GEC14-2014-000072

Abstract for an Invited Paper
for the GEC14 Meeting of
the American Physical Society

Effects of Emitted Electron Temperature on the Sheath

J.P. SHEEHAN, University of Michigan - Ann Arbor

It has long been known that electron emission from a surface significantly affects the sheath surrounding that surface, reducing the sheath potential and electric field. Typical fluid theory of a planar sheath with emitted electrons assumes that the plasma electrons follow the Boltzmann relation and the emitted electrons are emitted with zero energy, predicting a potential drop of Te across the sheath when the surface is allowed to float. A one-dimensional kinetic theory of sheaths surrounding planar, electron-emitting surfaces is presented which accounts for plasma electrons lost to the surface and the temperature of the emitted electrons. It is shown that ratio of plasma electron temperature to emitted electron temperature significantly affects the sheath potential when the plasma electron temperature is within an order of magnitude of the emitted electron temperature. The sheath potential goes to zero as the plasma electron temperature equals the emitted electron temperature, which can occur in the afterglow of an rf plasma and some low-temperature plasma sources. These results were validated by particle-in-cell simulations. The theory was tested by making measurements of the sheath surrounding a thermionically emitting cathode in the afterglow of an rf plasma. The measured sheath potential shrunk to zero as the plasma electron temperature cooled to the emitted electron temperature, as predicted by the theory.