

INVITED

Effect of Lattice Dynamics on Superconductivity in Iron Pnictides

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Recent discovery of superconductivity in $\text{LaFeAsO}_{1-x}\text{F}_x$ at superconducting temperature of $T_c=26\text{K}$ has triggered the energetic study of searching a new superconductor. The fact that T_c of Fe-based superconductors is sensitive to crystal structure [1] implies the importance of lattice dynamics. We, therefore, considered that study on crystal structure as well as phonon dynamics is essential to elucidate the mechanism of superconductivity in Fe-based superconductors.

We conducted inelastic x-ray scattering measurement using the synchrotron radiation x-ray at BL35XU in Spring-8 to study phonon dynamics of $\text{Ba}_{1-x}\text{K}_x\text{Fe}_2\text{As}_2$ system. Single crystals of $\text{Ba}_{1-x}\text{K}_x\text{Fe}_2\text{As}_2$ were used for the measurements. We have clarified phonon dispersion of non-doped BaFe_2As_2 and superconducting $\text{Ba}_{1-x}\text{K}_x\text{Fe}_2\text{As}_2$ at room temperature. Comparing both dispersions, we have clarified the difference between non-doped and superconducting samples.

To study crystal structure of LnFeAsO_{1-y} ($\text{Ln}=\text{La, Ce, Pr, Nd, Tb}$ and Dy), we conducted neutron diffraction measurement using high-resolution powder diffractometer D2B of the ILL in Grenoble, France and HERMES of the Institute for Materials Research, Tohoku University, installed at the JRR-3 reactor of JAEA at Tokai. The obtained spectra were analyzed by the Rietveld method.

We have clarified the superconducting phase diagram of LaFeAsO_{1-y} and NdFeAsO_{1-y} by estimating the oxygen content. Both systems show superconductivity above $y\sim 0.06$. But, doping dependence of T_c is different. In LaFeAsO_{1-y} , T_c attains maximum values at around $y=0.12$ and decreases with increasing y . Whereas in NdFeAsO_{1-y} , T_c increases till $y=0.26$. It seems that there is no universal relationship between T_c and carrier concentration. The obtained lanthanoid dependence of crystal structure parameters shows that FeAs_4 -tetrahedrons form a regular tetrahedron around $\text{Ln}=\text{Nd}$. [1] The relationship between the distortion of FeAs_4 -tetrahedrons and T_c indicates that T_c attains maximum values when FeAs_4 -lattices form a regular tetrahedron. These results suggest the clear relationship between structure and superconductivity.

[1] C. H. Lee et al., J. Phys. Soc. Jpn. 77 (2008) 083704.

Keywords : Pnictide superconductors, crystal structure analysis, neutron diffraction, inelastic x-ray scattering, phonon