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TECHNICAL NOTE

CRIMINALISTICS; ENGINEERING SCIENCES

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Sensitivity of TATP to a TASER Electrical Output

ABSTRACT: A series of experiments were performed to evaluate and document the effect of a TASER ("stun gun") on triacetone triperoxide (TATP), an easily manufactured explosive used often in IEDs and suicide bombing vests. TATP samples were synthesized and subjected to several tests of their sensitivity. These samples were run through a BAM Friction test with a result of <0.5 N, Impact Test with a result of 5.8 ± 0.4 cm, and Electrostatic Discharge test with a result of 0.073 ± 0.018 J. In addition, TATP was shocked with a TASER in a variety of configurations. The TATP reacted in 17/17 tests when the TASER arced through the TATP and 0/4 times when the TATP was configured in such a way that the TATP was not subjected to the electrical arc. Based on the experimental data, TATP will readily explode in a variety of configurations by a TASER or similar device. Testing should be expanded, as the data presented here are limited to a single formulation of TATP. Just one of a large array of TASER-like devices by a single manufacturer were tested; other devices, scenarios and formulations of TATP and other likely threat materials should be assessed.

KEYWORDS: forensic science, TATP, triacetone triperoxide, TASER, electrostatic discharge, suicide vest, stun gun

There is a general belief, heretofore without hard evidence, amongst the homeland security and law enforcement communities that a TASER (generic term for an electric stun gun used to subdue human and animal threats through application of electrical energy to disrupt a nervous system) will initiate "homemade" explosive materials, such as those used in suicide vests and other improvised explosive devices. Triacetone triperoxide (TATP) is a common example of a primary explosive fitting this description (1,2).

As a result of the importance of this information for the protection and well-being of law enforcement and others who may be exposed to a situation where a TASER might be used against explosives, and the lack of hard verifiable empirical data, the Department of Homeland Security, Directorate of Science and Technology, through a Department of Defense managed contract to Unconventional Concepts, Inc., decided to have performed a series of experiments to provide a basis for policy and safety decisions related to this area.

Triacetone triperoxide (TATP) is a highly sensitive primary explosive that can be easily synthesized by amateurs in home laboratories (1–7). The structure of TATP is shown in Fig. 1. The oxygen–oxygen single bonds are easily broken, making the TATP molecule extremely unstable with a reported activation energy (Ea) of 153 kJ/mol (3). TATP is sensitive to impact, friction, and electrostatic discharge (ESD), with a reported ESD sensitivity of 0.16 ± 0.05 J (1).

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TATP, in recent history, has been used as an improvised explosive due to the ease of obtaining materials and simple synthesis (1,3,4). TATP has also become a favorite for terrorists in improvised explosive devices (IED) for these reasons and can often be found in homemade detonators (1,2,8).

A TASER is a device used by law enforcement, homeland security professionals, and even civilians. It puts out an electrical charge to disable human targets. The TASER® model X26C was used in this work. It has a peak electrical current of 3 A, with an average current of 1.9 mA to 2.1 mA, and delivers 1200 volts into the load. This particular model is a factory standard civilian TASER. Manufacturer specifications for the TASER indicate that it will discharge 0.07 J/pulse into a person (9).

Due to the inherent instability of TATP and its use in IEDs (1,2), to include suicide vests, there is a risk that using a TASER to incapacitate a suspected suicide bomber could cause the IED to react. Work was performed at the Energetic Material Research and Testing Center (EMRTC) to investigate the response of TATP to the electrical impulse of a TASER and quantify its reaction. TATP was synthesized at EMRTC, and small samples were tested in small-scale sensitivity testing. Additional samples were subjected to the shock from a TASER in a variety of scenarios.

Methods

TATP Properties

All the TATP used in this work was synthesized at EMRTC using EMRTC standard TATP synthesizing procedures. The TATP was a white, crystalline solid and had a density of 1.2 g/cm^3, a moisture content of <6% and a melt point onset of 90.3°C, as measured by Differential Scanning Calorimetery (DSC) (Perkin Elmer, Diamond model). The final wash, prior to recrystallization, had a pH of 5.

