Emissive cathode immersed in a plasma: plasma-cathode interactions, operation and stability

F. Pagaud[1], V. Dolique[1], N. Plihon[1]

[1] *Laboratoire de Physique - ENS de Lyon & CNRS, Lyon, France*

Emissive cathodes are widely used as a source of primary electrons to ignite and sustain laboratory plasmas. They have recently been proposed as an external control parameter on a pre-existing plasma, for plasma potential control [1, 2, 3], or the modification of instabilities [4].

In this work, we report on detailed measurements and modeling of the operation of a hot emissive cathode consisting in a 500 µm diameter spiral wound tungsten filament, operated to control the characteristics of a high-density magnetized plasma column [3, 5]. The pre-existing plasma is generated in a 20-cm diameter cylindrical chamber in Argon at low pressure, using a 1 kW RF inductive source.

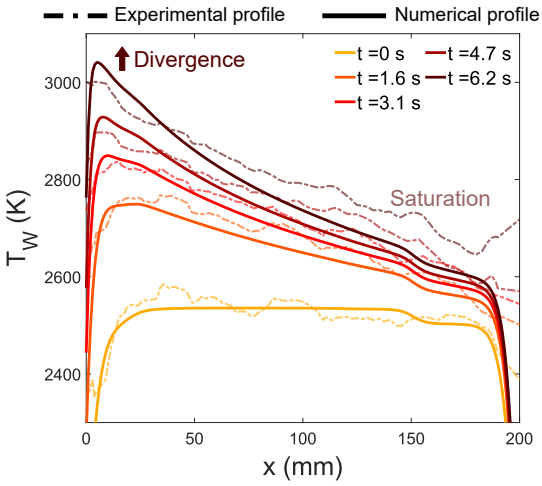

Figure 1: *Experimental and modelled temperature profiles along the cathode*

The electron current emitted by the cathode, controlled by the cathode temperature T_W, reaches up to 15 A and strongly affects the plasma parameters (ϕ_p, n, T_e). Optical measurements performed with a pyrometer revealed strong temperature heterogeneities along the cathode curvilinear coordinate x. Moreover, when the cathode voltage bias exceeds a threshold, the maximum temperature of the filament increases with time and finally diverges, leading to a divergence of the emitted current (see the temporal evolution of T_W in Fig. 1).

A complete thermal modeling of the cathode, including plasma-surface interactions, very accurately reproduces the experimental measurements.This remarkable understanding is an essential tool for further works on plasma parameters control using emissive cathodes, and confrontation with theoretical predictions [1].

References

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