Forensic Science Insights

Gossman Forensics – Louise Denlinger, David Gossman

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Fourier Transform Infrared (FTIR) Spectroscopy

Why is FTIR important to you?

Forensic evidence is invaluable for many types of investigations. Finding the factors that may have led to a fire, explosion, chemical spill, and chemical and/or environmental incident is of utmost importance. In many cases, evidence may be found at the scene that is of unknown composition and potentially crucial in assessing any incident. Arming an attorney with chemical evidence, documentation and analysis results can be pivotal for a favorable decision in litigation. Providing jurors with information that is clear and based on factual analytical results can assist in the believability of your case. Fourier Transform Infrared Spectroscopy (FTIR) is a laboratory method that is commonly used as part of many incident investigations.

What is FTIR?

FTIR is a non-destructive analytical method that can give the investigator information about materials with unknown chemical compositions. It has widespread uses and can characterize polymers, organic materials and sometimes inorganic materials in solid, liquid or gas form. In forensics, chemicals from samples such as paints, fire debris, synthetic materials, polymer coatings, drugs, accelerants, and organic contaminants can be identified. Not only is FTIR a well-established analytical method, but it is very reliable. This makes FTIR a powerful method for collecting chemical information on evidence from an incident scene.

Infrared spectroscopy is the analysis of infrared light interacting with molecules. It measures the amount of light the chemical bonds of a sample absorbs. All molecules have specific frequencies that they vibrate at, caused by specific energy levels that are associated with the bonds inside the molecule. In infrared spectroscopy analysis, infrared radiation is transmitted through a sample. Some of the infrared radiation is absorbed by the sample, and some of the infrared radiation is transmitted through the sample. The resulting signal at the detector is a spectrum representing a molecular "fingerprint" of the sample. The absorption peaks correspond to the frequencies of vibrations associated with the bonds of the atoms making up the material.

Like a human fingerprint, no two different molecular structures produce exactly the same infrared spectrum (although some can be very similar). This FTIR spectrum can be automatically compared to a library of compounds for a computer generated most-likely best fit, with an example seen in Figure 1. An experienced forensic chemist must apply knowledge of the chemicals and chemical interactions pertinent to the incident in order to definitively identify the compounds found in the spectra. Relying only on the computer generated best fit can leave the compound identification open to attack.

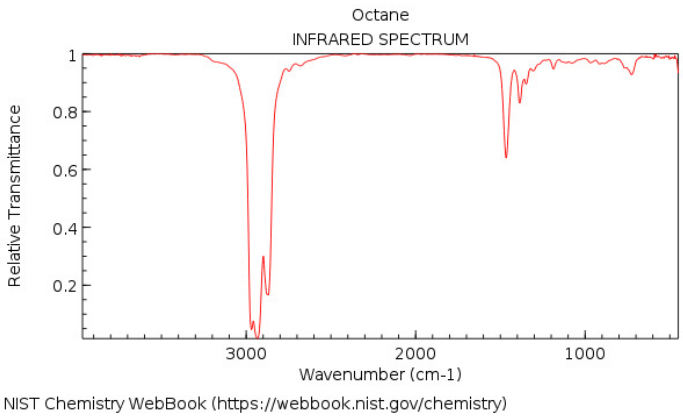

Figure 1: National Institute of Standards FTIR spectrum for octane

Medical Oxygen Cylinder Case

During the investigation of a flash fire in a medical oxygen cylinder, FTIR was used to analyze a debris fragment found inside of the regulator. The analysis raised additional questions since the results seemed to point to a non-combustible gasket material that is commonly found in regulators. After further visual and microscopic analysis of the debris fragment, additional FTIR analysis was needed to understand the composition of the material. The outer surface of the fragment was scraped off to analyze the chemical composition of the interior material. The figures below show the FTIR spectrum of that sample taken from inside the oxygen tank regulator. The first spectra show the results of the sample in its original state. The second spectra show the result after the outer layer of the sample had been scraped in the laboratory. The outer layer of residue masked crucial evidence.

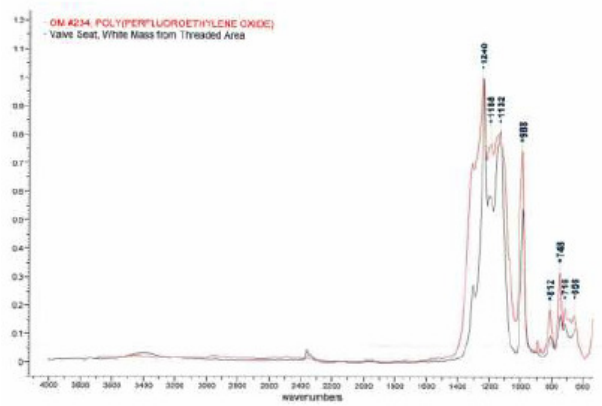

Figure 2 - Spectral Overlay of Sample

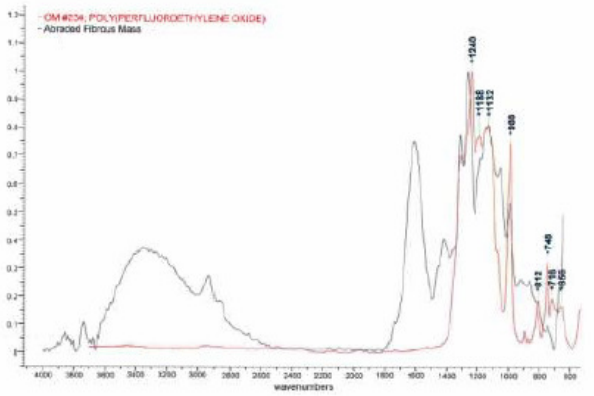

Figure 3 - Spectral Overlay of Abraded Sample

The analysis of the scraped sample revealed a cellulosic material which was found to be a contaminant inside of the oxygen tank regulator and the fuel for the fire. In this case, a high degree of understanding of FTIR analysis was essential. This is important because materials often volatize and re-condense during an incident. This can leave evidence collected at the scene coated with a thin layer that does not represent the underlying material. Removal of an interfering coating can be critical in establishing cause, origin and the responsible party. In this case, knowing that FTIR will only examine the outermost layer of a material, having a comprehensive analytical background and considering the key internal portion of the sample may have been hidden by fire condensed chemical residue was crucial in determining causation.

Definitive Evidence

Data interpretation is not straightforward. Only an investigator with a strong analytical chemistry background can discern if the results require further analysis. However, when interpreted by an experienced chemist, FTIR has the advantage of being considered definitive evidence. When presented to a judge or jury, it can provide a non-ambiguous insight into the nature and causation of an incident.

Conclusion

The chemical complexities of any incident scene can offer a rich source of vital information, but can be confusing and evidence is easily missed by an inexperienced forensic investigator. The team at Gossman Forensics has the background and experience to asses an incident site and uncover and collect potential chemical evidence that can be imperative to a case. Additionally, our team excels in understanding and evaluating laboratory results, including FTIR spectrograms. We are able to scrutinize results, identify masked or hidden evidence, and provide expert witness testimony and guidance in litigation.

Forensic Science Insights is a publication by Gossman Forensics, a division of ChemRight Laboratories, Inc. Please contact David Gossman, Chief Investigator, at 563-652-2822, by email at dgossman@gossmanforensics.com or visit us on the web at GossmanForensics.com.