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P2.4007 Alterations in anode sheath behavior in a leaky DC discharge system

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See full abstract here:
http://ocs.ciemat.es/EPS2019ABS/pdf/P2.4007.pdf
This paper reports the behavior of anode sheath in a planar dc discharge system brought about by changing the plasma boundary. Asymmetric parallel electrodes (anode dia. = 38 mm, cathode dia. = 76 mm, separation = 35 mm) were placed in a glass tube and covered by mica discs at the two ends of the glass tube. The whole assembly was placed in a stainless steel chamber. Both cathode and chamber were grounded. A small annular aperture in the mica disc was made on the anode side through which plasma can leak into the outer stainless steel chamber (partially exposed). Although no Negative Differential Resistance (NDR) region was observed in the current voltage (Id -Vd) characteristics of the discharge in fully open or fully closed cases [1], an NDR (sudden increase in Id along with sudden drop in Vd) region is observed in partially exposed cases due to the plasma leaking into the stainless steel chamber. Typically, the NDR is triggered at a threshold value of Id which depends on the gas pressure (argon). Plasma parameters were estimated from Langmuir probe (LP) characteristics. Another interesting feature observed is that as Id and Vd increase monotonically from their initial values, a minute but sharp kink (a sudden, small increase (drop) in Id (Vd)) can be seen in the discharge characteristics. After the kink there is small reduction in the slope of the Vd versus Id characteristic that is indicative of an increase in the conductance of the circuit. It is believed that this behavior is due to the onset of additional paths for the plasma current due to leakage of plasma into the conducting chamber (extended cathode) outside, via the orifice in the mica cover. Overall, the steepness of the slope of the Vd versus Id characteristic indicates an ion sheath at the anode, even though there is a slight decrease in this slope after the kink. This is also borne out by the difference between the anode and the plasma potentials (through LP measurements). As Id is increased further, a second threshold is reached where the Id - Vd characteristics exhibit a pronounced NDR with voltage drops and current jumps of order 90 V and 7 mA respectively (at 1200 mTorr). It will be shown that after the NDR an electron sheath is formed at the anode and that the flipping from an ion to electron sheath is an outcome of the large current required to be supplied by the anode.

Reference:
[1] P. K. Barnwal, R. Narayanan, S. Kar, A Ganguli and R. D. Tarey, 6th PSSI Plasma Scholar Colloquium (PSC-2018), SMIT, Sikkim, India (2018).

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