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Exploration of TATB Grain Structure on Detonation Sensitivity Using X-ray CT

Lindsey Kuettner[1], Larry G. Hill[2], John Yeager[2], Kevin Henderson[3], Brian M. Patterson[1]

[1.] Engineered Materials (MST-7), Materials Science and Technology, Los Alamos National Laboratory, Los Alamos, NM, USA
[2.] High Explosives Science and Technology (M-7), Explosive Science and Shock Physics, Los Alamos National Laboratory, NM, USA
[3.] Applied Modern Physics (P-21), Physics, Los Alamos National Laboratory, Los Alamos, NM, USA

Triaminotrinitrobenzene (TATB) explosive crystals are often used within a variety of explosive systems. The crystal loading and physical heterogeneity, the crystal size and shape, can all greatly affect the sensitivity of the explosive [1-2]. This is not only true for the morphology of the entire crystal, but also its internal microstructure. The internal structure of dry-animated TATB is comprised of residual NH_4Cl inclusions and voids that were created when washing out the NH_4Cl. Quantifying these inclusions and voids, as well as whole crystal structure, could lead to predictions of detonation sensitivity of HE lots.

In order to study the internal grain microstructural difference between TATB crystals, measurements were performed using nano- and micro-scale X-ray computed tomography (CT). 3D morphology of three different lots of TATB crystals with varying detonation sensitives were examined as well as a quantification of the inclusions and voids within crystals. Micro-CT images (Figure 1) with a 1 mm field of view compare the visual surface roughness and quantified crystal size of the 3 different lots. Nano-CT images (Figure 2) with a 65 µm field of view, compare the individual crystals' internal features.

The micro-CT images were segmented to obtain equivalent diameter information across the lots. The nano-CT images were segmented for both voids and NH_4Cl particles. These inclusions were quantified for fraction and size and rendered to visually represent the washing out of NH_4Cl during processing. Figure 3 shows the voids exiting the crystal and Figure 4 shows where a void connects to, or touches an NH_4Cl inclusion.

The micro- and nano- CT images collected, visually represent the differences of microstructure between lots, allowing for nondestructive ways to help predict the detonation sensitivity of TATB dry-animated explosives.

References:

[1] VW Manner et al., Materials **10** (2017), p. 638.
[2] DG Thompson et al., Propellants, Explosives, Pyrotechnics **35** (2010), p. 507.

