Alexandria Drewes
Senior
Major(s) Chemistry and Forensic Science

The Analysis of Various Burnt and Unburnt Accelerants Using Laser Induced Breakdown Spectroscopy

Dr. Alyssa Marsico, Department of Forensic Science

The question I tested was if Laser Induced Breakdown Spectroscopy (LIBS) could be used to analyze and identify a variety of different accelerants that were both burnt and unburnt. We hoped to determine if burnt and unburnt residue could be linked to one another regardless of the chemical reaction that takes place during burning. I started my research by getting background info on the current methods to analyze accelerants. The most popular way to analyze fire debris for ignitable liquid residue today is by using gas chromatography. (Choi 2017). This method does have some drawbacks as accelerants can only be tested if enough of the accelerant remains on a surface to produce a high enough concentration in the gas phase after collection. The analysis also requires the accelerant sample to be prepared before it can be tested, which increases analysis time and consumes the sample. LIBS does not have these limitations and uses light emitted from laser generated micro plasma to find the elemental profile of a sample without any sample preparation or sample consumption. (Gottfried 2009) In this research I used LIBS to analyze accelerants that included acetone, non-acetone nail polish remover, gasoline (two locations) and diesel fuel (two locations). These six accelerants were analyzed on two substrates: nylon rope and cotton cloth. The substrates and accelerants by themselves were run first to establish an elemental profile for each in order to know when differences were present. Next, the substrates were soaked in the accelerant and analyzed. Finally, the substrates were soaked in accelerant again and then burnt for 60 seconds, then analyzed. The elemental changes were observed and compared for each of the different accelerants and for the different substrates.

After completing my research, I analyzed the data to see if the levels of the elements present changed from the burnt to unburnt samples. The elements analyzed were carbon, hydrogen, oxygen, potassium, sodium and calcium. For most of the elements, the levels present in both the unburnt and burnt samples were similar for both substrates, so the type of substrate did not affect accelerant. There was no difference in the levels of elements presence in either the two different gasoline samples or the two different diesel fuel samples, regardless of where they were obtained from. This indicates that LIBS is not be an optimal method for distinguishing fuel obtained from two different locations. Calcium, sodium and potassium were all found in higher quantities in the burnt samples compared to the unburnt samples. Carbon was found in higher quantities in the burnt samples as well. This could be from soot deposits that form as a result the burning process. LIBS was able to show that the amount of certain elements present changed when comparting burnt and unburnt samples. Future research can be done by adding different accelerants, like lighter fluid or kerosene, to see if any differences can be found. Furthermore, different substrates could also be tested to determine if they could have an effect. Finally, looking at a wider range of elements could provide more unique elemental profiles that could distinguish between different types of accelerants.

Citations

1. Choi, Soojin, Jack J. Yoh *Fire Debris Analysis for Forensic Fire Investigation Using Laser Induced Breakdown Spectroscopy.* Spectrochimica Acta Part B: Atomic Spectroscopy 2017**,** 134, 75-80.
2. Gottfried, Jennifer L., Frank C. De Lucia, Chase A. Munson, and Andrzej W. *Miziolek Laser-induced Breakdown Spectroscopy for Detection of Explosives Residues: A Review of Recent Advances, Challenges, and Future Prospects*. Analytical and Bioanalytical Chemistry 2009, 395.2 283-300.