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Heating mode transitions in Capacitively Coupled CF_4 Plasmas at very low pressure

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The drift-ambipolar（DA) operation mode in Capacitively Coupled radio frequency CF_4 discharges was observed at very low pressure, and heating mode transitions were presented as the pressure increases based on a particle-in-cell/Monte Carlo collision (PIC/MCC) model

As can be seen in Fig.1, by increasing the pressure, the heating mode experiences a transition from DA+α (0.5pa) to α (1.4pa) mode: DA+α mode at 0.5 pa, DA+α mode with sheath nonlinearity[1], α mode with sheath nonlinearity at 0.8 pa and pure α mode at 1.4 pa.

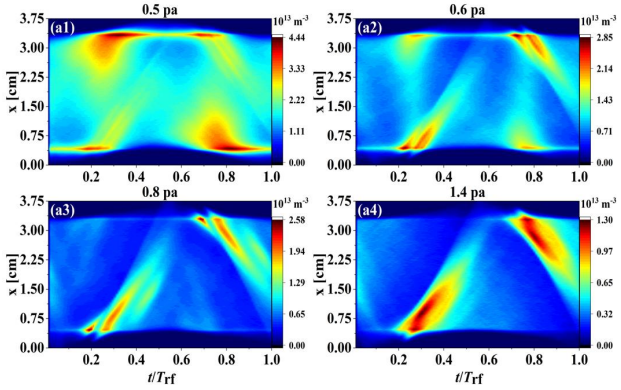

Figure 1. Spatiotemporal plots of the fast electron densities with energies above 30 eV at various pressures.

Correspondingly, the total electron power absorption within the sheath changes from negative to positive with rising the pressure, as displayed in Fig.2, which significantly affect the plasma characteristics. It seems that the DA operation mode is generally accompanied by a strong negative power absorption within the sheath, as the electrons are accelerated toward the collapsed sheath.

The physical mechanism revealed this work helps to understand the underlying plasma behavior in processing gas of practical applications at very low pressure.

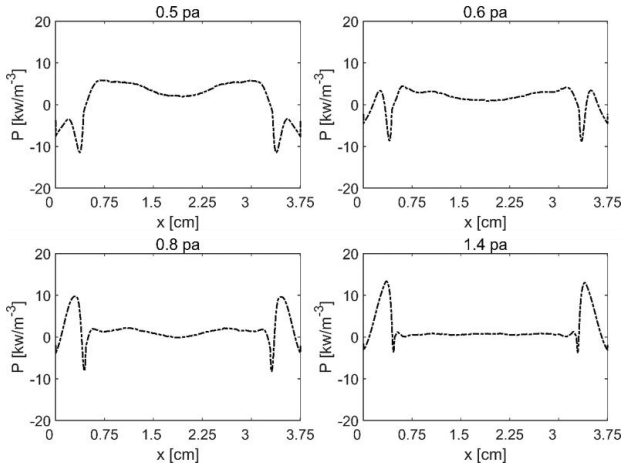

Figure 2. Spatial profiles of the time-averaged total electron power absorption.

References
1.Sun J Y, Zhang Q Z, and Wang Y N, 2021 Phys. Plasmas 28, 013509