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CHARACTERISTICS OF PLASMA JETS OF A HIGH-CURRENT VACUUM-ARC DISCHARGE*

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Plasma sources based on high-current discharges in vapors of aluminum electrode material initiated by breakdown along the surface of ceramics based on aluminum oxide are studied. Two geometries of discharge gaps with a corundum ceramic insert between the cathode and anode were tested. Option 1 - end, where the cathode, anode and the surface of the ceramic insert are in the same plane, option 2 - the cathode was inside the ceramic tube with an increase in the gap along the surface of the ceramic by 2-3 times. The capacitive storage provided the oscillatory regime of the discharge current with a period of ~5.7 μs. The discharge was initiated by a high-voltage breakdown over the surface of a ceramic insert between the electrodes. The current amplitude of the plasma gun was controlled both by the charging voltage (30–40 kV) and by the connection circuit [1].

The plasma flow velocity was measured by the time-of-flight technique using double probes with a reference electrode [1]. The flow velocity was measured by the time shift of the signal maximum from two probes. The figure shows a graph of the dependence of the plasma flow velocity on the amplitude of the vacuum arc current. It is found that with an increase in the discharge current, both the velocity and the concentration of the plasma jet increase for both variants of the discharge gap. The recorded decrease in the opening angle of the plasma jet with increasing current is obviously associated with an increase in the influence of the intrinsic magnetic field on the compression of the current-carrying plasma [2].

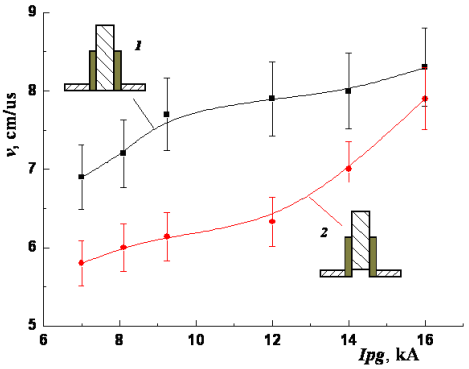

Fig.1. Зависимость скорости плазменного потока от разрядного тока. Dependence of the plasma flow velocity on the discharge current.

Large values of velocity for variant 1 can be associated with a more effective action of electrodynamic forces as the main mechanism for accelerating the current-carrying plasma along the axis of the system. If we assume that the velocity of the plasma bunch in the section between the discharge gap and the probes changes insignificantly, then the formation of a directed flow lags behind the onset of the current by ~ (200–300) ns. Due to the high thermal stability of the corundum dielectric insert, ceramic ablation is negligible. The plasma flow basically consists of ions of the electrode material with a significant proportion of ions of the cathode jet [2]. Plasma compression can be associated with the dynamic head of the convergent ion flow characteristic of the inertial regime. Estimation of the plasma concentration from the hydrodynamic model of a current-carrying jet gives the value $n \sim I^2/(M_i v^2) \sim (1\text{-}2)\cdot 10^{15}$ см$^{-3}$ for aluminum ions.

REFERENCES

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