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Effect of Axial Magnetic Field on Negative Ion Production in Asymmetric Cylindrical Capacitively Coupled Plasma

Electropositive argon plasma mixed with small fraction of electronegative oxygen gas is widely used in plasma processing applications such as etching, thin-film deposition, oxide formation and negative ion sources, where precise control over plasma density and negative ion concentration is essential for process optimization [1-4]. Since the plasma characteristics strongly depend on gas composition and external magnetic field, understanding the behavior of mixed electropositive-electronegative gas is an important topic of research.

In this study, we have experimentally investigated the production of negative ions in geometrically asymmetric cylindrical capacitively coupled radiofrequency (RF) plasma. The plasma is generated using a mixture of oxygen and argon gases. An axisymmetric magnetic field, varying from 0 to 10 mT is applied along the axial direction of the discharge chamber, which produces an azimuthal E×B drift. The effect of RF power and axial magnetic field on key plasma parameters such as electron, positive ion, and negative ion densities, negative ion fraction and electron temperature has been examined at a fixed gas pressure of 1×10−3 mbar. The experimental results explore a magnetic field domain for enhanced ionization and optimized negative ion production in cylindrical CCP discharges required for several applications.

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