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Cross section measurement of residues produced in proton- and deuteron-induced spallation reactions on ^{79}Se at 200 MeV/u using the inverse kinematics method

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The long-lived fission products (LLFPs) produced in nuclear reactors have been an important issue because of the difficulty of disposal due to their long lifetimes. Therefore, some treatment methods to transform the LLFPs into short-lived or low-toxic materials are desired, and nuclear transmutation technology is expected to be one of the solutions. However, the reaction data of LLFPs required to design optimal pathways of the transmutation process are scarce so far. One of the reasons is considerable difficulty in manufacturing and handling LLFP targets, which are necessary for the conventional measurement in normal kinematics such as the activation method.

In this study, we employed the inverse-kinematics method. By this method, the nuclide to be measured is delivered as a beam, so there is no need to handle the radioactive targets. In addition, this method has a crucial advantage in which one can measure the production yield over a wide range of isotopes regardless of their lifetimes, including stable isotopes.

We carried out an experiment to measure isotopic production cross section on ^{79}Se, an LLFP nuclide with a half-life of 3.27×10^5 years, through the proton- and deuteron-induced spallation reactions at RIKEN RI Beam Factory (RIBF). A beam including ^{79}Se at 200 MeV/u was produced by in-flight fission of a ^{238}U beam at 345 MeV/u and separated and identified using the BigRIPS in-flight separator. Then the beam bombarded liquid H_2 and D_2 targets. The fragments produced through the spallation reaction were identified event-by-event by using the SAMURAI spectrometer. The obtained cross sections corresponding for proton and deuteron injection were compared with the theoretical calculations with the CCONE code based on the exciton and Hauser-Feshbach models and the PHITS code based on the intra-nuclear cascade and statistical decay models. The detail of the experiment and the result of the analysis will be discussed.
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