The Role of Thermophysical Properties Measurements in Advancing Forensic Science

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Chemical analysis of real-world forensic artifacts is challenging. The important compounds that provide evidence of guilt, fraud, adulteration, or innocence can be trace or reactive and are typically in complex mixtures.

Vapor sampling is an attractive alternative to analyzing the forensic artifact itself. Vapor collection and sampling is standoff, noninvasive and provides a cleaner sample for instrumental analysis. Vapor characterization can provide important information for forensic science. For example, a forensic scientist will analyze the headspace above fire debris for evidence of arson during fire investigations. Vapor characterization can also be made portable, for example, the alcohol breathalyzer (in lieu of drawing blood) for evidence of alcohol intoxication.

Rapid decriminalization of cannabis by state governments has led to extensive R&D towards a cannabis breathalyzer for law enforcement use in identifying intoxication in a field environment. Several versions of breath collection devices are being marketed for the detection of THC (delta-9-tetrahydrocannabinol) in the breath of cannabis users. THC alone is not directly correlated to intoxication in all users, but THC, other cannabinoids and metabolites may indicate recent smoking or vaping. THC and other cannabinoids are non-volatile and chemically unstable, creating currently unsolved reliability challenges that did not exist for the alcohol breathalyzer. Additionally, while the partitioning behavior of alcohol between blood and breath is well understood due to decades of research, this correlation is not known for THC or other cannabis components.

The fluid characterization group at NIST is working to advance forensic science by leveraging our expertise in chemical characterization of multiphasic fluids and making fundamental thermophysical properties, including vapor-liquid equilibrium (VLE), vapor-solid equilibrium (VSE), partition coefficients, vapor pressure, and competitive adsorption of compounds important for fire debris analysis and cannabis breathalyzer development.