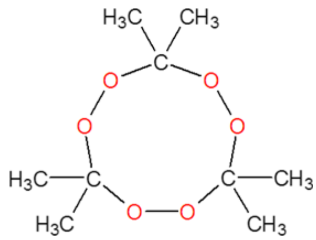

FIG. 1—*TATP molecule.*

Small-Scale Sensitivity Testing

Impact testing was performed using a Type 12 Impact tool (EMRTC) as per the AOP-7 Edition 2, Rev 1 Method 1013. In accordance with MIL-STD 1751A, the TATP was weighed out to 40 ± 2 mg samples and placed on 180 grit sand paper. Cyclotrimethylenetrinitramine (commonly called RDX) was run as a standard on this instrument before testing the TATP samples. A Bruceton analysis was run on the data collected from the impact testing.

Friction testing was performed using a BAM Friction instrument (Reichel & Partner, GMBH) as per the United Nations Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria, 5th Ed., Test 3(b) (i). Pentaerythritol Tetranitrate (PETN) was run as a standard on this instrument before testing the TATP samples. A Threshold Initiation Level (TIL) analysis was run on the data collected from the friction testing.

ESD sensitivity testing was performed using the method found in MIL-STD-1751A, Method 1032. Cyclotrimethylenetrinitramine (RDX) was run as a standard on this instrument (EMRTC) before testing the TATP samples. Both a Bruceton analysis and a TIL analysis were performed on the data collected from the ESD sensitivity testing.

Test Series Rationale

The goal of these experiments was to provide information and data to better inform decision-makers with respect to TASER use policy against explosive materials. Three sets of data were determined to be necessary, and experiments were designed to provide this information:

- Baseline characteristics and properties of the TATP formulation were needed to enable duplication of results and analysis of data if required.
- Baseline response of TATP to a TASER interaction in a controlled, pristine and fully quantifiable situation (cylinder test).
- Operational scenario-based data, representing to a limited extent, a real world scenario (organic tissue representing a shot with a probe in tissue and a probe in a device).

While it is recognized that these experiments are neither complete nor exhaustive for the scenarios chosen, they represent a first attempt at collection of key empirical data that can better inform decisions of practitioners *vis a vis* safety policy related to TASERs and TATP.

TASER Testing

The TASER was modified for these tests by unwinding the probes from the cartridge, turning off the TASER and clipping off the factory standard probes. Alligator clips were then soldered to the TASER leads in place of the standard probes.

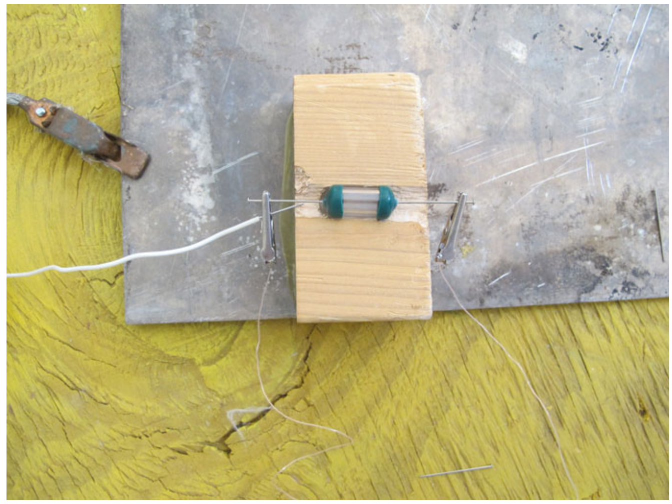

FIG. 2—*Cylinder test setup.*

Eleven (11) tests were performed using a contained sample in a test fixture for a “controlled” baseline. Two (2) tests were performed on open, flattened samples, and an additional series was performed on unbrined pork bellies, with skin, to represent the effect of the TATP/TASER interaction would have on actual tissue. Pig skin was chosen as a surrogate for human skin as it has many properties that make it similar to human skin including its dielectric properties (10). This series of testing simulated shooting a subject with a TASER where one probe enters tissue and the other enters a device holding TATP (such as a suicide bomber vest).

Test Setup

Eleven (11) tests were performed on TATP contained in a Plexiglas cylinder with a 0.25″ inner diameter and 0.75″ length. These cylinders were fitted with rubber caps on each end with brass pins placed in each rubber cap and fixed in place to give a gap between pins of 0.5″. The test charge can be seen in Fig. 2.

One rubber cap with pin was removed, and TATP was placed in each cylinder until full, at which point the cap with the pin was replaced to complete the charge sample. An average TATP sample weight of 240 mg was used for testing. The average pour density for these samples was 0.40 g/cm^3.

