B151 Modern Methodology for Explosives Tagging and Encoding Based on Luminescent Metal Organic Frameworks

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After attending this presentation, attendees will understand methods of post-blast identification, collection of explosive residues by the addition of luminescent taggants, and the possibilities of encoding based on the metal ratio of the lanthanide ions by Energy Dispersive Spectroscopy (EDS) and typical light emission.

This presentation will impact the forensic science community by providing an easy, fast, and unequivocal method of identification/collection of explosive residues by the addition of luminescent taggants in commercial explosives that act not only as an optical probe, but that provide an encoding based on the metal ratio. The information provided by this presentation can be used to offer evidence that allows the identification of suspects in the criminal use of explosives.

During the past several years, Brazilian authorities have reported an increase in the number of attacks throughout the country on Automated Teller Machines (ATMs) with the use of explosives. According to the eighth edition of the national survey on bank attacks in Brazil, an increase of 147% was observed between the years 2011 and 2014.[1] Concomitantly, a growth of 38% in the cases of deaths by terrorist attacks has been observed around the world, in accordance with the Global Terrorism Index, in which 49% of these correspond to explosives attacks.[2] The evidence indicates the use of Ammonium Nitrate-Fuel Oil (ANFO) obtained from miners and carries in the attacks on ATMs in Brazil.[3]

Tracking and identifying suspects after explosions is one of the most challenging tasks in the forensic field. After detonation, most of the residue of the explosives is lost due to the volatility of the material, with the remaining trace residues being spread over a large debris field.[4] The growing criminal use of explosives has driven authorities to seek technologies that allow tracking of explosives. In 1973, Ryan et al. proposed to include a miscellany of metals and oxides as a way to encode explosives; luminescent materials were incorporated in these taggants in order to make the visualization and collection of residues easier for analysis.[5] Although good results have been obtained for the identification of residues, the need for including additives in explosive and encapsulating taggants was reported, which rendered the process less attractive.[6-9]

This work proposes a method to tag explosives by the direct addition of a luminescent Metal Organic Framework (MOF), which acts simultaneously as an optical probe (allowing easier visualization and collection of explosive residues) and as a chemical taggant (which tracks the explosive's origin). This research reports the use of two isostructural MOFs, (La0.8Tb0.2)(DPA)3(H2O)3 and (La1.6Eu0.2Tb0.2)(DPA)3(H2O)3, synthetized hydrothermally that emit orange and green light, respectively. The taggants were incorporated directly and manually into samples of ANFO explosives. Charges of 10g of tagged explosives were attached and detonated in computer cabinets simulating conventional ATMs.

Post-explosion residues were visually observed *in situ*, using only an Ultraviolet (UV) lamp (254nm). Afterward, the residues were collected and identified by luminescence spectroscopy and Energy Dispersive Spectroscopy (EDS). The EDS metal ratio of the explosives showed a high precision when compared with the pure samples that allowed an unequivocal coding method for each taggant. It was possible to not only observe the luminescent residues at the explosion scene, but the emitted color coupled to metal ratio also allowed for the unequivocal identification of the taggants. The methodology proved to be easy, fast, and very reliable.

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Post-Blast, Taggant, Explosive