A107 The Influence of Acid Catalysts on Triacetone Triperoxide (TATP) Crystal Morphology

Peter J. Diaczuk, BS, 445 W 59th St, New York, NY 10019-2925; and Jack Hietpas, BS, 641 Park Ave, Apt 3, Syracuse, NY 13204*

Attendees of this presentation will learn about the different crystal morphologies formed as a result of using different acid catalysts during the synthesis of Triactetone Triperoxide (TATP).

This presentation will impact the forensic science community by revealing the considerable difference among crystals depending on the choice of acid, which may contribute to an investigation when the precursors are not known.

The use of improvised explosives for criminal, domestic and international terrorism is an ever-increasing problem. Methods for homemade manufacture of these non-military and non-industrial explosives often require little-to-no background in chemistry. TATP, a relatively exotic explosive, is currently receiving considerable attention because of this ease of procurement of starting materials and very simple synthesis reaction. First documented by Wolfenstein, the synthesis of TATP has been the subject of interest and research by scientists and hobbyists for over a century.[1] The two primary starting materials are easily available in relatively pure form from hardware stores, home improvement centers, and pharmacies, as well as in impure form when mixed with other compounds to create several different commercial products (e.g., bleaching agents, nail polish remover, drain cleaners, and many others). The "impurities" in these commercial products have been successfully studied and analyzed for carry-over into synthesized TATP by several instrumental methods.[2,3] Studies using different acid catalysts and their affect on the finished product have also been performed using instrumental methods.[4,5]

TATP is a powerful explosive but other undesirable properties exclude it as a viable explosive for military, commercial, or industrial use. In addition to its high vapor pressure, resulting in very rapid sublimation even at room temperature, it is far too sensitive to shock, impact, friction, and temperature for it to play a practical role in legitimate use, but these properties haven't discouraged its use in terror bombings (and bombing attempts) worldwide during its resurgence over the past 30 years. The dangers involved in the manufacture and handling of TATP have claimed the lives of many would-be "chemists;" in fact, the material is nicknamed the "Mother of Satan" by terrorist bomb makers due to its deadly instability and unpredictability.

The research presented here builds on previous work detailing the optical properties of two identified TATP polymorphs, and a preliminary study by Miller examining the crystal morphology of TATP synthesized using different acid catalysts. [6,7] This presentation expands on the work of Miller by further detailing the potential linkage between TATP crystal morphology and the specific acid catalyst used during its synthesis. The reagent-grade catalysts used for this study include sulfuric acid, hydrochloric acid, nitric acid, and phosphoric acid. The other parameters of the manufacturing process, including reaction temperature, number of times the precipitate was washed, and the temperature of the sublimation and recrystallization process, were kept identical. After synthesis and subsequent washing of the precipitate, the recrystallized crystal morphologies were clearly distinguishable from each other depending on which of the four acid catalysts was used during manufacture. Crystals catalyzed with sulfuric acid were almost cubic, those with hydrochloric acid were long needles, those with nitric acid were clumps of short needles, and those with phosphoric acid were rosettes. The results from these experiments provide a foundation in which a potential linkage between the acid catalyst used for TATP manufacture and the morphology of the synthesized crystals can be established. This information may potentially help as an investigative lead during initial phases of a bombing event when attempting to determine provenance of TATP samples recovered as evidence.

References:

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TATP, Crystal Morphology, Microscopy