acta phys. slov. 33 (1983), No. 3

PARAMETERS OF AIR PLASMA COMPRESSION IN FRONT OF THE PLASMA GUN[1])

ПАРАМЕТРЫ СЖАТИЯ ВОЗДУШНОЙ ПЛАЗМЫ ПЕРЕД ПЛАЗМЕННЫМ ПРОЖЕКТОРОМ

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The geometry of the compressed current sheat is given, the value of the current through the sheat is calculated and the negligible influence of the longitudinal pinch itself on the kinetic pressure is stated.

The geometry of the compressed current sheat, the value of the current through the sheat and the influence of the longitudinal pinch itself on the kinetic pressure are mentioned here. Experimental results were obtained by interferometric diagnostic.

The description of the experimental setup is in [1]. The development of the compressions at the 100 Pa air filling pressure is shown in [2]. The dense part of the compressed current sheat forms a cylindrical shape. The time dependence of the radius and the length are shown in Tab. 1. These dimensions are fixed in the time interval 3—4 μs. The plasma density in this compression has the minimum value in the zone of the plasma connection to the central electrode, increases with the axial distance and reaches the maximum in the centre of the ellipsoidal structure at the end of the cylindrical form of compression. This character keeps from the beginning to the decay of the compressed current sheath.

The longitudinal pinch of the current itself causes the compression forming. The current value was calculated in this paper with the help of two assumptions, stationary and isothermic plasma (the thermal equilibrium of electrons and ions states for density 10^{24} m^{-3} at the time 10^{-8} s) and the emission of the Joule heating by equilibrium electrodynamic radiation. The application of the Stefan-Boltzmann law is given by fulfilling of the conditions of radiation equilibrium, then the mean time of the ion-ion collisions $\sim 10^{-11}$ s is much less than the time for an emission of resonance lines $\sim 10^{-9}$ s [3]. The current I in the compression is given by

$$I^2 = 2\pi\gamma\sigma r^3 T^4, \qquad (1)$$

r is the radius of compression, γ conductivity of plasma, σ the Stefan-Boltzmann constant, T plasma temperature.

The current is the source of magnetic pressure which causes the kinetic pressure in the compression. The mean pressure $\bar{p}$ is given by

$$\bar{p} = \frac{\mu I^2}{8\pi^2 r^2}. \qquad (2)$$

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[1]) Contribution presented at the 4th Symposium on Elementary Processes and Chemical Reactions in Low Temperature Plasma in Stará Lesná, May 24—28, 1982.

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Table 1

τ (μs)	$r \times 10^3$ (m)	$L \times 10^2$ (m)	$I \times 10^{-3}$ (A)	$\bar{p} \times 10^{-5}$ (Pa)	p (Max) $\times 10^{-5}$ (Pa)
3.2	3.5	1.3	8	1.4	>10
3.4	4.0	1.3	10	1.7	>10
3.7	3.0	1.4	6	1.2	>10
4.0	4.0	1.6	10	1.7	10
4.15	3.0	1.8	6	1.2	7
4.3	2.5	1.9	4	0.9	6
4.6	2.2	2.0	3	0.8	5

r is the radius of compression, L is the length of compression, I is the current given by equation (1), $\bar{p}$ is the mean pressure given by equation (2), p (Max) is the maximum of the compression pressure in the centre of the ellipsoidal structure. The lower vaues are estimated for reason of a bad differentiation of the interferometric fringes in the time 3—4 μs.

The values of the current I and the mean pressure p are given in Table 1 for a temperature 2×10^4 K [2] and $\gamma = 5 \times 10^3\ \Omega^{-1}\ m^{-1}$ [4] (the influence of the microscopic fluctuations is not taken into account).

The following conclusions can be made. The current in the compression $(6—10) \times 10^3$ A in the time interval 3—4 μs is 10—20 % of the whole current and after 4 μs decreases. The kinetic pressure caused by this current is much less than the pressure in the centre of the ellipsoidal structure and may not have a great influence in its formation. The ellipsoidal structure keeps its form from the time of compression creation to the time of the plasma decay.

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Received June 7th, 1982