Magnetic phase diagram under low temperature and high pressure in RVO3 II

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Perovskite vanadium oxide RVO3 (R: rear earth or Y) shows various physical properties coupled with the spin and orbital states. [1] The orbital ordering is strongly coupled with the lattice distortion, i.e. Jahn-Teller distortion. Hence the pressure effect for the orbital state interests us, and the pressure-temperature phase diagram of the V 3d-orbital state was investigated by x-ray diffraction under high-pressure and low-temperature. [2] Under high pressure ($>$ 6 GPa), the orbital disorder (OD) - C-type orbital ordering (C-OO) phase transition was newly found in YVO3. At this transition, the space group does not change, although the symmetry is usually broken at an orbital order-disorder transition. Such an orbital order-disorder phase transition without the change of the space group was actually reported in LaMnO3. On the other hand, the magnetic symmetry breaking upon this phase transition can be also expected. To make clear the relation between the spin and orbital states, we have investigated the magnetic phase diagram of YVO3 under high-pressure and low-temperature using a hybrid anvil cell.

In order to determine the magnetic ordering phase, the magnetic scattering was explored by using the triple-axis spectrometer TOPAN. The temperature dependence of the magnetic peak intensities was measured at several pressures as shown in the figure. At ambient pressure (0GPa), the (0 1 0) magnetic peak reflecting the C-type spin ordering (C-SO) was observed below TSO1=118K. Moreover, the second magnetic transition was observed at TSO2=77K: there the magnetic peak at (0 1 0) disappears and that at (0 1 1) reflecting the G-type spin ordering (G-SO) appears. With increasing pressure, TSO2 remarkably increases while TSO1 has few pressure dependence. As a result, the C-SO phase completely disappears above 3GPa. Furthermore, TSO2 continues to increase even after the disappearance of C-SO phase. Finally, we could elucidate that the magnetic transition at TSO2 just corresponds to OD/C-OO phase transition above 6GPa; such a simultanious transition has never been reported in perovskite-type transition metal oxides. The result indicates that the magnetic ordering play an important role for the OD/C-OO phase transition.

[1] S. Miyasaka et al., Phys. Rev. B 68 (2003) 100406.
[2] D. Bizen et al., Phys. Rev. B 78 (2008) 224104; D. Bizen et al., J. Magn. Magn. Mater. 310 (2007) 785.

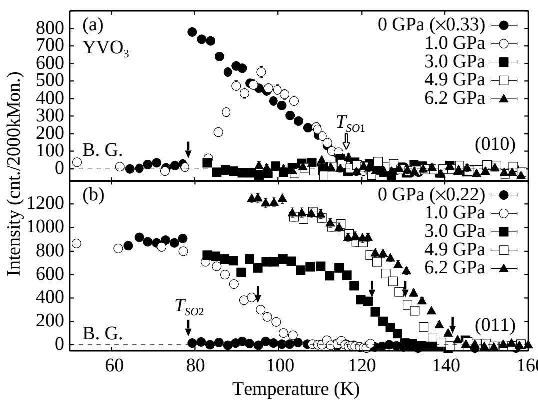

Fig. 1. Temperature dependence of the magnetic peak intensities at (0 1 1) and (0 1 0), which reflect G-SO and C-SO, respectively.