DIAGNOSTICS OF DUST PARTICLES ACCELERATION IN DUSTY PLASMA AFTERGLOW

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ABSTRACT: Investigations of dust-particle parameters in dusty plasma is of great importance for optimization of many industrial technologies based on plasma processing such as microelectronics, nanotechnologies and fusion [1]. The presence of residual charge on dust particle in the discharge afterglow that has been revealed recently opens up new possibilities for dusty plasma applications [2]. In this paper, the dust grain dynamics in the afterglow plasma of a capacitively coupled radio frequency discharge have been studied. The decay of dust structures is investigated in the post-discharge plasma and the numerical simulations are performed taking into account balance of forces acting on dust particles for estimation of their size and residual charge after the extinction of plasma.

The discharge was operated on frequency of 5.28 MHz between two parallel plate water cooled electrodes, separated by a distance of 21 mm. Ambient air was used as a process gas at pressure 100 Pa. Polydisperse Al_2O_3 particles with radii 0.1–20 μm were injected from the outside into the plasma volume. The dust grain dynamics in plasma and in the post-discharge were studied using the laser sheet imaging method. Dust particles were illuminated by a laser fan (λ=635 nm) in the plane perpendicular to the electrode plane. The video images of particles were analyzed for the determination of velocities of both the dust layers and individual grains. For the detection of the residual charge on a dust particle in the plasma afterglow DC bias was applied to the upper electrode instead of the RF voltage. The size and charge of dust grains were estimated from the balance of forces acting on the grains in the post-discharge phase.

The dust structure formed in RF plasma consisted of several layers levitated above the lower electrode at the distances which were depended on the grain size. We studied the dynamics of the two upper layers *I* and *II*, which preserved their structure for about 1 s after the discharge was switched off (Fig. 1). It is found that, after the RF power is switched off, dust grains with radii of r_D = 0.1– 0.25 mm preserve a residual negative charge which value Z can vary in the range from 1*e* to 10*e*, depending on the grain size.

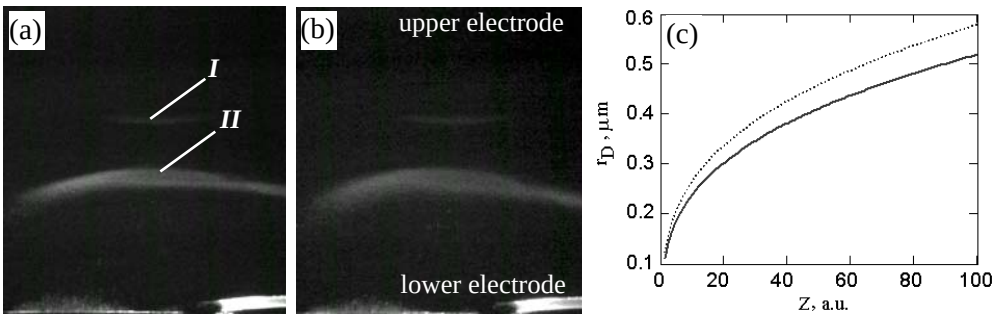

Fig. 1 The dust structure decay in the plasma afterglow: in 2 ms (a) and 82 ms (b) after the discharge switching-off, and particle radius estimated in dependence on the residual charge (c) for the layers *I* (solid) and *II* (dotted)

References

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