Test for the single-q/multiple-q magnetic orders on $^{160}Gd_2PdSi_3$ by the elastic neutron scattering under the uniaxial stress

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Recently, Eu or Gd based centrosymmetric Skyrmion host material have attract much interest in condensed matter physics. Because of its symmetry, their Skyrmion lattice (SkL) phase cannot be explained by the Dzyaloshinskii-Moriya interaction. There are several theories proposed as the origin of new SkL states [1-3]. In these theories, there are differences in the symmetry of the phases surrounding SkL phase. Therefore, in order to clarify how the SkL phase is stabilized in a certain system, it is necessary to clarify the adjacent phases.

Gd_2PdSi_3 is one of the centrosymmetric Skyrmion host material found recently. Gd_2PdSi_3 crystallize into AlB_2-type tetragonal structure [4]. Gd_2PdSi_3 exhibits antiferromagnetic orders at T_{N1} = 21 K, and T_{N2} = 19.5 K. The propagation vector $\boldsymbol{Q}$ in both phases is incommensurate and have $\boldsymbol{Q}$ = (q, 0, 0) with q ~ 0.14. The low temperature phase (IC-1) has elliptic screw type magnetic modulation [5]. It have not reached consensus whether the IC-1 phase is the multi-q order of these triple-q or the multi domain state of single-q orders.

In this research, we conducted a neutron elastic scattering experiment under uniaxial stress to examine the influence of in-plane stress in the IC-1 phase. If the domain fraction changes as stress increases, it can be probed as the change of the intensity of magnetic Bragg reflections. The experiments have conducted at a triple axis spectrometer PONTA(5G) installed at JRR-3. Enriched $^{160}Gd_2PdSi_3$ was produced by Y. Taguchi and K. Kikkawa of CEMS, RIKEN. We set (H0L) as scattering plane so as to apply the stress σ along vertical [010] direction. E_i = 14.7 meV and the collimation open-80'-80' were used. We also performed the experiment by using 2D detector produced by T. Nakamura and T. Kawasaki of J-PARC Center [6]. This experiment was carried out along the proposal No. 23522 and partly supported by ISSP of the University of Tokyo.

Figure 1(a) shows the intensity map around (1, 0, 0) reflection at ambient pressure. We observed 6 magnetic satellite reflections from three $\boldsymbol{Q}$s around a nuclear reflection simultaneously. The integrated intensities can be well reproduced by assuming each $\boldsymbol{Q}$ have same population. Figure 1(b) shows the integrated intensities of each magnetic reflections around (1, 0, 0) at σ = 0, and 200 MPa. By applying 200 MPa, we observed that the intensity of the reflections out of scattering plane changes systematically; the intensity of the two reflections closer to the origin $\boldsymbol{q_3}$ = (-q, q, 0) and -$\boldsymbol{q_2}$ = (0, -q, 0) decrease while the furthers $\boldsymbol{q_2}$ = (0, q, 0) and -$\boldsymbol{q_3}$ = (q, -q, 0) increase. This behavior cannot be explained by single-q multidomain scenario because two $\boldsymbol{Q}$ corresponding to these reflections are equivalent under the application of the stress along [010]. This result can be understood qualitatively by assuming a triple-q phase and the increase of the in-plane component of screw-type magnetic modulation.

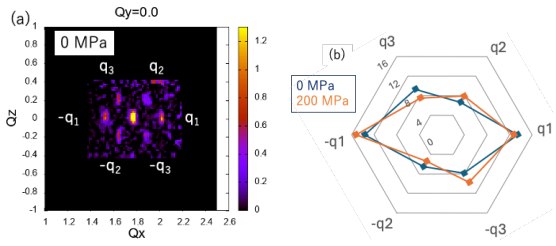

Figure 1 (a) Intensity map in (*HK*0) plane around (1, 0, 0) reflection. Q_x, Q_y, and Q_z corresponds to H, L, and K, respectively. (b) Integrated intensities of magnetic reflections at σ = 0, and 200 MPa.

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