D60 Evaluation of Ambient Pressure Ionization Mass Spectrometry Techniques for Routine Analysis of Explosives

Edward Sisco, BS, 6819 Old Waterloo Rd, Apt 1035, Elkridge, MD 21075; Jeffrey H. Dake, MSFS, 4930 N 31st St, Forest Park, GA 30297; and Michael J. Salyards, PhD, 45 High St, Sharpsburg, GA 30277*

After attending this presentation, attendees will be able to identify several of the most common Ambient Pressure Ionization Mass Spectrometry (API-MS) techniques, and more specifically, their capabilities and practicalities for routine trace explosives analysis. Ease of analysis, limits of detections, and comparisons with techniques currently being used in casework will be discussed.

This presentation will impact the forensic science community by providing the forensic science community with a head-to-head comparison of API-MS techniques with current analytical techniques for trace explosives analysis. The analytical techniques which are commonly utilized in trace explosives analysis include: GC/MS, CI-GC/MS, and HPLC. All three of these techniques require sample extraction and lengthy sample runs. API-MS techniques, however, offer the ability to analyze a sample in just seconds and, in some circumstances, without sample preparation at all. Furthermore, initial studies have shown API-MS techniques to be as or more sensitive than the current analytical techniques applied to explosives analyses.

API-MS is a fairly new and rapidly evolving area of mass spectrometry. Since the development and publication on the Desorbtive Electrospray Ionization (DESI) source in 2006, numerous variations have been developed. Within the API-MS family there are several different applied principles off of which the techniques are based. Techniques such as DESI and sonic spray ionization take advantage of a charged solvent spray to bombard a sample and generate characteristic ions. Other techniques, such as Direct Analysis In Real Time (DART®) and Low Temperature Plasma (LTP), induce ionization via interaction between the sample and a plasma. A final group of API-MS sources utilizes lasers to ionize samples and includes methods such as Laser Ablation Electrospray Ionization (LAESI). Since there are different mechanisms being utilized in each of these categories of techniques, it is important to understand the benefits and drawbacks each method provides.

While a number of different studies have looked into the individual techniques for explosives analysis, this study provides a head-to-head comparison of several of these techniques including DART®, DESI, and LTP. In this study over ten explosives are analyzed from a number of different classes including nitroaromatics, cyclic nitros, straight-chain nitros, and peroxides. Using standards of known concentrations, optimized methods for analysis were developed for the API-MS techniques and compared to documented methods for CI-GC/MS and HPLC, which are currently employed in casework. In addition, limits of detection of the explosives were determined and compared. To date, it has been shown that limits of detection for analysis by DART® have been up to two orders of magnitude more sensitive than CI-GC/MS. Furthermore, the API-MS sources allow for the analysis and differentiation of peroxide explosives, which could not be accomplished using current techniques. Additional portions of this study examine the effects of different sample substrates on analysis, and the addition of dopants to create adducts and increase sensitivity. In the case of DART®, the presence of acetone has been shown to increase the sensitivity for RDX and similar compounds with no deleterious effects on the sensitivity to other explosives. The results of this study have led to the development and implementation of a method of analysis for trace explosives using DART®-MS at the USACIL. Additionally, this study will prove the viability of API-MS techniques as a screening technique for trace explosives analysis in criminal investigations.

The opinions or assertions contained herein are the private views of the authors and are not to be construed as official or as reflecting the views of the Department of the Army or the Department of Defense.

Explosive Analysis, API-MS, Chemical Analysis

 ** Presenting Author*