INVESTIGATION OF THE INTERNAL SURFACES OF TUNGSTEN TILES OF THE RING TOKAMAK T-10 LIMITER [[1]](#footnote-1)\*)

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The use of materials in contact with plasma in new and promising thermonuclear devices (TND), such as ITER and DEMO, requires additional studies of their resistance under conditions of high thermal loads. The most highly-loaded elements of the TND are the limiter and divertor plates, which take on thermal loads in the range from 1 MW/m2 to ~1 GW/m2. High-temperature construction materials such as graphite and tungsten were used as the tokamak limiter material.
In recent years, limiters based on lithium capillary-porous structures (CPS) have been studied in many devices.

On the T-10 tokamak in 2015 instead of graphite, tungsten limiters were mounted. The limiters are made of tungsten grade VMP "Polema" used in the production of ITER divertor plates [1].
The paper presents the results of the analysis of tungsten plates of the T-10 tokamak limiter after
the experimental campaigns of 2015–2018.

Starting in spring 2016, a lithium CPS limiter was installed in the upper part of the vacuum chamber in the same toroidal section as the tungsten limiter. Its interaction with plasma during working discharges led to evaporation, and sometimes also to spraying drops of liquid lithium into the chamber. Such processes could lead to lithium entering both the front surface of the tiles and in the gap between them. Since the limiter temperature rises significantly during working pulses, the lithium droplets that entered the gap between the tiles did not freeze, but spread over the surface of the tungsten, forming a film. In the presence of air, such a film intensively reacts with oxygen to form lithium carbonate Li2CO3.

The installation of a lithium limiter in the T-10 tokamak chamber was supposed to demonstrate the possibility of using a lithium film to protect highly-loaded tungsten surfaces from damage. Since the inner shadow surfaces of the tiles do not experience such strong thermal and particles loads as front surfaces, they can be used to assess the effect of small and medium thermal loads on the protective properties of a lithium film. In addition, gaps can serve as a collector for collecting material eroded during working and cleaning discharges (dust, drops). Therefore, the analysis of the state of the internal surfaces of T-10 tokamak tiles can be used to predict damage to the tungsten limiter at moderate heat loads (up to 2 MW/m2) in the ITER tokamak under construction.

After the end of the 2018 campaign, the ring limiter was removed from the T-10 tokamak and the W plates were examined using scanning electron microscopy, energy dispersive analysis, X-ray phase analysis, thermal desorption spectroscopy, and microhardness measurements. A large amount of experimental data on tiles was collected, which were in a wide range of thermal and particle loads. This paper presents the results of a study of W plates with thermal loads not exceeding
25–30 MW/m2, limiting the plasma on the inner side. The main attention is paid to the internal surfaces in the gaps between the plates of the ring limiter.

References

1. S.A. Grashin, I.I. Arkhipov et al., Fusion Engineering and Design 146 (2019) 2100–2104.
1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/XLVII/E/ru/IS-Arkhipov.docx) [↑](#footnote-ref-1)