Multielectron Excitation in 3*d*-Transition Metal Compounds

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Although photoabsorption has been generally treated as a single-electron excitation, various relaxations, which include many-body effects and give influence on the absorption spectrum, are induced following the creation of an inner-core hole. Such phenomena usually have a small intensity and are classified as secondary process. Among them multielectron excitation (MEE) has attracted extensive interest because of the observations of X-ray magnetic circular dichroism (XMCD) associated with MEE [1,2]. Here, to improve the efficiency and accuracy of XMCD-MEE spectrum, helicity-modulation technique using a diamond phase plate is applied and its advantage is examined..

A synthetic diamond (111) crystal slab 0.5 mm in thickness was operated around the 220 reflection in transmission Laue geometry. A piezoelectric vibrator functioned with 40 Hz for alternating between the offset angles, so as to produce a $\pi/4$ phase shift. XMCD signal was monitored by a lock-in amplifier. The direction of magnetic field of 0.6 Tesla was fixed and tilted by 45° away from the incident X-ray. Data were accumulated every 0.2 sec at intervals of 1 eV. The samples used in this work include the following ferromagnetic and ferrimagnetic iron compounds: Fe_2B, Fe_4N, and spinel-ferrites MFe_2O_4 (M= Mn, Fe, Co, Ni, and Cu).

Figure 1 shows the Fe *K*-edge XMCD spectrum, aligned the absorption edge energy E_0. Dichroic signals clearly appear around E_0, which provides the information about 3*d*-orbitals hybridized with 4*p*-states. In addition, another dichroic signal is observed in the higher energy region of $(E-E_0)\sim60$ eV, which is of XMCD associated with MEE. The intensity of this signal is as same order as that in the XMCD located at E_0. The spectrum is mainly shaped by a positive single peak and is clearly different from a dispersion-type XMCD spectrum around the edge. It should be emphasized that the XMCD-MEE is not sensitive to a kind of magnetic material but the element of absorbing atom. Hence, the energy position seems to be independent of material and to show a characteristic value of Fe element. These results are the important information for understanding the nature of MEE.

Availability of the helicity-modulation technique has been successfully demonstrated by the XMCD-MEE spectrum at the Fe *K*-edge, which is ascribed to improvement in S/N ratio, XMCD efficiency, statistical accuracy, energy resolution, etc.

References

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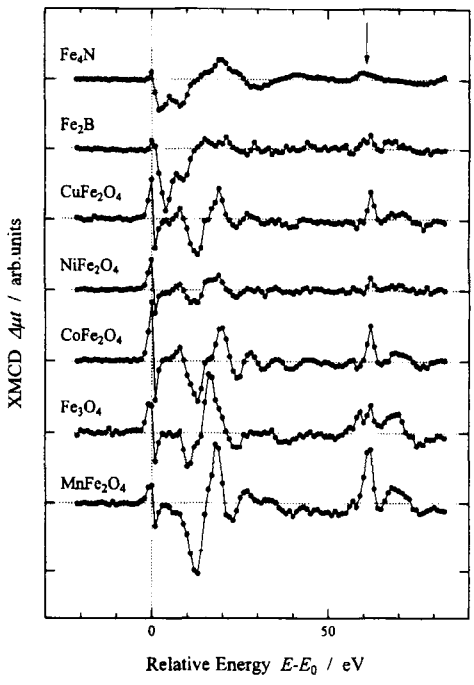

Fig.1. Fe *K*-edge XMCD spectrum aligned the absorption edge energy E_0.