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Twin-to-single crystal transformation in $La_{1-x}Sr_xCoO_3$ by magnetic fields

Tôru KYÔMEN*, Minoru HANAYA, Masahiro Naito, Kenta Hiiragi, Kosuke SUZUKI and Masahisa ITO
Graduate School of Engineering, Gunma University, Kiryu, Gunma 376-8515, Japan

Introduction

Electronic and spin states of a metallic ferromagnet $La_{1-x}Sr_xCoO_3$ have attracted many researchers since suggestion of intermediate-spin state [1]. However, difficulty of the single crystal preparation disturbs the progress in the research of the compounds.

$La_{1-x}Sr_xCoO_3$ ($0 \leq x \leq 0.7$) crystals have a cubic perovskite-type structure at high temperatures and transform to a rhombohedral structure by contraction in a [111] direction of the cubic unit cell at a low temperature. There are thus four variants in the rhombohedral phase. In actual, any crystal we have grown was not a single crystal but a twin crystal [2].

In our previous studies [3], we have observed that the variants of $La_{1-x}Sr_xCoO_3$ twin crystal were reoriented by magnetic fields and suggested the origin is strong magnetocrystalline anisotropy with a plane of easy magnetization. In the present study, we tried and succeeded to change a $La_{0.57}Sr_{0.44}CoO_{3.01}$ twin crystal a single crystal by applying magnetic fields.

Experimental

$La_{0.57}Sr_{0.44}CoO_{3.01}$ twin crystals were grown by a flux method [2]. The Curie temperature was about 240 K. 100 Laue spot was measured at 60 K in order to investigate the change in the twin structure by magnetic fields. The *c* axis of one variant (variant 1) was aligned to the vertical line and the *ab* plane was set parallel to the horizontal plane. An imaging plate was set for the normal line to be perpendicular to the incident X-ray direction.

Results and Discussion

Figure 1(a) shows 100 (indexed by hexagonal setting of rhombohedral lattice) Laue spot of a $La_{0.57}Sr_{0.44}CoO_{3.01}$ twin crystal measured at 60 K before applying magnetic fields. Because of the twin structure, the 100 Laue spot split into a few spots. After this measurement, 20 kOe magnetic field was applied along a direction parallel to the *ab* plane (plane of easy magnetization) of variant 1 and the crystal was rotated by 120° about the *c* axis under the fields. During the rotation, the magnetic field was always parallel to the plane of easy magnetization. Then, the magnetic field was changed to zero, and 100 Laue spot was measured again as shown in Fig. 1(b). It is found that the splitting disappeared.

The result was understood as follows. There are four variants in the crystal. The variant 1 has the lowest magnetic energy among the four variants when the magnetic field was applied parallel to the plane of easy magnetization. The other variants have higher energy. The energy of the other variants changes by rotating the crystal about the *c* axis of variant 1. The variants would transform to variant 1 when the magnetic energy is highest.

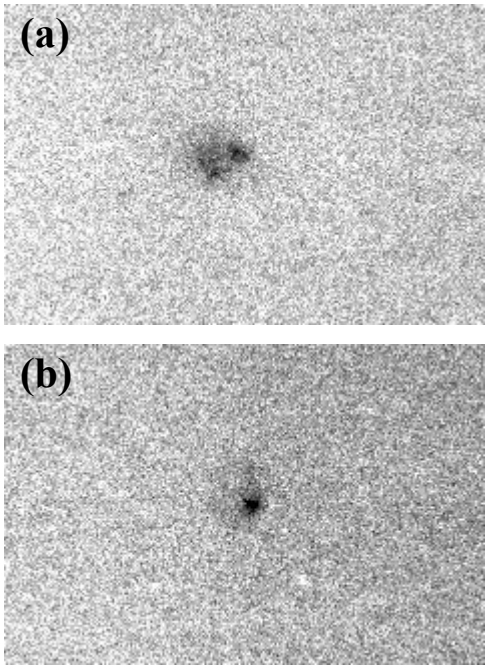

Figure 1 100 Laue spot before (a) and after (b) applying magnetic fields parallel to an easy-plane of magnetization of a $La_{0.57}Sr_{0.44}CoO_{3.01}$ twin crystal.

Conclusions

It was succeeded to change a $La_{0.57}Sr_{0.44}CoO_{3.01}$ twin crystal a single crystal by applying magnetic fields along all directions parallel to an easy-plane of magnetization.

References

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*tkyomen@ gunma-u.ac.jp