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Spatiotemporal analysis of electric field reversal in capacitively coupled SiH_4/Ar RF discharge

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In this work, electric field reversals in capacitively coupled radio frequency (RF) SiH_4/Ar discharges are investigated by a fluid/electron MC hybrid model, considering the influences of gas ratio, pressure and voltage amplitude. Firstly, weak reversed electric fields have been observed outside the collapse sheath in the mixed gas discharge with about 10% SiH_4 added. In this case, tails of EEDFs (Electron Energy Distribution Functions) in sheath periphery region during sheath expansion period stretch vastly to higher energy area than those during sheath collapse phase. The reversed fields could only heat a fraction of electrons, which are nevertheless not sufficient for background gas ionization. With more SiH_4 added in the mixed gas, the electron heating by the reversed fields identically has a critical role compared with that caused by the expansion sheath. And the EEDFs near the sheath region during sheath collapse period keep roughly unchangable with those at the sheath expansion phase. Moreover, the electron densities exhibit layer structures as the SiH_4 ratio increases owing to the extrusion by intensive electric field reversal as well as enhanced ionization rate during sheath collapse phase. In addition, we also investigate the pressure and voltage amplitude effects on the electric field reversal. Note that the reversed electric fields are enhanced significantly as the pressure and voltage amplitude increase, playing their critical roles in electron heating and ionization at the sheath collapse phase.

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