Pathways for Increased Performance of a Rotating Magnetic Field Thruster

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The design of a rotating magnetic field (RMF) thruster is presented. RMF thrusters are a type of inductive pulsed propulsion device. It utilizes a rotating magnetic field to produce an azimuthal current in the presence of a steady background field with a radial gradient to eject plasma at high velocity and repetition rates [1]. Historically, performance of RMF thrusters has been low. The highest observed efficiency is 8% [2]. To better understand the device, the University of Michigan's Plasmadynamics and Electric Propulsion Laboratory (PEPL) developed an RMF test article capable of operating over a number of conditions. The thruster was tested at power levels lower than 1 kW. There was little to no thrust measured and coupling efficiency was less than 5% for all cases [3].

In an effort to increase the thrust and efficiency, PEPL has designed an advanced test article that leverages lessons learned from previous experimental campaigns as well as recent analytical models indicating how to better optimize the thruster [3,4]. Notably, the thruster casing has been switched from a conductive aluminum assembly to a nonconductive G10 one. This reduces losses due to the magnetic fields coupling to structural materials instead of the plasma. Further, a plasma baffle has been installed downstream of the pre-ionizer hollow cathode to help diffuse the neutral gas and plasma towards the RMF antennae. Finally, the thruster will be operated at power levels in excess of 5 kW. It is theorized that higher coil currents will significantly increase the coupling between the RMF coils and plasma. These design changes will ideally lead to increased overall thruster performance compared to previous designs.

References

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