DOI: 10.34854/ICPAF.51.2024.1.1.204

TESTING OF HIGH-TEMPERATURE CERAMICS WITH PULSED HEAT LOAD, POSSIBLE IN THE DIVERTOR ZONE OF THE ITER TOKAMAK *)

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Fusion devices require research into new materials for the manufacture of plasma-facing components (PFC). The currently approved material composition, for example, of the ITER tokamak, has a number of disadvantages, including a high average atomic number, as well as insufficient resistance of the PFCs to pulsed heating. A promising, but largely untested idea is the proposal to use high-temperature ceramics for the manufacture of PFCs coating. Among the main advantages of ceramics are a low average charge number and a high enough operating temperature. The main disadvantages are brittleness and possible high tritium retention, especially in the case of carbon-based ceramics.

When choosing a material, it is necessary to understand the details of the erosion processes, in particular, during thermal shocks and during plasma confinement. To study the erosion of high-temperature ceramics during pulsed heating, a stand with in situ diagnostic systems was created on the basis of the BETA complex [1]. Thermal shocks were simulated using a pulsed IR laser, allowing the expected power density to be achieved during transient processes during plasma confinement on the surface of the samples. The stand was equipped with diagnostic systems to monitor the dynamics of erosion of the irradiated surface of the samples, its temperature, and the absorbed power density.

During the experimental work, a test was carried out of ceramics that are considered for use as a material for the manufacture of PFCs coating: B4C in the form of a monolithic sample and coatings deposited on tungsten, SiC, ZrB2, and ZrB2-SiC in proportions 70:30 and 80:20. Experimental results made it possible to characterize the behavior of ceramics during thermal shocks, determine acceptable heating parameters at which surface erosion with loss of substance does not occur. This allowed to draw a conclusion about the prospects of their use in fusion devices from the point of view of resistance to thermal shocks in case of transient processes occurring during plasma confinement.

The work on developing a system for laser heating of ceramics was partially supported by the RSF grant No. 23-19-00212.

References

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