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THERMIONIC EMISSION BY A THIN BARE TETHER WITH LOW-W COATING

Abstract

In the absence of an active cathodic device, the current flowing along an orbiting bare tether vanishes at both ends and the tether is said to be electrically floating. For negligible thermionic emission and orbital-motion-limited (OML) collection throughout the entire tether (electron/ion collection at anodic/cathodic segment, respectively), the anodic-to-cathodic length ratio is very small due to ions being much heavier, which results in low average current and drag.

The electride C12A7:e-, which might present a possible work function as low as 0.6 eV and moderately high temperature stability, has been proposed as coating for floating bare tethers. Thermionic emission along a thus coated cathodic segment, under heating in space operation, may be more efficient than ion collection and, in the simplest drag mode, may eliminate the need for an active cathodic device and its corresponding gas-feed requirements and power subsystem, which would result in a truly "propellant-less" tether system.

Around each local element of a bare tether as a cylindrical probe uniformly polarized at the local bias relative to the plasma and presenting intense thermionic emission, a double layer (DL) would be established. A study of thermionic current law for the space-charge-limited DL and its transition to Richardson-Dushman's current law along the cathodic segment was recently carried out for simple conditions [1]. In the present work, the generic case of a tether with radius well within the OML regime, which result in a complex sheath law, is discussed. Also the temperature is self-consistently obtained considering both the heating under space operation and the thermal properties of the tether material. Assuming OML electron collection along the anodic segment, a detailed calculation of current and bias profiles along the entire tether length is carried out. The efficiency of current generation is discussed at a range of ambient space conditions, tether geometry, and material properties.

References

[1] Xin Chen and Juan R. Sanmartin, Phys. Plasmas 19, 073508 (2012)