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LEAKAGE OF CURRENT FROM MITL WITH CERAMIC COATING CATHODE*

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It was shown in [1] that the ceramic coating reduces the expansion of dense plasma from the surface of the MITL cathode. This made it possible to consider the coating of MITL cathodes with ceramics as protection against current leakage. The purpose of this work was to study the processes of current flow in MITL, in which the cathode is covered with ceramics. For this purpose, a 40mm short-circuited MITL was installed at the output of the eight-module installation of the Angara-5-1. The amplitude of the generator current reached 3 MA. The time of the current rise to the maximum was ~ 100 ns. With the help of loops, the currents were measured: flowing into the MITL, and at the end of the MITL.

Hollow stainless steel tube with a diameter of 3 mm and a wall thickness of 220 microns was used as the MITL cathode. The skin time of the current in the linear approximation (at low current amplitudes) is 16 ns, which is smaller than the duration of the current pulse. In a number of experiments, a ceramic tube with an inner diameter of 3 mm and an outer diameter of 5 mm was put on this tube.

An insulated conductor was located inside the cathode tube, which had contact with its inner surface and was used to measure the electric field strength on the inner surface of the tube. The MITL anode is made of stainless steel, its inner diameter is 20mm. The inductance of such a MITL is equal to 10 nHn. With the internal resistance of the generator of theAngara-5-1 installation 0.25 Ohms, the time of filling the MITL with a magnetic field is 40 ns, thus filling the MITL with a field occurs more than 2 times faster than the current reaches the amplitude value.

Based on the totality of the recorded information (electrical signals, laser shadow pictures and streak camera pictures), it can be argued that in the case when the MITL cathode was coated with ceramics, plasma formation on it occurs earlier than without such a coating. It is shown that, for our case of classical MITL, in which the cathode was located coaxially inside a cylindrical anode, just as in [2], in the case of coating the MITL cathode with ceramics, not all off the current entering the MITL flows to its end.

Numerical simulation of the processes occurring when a current with a linear density of up to 3 MA/cm is passed through a thick-walled tube with a wall thickness of 220 microns was carried out. A system of one-dimensional one-temperature magnetohydrodynamic equations was solved. To describe the properties of a real substance, wide-range semi-empirical equations of state [3] were used, taking into account phase transformations (melting and evaporation) and the possibility of realizing metastable states, as well as the dependence of transport coefficients (conductivity and heat capacity) on temperature [4, 5]. The numerical results are in good agreement with the measured value of the electric field strength on the inner surface of the tube.

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