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A PLUG AND PLAY PULSED ELECTROTHERMAL THRUSTER FOR CUBESAT APPLICATIONS

Abstract

Pulsed Plasma Thrusters (PPTs) are well known for their simple, robust and lightweight design. They look back at numerous space flights and represent a cheap solution for secondary propulsion and even primary propulsion for long duration missions. A recent study at the Institute of Space Systems (IRS) found an international trend to improve access to space by aiming at the development of cheaper and smaller satellites as well as to increase the mission range of as yet unpropelled micro satellites. The PPT's comparably high specific impulse and use of solid propellant has led to an effort at IRS to turn its advantages into a feasible propulsion system option preferable to conventional chemical systems. A new miniature pulsed electrothermal thruster (PET) has been developed at IRS, drawing experience from ten years of PPT development and wide expertise in the fields of electric thrusters, re-entry technology and numerical plasma simulation at IRS. The PET uses a capacitor for energy storage in between pulses with a power consumption below 5 W. The capacitor voltage is applied to two coaxial electrodes at either ends of a hollow cylinder. One of the electrodes is closed while the other is shaped into a supersonic nozzle to create a discharge channel. An igniter triggers a breakdown between the electrodes, creating discharge plasma. The plasma ablates the inner cylinder walls while the nozzle expands the heated gas and accelerates it to create thrust. The PET proved flawless operation and is now also used for education as part of a mandatory student electric thruster laboratory (LEA) at IRS with its very own test facility. The next step at IRS is to build up, test and optimize a flight-ready thruster system with the PET and miniaturize existing hardware for thruster operation, monitoring and control. To account for and preserve the robustness of the system, we aim at developing a Plug and Play solution for seamingless integration into standard CubeSat architectures. The work presented in this paper will include a detailed description of the optimized PET thruster hardware and its miniaturized system components. A description of the thruster theory will be included for data analysis and optimization. The system architecture and technical data are presented for integration into common CubeSat platforms. Testing setups for lifecycle testing and thruster performance characterization will also be described and results from the tests will be presented and analyzed.