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Multi-physics Meso-scale Finite Element Simulation of HMX-based Solid Propellant Subjected to Thermal Insults GAURAV SRIVASTAVA[1], Assistant Professor, KAREL MATOUS[2], Associate Professor —
A large strain chemo-thermo-mechanical numerical framework has been developed to model the coupled chemical, thermal and mechanical behavior of solid propellant at the meso-scale. The mechanical behavior is modeled using a hyperelastic material model with viscous damage and J2 plasticity. The model admits a general nonlinear coefficient of thermal expansion to capture the thermo-mechanical behavior. The chemical model considers a system of chemical reactions with the rate kinetics being governed by a modified Arrhenius law. The thermal model considers thermodynamically consistent energy contributions from the inelastic mechanical deformations and the chemical reactions. The finite element method has been employed to discretize the continuum equations. Some simulation results will be presented to demonstrate the use of the developed framework in modeling the behavior of HMX-based solid propellant under thermal loads. The developed framework captures the large volumetric strains that are a characteristic of the β-δ phase transition of the HMX crystals and is able to predict locations of potential cracks in the binder. Such a simulation tool may prove to be useful in determining optimal conditions for the safe storage of such materials.

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