E104 An Application for Forensic Analysis: The Discrimination of Fibers Using a Trace Organic Additive and Pyrolyzate Marker

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Learning Overview: After attending this presentation, attendees will understand the value of a Thermal Desorption and Pyrolysis device combined with Direct Analysis in Real Time Mass Spectrometry (TDP/DART®-MS) for the rapid discrimination of polymer material products, such as cloths, fibers, and containers.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by explaining how TDP/DART®-MS can be effectively applied as an identification and screening technique for tracing evidence.

Scientific examination of miscellaneous evidence collected at the crime scene is required to extract information during a criminal investigation. There are two methods of approaching physical evidence, namely, identification and comparison.[1] The former involves surveying and recording the substances that make up the evidence. In the latter, the same inspection is applied to a specimen of unknown origin (suspected sample) found at the scene of the crime and an apparent specimen (controlled sample) derived from or near the suspect. Subsequently, an analysis is performed using test results to ascertain whether the two are from the same source. The comparison process uses a combination of numerous methods, including observing features and appearance, measuring physical properties, and analyzing chemical compounds. For chemical analysis, comparison of trace compounds is sometimes more effective than the main compound.[2]

The DART® ion source is one of the ambient ionization methods reported by Robert B. Cody et al. in 2005.[3] It is excellent in versatility and speed, as ionization occurs easily by holding the sample over an ion source. However, when a product consisting of a polymer material, such as cloth or plastic, is to be analyzed, it is difficult to observe the peak of the target compounds. Therefore, a TDP process was developed for DART®-MS, which consists of a device capable of directly heating the sample from room temperature to 600°C. It has also been established as being usable for the identification of additives and polymer matrices in polymer material products. In this presentation, it is shown that the TDP/DART®-MS method can be used for both identification and comparison of polymer material products by using the analysis results of various polymer materials.[4]

In this study, several types of cloth fibers were used as samples. Mass spectra were obtained by a quadrupole Time-Of-Flight (qTOF) mass spectrometer equipped with a DART® ion source and a TDP unit. The TDP unit was mounted between the DART® ion source and the mass spectrometer. Mass spectra were measured in the positive-ion mode as the samples were heated from room temperature to 600°C. Analysis results of fibers using TDP/DART®-MS, namely, organic additives contained in fibers and pyrolysis products of polymer matrix, were detected at the thermal desorption region and pyrolysis region, respectively. It was confirmed that this analysis method is useful for the identification of polymer materials by using the pyrolysis products of polymer matrices as a marker. Additionally, this study established that this analysis can be used for comparison by using both organic additives and pyrolysis products of these samples as a marker. Thus, the combination of conventional methods and TDP/DART®-MS could contribute to the differentiating of evidence in criminal investigations.

Reference(s):

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3. R.B. Cody, J.A. Laramée & H.D. Durst. Versatile New Ion Source for the Analysis of Materials in Open Air Under Ambient Conditions *Anal. Chem.*, 77, 2297-2302 (2005).
4. Chikako T. et al. The Identification of Fine Plastic Materials by Thermal Desorption and Pyrolysis Combined with Direct Analysis in Real Time-Mass Spectrometry (TDP/DART®-MS). *Proceedings of the American Academy of Forensic Sciences*, 70th Annual Scientific Meeting, Seattle, WA. 2018.

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