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Optimization of Activation Detector for Benchmark Experiment of Large-angle Elastic Scattering Reaction Cross Section by 14MeV Neutrons

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<span> The elastic scattering reaction cross section data commonly show smaller in backward angles compared to those of forward angles when the energy of the incident neutron is high. However, in high neutron flux field, such as fusion reactor, the back-scattering reaction cross section is becoming not negligible on the calculation result. Until now, there were differences reported between experimental and calculated values of neutron benchmark experiments using a DT neutron source, which focused on back-scattering phenomena like a gap streaming experiment. For this problem, the author's group developed a benchmark method for large-angle scattering cross sections and has carried out experiments with an iron sample for the last few years. The benchmark method was successfully established based on the activation of Nb foil having a large activation cross section at around 14 MeV.

<span> We are now planning to carry out benchmark experiments for other fusion structural materials such as tungsten, lead, F82H and so on. And in the next step, we aim to consider benchmark experiments for lighter materials like Li, Be, B, C, N and O. In this case, the energy of neutrons generated by backscattering is low. Especially for Li, being one of the most important materials in fusion reactor, back-scattering neutrons cannot be captured by Nb foil due to the high threshold energy of ⁹³Nb(n,2n) reaction.

<span> In this study, to solve this problem, we examined possible nuclides having a low activation reaction threshold energy, so that it can react with low energy neutrons generated by the backscattering of Li, and simultaneously having not too low threshold energy, so that the influence of room-return neutrons can be eliminated properly. The optimization was achieved by calculating and comparing the number of counts for all the possible reactions of all the existing stable nuclides considering appropriate irradiation and measuring times. The activation reaction cross section data were taken from JENDL/AD-2017.

<span> As a result, we have found that ¹⁸¹Ta(n,2n) was the most suitable reaction giving us the largest number of counts in an acceptable short experimental time. Then experiments were carried out to confirm whether ¹⁸¹Ta(n,2n)<sup> cross section was consistent with the nuclear data.

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