Trace Analysis and Physical Property Characterization of Energetic Materials (Explosives)

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Currently, there is a need for standardization, calibration and certification of energetic (explosive) material detection devices. To this end, our laboratory is making the required fundamental measurements needed for certification, and in this poster two such measurements are presented. The first area is quantitative headspace measurements on several practical energetic materials, e.g., 2,4,6-trinitrotoluene (TNT) and C-4. A headspace measurement is made by placing a small amount of a material in a sealed vial in a temperature controlled environment. A capillary is attached to flow He gas into the vial and an activated porous layer open tubular (PLOT) column is attached to the vial to allow He gas and other volatile constituents in the headspace to flow out of the vial. To increase the efficiency of analyte collection, the PLOT column is housed mainly in a cryostat that is chilled to ~5 °C. After a predetermined time the PLOT column is removed, the constituents are eluted and analyzed. Detection can be complicated by the fact that explosive materials are often mixed with taggents (materials added intentionally for identification), plasticizers, motor oil and binders (materials added to make all of the components cohere). Additionally, the major component in the mix is not necessarily the easiest component to detect; however, this fact is not important as long as several of the components can be detected. Headspace measurements have been performed on the pure explosive compound 2,4,6-trinitrotoluene (TNT), the practical military explosives C-4, Semtex-A and Semtex-H (plastic explosives made from RDX and PETN (trinitro-triazacyclohexane and pentaerythritol trinitrate, respectively), detonator cord (lead azide) and detonator sheet. Additionally, we present a novel apparatus and method for detecting and quantifying the permeation of hydrogen peroxide (H_2O_2) through polymer barriers (i.e., plastic bottles). H_2O_2 has been used to make improvised explosives or incendiary weapons that resemble a bottled drink. An analytical method developed by the Transportation Security Laboratory (DHS) that utilizes an HPLC-Fluorescence Detector was implemented in our laboratory. Measurements have been performed with 35 and 50 % hydrogen peroxide. The polymer barrier used was obtained from a blow-molded (polyethylene terephthalte) PET bottle that was 0.009 in thick. Here, we show how the increase in hydrogen peroxide concentration in the chamber that was initially 100 % water can be used to track H_2O_2 permeation through the barrier.