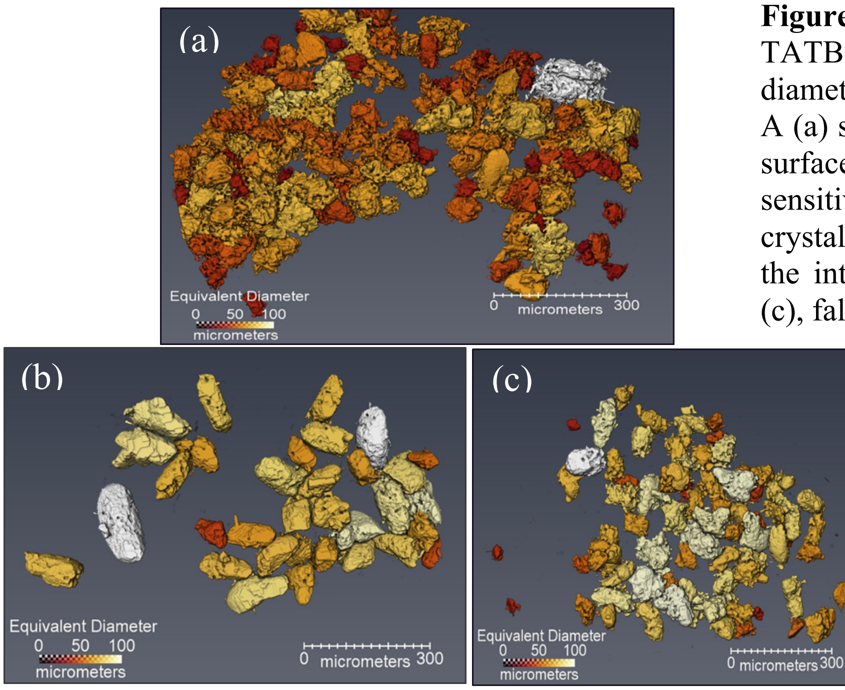


Figure 1. 3D full volume rendering of TATB crystals colored by equivalent diameter. The most sensitive lot, Lot A (a) shows smaller crystals with more surface roughness, and the least sensitive lot, Lot B (b) has larger crystals and smoother surfaces, with the intermediately-sensitive lot, Lot C (c), falling in between.

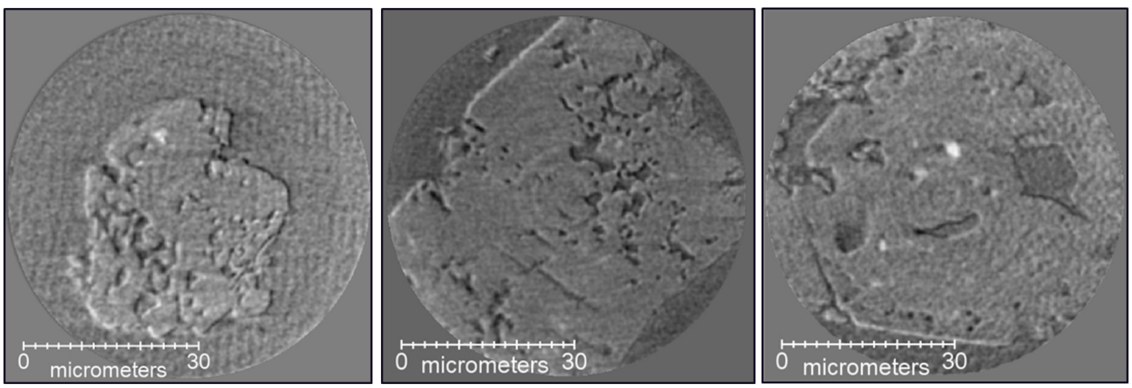
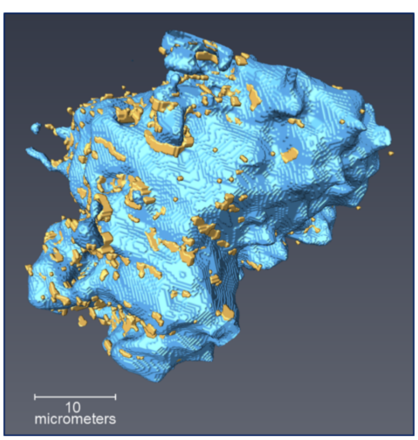


Figure 2. Nano-CT slice in XY view of single TATB crystals from three different lots; Lot A (a), Lot B (b), and Lot C (c). NH_4Cl inclusions are lighter colored, voids are seen throughout the crystals.



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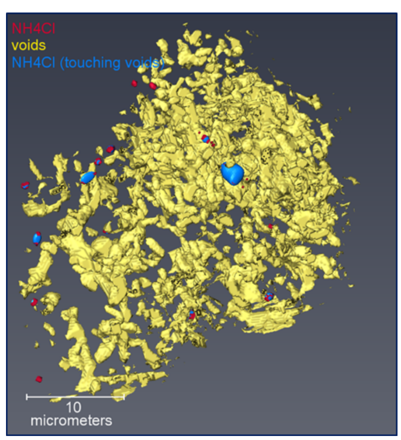

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Figure 3. A 3D rendering of a (blue) Lot A crystal showing where voids (yellow) "exit" the crystal, due to the washing that occurs in processing.

Figure 4. A 3D rendering of the inclusions within this sample crystal (Figure 3). The voids (yellow) and NH_4Cl inclusions (blue) within the crystal. The NH_4Cl particles rendered, are those that were also touching a void. Red is the NH_4Cl not touching a void. This shows the incompleteness of washing out NH_4Cl when processing.

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