CORROSION Behavior OF LOW ACTIVATED STEEL joined WITH TUNGSTEN CLADDING IN LIQUID LITHIUM [[1]](#footnote-1)\*)

DOI: 10.34854/ICPAF.2023.50.2023.1.1.226

Popov N., Bachurina D., Bogdanov R., Suchkov A.

National Research Nuclear University (MEPhI), Moscow, Russia, [NSPopov@mephi.ru](mailto:NSPopov@mephi.ru)

Development of fusion research facilities, as well as fusion reactors projects as ITER and DEMO, demand new advanced plasma-facing components (PFC). Conventional water cooling is not capable to absorb heat flow up to 20 MW/m2 at divertor target, therefore, use of liquid metals as a coolant is prospective [1-3]. The divertor consists of a tungsten target connected to a base material – steel. Currently, brazing is applied to bond tungsten with steel, using 48Ti-48Zr-4Be wt.% (TiZr4Be) filler metal and Ta interlayer to decrease residual thermal stresses.

Lithium has a high thermal conductivity and heat capacity, in addition, lithium is the keystone in the liquid metal wall concept. However, this metal is limited in compatibility with fusion-relevant materials due to the high rate of corrosion, especially for copper and bronze, which are used in cooling pipes [4]. The corrosion of most materials in liquid lithium has already been studied previously, however, the corrosion resistance of brazed joints remains unknown.

The corrosion resistance of W/EK-181 braze joints obtained by high-temperature brazing with TiZr4Be filler metal was investigated. Brazing was carried out using Ta interlayer to compensate the difference between the CTE of tungsten and steel. Corrosion tests were carried out by ampoule method in a Li melt at 600 °C for 100 hours. The obtained results show the presence of corrosion products – phases of the composition 80.9Fe-12.2O-4.6Ti-1.6Cr-0.4Zr-0.3Ta at.%, on the seam surface. There were no signs of dissolution of the brazed joint. Chromium carbides were found on the surface of the steel.

Transmission electron microscopy was used for a detailed study of corrosion products. Analysis of the microstructure of the compound showed that local dissolution of chromium-containing phases occurred in the steel, and an oxide film is located between the corrosion products and the seam. Corrosion products were deposited on the surface of the joint due to a decrease in the solubility of chromium in liquid lithium during cooling of the specimens.

Since there is no significant dissolution of the most vulnerable part – the tungsten compound with low-activated steel, the joint can be considered corrosion-resistant in static liquid lithium for 100 hours. Corrosion damage does not affect the brazed joint, the main type of damage to the joint is local corrosion of chromium-containing phases in steel EK-181.

References

1. Natesan K., Reed C.B., Mattas R.F. Assessment of alkali metal coolants for the ITER blanket // Fusion Engineering and Design. 1995. Vol. 27, № C. P. 457–466.
2. Nygren R.E., Tabarés F.L. Liquid surfaces for fusion plasma facing components—A critical review. Part I: Physics and PSI // Nuclear Materials and Energy. Elsevier Ltd, 2016. Vol. 9. P. 6–21.
3. Rindt P. et al. Conceptual design of a liquid-metal divertor for the European DEMO // Fusion Engineering and Design. Elsevier B.V., 2021. Vol. 173, № April. P. 112812.
4. Meng X.C. et al. Corrosion characteristics of copper in static liquid lithium under high vacuum // Journal of Nuclear Materials. 2019. Vol. 513. P. 282–292.

1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/L/E/ru/IU-Popov.docx) [↑](#footnote-ref-1)