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Structural study of 112-type $Ca_{1-x}La_xFeAs_2$

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1 Introduction

Synchrotron x-ray diffraction studies of $Ca_{1-x}La_xFeAs_2$ [1] with monovalent arsenic zigzag chain layers are presented. While the crystal twins appear in all samples for the nominal composition of x = 0.25, we successfully obtained the samples without crystal twins for the nominal composition of x = 0.17.

2 Experiment

Single crystalline samples of $Ca_{1-x}La_xFeAs_2$ with x = 0.17 and 0.25 were synthesized by the conventional solid state reaction method. Single crystalline x-ray diffraction data were collected at BL8A beamline at KEK facility (Japan). A typical size of 40 × 40 × 20 μm^3 was measured with the wavelength of 0.6899 Å. The electrical resistivity ρ_{ab} (parallel to the *ab*-plane) and magnetization M were measured using the standard DC four-terminal method in a physical property measurement system (Quantum Design PPMS) and a SQUID magnetometer (Quantum Design MPMS) equipped at the Institute for Solid State Physics (ISSP, Japan), respectively.

3 Results and Discussion

Fig.1 shows the single crystal x-ray diffraction patterns of the present material, $Ca_{1-x}La_xFeAs_2$ with nominal composition of x = 0.25. At a first glance, Bragg peaks are split by two with streaks in between them, clearly indicating the appearance of twinned domains. In the experiments, we checked 40 samples in total and found that the twin domains appear in all samples measured. The twin peaks can be successfully indexed by assuming that the domains are sharing the plane parallel to *bc* plane, as shown in Fig.1. Due to the twin formation in the present material with the monoclinic structure of β ~ 91.4°, the surface of the crystal should be waving, which can be clearly observed using polarized microscope, as shown in Fig.1. The structural analysis of the twinned samples is possible in principle, however, the appearance of streaks prevent us from obtaining accurate structural parameters.

On contrast to the samples with nominal composition of x = 0.25, we successfully obtained samples without any twinned domains for the nominal composition of x = 0.17. The single crystal x-ray diffraction patterns clearly exhibit narrow Bragg peaks without any signs of splitting. The obtained samples show bulk superconductivity at the onset T_c = 25 K with a shielding volume fraction (VF) of 35% in magnetic susceptibility measurement. The emergence of the superconductivity can be also confirmed using electronic resistivity measurement with

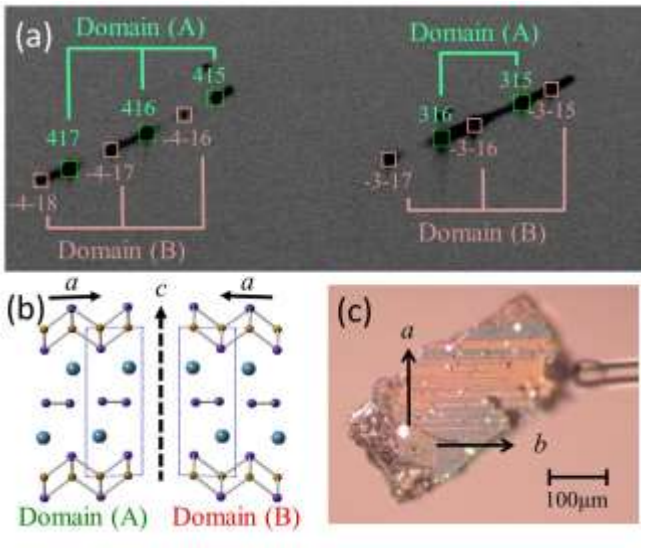

Fig.1 (a) Single crystal x-ray diffraction patterns of $Ca_{1-x}La_xFeAs_2$ with nominal composition of x = 0.25. Peaks are split due to the crystal twins. (b) Schematic view for the relationship between twinned domains in the real space. (c) Polarized microscope image for a single crystal with twinned domains.

the trace superconductivity at the onset T_c = 47 K, which is the highest record of trace superconductivity among all 112-type superconductors reported so far. The transition temperatures are gradually suppressed by increasing magnetic fields. La content x is refined to be 0.182(5) from the single crystal x-ray diffraction experiment, which is close to the nominal value of x = 0.17. It is noteworthy that the relationship between bulk T_c determined from the magnetic susceptibility measurement and the La content x can be well plotted on the phase diagram presented in the previous report [2]. Compared with the reported lattice parameter of $Ca_{1-x}La_xFeAs_2$ with x = 0.195 [1], we can find the x dependence in lattice parameters is small. In order to have a further critical discussion about the deviation of lattice parameters depending on x, more systematic structural studies should be performed in near future.

References

[1] N. Katayama *et al.*, J. Phys. Soc. Jpn. 82 (2013) 123702.
[2] K. Kudo *et al.*, J. Phys. Soc. Jpn. 83 (2014) 093705.

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