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Author: Mr. Assylkhan Kosdauletov
Korea Advanced Institute of Science and Technology (KAIST), Korea, Republic of, a.k.kz@mail.ru

Dr. Jungkun Jin
Korea Advanced Institute of Science and Technology (KAIST), Korea, Republic of, jkjin@kaist.ac.kr
Dr. Eun Sang Jung
Korea Advanced Institute of Science and Technology (KAIST), Korea, Republic of, jes84@kaist.ac.kr
Prof. Sejin Kwon
Korea, Republic of, trumpet@kaist.ac.kr

CATALYTIC DECOMPOSITION OF N2O USING NOBLE METALS TO DEVELOP MONOPROPELLANT THRUSTER

Abstract

Nitrous Oxide (N2O) attracts many researchers' attention, due to its non-toxic, non-flammable, non-explosive and simple storage characteristics. N2O can be used as a monopropellant in reaction control system (RCS) of launch vehicles and spacecraft. N2O has also been used an oxidizer in hybrid rockets as well as liquid bipropellant rockets and a green monopropellant. However, the flight heritage of N2O propulsion system has rarely been reported. Due to high vapor pressure (52.4 bar. at 294K), N2O (self-pressurizing) thruster does not need an additional propellant expulsion system, while other monopropellants such as Hydrazine (N2H4) and Hydrogen peroxide (H2O2) require the pressurization. N2O is non-corrosive and may be used with common structural materials, temperature is wide, whereas specific materials are required for long-term storage of other propellants. Thermal decomposition of N2O can be done at 793K; however, the gas in the reaction chamber should be heated more than 1273K to maintain enough reaction rates as a propellant. The temperature can be reduced by adapting catalysts, and Surrey Space Center insisted that the minimum required temperature was 473K. However, information about the catalyst and its preparation was not reported. In the present study, catalytic decomposition of N2O was carried out with different catalysts to bring to light suitable catalyst for further development of the N2O monopropellant thruster. Two noble metal catalysts Pt and Ir, which were widely used in monopropellant system like as H2O2 and N2H4, were chosen to decompose nitrous oxide. As a support 1.8" pallet type γ-Al2O3 phase were chosen. Moreover, Pt and Ir catalysts are suitable to two different type of green-propellant that can be used with different thrust levels and Isp. Each catalyst was tested with different chamber pressure and preheating temperature. Compared to Pt, Ir showed lower decomposition temperature of N2O and reaction observed at 503K, furthermore repeatability of reaction was observed. However, deactivation of the Ir catalyst was observed during the experiment. In addition, the minimum required preheating temperature decreased as the chamber pressure increased. Also, preliminary test with Ru catalyst, which was prepared in the small laboratory by a wet-impregnation method, was carried out in present study. From the existing experimental results, the use of other high temperature-resistant catalyst support such as α- Al2O3 was considered.