Anisotropic damping of transverse acoustic and optical modes in the relaxor ferroelectric 0.7 $Pb(Mg_{1/3}Nb_{2/3})O_3$-0.3 $PbTiO_3$

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Relaxor ferroelectrics have gained great interest recently due to their promising application as piezoelectric devices. $Pb(Mg_{1/3}Nb_{2/3})O_3$ (PMN) is a typical relaxor which shows a broad and frequency dependent peak in dielectric susceptibility. It is widely believed that the polar nanoregions (PNR) occurring at temperatures much above T_c, the so-called Burns temperature T_d, play an important role in such relaxor behavior. The lattice dynamics in PMN are characterized by a soft, zone center, transverse optic (TO) mode observed below T_d, which is the so-called waterfall. Neutron scattering measurements by Naberezhnov *et al.* on PMN revealed the onset of strong diffuse scattering at or very near $T_d \sim 600$ K [1], indicating a close connection between the PNR and the diffuse scattering. Thus, it is expected that the local crystal distortion in PNR is driven by the soft TO. To elucidate the lattice dynamics in PNR, we investigated low energy phonon modes in PMN-30%PT. Neutron scattering experiments were performed on the triple-axis spectrometers HER installed at the JRR-3 Reactor of the JAEA.

Figures 1 show the constant Q spectrum at (2.15 1.85 0) and (2 -0.21 0) taken at $T = 600$, 400, and 200 K. If the lattice dynamics is isotropic, these spectrum show peaks for a transverse acoustic (TA) mode and a transverse optical (TO) mode at the same energies, because both Q's locate at the same $q = 0.21$ along the transverse direction from each Bragg position. At $T = 600$ K ($> T_C$), well-defined TA and TO modes were observed for (2 -0.21 0). For (2.15 1.85 0), while the TA mode looks very similar to that for (2 -0.21 0), the TO mode is softer and broader in energy than that for (2 -0.21 0). Below T_C, on the one hand, the TO mode for (2.15 1.85 0) becomes underdaped, on the other hand, the TA mode for (2.15 1.85 0) becomes overdamped as shown in Fig.1(b) and (c). The damped TA and TO modes were observed for $q =< 110 >$ directions which are the same directions of the anisotropic diffuse scattering. We speculated that PNR's trap soft phonon modes as a central peak. Besides, for the current case, PNR's may trap phonon modes anisotropically.

References

[1] A. Naberezhnov *et al.* , Eur. Phys. J. B, **11**, 13 (1999).

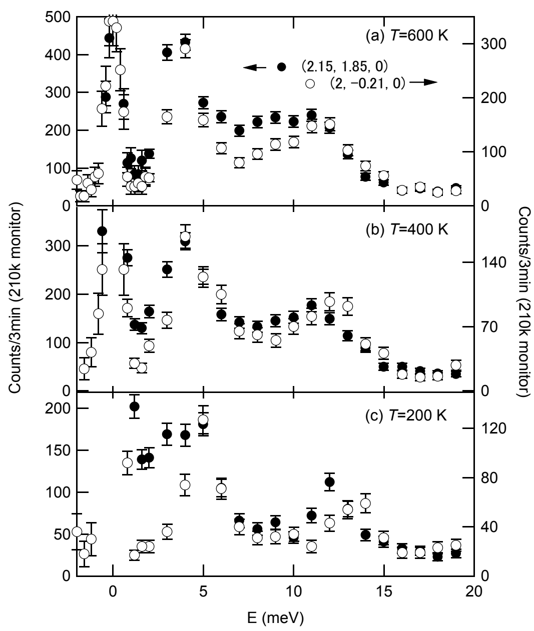

Fig. 1. Constant Q scan at (2.15 1.85 0) (closed circles) and (2 -0.21 0) (open circles) taken at $T = 600$, 400, and 200 K.