

A MODERN APPROACH TO HIGH EXPLOSIVES MANUFACTURING

New formulation methods are combined with modeling and simulation to fill critical knowledge gaps and enable new methods to manufacture plastic bonded high explosives

LDRD investments ensure that ongoing high explosives (HE) science research and technology remain a critical component to keeping the nation safe and secure. This LDRD project has contributed new capabilities design to modernize the way to approach the development of explosives. Plastic-bonded explosives (PBX) are made with a >90% amount of HE powder with the remainder being a polymer binder. The mixing, or formulation, of crystals and binders forms a composite material commonly referred to as “prill”, which then becomes a feedstock for pressing. The physical attributes and distribution of the constituents within prill all play an important – and complicated - role in achieving the careful balance of properties such as performance, safety, mechanical properties, aging and scaling to production.



LLNL and collaborators at Colorado School of Mines outside the Edgar Mine where explosives research and testing occurs.

The enterprise has relied on a wet-slurry process for formulating HE prill for over 70 years. The process works well for a variety of materials but can struggle with others as the process is scaled up. One primary goal of this LDRD was to expand the toolset to formulate HE prill, giving us new methods to manipulate these feedstocks and then to explore how these changes affect downstream properties of interest after compaction. The team is looking at resonant acoustic mixing (RAM) as an efficient, bladeless option to safely process explosives, and extrusion-spheronization which is a commonly-used technique in the pharmaceuticals industry. Additionally, collaborators at The Colorado School of Mines (CSM) developed a method to use a robotic dispensing station to controllably deposit single prills of HE. Other new methods are being explored to improve our toolset and efficiencies to work with HE – which is often starved for data. This includes assessing automation, adopting testing methods from external industries, AI / ML methods to speed up simulations of performance, and adding new characterization methods ranging from surface science and wetting to x-ray movies of detonation.

Key achievements include development of the following capabilities:

- Three new methods to formulate HE prill and control properties of interest
- Atomistic simulations of HE/binder interactions, modeling of formulation and compaction processes, mechanical and detonation property predictions
- State-of-the-art diagnostics to image detonations installed at Colorado School of Mines
- New tools including automation, pharmaceutical approaches, and methodologies to answer questions of interest

Programmatic Impact

This LDRD funded project added several new capabilities to formulate, understand, and characterize HE and balance properties of interest. Approaches from other industries have been adapted for safe use with HE and are investigated to add efficiency and/or accelerate development. Some of the methods here will be scaled up and applied for target materials of interest as part of the transition strategy and may re-shape how we approach the development-to-production cycle for HE components.

LDRD Investment

Project #	Project Title	PI	Duration (FY)
24-SI-004	A Modern Approach to High Explosives Manufacturing	Kyle Sullivan	2024-26

