

RADIAL REDISTRIBUTION OF THE COMPONENTS IN HELIUM-HYDROGEN MIXTURE DISCHARGES¹⁾

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In this paper the results of the investigation of the radial redistribution of the components in a positive column of He-H₂ mixture discharges are presented. In order to obtain the radial distribution of the hydrogen atoms in the striations, the transverse distribution of the intensities of the helium ($I_{He}(\tau)$) and hydrogen ($I_H(\tau)$) spectral lines were measured. A very interesting effect was obtained due to the presence of negative ions.

I. INTRODUCTION

The information about a degree of radial redistribution of the components in a stratification positive column plasma, depending on experimental conditions, could be used for the optimum functioning of existent equipments and for a purposeful designing of new ones [1].

II. METHOD

The radial redistribution of the hydrogen atoms in the striations was analysed. In order to obtain the radial distribution of the atom density, the transverse distribution of the intensities of the helium ($I_{He}(\tau)$) and hydrogen ($I_H(\tau)$) spectral lines were measured. These intensities may be expressed as [2]:

$$I_{He}(\tau) = h\nu_{He} \cdot n_{He} \cdot n_e(\tau) \cdot K_{He}, \quad (1)$$

$$I_H(\tau) = h\nu_H \cdot n_H \cdot n_e(\tau) \cdot K_H, \quad (2)$$

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where n_e , n_{He} and n_H are the densities of the electrons, the helium and hydrogen atoms respectively; ν_{He} , ν_H - the spectral line frequencies, and K_{He} , K_H - the excitation rate coefficients of the corresponding atoms.

If the electron energy distribution and the density of helium atoms do not change along the radius, the radial distribution of the density of admixture (H) atoms in the ground state may be obtained from the ratio of the hydrogen and helium spectral line intensities, measured at different places of the discharge tube $I_H(\tau)/I_{He}(\tau)$.

The radial distribution of radiation intensity was determined by measuring intensities averaged along the sight beam. These averaged intensities are related to local ones by the Abel equation [3], which was solved numerically applying the Tikhonov regularization method [4].

III. A RESULTS AND DISCUSSION

Our experimental conditions were: $P_{He} = 0.1 \div 0.3$ torr, $P_{H_2} = (1 \div 6) \times 10^{-2}$ torr, $I_d = 0.1 \div 0.2$ A. The positive column was created of several immovable striations. The obtained results for the spatial redistribution of the mixture components are presented in the figures.

From Fig. 1. it is seen that the degree of radial redistribution increases with an increase of the partial pressure of helium (a) and the discharge current (b). It could be explained by the growth of the electron density and, accordingly, the rate of ionisation of the admixture (H) atoms. It leads to an increase of the admixture ions current at the walls of the tube and to an increase of the degree of radial redistribution of the components. With an increase of the partial pressure of hydrogen, other parameters remaining constant, the degree of the radial redistribution of the components decreases (c). It could be explained by a decrease of the electron energy and, accordingly, the rate of ionisation of the hydrogen atoms and molecules.

From Fig. 2. it is seen that the degree of the radial redistribution of the components strongly depends on the position in the striation. In the "tail" of a striation the redistribution of components is determined by the cathodoresis mechanism, whereas in the "head" of a striation the redistribution of components has quite an opposite appearance. Such redistribution could be explained only by a thermodiffusion mechanism because in the "head" of a striation the radial electric field $E_r(\tau) \approx 0$, and the cathodoresis mechanism play no role. The distinction between the hydrogen atoms and the molecules redistribution was found within error limits.

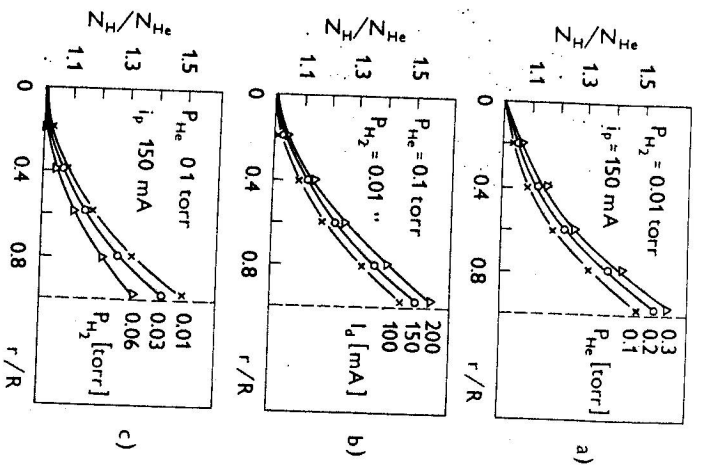


Fig. 1. Radial redistribution of the components in Helium-Hydrogen mixture discharge as a function of different experimental conditions.

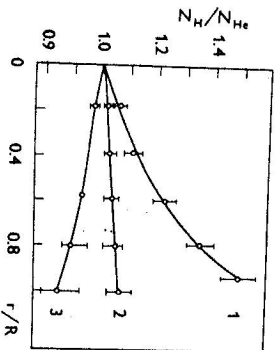


Fig. 2. The redistribution of hydrogen atoms along a radius of the tube in the "tail" (1), the middle (2) and the "head" (3) of striation $P_{He}=0.1$ torr, $P_{H_2}=0.01$ torr, $I_d=150$ mA.

IV. CONCLUSION

In the experiment, using He-H₂ mixed gas plasmas, with negative ions present, a redistribution of components in a stratification positive column was investigated. The observed redistribution was detected for the first time.

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РАДИАЛЬНЫЕ ПЕРЕРАСПРЕДЕЛЕНИЕ КОМПОНЕНТ ПРИ РАЗРЯДЕ НЕ-Н₂ СМЕСЕЙ

В работе приведены результаты исследованной радиального перераспределения при разряде в положительной колонне смеси He-H₂. С целью определения радиального распределения атомов водорода в стратификации, камере поперечное распределение интенсивностей спектральных линий $ln(\sigma^*)$ гелия и $ln(\sigma^*)$ водорода. Интересный результат в поперечном присутствии отрицательных ионов.