# Experimental report

13/02/2019

**Proposal:** 5-54-256 **Council:** 4/2018

**Title:** Investigation of high pressure phase in multiferroic perovskite DyMnO3 by using CryoPAD and Hybrid-Anvil-Cell

**Research area:** Physics

**This proposal is a new proposal**


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Mechthild ENDERLE


**Samples:** DyMnO3

| Instrument | Requested days | Allocated days | From | To |
|---|---|---|---|---|
| ORIENTEXPRESS | 0 | 1 | | |
| IN20 CPA | 7 | 8 | 25/09/2018 | 03/10/2018 |


**Abstract:**

We propose to perform neutron polarimetry analysis under high-pressure for multifefrroic DyMnO3 using CryoPAD in combination with hybrid-anvil-cell developed by the user. Giant electric polarization has been recently discovered to be induced by hydrostatic pressure in RMnO3 (R=Dy, Tb, and Gd). Our recent unpolarized neutron diffraction experiment under pressure for TbMnO3 suggested that not only the E-type (up up down down) Mn spin ordering, but also rare earth ordering (noncollinear) plays an important role for significant change in the giant polarization in the rare earth manganites. (N. Terada et. al. PRB 081104(R) (2016))However, for further understanding the pressure induced giant polarization, it is essential to investigate details of rare earth spin ordering as well as Mn spins, by neutron polarimetry analysis.

Experimental report for “Investigation of high pressure phase in multiferroic perovskite $DyMnO_3$ by using CryoPAD and Hybrid-Anvil-Cell”

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

**Experiment:** The neutron polarimetry experiments were carried out using a CRYOPAD apparatus[1, 2] on the IN20 beam line. Single crystal samples of $DyMnO_3$, grown by the floating zone technique, were cut into rectangular shapes with dimension of 0.5 × 0.5 × 0.2 $mm^3$ 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. The incident neutrons are polarized and monochromatized at the Heusler monochrometer. The incident wavelength 1.53 Å was employed. A sapphire anvil with a 2.4 mm diameter culet, supported by MP35N was used, and WC with a nonmagnetic Ni binder were employed. These materials were confirmed to be nonmagnetic by magnetization measurements. Aluminum gaskets (Al2017) 1.0 mm diameter hole were used. The HAC was inserted into a Orange cryostat.

**Results:** In this experiment on IN20 in September 2018, we succeeded in measuring the pressure dependence of neutron polarization matrix as well as k-vector (fig. 1) up to 5 GPa, by using CRYOPAD in combination with our developed nonmagnetic Hybrid-Anvil-Cell as mentioned above. We could observe tendency that one of matrix elements, $P_{yy}$, significantly changes above ~ 4 GPa, which indicates that Dy spin ordering gradually changes from spiral to collinear structure. However, in the previous experiments, due to limitation of machine time, I have not measured the complete set of pressure dependence beyond 5 GPa.

**Conclusion:**

As mentioned above, we have determined the pressure dependence of one of polarization matrix elements and k-vector. 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 $DyMnO_3$.

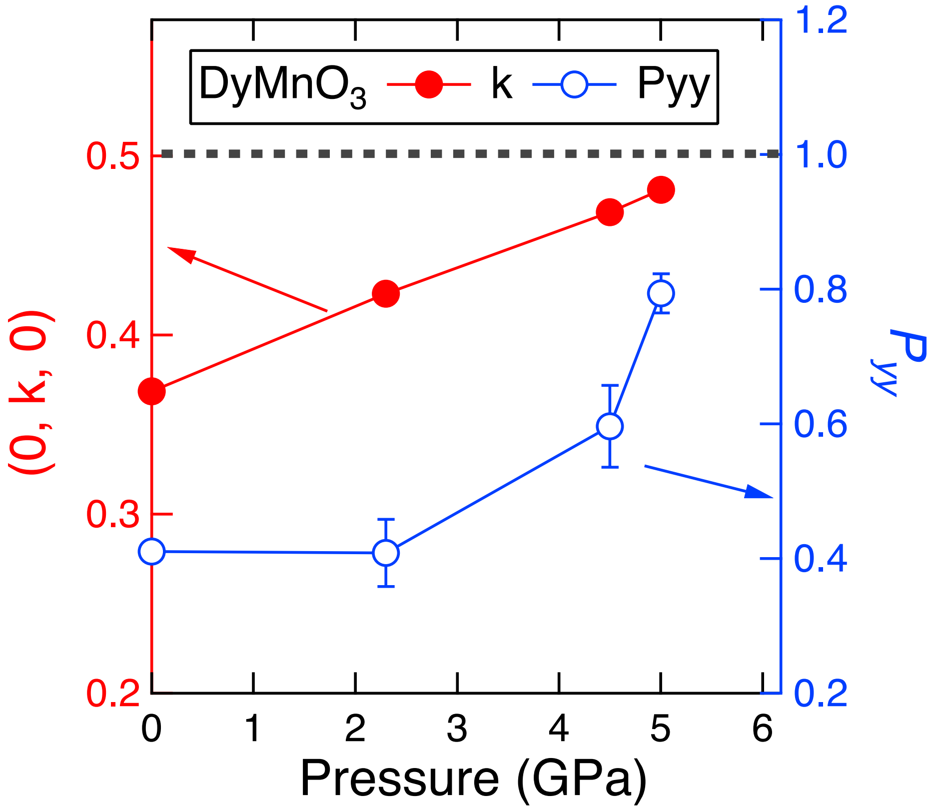


Fig. 1 Pressure dependence of propagation wave number k and polarization matrix element Pyy. The data were measured in the previous measurements on IN20.