Realistic treatment of plasma-surface interactions in simulations of low temperature plasmas

Julian Schulze [1], Aranka Derzsi [2], Manaswi Daksha [1], Benedek Horvath [3], Birk Berger [4], Ihor Korolov [1], Steven Brandt [2], Mark Koepke [2], Zoltan Donko [3], and Peter Awakowicz [1]

[1]*Department of Electrical Engineering and Information Science, Ruhr-University Bochum, Germany*

[2]*Department of Physics, West Virginia University, U.S.A.*

[3]*Institute for Solid State Physics and Optics, Wigner Research Centre for Physics, Hungarian Academy of Sciences, Hungary*

[4]*Brandenburg University of Technology, Electrodynamics and Physical Electronics Group, Germany*

Technological plasmas are used to modify boundary surfaces, but boundary surfaces also affect the plasma via particle emission, absorption and reflection. Such plasma-surfaces interactions are implemented in simulations based on surface coefficients such as secondary electron emission coefficients (SEEC) and sticking probabilities. Typically this is done in a rudimentary way by either neglecting such processes completely or by using guessed coefficients, which are assumed to be constants independent of the surface material, incident particle species and energy. We demonstrate how sensitive PIC/MCC simulation results of capacitive RF plasmas are to the choice of these coefficients. We implement realistic material specific and energy dependent SEECs for ion, fast neutral, and electron impact as well as probabilities for elastic and inelastic electron reflection. Strong effects of using realistic heavy-particle-induced SEECs on the plasma density and other plasma parameters are found. At low pressures and high driving voltage, dramatic effects of including electron induced SEECs are also revealed. Based on these findings, we employ an ab-initio model to calculate realistic ion induced SEECs based on the Auger effect as input of our simulations and conclude that a realistic treatment of plasma-surface interactions is essential to obtain realistic results. ?

This work was supported by the German Research Foundation via SFB TR-87 and SFB 1316 (projects A4 and A5), the US NSF Grant no. PHY-1601080, and the National Office for Research, Development and Innovation, Hungary (NKFIH) via grant 119357.