Dust Particle Motion in the Collisional Sheath of an Argon RF Discharge under the Effect of Thermal Ions

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In this work, the behavior of dust particles inside the collisional sheath of a radio-frequency argon discharge in the presence of thermal ions is investigated. A one-dimensional time-averaged fluid model is used, where the electrons are assumed to follow the Boltzmann distribution, while the positive ions are treated as a fluid. In the presence of thermal ions, new expressions of dust oscillation time and damping coefficient are established. The results show that the levitation of dust particle in the sheath depends on the resultant force acting on the dust, which is the sum of electric, gravitational, neutral drag and ion drag forces. In RF sheath with cold ions ($T_i = 0$), the dust levitates from the electrode with zero initial velocity and escapes the sheath to enter the plasma region. However, with thermal ions ($T_i \neq 0$), the dust particle is stably suspended in the sheath region and makes damped oscillations around its balancing position. Moreover, with an increase in ion temperature, the dust particle approaches the electrode and oscillates with low amplitude.