Confirmation of the order of states in ^{100}Nb

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The neutron-rich niobium isotope ^{100}Nb has two β-decaying states. In the presently adopted nuclear data,[1] the half-life and spin parity of the ground state are $T_{1/2} = 1.4(2)$ s and $J^\pi = 1+$, respectively. For the isomeric state, the half life is experimentally given, $T_{1/2} = 2.99(11)$ s, whereas the prediction is only available for the spin value, $J^\pi = (5)+$. In the adopted γ-decay scheme of ^{100}Nb, transitions connected to the ground and to the isomeric states are entirely isolated from each other. The excitation energy of the isomeric state is experimentally determined for the first time using Pennig-trap mass spectrometry.[2] However, clear evidence linking the states to their decay properties was not given. Therefore, there is an ambiguity in the assignment of the ground and isomeric states under the present condition.

The β-decay correlated mass measurement of ^{100}Nb was conducted to confirm this. The experimental setup is described in our previous work.[3] ^{100}Nb ions were produced by the spontaneous fission of a 9.25 MBq ^{252}Cf source. A multi-reflection time-of-flight mass spectrograph combined with the β-TOF detector enabled us to achieve the simultaneous measurement of the TOF and decay events, which was employed for the correlation measurement.

In the analysis process, the TOF events were selected first to make the correlation, and then, all β-decay events that occurred within the time window centered on the selected TOF events were collected as the correlated ones.

The TOF spectrum of ^{100}Nb^{1+} is shown in Fig. 1(a), and the peaks of the ground and isomeric states are well resolved. Figures 1(b) and (c) plot the time spectra of β-decay events correlated with Regions I and II, respectively. The extracted half-life of Region I is 1.22(34) s, and it agrees with that of the adopted ground state. For Region II, which corresponds to the isomeric state, 2.51(69) s is obtained, and it is consistent with the literature value. The masses of both states were also determined (Table 1). The isomer excitation energy is extracted to be 299(12) keV and is consistent with the literature value of 313(23) keV. Thus, the present TOF-gated β-decay data confirmed the adopted level scheme and provided more precise excitation energy for the isomeric state.

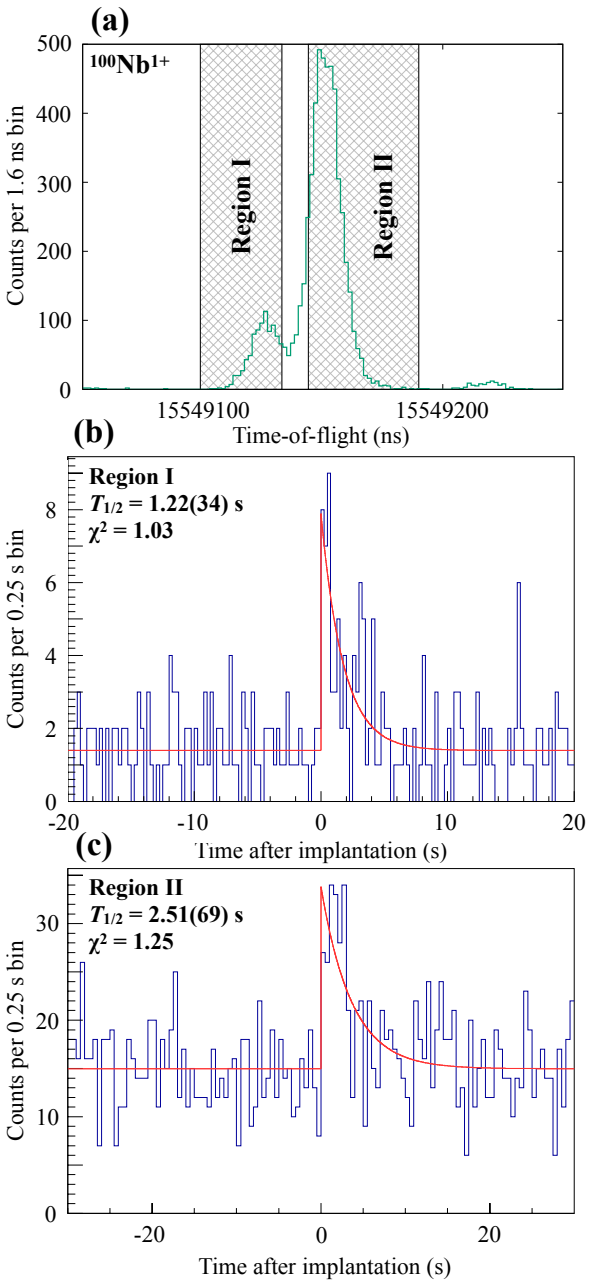

Fig. 1. (a) Time-of-flight spectrum of ^{100}Nb^{1+}. (b) β-decay events correlated to Region I. The red line shows the fit result with a decay curve + constant background. (c) The same as (b) but for Region II.

Table 1. Square of the time-of-flight ratios and extracted mass excesses. ^{100}Zr^{1+} was used as a mass reference. The extracted excitation energy E_X is also shown.

Species	ρ^2	ME (keV)
^{100}Nb^{1+}	0.999963298(30)	−79788.6(86)
^{100}Nb$^{m,1+}$	0.999966508(23)	−79489.9(84)
		$E_X = 299(12)$

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