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Activation Foil Selection for High-Precision Benchmark Experiments on Large-Angle Elastic Scattering of Lithium by 14 MeV Neutrons/14 MeV 中性子によるリチウム大角度弾性散乱ベンチマーク実験の高精度化に向けた放射化箔の選定

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In fusion reactors, large angle neutron scattering reactions significantly affect neutronics calculations, particularly for the reactor blanket. Previous integral experiments for large angle scattering cross section data at JAEA/FNS revealed discrepancies between experimental and calculated values [1]. Therefore, benchmarking studies on large angle scattering cross sections were indispensable. The authors'group has developed a benchmark experimental system using two shadow bars composed of conical irons to validate large angle scattering cross sections [2].
In a previous study, a benchmark experiment for lithium was performed using hafnium as the activation foil. However, the statistical error was considerable due to neutrons scattered from walls and surrounding materials.
In this study, new candidate activation foils were examined to reduce statistical error by considering reaction cross section, threshold energy, half-life, and γ-ray intensity based on the data from JENDL-5. Subsequently, the activation reaction rate for each candidate foil was calculated using the neutron flux obtained from MCNP5 simulations and the activation cross sections. The expected γ-ray count detected by a Ge detector was also estimated, and the corresponding statistical error was evaluated. As a result, magnesium showed the lowest statistical error through the ^{24}Mg(n, p)^{24}Na reaction. However, the result was still insufficient for achieving a high-precision benchmark experiment. To further reduce the statistical error, additional activation foils with lower threshold energies were considered, and recalculations were performed. It was found that using an indium foil with the ^{115}In(n, n')^{115m}In reaction could further reduce the statistical error. However, in this case, background neutrons with energies above approximately 1 MeV also activated the indium foil, making it difficult to deduce only the large angle scattered neutrons.
In the future, further improvements will be required to suppress the contribution of the background neutrons when using indium foils. In addition, we plan to develop an experimental system that minimizes statistical errors by optimizing the materials and configurations of the surrounding components of the experimental assembly, and carry out benchmark experiments on the large angle scattering cross section of lithium.

References

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