Forensic Analysis Methodology and Database for Homemade Explosives

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Background

- Forensic identification of homemade explosive (HME) materials is critical for determining the origin of explosive mixtures and precursors, and formulation procedures.
- The forensics community traditionally uses a multi-evidence investigation strategy.
- It has been proposed to establish a database (with specified confidence levels) of thermal, mass, infrared spectral signatures, and isotopic composition and ratios of correlated pre-identified HME precursors.
- As an initial phase to this proposal, thermal signatures from a variety of HME samples and recipes have been obtained and analyzed in collaboration with the FBI/ATF.

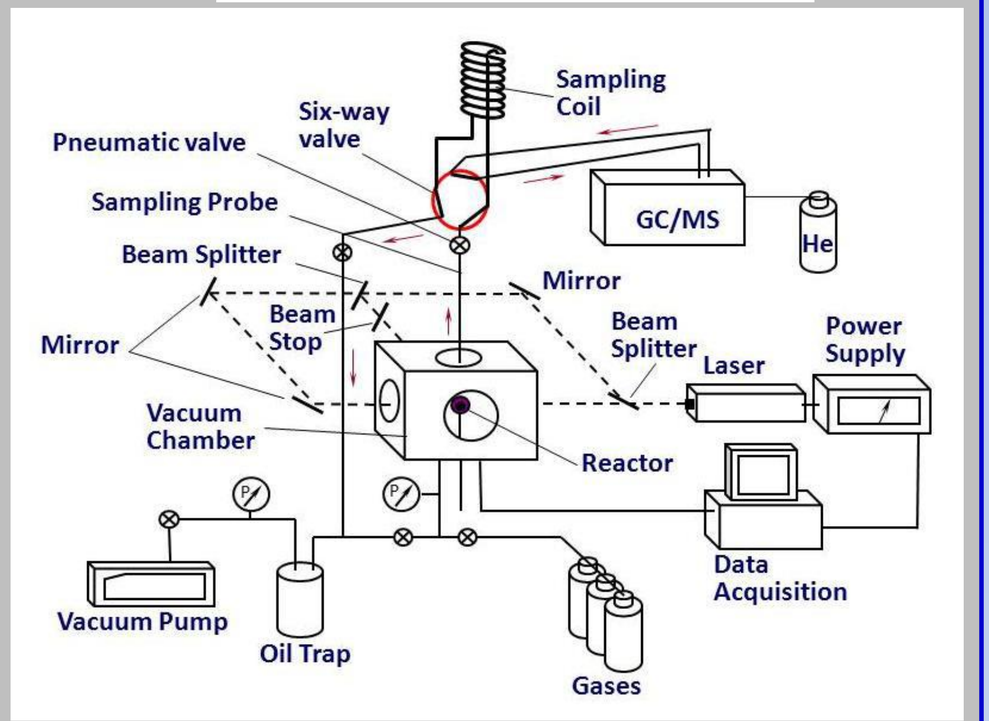
Methodology & Database

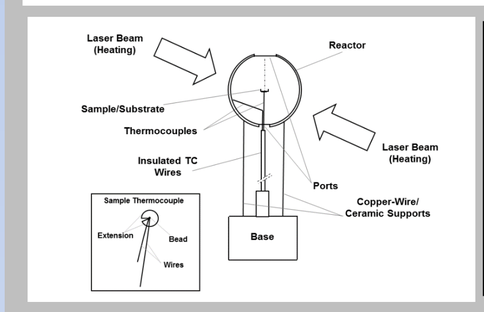
- LDTR is a novel and developing methodology, which will be used to obtain the thermal signatures of HMEs.
- Ammonium nitrate (AN) and nitromethane (NM) were investigated under a variety of operating conditions and protocols.
- Ammonium nitrate/nitromethane (ANNM) mixture and its individual constituents, as well as an additional ten HME mixtures, were also investigated under a variety of operating conditions and protocols in collaboration with the FBI/ATF.
- It was demonstrated that the LDTR can serve as a diagnostic tool for characterizing the thermal and chemical behavior of trace amounts of HMEs.

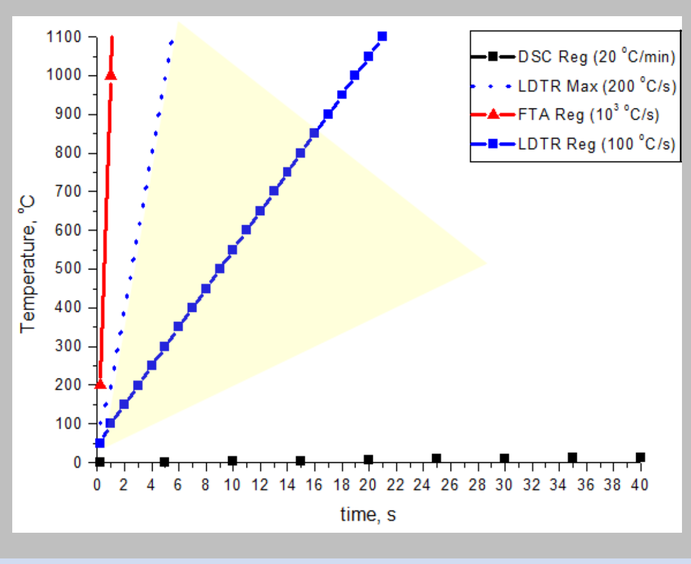
HME Mixtures

Title	Stoichiometric Oxidant/Fuel Mixture Ratio
Ammonium nitrate/nitromethane (ANNM)	71/29
Ammonium nitrate/cellulose	90/10
Ammonium nitrate/confectioner's sugar (ANS)	84/16
Ammonium nitrate/No. 2 diesel (ANFO)	94/6
Ammonium nitrate/petroleum jelly	90/10
Ammonium nitrate/paraffin wax	90/10
Ammonium nitrate/ethylene glycol	87/13
Nitromethane/cellulose	saturated
Nitrobenzene/cellulose	saturated
Ammonium nitrate/cellulose/nitromethane	90/10/saturated
Ammonium nitrate/cellulose/nitrobenzene	90/10/saturated

