403e Tuning the Reactivity of Nanoparticles and Nanoparticle Mixtures

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Nanostructured fuel/oxidizer composites are being looked upon as a possible approach to enhance energy release rates. Here we report on two methods for tuning reactivity. In the first case our goal is to increase reactivity, while the second to decrease reactivity. In the first csse we form energetic nanocomposite aerosol materials, composed of assembled fuel and metal oxide nanoparticles with significantly higher energy release rate. The method is based on electrostatically enhanced assembly to promote the preferential arrangement of aluminum (fuel) nanoparticles with iron oxide (oxidizer) nanoparticles in the aerosol phase. Two unipolar chargers are employed to generate oppositely charged aluminum and iron oxide particles, which enhance the formation of intimately interconnected nanocomposite energetic materials. The results of burning tests and thermal analysis using differential scanning calorimetry (DSC) showed that aluminum/iron oxide nanocomposite aerosol materials synthesized by bipolar assembly had burning rates that are a factor of 10 higher than those produced by random Brownian coagulation.

We also present a novel method for tuning the reactivity of nanoenergetic materials by coating a strong oxidizer nanoparticle (Potassium permanganate; ~150 nm) with a layer of a relatively mild oxidizer (Iron oxide). The measured reactivity for a nano-Al/composite oxidizer could be varied by more than a factor of 10 as measured by the pressurization rate in a closed vessel (Psi/microsecond), by changing the coating thickness of the iron oxide. The composite oxidizer nanoparticles were synthesized by a new aerosol approach, where the non-wetting interaction between iron oxide and molten potassium permanganate aids the phase segregation of a nanocomposite droplet into a core-shell structure.