

Resonant X-ray Scattering Study of $\beta\text{-Ag}_{1/3}\text{V}_2\text{O}_5$

Kenji OHWADA^{1*}, Toru TYAMAUCHI², Yasuhiko FUJII³, Yutaka UEDA²
¹QuBS, JAEA, Sayo, Hyogo 679-5148, Japan
²ISSP, The Univ. of Tokyo, Kashiwanoha, Kashiwa, Chiba 277-8581, Japan
³CROSS, Tokai, Ibaraki 319-1106, Japan

A series of beta-vanadium bronzes ($\beta\text{-A}_{1/3}\text{V}_2\text{O}_5$) exhibits some exotic physical properties under high pressure (HP).

A basic structure is common to all $\beta\text{-A}_{1/3}\text{V}_2\text{O}_5$ series (space group $P2_1/a$). In spite of the common structure, physical properties are quite different and depend on a carrier number. When the A site is occupied by an ion having 1+ valence (Na^+ , Ag^+ ...), the system shows superconductivity under HP [1]. On the other hand, when the A site is occupied by an ion having 2+ valences (Sr^{2+} ...), the system shows devil's flower-like behaviour under HP [2]. However, most of the samples (A = Na, Sr and so on) commonly show a charge ordering with $\mathbf{b}' = 6\mathbf{b}$ unit cell at low temperature in spite of a different modulation of the charge instability above metal-insulator (M-I) transition at T_c [3]. To study an intrinsic difference among $\beta\text{-A}_{1/3}\text{V}_2\text{O}_5$ system, we have focused upon the charge order pattern of each system.

The charge arrangement pattern of A = Na system in the $\mathbf{a} \times 6\mathbf{b}$ unit cell has already been predicted by neutron diffraction [4] and NMR [5] measurements. The $6\mathbf{b}$ -lattice modulation along the \mathbf{b} axis is given by the combination of the non-integer valence arrangement with the period of $3\mathbf{b}$ and the preexistent cation arrangement with the $2\mathbf{b}$ -lattice modulation. The valence also disproportionates among the V1, V2 and V3 sites with non-integer d -electron number. Both neutron diffraction [4] and NMR [5] measurements also predicted the existence of no- d -electron site with the period of $3\mathbf{b}$.

Up to this point, we studied the systems of A = Na and Sr by a resonant x-ray scattering (RXS) technique. The measured spectra show quite different energy dependences, which represent that the charge order pattern of each system is different [6]. In the case of the A = Na system, the energy spectra is consistent with the charge order pattern predicted by the neutron diffraction and the NMR measurements [6].

In this experiment, we have focused on A = Ag system, which overall shows the same physical properties compared with the A = Na system except for the slight differences above T_c [3]. We have particularly interested in whether the charge arrangement pattern is the same or different from each other below T_c .

Experimental

Experiment was carried out at BL-4C of Photon Factory. We used the RXS technique [7, 8]. The RXS intensity near main edge of V-K absorption edge (around 5.47 keV) well reflects the charge disproportionation pattern among V sites [7, 8].

Results

Figure 1 shows energy spectra of 020 reflection as well as 0 8/6 0 reflection measured at 100 K.

Preceding study of the A = Na system, strong 0 10/6 0 reflection could be observed, however, in the case of the A = Ag system, 0 10/6 0 reflection could not be observed. Instead, weak 0 8/6 0 reflection was observed. The result represents that the charge order pattern of the A = Ag system is different from that of the A = Na system. The precise charge order pattern is now under analysis.

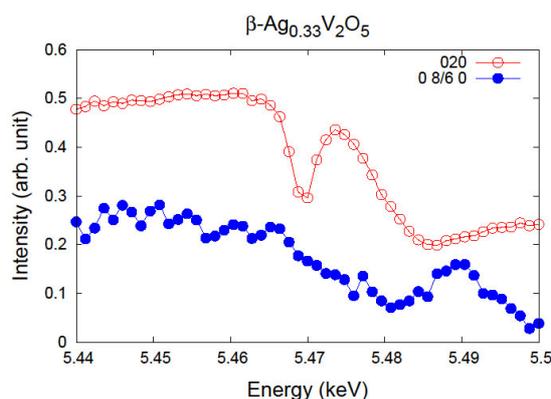


Fig. 1. Energy dependence of the intensity measured at fundamental Bragg position (0, 2, 0) and superlattice Bragg position (0, 8/6, 0).

References

- [1] T. Yamauchi *et al.*, Phys. Rev. Lett. **89** 057002 (2002).
- [2] T. Yamauchi *et al.*, Phys. Rev. B **77** (2008) 104529.
- [3] T. Waki *et al.*, J. Phys. Chem. Solids **68** (2007) 2143.
- [4] S. Nagai *et al.*, J. Phys. Soc. Jpn. **74** (2005) 1297.
- [5] M. Itoh *et al.*, Phys. Rev. B **74** (2006) 054434.
- [6] K. Ohwada *et al.*, private communications.
- [7] K. Ohwada *et al.*, Phys. Rev. Lett. **94** (2005) 106401.
- [8] K. Ohwada *et al.*, Phys. Rev. B **77** (2008) 094136.

* ohwada@spring8.or.jp