LASER-BASED FORENSIC METHODOLOGY TO IMPROVE IMPROVISED CHEMICAL IDENTIFICATION

Ashot Nazarian (NIST) and Cary Presser (NIST)

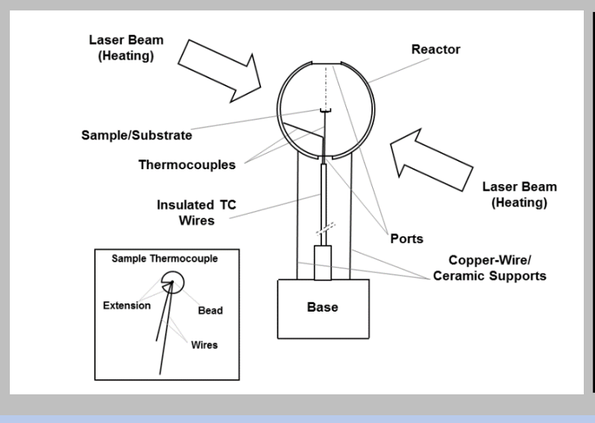
Background

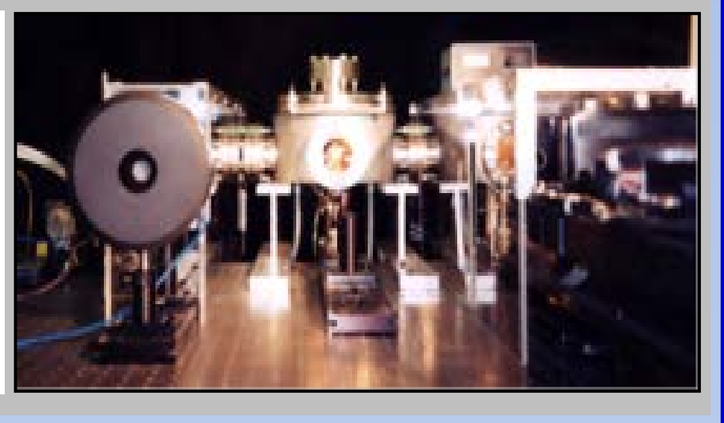
- The forensic community, federal and state law enforcement, first responders, and counter terrorism organizations are in need of measurement techniques and data to identify quickly and accurately improvised chemical compositions.
- One possible approach to confront this issue is the application of a laser-heating technique, referred to as the laser-driven thermal reactor (LDTR). This technique can provide more precise analysis and improved signal-to-noise ratio over current available techniques, such as with differential scanning calorimetry (DSC), differential thermal analysis (DTA), thermogravimetric analyzers (TGA), and others.
- Table 1 compares the basic operating features between the LDTR and DSC. The LDTR provides information at an order of magnitude higher heating rate and shorter measurement time. The LDTR can be used to analyze a wide range of liquid and solid single-component substances, and mixtures.

Methodology Capability

- LDTR is a novel and developing calorimetry methodology, which is being used to obtain thermal signatures of improvised chemical mixtures.
- It was demonstrated that the LDTR can serve as a diagnostic tool for identifying trace amounts of improvised chemical mixtures, and their thermophysical and thermochemical properties.

Experimental Arrangement





Forensic practitioners successfully use 6-point, latent-print identification (see Fig. 2); similarly, the LDTR can provide a 6-point, thermophysical-/thermochemical-based identification of improvised chemical mixtures (see Fig. 1).

Table 1. Comparison of operating features, and benefits of using the LDTR.

Performance Measure	DSC	LDTR	LDTR Benefit
Measurement time (s)	6,600	30	Cost savings - faster results
Heating rate (K/s)	0.3	50	Improved detection – higher signal-to-noise

Table 2. Identified thermophysical and thermochemical properties from LDTR thermograms.

No.	NIST Ref. Data
1	Phase-transition point
2	Melting point
3	Boiling point
4	Deflagration temperature
5	Decomposition temperature
6	Specific energy released

