The Summer Undergraduate Research Fellowship (SURF) Symposium
3 August 2017
Purdue University, West Lafayette, Indiana, USA

Simulating Dynamic Failure of Polymer-Bonded Explosives under Periodic Excitation

Rachel K. Kohler,
School of Engineering and Computational Sciences, Liberty University
Camilo Duarte Cordon and Marisol Koslowski
School of Mechanical Engineering, Purdue University

ABSTRACT

Accidental mishandling of explosive materials leads to thousands of injuries in the US every year. Understanding the mechanisms behind the detonation process is crucial to prevent such accidents. In polymer-bonded explosives (PBX), high-frequency mechanical excitation generates thermal energy and can lead to an increase in temperature and vapor pressure, and potentially the initiation of the detonation process. However, the mechanisms behind this energy release, such as the effects of dynamic fracture and friction, are not well understood. Experimental data is difficult to collect due to the different time scales of reactions and vibrations, so research is aided by running simulations to computationally understand experimental results. Using phase-field model of fracture, we simulate the behaviors of various crack orientations in single particles of HMX bonded in a polymer matrix. Larger amplitudes induce higher rates of energy buildup which lead to quicker crack propagation, while higher frequencies generate higher spikes in temperature. However, crack location and orientation with respect to loading also significantly affect damage rates and temperature fluctuations. Cracks perpendicular to the loading vibration wave propagate most readily and appear to generate the most frictional energy, especially along the crystal-polymer interface.

KEYWORDS

explosives, composite materials, detonation, simulation, dynamic fracture, vibration