Cross-section measurement of neutron-rich isotopes produced from an RI beam of ^{132}Sn using a two-step scheme

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The production cross sections of neutron-rich radioactive isotopes (RI), including $^{125-128}$Pd produced from a less-exotic RI beam of ^{132}Sn, were measured using BigRIPS and ZeroDegree at the RIKEN RI Beam Factory (RIBF) in November 2017.

A two-step reaction scheme was proposed[1] for the efficient production of mid-heavy very-neutron-rich RIs. In this scheme, a long-lived neutron-rich RI such as ^{132}Sn, whose half-life is 40 s, is produced by an ISOL in the first step, and accelerated by post-accelerators. In the second step, more exotic nuclei, such as $^{125-128}$Pd, are produced by a fragmentation reaction. With this scheme, one may obtain greater yields of very neutron-rich RIs than those obtained by direct production through the in-flight fission of a ^{238}U beam, which is currently a very popular method to produce them. To evaluate the yields of RIs by the two-step scheme with a ^{132}Sn beam, we measured the production cross sections of neutron-rich Pd isotopes beyond ^{125}Pd, up to which the cross sections had already been measured at GSI together with the neighboring RIs.[2]

In the experiment, the ^{132}Sn beam was produced at BigRIPS by the in-flight fission of a 40-pnA 345-MeV/nucleon ^{238}U^{86+} beam impinging on a 4-mm-thick Be target. The ^{132}Sn-beam energy was 278 MeV/nucleon, the intensity was 35 kHz, and the purity was 50%. The neutron-rich Pd isotopes were produced by the fragmentation with a 6-mm-thick Be target at the entrance of ZeroDegree. The particle identification (PID) was performed by deducing the atomic number Z, the mass-to-charge ratio A/Q, and the mass number A of the RIs based on the TOF-$B\rho$-ΔE-TKE method in ZeroDegree. Two 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.

The Z vs A/Q PID plot of the ^{128}Pd setting is shown in Fig. 1. Many fully-stripped isotopes are observed with the partially-stripped ones. ^{127,128}Pd^{46+} are well identified in the plot. The events in the two blobs on the right side of ^{128}Pd^{46+} are the H-like ions of ^{126,127}Pd^{45+}. From the yields of RIs, their transmission in ZeroDegree, and the beam dose of ^{132}Sn, the production cross sections were deduced. In Fig. 2, the cross sections obtained in this experiment at RIBF and the ones at GSI[2] are shown with the cross-section formulae COFRA1.0[3] and EPAX3.1a.[4] Both formulae reproduce the experimental cross sections fairly well. Further detailed analyses are in progress.

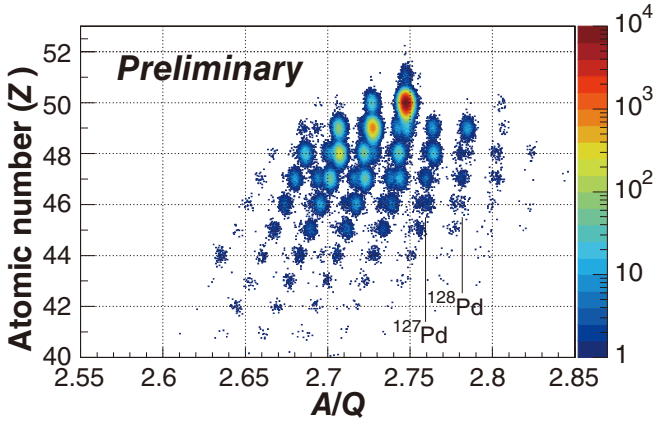

Fig. 1. The Z versus A/Q PID plot of ^{128}Pd setting in ZeroDegree. Partially-stripped contaminants are included in the plot with the fully-stripped ^{127,128}Pd.

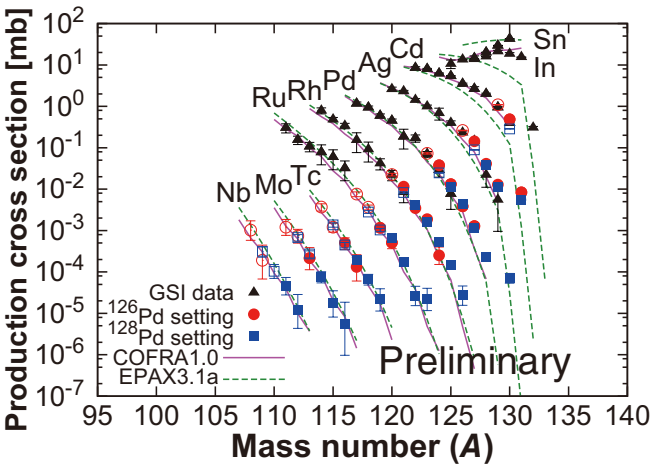

Fig. 2. The experimental cross sections of neutron-rich RIs produced from ^{132}Sn beams at RIBF and GSI[2] with cross-section formulae COFRA1.0[3] and EPAX3.1a.[4]

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