Example

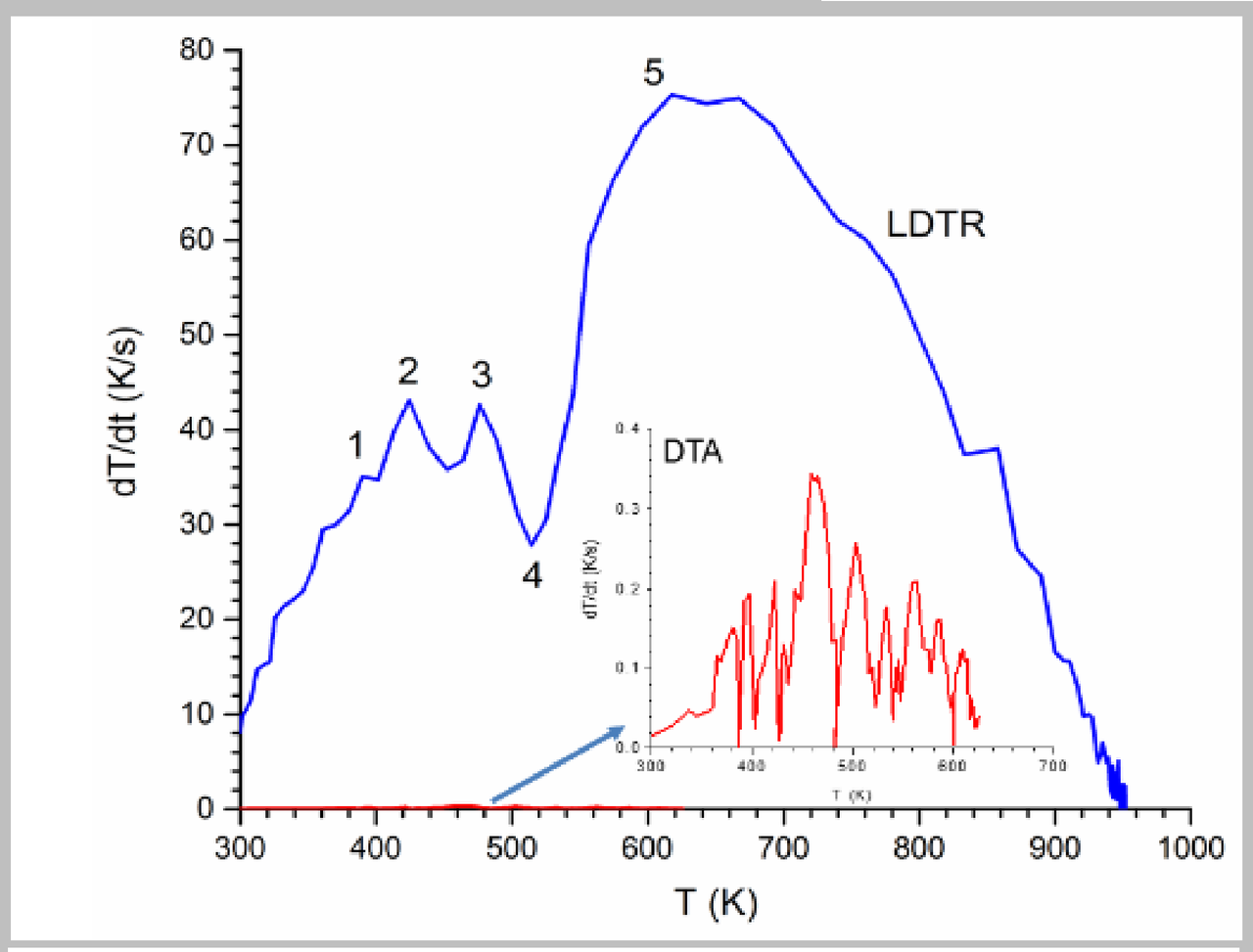


Figure 1. Comparison of LDTR and DTA thermal signatures for ammonium nitrate.

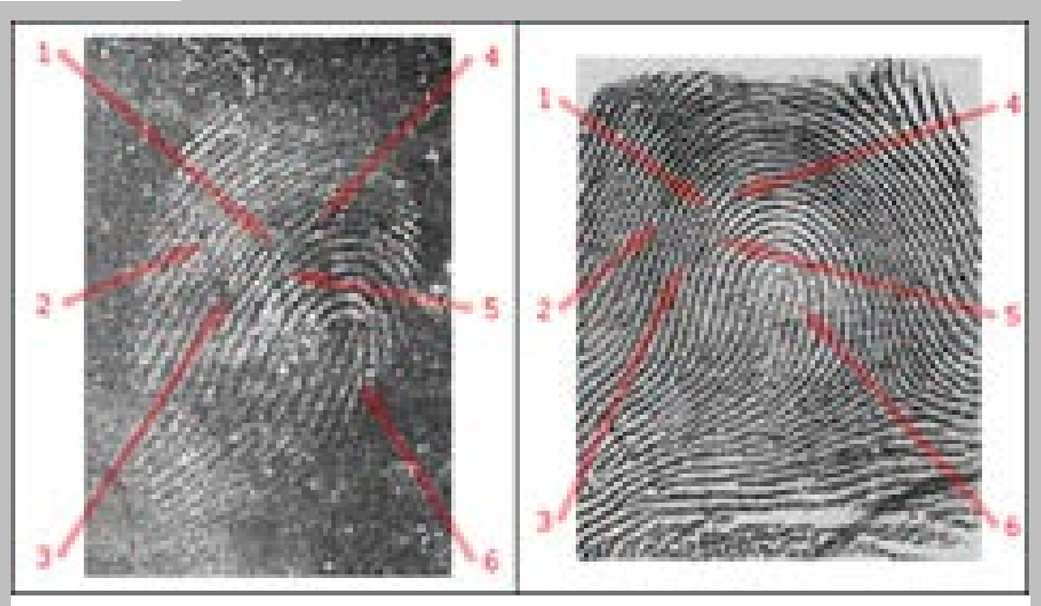


Figure 2. Real case data.
https://www.fbi.gov/news/stories/2014/august/latent-hit-of-the-year-award /latent-hit-of-the-year-award.

Benefits

Potential benefits include improved resolution of thermal-signature features, use of established NIST thermochemical databases (Table 2), and improvised chemical identification at levels acceptable to the criminal justice community.

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