Phonon dynamics of iron-based superconductors

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Recent discovery of superconductivity in LaFeAsO1-xFx at superconducting temperature of Tc=26K has triggered the energetic study of searching a new superconductor. The fact that Tc of Fe-based superconductors is sensitive to crystal structure implies the importance of lattice dynamics. Calculations using the density functional perturbation theory, however, only found a moderated electron-phonon coupling constants, which is too small to explain the high Tc's. A conventional electron-phonon coupling can thus be excluded as pairing mechanism, nevertheless unconventional coupling might still be possible. Studies on phonon dynamics using single crystals are essential for elucidating the role of phonons in the appearance of superconductivity in Fe-based superconductors.

We found that phonon softening occurs under K doping in Ba1-xKxFe2As2 using inelastic X-ray scattering technique [1]. On the other hand, no softening occurs under Co doping in Ba(Fe1-xCox)2As2. In this study, we try to clarify whether there is an anomaly at Tc in optimum doped Ba(Fe1-xCox)2As.

Neutron scattering measurements were carried out using a triple-axis spectrometer, TOPAN at the JRR-3 reactor of JAEA at Tokai. A single crystal of Ba(Fe1-xCox)2As2 was grown by the self-flux method using excess FeAs. A single crystal was installed in an Al container filled with He thermal exchange gas. A closed cycle He refrigerator was used to cool samples down to 8 K with temperatures monitored by a Si diode.

We measured phonon dispersion along [100] and [110] directions at T=R.T, 31K, and 8K. As results we could not find a softening with cooling. We only found a hardening at low temperature owing to volume shrinkage. Further study is required to find a fingerprint of correlation between phonon and superconductivity in iron-based superconductors.

[1] C. H. Lee et al., J. Phys. Soc. Jpn. 79, 014714 (2010).