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INVESTIGATION OF PARAMETRIC DYNAMICS INSIDE A HEATERLESS HOLLOW CATHODE (HHC)

Abstract

Hall effect thruster (HET) is one of the rapidly growing and highly demanding technology in the field of electric propulsion. Hollow cathode is an integral part of the HET due to its ability of efficient electron production for plasma generation and beam neutralization. Hollow cathodes are basically classified in two categories, heater type and heaterless hollow cathodes (HHCs). Bellatrix Aerospace recently developed a heaterless hollow cathode for operation along with lower power hall effect thrusters. In view of the plasma breakdown process, during ignition of heaterless hollow cathode, the resulting parameters are highly oscillatory. It is reported earlier that these oscillations have significant impact on the stable operation as well as life of the unit developed. This paper describes the ignition oscillations and periodic steady state fluctuations that were captured for parameters like keeper voltage, keeper current, anode voltage and anode current. Detailed analysis of the captured waveforms is done and correlated with the cathode flow rate, anode, and keeper current. It is observed that keeper introduces its own impact on HHC operation and contributes to a power balance inside plasma. On keeping the keeper floating, a decrease (few volts) in keeper voltage and increase in anode voltage is observed. Also, anode current fluctuations are suppressed with floating keeper mode. Generally, it is observed that, transition time from ignition state to steady state decreases with increasing keeper current. Rigorous Time-series and Fourier space analysis have been carried out for each set of experimental conditions which has paved the way to explore fundamental mechanisms inside HHC during ignition as well as steady state operation. Attempt has also been made to understand the dependency of the life of the HHC with oscillation parameters. Detailed results will be discussed and presented.