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PLASMA LINEAR DEVICE PLM-M FOR TESTING THE IN-VESSEL COMPONENTS OF A HYBRID FUSION REACTOR *)

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In order to test refractory materials with stationary plasma loads with a power density of 1–5 MW/m^2, simulating a stationary load on the plates of the divertor of a hybrid thermonuclear reactor, a plasma device PLM-M - plasma linear multicusp upgraded was built at the MEI Research Institute. Plasma tests of materials in PLM-M are supplemented by irradiation with powerful laser pulses, which simulates the level of pulsed load of ELMS and disruptions to divertor plates expected in the reactor, including in ITER.

The magnetic system of the PLM-M device was built according to the scheme of a linear multicusp - an eight-pole multicusp. A longitudinal magnetic field is created by a solenoid to ensure the MHD stability of the discharge. Such an eight-pole plasma trap circuit is unique in the world. PLM-M parameters: diameter/length of the discharge chamber were 15/100 cm, longitudinal magnetic field on the axis of the plasma discharge was up to 0.035 T, magnetic field induction near the walls of the chamber was up to 0.2 T, diameter of the hot zone of the cylindrical plasma discharge of 3.5 cm was set by the diameter of the anode aperture, plasma density was (0.1–2)·10^{19} m^{-3}, the electron temperature is 2–10 eV with a fraction of hot electrons up to 50 eV, the ion flow from the plasma to the tested material samples is up to $1\cdot10^{23}$ m^{-2} s^{-1}, the power of the plasma-thermal load on the tested samples is 0.4–4.5 MW/m^2, the duration of the discharge – stationary for up to 500 minutes or more, the plasma-forming working gas is helium. A receiver chamber with a diameter/length of 100/200 cm is used to place cooled samples of the heat-shielding lining of a hybrid thermonuclear reactor in the plasma beam. The pumping system using oil-free vacuum pumps ensures that the pressure in the working chamber and receiver is up to $7\cdot10^{-7}$ Torr. Ionization of plasma-forming gas atoms in the PLM-M occurs as a result of an electron impact in the cathode node zone. An additional RF heating system using a helicon antenna in the PLM-M will be used to achieve a plasma electron density of up to 10^{20} m^3 and an electron temperature of 15 eV or more.

The system of optical diagnostics of near-surface plasma in PLM-M consists of an MS7504(i) monochromator spectrograph, an optical line with a collimator and an AvaSpec four-channel spectrometer with a fiber-optic cable for recording radiation in the spectral range of 200–1100 nm with a resolution of 0.013 nm. Simultaneously recorded wavelength range of 16.5 nm, spatial resolution of 0.01 cm. Spectra are recorded by a CCD camera with a frequency of up to 500 kHz.

The probe diagnostic system consists of movable Langmuir probes electrically immersed in plasma at a speed of up to 1 m/s.

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*) abstracts of this report in Russian