Experiments on alignment of dust particles in a plasma sheath

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Major factors affecting the formation of plasma crystals include particle interaction potentials, plasma fields, as well as external forces. The nature of particle arrangements in systems containing large number of particles can be understood by considering a simpler test system which allows these influences to be studied more easily. The simplest experiment and model employs a system of two particles arranged vertically or horizontally, maintained by an electrostatic confining potential in the horizontal direction and a combination of plasma sheath and gravitational potentials in the vertical direction.

Here, we report an experimental investigation of the stability of vertical and horizontal confinement of dust particles levitated in an rf sheath. The experiments were carried out in argon plasma with micron-sized dust particles. Changes of particle arrangement were triggered by changing the discharge parameters (pressure and peak-to-peak voltage) as well as by applying an additional bias to the confining electrode. The region where the transition was triggered by changes of discharge parameters and the transition from horizontal to vertical alignment has been found to be more pronounced than for the reverse transition, as shown in Fig. 1. A clear hysteresis effect was observed for transitions triggered by changes of the confining voltage. The instabilities observed are discussed in terms of a model [1] which considers the disruptive effect of the confining potentials in directions perpendicular to the particle oscillations.

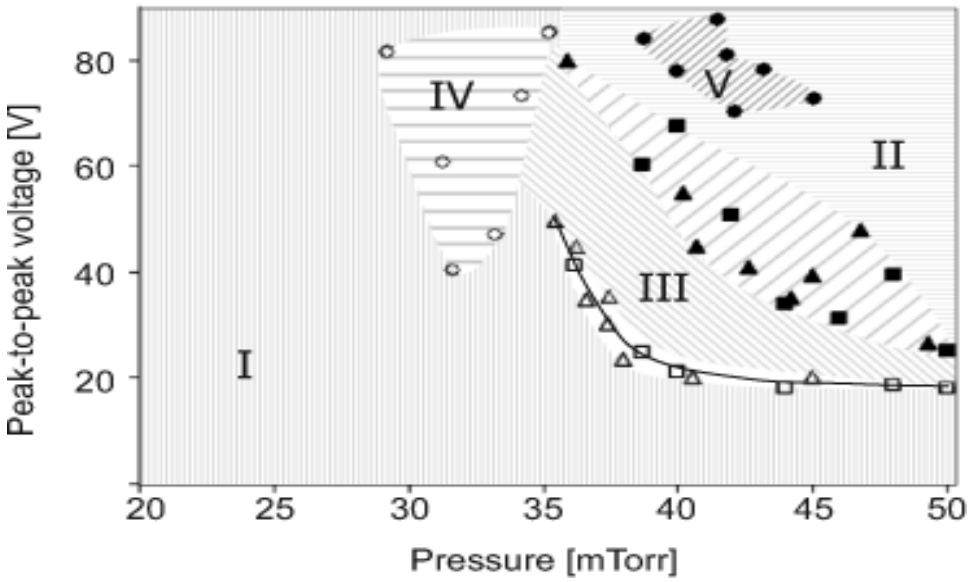

Fig. 1. Particle arrangement as a function of discharge parameters: I - vertically aligned particles; II - horizontally aligned particles; III - the transition region between the vertical and horizontal alignments; IV - horizontal rotation of the upper particle in the vertical alignment; V - circular oscillations of horizontally aligned particles. Solid symbols are for vertical-horizontal transitions and open symbols are for horizontal-vertical transitions. Triangles indicate pressure triggered changes, and squares indicate voltage triggered changes; open circles indicate rotation of vertically aligned particles, solid circles circular oscillations of horizontally aligned particles.

[1] S.V. Vladimirov and A.A. Samarian, Phys. Rev. **65**, 046416 (2002)