Particle charge in PK-4 dc discharge from ground and microgravity experiments

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The complex plasma facility Plasmakristall-4 (PK-4) was installed in the Columbus module of the International Space Station (ISS) in November 2014. This is an experimental laboratory developed to provide a range of various experiments in the direct current (dc) or/and radio-frequency (rf) low temperature gas discharge. It allows to use different manipulation technics (e.g. laser manipulation, thermal and electrical disturbances, etc) [1].
Because of the gravity force the positions of microparticles in discharge on ground differ from those under microgravity conditions. The comparison of both cases gives the possibility to resolve discharge parameters as well as main microparticle characteristics in radial direction of the discharge tube. The aim of the current work is to estimate the radial distribution of the particle charge within the discharge tube from the measurements of the particle drift velocity in PK-4 set-up.
The experiments have been performed in the Flight Model (FM) onboard ISS as well as in Science Reference Model 1 (SRM 1) of PK-4 in ground based laboratory, which is functionally identical to the FM. The pressure ranged from 20 to 100 Pa in argon and neon gases with the variation of the discharge current from 0.5 to 1.5 mA. The particles of three different diameters of 1.3, 2.5 and 3.4 µm have been injected into the chamber. They were illuminated by the laser beam and their motion was filmed by video cameras with 35 fr/sec and 14,2 µm/pixel resolution. The velocities have been estimated by measuring the velocity of the whole particle cloud as well as from the intensity slope on the so-called space-time diagram.
The experimental data from ISS show that under microgravity conditions the velocities of microparticles are always lower than those measured on ground, as it already has been observed in parabolic flight experiments [2]. The difference is more pronounced in the lower pressure range (20-30 Pa). Drift velocities from experimental data have been compared with the results of analytical model, which yielded the estimation of the particle charge for chosen experimental conditions on ground and under microgravity. In the developed model variations of the discharge parameters in radial direction of the discharge tube have been taken into account. The experimentally measured and theoretically estimated particle velocities as well charges show different pressure behavior in argon and neon gases.
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