Experimental Arrangement

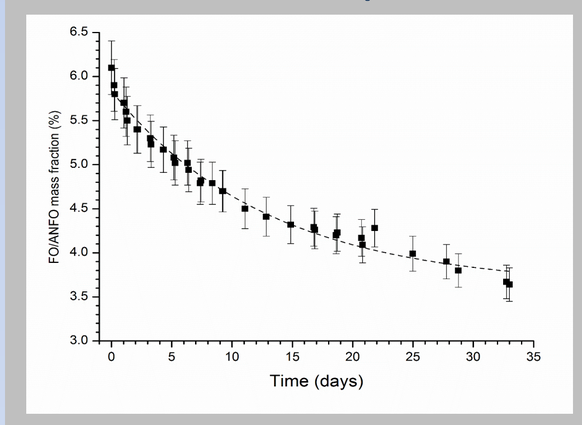


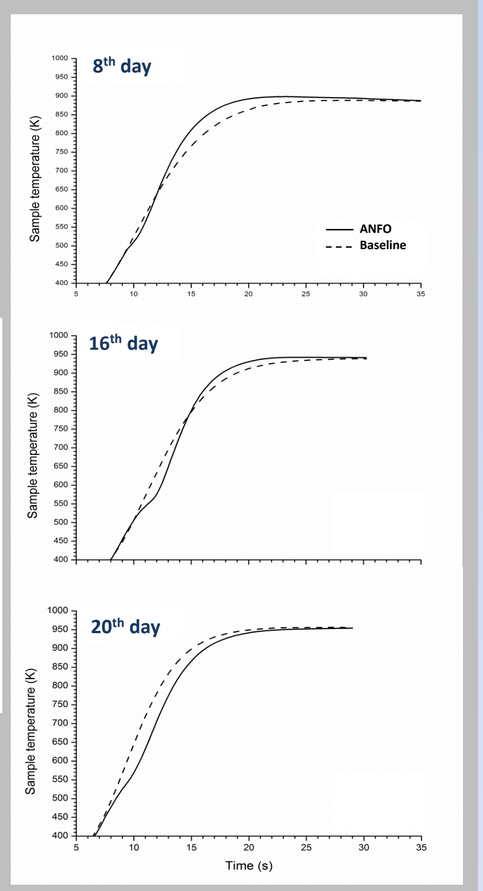


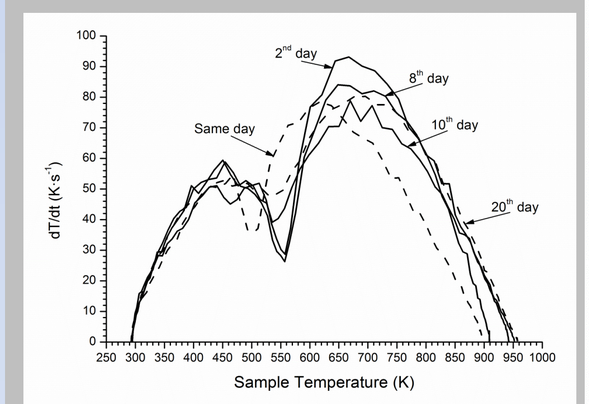


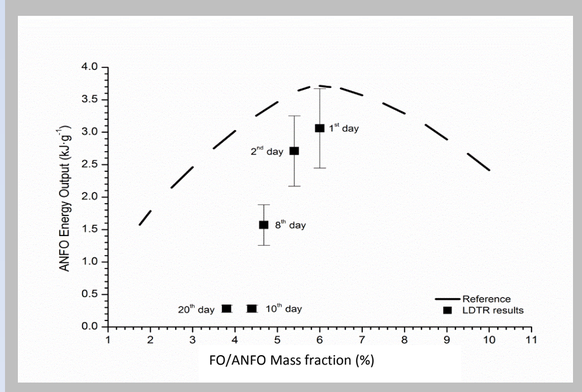
Example – ANFO Thermal Behavior

- Aging of the HME results in preferential vaporization of the fuel volatile hydrocarbon fractions and reducing the HME potency.
- The LDTR thermograms can discriminate these changes in the HME chemical composition.









Summary

- Thermograms were obtained for 11 different HME compositions.
- The thermograms were found to be different than the individual components and each other, indicating sensitivity of the LDTR technique to uniquely identify different HME compositions for forensic analysis.
- Currently, measurements are underway to include HMEs synthesized by the FBI, and nanoparticle metal/metal oxide thermite powders.
- It is expected that this approach will enable development of a standardized methodology and data format for populating a signature database.

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