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Development of the Electrothermal Pocket Rocket for CubeSats

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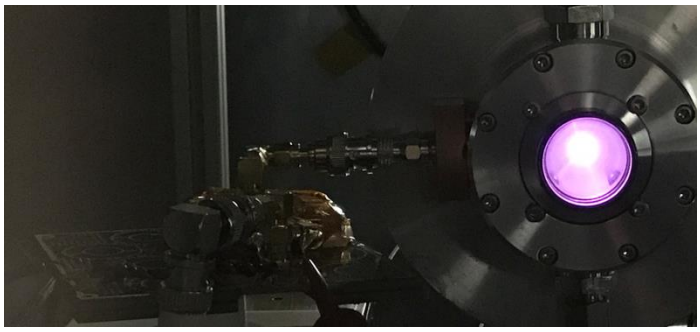

Figure 1. MiniPR plasma powered by the switch mode amplifier in vacuum

Radiofrequency thrusters have been used successfully, but rarely, on spacecraft, i.e. the Radio-frequency Ion propulsion RIT-10 system aboard EURECA in 1992 and the RITA-10 aboard ARTEMIS which saved the mission in 2002/2003. 'CubeSat' nano-satellites provide low-cost access to space, and open doors to unprecedented and unique projects that are now accessible to universities and small companies. The process is facilitated by ongoing miniaturization and lower costs of electronics systems and components, including 3D printing. Australia is involved in the European Union 'QB50' 'CubeSat' project [www.qb50.eu] comprising a launch into space of about 50 CubeSats from 27 Countries aimed at studying the Earth's ionosphere and lower thermosphere. While many essential CubeSat parts are available off the shelf (electrical power system, attitude control system, on board computer…), low-cost low-volume low-weight and low-power propulsion systems which could provide orbit control and formation flying in future CubeSat missions have yet to be fully developed. In the miniaturised instant 'on' Pocket Rocket thruster, MiniPR, a radiofrequency plasma is employed to heat the gas via charge exchange collisions and ambipolar flow to create a form of electrothermal thruster which has its heating mechanism in the centre of the flowing propellant rather than on the thermally lossy walls. MiniPR's steady-state characteristics can now be successfully simulated using computer fluid dynamics codes. A low weight (150 g), small but structurally supportive (10 cm by 10 cm by 1 cm), robust and efficient dc to rf power supply has been successfully designed and tested at atmospheric pressure and in vacuum (**Figure 1**) to power a 1 to 15 Watts plasma for continuous and pulsed operation with argon as propellant. The power supply consists of a switch mode amplifier and impedance matching network for optimum plasma ignition, tuning and control. It is designed to be combined with a miniaturized propellant sub-system to fit within a ½ U CubeSat.

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