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Synthesis and Gamma Decay of New Heavy Neutron-Rich Isotope ^{175}Er

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A new isotope ^{175}Er was synthesized for the first time by the ^{176}Yb(n,2p)^{175}Er reaction in irradiation of natural metal ytterbium targets with 14 MeV neutrons. The activities of ^{175}Er were observed by γ(X) ray spectroscopy. Eight new γ rays of 76.5, 120.9, 123.7, 128.5, 227.3, 234.0, 281.4, and 1167.5 keV with half-life of 1.2 ± 0.3 min were found and assigned to the β decay of ^{175}Er. A partial decay scheme of ^{175}Er was proposed.

Key words: Synthesis of new nuclide, γ decay, half-life, decay scheme.

The fast neutron-induced fusion-evaporation reactions or direct processes at heavy target nuclei is considered as one of the most effective ways to produce nuclei far from stability in the region of heavy mass neutron-rich isotopes. In our previous studies [1,2], two new nuclides ^{185}Hf and ^{237}Th have been synthesized by the (n,2p) reaction using fast neutron bombardment of ^{186}W and ^{238}U, respectively. Recently, we have again performed for the first time the identification of a new isotope ^{175}Er via the ^{176}Yb(n,2p)^{175}Er reaction induced by 14 MeV neutron bombardment of natural Yb targets and measured γ-rays from its decay.

The experimental irradiations were performed at the 600 kV Cockcroft-Walton accelerator in our institute using 14 MeV neutrons. The natural metal Yb foils of about 80 mg/cm^2 were irradiated for 3 min. After the irradiation, the irradiated target samples were transported quickly into a well-shielded lead room by a rabbit system and the measurements started immediately. A HPGe planar detector and two HPGe detectors were used for measurements of X-γ-t, γ-γ-t coincidence spectra and γ single

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Table 1
Gamma-ray energies, intensities, and coincidences in the decay of ^{175}Er.

Energy[a] (keV)	I_γ[b] (%)	γ rays in coincidence[c] (keV)
X		120.9,234.0,1167.5
76.5		(120.9),(1167.5)
120.9	≈97	X,(76.5),234.0,(281.4),1167.5
123.7		234.0,281.4,1167.5
128.5		(227.3),281.4
227.3	≈32	(128.5),281.4
234.0	100	X,120.9,123.7,281.4
281.4	≈50	120.9,(123.7),128.5,(227.3),234.0
1167.5	≈150	X,76.5,120.9,(123.7)

(1) The uncertainty in γ ray energies is ±0.6 keV.
(2) Intensity of 234.0 keV γ ray is normalized to 100. Data from our coincidence measurements.
(3) X = TmK X rays. ( ) denotes a weak coincidence.

spectrum on the samples, respectively. The measurements lasted 5 min. The data were recorded on magnetic disks. The irradiation and data accumulation were repeated hundreds times.

In the X-γ-*t* experiments, we observed two new γ-rays of 234.0 and 1167.5 keV in coincidence with clear Tm K_{α_2} X-ray. Based on the two new γ-rays, the other 6 new γ-rays have been found through the γ-γ coincidence relations in the γ-γ-*t* experiments (Table 1). The 8 new γ-rays have the same half-life (1.2±0.3 min). Therefore, they belong to the decay of the same isotope. Such a nuclide could only be one of the isotopes of Yb or Er. According to the energies and half-life of the γ-rays, it does not belong to any of the known Yb or Er isotopes. Moreover, the unknown isotope produced by irradiation of natural Yb targets with 14 MeV neutrons can only be ^{175}Er.

Based on the Table 1 and energy sum relations, a decay scheme of ^{175}Er was proposed. The levels in the decay scheme are basically in agreement with some excited states of ^{175}Tm obtained by G.Lϕvhϕiden *et al.* in the ^{176}Yb(t,α)^{157}Tm reaction study [3].

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