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 proposed1) 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-$Bp$-$

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 GSI2) with cross-section formulae COFRA1.03) and EPAX3.1a.4) Both formulae reproduce the experimental cross sections fairly well. Further detailed analyses are in progress.

References