Resonant X-ray Raman scattering spectra of Ce-compounds

Shun-ichi Nakai[1], Tohru Watanabe[1], Katsuhiro Sasaki[1], Tatsuya Iwasaki[1], Masashi Odaka[1],
Takayuki Kashiwakura[1], Takafumi Yamazaki[1] and Toshiaki Iwazumi[2]

[1]Department of Electrical and Electronic Engineering,
Utsunomiya University, Utsunomiya 321-8585, Japan
[2]IMSS, Photon Factory, KEK, Tsukuba 305-0801, Japan

Resonant L_α X-ray emission spectra (RXES) of Ce-compounds, CeF_3, CeO_2 and CeB_6 were measured around the L_{III} absorption threshold. RXES were measured at the beam line BL - 7C of Photon Factory, KEK,Tsukuba. An incident photon energy was selected with Si (111)double-crystal monochromator. The emission spectra were measured by a curved Ge (400) crystal monochromator, "Escargot". The total resolution was about 1.2eV.

Figure 1 (a) shows the Ce L_{III} X-ray absorption spectrum (XAS) of CeO_2. The spectrum shows two peaks. The RXES of CeO_2 were taken at selected excitation energies showed by vertical arrows for 1 to 19 in (a) and are represented in Fig. 1 (b). The quadrupolar transition peaks A ($\omega_i - \omega_s = 880.5eV$) and A' (883.0eV) are also observed and its intensities go through a maximum at 5718eV (Spectrum No.8). In Fig.1 (b), three resonant Raman peaks B_1, B_2 and B_3 are observed at $\omega_i - \omega_s$ 887.0eV, 891.0eV and 899.0eV, respectively. The intensities of B_1, B_2 and B_3 go through a resonant maximum at 5725 eV (Spectrum No.11), 5729eV (Spectrum No.13) and 5736eV (Spectrum No.16), respectively, which correspond to the shoulder structure, first absorption peak and 2nd absorption peak of XAS in Fig. 1 (a). From these correspondences between the resonant Raman peaks and the absorption structures, the origin of B_1, B_2 and B_3 peaks may be attributed to the $4f^2$, $4f^1$ and $4f^0$ configuration in the initial states, respectively. (Ref. 1)

The Ce L_{III} XAS of CeB_6 is shown in Fig. 2 (a). The RXES of CeB_6 were taken at selected excitation energies showed by vertical arrows for 1 to 16 in (a) and are represented in Fig. 2 (b). In this case, only one broad quadrupolar transition structure A is observed at $\omega_i - \omega_s = 877.5eV$. Two resonant Raman peaks B_1 and B_2 are observed at $\omega_i - \omega_s = 881.0eV$ and 884.5eV. The intensities of B_1 and B_2 go through a resonant maximum at 5721eV (Spectrum No.6) and 5724eV (Spectrum No.8).

References

[1] J. Röhler; in *Handbook on the Bhysics and Chemistry of Rare-Earths Vol.10*, edited by K.A. Gschneider, Jr., L. Eyring and S. Hüfner, (Elsevier Science Publishers B. V., 1987)
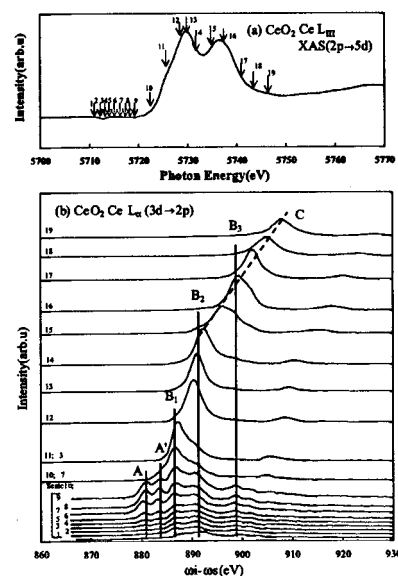
Fig. 1 (a) Ce L_{III} XAS of CeO_2, (b) CeL_α RXES for CeO_2 excited with different photon energies, as indicated by arrows in (a).
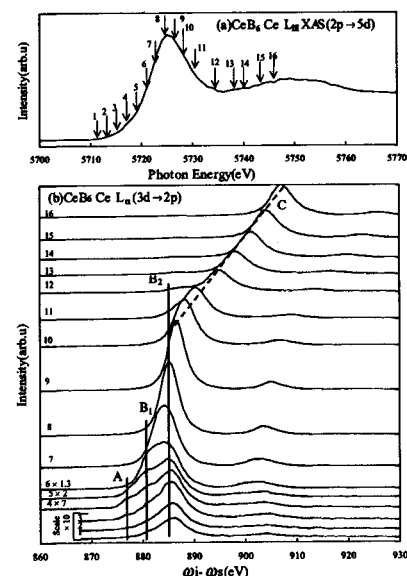

Fig. 2 (a) CeL_{III} XAS of CeB_6, (b) CeL_α RXES for CeB_6 excited with different photon energies, as indicated by arrows in (a).