The alligator clips on the modified TASER probe were placed on the two pins on the test charge. The cartridge was then attached to the TASER gun, and the trigger pulled to give an electrical current through the test sample, arcing between the 0.5″ gap in the cylinder. No other modification to the TASER was made, thereby leaving the discharge properties unchanged.

Two (2) tests were performed on unconfined TATP by placing 240 mg of TATP powder onto a 1.5″ × 1.5″ × 0.125″ Plexiglas plate. This plate was then placed between two brass pins secured in rubber stoppers to give a 0.5″ gap between the pins. The alligator clips attached to the TASER cartridge leads were placed on the two pins to give a current through the TATP sample, arcing between the 0.5″ gap. The setup can be seen in Fig. 3.

A series of tests were conducted on unbrined pork bellies with skin. The tests were run in various configurations, outlined below in Fig. 4. In each test, the two electrodes were placed 12″ apart, with one firmly embedded in the pig skin to a depth of

FIG. 3—*Unconfined TATP setup.*

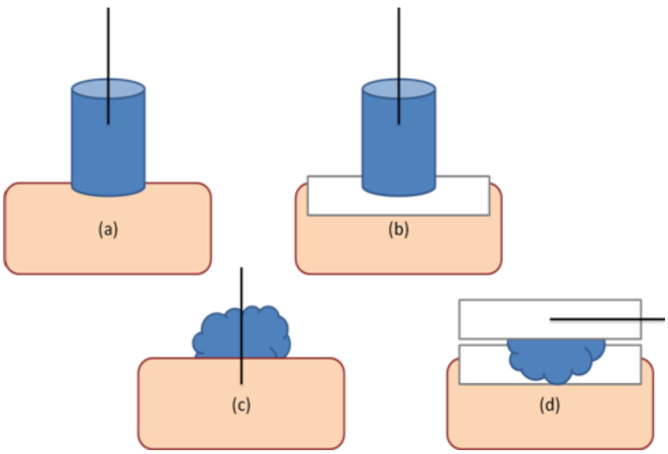

FIG. 4—*(a) TATP confined in a cylinder, in direct contact with the pork skin, with a gap between electrode and skin. (b) TATP confined in a cylinder, with cotton cloth between the TATP and skin, and a gap between the electrode and skin. (c) an unconfined pile of TATP in direct contact with the pork skin, with the electrode embedded directly in the pork skin. (d) a pile of TATP sandwiched between two layers of cotton cloth, with the electrode laying on top of the cloth.*

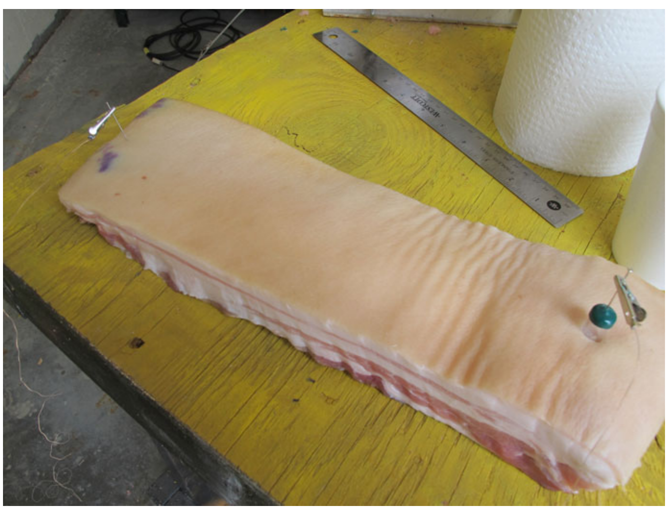

FIG. 5—*Pork belly setup.*

TABLE 1—*Sensitivity test results.*

Small-Scale Test	RDX/PETN Standard	TATP
Impact Test	23.6 ± 1.2 cm (RDX)	5.8 ± 0.4 cm
BAM Friction (TIL)	36 N (PETN)	Too low to measure, <0.5 N
ESD (TIL)	1.41 kv: 0.099 J (RDX)	0.45 kV: 0.01 J
ESD (Bruceton)	0.17 ± 0.042	0.073 ± 0.018 J

