

The effects of surface processes on the characteristics of low-pressure capacitively coupled plasmas: insights from particle based simulations

A. Derzsi

Wigner Research Centre for Physics - Budapest (Hongrie)

Low-pressure capacitively coupled plasmas (CCPs) are basic tools in a variety of plasma processing applications of surfaces. Simulations based on the Particle-in-Cell method combined with Monte Carlo type treatment of the collision processes (PIC/MCC method) have been used to study a wide variety of phenomena and effects in CCPs, e.g. the electron power absorption and power absorption mode transitions, the ionization dynamics, the effects of surface processes on the discharge characteristics, the possibilities to control the particle flux energy distribution functions relevant for the applications, etc. The discharge models used in PIC/MCC simulations usually adopt several assumptions related to the description of the interaction of plasma particles with the boundary surfaces. The reason for this is the lack of reliable surface coefficients for different combinations of the discharge gas and electrode material under various discharge conditions, required as input data in the simulations. However, the surface processes included in the discharge model and the assumptions made on these surface processes have a strong effect on the calculated discharge characteristics. Largely different simulation results can be obtained for the same discharge conditions based on different (simple or realistic) descriptions of the various plasma particle-surface processes in the discharge model. Recently, the importance of the realistic description of the various surface processes in kinetic simulations of CCPs has attracted increasing attention. The simple models used to describe e.g. the secondary electron emission induced by heavy-particles and electrons have been replaced by complex, more realistic models, which take into account the dependence of the secondary electron yield on various factors, such as the energy of the incident particles, the electrode material and its surface conditions. In this talk, a summary on the recent efforts to describe the interaction of plasma particles with the boundary surfaces realistically in particle based simulations of CCPs is given, as well as an overview of how the realistic surface models implemented in the simulations have enabled an improved understanding of the effects of elementary surface processes on the plasma parameters in low-pressure capacitively coupled radio frequency discharges.