Enhancement of Energy Release Rate of NanoEnergetic Composite Materials by Controlling Their Nanostructures

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In this work, we demonstrate a new method to enhance the exothermic reactivity of nanoenergetic materials by employing the mixture of fuel nanoparticles and metal oxidizer nanofibers. With the assistance of an electrospining method, the composite of polyvinylpyrrolidone (PVP) and $Cu(NO_3)_2$ was first formed into nanofibers, and then metal oxide nanofibers were finally remained by removing polymer templates through subsequent calcinations at various medium temperatures (400~800^oC). The resulting metal oxide nanofibers were then mixed with Al nanoparticles by sonication energy. After the sonication of both Al and CuO nanomaterials, they were observed to be tightly aggregated by SEM and TEM analyses.

The resulting nanoenergetic materials composed of Al nanoparticles and CuO nanofibers prepared in this approach were then exploded by an electronic hot wire to measure the degree of positive pressure rate (i.e. dP/dt) generated in a pressure cell tester system. As the result of a series of explosion experiments, we found that the energy release rate of Al nanoparticles/CuO nanofibers-based energetic composite materials was increased up to ~60% compared with that of Al/CuO nanoparticles. This indicates that the metal oxide nanofibers inherently provide higher specific surface area to the fuel metal nanoparticles (i.e. Al) than spherical metal oxide nanoparticles so that the oxygen supply from metal oxide nanofibers can be made much faster when the fuel metal nanoparticles were ignited.

References

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