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A unified view of burn models for energy localization due to hotspot ignition and growth in shocked energetic materials H. S. UDAYKUMAR, SANGYUP LEE, NIRMAL RAI, University of Iowa, ANGELA DIGGS, BARRETT HARDIN, AFRL-RW — Shock-to-detonation transition (SDT) in an energetic material can occur if the rate of chemical energy deposition is sufficiently rapid that there is a coupling between the shock and chemical reactions. Arrhenius kinetics cannot meet the time scale requirement. Therefore, “burn models” have traditionally been used to provide the power deposition needed for modeling of SDT. We show that burn models, such as the multiple Arrhenius reactors viewpoint, the SURF model and the ignition-and-growth (IG) model, all lead to a common time scale for the energy deposition rate. Tthis common time scale is shown to depend on the average void size in the control volume, is inversely proportional to the porosity and is inversely proportional to the rate of area change of a representative hot spot. This is consistent with experiments and physical expectations, since smaller voids and larger porosity will increase sensitivity; larger rates of change of areas will also increase the sensitivity. The common time scale among ignition-and-growth based burn models allows for a unified approach to construct meso-informed reactive burn models using high-fidelity meso-scale numerical simulations; this approach is applied to construct a surrogate model for energy localization rate.

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