Modelling of argon/dust pulsed plasma

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A spatially-averaged model for an argon/dust pulsed plasma is developed in this study [1]. We analyze how the plasma properties depend on the shape of the electron energy probability function (EEPF), the pulsing frequency and the duty cycle. In addition, the case of dust-free plasma is considered.

It is found that the results of theory and experiment agree better if the assumed EEPF has a Druyvesteyn shape instead of a Maxwellian one. As an example, we compare electron and metastable atom densities for different plasma states. In particular, the model shows that in the presence of dust and at some pulsing frequencies the electron density decreases rapidly in the very beginning of the on-period. In our opinion, this decrease is due to an enhancement of electron collection by dust particles at the beginning of the on- period. Further, variation in the pulsing frequency differently affects the metastable density in a dust-free and in a dusty plasma. For large pulsing frequencies (≥ 7 kHz), the metastable density in presence of dust is smaller than in the continuous-wave discharge, contrary to the dust-free case. Our model shows that the collection of electrons by dust particles causes the faster variation of the effective electron temperature leading to the lower metastable density.

Using a 1D model we describe the plasma properties during the off-period (afterglow) also. The charge of a dust particle and the forces affecting the dust particle are studied for different neutral gas pressures and dust radii. It is found that at long afterglow times, the electric force affects more essentially the dust particle than the ion drag force.

These results on dusty pulsed plasmas are relevant to many applications involving nonstationary plasmas containing impurities such as those for synthesis of novel nanomaterials.

[1] I.B. Denysenko, I. Stefanović, M. Mikikian, E. Kovacevic, J. Berndt, J. Phys. D: Appl. Phys. **54**, 065202 (2021).