Progress on the Development of a Direct Evaporation Bismuth Hall Thruster

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ABSTRACT

One of the most pivotal issues when attempting direct evaporation of bismuth is maintaining precise thermal control of the evaporation reservoir. In our scheme, bismuth is packed within one the of anodes and is directly evaporated using discharge waste heat. The use of segmented anodes allows power to be directed inside of the discharge chamber by controlling where the discharge current attaches. Fractional portions of the discharge current may also be attached to more than one anode giving rise to a continuum of operating points. By controlling where in the thruster the current attaches the deposition of waste heat may be controlled much like a thermostat. As the current is shifted around, the anodes will see either an increase or decrease in temperature. Since the evaporation rate of bismuth is a function of temperature, the mass flow rate can be controlled by using electric fields to direct the electron current to/from the bismuth reservoir.

The objective of this discharge current sharing scheme is to maintain the bismuth reservoir at a given temperature which corresponds to a known bismuth evaporation rate. A control loop can be wrapped around this system allowing for closed loop thermal control and therefore mass flow control. Results of running a xenon-fed bismuth demonstrator thruster under closed loop thermal control will be presented. Performance characteristics of the xenon demonstrator are also monitored to explore how thrust and plume divergence changes as discharge current is shifted to different anode segments.