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Observation of nuclear resonance on the first excited level of Osmium-187

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Introduction

It is known that the first excited level of Osmium-187 exists at a low energy of 9.746 keV, and the half life is 2.38 ns [1]. The nucleus is expected that Nuclear Excitation by Electron Transition (NEET) occurs in *L*-shell ionization [2]. The most probable NEET is between the $L_1^{-1}(2S_{1/2}^{-1}$, 12.968keV) $\rightarrow M_1^{-1}(3S_{1/2}^{-1}$, 3.049keV) atomic hole transition (9.919keV) and the nuclear transition between the ground and 9.8-keV excited level (M1+E2, $1/2^- \rightarrow 3/2^-$). The energy difference between these transitions is only 173 eV. We have tried to observe NEET on ^{187}Os using synchrotron X-rays at beamline AR-NW2A. Here, we report on observation of nuclear resonance at 9.8-keV level. The energy of the first excited level was decided from the X-ray absorption edges.

Experiment

A silicon avalanche diode (Si-AD, Hamamatsu SPL0601) was used to detect internal-conversion electrons emitted from excited nuclei. The device was 3 mm in diameter and had a depletion layer 30μm thick. The surface layer of the Si-AD was made of a thin Si_3N_4, 25nm thick A focused monochromatic X-ray beam was defined to $^H1\times{}^V0.6$ mm by slits. We used an osmium target that was made of metal powder on adhesive carbon tape. The powder of ^{187}Os was enriched to 99.4%. The Si-AD was installed in a vacuum chamber for the NEET experiment and was located 2.5mm above the target. A fast amplifier was used for outputs from the Si-AD. In order to measure X-ray absorption spectra and to monitor intensity of the incident X-rays, photodiodes (silicon PIN-PD, 30μm thick) of transmission type were used. One of the PD was located in front of the vacuum chamber and the other was installed behind the sample in the chamber.

Results

In order to determine the resonant energy, we need an absolute energy scale for the incident X-rays. We tried to measure X-ray absorption edges near 9.8-keV level. The X-ray absorption spectra near Zn-*K*, Er-L_1 and Ta-L_3 edges were measured by scanning energy of the monochromator. The incident beam intensity and that behind the sample were measured as PDF and PDB, respectively. Table 1 shows the edge energies determined by fitting the derivative of ln (PDF/PDB) with Lorentzian and the data taken from a reference [3]. An energy scale was decided by calibration using those data.

Table 1: Measured energies of the absorption edges

Abs. edges	Experiment (eV)	Reference (eV)
Zn *K*	9658.64±0.03	9660.755±0.030
Er L_1	9756.72±0.04	9757.8±1.1
Ta L_3	9875.59±0.06	9876.7±1.2

Events emitted from decaying excited nuclei were selected by time spectroscopy. Counts of the delayed events were recorded by gating with a signal width produced from a RF signal from the accelerator. Since the prompt pulses of the amplifier outputs were huge and their tail part was overshot to plus level, a dead time more than 20 ns masked signals emitted from the nuclei. We found nuclear resonance by scanning energy of the incident X-rays although the event rate was low, 0.3 s^{-1} due to the long dead time. Figure 1 shows a peak of the delayed events measured around the resonant energy.

We found that the first excited level of ^{187}Os existed in (9776.9±1.2) eV. This value has a discrepancy of about 30eV from that written in the literature [1]. We are now in preparation of observing NEET on ^{187}Os, considering this value for nuclear resonance.

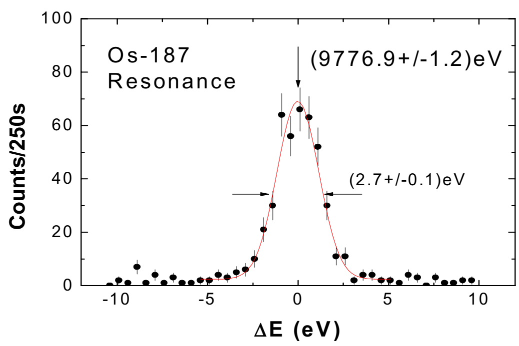

Fig.1: Peak for the nuclear resonance of ^{187}Os

References

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