Multi-atomic resonant photoemission effect (MARPE) observed for Co and Mo binary sulfide

Tomoaki TANAKA[1,2], Motoyasu IMAMURA[1], Nobuyuki. MATSUBAYASHI[1], Hiromichi SHIMADA[1]
1National Institute of Advanced Industrial Science and Technology, Tsukuba, Ibaraki305-8565, Japan
2New Energy and Industrial Technology Development Organization, Toshima-ku, Tokyo 170-6028, Japan

Introduction

The multi-atomic resonant photoemission effect (MARPE) was reported for the first time for MnO, Fe_2O_3 and $La_{0.7}Sr_{0.3}MnO_3$ in 1998 [1]. The present study was performed to investigate if the MARPE is observed for a sulfide system. Co and Mo binary sulfide that is known as the catalytically active phase for hydrodesulfurization was chosen as a sample.

Experimental

The Co and Mo binary sulfide sample was prepared by spin coating using an aqueous solution of Co nitrate and ammonium heptamolybdate and a SiO_2/Si(100) wafer. After spin coating, sulfidation was carried out in a glass reactor under a flow of 50ml/min of 10% H_2S for an hour at 673K. All the measurements were performed at the beam line 13C using a micro-channel-plate for absorption spectra and a hemispherical electron analyzer (PHI 1600C) for photoelectron spectra. The Co L-edge x-ray absorption spectrum was measured by the total electron yield and photoelectron spectra of S2p were accumulated with a pass energy of 11.75 eV.

Results and discussion

MARPE occurs when the photon energy is tuned to the absorption edge of an atom neighboring the emitting atom, with the emitting level giving a lower binding energy than the resonant level. In the present experiment, the magnitudes of S2p photoemission electrons were monitored near the Co2p absorption edge.

The spectrum in Fig. 1 shows an S2p photoemission spectrum of CoMo sulfide after subtracting a Shirley type background. The spectrum was fitted with two Gaussian functions to derive the S2p peak areas that are obtained from the sum of $2p_{3/2}$ and $2p_{1/2}$ component shown in the figure 1.

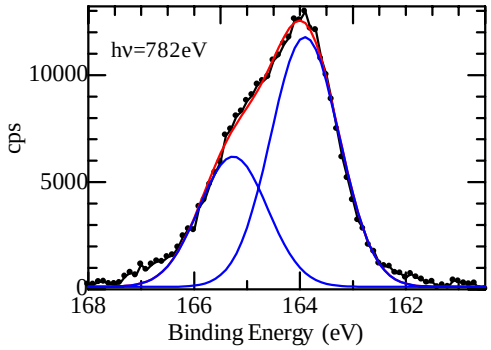

Figure 1 S2p photoemission spectrum of CoMo sulfide with curve fitting by Gaussian functions

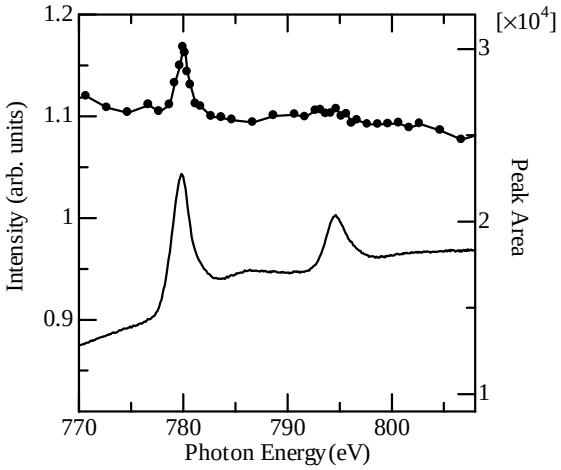

Figure 2 S2p peak areas of CoMo sulfide as a function of photon energy with Co L-edge x-ray absorption spectrum

Figure 2 shows the change in the S2p peak areas as a function of the photon energy. The Co L-edge x-ray absorption spectrum of the CoMo sulfide is also displayed in Fig. 2. The comparison of the two profiles clearly indicates the resonant enhancement of S2p peak areas at the peak of the $Co2p_{3/2}$ absorption edge. In contrast, the enhancement is very small or not observed for $Co2p_{1/2}$ edge.

The above result shows that MARPE occurs for the Co and Mo sulfide system, as a first example except for oxide systems. More detailed study is now being performed.

References

[1] A. Kay et al., Science, **281**(1998) 679.

* tanaka-t@aist.go.jp