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Recent development of EEDF measurement and control in multi-dipole confined hot cathode discharges at the ASIPP

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This talk presents the latest works associated with electron temperature and density measurement and control in a multi-dipole confined hot cathode discharges from the ASIPP.

Implementing an improved model for Langmuir probe diagnostics to better separate the ion current from the I-V trace, a three-temperature Maxwellian EEDF composition is observed[1]. The dependence on neutral pressure and discharge current of each electron species suggests that sheath expansion and high energy electron current contribute differently on the Langmuir probe's I–V trace. It also supports the existence of a very hot (> 15 eV) degraded primary electron species separate from the typical hot electron (~ 3 eV) species. Thus, sweeping of the Langmuir probe beyond the bias voltage of the hot cathode will be necessary to resolve the contribution of the degraded primaries to the I–V trace.

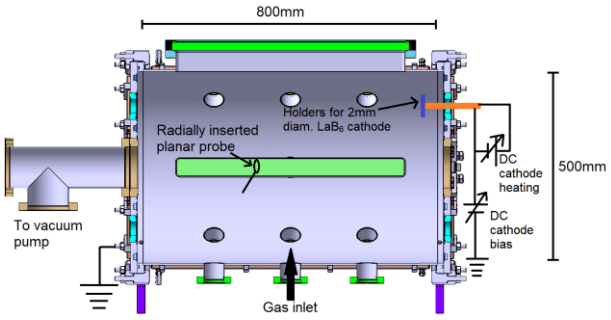

Figure 1: Diagnostic Test Source – II (DTS-II) in the Institute of Plasma Physics

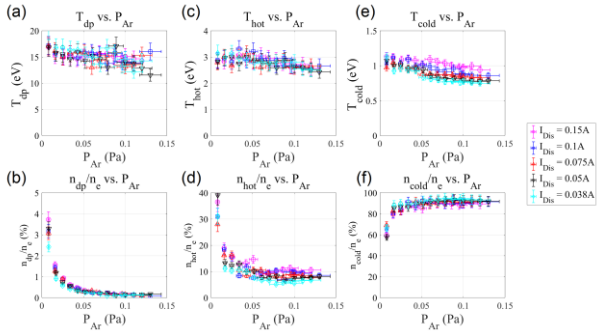

Figure 2: (a) Temperature T_{dp} and (b) relative density n_{dp}/n_e of the hottest electron species, (c) temperature T_{hot} and (d) relative density n_{hot}/n_e of the mid-temperature electron species, and (e) temperature T_{cold} and (f) relative density n_{cold}/n_e of the coldest-temperature electron species out of the three-Maxwellian EEDF graphed against neutral argon pressure P_{Ar} at various discharge current I_{Dis}.

MacKenzie's Maxwell Demon has been revisited with an added analytical aspect to show a higher energy selectiveness of the Maxwell Demon than that of the solid electrode for plasma heating[2]. Experimental results also show that the Maxwell Demon heats the plasma with smaller disturbance of electron density and plasma potential due to less absorption of higher energy electrons.

A new DC heated LaB6 cathode has been developed in the ASIPP in the recent years to directly replace existing tungsten filament discharges[3]. These cathode exhibits much less blackbody radiation than tungsten filaments due to their much lower work function. Cathode's emission performance is also shown to be greatly improved simply by designing a gas inlet close to the cathode, reducing space charge effects via neutral collisional effects.

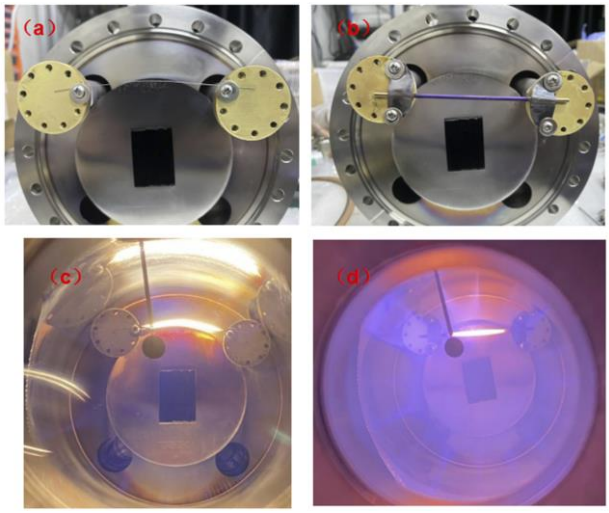

Figure 3: Tungsten filament (a) and (c) and LaB_6 rod (b) and (d) hot cathode and DC discharge photo.

References

[1] C-S. Yip et al. PSST 31 (2022) 045002
[2] C-S. Yip et al. Submitted to PSST
[3] D. Jiang, et al. RSI 92 (2022) 123503

Note: Abstract should be in (full) double-columned one page.