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IGNITION DELAY IMPROVEMENT BY CATALYSTS SUPPORTED ON ACTIVATED CARBON FOR HYDROGEN PEROXIDE HYPERGOLIC HYBRID ROCKET

Abstract

Recently, hypergolic hybrid rocket has been considered as the propulsion system for NASA's Mars Ascent Vehicle. So, many research groups are making efforts to increase the technical readiness level of hypergolic hybrid rocket. Hypergolic hybrid rocket, which does not require an additional ignition device, has advantages such as easy re-ignition, low-temperature storability and long-term storability of solid fuel. Thus, it is attracting attention as a future space propulsion system. Among various storable liquid oxidizers, hydrogen peroxide rockets are primarily accompanied by catalytic ignitors. However, in the case of a hydrogen peroxide rocket with catalytic bed, the pressure drop on the catalyst bed and the weight of the catalyst bed are increased when the propulsion engine is enlarged. Therefore, many groups are working to increase the technical level of hydrogen peroxide hypergolic rockets without a catalyst bed. Focusing on the fact that catalytic decomposition occurs when hydrogen peroxide meets various metals, study has been conducted to add catalytic additives to solid fuels to improve ignition performance for hydrogen peroxide hybrid rocket. In this study, various metals for hydrogen peroxide were supported on activated carbon nano particles with a large specific surface area and then mixed with the hypergolic solid fuel. As the hydrogen peroxide catalyst material, Pd, Pt-Ru, Pt, Ru, Mn, Fe, Pb, Co, Cr, Ni, and Cu were selected. Activated carbon was impregnated with a catalyst metals having a theoretical concentration of 20 wt% using the catalyst precursors. Then, the ignition characteristics of hypergolic solid fuel and pure catalysts were captured and ignition delays were measured through the hypergolic drop test with 95 wt% hydrogen peroxide. Among them, activated carbon loaded with Pd, Pt-Ru, Pt, Ru, Mn, and Fe had very short ignition delay of 1 to 7.5 ms with 95 wt% hydrogen peroxide. It was confirmed that the ignition delay was improved from 16 ms to 1.2 ms when 1 wt% of catalyst on activated carbon was added to the hypergolic solid fuel containing 25 wt% of ammonia borane in polyethylene. Further, ignition characteristics of each catalysts and catalyst combined hypergolic solid fuels were studied through 4000 fps high-speed camera images. In conclusion, it was confirmed that metal catalysts on activated carbon can be actively utilized in constructing the solid fuel of a hypergolic hybrid rocket using a storable oxidizer such as hydrogen peroxide that reacts strongly with metallic substances.