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Nanoenergetic Materials as Effective Heat Energy Sources for Enhanced Gas Generators

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Abstract : In this study, we systematically investigated the effect of nanoscale energetic materials in formulations of aluminum nanoparticles (Al NPs; heat source)/copper oxide nanoparticles (CuO NPs; oxidizer) on the combustion and gas-generating properties of sodium azide microparticles (NaN3 MPs; gas-generating agent) for potential applications in gas generators. The burn rate of the NaN3 MP/CuO NP composite powder was only ~0.3 m/s. However, the addition of Al NPs to the NaN3 MP/CuO NP matrix caused the rates to reach ~5.3 m/s, respectively. In addition, the N2 gas volume flow rate generated by the ignition of the NaN3 MP/CuO NP composite powder was only ~0.6 L/s, which was significantly increased to ~3.9 L/s by adding Al NPs to the NaN3 MP/CuO NP composite powder. This suggested that the highly reactive NPs, with the assistance of CuO NPs, were effective heat-generating sources enabling the complete thermal decomposition of NaN3 MPs upon ignition. Al NPs were highly effective in the gas generators because of the increased reactivity induced by the reduced particle size. Finally, we successfully demonstrated that a homemade airbag with a specific volume of ~140 mL could be rapidly and fully inflated by the thermal activation of nanoscale energetic material-added gas-generating agents (i.e., NaN3 MP/Al NP/CuO NP composites) within the standard time of ~50 ms for airbag inflation.

Keywords : nanoenergetic materials, aluminum nanoparticles, copper oxide nanoparticles, gas generators
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