# The Influence of a Positively Biased Electrode

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This work reports on our new understanding of the conditions required for an electrode biased above a bulk plasma potential to influence the bulk plasma. One example of a positively biased electrode is a simple Langmuir probe in electron collection mode. Under what conditions does the potential of this electrode influence the bulk plasma? We describe a range of plasma-electrode interfaces (sheath structures), and the relative wall-to-electrode size thresholds that separate them. We include theoretical, experimental, and computational descriptions of sheaths near positively biased electrodes. In particular, we identify the conditions at which the electrode modifies the bulk plasma potential. The modifications to the electron velocity distribution function (EVDF) are investigated, as well as the length scales of that modification (e.g., the electron presheath length scale).

## 1. Description

As related in [1], based on global current balance arguments, a small positively biased electrode of size $A_E$ in a bulk plasma contained in a grounded vessel of surface area $A_W$, will have a sheath structure determined by the area ratio $A_E/A_W$ and the mass ratio parameter $\mu = (2.3m_e/m_i)^{1/2}$. In the absence of an electrode, some plasma potential is reached as the loss of electrons and ions to the walls is balanced. Once a positively biased electrode is introduced, however, there is an increased rate of electron loss to it relative to the flux to the grounded wall. This additional electron loss has negligible effect on the bulk plasma if it is sufficiently small. As the electrode area increases, it collects an increasing electron flux, the loss of which results in an increased bulk plasma potential, but still not to the level of the electrode. Continuing to increase the electrode area, and continuing to increase the flux of electrons to the electrode, eventually results in an increased plasma potential that is above the biased electrode. At this point we have an ion sheath at all surfaces, albeit the voltage drop at the electrode is smaller than that at the grounded walls. Simulation [2] and experimental [3] results will be presented.

These transitions occur at approximately $A_E/A_W = \mu$ (electron sheath to an intermediate state), and $A_E/A_W = 1.7\mu$ (intermediate state to ion sheath). The length scale at which the electron sheaths influence the plasma is studied and found to be much longer than previously assumed [4]. The past assumption that the EVDF at the edge of the presheath can be assumed to be half-Maxwellian is found to be incorrect and a new description is provided [5].

Finally, we hope to present some work identifying the role increased electrode potentials have on generating anode spots, and transition/hysteresis effects.

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## 2. References

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