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# Structural variations of ferroelectric material $(Bi_{1-x}La_x)_2SiO_5$ ($0 < x < 0.1$)

J. Yamaura[1,*], H. Taniguchi[1,2], S. Tatewaki[2], S. Yasui[3], Y. Fujii[4], I. Terasaki[2]
[1]Materials Research Center for Element Strategy, Tokyo Institute of Technology, Kanagawa, Japan
[2]Department of Physics, Nagoya University, Aichi, Japan
[3]Laboratory for Materials and Structures, Tokyo Institute of Technology, Kanagawa, Japan
[4]Department of Physical Sciences, Ritsumeikan University, Shiga, Japan

Ferroelectric materials have been explored in a long while. They have usually an oxygen octahedral coordination to the central transition metal, however, a ferroelectric tetrahedral oxide recently reported in $Bi_2SiO_5$ [1]. The ferroelectricity comes from zig-zag tilting of $SiO_4$ one-dimensional chains. Moreover, an internal deformation of $SiO_4$ tetrahedron gives rise to large spontaneous polarization. A ferroelectric phase transition in $Bi_2SiO_5$ occurs with changing from a high-temperature paraelectric *Cmcm* phase to a low-temperature ferroelectric *Cc* phase at 673 K.

In order to investigate an origin of the dielectric anomaly observed in the low-temperature, synchrotron powder X-ray diffraction measurements were performed for $(Bi_{1-x}La_x)_2SiO_5$ ($x$ = 0, 0.10) using the curved imaging plate diffractometer at the wavelength of $\lambda$ = 0.99925 Å on BL-8A, KEK-PF. The images were integrated to yield $2\theta$-intensity data. The structure analysis was examined with RIETAN-FP program [2].

Figure 1 shows the lattice parameters for $x$ = 0 on *Cc* space group in monoclinic crystal system [3]. Two anomalies were observed at 30 K and 100 K for every crystallographic axis, corresponding to the observed dielectric anomaly. Because neither extra peak nor additional peak split was obtained in the diffraction patterns at the lowest temperature, we consider that no further symmetry lowering exists within the experimental resolution. In $x$ = 0.10, the low-temperature lattice anomalies disappear as illustrated in Fig. 1. This trend is in good agreement with the $x$ dependence of ferroelectricity [3]. Taking account of the strong correlation between ferroelectricity and crystal structure, the low-temperature anomaly is considered to originate from the ordered one-dimensional $SiO_4$ chains. This is similar to an isosymmetric phase transition in orthopyroxene, strongly related to the one-dimensional $SiO_4$ tetrahedral chains. Thus, we suggest that isosymmetric transitions emerge with the present lattice anomalies observed at low-temperature.

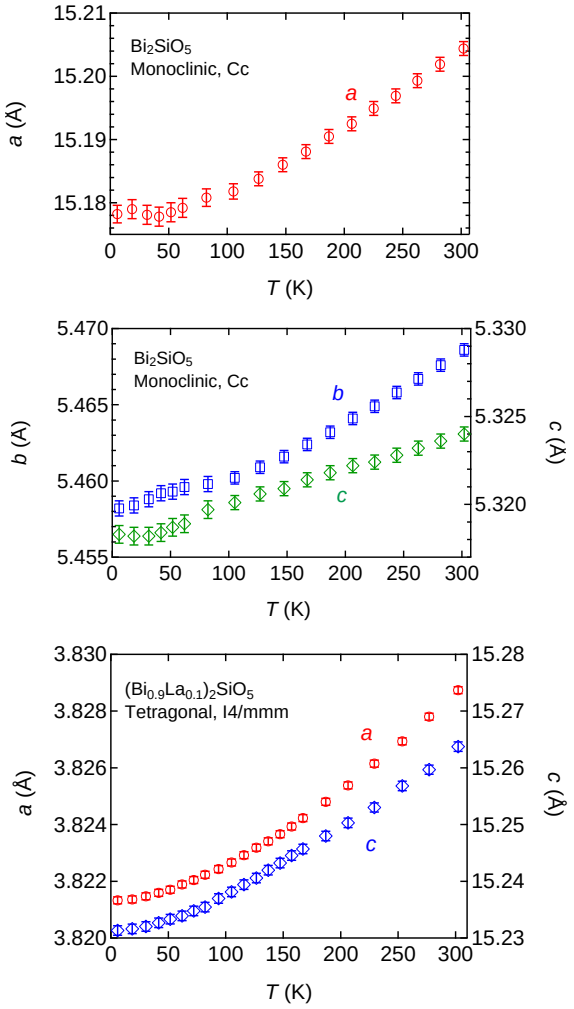


Fig. 1 Lattice parameters for $(Bi_{1-x}La_x)_2SiO_5$ ($x$ = 0, 0.10) [3]. The $x$ = 0 compound is monoclinic, *Cc* structure and the $x$ = 0.1 compound is tetragonal, *I*4/*mmm* structure. The $\beta$ angle data in $x$ = 0 is not shown here. In the $x$ = 0 two anomalies are observed at 30 K and 100 K, while the anomalies disappear in the $x$ = 0.1.

References

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* jyamaura@mces.titech.ac.jp