Fluid Modeling of Effect of Secondary Electron Emission on Atmospheric RF Dielectric Barrier Discharge in Argon

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The secondary electron emission (SEE) coefficient is one of the essential physical parameters of RF discharges. Its role in the discharge has been studied by a number of scholars[1,2].

This work reports a numerical study of a RF argon dielectric barrier discharge at atmospheric pressure. By applying plasma fluid theory, a one-dimensional model on the discharge coupled with the drift-diffusion approximation is established. The effect of the SEE on the discharge is investigated. In this work, the secondary electron emission coefficients are assumed constants and their values are set as 0.01, 0.1, 0.2 and 0.3, respectively. The model is solved numerically by a finite difference method.

A series of numerical results are obtained with the different secondary electron emission coefficients, which indicate that the secondary electron emission coefficient has a significant effect on the discharge. The plasma density in the bulk region increases as the secondary electron emission coefficient increases, as shown in Fig.1(a). The electric field, the electron temperature and the ionization rate, in Fig.1(b), (c) and (d), increase significantly mainly in the sheath regions, while the changes are insignificant in the bulk plasma region. The secondary electrons primarily gain energy in the electric fields in the sheath regions, leading to increases in the charge accumulations on the surfaces of the two electrodes, which in turn acts on the electric fields, causing the electric fields in the two sheath regions to increase. At the same time, the electron temperatures in the two sheath regions increase. These results show that secondary electrons mainly act in the two sheaths. Also, the ionization rate increases and the occurrences of all types of the reactions are more intense, which will generate more electrons, ions, and metastable atoms. This paves the way for a deeper understanding of the discharge process. This work is supported by the Liaoning Provincial Education Department Scientific Research Project No. L2019049.

References

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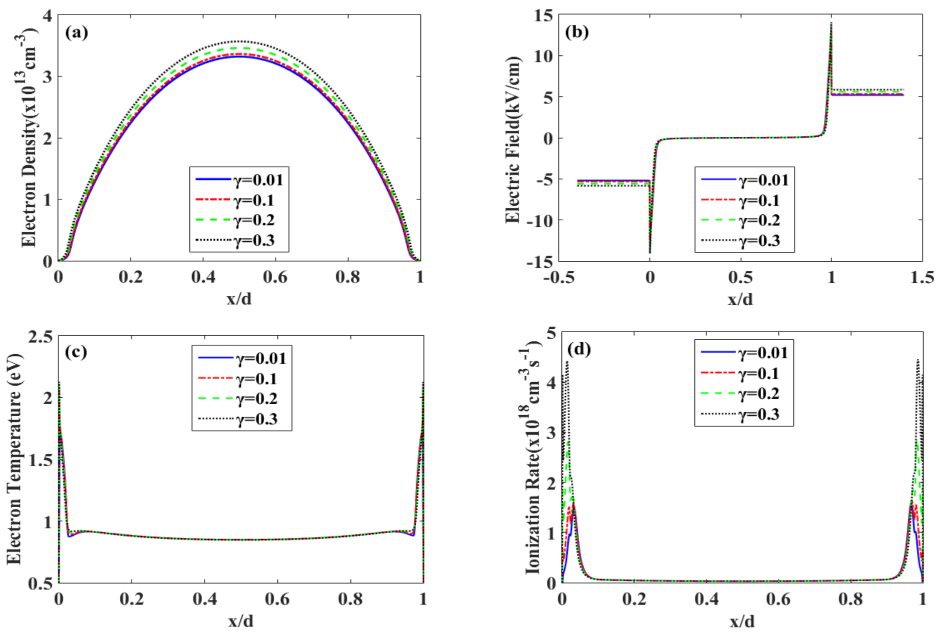

Fig.5. Cycle-averaged (a) electron densities, (b) electric fields, (c) electron temperatures and (d) ionization rates at 20000th discharge cycle driven by RF voltage sources with different SEE coefficients.