The effect of pulsed RF discharge on complex plasma parameters

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In this work experimental and simulation results of investigation of complex plasma parameters in continuous and pulsed RF discharge are presented. Pulsed discharges have a wide range of advantages, for instance, they affect the orbit of etching ions, reduce the damage of substrates, reduce the heating quantity of substrates, and save the source energy. Such RF discharges were used to deposit super hydrophobic coatings, which attracted the interest of many researchers and applicators [1-3].

In the experimental part of this work plasma parameters, such as axial distributions of electron temperature and ion density of plasma of the continuous and pulsed RF discharge were studied by probe diagnostics at different modulation frequencies and duty cycles. It was revealed that a decrease in the modulation frequency with 50% duty cycle of RF signal leads to the reduction of the electron temperature. The influence of the modulation frequency on the ion density is observed only at comparatively large values of pressure.

In the simulation part the continuous and pulsed RF discharge is described by the Particle-in-Cell simulation incorporating Monte Carlo treatment of collision processes (PIC/MCC) [4-5]. The pulsed RF discharge was found to result in a decreased electron temperature and plasma density. This is because, during one pulse period, the time of the pulsed RF discharge is shorter than the time of the continuous discharge, thus the plasma in the pulsed discharge obtains far less energy from the electric field.

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Nanoparticle formation from thin film sputtering: A complex dust cloud structure

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Dense clouds of nanoparticles can be formed in typical capacitively-coupled radio-frequency discharges operating at low pressure, by sputtering thin films deposited on the electrodes. As the nanoparticle size, and thus mass, are small, gravity is not the dominant force and they can easily occupy most of the plasma volume except the sheathes (where the local electric field repels them) and the void, a dust-free region where the outwards ion flux pushes them away.

The void is a very intriguing structure at the origin of many complex phenomena. For example, it is a region where many instabilities are observed and where new generations of nanoparticles can grow following a cyclic process [1-5]. The void can grow in size evacuating all nanoparticles from the discharge before a new generation appears, or successive generations can rapidly succeed each other inside the void and coexist as shown in Fig. 1a. In this last case, clear empty spaces separate the different generations.

Most of the experiments reveal the presence of a single central void. Nevertheless, in a new reactor we observed the existence of two symmetric voids [6]. These voids can stay distinct (Fig. 1b) or merge and form a single one. In both situations, new generations of nanoparticles can emerge from these regions where conditions of fresh nanoparticle nucleation are fulfilled.

In this presentation we will show some particularities of the void formation and how successive generations of nanoparticles can emerge from this region.

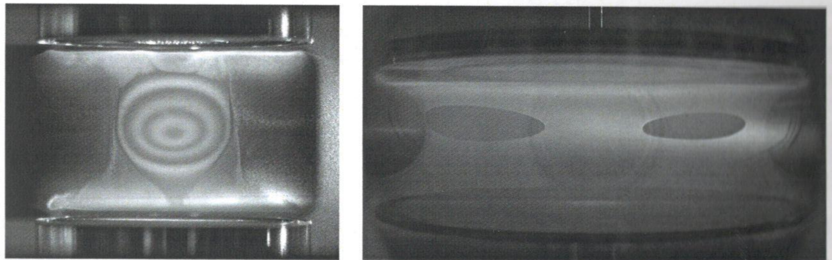

Fig. 1. Clouds of nanoparticles observed by laser light scattering in different reactors. (a) Successive generations of nanoparticles that rapidly succeed each other inside the void. (b) Cloud of nanoparticles with a clear two-void structure

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