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Investigation of the long-term exposure of a high power proton beam on the Ta-substrate of a neutron-generating target

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At BINP an accelerator neutron source was developed to implement the concept of in hospital BNCT based on $^{7}Li(p,n)^{7}Be$ reaction [1]. Neutron flux parameters achieved are sufficient to initiate clinical trials. This paper is devoted to an important and previously unexplored problem – the lifetime of a lithium neutron producing target under conditions of daily operation at a high power proton beam. The conducted experiments showed [2] that one of the promising options for realizing a thin, long-living and blistering-free lithium target is the multilayer Li-Ta-Cu-Water structure with layer thicknesses of 100 μm - 100 μm - 3 mm - 3 mm respectively. In this paper endurance tests of such a Ta-Cu-Water structure (specially prepared by OIST team) without lithium under a proton beam with 2 MeV energy and 1 kW/cm^2 power density were carried out. Multilayer structure was irradiated during 11 days by protons with an average current of 0.5 mA to a total fluence of 22.8 mA·h. As a result, the surface of the tantalum layer was visibly modified: the polished tantalum became matted. We assume that this phenomenon is associated with the formation of tantalum hydrides, since the average H:Ta mole ratio in the 100 μm thick tantalum layer could reach 1:1. It was also found that during the tests, the average surface temperature of the tantalum layer was continuously increasing from an initial 165 °C to more than 200 °C, which can also be explained by reduced thermal conductivity of the tantalum hydrides formed. The obtained result is important for the lifetime of the target, since the temperature of the target should not exceed 180 °C in order to avoid melting of the lithium layer on its surface. The work describes the experimental setup, presents and discusses the results of the tests and proposes a plan for further research on the development of a neutron producing target with a long service life.

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