FLUCTUATION CHARACTERISTICS OF PARAMETERS OF DC GLOW DISCHARGE AT ATMOSPHERIC PRESSURE DUE TO GLIMMER OF ANODE SPOTS

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Anode current spots patterns are considered as an example of self-organization in glow discharges. The experimental results [1] have shown that the spots forming stable patterns on anode in the DC atmospheric pressure glow discharge (APGD) in helium are blinking. The correlation between fluctuations of both integral light intensity of spots and discharge current (or voltage) has been established. The current oscillation amplitude can be reached about 15% of averaged current value at 0.8 A [1]. Such strong oscillations in the discharge current can have a significant effect on other characteristic regions of the glow discharge, as well as on the stability of the discharge as a whole.Fluctuations of glow discharge parameters at currents up to hundreds of mA are report in detail in [1]. In contrary with [1], the given experiments are performed at large currents till 3-4 A. The oscillations of light intensities from different discharge regions and discharge current are analysed with the use of elements of chaos theory. The effect of the current fluctuations on the broadening of Stark components of helium and hydrogen lines in the cathode fall layer is under investigation as well.

The APGD in helium is ignited in an air-locked discharge chamber in a two-electrode configuration similar to [1]. In the experiments, the cathode is always flat and made out of copper. The shapes of the copper or tungsten anodes are flat or weakly rounded. Helium flow of about 1-2 l/min at atmospheric pressure is supplied through the chamber. In Fig. 1, an image of the anode pattern at the angle (~30 degrees) to the electrode surfaces is shown. In the presented case the gap is 8 mm and averaged current is 0.8 A. The number of anode spots, their intensity and anode area that they occupy primarily depends on the discharge current and the interelectrode gaps. The influence of anode shape and its material is not that strong.



Fig.1. Image of anode spots pattern

According to [2], using the registered time series of oscillations, the corresponding attractors are constructed. The attractor of current oscillations in a helium discharge is a torus, which quickly reaches the limit cycle with a dimension in the range 1.2-1.5.

The influence factors (anode temperature and small admixtures of other gases in helium flow) on both an anode spots picture and parameters of oscillations are established. Using them, we change anode spots picture and, correspondingly, the oscillation parameters and their attractors. Thus, with an admixture of argon, the current oscillations become irregular, their Fourier spectrum widens considerably. The attractor with a dimension of 2-3.5 has a core and several spirals.

Some features of applications of polarized Stark spectroscopy for electric field determination in the cathode fall layer of dc atmospheric pressure helium discharges in presence of current oscillations are discussed. It is shown that electric field in cathode fall layer has strong fluctuating component determining the Stark components of helium and hydrogen lines

The anode spots picture and caused by them oscillation of electrical parameters are investigated in three-electrode configuration as well. In this case, the spots picture on the additional anode is characterised by large occupied area and unusual patterns.

References

1. Arkhipenko V.I., Callegari T., Safronau Y.A., Simonchik L.V. and Tsuprik I.M. Plasma Sources Sci. Technol.,Vol. 22, 045003, (2013).
2. Pyragas K. Phys. Lett. A, Vol. 170, pages 421 (1992).