

DESIGN and DEVELOPMENT of NANOENERGETIC MATERIALS with TUNABLE COMBUSTION CHARACTERISTICS

In recent years, nanoengineered thermites with tunable and tailored characteristics have attracted a great deal of attention owing to their enormous potential as excellent reactive materials, green primers, and structural energetic materials etc. Nanothermites are typically composed of metal oxide (oxidizer) and metal (fuel) nanoparticles. A variety of nanostructured oxidizers such as Fe_2O_3 , CuO , Bi_2O_3 and MoO_3 etc have been prepared in our laboratory. Various morphologies of oxidizers include nanorods, nanoparticles, and mesoporous structures exhibiting high surface area. Surfactant templating method has been developed for the synthesis of ammonium nitrate (NH_4NO_3) nanoparticles with a size distribution of 10–100nm. The physical and the chemical properties such as morphology, surface area, purity, composition, crystal structure of these metal oxide nanostructures have been determined by a host of characterization tools. Among the nanothermites, CuO nanorods/ Al nanoparticles exhibit the best combustion performance measured in terms of combustion wave speed of 2600 100 m/s and reactivity of 11 1 MPa/sec. Nanothermites based on CuO nanorods/ Al nanoparticles were then modified by mixing with polymers such as nitrocellulose (NC) and/or explosives such as (NH_4NO_3) nanoparticles, RDX (micron and nano size) and CL20 and the reaction rates of these nanocomposites were determined. Among the polymers, nitrocellulose coating of nanothermites is very interesting. Both the NC and the Teflon coated CuO/Al based nanothermite systems exhibit the ability to generate shock waves during their fast combustion. The NC coating has shown tremendous potential to reduce the high sensitivity of nanothermites to electrostatic discharge (ESD), friction and impact. Experimentally measured combustion characteristics are found to correlate very well with the physical and chemical characteristics of metal oxide nanostructures. The developed technology in our lab demonstrates the potential to tune and tailor the combustion characteristics of nanothermites to the desired level by proper choice and combination of fuel and oxidizer materials, their dimensions, and the process of self-assembly with reduced sensitivity.

POTENTIAL AREAS OF APPLICATIONS:

- Microthrusters;
- Propellants;
- Propellant Initiators;
- Suitable Replacements for Lead and Sulfur based Primers;
- Shockwave drug delivery systems;

PATENT STATUS: Provisional and non-provisional application on file

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