Measurement of cross sections for nuclear reactions of interaction of protons and deuterons with lithium at ion energies 0.4 – 2.2 MeV

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An accelerator based epithermal neutron source for the development of boron neutron capture therapy (BNCT), a promising method for the treatment of malignant tumors, and other various applications 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 or ^{7}Li(d,n) reaction, and a beam shaping assembly for forming a therapeutic beam of epithermal neutrons. The facility is capable of producing α-particles through different reactions.

Knowledge of the cross sections of the reactions Li(p,), Li(d,) is important both for nuclear data evaluation, as well as within the framework of BNCT and other applications. In this work, the cross sections of the following nuclear reactions were determined with good accuracy for proton/deuteron energies E = 0.4 – 2.2 MeV: ^{7}Li(d,nα)^{4}He, ^{7}Li(d,α)^{5}He → α + n, ^{6}Li(d,α)^{4}He, ^{6}Li(d,p)^{7}Li, ^{6}Li(d,p)^{7}Li*, ^{7}Li(p,α)^{4}He. The measurements were made using a silicon-based semiconductor α-spectrometer by ion scattering spectroscopy. The energy distribution of alpha particles from a thick layer of boron carbide when irradiated with a proton beam with energies from 0.6 to 2.1 MeV was measured. The results show that it is possible to measure the cross sections of the nuclear reactions ^{11}B(p,α)^{8}Be and ^{11}B(p,α)αα using the thin boron layer. For the deposition of a thin layer of boron on a metal substrate it is proposed to carry out a magnetron sputtering method with preheating of the thermally insulated target by a low-current high-voltage discharge. Measurement of the reaction cross section is important for both boron-proton-capture therapy and for neutron-free thermonuclear energy on the ^{11}B(p,α)αα reaction.

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