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Electric Propulsion (4)

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ELECTRIC MICROPROPULSION RESEARCH AT BEIJING INSTITUTE OF TECHNOLOGY

Abstract

There has been increasing interest in satellite systems in the kilogram weight range, i.e., the nano/micro-satellite weight range. One example of this is the ubiquitous CubeSat architecture. These small lightweight satellites have seen widespread adoption by both academic institutions and small organizations due to their relatively low cost compared to traditional satellites and potential for rapid development and deployment. This has in part been aided by the miniaturization of technology, which has allowed these small satellites to perform Earth observation and scientific measurement missions even with a small size and mass. However, while the electronic systems have enjoyed the benefits of technological miniaturization, there is a very apparent lack of suitable efficient electric propulsion systems available at these size scales. More mature electric propulsion systems such as ion thrusters or Hall thrusters begin to exhibit considerable losses when they are scaled down in size. Two promising systems currently being investigated at Beijing Institute of Technology are the pulsed plasma thruster (PPT) and the micro-cathode arc thruster (μCAT). These are both electromagnetic propulsion systems. In particular, PPTs are a structurally simple form of electric propulsion and were the first to be operated in orbit on the Zond-2, which was launched in 1964. Due to their structural simplicity, they are ideally suited for miniaturization. The μCAT system has many similarities with PPTs, and are a form of vacuum arc thrusters. The propellant of a μCAT is the cathode material, which is slowly eroded and accelerated out of the thruster. At the Beijing Institute of Technology, research has been performed both in pursuit of understanding some of the fundamental operating principles of these thrusters as well as to optimize them and extend their lifetimes. With the PPT, we investigated the effect of asymmetric electrodes on the propellant ablation and plasma acceleration processes, showing that a shorter anode beyond a critical length tends to positively influence the plasma parameters measured using emission spectroscopy. We are also investigating alternative propellants, including non-volatile liquids, with the aim of identifying more suitable alternatives for micropropulsion applications. With the μCAT, our research currently focuses on extending the thruster lifetime through understanding the fundamental operating characteristics. This presentation will provide an overview of the work currently being undertaken at Beijing Institute of Technology with the aim of furthering the development of micropropulsion systems suitable for small satellites.