Isomer spectroscopy of neutron-rich nuclei near $N = 40$

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A study on isomeric γ decays in the vicinity of the neutron-rich nuclei of $N = 40$ has been performed at the RIKEN Nishina Center RI Beam Factory. Neutron-rich nuclei were produced by fragmentation of a ^{70}Zn primary beam at 345 MeV/nucleon in a ^{9}Be target. The fragments were separated and identified on an event-by-event basis via the TOF-Bρ-Δ E method using the BigRIPS, the High Resolution Beam Line, and the SHARAQ spectrometer, and were implanted in a plastic active stopper. Delayed γ-rays were detected using two clover-type high-purity germanium detectors and sixteen NaI(Tl) detectors located outside the vacuum chamber at the downstream side of the final focal plane of the SHARAQ beam line by a DAQ system with an independent trigger from the beamline DAQ system. The data of the delayed γ-rays were correlated with the data of particles identified using a common timestamp. Data of all the delayed γ-rays were recorded without any hardware time window. Delayed γ-rays within < 5 ms from beam implantation were regarded as valid events. This is much shorter than the beam rate and there was almost no chance of incorrect identification of particles owing to multiple beam implantation during the time range. The experimental setup is presented in detail in Ref.[1].

We identified 8 isomers with half-lives in the microsecond range, including the discovery of 2 new isomers in very neutron-rich nuclei, ^{58}Sc^{m} and ^{61}Ti^{m}, and obtained a wealth of spectroscopic information such as γ-ray energy, half-lives, and γ-ray relative intensities for a wide range of neutron-rich exotic nuclei. The isomers that We observed in the present experiment are summarized in Tables 1 and 2 along with the γ-ray energies (E_γ) and the half-lives ($T_{1/2}$). Figure 1 shows the γ-ray energy spectra of the new isomers.

The known isomers observed in the present experiment are consistent with the previous work. Further analysis is in progress.

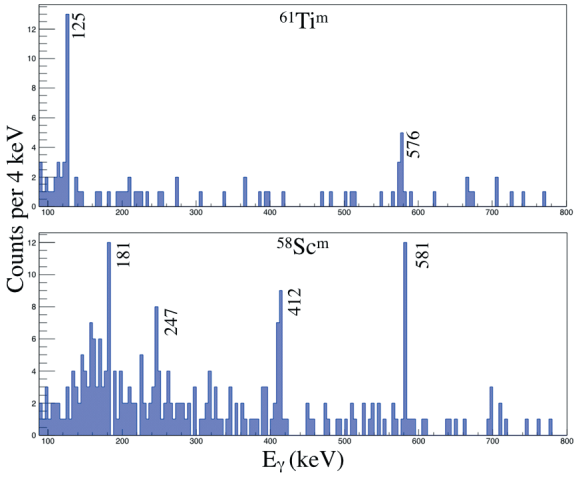

Fig. 1. Delayed γ-rays energy spectra of new isomers identified in the present work. Peaks are labeled with energies in keV.

Table 1. γ-ray energies and half-lives of previously known isomers observed in the present work.

Isomers	E_γ[keV]	$T_{1/2}$[μs]
^{60}V^{m} [Ref.[2,3]]	99.6(1)$_{stat}$; 103.7(2)$_{stat}$	0.221(13)
^{59}Ti^{m} [Ref.[3]]	108.9	0.572(19)
^{56}Sc^{m} [Ref.[3,4]]	140.6(2)$_{stat}$; 187.8(3)$_{stat}$; 587.5(1)$_{stat}$;728.0(4)$_{stat}$	0.228(24)
^{54}Sc^{m} [Ref.[3–5]]	110.6	2.82(9)
^{50}K^{m} [Ref.[2,3]]	128.3(1)$_{stat}$;172.5(1)$_{stat}$	0.132(9)
^{43}S^{m} [Ref.[3,6]]	320.6	0.414(14)

Table 2. New isomers observed in the present work along with the γ-ray energies (E_γ), half-lives ($T_{1/2}$), and γ-ray relative intensities (I_γ).

Isomers	E_γ[keV]	$T_{1/2}$[μs]	I_γ(%)
^{61}Ti^{m}	576.1(3)$_{stat}$	0.23(9)	100
	125.2(4)$_{stat}$	0.32(13)	50(27)
^{58}Sc^{m}	580.9(2)$_{stat}$	0.49(15)	100
	412.3(5)$_{stat}$	0.86(50)	85(36)
	247(2)$_{stat}$	1.25(83)	26(19)
	180.5(4)$_{stat}$	0.58(20)	27(14)

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