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SPHERICAL STRATA IN GLOW DISCHARGE

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ABSTRACT. We present the results of the study of spherical stratifications in three-dimensional glow discharge. Strata radii dependence upon discharge pressure and current are determined. The magnitude of the radius of stratum upon its number is measured. The radial distribution of voltage between an electrical probe and the grounded cathode is also studied.

INTRODUCTION

The striations are appearance of alternating bright and dark regions in the positive column of a glow discharge. This phenomenon may be observed in atomic and molecular gases at pressures from 1 to 10^4 Pa. The striation may be static or moving with velocities up to 10^5 cm/s. The main processes that define the characteristics of striations are ionization by electron impact and ambipolar diffusion (Недоспасов 1968, Пекарек 1968). In this paper we present characteristics of spherical stratifications in a three-dimensional glow discharge. After Nerushev *et al.* 1998. these stratifications we named strata.

2. EXPERIMENTAL

Experimental setup is shown in Fig. 1. A spherical vacuum chamber (100 cm diameter) is made of nonmagnetic steel. The chamber was evacuated to 10^{-2} Pa and then filled with different gases. All measurements are performed in the range of pressures 1 – 20 Pa. The chamber is grounded and in this glow discharge served as cathode. An anode made of copper (2.5 mm in diameter) is placed radialy, and is isolated by a glass tube, so that its nonisoleted part (1cm in length) was in the center of the discharge chamber. To run the discharge a 0 – 2 kV and 0 – 100 mA current stabilized power supply was used. A ballast resistor of 20 kΩ was placed in series with the discharge and power supply. A window made of Plexiglas and located in the middle of the discharge vessel is used for photographing with a CCD camera.

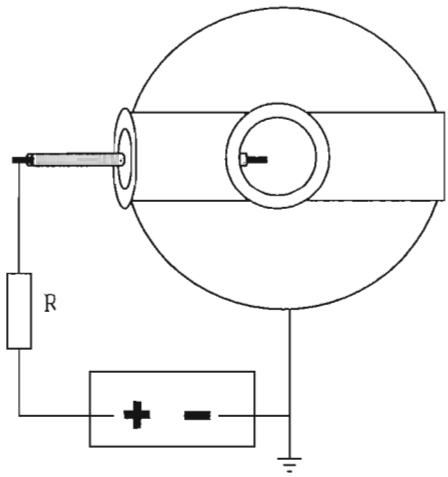

Fig. 1. Experimental setup.

3. RESULTS AND DISCUSSION

Spherical concentric strata were observed in various gases: air, pure N_2, mixture N_2 and H_2 when the central electrode is the anode. The strata were not observed in pure H_2 and Ar. The photograph of typical strata was shown in Fig. 2. If the central electrode is cathode the strata were not observed. The addition of some poliatomic gases as acetone and ethanol increase the number of strata.

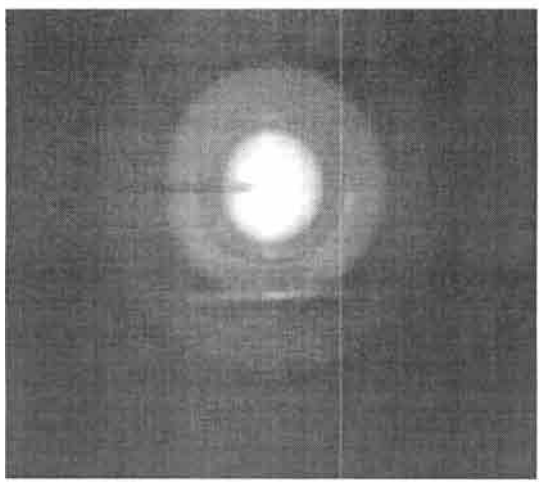

Fig. 2. Photograph of the strata in the air-acetone mixture. P = 5 Pa. I = 12 mA.

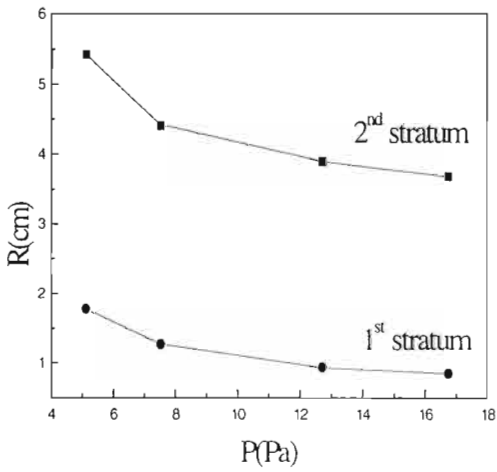

Fig. 3. Strata radii as a function of pressure. I = 20 mA.

