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A New Method to Reduce Systematic Uncertainties of Capture Cross Section Measurement Using a Sample Rotation System/試料回転法を用いた中性子捕獲断面積の高精度化のための新たな手法

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Precise nuclear data for neutron-induced reactions are necessary for the design of nuclear transmutation system. Nevertheless, current uncertainties of nuclear data for minor actinide (MA) does not achieve requirements for the design of transmutation facilities. Measurements of the neutron capture cross section are ongoing at the Accurate Neutron Nucleus Reaction measurement Instrument (ANNRI) in the Materials and Life science experiment Facility (MLF) of the Japan Proton Accelerator Research Complex (J-PARC). The determination of an incident neutron flux for measurements of neutron capture cross section is one of the main causes that affect the final uncertainty of the cross section results.

In the present work, we suggest a new method to reduce systematic uncertainties of capture cross section measurements. The method employs change of the self-shielding effect with sample rotation angle. In the new technique, a sample area density of a boron sample which is used for measurements of the incident neutron spectrum. In capture cross section measurements in ANNRI, a boron sample is placed to determine the incident neutron spectrum by counting 478 keV γ-ray from the ^{10}B(n,$\alpha\gamma$)^{7}Li reaction. The uncertainty of the boron sample area density that is usually calculated from the mass and the area introduces the uncertainty of the incident neutron spectrum. In this method, the boron sample is tilted with respect to the neutron beam direction, thereby changing the effective area. The neutron self-shielding effect increases with the effective area density. This results in change of the shapes of time-of-flight(TOF) spectrum of 478 keV γ-ray counts form the ^{10}B(n,$\alpha\gamma$)^{7}Li reaction with the tilted angle. Comparing the difference of the TOF spectra at different angles and assuming the 1/v energy dependence of cross section of the ^{10}B(n,$\alpha\gamma$)^{7}Li reaction, the area density of the boron sample can be determined without using the sample mass and area.

Theoretical and experimental studies on the new method are ongoing. Calculation using Monte Carlo simulation code PHITS were carried out to study the feasibility of the present method. Test experiments using a sample rotation system at ANNRI were also performed. Preliminary results will be given in this poster session.

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