8th Asia-Pacific Conference on Plasma Physics, 3-8 Nov, 2024 at Malacca

An experimental study of a low power ablative Z-pinch pulsed plasma thruster with different electrode configurations

Jiqin Wang[1], Weizong Wang[1]
[1] Advanced Space Propulsion and Energy Laboratory (ASPEL), School of Astronautics, Beihang University, China
e-mail (speaker): by2315121@buaa.edu.cn

The pulsed plasma thruster (PPT) is one of the earliest electric propulsion (EP) systems applied on satellites[1]. Possessing advantages including high reliability and robustness, PPTs has shown great potential in space mission including attitude control and orbit maintenance. However, at low power, the traditional parallel plate PPT which relies on electro-magnetic (EM) acceleration has low thrust efficiency[2]. The ablative Z-pinch pulsed plasma thruster (AZPPT) discharges in a cylindrical cavity, in which the ablated products are essentially accelerated by electro-thermal (ET) effect. Previous studies have proven that at low power, the thrust efficiency of AZPPT is higher than that of EM-PPT due to the decline of late-time ablation and dominance of ET acceleration, making AZPPT very competitive in missions of microsatellites[3]. Electrodes can have great influence on PPTs' performance. But in field of AZPPT, such research has not yet been conducted.

In this work, AZPPTs with four cathode configurations are tested with Rogowski coil, torsional pendulum and intensified charged coupled device (ICCD) to further enhance the thrust performance and study the plume characteristics of AZPPT. The four cathode configurations are shown in Fig.1 (a). Case 1 and Case 2 are categorized as cathodes with long nozzles. Case 1 and Case 3 are categorized as cathodes which cover the side of propellant. The impulse bits of four cathodes at different voltages are shown in Fig.1 (b). At low voltage, impulse bits of short nozzles are higher than that of long nozzles due to less interaction between plasma plume and nozzle wall, whereas at high power, impulse bits of long nozzles are higher than those of short nozzles because nozzle can significantly converge the plume. The circuit parameters of Case 1 and Case 3 are similar, while those of Case 2 and Case 4 are similar, as shown in Fig.1 (c), (d) and (e), which indicates that the end face of cathode influences the ablation process more significantly. Case 1 has the best potential of converging the plume, as shown in Fig.1 (f) and Fig.1 (g).

References

[1] D. Lev *et al*, Acta Astronaut. **159** 213-227 (2019)
[2] L. Cheng *et al*, Phys. Plasmas. **25** 093512 (2018)
[3] T.E. Markusic *et al*, J. Propul. Power. **21** 392-400 (2005)

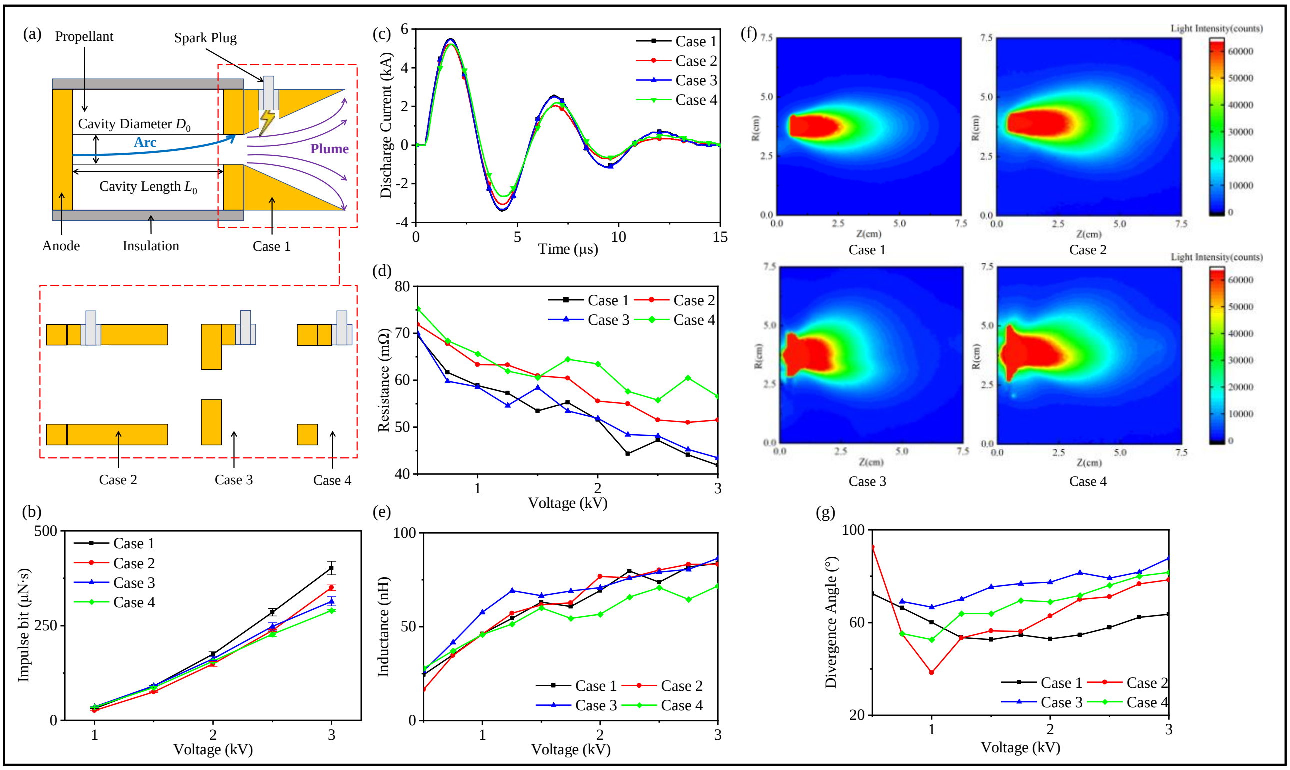

Figure 1. (a) The configurations of different cathodes, (b) The impulse bits of four cathodes at different voltages (c) Discharge currents of four cathodes at 2 kV, (d) Plasma resistances of four cathodes at different voltages, (e) Plasma inductances of four cathodes at different voltages, (f) Plume images of four cathodes at 2 kV, (g) Divergence angles of four cathodes at different voltages.