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Miniature Vacuum Arc Thruster with Controlled Cathode Feeding

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A new type of micropropulsion device is presented –the inline-screw-feeding vacuum-arc thruster (ISF-VAT). This thruster couples a conventional "triggerless" vacuum arc ignition system with a feeding mechanism that maintains a steady state discharge performance. The feeding mechanism implements a screw action on a central cathode rod. At a predetermined rate, a complete and uniform erosion of the cathodes tip is obtained as well as "healing" of the insulator coating. The in-line feeding of the cathode forces the arc to emerge on the tip of the cathode eliminating the need for an additional plasma acceleration stage. The ISF-VAT feeding mechanism is computer controlled, and offers reliable operation of the thruster over a large number of pulses. Characterization of the ISF-VAT performance is presented, conducted on an experimental prototype in the Aerospace Plasma Laboratory, Technion. Measurement results of the mass flow rate, electrical parameters of the discharge, and thrust are presented. Using a Ti cathode at a discharge power of 3 W, a mass flow rate of $\approx 1.8 \times 10^{-9}$ kg/s and a thrust level $\approx 7 \mu\text{N}$ were measured. More than 10^6 pulses were demonstrated in a single run, accumulating a total impulse of 0.1 Ns. The thruster prototype dimensions are $15 \times 15 \times 65 \text{ mm}^3$, and is ≈ 60 g in mass.

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