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Electrical and Structural Properties of $BiFeO_3$-$BaTiO_3$ lead-free piezoelectric ceramics

Interdisciplinary Graduate School of Medicine and Engineering, University of Yamanashi [1],

○Sangwook Kim[1] and Satoshi Wada[1]

E-mail: swada@yamanashi.ac.jp

Lead-based piezoelectric bulk ceramics, such as $Pb(Zr,Ti)O_3$, are used for various devices, because of their excellent piezoelectric properties. However, the toxicity of lead and its high vapor pressure have led to a demand for alternative lead-free piezoelectric materials that are environmentally benign from the viewpoint of sustainable development. Recently, the $BiFeO_3$-$BaTiO_3$ ceramics are kind of replacement lead-based piezoelectric materials. The $BiFeO_3$-$BaTiO_3$ lead-free piezoelectric ceramics have a potential to be applied at high operation temperature, because of their high curie temperature. The phase diagrams of $BiFeO_3$-$BaTiO_3$ lead-free ceramics were reported two different phase diagram. M. M. Kumar *et al*. reported that structure was changed from rhombohedral to cubic at $0.67BiFeO_3$-$0.33BaTiO_3$ composition. On the other hand, S. O. Leontsev and R. E. Eitel reported that structure was changed from rhombohedral to pseudo-cubic structure at $0.75BiFeO_3$-$0.25BaTiO_3$ composition. The information of phase transition composition is unclear in $BiFeO_3$-$BaTiO_3$ system.

In this study, $(1-x)BiFeO_3$-$xBaTiO_3$ (x = 0.25, 0.30, 0.33, 0.35, and 0.40) bulk ceramics were formed using solid state reaction method. The crystal structures were investigated using x-ray diffractometer. The crystal structures of solid solution ceramics are rhombohedral for $0.80BiFeO_3$-$0.20BaTiO_3$, an intermediate structure between rhombohedral and pseudo-cubic for $0.75BiFeO_3$-$0.25BaTiO_3$ and a pseudo-cubic structure from x = 0.30 to 0.40, respectively. The lattice parameters and cell volumes were increased with increasing $BaTiO_3$ contents. The shapes of polarization-electric field hysteresis loops were changed from hard-type to soft-type, because $BiFeO_3$ and $BaTiO_3$ are hard-type and soft-type ferroelectrics. The remanent polarization were highest observed ~34 $\mu C/cm^2$ at $0.75BiFeO_3$-$0.25BaTiO_3$ composition. The coercive field were decreased with increasing $BaTiO_3$ contents. The piezoelectric properties, strain value from Strain – Electric filed curves, were observed ~ 0.20% with 60 kV/cm in $0.70BiFeO_3$-$0.30BaTiO_3$ composition. The negative strain were decreased with increasing $BaTiO_3$ contents, because of decreasing coercive field. More detailed properties will be discussed in presentation.