Investigation of magnetic ordering in high pressure phase of $DyMnO_3$

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Abstract: In the experiments, we have succeeded in measuring the pressure dependence of the magnetic k-vector and polarization matrices of multiferroic $DyMnO_3$ under high pressure condition, by using the WISH TOF diffractometer and the CryoPAD apparatus on IN20 beamline in combination with our developed Hybrid-Anvil-Cell (HAC). This experiment determined the pressure dependence of some of neutron polarization matrices as well as magnetic propagation vector up to 5 GPa.

Unpolarized and polarimetry neutron experiments were carried out using WISH at ISIS and IN20 at ILL. Single crystal samples of $DyMnO_3$ for both the experiments, grown by the floating zone technique, were cut into rectangular shapes with dimension of 0.5 × 0.5 × 0.2 mm3 for experiments up to 5 GPa. The crystal qualities were kept even under pressure up to 5.0 GPa, by using glycerin as the pressure transmission medium. The cut samples were mounted in the HAC with the a-axis vertical, in order to provide access to the monoclinic (0, K, L) reflections. For the polarimetry experiment on IN20, the incident neutrons are polarized and monochromatized at the Heusler monochrometer. The incident wavelength 1.53 was employed. A sapphire anvil with a 2.4 mm diameter culet, supported by MP35N was used.

In the experiment on WISH and IN20 in July and September 2018, we succeeded in measuring the pressure dependence of k-vector and neutron polarization matrix up to 5 GPa. We could observe tendency that one of matrix elements, Pyy, significantly changes above 4 GPa, which indicates that Dy spin ordering gradually changes from spiral to collinear structure. However, in the previous experiments on IN20, due to limitation of machinetime, I have not measured the complete set of pressure dependence beyond 5 GPa.

In conclusion, we have determined the pressure dependence of the d-vector and polarization matrix elements. However, it is necessary to perform additional experiments to make this complete and clarify the magnetic ordering for higher pressure phase with the giant electric polarization in $DyMnO_3$.

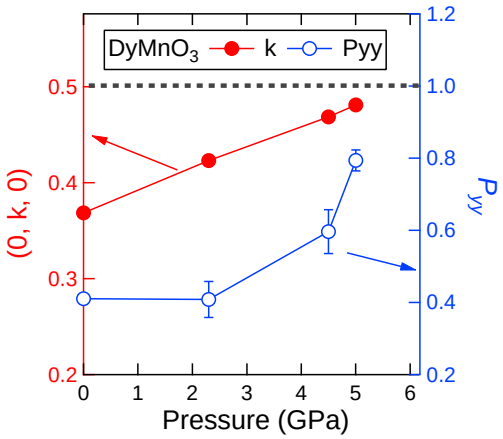

Fig. 1. Pressure dependence of propagation wave number k and polarization matrix element Pyy. The data were measured in the previous measurements on IN20.