OPTICAL DIAGNOSTICS OF THE PLASMA DYNAMICS IN «VACUUM SPARK»

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This paper reports some visual information related to the dynamics of the high-current discharge of the «vacuum spark» type. Our experiment was performed with the PFM-72 plasma micropinch device, when the triggering discharge was produced near the needle anode made of **Fe** by four auxiliary sources of weak plasma. The flat cathode was manufactured from **Mo**. The typical characteristics of the discharge device: the capacitance of 12 μF; the charge voltage up to 20 kV; the discharge current of (60 - 250) kA; the current period about 5 μs; the pressure in the work chamber of (10^{-1} - 10^{-3}) Pa.

In previous researches on this installation we studied the accelerating processes [1] and the radiating characteristics in VUV and soft X-ray ranges [2,3]. These investigations where performed with help complex of the diagnostic equipment allowing to determine the basic parameters of plasma: contactless noiseproof testers of a current and voltage of the discharge; multichannel scintillator detectors of x-ray radiation for receiving of spectra in time and integral spectrum for the discharge; the x-ray diffraction spectrograph with the high resolution; the track detector of x-ray radiation on the bases of nuclear emulsion and pin-hole camera to determine a spectrum with the spatial resolution; the spectrograph of a wide spectral range on a base TLD and absorption filters; the small-sized magnetic analyser of electrons; Tomson spectrograph for the analysis of ion component by a method of parabolas; the multichannel magnetic energy-mass-analyzer of ions (1 keV - 1 MeV on hydrogen).

Among the most interesting experimental results received until now, it is possible to highlight the following : for the first time integrated over the time the distribution function of electrons emitted from discharge plasma are registered; the spectrum of bremsstrahlung of electron components of plasma in various regimes of pinch and dependence of a spectrum on element composition of discharge plasma is investigated; the polarisation of multicharged ion radiation in a x-ray range is discovered; dynamics of temperature of plasma in the micropinch discharge is investigated.

To investigate dynamics of the discharge plasma, the TEA nitrogen laser (λ=337 nm) for probing of dense plasma in complex with shearing interferometer and the optical system

for high-speed photoelectric registration of visible radiation as a function of time were created.

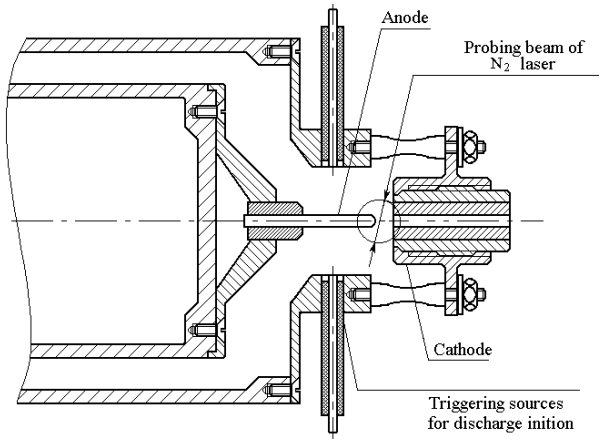

Fig. 1. Electrode system of installation PFM-72.

The electrode system of main discharge with four initiating auxiliary plasma sources is shown in Fig. 1. In centre of the cathode a hole with diameter 3 mm was drilled. But a run of experiments was performed with the **Fe** solid cathode. The filling of disruptive distance by triggering plasma is created in ~ 0.6 μs, but a current rise is started earlier. The reason of that is an emission of electrons due to the effect of auxiliary sources radiation on the cathode surface.

The marked gradients of electron density are observed in 0.7 μs after starting of the initiating discharges (see shadow photographs). After that a current structure similar to a funnel is formed near the anode (**t**~1.0 μs) and is moved to the cathode. Approximately in this time the half-sphere from evaporating anode material is produced near an end of the anode and it exists up to ~3.5 μs, following which the plasma is not registered on shadow photographs. The shearing interferograms are consistent with presented shadow pictures.

A recording of visible radiation from discharge plasma by high-speed photo-electronic camera was performed with slit orientation parallel and perpendicularly to discharge axis. Series of contractions are observed for both slit orientation.

References

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