Mechanical Engineering Dissertation Defense

Effect of Pore Morphology on the Thermal Evolution of PETN and Meso-Erythritol Microstructures under Shock Loading

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Abstract

Energetic materials, particularly those with a granular microstructure, find wide applications in the military and civilian sectors. A comprehensive understanding of their shock response is crucial for the development of safer explosives and predictive models. Initiation of the explosive reaction, a critical safety concern, is believed to be triggered by the formation of hotspots, localized high-temperature regions. Although direct observation of hotspots remains elusive, computational simulations offer a unique window into their behavior. This work investigates the impact of microstructure, particularly pore distribution, on hotspot formation and initiation sensitivity of hotspots in granular explosives, focusing on Pentaerythritol Tetranitrate (PETN) and its potential surrogate, Meso-Erythritol (ME). Building upon findings that link hotspot size and temperature to material heterogeneity, this research integrates experimental characterization of ME and mesoscale simulations of both ME and PETN to quantify how the pore distribution influences hotspots. This study advances the understanding of the initiation mechanisms in energetic materials, paving the way for the design of safer explosives and more robust predictive modeling tools.

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