GEC20-2020-000022

Abstract for an Invited Paper
for the GEC20 Meeting of
the American Physical Society

Electron heating and the Magnetic Asymmetry Effect in magnetized capacitive radio-frequency plasmas[1]

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Capacitively coupled radio frequency (RF) magnetrons are frequently used for sputter deposition of ceramic layers. However, fundamentals of their operation such as the effects of the magnetic field on the electron power absorption dynamics and the formation of process relevant flux-energy distribution functions are not understood. In order to address these issues, we characterize such a discharge operated in argon with oxygen admixture at low pressure by a synergistic combination of different experimental diagnostics [current/voltage measurements, retarding field energy analyzer, multipole resonance probe, phase resolved optical emission spectroscopy (PROES), magnetic field measurements]. These experimental results are compared to Particle in Cell (PIC) simulation and model results. We find that the magnetron magnetic field induces a discharge asymmetry. This Magnetic Asymmetry Effect affects the DC self bias and ion flux-energy distribution functions at boundary surfaces, which can be controlled by adjusting the magnetic field [1]. Tuning the magnetic field also allows to magnetically control the self-excitation of plasma series resonance oscillations of the RF current and, thus, Non- Linear Electron Resonance Heating (NERH) [2]. PROES and PIC simulations reveal space and time resolved insights into the dynamics of the electron power absorption in the presence of the magnetic field. [1] M. Oberberg et al. 2018 Plasma Sourc. Sci. Technol. 27 105018 [2] M. Oberberg et al. 2019 Plasma Sourc. Sci. Technol. 28 115021

[1]This work was performed in close collaboration with Moritz Oberberg, Birk Berger, Dennis Engel, Christian Woelfel, Denis Eremin, Jan Lunze, Ralf Peter Brinkmann, and Peter Awakowicz. Funding by the DFG via the project 417888799 is gratefully acknowledged.