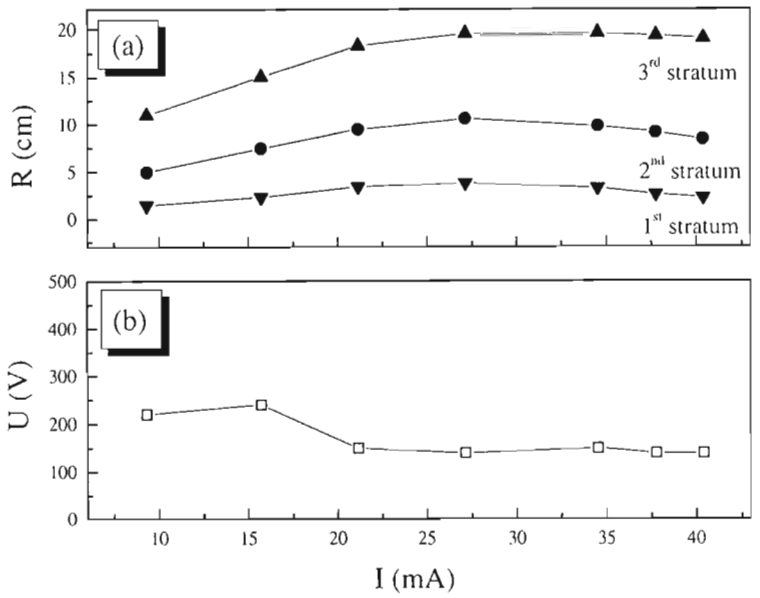

Fig. 4. a) Strata radii vs. current, b) V-A characteristic of glow discharge.

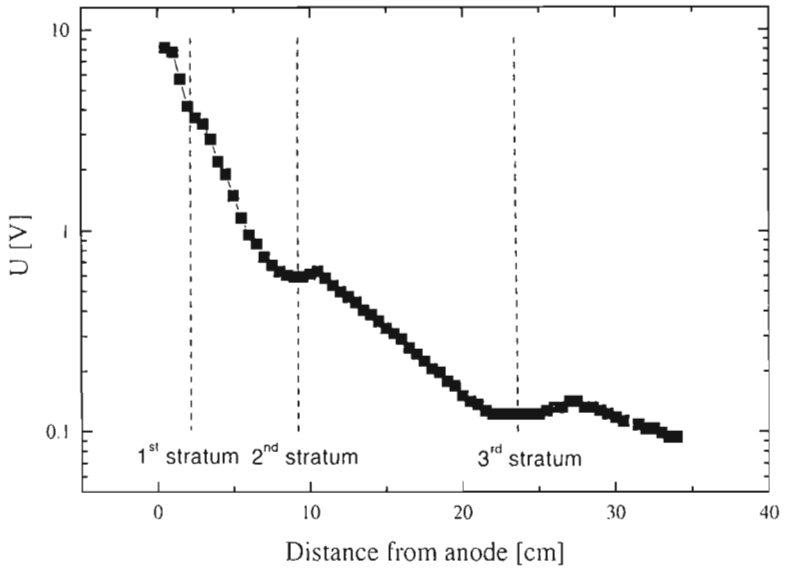

Fig. 5. Radial distribution of voltage between an electrical probe and the grounded cathode.

The radii of the strata depend upon the pressure, gas species and current trough the discharge. The radius of stratum as a function of the pressure is presented in Fig. 3. Where is shown that radii of the strata decrease as the pressure increase.

Figures 4a and b show the dependence of the strata radii as a function of the current and voltage-current characteristic, respectively. The stratum radius increases with the current to curtain value and then decreases, see Fig. 4a. If the current is smaller or greater then those at the graph, number of strata changes.

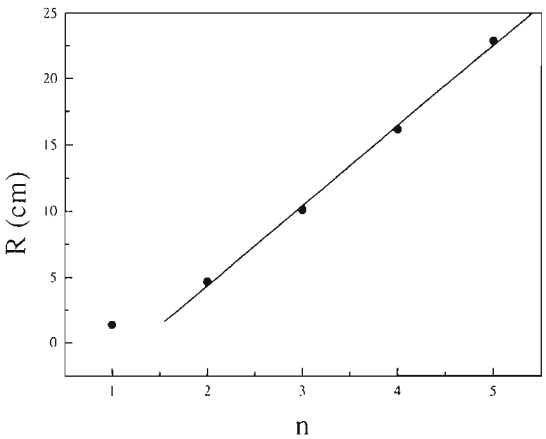

Fig.6. Strata radii vs. its number

With an electrical probe, voltage between the discharge plasma and the grounded cathode is measured, see Fig. 5.

In order to test theoretical model functional dependence of the stratum radius versus stratum number is required (Nerushev *et al.* 1998). The result of these measurements is shown at Fig. 6.

The best fit of the dependence *R(n)*, see Fig. 6. is a linear function $R_n = an + b$. In (Nerushev *et al.* 1998) R_n is exponential function of n, $R_n=R_1 exp(\beta n)$, where R_1 is the radius of the first stratum. The difference in these two dependencies is probably caused by different shape of the discharge chamber, which was in the case of Nerushev cylindrical.

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