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EXPERIMENTAL RESEARCH OF CATALYTIC IGNITER FOR SPACE WATER ELECTROLYSIS PROPULSION

Abstract

The water electrolysis propulsion system generates thrust through the combustion of hydrogen and oxygen that is produced in a stoichiometric ratio by electrolyzing water. The mechanism of the water electrolysis propulsion system converts electrical energy into chemical energy so that it can be seen as a hybrid electric propulsion slightly different from general electric propulsion methods such as Hall-Effect Thrusters, Ion Thrusters, etc. Water is an excellent propellant because it is a stable, non-toxic substance with a high energy density. Also, it is abundant in the solar system, such as the moon, Mars, and asteroids so that it can be linked-to in situ resource utilization missions. In this study, a PEM(Proton Exchange Membrane)-based water electrolyzer was adopted to produce hydrogen and oxygen, and catalytic ignition was adopted as a method of ignition of hydrogen and oxygen. In the design process of the space propulsion system, consideration of the actual space environment must be performed, so experimental verifications in the space environment condition were performed for each sub-component level. In this study, an experimental analysis and design for the catalytic igniter were performed. Platinum-based catalysts were synthesized, and the characteristics of the catalyst were analyzed through catalytic ignition experiments. To determine supplying and operating conditions of the thruster, ignition time was measured in a wide range of equivalence ratios of the supplied hydrogen and oxygen. The configuration and material of the catalysts were modified based on the ignition experiment results. After designing the catalytic igniter, performance tests were performed under ground conditions, and the performance of the catalytic igniter was verified in high vacuum conditions and various temperature ranges by using a thermal vacuum chamber that can simulate the space environment. A thruster model capable of mounting the designed catalytic igniter was manufactured, and the successful operation and performance of the integrated thruster model were verified.