B39 The Analysis and Classification of Tire Rubber Deposits Using Pyrolysis-Gas Chromatography/Mass Spectrometry (Py-GC/MS)

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After attending this presentation, attendees will better understand a successful recovery method for tire rubber deposits left as a result of skidding or braking incidents at the scene of a crime, the role that road surface plays as a contaminant, and the ability to associate these rubber deposits with the tire from which they originated.

This presentation will impact the forensic science community by contributing valuable and novel information on a topic with little previous research, none of which was previously conducted in the United States. This presentation will encourage forensic scientists to recognize this as a useful type of evidence within the forensic trace field as well as demonstrate an effective method for tire analysis that can be performed in crime laboratories.

Many crimes involve the use of motor vehicles and, as a result, impressions or tire deposits may be left behind. This type of evidence has the ability to provide forensic scientists with information about a vehicle's tires, such as tread pattern and brand, and therefore possibly information about the vehicle size or type.[1] Oftentimes, these impressions and markings are not of the best quality and provide very little probative information. In these cases, it would be beneficial to be able to analyze tire rubber deposits left at a scene; however, comprehensive studies have not been done on this topic. Previous research has identified Py-GC/MS as a successful method in the analysis of rubber deposits. These studies have shown this instrument's ability to distinguish between different manufacturers of tires as well as between different tire models of the same manufacturer on the basis of tire tread chemical composition.[2,3] Other studies have confirmed these findings, as well as applied statistics to help determine that there is low intra-variability within each tire and a high enough inter-variability between tires to correctly assign deposits to their source tire.[4] While this research has explored some sample collection methods and has acknowledged the possibility of road surface contamination, neither have been comprehensively studied.

In this experiment, tire deposits were made on both concrete and asphalt by eight different vehicles, each with a different brand or model of tire. Immediately following each deposit, both concrete and asphalt surfaces were tape lifted separately to collect any rubber deposits left behind. A thin slice of tread was removed from four different areas of each tire that made a deposit. Using a stereomicroscope, each tape lift was examined and rubber deposits were removed with tweezers. Each was analyzed separately using a validated rubber method adapted from previous research on the Py-GC/MS.[4,5] Four tire tread samples from the tire that made the corresponding tire deposit were then run on the Py-GC/MS. Control samples of the asphalt and concrete were collected and analyzed to account for any contamination. The resulting chromatograms were superimposed and compared to study retention times and overall peak patterns. Then, Target Compound Identification (TCI), normalization, and peak area were used to determine whether different tires had distinguishing chromatograms and if tire deposits had the same chromatograms as their corresponding tire tread samples.

Extracted ions and TCI were used to classify each sample based on its primary rubber content. Six of the eight samples were classified as Styrene-Butadiene Rubber (SBR) and the other two as a mix of SBR and Natural Rubber (NR). The data was normalized to the styrene peak for SBR samples and the limonene peak for SBR/NR samples. In addition to normalization, the peak area, relative intensity, and extracted ions were used to help further classify each group based on the presence of small amounts of additives that differ between tire models and brands. Concrete and asphalt surfaces do contribute a small amount of contamination, but it does not interfere in the association of the deposit to the tire from which it originated. This preliminary analysis of the data reveals two important conclusions: (1) there are noticeable differences in chemical composition between different brands and models of tires; and, (2) tire deposits have the same composition as the tire tread samples from which they originated. The use of tape lifts as a recovery method in this study proved to be successful compared to other methods tested. The tape lifts collected a sufficient amount of tire residue for analysis without any significant interference from the adhesive. This method worked even in situations in which cars left very light deposits behind.

In conclusion, this study demonstrates that not only can different types and models of tires be differentiated from one another, but their rubber deposits can also be differentiated from one another as well as associated to the tire from which they originated. The findings from this research could be used to develop specific tire deposit recovery methods to be used during evidence collection as well as integrate tire rubber analysis as an examination that crime laboratories perform.

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Rubber Deposits, Tires, Pyrolysis

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