AB001. Study of impurity accumulation in a lithium neutron-generating target

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Background: The prevalence of cancer is steadily increasing. Boron neutron capture therapy (BNCT) is considered one of the promising approaches in the treatment of malignant tumors. An accelerator-based epithermal neutron source for the development of BNCT, a promising method for the treatment of malignant tumors, is proposed, created, and is functioning at the Budker Institute of Nuclear Physics. The neutron source consists of a tandem accelerator of charged particles of an original design, a lithium neutron-generating target for generating neutrons as a result of the ^{7}Li(p,n)^{7}Be reaction, and a beam shaping assembly for forming a therapeutic beam of epithermal neutrons. The purity of the lithium layer affects the yield of neutrons from the target, which makes it important to determine the elemental composition of the target. The urgent task is to study and confirm the generating properties of the lithium target for planning and conducting therapy.

Methods: Lithium is known to actively interact with air. The compounds formed during this interaction reduce the neutron yield from the lithium neutron-generating target. In this work, the accumulation of impurities in a lithium target as a function of exposure to air and the proton fluence on the target was investigated by energy analysis of backscattered protons. The spectrum of backscattered protons was measured with a semiconductor silicon detector (Si charged particle radiation detectors for alpha spectroscopy).

Results: Lithium is sputtered pure, with negligible amounts of carbon and lithium oxide on the surface. Lithium oxide and carbon accumulate on the target surface during prolonged irradiation, but it has little effect on neutron yield. Lithium oxide and carbon are expected to prevent evaporation of lithium from the target surface and protect the lithium from nitrogen penetration. Above the critical power density, copper diffuses into the lithium, reducing the neutron yield.

Conclusions: The results obtained are extremely important for the prolonged generation of a stable neutron flux for BNCT and other applications.

Keywords: Boron neutron capture therapy (BNCT); lithium target; neutron source

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki and its subsequent amendments. Ethical approval was not required for this study because it did not involve human or animal participants, nor did it entail the use of personal data.

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