Study on expansion of electron sheath and breakdown in it
YEONG-SHIN PARK, DA-HYE CHOI, KYOU NG-JAE CHUNG, YONG-SEOK HWANG, Seoul National University — Electron sheath forms in front of a small electrode biased positively with respect to the potential of surrounding plasma. Based on the collisionless Child-Langmuir model for ion sheath in low pressure plasma, electron sheath model has been suggested. Equation of electron sheath thickness derived from the model describes that the thickness is determined by plasma density, electron temperature and sheath voltage as the ion sheath is. However, electron sheath is about 1.6 times thicker than ion sheath at same conditions. The calculated sheath thicknesses are verified by probe diagnostics as well as particle simulation. Monitoring the variation of ion saturation current of Langmuir probe with tiny tip with respect to sheath voltage, locations of sheath edge are measured at different plasma densities and electron temperatures. Using the 1D particle-in cell code, thickness of electron sheath are investigated, as well. Outbreak voltages of the breakdown in the electron sheath are gauged at various pressures and powers. Regarding the plasma as a cathode, biased electrode as an anode and electron sheath thickness as a discharge gap respectively, one-dimensional breakdown model is suggested. Applying Townsend’s criteria of DC discharge to this breakdown model, a nonlinear equation for breakdown voltages is derived. Comparison of model-based numerical calculations to experimental results shows a good agreement between them.

Yeong-Shin Park
Seoul National University

Date submitted: 11 Jun 2010