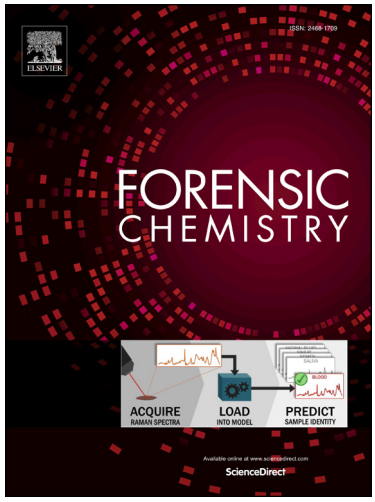

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Mathew S. Boll, Kyle C. Doty, Ray Wickenheiser, Igor K. Lednev

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Differentiation of Hair Using ATR FT-IR Spectroscopy: A Statistical Classification of Dyed and Non-dyed Hairs

Mathew S. Boll[1], Kyle C. Doty[1], Ray Wickenheiser[2], and Igor K. Lednev[1,*]

[1]Department of Chemistry, University at Albany, State University of New York, 1400 Washington Avenue, Albany, New York 12222, United States

[2]New York State Police Crime Laboratory System, 1220 Washington Avenue, Albany, New York 12226, United States

*Corresponding author: ilednev@albany.edu

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Abstract

Although hair is one of the most common and abundant types of evidence found at a crime scene, the current forensic analyses employed underutilize its full potential evidentiary value. Microscopy is the fundamental technique used to analyze forensic hair evidence, but even this routine and well-accepted method has limitations. In this study, non-dyed and dyed hairs from individuals varying in race, biological sex, and age, were analyzed using attenuated total reflection Fourier transform-infrared (ATR FT-IR) spectroscopy. Through the incorporation of multivariate statistical analysis, spectra collected from dyed and non-dyed hairs were differentiated with high accuracy. After hair spectra were determined to be dyed or non-dyed, dyed hair spectra were successfully differentiated amongst themselves based on brand (or manufacturer) and dye color. The methodology developed here allowed for predicting whether an individual used a permanent hair dye, and then the brand and color of hair dye used, with at least 90% confidence. The high accuracy shown in this study illustrates the ease and robustness of coupling ATR FT-IR spectroscopy and multivariate statistics for forensic hair analysis, specifically for the analysis of hairs dyed with dark colored hair dyes. The use of spectroscopy for forensic hair analysis, as demonstrated by this initial proof of concept study, would advance the field of trace evidence as a whole, and can potentially be utilized to confirm conclusions drawn from methodologies employed currently, in turn leading towards increased individualization.

Keywords

Attenuated total reflection Fourier transform-infrared (ATR FT-IR) spectroscopy, Chemometrics, Trace evidence, Forensic hair analysis, Human hair