# States and Structures -Atomic and Molecular Physics-


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## Scope of Research

In order to obtain fundamental information on the property and structure of materials, the electronic states of atoms and molecules are investigated in detail using X-ray, SR. Theoretical analysis of the electronic states and development of new radiation detectors are also performed.

## Research Activities (Year 2001)

### Presentations

The information on $L_{III}$ and $L_{II}$ shell in $K$ x-ray absorption and emission of $Cr_2O_3$, Ito Y, 7th International Conference on Applications of Nuclear Techniques, June 17-23, 2001 Crete, Greece, Oct. 19, 2001.

On $K\alpha_{1,2}$ spectra of Copper, Ito Y, 7th International Conference on Applications of Nuclear Techniques, June 17-23, 2001 Crete, Greece, Oct. 19, 2001.

Fluoride Ion Conduction in Pb1-xSnxF2 Solid Solution System, Yoshikado S. (Doshisha University ), Ito Y, J.M.Reau (Institut de Chimie de la Matiere Condensee de Bordeaux), International Conference on Solid State Ionics, July 8-12, 2001, Australia, July 8, 2001.

Fabrication and evaluation on Battery in Fluorine compounds, Togashi G (Doshisha University), Ito Y, Yoshikado S (Doshisha University), 27th annual meeting in Solid State Ionics, Tokyo, Nov. 12, 2001.

On W $L\beta$ visible satellite, A. M. Vlaicu (NIRM), Fukushima S (NIRM), Ito Y, 37th annual meeting in x-ray analysis, Tsukuba, Oct. 29, 2001.

X-ray spectral measurements using Xe gas sintilation counter with a large window, 30 $cm^2$, Nakanishi Y, Ito Y, Omote K (Rigaku Denki X-ray Lab.), 37th annual meeting in x-ray analysis, Tsukuba, Oct. 30, 2001.

Topics

## Evolution of $K$ and $L$ satellites of X-ray emission spectra at BL15XU, SPring-8

The existance of two or more holes in atomic inner shells gives rise to satellite lines with energies that are shifted from the corresponding one-hole (diagram) lines. One of the method to study the origins of satellite lines is to find the threshold of the excitation energy. For that experiment it is effective to measure emission spectra, tuning excitation energy used by synchrotron radiation.

In $K\alpha$ spectra of *3d* transition element very weak satellite line appears in the higher energy region for $K\alpha_1$. It is called $K\alpha_{3,4}$, and thought as the transition from multiple hole state. We measured Fe $K\alpha$ spectra at various excitation energy to investigate the origin of the satellite.

The relative intensity of $K\alpha_{3,4}$ looks gentle dependence for the excitation energy. That relative intensity is saturated at the energy higher about 2000 eV than the energy of the threshold. $K\alpha_{3,4}$ satellite is thought the transition from *1s2p* to $2p^2$. This experiment suggests that shake-off process connects predominantly the creation of the *2p*-spectator hole.

For heavy element we focused on satellite lines of Au $L\beta_2$, which has two satellites in the high-energy side. They are thought to be ascribed to the spectator hole $M_{4,5}$. We measured Au $L\beta_2$ spectra at various excitation energy including $L_1$ edge.

In the spectra excited at 14390 eV and 15000 eV (above $L_1$ edge), we can confirm two satellites at high-energy side of $L\beta_2$. On the other hand satellite doesn't appear in the spectra excited at 14320 eV (below $L_1$ edge). It is clear that $L\beta_2$ satellite lines grow up with $L\beta_3$, which has initial stage with vacancy at $L_1$ subshell.

We did energy scan for the peak intensity of $L\beta_2$" ($L_3M_4$-$M_4N_5$) which is most far distance from main peak. That intensity (red square) grows up with $L_1$ absorption spectra (blue line). So that the present experiment suggests that Au $L\beta_2$ satellite lines are caused mainly by $L_1$-$L_3M_i$ (i=4,5) Coster-Kronig transition.

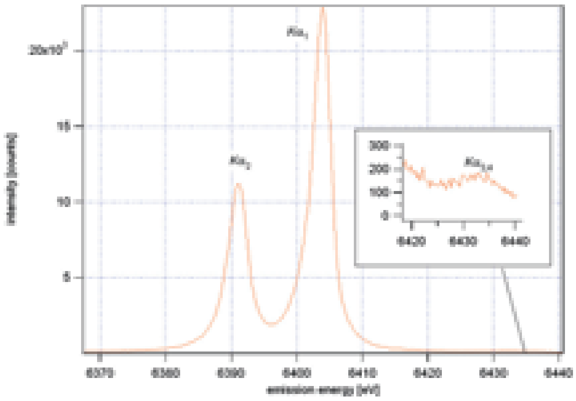

**Figure 1.** Fe $K\alpha$ emission spectra

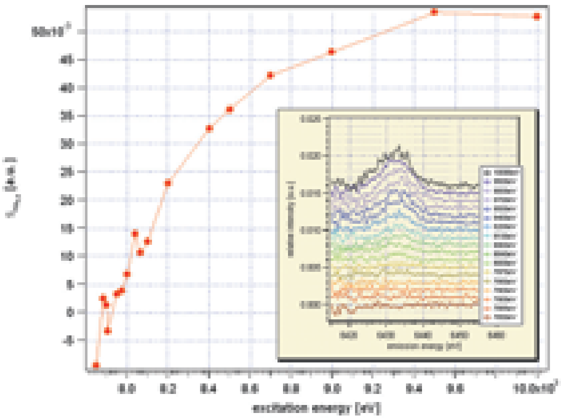

**Figure 2.** Energy dependence of relative intensity Fe $K\alpha_{3,4}$ satellites for $K\alpha_1$

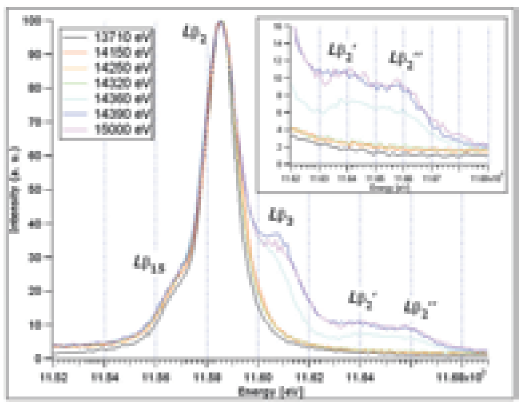

**Figure 3.** Au $L\beta_2$ emission spectra at various excitation energies

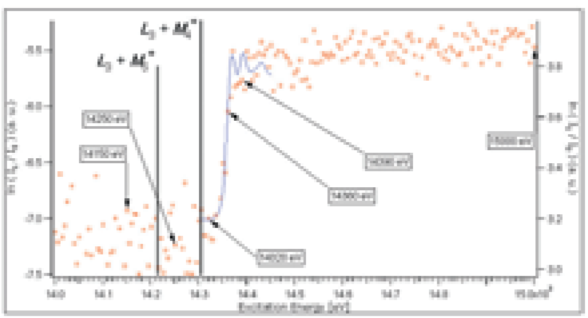

**Figure 4.** Energy scan of Au $L\beta_2$" satellite's intensity and Au $L_1$ absorption spectra