E3 Classification of Tires Using Elemental Fingerprinting

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Learning Overview: After attending this presentation, attendees will have gained insight into the use of elemental analysis to yield forensic classification of tire trace evidence.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by providing the foundation for a neglected form of evidence: the rubber material left as vehicle tire marks.

Tire evidence is a form of trace evidence that is often overlooked in today's forensics. Tire evidence can often be found at crime or accident scenes, most often in the form of skid marks. Traffic accidents represent a large portion of incidents in the world, covering property damage, injuries, and/or fatalities. In the United States between 2004 and 2018, 5% of traffic cases were fatal hit and runs, where knowledge about the car tire could sometimes be the only information available. While the pattern of the tire skid mark has been used before to link a tire or car to a scene, the widespread use of anti-lock braking systems makes this an almost impossible and often abandoned route of analysis. With this in mind, using the chemical profile of a tire has the potential to link a car or tire back to a scene in which its trace material is found.

Most current research into this topic involves looking at the molecular signature of the tire through pyrolysis-gas chromatography mass spectroscopy. However, there is concern that the conditions of skid mark trace evidence formation will obscure the molecular signal of the tire and will be hard to replicate exactly through analytical methods, possibly making classification impossible. A route to avoid this issue is to instead look at the elemental profile of the tires, which is less likely to be different between tire and skid mark. Looking at the elemental profile is an accepted technique in the current forensics field, which can be obtained in many ways from Energy-Dispersive X-Ray (EDX) spectroscopy to Laser Ablation-Inductively Coupled Plasma/Mass Spectrometry (LA-ICP/MS) to Laser-Induced Breakdown Spectroscopy (LIBS).

Thirty-two tire samples (18 brands) provided by the Florida Department of Law Enforcement were analyzed using LIBS under argon atmosphere. These samples were taken from the surfaces of tire treads and analyzed using an Ultraviolet (UV) LIBS unit (J200, Applied Spectra). Data were analyzed through Principal Component Analysis (PCA) followed by Linear Discriminate Analysis (LDA). PCA is used to reduce the dimensionality of the data, while LDA serves as the classification method, leading to an accuracy close to 99%. These first results are promising and open the path to the use of tires and their residues as a forensic evidence that has so far been neglected.

Tires, Trace Evidence, Elemental Analysis

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