MEGAWATT ELECTRON BEAM FOR GDt device

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The study is devoted to the problem of the interaction of a high-power electron beam with a gas-dynamic trap plasma in order to substantiate the possible use of electron beams in next-generation thermonuclear facilities. In particular, the installation of a GDMT for the confinement of a thermonuclear plasma with an electron temperature of up to 2 keV, a relative pressure of up to 40%, a density of fast ions up to 3.5·1014 cm–3 and lifetime energy of 1 s is projected at the INP SB RAS. Achieving these parameters will ensure the efficiency of the DT fusion reaction at a level of 10% and demonstrate the possibility of building a fusion reactor based on an open-type trap. An important part of the GDMT is electron beams injected from the end tanks into the central cell. These beams should perform two key functions:

1) control of the plasma electric potential radial profile, which is necessary to overcome the influence of MHD instabilities on particle and energy confinement;

2) additional heating of the electron plasma component.

This paper is devoted to the problems of the interaction of an electron beam and a hot two-component plasma. A source of an electron beam with a design power of up to 5 MW (50 kV, 20 A, 5 ms) was developed and manufactured at the INP SB RAS. To accomplish this task the design based on the use of a coaxial diode with magnetic insulation [1] was chosen. The diode consists of a cathode of convex spherical shape with a diameter of 20 mm, a focusing electrode and a cylindrical anode. A magnetic field of the order of 0.1 T in the region of beam formation is created by a solenoid mounted on the body of the electron gun. An additional positively charged cylindrical electrode located along the beam and isolated from the anode cylinder is used to cut off and weaken the ion flux from the trap. The cathode is made of lanthanum hexaboride and, when heated to a working temperature of 1700 °C, is capable of producing an emission current density of up to 10 A/cm2. The chosen formation scheme makes it possible to produce a beam with small transverse velocity components, which is necessary for its adiabatic injection into the GDT mirror plug, where magnetic field of up to 13 T.

The described source was tested on the bench where showed reliable operation with parameters slightly lower than the design ones. Then it was installed in the GDT expander tank. This paper is devoted to the first results of electron beam injection into GDT plasma.

References

1. Beebe, E. et al, Review of Scientific Instruments, Vol. 71, p. 893–895, 2000.