Isomer study on neutron-rich Pm isotopes using EURICA at RIBF

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It has been known that large prolate deformation develops in neutron-rich $Z \sim 60$ nuclei. This can be seen from the systematics of excitation energies of the first 2^+ states of even-even $Z = 55$ to 66 nuclei as shown in FIG.1 of ref[1]. In this deformed region, many K-isomers with micro second half-lives have been discovered. For example, $K^\pi = 4^-$ isomers are systematically observed in $Z = 62$ to 68, $N = 100$ isotones[2,3]. It is interesting to investigate whether the same kind of isomers exist in lower Z isotones, as this information will be helpful in understanding the deformed shell structure of such highly neutron-rich nuclei.

We performed isomer and β-γ spectroscopy on neutron-rich $Z = 56$ to 61 isotopes at RIBF. The neutron-rich isotopes were produced using in-flight fission of a 345MeV/nucleon ^{238}U beam. Fission fragments were identified by measuring the time-of-flight (TOF) and magnetic rigidity ($B\rho$) in the second stage of BigRIPS and by measuring the energy loss (ΔE) by the ion chamber at the final focal plane, F11. The measurement was conducted in two different setups. In one setup, the beam was implanted into an active stopper, WAS3ABi[4] which consists of five layers of Double-Sided-Silicon-Strip Detectors (DSSSDs) with 40×60 strips, in order to obtain β-γ and isomer data at the same time. In this setup, the total implantation rate was limited up to ∼100 cps. In the other setup, a copper stopper was introduced instead of the DSSSD to accept a wide range of nuclides with a high total rate,

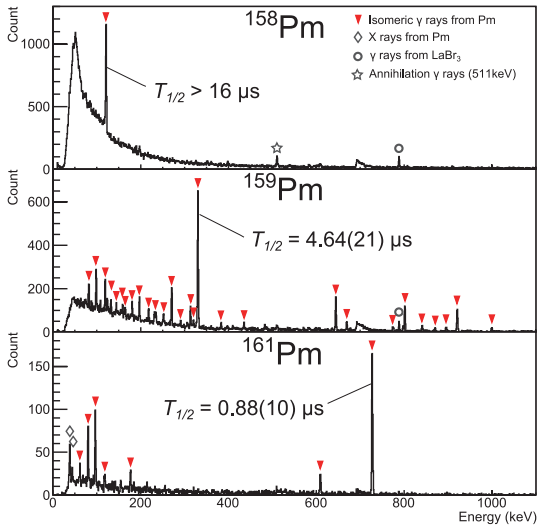

Fig. 1. Preliminary γ-ray energy spectra of ^{158}Pm, ^{159}Pm and ^{161}Pm. The time windows of ^{158}Pm is up to 16μs and that of ^{159}Pm and ^{161}Pm are up to 5μs. Events close to the timing of the beam implantation are excluded. Half-lives of ^{159}Pm and ^{161}Pm are obtained from the 330 and 728keV γ ray respectively.

in order to optimize the isomer search. The γ rays from the isomeric states were detected by EURICA[5], which is an array of 12-cluster Ge detectors. Each cluster consists of seven crystals that enable adding back Compton-scattered events in the neighboring crystals.

After the analysis of the data, isomers were found in Pm isotopes with $A = 158$, 159, and 161. Fig. 1 shows the preliminary energy spectra of the delayed γ rays for the Pm isotopes. Many new γ rays were observed for them. Half-lives of ^{159}Pm and ^{161}Pm were obtained by fitting the timing spectra gated by the γ-ray energy. ^{158}Pm was found to have a half-life much longer than the 16μs time window. Further analysis of the γ-γ coincidence and relative intensities are in progress to construct the level schemes. β-γ analysis will also be performed to obtain more information on the low-lying states of these nuclei.

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