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A Generalized Reduced Model of Uniform and Self-Propagating Reactions in Reactive Nanolaminates LEEN ALAWIEH, Johns Hopkins University, OMAR KNIO, Duke University; Johns Hopkins University, TIMOTHY WEIHS, Johns Hopkins University — Reactive nanolaminates are comprised of alternating layers of materials that react exothermically. Self-propagating reaction fronts, traveling at speeds that can exceed 10m/s, can be initiated in these materials using an external heat source. The wide range of length and time scales involved in such reactions presents a typical modeling challenge due to the inherent interplay of the different scales in the underlying dynamics and the eventual end-product. In this presentation, we will discuss the development of a reduced reaction model for Ni/Al nanolaminates. The model incorporates a generalized, anisotropic description of thermal transport that also accounts for the dependence of thermal conductivity on composition and temperature. A generalized description of intermixing is also developed, that incorporates information derived from disparate experimental observations, and molecular dynamics (MD) computations. Using insights gained from MD computations, intermixing is described using a simplified, temperature-dependent composite diffusivity relation that enables us to reproduce measurements of low-temperature ignition, homogeneous reactions at intermediate temperatures, as well as the dependence of reaction fronts on micro-structural parameters.

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