PIC simulation on the effects of secondary electron emission in capacitive oxygen discharges

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Abstract: Secondary electron emission by ion bombardment at the electrodes, as an important factor for ionization dynamics in radio-frequency capacitively coupled plasmas (RF CCPs), is investigated by particle-in-cell/Monte Carlo collision model (PIC/MCC) simulation in an electronegative oxygen discharge. The introduction of the secondary electrons in the bulk, which could increase the electron density obviously, may greatly influence the electron heating mode of the discharge. Especially for electronegative discharges, more electrons especially in the plasma bulk may lead to an increased electrical conductivity and a reduced electric field, which would shield the ions' mobility and weaken the electronegative characteristics. By increasing the electron emission coefficient, with the decreasing electric field in the bulk, a transition of electron heating mode is observed as well as the enlarged gaps in the self-organized striation structure (Liu et al 2016 Phys. Rev. Lett. 116 255002). At last, the striations would disappear when the emission coefficient is great enough. As to the transition of heating mode, with more secondary electrons involved, impact ionization in the plasma bulk is attenuated, while the ionization caused by secondary electrons in sheaths is enhanced. This leads to the electron heating mode transition from striated (STR) mode to ?-mode. Besides, in our investigation we further notice that the effects of the secondary electron emission on this transition of heating mode are greatly influenced by the gas pressure and voltage amplitude. The ?-mode is more likely to dominate the discharge under higher gas pressure or driving voltage.

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