Accelerator-based BNCT system in Nagoya University (1) - Project status -

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A low energy proton reaction using lithium is one of the most suitable reactions for the accelerator-based BNCT, because a sufficient flux and good quality of epi-thermal neutron beam can be obtained by using a compact beam shaping assembly (BSA) and low activation of accelerator facility reduces the radiation exposur for medical staffs. However, metalic lithium has several

difficulties in chemical properties (low melting point, high chemical activity and 7Be production) as a target material. For resolving those isssues, we have developed a compact and sealed Li target in combination with a DC accelerator. We have constructed a compact accelerator-driven neutron source to confirm the practical reliability and performance of the sealed lithium target for the BNCT application in the Nagoya University.

Metalic lithium on the target base plate is covered by a titanium foil. Low-energy and high current proton beam (2.8MeV, 15mA) is passing through the titanium foil and irradiates the lithium (Beam power density < 7MW/m2). Strong turbulent flow is arose with ribs in cooling water channels of the target and have been confirmed to be able to remove high beam flux. Neutrons with the energies of less than 1MeV are produced by the 7Li(p,n)7Be reaction under the irradation of the 2.8MeV proton beam. The fast neutrons were moderated by a compact beam shaping assembly (BSA) with a nozzle to meet the specifications indicated in the IAEA-TECDOC-1223. The sealed lithium target was strongly activated due to proton beam irradiation and should be changed by using a remote target exchange system.

We had installed a compact BSA (1.7m in dia.) with the selaed lithium target in the facility and started to generate epi-thermal neutrons from the December in 2018. We are controlling beam profile on the target by using a newly developed profile monitoring system and measuring the target temperature profile with a multi-thermocouple system to keep the target temperature less than the melting point. To monitor the accidental leakage of Li vapor from the target to the beam line, a fast quadrupole mass spectrometer was set on the target beam line. We measured the neutron distributions in a water phantom to evaluate the neutron beam quality by scanning an optical fibre-based neutron detector (LiF/Eu:CaF2). We had successfully performed “In vitro” cell tests to evaluate the performance of the NAGOYA-UNIVERSITY-BNCT system.