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A STUDY ON THE IMPROVEMENT OF IGNITION AND THRUST REPEATABILITY OF A MICRO SOLID PROPELLANT THRUSTER ARRAY

Abstract

With advance in MEMS technology, the nano-satellites have received attention in the space field due to its low launch cost, production cost and operation cost. To successfully develop and operate the nano-satellites, it is essential to develop micro propulsion systems for attitude or orbit control. A micro solid propellant thruster is one kind of those micro propulsion systems. It has very simple structure and does not need moving parts such as valves and pumps, hence it is considered as the most suitable micro-thruster among micro propulsion systems. In general, it consists of a nozzle, an igniter and a chamber likes conventional solid propellant thrusters. To compensate for the one-shot characteristic of the solid propellant, the micro solid propellant thruster has been developed as in an array-type. For this array-type micro thruster to be usable in nano-satellites, the thruster units in the array must have a low performance variation and a high ignition success rate with uniform characteristics, i.e., good repeatability, so that the systems can be controlled effectively. Although many research teams developed the micro solid propellant thruster array, those points are still awaited. In this study, as the first step toward achieving those points, we develope a novel type of micro igniter because the igniter is the key component of a micro solid propellant thruster. The developed micro igniter is fabricated using a glass wafer for high structural stability of a membrane. In this design, the heater which generates Joule's heat is in direct contact with the propellant to improve an adhesion between the membrane and the propellant. And thickness of the membrane can be uniform by polishing process of the glass wafer for its same rupture time. After the igniter is fabricated, other components are fabricated and integrated with the igniter. The size of fabricated micro solid propellant thruster array is 5 x 5, and all components are fabricated using a glass wafer. The ignition performance evaluation and thrust performance evaluation of the thruster array is conducted. The measured ignition success rate is 100%. The calculated standard deviations of the ignition delay and ignition energy of the thruster units are 1.35 ms and 3.11 mJ, respectively. The calculated standard deviation of the thrust and total impulse are 0.369 N and 0.04 mNs, respectively. Through the development of the micro igniter, we successfully improve the ignition repeatability and thrust repeatability of the micro solid propellant thruster array.