Production cross-section measurement for radioactive isotopes produced from ^{124}Xe beam at 345 MeV/nucleon by BigRIPS separator

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We have measured the production yields and the production cross-sections for a variety of proton-rich radioactive isotopes (RIs) produced from a 345-MeV/nucleon ^{124}Xe beam using the BigRIPS separator.[1] The RI beams were produced by projectile fragmentation of the ^{124}Xe beam on a 4-mm Be target. Two BigRIPS settings were conducted in this work.

One was the ^{91}Rh setting, in which the $B\rho$ setting is optimized for ^{91}Rh, for producing RIs with atomic numbers $Z = 41{-}48$, and the other was the ^{80}Y setting for $Z = 35{-}42$. The particle identification of the RIs was based on the TOF-$B\rho$-ΔE method in the second stage of the BigRIPS.[2]

The production cross-sections were deduced from the measured production rates and the transmission efficiency in the separator, which was simulated with the calculation code LISE^{++}.[3] In the simulation, exponential tails of the momentum distribution of the RIs in the low-momentum regions fell off slower than the momentum distribution observed in the experiment; therefore, we adjusted the parameter "coef", which controls the slope of the distribution tail. In the ^{91}Rh setting, "coef" was set to 1.9, which was obtained from the momentum distribution of ^{99}Rh in our first ^{124}Xe-beam experiment.[4] In the ^{80}Y setting, "coef" = 2.4 reproduced the distribution of RIs fairly well. The parameter "coef" may depend on the region of the RI beams. The parameters for the angular distribution were not changed from the original values in the code.

The measured production cross-sections of the RIs are shown in Fig. 1. In these figures, the solid and dashed lines show the cross sections predicted from the empirical formulas EPAX3.1a[5] and EPAX2.15,[6] respectively. EPAX3.1a reproduces the measured cross sections with a wide range of Z better than EPAX2.15; however, some isotopes show systematic discrepancies around the very proton-rich region and the high-Z region. These discrepancies are also observed in the proton-rich RIs produced from the 345-MeV/nucleon ^{78}Kr beam.[8]
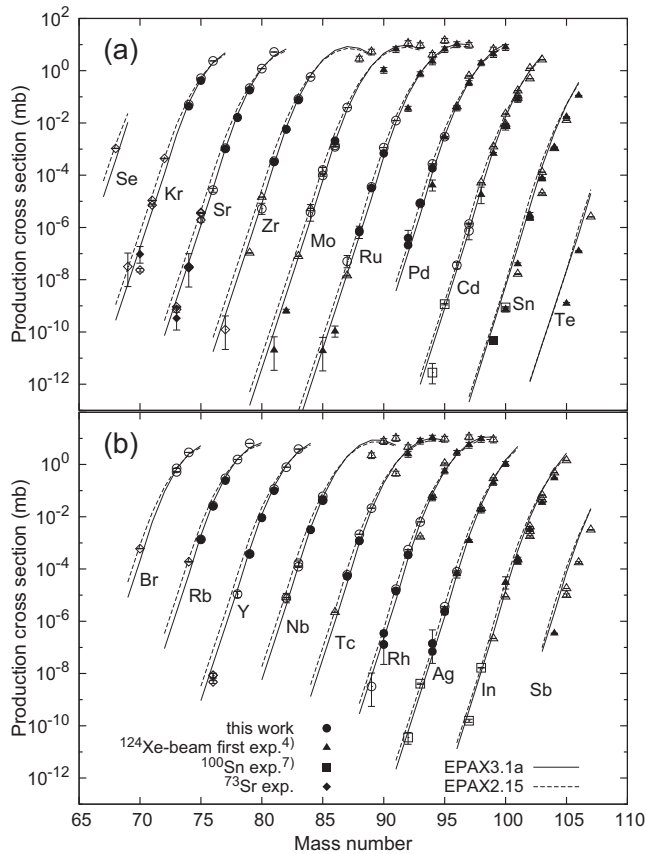

Fig. 1. Production cross-sections of RIs produced in the ^{124}Xe + Be reaction at 345 MeV/nucleon with predictions of EPAX parametrizations. (a) Results for even-Z isotopes. (b) Results for odd-Z isotopes. The filled and open symbols indicate that the distribution peaks of RIs were located inside the slit opening at each focus and outside at some foci, respectively. Solid and dashed lines show the values predicted using EPAX3.1a[5] and EPAX2.15[6] formulas, respectively.

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