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A Lagrangian Framework for Analyzing the Fracture and Heating of PBXs under Impact Loading

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We have developed a Lagrangian framework for quantifying the thermomechanical response of polymer-bonded explosives (PBX) at the microstructural level. Based on the cohesive finite element method (CFEM), this framework accounts for large deformation, thermomechanical coupling, failure in the forms of microcracks in both bulk constituents and along grain/matrix interfaces, contact along crack surfaces and frictional heating. Implementations in 2D and 3D use both digitized micrographs of actual PBX materials and computationally generated microstructures with systematically varying attributes, allowing the effects of phase morphologies, packing and size to be considered. Constitutive responses considered include thermo-elasto-viscoelasticity for the polymeric binders, hyperelasticity for energetic grains, and thermo-elasto-viscoplasticity for metallic inclusions. In this presentation, I will discuss insights gained from analyses carried out using this Lagrangian framework, including quantitative relations between strength and microstructure, transition in heating mechanism from viscous dissipation to frictional dissipation, and distribution of hot spots.