High Pressure Science

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High-pressure studies on the crystal structure of iron-based superconductors

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Introduction

The discovery of an iron-based layered superconductor $LaFeAsO_{1-x}F_x$ [1] with T_c of 26 K had a significant impact in the field of condensed matter physics and had triggered the rapid development of extensive investigation of superconductivity. In these studies, high-pressure experiments have been played an important role. Large enhancement of T_c under high pressure was revealed for 1111-type iron-based superconductors [2-4], which indicates the pressure effect is one of the important routes to investigate the iron-based superconductors.

Experimental

Polycrystalline samples of 1111-type iron-based superconductors were synthesized by a solid state reaction method [1]. The high-pressure x-ray diffraction measurements were performed using synchrotron radiation at PF-BL18C at High Energy Accelerator Research Organization (KEK) with a wavelength of 0.061642 nm. High-pressure was generated using a diamond anvil cell (DAC) with a liquid pressure-transmitting medium (methanol:ethanol = 4:1).

Results and discussion

The normalized volume V/V_0 for $LaFeAsO_{1-x}F_x$ and LaFePO as a function of pressure at room temperature are shown in Fig. 1(a). The normalized lattice constants a/a_0 and c/c_0 are shown in Fig. 1(b), where the c/c_0 is more compressible than the a/a_0 for both systems, which is usually observed in the layered compounds. Moreover, the value of c/a decreases linearly with applying pressure. The linear compressibility of κ_c in LaFePO is smaller than the values of $LaFeAsO_{1-x}F_x$. Although a bulk modulus is 1.5 times larger than that of $LaFeAsO_{1-x}F_x$, the pressure dependence of the linear compressibility ratio κ_c/κ_a shows the almost same value for both compounds. From these results, the compression curves of the iron-based superconductors are similar to cuprate superconductors. Recently, it is indicated that the T_c correlates with precise crystal parameters, for example, atomic positions, bond angles, and so on [5]. It is necessary to perform further high-pressure x-ray diffraction measurements to determine precise crystal parameters, in order to understand the pressure effect on T_c.

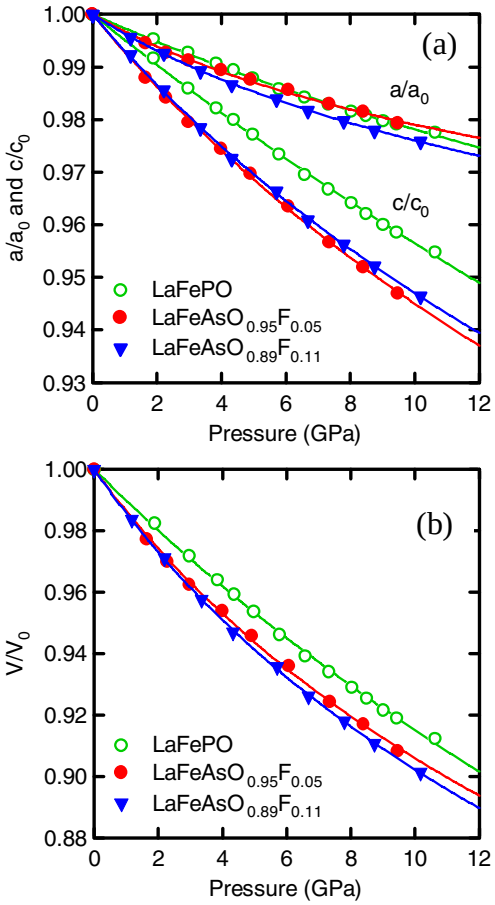

Figure 1. Pressure dependence of (a) the normalized volume V/V_0 and (b) the normalized lattice constants a/a_0 and c/c_0 for $LaFeAsO_{1-x}F_x$,(x=0.05 and 0.11) and LaFePO. The solid curves are guides to eyes.

References

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