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Title

High thrust, low power, green propellant electro-thermal resistojet thruster

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Abstract

In recent years, space access has become more available for commercial and academic use. The total number of satellites operating in orbit exceeded 4800, with mostly small satellites contributing to that number. As of August 2022, the total nanosatellites launched into space exceeded 2068, of which at least 134 had propulsion systems [1]. , FFC (Federal Communications Commission) adopted a rule that shortens the 25 year guideline to 5 years for post-mission satellite de-orbitation [2], forcing virtually every satellite to have on-board propulsion, even those which have previously not considered thrusters due to limited maneuvers required Increased practice of EOL disposal, proximity operations, and collision avoidance maneuvers, even using nanosatellites, generate the market need for relatively high-thrust, low-power, low-cost and compact propulsion systems Resistojet thrusters can meet all these requirements, as they offer much lower complexity and higher thrust-to-power compared to other electric thrusters such as HET or GIT. There are few examples of such thrusters [3], [4], [5], but they have specific impulse (Isp) ranging between 80 and 120s.

Liftero develops a resistojet thruster dedicated to nanosatellites since 2019. Our goal is to develop modular and scalable propulsion with thrust ranging from a few up to dozens of milinewtons with Isp at least 160s and power level in the range of 10 - 30 W. The project is run with an iterative and agile development approach. We used state-of-the-art manufacturing methods like EBW (Electron Beam Welding), 3D printing and precision micro-machining. The development is supported by extensively used simulation software with our internally developed mathematical models. Each thruster iteration has been benchmarked at the Institute of Heat Engineering at Warsaw University of Technology. This paper presents the development and testing of the resistojet thruster using low pressure and safe propellants, such as isobutane and water. With use of space-proven COTS critical components we mitigated risk of failure during in-orbit operation. The thruster core in form of the heating element has been designed to handle high temperatures, allowing to achieve a specific impulse of up to 200s.

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