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P5.3001 Studies on the plasma parameters and electron heating mechanism in RF biased inductive discharges

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Studies on the plasma parameters and electron heating mechanism were investigated in the RF biased inductively coupled plasmas (ICPs), which are widely used and studied in various industrial plasma processes and laboratory research, by using careful plasma diagnostic techniques. In RF biased ICP (ICP+CCP), as the RF bias power was increased, plasma density increased at the high ICP power and decreased at the low ICP power. This change in the plasma density suggests that the RF bias affects the plasma parameters, as well as the self-bias voltage and can be explained by the global model. Plasma uniformity was changed by the non-uniform power deposition of the RF bias and the uniformity was enhanced by the RF bias power. Electron heating mechanism by the ICP (inductive field) and the RF bias (capacitive field) was investigated. It was observed that with small RF bias powers in the ICP, the EEDF evolved from bi-Maxwellian distribution to Maxwellian distribution by an enhanced plasma bulk heating, and the collisionless sheath heating was weak. In the capacitive RF bias dominant regime, however, high energy electrons by the RF bias were heated on the EEDFs in the presence of the ICP and the collisionless heating mechanism of the high energy electrons transited from the anomalous skin effect by the ICP to the capacitive coupled collisionless heating by the electron bounce resonance in the RF biased ICP. As a study on the observation of the collisionless heating by the inductive field, the EEDFs with applying the ICP power were measured in the CCP. A significant heating of low energy electrons was seen in the E mode and it indicates that collisionless heating in the skin layer is an important electron heating mechanism of low pressure ICP, even when the discharge is in E mode. This Experiment was also preformed in the electro-negative gas (Ar/O2) and it was found that the Ohmic heating is inefficient with O2 gas pressure due to the decreased bulk electric field by the negative ions. The combined effect of collisionless heating by capacitive and induced electric fields was also investigated in the Ar/O2 RF biased ICP.

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