Ignition and Combustion of HTPB-based Solid Fuels Loaded with Micron-sized Metals

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ABSTRACT

Hybrid propulsion provides several safety and operating advantages over both solid and liquid propulsion systems[1]. However, these advantages are hindered by the low regression rate of the solid fuel. Loading the solid fuel with metal additives can increase regression rates, while decreasing ignition delays. The conventional micron-sized additives used for solid fuel loading are usually not effective in enhancing the regression rate of hybrid fuels[2]. On the contrary, nano-sized additives can provide considerable regression rate enhancement, but they require proper manufacturing techniques to disperse the additive down to the nano-scale[3-4]. Innovative micron-sized metal powders can provide enhanced reactivity, while avoiding dedicated manufacturing procedures for additive dispersion.

This paper discusses an experimental investigation focused on the effects of various micron-sized metal additives on the behavior of solid fuel formulations based on Hydroxyl-Terminated PolyButadiene (HTPB). Oxygen was selected as oxidizer for ignition delay and regression rate tests. A continuous CO_2 laser with a wavelength of 10.64 μm was used to ignite the fuel. A relative grading of solid formulation performance was performed taking unloaded HTPB as baseline. Three different micron-sized additives were investigated in the experimental activity. The first one is conventional Mg. The other two are innovative metal additives: amorphous Aluminum and composite MgB90 (20% Mg). The latter is a dual metal additive composed by 20% Mg and 80% B with 90% purity.

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