



A72 Quantification of Inkjet Printed Ammonium Nitrate Test Materials by Ultraviolet Visible (UV/VIS) Spectroscopy

Marcela Najarro, MFS*, Timothy J. Barr, and Greg Gillen, PhD, National Institute of Standards and Technology, 100 Bureau Drive, Mailstop 8371, Gaithersburg, MD 20899

After attending this presentation, attendees will understand the feasibility of using UV/Vis to quantify ammonium nitrate.

This presentation will impact the forensic science community by introducing a simple analytical technique capable of accurately quantifying ammonium nitrate.

Ammonium nitrate (AN) is a white crystalline solid and strong oxidizing agent produced from the reaction between ammonia and nitric acid. Ammonium nitrate constitutes approximately 80 to 90% of the explosive used in the United States for industrial purposes (i.e. coal mining, metal mining, and civil construction). In addition, it is widely used as high-nitrogen fertilizer by the agricultural community. Even though ammonium nitrate alone is not an explosive, when mixed with fuel oil it forms a reasonably powerful commercial explosive. Due to its wide availability in the United States and worldwide, ammonium nitrate fuel oil (ANFO) has become the weapon of choice for domestic terrorism as well as devastating terror attacks worldwide. The Oklahoma City Bombing of the Murrah Federal Building in 1995 used about 5,000 pounds of ANFO.

ANFO is often encountered in the form of an improvised explosive device (IED) or car bombs. In 2009, ammonium nitrate fertilizer was used to make about 95 percent of the IED's in Afghanistan and accounted for most of the U.S. casualties. Therefore, analytical techniques such as Raman spectroscopy, Laser-induced breakdown spectroscopy (LIBS), and Infrared spectroscopy are of particular interest since they are capable of non-contact detection by using highly energetic lasers from varying distances. Test materials with known amounts of deposited ammonium nitrate are currently being developed to evaluate the capabilities of detection of a variety of techniques. The goal of this project was to determine the feasibility of using ultraviolet visible spectroscopy (UV/VIS) as a quantitative technique for the ammonium nitrate test materials (target accuracy and precision of 5% relative standard uncertainty). This goal will entail the characterization of UV/VIS, including determining its sensitivity, repeatability of measurements, and

standard uncertainty) within a two hour period. Advantages of using UV/Vis spectroscopy to quantify ammonium nitrate are its ease in operation, rapid sampling time (~ 1 min/sample), and lack of sample preparation. A significant disadvantage of using UV/Vis for ammonium nitrate is the limited linear dynamic range (2 – 18 µg/mL) and the short wavelength at which it absorbs, leading to more specific solvent, cuvette, and spectrometer requirements. Gravimetric measurements of solid ammonium nitrate proved difficult given the hygroscopic nature of the compound in crystalline form. Results also indicate that inkjet printing is a suitable technique for precision deposition of ammonium nitrate. The main advantage of using inkjet printing systems to deposit ammonium nitrate is their good repeatability (< 4% uncertainty per run). Significant disadvantages of printing ammonium nitrate are consistent with standard inkjet printing systems, which include clogged tips and crystallization around the tip leading to inconsistent results.

Ammonium Nitrate, UV/VIS, Inkjet Printer