Abstract Submitted
for the SHOCK19 Meeting of
The American Physical Society

The role of heat conduction on hot-spot formation in energetic materials ELISEO IGLESIAS, University of Texas at San Antonio, BABAK RAVAJI, JUSTIN WILKERSON, Texas AM University — Understanding and mitigating the formation of hot-spots in energetic materials, e.g. polymer-bonded explosives (PBX), is vital to improving their overall safety. Accidental hot-spot formation can occur when heat generated via plastic dissipation overwhelms the rate of thermal conduction. It is commonly assumed that under dynamic loading conditions, e.g. strain rates in excess of 100% per millisecond, that thermal conductivity is too slow to be effective, i.e. adiabatic. As such, it has become common place to carry out computational simulations of such high strain-rate deformation assuming adiabatic conditions. Here we carry out mesoscale (explicitly resolving the microstructure in PBX) finite element calculations with and without adiabatic assumptions. The effect of loading rate is studied in detail to elucidate the effect of competing timescales of loading rate versus thermal transport timescales. These calculations enable us to map out the regimes where the adiabatic assumption is appropriate and regimes where it can introduce non-trivial inaccuracies, i.e. over-predictions of hot-spot temperatures. For situations where thermal conduction plays a fairly significant factor on hot-spot formation, we experimentally investigate the implications for the design of PBX with reduced sensitivity to accidental ignition. In particular, we find that enhancing the thermal conductivity of the binder phase, e.g. through the incorporation of nanoparticles with ultrahigh conductivities, can result in the generation of cooler hot-spots and hence improved sensitivity.

Justin Wilkerson
University of Texas at San Antonio

Date submitted: 28 Feb 2019 Electronic form version 1.4