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Shock Initiation Thresholds of Various Energetic Materials

David L. Damm[1], Eric J. Welle[2], Cole D. Yarrington[1]

1. Sandia National Laboratories*, Albuquerque, NM, 87185

2. Air Force Research Lab, Eglin AFB, Eglin, FL

Abstract

Shock initiation threshold data for several energetic materials has been analyzed for both short-pulses and long, sustained shocks. In the limit of long duration shocks, the critical pressure for initiation is governed by the balance between chemical energy release in the vicinity of hotspots and thermal dissipation which cools the hotspot and can quench reactions. The observed trends in critical pressure from one material to the next are related to the thermophysical properties and chemical reaction kinetics of each material. Scaling analysis, combined with hydrocode simulations of collapsing pores has confirmed these trends; however large uncertainty in the reaction kinetics under shock loading prevents an accurate quantitative description of hotspot ignition. For a given pore diameter, scaling analysis allows a quick estimate of the temperature at which the reaction rate will exceed the rate of thermal dissipation. Using published thermophysical property data and reaction kinetics we found that the trend in critical hotspot temperatures for several common materials (e.g. PETN, HMX, HNS, and TATB) matches the observed trend in initiation sensitivity. The hydrocode simulations of pore collapse provide a link between the critical temperature and the initial shock pressure. For these simulations we have used recently published QMD-based equations of state for the fully-dense, crystalline phase and have included the effects of variable specific heat, viscous dissipation, and plastic work. These results will be presented and the need for physically-meaningful reaction rates will be emphasized.

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