TABLE 2—*Cylinder test configuration.*

Test	Figure	Mass (mg)	Result
Test 1	2	244.6	Reacted
Test 2	2	221.8	Reacted
Test 3	2	262.7	Reacted
Test 4	2	226.6	Reacted
Test 5	2	248.2	Reacted
Test 6	2	250.6	Reacted
Test 7	2	255.4	Reacted
Test 8	2	207.9	Reacted
Test 9	2	193.9	Reacted
Test 10	2	313.4	Reacted
Test 11	2	245.5	Reacted

TABLE 3—*Unconfined powder test.*

Test	Figure	Mass (mg)	Result
Test 12	3	240	Deflagration
Test 13	3	240	Deflagration

0.125″, and the other placed in the TATP sample as described. The alligator clips were attached to the pins to give an electrical current through the pork belly and through the TATP between the two pins. The test setup can be seen in Fig. 5.

Attached to the cartridge leads from the TASER were an oscilloscope (Tektronix, Model TDS5054B) and a high voltage probe (Pinktek, Model HVP - 40) (to keep from overloading the oscilloscope). These were set up to read the voltage and current entering the sample.

Results

The small-scale sensitivity results are compiled in Table 1.

TASER Test Results

Results of the tests conducted on TATP confined in a cylinder are shown in Table 2, and results from tests conducted on a loose pile of TATP are shown in Table 3.

Results of the tests conducted on TATP performed on a pork belly are shown in Table 4 in the different configurations as seen in Fig. 4.

Discussion

TATP is a sensitive primary explosive. In small-scale sensitivity testing, it was shown to have an impact sensitivity of 5.8 ± 0.4 cm. A friction sensitivity of <0.5 N was found, and this result was found because the BAM friction instrument only reads down to 0.5 N and TATP gave consistent "goes" at this setting. The electrostatic discharge sensitivity was found to be a TIL of 0.45 kv: 0.01 J and a Bruceton of 0.073 ± 0.018 J.

TABLE 4—*Pork belly tests w/configurations.*

Test	Figure	Configuration	TATP mass	Result
Test 14	4(*a*)	TATP cylinder on pork belly	240	Reacted
Test 15	4(*a*)	TATP cylinder on pork belly	240	Reacted
Test 16	4(*c*)	TATP pile on pork belly	240	No Go
Test 17	4(*c*)	TATP pile on pork belly	240	No Go
Test 18	4(*b*)	TATP cylinder on cloth	240	Reacted
Test 19	4(*b*)	TATP cylinder on cloth	240	Reacted
Test 20	4(*d*)	TATP sandwiched in cloth	240	No Go
Test 21	4(*d*)	TATP sandwiched in cloth	240	No Go

It is possible for TATP to explode when subjected to the output from a TASER. TATP exploded each time it was subjected to an arc from a TASER. Running eleven (11) Plexiglas cylinders full of TATP gave 11 "goes". It should be noted that in some of the tests, it can be seen in the high-speed video that multiple arcs occur before the TATP is exploded. The electrostatic discharge sensitivity Bruceton analysis gave a sensitivity of 0.073 ± 0.018 J. This electrostatic discharge sensitivity and the knowledge that the TASER produces 0.07 J per pulse help explain why the TATP did not explode on the first arc every time. The two (2) unconfined TATP powder tests both caused a deflagration. What occurred here was the arc across the pins dispersed the TATP, which then immediately burst into flames, giving a rapid deflagration. Reactions on pork bellies occurred whenever the electrical current was able to arc through the TATP. The cylinder tests on the pork bellies all gave reactions, while the unconfined TATP tests gave "no goes". This occurred because the pin was stuck directly into the pork belly; so, the current followed the path of least resistance by not going through the TATP. This also occurred in the setup shown in Fig. 4(*d*). It was noted in high-speed videos that the electrical current did not arc through the TATP, due to the close proximity of the bare electrode to the pork skin away from the TATP pile.

Under the right circumstances, the electrical output from a TASER is sufficient to cause a reaction in TATP in various scenarios. Testing should be expanded as the data presented here are limited to a single formulation of TATP, and just one of a large array of TASER-like devices by a single manufacturer; other devices, scenarios and formulations of TATP and other likely threat materials should be assessed. Future work on this project could include subjecting other common homemade explosives to the electrical output of a TASER to see whether a reaction would occur. Full-scale testing of the TASER on a mimic suicide vest would also be a probable route for more empirical data. Another point of interest that will be studied is whether or not the impact energy from the probes would be enough to cause a reaction in TATP.

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