Comparison between measurements from emissive probe, Langmuir probe and LIF spectroscopy in the discharge of Hall thrusters

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Emissive probe and Langmuir probe can be considered as complementary diagnostics. An emissive probe is a loop of thoriated tungsten wire which is heated until it emits electrons [1]. It gives access to the floating potential (V_f), the plasma potential (V_p) and the electronic temperature (T_e) very easily and quickly. The Langmuir probe gives a more complete set of data (V_p, V_f, T_e, electronic density and EEDF). LIF (Laser-Induced Fluorescence) spectroscopy gives access to the ions velocity distribution function (VDF). Using and appropriate traitment of the VDF, one can obtain the ion acceleration potential. In this contribution, the three diagnostics techniques are compared to one another, especially in terms of electrical potential.

Firstly, the two aforementioned diagnostics are used in the E×B discharge of a low-power (200 W) Hall Thruster (HT). A HT is one type of electrostatic thruster [2] in use onboard geosynchronous satellites. Inside the thruster channel and in the near-field plume of such a thruster, i.e in the ion beam downstream the thruster exit plane, the charged-particle flux is very high. The challenge for the emissive probe consists in maintaining a sufficiently long probe lifetime by minimizing sputtering. Therefore, we used a compact fast-moving piezoelectric linear stage to keep the probe in the plasma only for a short time [3]. Two different electronic systems are used to polarize the Langmuir probe and to collect the current. As the plasma potential can attain several hundreds volts in a HT, the Langmuir probe unit must be able to i) deliver such a high voltage and ii) measure a current of several hundreds milliamperes. Notice the Langmuir probe size can not be too small to warrant the probe can accept a large energy flux without being destroyed. The plasma potential measurement with both probes is compared to the ion acceleration potential obtained from LIF data.

Secondly, the emissive probe has been used to diagnose the plasma in a 1.5kW-class HT. LIF spectroscopy measurement were carried out as well to obtain a reference accelerating potential profile along the channel axis. In such a thruster, the ion current is higher and the higher voltage induces higher particles fluxes and energy. Here we present a robust design combined with a proper measurement procedure that permitted to go up to a discharge voltage of 450V.

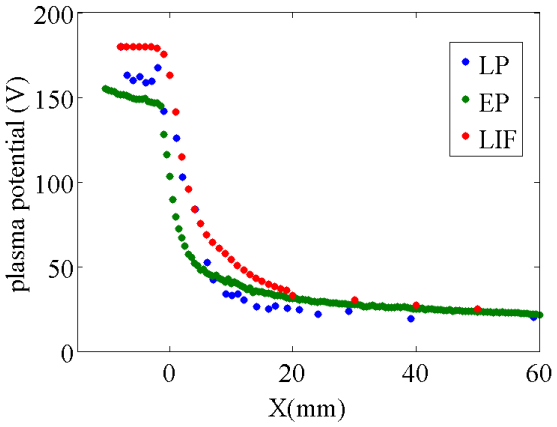

Fig. 1: *Representation of the plasma potential in a 200W-class HT along the channel axis for three diagnostics : the Langmuir probe (LP), the emissive probe (EP) and for LIF. The position X=0 refers to the HT exit plane.*

References

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