Letter to the Editor

RADIAL CHANGES OF THE ELECTRON DENSITY IN FLOWING AFTERGLOW PLASMA[1)]

РАДИАЛЬНЫЕ ИЗМЕНЕНИЯ КОНЦЕНТРАЦИИ ЭЛЕКТРОНОВ В ПОТОКЕ ПЛАЗМЕННОГО ПОСЛЕСВЕЧЕНИЯ

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By help of the Langmuir probe movable both in the axial and in the radial direction, radial profiles of the saturated ion current were measured in the argon flowing afterglow.

The apparatus for the study of the flowing afterglow [1], described in [2, 3], was modified by using a platinum cylindrical probe (5 mm long, 50 μm radius) movable along the radius of the flowing tube (cca 30 mm) and along the axis of the flowing tube. The plasma was produced by a dc discharge in argon. The cathode was placed in the side arm of the flowing tube. The anode (of a cylindrical ring shape) was placed in the upstream end of the flowing tube. The pressure of argon was 53 Pa, the discharge current was 5 mA. The flow gas velocity was about 50 ms^{-1}.

By means of one probe method, the saturated ion current was measured at a large negative probe voltage. This current is proportional to the electron density, e.g. [4],

$$i_+ = \alpha n_e \sqrt{\frac{2kT_{es}}{M_i}}\, S \tag{1}$$

where i_+ is the saturated ion current, α the correction factor, calculated in the limits 0.4—0.8, T_e is the electron temperature, n_e the electron density, S is the value of the collecting area, M_i the mass of the ion, k the Boltzmann constant.

In Fig. 1 the dependence of the saturated ion current for the probe bias — 30 V on the radius for different distances l from the anode of the source discharge is shown. It is evident that the radial distribution character changes. The antisymmetry of the system caused by the source discharge geometry is evident too, it means that the maximum of the current is near the tube wall for small l. This region is influenced by the source discharge, as evidenced by measurements in [2].

For more detailed analyses of the electron radial distribution the electron density was calculated from equation (1), for $l = 110$, 260 and 485 mm. For these positions the electron temperature was determined from one probe characteristics [5]. The value 0.6 for α and the mass of Ar^+ were used. Results are shown in Figure 2, curves 1, 2, 3, where for the zero value of r the maximum of the electron density in each position is defined. The Bessel radial density distributions for the same values of n_0 are included for comparison. It is seen that the maximal deviation from the Bessel distribution is for the

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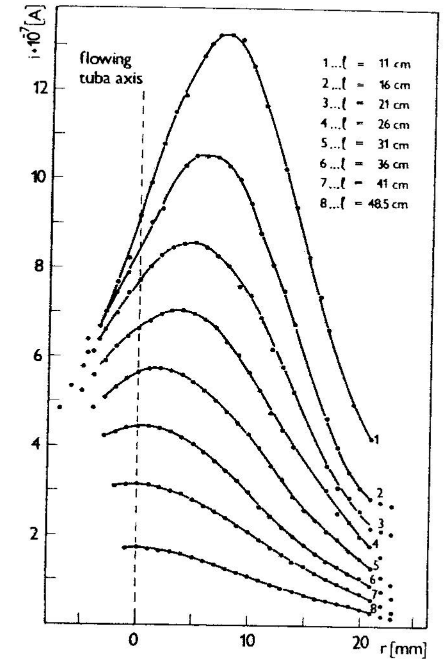

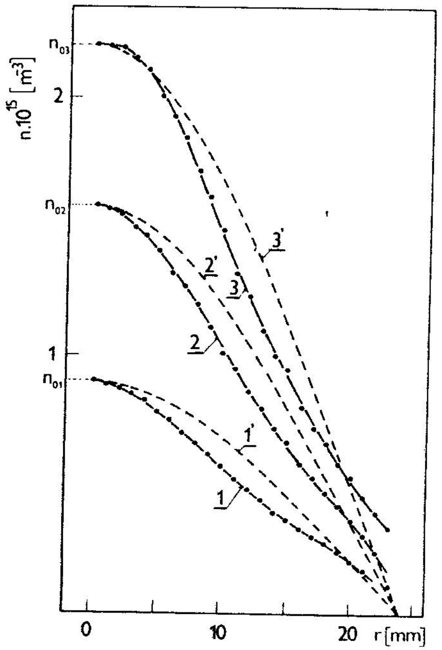

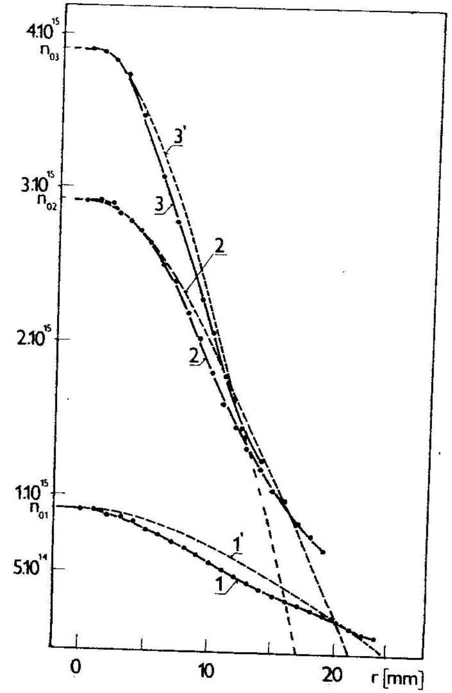

Fig. 1. Saturated ion current dependence on the radius for different distances from the anode of the source discharge.

Fig. 2. Calculated electron density and the Bessel distribution for different l (curves 1, 1′ for l = 485 mm, 2, 2′ for 260 mm and 3, 3′ for 110 mm).

Fig. 3. Density radial distribution for $l = 485$ mm (curve 1), for $l = 410$ mm (curve 2), for l = 360 mm (curve 3). Curves 1′, 2′, 3′ show the corresponding Bessel distribution.

position at the greatest distance from the source discharge, i.e. for the smallest antisymmetry of the system. This deviation is about 20 %. For the nearest position to the discharge it is about 6.5 % only, and for $l = 260$ mm it is cca 9 %. In Figure 3 there are shown similar dependences for $l = 485$, 410 and 360 mm. These are the cases, where the electron density maximum is in the flow tube axis (see Fig. 1). The value 3200 K for electron temperature was used. Calculated electron densities are shown by curves 1, 2, 3 corresponding to the Bessel distribution of the curves 1′, 2′, 3′. the deviations are practically the same, about 20 %.

It is evident that for the determination all influences on the radial distribution, analyses of more types of particles and other physical processes are necessary.

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