3C/2008G560

Magnetic-field induced reorientation of variants in a $La_{1-x}Sr_xCoO_3$ twin crystal

Tôru KYÔMEN*, Akito SANO, Minoru HANAYA, Kosuke SUZUKI and Masahisa ITO
Graduate School of Engineering, Gunma University, Kiryu, Gunma 376-8515, Japan

Introduction

$La_{1-x}Sr_xCoO_3$ ($0 \leq x \leq 0.7$) crystals have a cubic perovskite-type structure at high temperatures and transform to a rhombohedral structure with contraction in [111] direction of cubic unit cell at a low temperature. There are thus four variants in the rhombohedral phase and ferroelastic properties have been reported in $LaCoO_3$ [1]. In addition, $La_{1-x}Sr_xCoO_3$ ($x \geq 0.2$) crystals show a ferromagnetic phase transition below 250 K [2]. Therefore, $La_{1-x}Sr_xCoO_3$ crystals are multiferroic materials with ferroelastic and ferromagnetic properties.

Recently, we succeeded to prepare high-quality single crystals of $La_{1-x}Sr_xCoO_3$ and clarified that this crystal has strong uniaxial magnetocrystalline anisotropy with magnetization-easy plane [3]. Moreover, we observed anomalous magnetization process, which implies that the variants are reoriented by magnetic fields, when a magnetic field was applied in [110] direction of pseudocubic unit cell. On the other hand, no anomalous magnetization process was observed in [100] direction. The origin of this anomalous magnetization process was investigated in the present study.

Experimental

$La_{0.57}Sr_{0.44}CoO_{3.01}$ single crystals were grown by a flux method [3]. Change in the twin structure by magnetic fields was investigated by Laue method at 30 K. An imaging plate was set for the normal line to be perpendicular to the incident X-ray direction.

Results and Discussion

Figure 1 shows Laue photographs obtained with the following procedures. The photograph 1(a) was taken just after the sample was cooled down to 30 K. It is found that each Laue spot splits into several spots due to twin structure. After the photograph 1(a) was taken, 2 T magnetic field was applied close in [110] direction of pseudocubic unit cell and then the photograph 1(b) was taken in 2 T. It is found that left-bottom spot of each Laue spot disappeared. Then, the magnetic field was turned off and the photograph 1(c) was taken in 0 T. No appreciable difference was observed between 1(b) and 1(c). Then, 2 T magnetic field was applied in [1-10] direction for 5 min. After the magnetic field was turned off, the photograph 1(d) was taken in 0 T. It is found that left-bottom spot of each Laue spot appeared again.

Figure 2 shows Laue photographs obtained with the following procedures. The photograph 2(a) was taken in 0 T after 2 T magnetic field was applied close in [110] direction for 5 min and then turned off. Then, 2 T magnetic field was applied close in [100] direction for 5 min. After the magnetic field was turned off, the photograph 2(b) was taken in 0 T. There is no difference between 2(a) and 2(b). The photograph 2(c) was taken in 0 T after 2 T magnetic field was applied close in [1-10] direction for 5 min and then turned off. Then, 2 T magnetic field was applied close in [100] direction for 5 min. After the magnetic field was turned off, the photograph 2(d) was taken in 0 T. There is also no difference between 2(c) and 2(d).

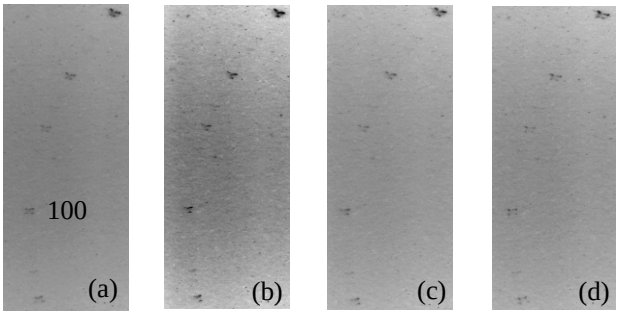

Figure 1 Laue patterns obtained before and after applying 2 T magnetic field close in [110] or [1-10] directions. See text for details.

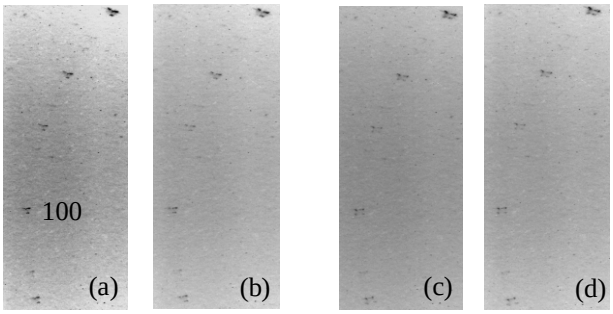

Figure 2 Laue patterns obtained before and after applying 2 T magnetic field close in [100] direction. See text for details.

Conclusions

The present study clearly showed that the variants in a $La_{1-x}Sr_xCoO_3$ twin crystal are not reoriented by magnetic fields in [100] directions but reoriented by magnetic fields in [110] directions, which is consistent with the results of magnetization measurements.

References

[1] N. Orlovskaya et al., Acta Materialia **50**, 715 (2002).
[2] M. A. Senaris-Rodriguez et al., J. Solid State Chem. **118**, 323 (1995).
[3] T. Kyômen et al., Chem. Mater. **20**, 5114 (2008).

*tkyomen@chem-bio.gunma-u.ac.jp