Pseudospin-phonon coupling in Relaxor Ferroelectrics PMN-x%PT

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Relaxor ferroelectrics gain much attention due to their extreme piezoelectric responses over a wide temperature range. It is widely believed that polar nanoregion (PNR), a local nanometer-sized region with ferroelectric polarization and atomic shift, plays an important role in the relaxor behavior. Despite intense investigations, the microscopic mechanism of the formation of PNR remains unclear. The structural phase transition are usually divided in displacement or of order-disorder type. From neutron scattering, soft mode was reported, suggesting displacement behavior[1]. On the other hand, quasi-elastic scattering has also been reported, which indicates order-disorder mechanism. This coexistence reminds pseudospin-phonon coupled system which was studied thoretically by Y. Yamada *et al.*[2] and confirmed experimentally by Y. Noda[3]. The purpose of the present work is to clarify the nature of pseudospin-phonon coupling in relaxors. Neutron scattering experiments on typical relaxor ferroelectrics PMN-30%PT single crystal were performed on the triple-axis spectrometers HER installed at the JRR-3 Guide-hall of the JAEA.

Figure 1 shows the contour map of the phonon scattering intensity at $(1+q, 1-q, 0)$ measured at $T = 400$ K. At $T = 400$ K($\sim T_C$), the transverse acoustic (TA) mode below 2.5 meV is heavily overdamped, while the TA mode above 2.5 meV is underdamped. This overdamping starts from $T \sim 500$ K on cooling. In the pseudospin-phonon coupled system, phonon becomes overdamped on cooling to T_C when phonon frequency is comparable to the relaxation rate of spin-flipping. On the other hand, underdamped spectrum is expected for higher frequency phonon modes than the relaxation mode. Current result indicate that relaxors is the intermediate case between displacive and order-disorder type due to strong coupling between relaxations ($\Gamma \sim 2.5$ meV) of polarization in PNR and phonon modes.

References

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[2] Y. Yamada *et al.*, J. Phys. Soc. Jpn, **36** 641 (1974).
[3] Y. Noda *et al.*, J. Phys. Soc. Jpn, **48** 1576 (1980).

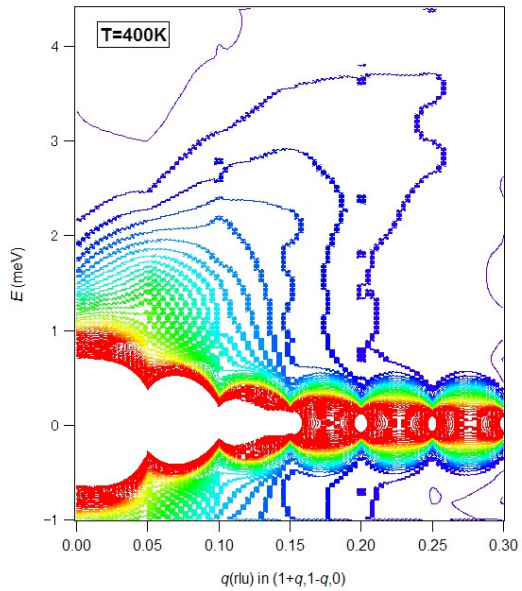

Fig. 1. The contour map of the phonon scattering intensity at $(1+q, 1-q, 0)$ as a function of q and energy measured at $T = 400$ K. The line of color shows intensity from 5 counts (blue) to 1000 counts (red).