Cross-section measurement of neutron-rich Pd isotopes produced from an RI beam of ^{132}Sn at 280 MeV/nucleon

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We performed an experiment to measure the production cross sections of $^{125-128}$Pdfrom a radioactive-isotope (RI) beam of ^{132}Sn by using the BigRIPS separator and the ZeroDegree spectrometer at the RIKEN RI Beam Factory (RIBF) in November 2017.

In-flight fission of ^{238}U beam is a useful method for the production of mid-heavy neutron-rich isotopes. At RIBF, approximately 120 new isotopes have been produced from the ^{238}U beam, and various nuclei, such as a double-magic nuclide, ^{132}Sn, are supplied for many experiments. However, the production cross sections decrease drastically for more exotic nuclei. Thus, the nuclei in a very neutron-rich region, such as the ones involved with the rapid process in nucleosynthesis, are difficult to be produced by the in-flight fission of ^{238}U.

Another method of RI-beam production is an ISOL technique, by which greater yields of RIs are produced in the target by a proton beam even at the same beam power as the ^{238}U beam for in-flight fission. However, the extraction efficiency is not good, especially for exotic nuclei with short half-lives.

To solve these problems, a two-step reaction scheme[1)] was proposed for the efficient production of very neutron-rich nuclei. First, a long-lived RI such as ^{132}Sn, which has a half-life of 40 s, is produced by an ISOL and reaccelerated by post-accelerators. Then, objective exotic nuclei, such as $^{125-128}$Pd,are produced by fragmentation by impinging on a secondary target. By using this scheme, one may obtain greater yields of neutron-rich nuclei than those obtained by direct production through the in-flight fission of the ^{238}U beam.

Production cross sections up to ^{125}Pd were already measured at GSI;[2)] thus, we measured those of more neutron-rich Pd isotopes. A ^{132}Sn beam was produced from a 40-pnA 345-MeV/nucleon $^{238}U^{86+}$ beam impinging on a 4-mm-thick Be target. Its energy was 280 MeV/nucleon, the intensity was 30 kHz, and the purity was 50%. The neutron-rich Pd isotopes were produced at a 6-mm-thick Be target at F8. The particle identification (PID) of the isotopes was performed by deducing the atomic number, Z, and mass-to-charge ratio, A/Q, of the fragments based on the TOF-$B\rho$-ΔE method in the ZeroDegree spectrometer, which is essentially the same method as the one in BigRIPS.[3)] $LaBr_3$ crystal was installed at F11 for measuring the total kinetic energy. Two ZeroDegree settings—the ^{126}Pd setting and the ^{128}Pd setting—were applied for measuring the cross sections of ^{125,126}Pd and ^{127,128}Pd, respectively.

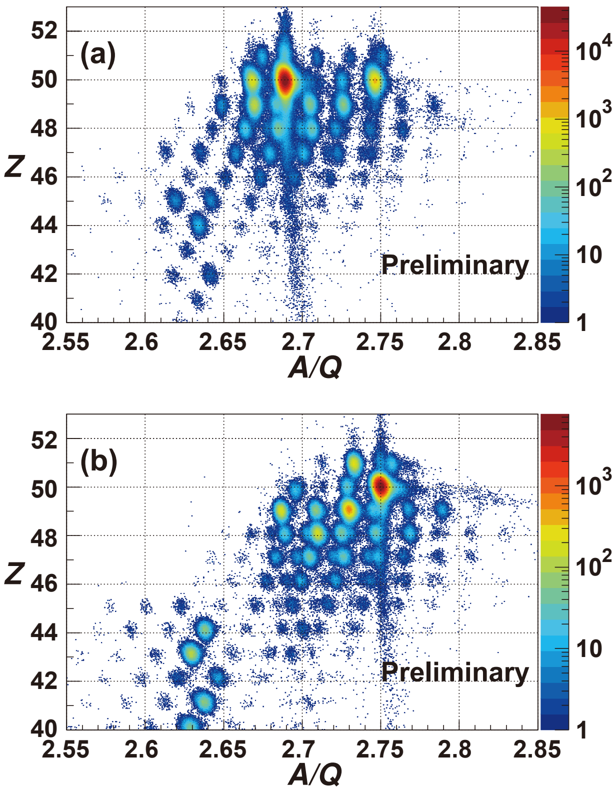

Fig. 1. The Z versus A/Q PID plots in the ZeroDegree spectrometer. (a) The ^{126}Pd setting. (b) The ^{128}Pd setting.

The Z vs A/Q PID plots for the nuclei produced from the ^{132}Sn beam are shown in Fig. 1. Many isotopes including $^{125-128}$Pd are observed. Further analyses, such as the improvement of the A/Q resolution and the removal of background events, are in progress.

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