Performance Enhancement of HTPB Fuels burning in Gaseous Oxygen by Metallic Additives

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Low regression rates in hybrid rockets have limited their capability and application. Addition of metallic particles to hybrid rocket fuel systems has been shown to increase the regression rate specific energy of the fuel. This behavior has been widely explored for aluminum additives, but relevant data is lacking for alternative metal fuels. In the current study, HTPB fuel grains were loaded with aluminum, magnesium, titanium, and zirconium micro-particles; aluminum and boron nano-particles; and magnesium-coated boron nano-particles to study their relative effects on the combustion behavior. Ballistic experiments were conducted in gaseous oxygen crossflow at moderate pressure (<1 MPa) and oxidizer mass fluxes up to 300 kg/m^2-s. Accumulation of the metals on the fuel surface is observed to reduce heat feedback from the diffusion flame to the virgin fuel. The combustion efficiency of all motors is observed to vary with residence time of the fuel in the combustion chamber. Fuels loaded with micro-zirconium outperformed all other in terms of theoretical performance and experimental regression rate.