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MEMS BASED MICRO-PROPULSION SYSTEM FOR CUBESATS AND POCKETQUBES

Abstract

Microelectromechanical systems (MEMS) techniques uncovered new opportunities in satisfying the mission requirements of the growing next generation nano- and pico-satellite missions. In particular, micro-propulsion is universally recognized as one of the key enabling technologies to help this class of satellites making the next step and become credible candidates to a wide range of scientific and commercial applications. In this context, TU Delft is developing a miniaturized electro-thermal propulsion system operating with green liquid propellants, for application on a wide range of nano-satellite formats from CubeSats (10x10x10 cm units) to PocketQubes (5x5x5 cm units). A preliminary design of the complete micro-propulsion system is under development at TU Delft, including the thruster, propellant tank, the valve and the driving electronics. The micro-propulsion system must be capable of delivering very low levels of thrust in the range from 0.1 mN to 10 mN and specific impulse from 50 s to 100 s while meeting the critical requirements of low mass (450 g), low power consumption (less than 10 W) within a small volume of 90x90x80 mm3, enabling sophisticated maneuvers and extending mission lifetime. To address this need and to fill an existing gap in the state-of-the-art of micro-propulsion, two kinds of micro-thrusters are considered in this development; a Vaporizing Liquid Micro-resistojet (VLM) and a Low Pressure Micro-resistojet (LPM). The insights drawn from the current propellant tank design (specifically intended for the CubeSat standard) are used for designing a smaller version compatible

with the PocketQube standard, taking particularly into account the propellant leakage, one of the major concern for all propulsion systems, but particularly for miniaturized ones due to the severely limited amount of the propellant supply. A number of test results will be shown in the paper on the electrical, mechanical and functional characterization of the MEMS thrusters, fabricated in the Else Kooi Laboratory at TU Delft. The results of these tests prove that the thrusters are in- line with all target parameters, e.g. power and mass flow rate, and validate the design and manufacturing process flow that has been developed. In particular, tests conducted on thruster models covered with a transparent glass layer allowed for identifying the characteristics of the two-phase flow in the boiling propellant. Finally, the feasibility of using commercially available valves for actively controlling the flow will be assessed through the results of simulations in time and frequency domains