Search for the "missing" α-decay branch in ^{239}Cm

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It is of special interest to search for those unknown α-emitters in the transuranium region which (i) are located along the path of α-decay chains that start in the superheavy element region, and (ii) establish a link to nuclides with known masses. The knowledge of all Q_α values in an α-decay chain provides direct information on strongly desired mass values of SHE [1]. A search for the α-decay of ^{239}Cm was carried out at JAERI applying nuclear chemistry techniques [2]. Three α-events with an energy of 6.43±0.14 MeV were assigned to ^{239}Cm and the α/EC branching ratio was estimated as $(6.2 \pm 1.4)\times10^{-5}$. However, due to this poor statistics, not only the α-energy was determined with an insufficient precision but also the isotope assignment remained questionable.

In our experiment, curium isotopes were produced in the reaction ^{232}Th(^{12}C,xn)$^{244-x}$Cm. Banana-shaped ^{232}Th targets were prepared by molecular plating at the University of Mainz. As a backing material, 5 μm thick Ti and 15 μm thick Be foils were used. Th target thicknesses were ≈ 700 μg/cm^2 on Ti and ≈ 900 μg/cm^2 on Be. $^{12}C^{2+}$ beams from the UNILAC were chosen such that after passing through a 20 μm Be vacuum window, He cooling gas of 200 mbar, and the backing material, the ^{12}C projectile energy was 74 MeV in the middle of the target. According to HIVAP calculations, this energy corresponds to the maximum of the excitation function for the reaction ^{232}Th(^{12}C,5n)^{239}Cm. Irradiations were performed with the rotating target wheel ARTESIA. Reaction products recoiling out of the target were implanted into 3.9 μm Cu catcher foils mounted 4 mm behind the rotating target wheel. Most fission fragments passed through the catcher because of their high TKE. To avoid overheating of the target and catcher material by the intensive ion beam, irradiations were carried out in a He atmosphere at 200 mbar. Each irradiation lasted ≈6 to 8 hours, and typical (particle) beam intensities varied between 0.3 μA during daytime and 0.85 μA at night. After irradiation, the copper catcher wheel was dismounted and was transported to a chemistry laboratory. The radiochemical separation procedure to prepare a purified Cm sample for α-spectroscopy was finished within 1.5 h or less. This procedure is described in a separate contribution to this report [3].

Two separate runs were carried out at the beginning and end of November. During the first run, targets with Th on Ti were used. They failed because of massive losses of target material from the Ti backing during the irradiation. Furthermore, ^{48,49,51}Cr, $^{43,44,46-48}$Sc, and ^{55,56}Co were produced from ^{12}C on Ti reactions with very high β- and γ-activities masking complementary γ-spectroscopic measurements. During the second run, targets with Th on Be foil were used which did not show significant Th losses. β and γ activities were about ten times lower than in the first run, and the nuclides mentioned above were not present.

In attempts to identify ^{239}Cm by γ-spectroscopic measurements, some samples were measured with a γ-x-detector and with a Ge-clover detector. γ-ray spectra dominantly showed lines from the decay of ^{153}Sm, ^{150,151}Pm and ^{147}Nd originating from fission of the compound nucleus. Cross sections for these isotopes are about 5 mb [4]. These activities from chemically not separated homologous rare earth elements did not allow identifying ^{239}Cm in the (single) γ-spectra or any Cm by characteristic x-rays. A further evaluation of coincidences is under way.

Samples were assayed for α-activities by 450 mm^2 PIPS detectors. The energy resolution of the evaporated samples was 60 keV. The α-events together with detector numbers and associated times were recorded and stored in list mode. Fig. 1 shows, for the first 10 h measuring time, the sum spectrum of five samples. As expected, ^{240}Cm (4n-channel, ≈100% α-decay) with α-energies of 6.29 and 6.24 MeV is dominant. Interestingly, there are some events around 6.5 MeV, close to the energy of ^{238}Cm (6n-channel). Data analysis and search for ^{239}Cm with a reported energy of 6.43 MeV [2] are in progress.

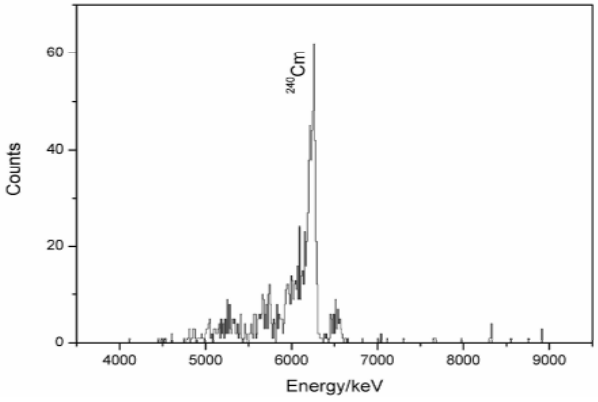

Fig.1 Sum α-spectrum of five samples (t_m =10 h each).

[1]G. Münzenberg. FRS Berichte, GSI (1995) (unpublished)

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