The Origin of the Thermal Treatment Effects on Crystal Structure and Electrical Properties in $BiFeO_3$-$BaTiO_3$ Lead-free System

Interdisciplinary Graduate School of Medicine and Engineering, University of Yamanashi,

Sangwook Kim, Gopal Prasad Khanal, and Satoshi Wada

E-mail: swada@yamanashi.ac.jp

The lead-based piezoelectric materials, such as $Pb(Zr,Ti)O_3$, are widely used in the piezoelectric devices, because of their high piezoelectric properties in morphotropic phase boundary. However, high toxicity and environmental problem of lead, the lead has been restricted for use. Recently, $BiFeO_3$-$BaTiO_3$ lead-free system is one of replacement for lead-based piezoelectric materials, because their high Curie temperature. In the early stage of $BiFeO_3$-$BaTiO_3$ study, the electrical properties of $BiFeO_3$-$BaTiO_3$ were less than those of other piezoelectric materials. Recently, it is reported that electrical properties were enhanced with thermal treatment process in lead-free piezoelectric system.

In this study, $0.80BiFeO_3$-$0.20BaTiO_3$ (BF20BT) lead-free ceramics were fabricated with solid state reaction method. In order to study for thermal treatment effects, the three types samples were prepared with as-sintering ($BF20BT_S$), annealing ($BF20BT_A$), and quenching ($BF20BT_Q$) process. The crystal structure were investigated from x-ray diffractometer and Rietveld method. The crystal structure were observed with rhombohedral structure. The lattice parameter, volume, and lattice distortion were increased with quenching process. The piezoelectric properties were investigated from strain – electric field (S-E) curves. The piezoelectric properties were increased with quenching process. The ferroelectric properties were observed with polarization – electric field (P-E) hysteresis loops. The remanent polarization were increased with quenching process. The imprint behaviors was observed in $BF20BT_S$ and $BF20BT_A$. However, the imprint behaviors was not observed in the $BF20BT_Q$ ceramics as shown in fig 1(a) and (b). In other study for quenching effect, the bond-length and polyhedral distortion were calculated with final structure refinement results. The A-O bond length and B-O bond length behaviors were diffraction exhibited with thermal treatment process. More detailed structural and electrical properties will be discussed in presentation.

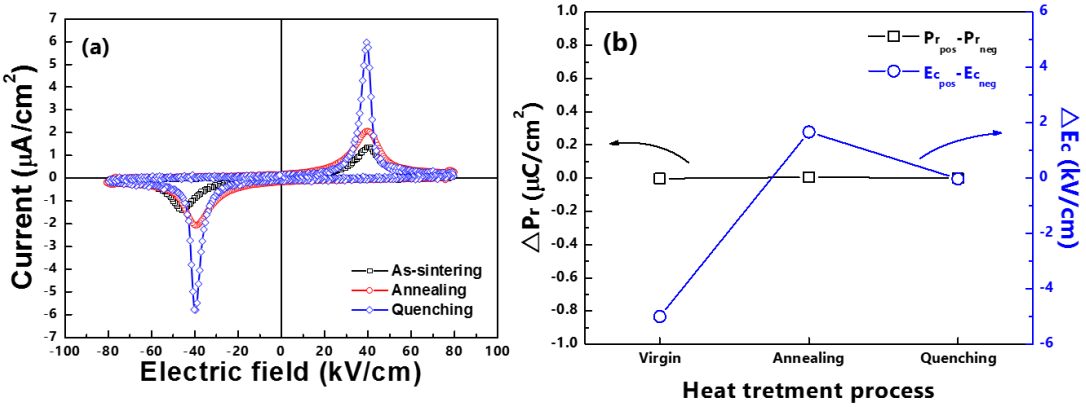

Figure 1 (a) The switching current and (b) imprint behaviors with heat treatment process.