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REACTION RATE MEASUREMENT OF WIRE-FED MAGNESIUM IN WATER-VAPOR FLOW FOR MICROPROPULSION SYSTEM

Abstract

Micropropulsion system is necessary for micro spacecraft to conduct missions especially in deep space. Two points are required for micropropulsion system: safety and high density. Safety is needed because micro spacecraft are mostly launched as secondary payloads, which should not be harmful to a main payload. High density is suitable due to the limited volume and mass of micro spacecraft. From this point of view, a hybrid motor, whose fuel and oxidizer are in different phases, is a promising candidate. Among them, a metal-water propulsion system has been widely researched. In this study, a propulsion system which utilizes magnesium wire as a fuel and water as an oxidizer is worked on. Both magnesium wire and water are green and safe propellants. Also, they have high density because they are in the solid or liquid phase in the standard state, respectively. Therefore, the propulsion system could be a low-pressure system unlike the most hybrid motors, whose maximum design pressure is about several atm. In the previous studies, the magnesium wires with a diameter of 0.2 – 0.8 mm were burned in the water vapor with a pressure of 10 – 70 kPa, and the reaction rate of magnesium was acquired. Then the propulsive performance was calculated using those results. However, the system was closed system, and neither the magnesium wire nor water vapor were supplied from the outside of the combustor. The steady state combustion of a magnesium wire in the flow of water vapor should be addressed in order to apply this combustion to a micropropulsion system. The purpose of this study is to measure the reaction rate of a magnesium wire in water vapor flow and discuss the applicability to a micropropulsion system with changing some major parameters. The major parameters are flow velocity, feeding velocity of a magnesium wire, composition of a magnesium wire, and so on. For this purpose, a laboratory-scale combustor was established, which was accompanying with a feeding system of a magnesium wire and water vapor. In the conference, the experimental results will be presented focusing on the reaction rate of magnesium, which is important for the estimation of thrust performances. Also, the applicability of the combustion will be discussed.