Modelling of ion-gridded plasma thrusters powered by radiofrequency inductive coils

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As the need for telecommunication satellites in Low Earth Orbit (LEO) is rising, new propulsion systems for constellation operation should be easy to down-scale, should not be perturbed by the Earth magnetic field, and should be operated with affordable propellant. Several concepts were developed at LPP since 2006 to match these requirements. The modelling of radiofrequency gridded thrusters has been proposed building on the knowledge of plasma discharges for etching applications. The first model was primarily made for Xenon [1] and it was later extended to iodine plasma [2]. A first kinetic model for iodine chemistry was investigated by P. Grondein in her thesis [3]. Two limitations on the original model were identified: (i) gas heating was not properly modeled, and (ii) collisionless (also called stochastic in the literature) heating was not included.

In this paper we will address the two above issues. It is shown that adding to the model the contribution of the ion acceleration in the sheath to the neutral gas power balance equation leads to a significant increase of the neutral gas temperature in steady-state. This is in agreement with other studies carried out recently [4]. In addition, we included collisionless heating and showed that it can contribute significantly to inductively coupled plasma generation, and the plasma response to the external coil excitation can be modeled using an effective collision frequency [5]. Interestingly, it was also observed that at in high power regimes, the particle populations may exhibit strong oscillations in the kHz range, recalling former results on breathing modes in Hall thrusters [6]. Both numerical PIC simulations and experiments are ongoing to validate the results of this volume-averaged model.

References


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