Compressive behavior of simulated explosive-filled granular material

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Historically, adhesion research related to energetic materials has been focused on examining the interaction between explosive crystals and the substrate of interest. However, this neglects the effects of the binder material in composites such as Composition C-4. These types of explosives are actually agglomerates comprised of the energetic particulate material and some manner of liquid binder. In the case of Composition C-4, the energetic material is RDX (cyclo-1,3,5-trimethylene-2,4,6-trinitramine) bound by a “liquid” mixture of rubber, plasticizer, and oil. By creating a simulant granular material with the same mechanical properties as ‘live’ compounds, we may understand how the live materials behave during swabbing, improving the ability of swabbing in a security environment to effectively detect these non-ideal plastic explosives. Previous work to this effect has attempted to quantify the effects of applied force, while assuming a constant swipe speed. However, our results indicate that not only is the binder itself non-Newtonian, but the overall agglomerate behaves in a non-Newtonian manner, as well. Hence, the swipe speed could perhaps be one of the principal factors in optimizing contact-based sampling.

Ultimately, this project aims to increase the current understanding of material behavior based on mechanical properties, as well as operator procedure. By mimicking the binder properties and the particle size distributions, we have created a benign surrogate behaves very similarly to live C-4 in compression tests. Because the mechanical behavior of the bulk simulant material is remarkably comparable to that of the live C-4, we believe that the simulated composite may be used aid swipe testing without requiring the presence of highly regulated material. The future of this research is to confirm the simulant exhibits analogous behavior to residual Composition C-4, after which contact sampling efficiency tests may be performed. Ultimately, this work has furthered our current understanding of the mechanical properties of energetic-filled composites, and will also enable further research to be conducted to evaluate new swab materials, as well as an optimum swipe protocol.