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Generalized Analytical Model for the Radio-Frequency Sheath
UWE CZARNETZKI, Ruhr-University Bochum, Institute for Plasma and Atomic Physics — An analytical model for the planar radio frequency (RF) sheath in capacitive discharges is developed based on the applied RF voltage as the boundary condition. The model applies to all kind of waveforms for the applied RF voltage, includes both sheaths in a discharge of arbitrary symmetry, and allows for an arbitrary degree of ion collisionallity in the sheaths (charge-exchange collisions). Further, effects of the finite floating potential during sheath collapse are included. The model can even be extended to electronegative plasmas with low bulk conductivity. The individual sheath voltages, the self-bias, and the RF floating potentials are explicitly calculated by a voltage balance equation using a cubic-charge voltage relation for the sheaths. In particular, the RF-phase as a function of the sheath voltage is determined. This is an input for a single second order non-linear integro-differential equation which is governing the ion flow velocity in the sheath [1]. Fast numerical integration is straight forward and in many cases approximate analytical solutions can be obtained. Based on the solution for the ion flow velocity, densities, electric fields, currents, and charge-voltage relations are calculated. Further, the Child-Langmuir laws for the collisionless as well as the highly collisional case are derived. Very good agreement between model and experiments is obtained.

[1] U.Czarnetzki, Phys. Rev. E **88**, 063101 (2014).

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