

Investigations of Jet-Formation Processes in Miniature Magneto-Plasma Compressor for High-Altitude Air-Breathing Plasma Jet Propulsions

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Unique properties of plasma jets, generated by Magneto-Plasma Compressors (MPC) operated in a High-Pressure Residual Gas Regime (HPRGR), were demonstrated in ¹⁻³. One of possible ways for the MPC to be used in applied high-altitude aerodynamics may be the realization of the MPC version with a comparatively low input energy. The Miniature Magneto-Plasma Compressor (MMPC) with an outer diameter of 12 mm and a pulse energy as little as 15-20 J operating in the HPRGR was reported to be successfully created and preliminary tested in ⁴.

In the present work, the parameters of an MMPC-based plasma actuator were experimentally investigated. The investigations cover the dynamics of a plasma jet generated under different residual gas pressures, spatial and temporal distributions of plasma jet parameters (temperature, density, and velocity), and estimations of the MMPC jet impulse bit. An experimental setup for these measurements contains a test chamber (static pressure 10-500 Torr), a Schlieren optical channel with a 500-ns gated CCD camera, a gated spectrometer (200 – 770 nm, 0.25 nm, 10 μ s), and a test pendulum for thrust measurements.

As the results of our experiments show, the 12-mm outlet diameter MMPC functioning under static pressures of 10 – 70 Torr, creates the submerged plasma jets in a quiescent surrounding gas (air) with a high velocity (2 km/s), a great penetration ability (amounting to more than 8-10 outer diameters of the tested MMPC, see Fig. 1) and the impulse bit more than 4000 μ N*s under the input energy of about 20 J/pulse. The above results show that the examined types of the MMPC could be used as comparatively long-range plasma jet guns and become a base unit to create MMPC arrays in a new generation of plasma actuators⁴ and thrusters for applied aerodynamics⁵.

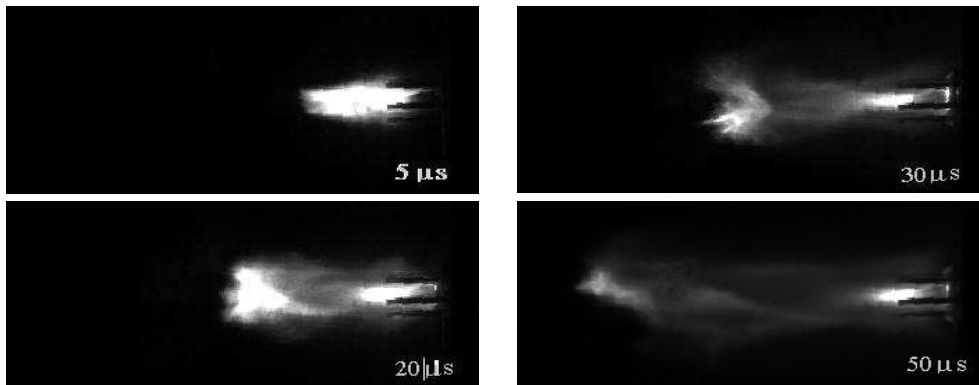


Fig.1. Submerged plasma jet generated by MMPC in quiescent air (30 Torr). Dynamics of expansion at different time delays after the MMPC launching

References

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