Resonant x-ray scattering study of NaV_2O_5 under high pressure

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Introduction

Devil's Flower has been reproduced in the Temperature-Pressure phase diagram of charge-lattice-spin coupled system NaV_2O_5 [1]. All of experimentally observed phases have 2a×2b×Zc type superstructures and the corresponding wave number q_c (=1/Z, C_{q_c}-phase) sequences at several temperature and pressure ranges are well understood as the **Devil's Staircase** type sequence theoretically obtained from the ANNNI model [2]. The q_c sequences were directly determined by the synchrotron x-ray diffraction technique which well probes the lattice modulation but barely probes the charge modulation. It is not clear whether the charge modulation has the same q_cs observed in Ref. [1].

Experimental

To clarify the coupling of the two degree of freedom, charge and lattce, we have investigated the resonant x-ray scattering (RXS) at low temperature and high pressure around V *K*-edge (5.47 keV). The RXS well probes the charge modulation. Since the 5.47 keV x-ray cannnot through the diamond anvils, we have thus developed a new diamond anvil cell for RXS (RXS-DAC) as schematically shown in Fig. 1. 5.47 keV x-ray comes into and comes out from the sample chamber through the Be gasket. Single crystal of NaV_2O_5 and NaCl (for pressure marker) were enclosed with the n-i pentane 50:50 mixture for pressure transmitting media.

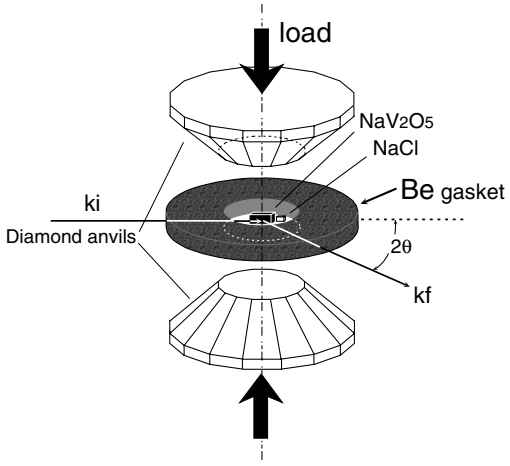

Figure 1: Schematical drawing of the RXS-DAC.

Result and discussion

Fig. 2 shows the energy scan at Q = (7.5 0.5 L) observed at 0.1 MPa (L=0.25, $C_{1/4}$-phase), 0.6 GPa (L=0.25, $C_{1/4}$-phase) and 1.2 GPa (L=0.0, C_0-phase) at 8K. Peaks around 5.468 keV (pre-edge) and 5.475 keV (main-edge) well reect the edge difference between V^{4+} and V^{5+} generated by the charge ordering. We also observed the similar energy prol e at (7.5 0 0.2) and nally conrmed that the charge modulation and the lattice modulation have the same q_cs. The intensity reduction at pre-edge (5.468 keV) may be caused by the geometical change around the V sites [3]. On the other hand, the main-edge peak intensity at 5.475 keV shows the pressure independence. This means that the charge order fully takes place in spite of the atomic shift suppression [1] under pressures.

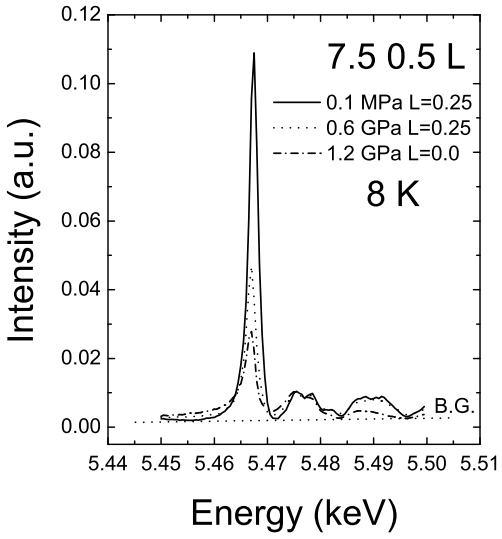

Figure 2: The energy scan at Q = (7.5 0.5 L) observed at 0.1 MPa (L=0.25, $C_{1/4}$-phase), 0.6 GPa (L=0.25, $C_{1/4}$-phase) and 1.2 GPa (L=0.0, C_0-phase) at 8K.

References

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