Investigation of Ion Dynamics in Capacitively Coupled Argon-Xenon Discharges

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Technological plasmas applied for etching or thin film deposition frequently consist of multiple gas and ion species. Accurate control of the ion energy is an essential requirement in these processes. The main goal of this work is to investigate the influence of the gas composition on the ion dynamics within these discharges. A low-pressure argon-xenon plasma is chosen and investigated via a Particle-In-Cell/Monte Carlo Collision (PIC/MCC) simulation. The main advantage of this noble gas mixture is its simple chemistry, which leads to a feasible number of ion species to be considered. The ion energy distribution functions (IEDFs) at the electrodes of a geometrically symmetric capacitively coupled radio-frequency (RF) discharge (Fig. 1) provide information about the ion dynamics within the discharge volume. The cross section of the interaction of argon ions with xenon neutrals is largely unknown. The same holds for the interaction of xenon ions with argon neutrals. For this reason, some model cross sections are assumed and the resulting IEDFs are determined. Additionally, a variation of the gas composition is conducted using different approaches for the Ar-Xe interaction cross sections. Furthermore, we investigate the influence of different discharge parameters (e.g., pressure and driving voltage) on the IEDF and the ion dynamics.

Figure 1: IEDF of argon and xenon ions obtained by PIC/MCC simulation using a 1D cartesian grid. Discharge conditions: $V_{RF} = 900$ V, $f_{RF} = 13.56$ MHz, $p_{gas} = 5$ Pa, $L_{gap} = 25$ mm, 90% Ar, 10% Xe