Decay measurement of ^{283}Cn produced in the ^{238}U(^{48}Ca,3n) reaction using GARIS-II†

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A new gas-filled recoil ion separator GARIS-II[1] will be utilized for new superheavy element (SHE) search, precise mass measurement of SHE nuclide, and SHE chemistry and spectroscopy. In this work, the production and decay properties of ^{283}Cn were investigated as the first step towards the identification of SHE beyond $Z = 118$.

The 251.8 MeV $^{48}Ca^{11+}$ beam was provided by the RIKEN heavy-ion linear accelerator (RILAC). The $^{238}U_3O_8$ targets were prepared on 3-μm Ti backing foils using an electro-deposition technique. On an average, the thickness of the ^{238}U targets was 312 μg/cm^2 as $^{238}U_3O_8$. The sixteen sector-targets with 15-mm width were mounted on a rotating wheel of 300-mm diameter. The target was irradiated by a beam with an average intensity of 0.93 particle μA. The wheel was rotated at 2000 rpm during irradiation. The total beam dose was accumulated to 2.2×10^{18} during the net irradiation time of 4.5 days. The evaporation residues of interest were separated in-flight from the primary beam and other reaction products using GARIS-II. The inside of the separator's chamber was filled with pure helium at a gas pressure of 70 Pa. The magnetic rigidity for measuring ^{283}Cn was set to 2.23 Tm. The focal plane detector (FPD) of GARIS-II consists of double sided Si detectors (DSSD). The DSSD is surrounded by six side Si-detectors (SSDs), which form the DSSD box.

The decay events originating from the products in the reaction ^{48}Ca + ^{238}U were searched using the position correlations between mother and daughter nuclei at the same pixel within 100 s. As a result, two decay chains were found, as shown in Fig. 1. The first chain was an ER-SF, which consisting of 172 MeV (= 167 + 5) two-fold fission, and it was found 14.4 s after the implantation of ER with 12.2 MeV into DSSD. On the other hand, the decay pattern of ER-α-SF in the second chain was different from that of the first one. The 9.45(5) MeV α-decay was observed 5.4 s after the implantation of ER with 11.8 MeV into DSSD. Finally, 154 ms after the α-decay, a two-fold fission event with 179 MeV (= 137 + 42) was detected at the same pixel. During the net irradiation time of 4.5 days, we observed no other coincidence events between the signals from DSSD and SSD, indicating that our setup has a high sensitivity to SF events. The observed decay energy and time distributions for each generation in the correlated chains indicates good agreement with the reported data on ^{283}Cn and ^{287}Fl, which were studied using recoil separator DGFRS,[2,6] SHIP,[4] and BGS.[5]

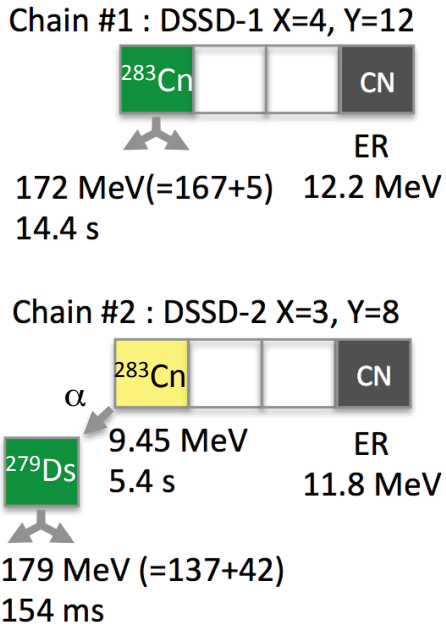

Fig. 1. The two observed decay chains produced in the reaction ^{48}Ca + ^{238}U → ^{286}Cn* at a beam energy of 251.8 MeV. The DSSD-ID number, pixel number in the horizontal (X) and vertical (Y) directions, and kinetic energy of ER are given, as well as the decay energy and time for each α-decay and/or SF.

The cross-section of $\sigma_{3n} = 2.0^{+2.7}_{-1.3}$ pb obtained in this work was consistent with the reported values of $\sigma_{3n} = 2.5^{+1.8}_{-1.1}$ and $0.72^{+0.58}_{-0.35}$ pb from both DGFRS[3] and SHIP,[4] respectively.

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