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Nonlinear Electron Power Absorption in Capacitively Coupled Radio Frequency Discharges

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In low pressure capacitively coupled radio frequency (CCRF) discharges, the expansion of the plasma sheaths generate highly energetic electron beams traversing the discharge gap and supporting the plasma via ionization. The penetration of these electrons into the plasma bulk can lead to significant plasma oscillations and propagation of electrostatic waves. Consequently, the electron power absorption as well as the RF current indicate significant nonlinear dynamics in the low pressure regime. In this work, we investigate the nonlinear electron power absorption by means of 1d3v Particle-In-Cell / Monte Carlo Collisions (PIC/MCC) simulations in geometrically symmetric and asymmetric CCRF discharges. Pronounced electron power gain and loss dynamics are observed in the region between the plasma bulk and the plasma sheaths during the phase of sheath expansion. Oscillations observed in the RF current —which is a global parameter that can be easily measured by a current probe in an experiment —can be clearly attributed to these discharge dynamics.

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