PIC/MC simulation of breakdown dynamic near high power microwave out-put window inside

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High-power microwave has important applications in controlled thermonuclear fusion heating, microwave high-gradient accelerator, high-power radar, directed-energy weapon, super jammer, impact radar and other aspects. This paper focuses on the process of dielectric multipactor and background argon ionization during the discharge breakdown near the HPM dielectric window/vacuum interface, A 1D electrostatic model was adopted in present work. The model, includes secondary electron emission, electrostatic field induced by the remaining positive charge on the dielectric window, the motion of charged particles under electrostatic and microwave field, as well as the collision process between electron and background gas, and the corresponding PIC/MC code has been developed. We examined the effects of gas pressure, microwave frequency, and microwave amplitude on discharge breakdown. It is found that there is only electron multipactor process during the discharge breakdown on dielectric window in vacuum. At low pressure (100 mTorr), electron multipactor and gas ionization are coexistent. However, at high pressure (760 Torr), the gas ionization dominates the breakdown process. In addition, it has also been observed that at 100 mTorr, the moment of gas ionization moves forward first and then backward with increasing the microwave amplitudes or the microwave frequency, especially at twice 2.85 GHz, gas ionization occurs earliest. This phenomenon is explained by the secondary electron emission model. Meanwhile, the results show that the position of plasma density peak from gas ionization gradually approaches the dielectric window as the microwave amplitude increases. However, with continuously increasing the microwave frequency, the plasma density peak approaches the dielectric window first and then moves away in the opposite direction.

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