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PERFORMANCE EVALUATION OF LANTHANUM DOPED CATALYST SUPPORT FOR A 50 N HYDROGEN PEROXIDE THRUSTER

Abstract

A number of green monopropellants have been investigated over decades to replace the highly toxic hydrazine. HAN, ADN and blended hydrogen peroxide are typical green monopropellants whose specific impulse is comparable to hydrazine. All the alternative green monopropellants have a decomposition temperature significantly higher than that of hydrazine, which is responsible for degradation of conventional catalyst support material. Doping rare earth metal was known to improve the high temperature tolerance of the alumina. The repeated curing after doping, however, tends to decrease the specific surface area of the catalyst support material. We selected La as the doping element and prepared La hexaaluminate (LHA) by wet impregnation procedure. La nitrate was used as the precursor of La and commercial γ-Al2O3 was used as the substrate. The reactivity of the prepared catalyst was measured by a drop test in a bath of 70 wt.% hydrogen peroxide. Further characterization of the prepared catalyst was carried out by Brunauer-Emmeett-Teller (BET) and X-ray diffraction (XRD). The XRD analysis on the prepared catalyst exhibited that La was properly doped on alumina. The specific surface area of the LHA measured by BET was 32.8.0m2/g.. The drop test of the LHA resulted in reactivity decrease from untreated γ-Al2O3 when the same active materials, MnO2 + PbO, were loaded on both catalyst supports. The reactivity decrease with LHA heat less than 37%. Considering that the catalyst bed of a typical monopropellant thruster is slightly oversized, this reactivity decrease will not decrease the overall performance of the thruster. The characterization of catalyst alone cannot predict the performance of the catalyst when it was inserted in an actual thruster. The catalyst needs to maintain the high specific surface area and mechanical integrity under the harsh conditions. In order to examine the catalyst performance in a thruster, a 10 N thruster was designed and built. 90 wt.% hydrogen peroxide blended with ethanol whose decomposition temperature ranges from 1,000 1,300 °C depending on the ratio of blending was used. The specific impulse of the thruster is proportional to the decomposition temperature and chamber pressure. Thrust and pressure inside the thrust chamber with the hydrogen peroxide blended with ethanol at an O/F ratio of 30 were measured. During the firing duration of 30 seconds, the thrust and chamber pressure remained steady without noticeable degradation of the catalyst despite the high decomposition temperature of the hydrogen peroxide blended with ethanol at 1300 °C.