The PLM installation for plasma testing of heat-resistant materials

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The PLM (plasma linear multicusp) installation created at MPEI is a linear magnetic trap designed to create and long-term maintain a plasma with an electron temperature $T_e \approx 1$ to 5 eV with near 50 eV "hot" fraction and an electron concentration $n_e \sim 10^{17}$ to 10^{19} m^{-3} at a pressure in the installation chamber 10^{-3} to 10^{-1} Torr.
This report will present the testing results of fusion reactor first wall thermal protection element prototypes. Experiments [1] made it possible to obtain data on damage to the materials and on the parameters of near-surface plasma. During the experiments, it was found that stochastic highly porous nanostructures with characteristic size 20–50 nm and the layer thickness about 1.5 μm uniformly filling the entire plasma-facing surface of the test samples. The optimal surface temperature for the formation of such structures was determined, which was 600–800 °C at a plasma flow power density of 0.5–1 MW/m^2. The formation time of a highly porous layer is 2–4 hours, with further exposure to plasma, the thickness and structure of the layers does not change. At fluence of $\Phi = 8 \times 10^{27}$ m^{-2} with ion flux $\Gamma = 2 \times 10^{22}$ m^{-2}s^{-1} the thickness of nanostructure layer on tungsten sample reached 2 μm and did not grow further. The obtained fluence at PLM is close to the maximum achieved fluence at PISCES-B device [2].
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[1] Kavyrshin D I *et al* 2023 *Fusion Sci. Technol.* **79** 421–431
[2] Baldwin M J and Doerner R P 2008 *Nucl. Fusion* **48** 035001