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COMPRESSION ZONE FORMATION IN PLASMA STREAMS GENERATED BY MAGNETO-PLASMA COMPRESSOR

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Compressed plasma flows are considered as important plasma dynamic phenomena due to numerous different applications of dense magnetized plasma, such as plasma optics, novel ion-plasma technologies, including deposition of different coatings, surface modification etc. For all those applications it is necessary to provide effective control of spatial position of the compression zone that allows minimization of electrodes erosion and impurity admission into the plasma stream.

Recent experiments were carried out in magneto-plasma compressor (MPC) device [1]. The MPC channel is formed by cylindrical road-type anode with outer diameter of 8 cm and conical solid cathode with outer diameter 3 cm. The maximum value of discharge current was about 400 kA and the discharge duration 10 mcrs. MPC was installed into vacuum chamber with diameter 40 cm and length 200 cm. Initial conditions for discharge ignition were changed by variation of working gas atomic mass and value of residual pressure in vacuum chamber. At this, total mass flow rate was kept constant.

Two different mechanisms of compression zone formation were analyzed. First one is a ballistic mechanism, when compression zone is formed due to collapsing plasma flow and plasma parameters depend on plasma stream velocity. Another mechanism is an electromagnetic one, when compression zone is created by electromagnetic force generated by electric currents in plasma stream. Set of magnetic probes was applied for measurements of spatial distributions of electric current in plasma. Temporal and spatial distributions of plasma density with high resolution were obtained using the Stark broadening of spectral lines.

Experimentally it was shown that plasma stream parameters and compression zone position are strongly depend on electromagnetic force distribution and rather weakly influenced by plasma stream velocity. Plasma density in compression zone and distance from MPC output to compression region are increased with decreasing initial concentration. The maximum value of plasma density achieved $n = (3 \div 5) \times 10^{18}$ cm^{-3}.

References:

1. Solyakov, D.G. et al. Formation of the compression zone in a plasma flow generated by a magneto-plasma compressor / D.G. Solyakov // Plasma Physics. – 2013. – vol.39 – p. 1099.