samples in forensic laboratories involve a series of different tests, including the comparing of fibers microscopically, through the use of micro-chemical and micro-solubility tests, FTIR microscopy, etc. This study will attempt to test the ability of the DART®-AccuTOF™ for fiber analysis in either a screening or confirmatory capacity.

This presentation will impact the forensic science community by demonstraiting how DART®-AccuTOF™ was able to correctly identify and distinguish the various polymer classes and sub-classes (i.e.; Nylon versus Polyester as well as Nylon 6 versus Nylon 6/6). Although it is destructive, the rapidity of the technique along with its high power of discrimination makes it a favorable test to be either added to the series of tests, or can even replace a few of them.

Fibers are associative evidence that is encountered in numerous forensic circumstances. They can be found in crime scenes that involve breaking and entering, hit and runs, and even rape. This study focused on nylons, polyesters, and olefins, which are the most frequently encountered carpet fibers. An attempt to analyze the multiple polymer types was done using Direct Analysis in Real Time (DART®) coupled with accurate mass spectrometry (AccuTOF™). Twelve nylon, polyester, and olefin polymer standards were used to optimize parameters for the analysis of carpet fibers. A DART® helium gas temperature of 275°C was chosen as an optimum for analysis due to the differences in melting point for the various polymer types. Use of collision-induced dissociation to enhance fragmentation increased the power of discrimination, albeit decreasing sensitivity. A function switching method between 20 and 30 volts was established in order to provide greater spectral detail, while minimizing fragmentation which would lead to an even more cluttered spectrum. Minimal sample preparation was needed to analyze the samples; however, due to the small sample gap between the DART® ceramic and orifice, care was taken in order to not obstruct the orifice with the samples. This involved sampling the carpet fibers using a pair of tweezers, which was taped to a dowel, held tightly with a clamp. The main disadvantage of this process is that it is a destructive technique. All 12 polymer standards were successfully differentiated and identified using DART®-AccuTOF™ based on the presence of their monomers and associated dimers and trimers. A total of 32 carpet samples were analyzed in this study. Carpet samples of known compositions were correctly identified by class, and the remaining carpet samples of unknown compositions were also correctly identified following FTIR identification. In addition to identifying polymer class, the sub-class was identified in some cases such as nylon 6 versus nylon 6/6. All carpet fiber spectra demonstrated an intense peak at 282 Da, which was attributed to oleamide, a slipping agent that is used to enhance the extrusion of the fiber strands through the spinneret in the fiber-making process. The results demonstrate the capability of DART®-AccuTOF™ being implemented as an addition to the series of tests conducted to analyze carpet fibers. In addition to carpet fibers, other types of fabric and materials may also be analyzed using this technique. Reproducibility studies may allow for the use of this technique to directly compare known and questioned fiber evidence.

DART® AccuTOF™, Carpet Fibers, Nylon

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