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Flight Experiments and Recent Developments in Micro-Cathode Arc Thrusters for CubeSat Propulsion

Michael Keidar
The George Washington University

The George Washington University (GWU) has developed a CubeSat-class thruster called the Micro-Cathode Arc Thruster (μCAT) [1]. The μCAT is a high Isp (2000-3500s), solid metal fueled, low average power (<0.1 W when operating) micro-thruster of small cross section (5 mm), with a mass of less than 200g, and no pressurant tanks. Electric current forms a plasma discharge between a concentric cathode-anode configuration. Thrust is produced through arc discharge, eroding some of the cathode material in uniform manner, to exit at high velocity, during which it is accelerated out the nozzle by a Lorentz force. Thrust can be controlled by varying the frequency of pulses, with a demonstrated range to date of 1-50 Hz, (1 μN - 0.05 mN). The μCAT design achieves uniform electrode erosion, and has demonstrated over two months of continuous operation during trials. The system operates at low voltage, accepting unregulated DC power from the spacecraft bus. The corresponding exhaust plume is 99% percent ionized, with near zero backflux.

Thruster subsystem was developed for the BRICSat-P which was launched in May of 2015 [2]. Some data has been downloaded from the satellite, and it shows that the satellite has successfully operated the propulsion system. The propulsion system was able to reduce initial tumbling from an estimated 30 º/s to within 1.5 º/s after 48 hours. New ideas for high thrust-to power ratio microthruster will be discussed [3].

[1] M. Keidar, T. Zuang, A. Shashurin, G. Teel, D. Chiu, J. Lucas, S. Haque, L. Brieda, Electric Propulsion for Small Satellites, *Plasma Phys. Control. Fus.* **57** 014005 (2015).

[2] S. Hurley, G. Teel, J. Lukas, S. Haque, M. Keidar, C. Dinelli, and J. Kang, Thruster Subsystem for the United States Naval Academy's (USNA) Ballistically Reinforced Communication Satellite (BRICSat-P), *Trans. JSASS, Aerospace Technology Japan*, **14**, No. ists30, pp. Pb_157-Pb_163 (2016).

[3] J. Lucas, G. Teel, J. Kolbeck, and M. Keidar, High Thrust-to-Power Ratio Micro-Cathode Arc Thruster, *AIP Advances* **6**, 025311 (2016).