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Meso-scale Simulations and Instrumented Experiments in Metastable Intermolecular Composites

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Impact initiation of reactions in various aluminum-based intermolecular composites in the form of powder mixture compacts and cold-rolled laminates are being investigated using instrumented gas-gun impact experiments under conditions of uniaxial-strain and uniaxial-stress loading. Time-resolved stress and particle velocity measurements as well as high-speed imaging are used for monitoring the deformation and reaction states to obtain evidence of reaction based on changes in compressibility and shock-velocity, as well as via direct light emission. Meso-scale numerical simulations with CTH multimaterial hydrocode are also performed on actual (imported) micrographs. The simulations allow qualitative and quantitative probing of the local configurational changes and their effects on impact-initiated reaction mechanisms, following validation of macroscopic properties by correlations with experiments. The heterogeneous nature of wave-propagation through reactants of dissimilar elastic and plastic properties and morphological characteristics, produce effects that give rise to turbulent flow, vortex formation, and dispersion of reactants across large distances. Understanding of these processes as a function of mathematically represented constituent configuration and state of stress/strain is essential for designing energetic/reactive materials systems with tunable energy release characteristics.