M Edge Absorption Measurements of HfO_2 and Lu_2O_3 at BL13

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The third row of transition elements in metallic compounds have partially filled 5d orbital which may play important roles in functional materials. X-ray absorption experiments at the L_{23} edges is known to give information about the 5d orbital through the 2p-5d dipole excitation [1]. L_3 edge measurement is also used to study the valence state of rare earths [2]. In this short note, we focus on theshallower M_{23} and M_1 cores of Lu and Hf, which might give additional information.

Measurements have been carried out at BL-13 of the SR Center of Ritsumeikan University using the total electron yield method. Powdered samples of Lu_2O_3 (NewMet, 99.99 %) and HfO_2 (NewMet, 99.7% except for 4.3 % Zr) were attached on the carbon ta pe.

The observed spectra at the Hf $M_{2,3}$ and Lu M_2 edges of HfO_2 and Lu_2O_3 are shown in Fig. 1. The lineshapes closely resemble with each other. If we compare the lineshapes of M_3 and M_2 edges for Hf, the former is slightly narrower than the latter. Lineshapes of Hf and Lu M_2 edges resemble with each other. Electrons are excited from the 3p core level to the unfilled 5d orbital. In both HfO_2 and Lu_2O_3, the 5d band is nominally fully open. The 5d band structure is expected to be different between HfO_2 and Lu_2O_3 but such difference is not reflected in the observed M_2 spectra presumably because of the relatively short lifetime of the 3p core hole. When the filling of the 5d band is changed for example by increasing the atomic number, the M_{23} lineshapes are expected to reflect the changes.

The M_1 edge of Lu is shown in Fig. 2. Extrinsic noise signals are seen in this spectrum. This is mainly because the peak height of the M_1 edge is much smaller than that at the M_{23} edges. It is found that the noise, presumably due to the fluctuation either of the light source or of the beamline, is not removed sufficiently just by dividing the sample current by the mirror current.

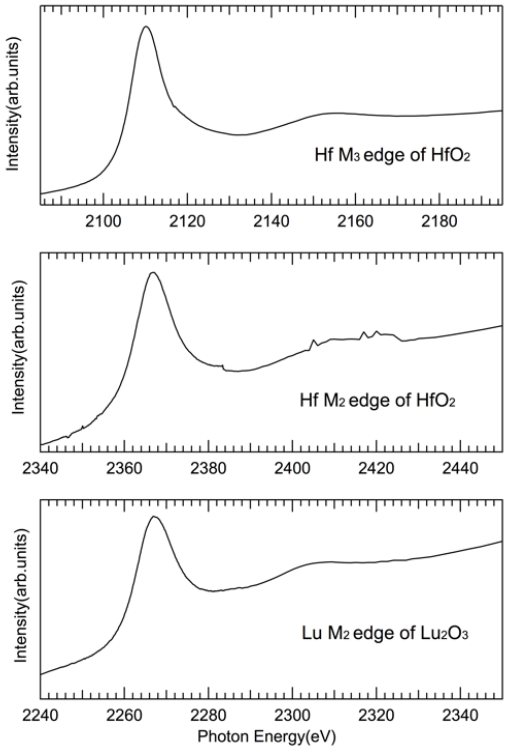

Fig. 1. Total electron yield spectra at Hf $M_{2,3}$ and Lu M_2 edges of HfO_2 and Lu_2O_3.

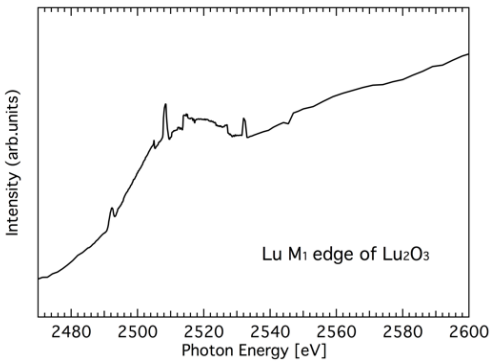

Fig. 2. Total electron yield spectr um at Lu M_1 edges of Lu_2O_3.

References

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