MPCS-2017-Va01

Scalability and Reliability of Vacuum Arc Thrusters for CubeSat Missions

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Vacuum arc thrusters VATs are a suitable choice for picosat missions. Their simple geometry as well as high Isp paired with a low mass PPU allow to fulfill many cubesat requirements with regard to mission requirements, power and mass budget. The VAT can be operated in pulsed or DC mode, the impulse bits can be adjusted by simple means and it is a plasma thruster, hence no neutralizer is required [1].

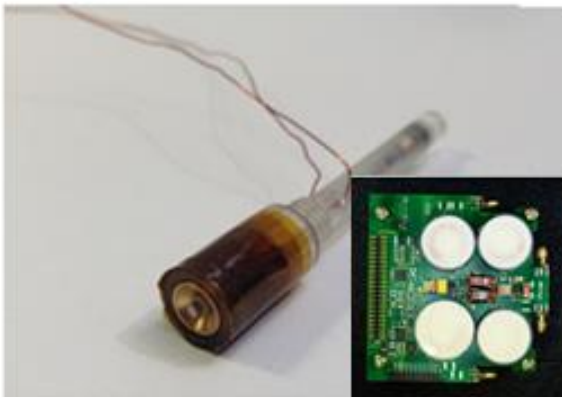

Figure 1. Thruster head and PPU for 1U Cubesat

Yet there are still some issues that need attention especially when it comes to propellant consumption and plasma ignition.

Plasma initiation of a vacuum arc requires high voltages, which for cubesats introduces the problem of voltage conversion (Cubesat bus voltages are usually in the vicinity of ~5V), and handling of high voltage may lead to unwanted discharges in densely packed electronics circuits. Possibilities to avoid high initiation voltages have been published and shown to exhibit a high reliability [2] yet this reliability depends on the I-bit produced and may thus produce lifetime issues.

Propellant feeding is another issue. VAT propellant may be any conductive material. Usually it is consumed at a rate of ~50µg/C, leading to a production of highly ionized vapor leaving the cathode at a velocity of ~104 m/s. While the propellant can be provided as a solid in numerous geometrical embodiments, the erosion homogeneity is again a matter of pulse power and pulse length, leading to certain I-bit requirements for certain cathode geometries.

Using an example of an actual cubesat mission [3] the issues with regard to reliability will be addressed and scaling issues as well as possibilities for the use of VAT in pico-satellites will be discussed.

[1] J. Schein, A. Anders, R. Binder, M. Krishnan, J. E. Polk, N. Qi and J. Ziemer, Inductive Energy Storage Driven Vacuum Arc Thruster, *Review of Scientific Instruments*. **72** (2002).

[2] A. Anders, J. Schein, N. Qi, Pulsed vacuum-arc ion source operated with a "triggerless" arc initiation method, *Review of Scientific Instruments* **71**, 827-9 (2000).

[3] I. Kronhaus, K. Schilling, M. Pietzka, J. Schein, Simple Orbit and Attitude Control Using Vacuum Arc Thrusters for Picosatellites, *Journal of Spacecraft and Rockets* **51**, 2008 (2014).