UNIVERSITY OF RHODE ISLAND

Department of Chemistry

Room 234 Pastore Hall

3:00 p.m, Monday, Feb. 29, 2016

Matt Porter

Ph.D Research Seminar

Chemistry Department

URI

"Providing Tools to Fight the Terrorist Threat"

HOST

Louis Kirschenbaum

Department of Chemistry

401-874-2340

Matt Porter

Providing Tools to Fight the Terrorist Threat

Part I

Hexamethylene Triperoxide Diamine (HMTD) is a homemade explosive easily synthesized from hexamine, citric acid, and hydrogen peroxide. Although HMTD is very sensitive and prone to stability problems, it has a history of terrorist use, such as in the London bombing of 2005. Because law enforcement personnel must handle this material with no guarantee of purity nor indication of additives, the stability and reactivity of HMTD were studied in a number of environments for the sake of safety. By thermal analysis, water and weak acids were found to destabilize HMTD. Synthesis and decomposition mechanisms were probed with isotopic labeling and mass spectrometry. The data suggests the synthesis proceeds through a complete break-down of hexamine. The decomposition was found to be humidity dependent, where the distribution of condensed phase products is drastically affected.

Part II

Currently there is a need for specialized pyrotechnic materials to combat the threat of biological weapons. Materials have been characterized based on their potential to produce heat and iodine gas to kill spore-forming bacteria (e.g. anthrax). One formulation, already proven to kill anthrax simulants, is diiodine pentoxide with aluminum; however, it suffers from poor stability and storage problems. The heat and iodine output from this mixture and candidate replacement mixtures were measured with bomb calorimetry and extraction and analysis of iodine by UV-Vis. Of the mixtures analyzed, calcium iodate and aluminum was found to be the highest producer of iodine gas. The heat output of this mixture and others can be tuned by adding more fuel, with the cost of some iodine. Products of combustion were analyzed by thermal analysis and XPS.

Part III

As seen in multiple cases, including the Boston Marathon bombing, improvised explosives may be as simple as a fuel/oxidizer mixture initiated by a hot wire. The knowledge of which materials or compositions are explosive is incomplete, and tests for explosivity are currently conducted at specific scales. For example, ammonium nitrate is classified as an oxidizer because

it does not explode at the pound scale, but can become explosive at a larger scale or with a fuel added. Ideally, a small scale metric (possibly gram scale) would be developed to predict whether fuel/oxidizer mixtures will be explosive at larger scales. Explosive mixtures known to be ignitable by hotwire were analyzed with a pressure transducer during bomb calorimetry experiments. In the future, these results will be correlated with larger scale tests in order to prove this as a metric for screening threat materials.