Material design direction using materials softening for high performance piezoelectric ceramics

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Nowadays, lead-based piezoelectric ceramics are used piezoelectric devices, because of their high piezoelectric property in morphotropic phase boundary (MPB). However, lead has been restricted for use, because of high toxicity and environmental problem. Recently, the $BiFeO_3$-$BaTiO_3$ (BF-BT) lead-free piezoelectric ceramics has attracted attention to alternate of lead-based piezoelectric ceramics, because of their high piezoelectric property and high Curie temperature. The BF-BT ceramics. An interesting property of BF-BT ceramics is that maximum piezoelectric response is exhibited meanwhile the ferroelectric property decreasing trend. This phenomenon is related to material softening. However, the origin of material softening in the BF-BT system is unclear.

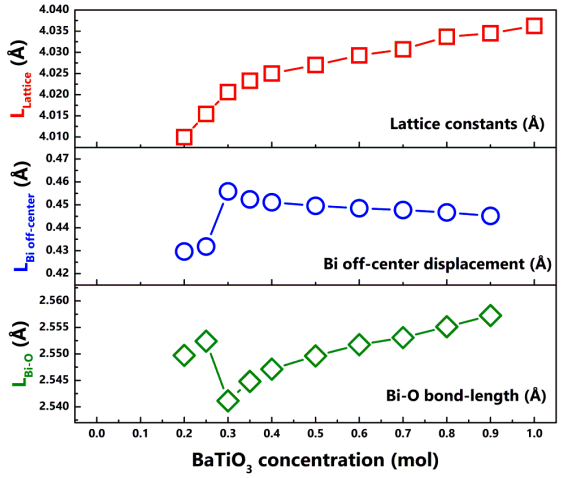

Figure 1 The structural parameters of $BiFeO_3$-$BaTiO_3$ ceramics as a function $BaTiO_3$ concentration.

In this study, the origin of material softening in BF-BT ceramics were investigated in detail along with their structural characteristics. The maximum material softening was exhibited by the BF30BT ceramics. The crystal structure of BF30BT ceramics was cubic (950K) and rhombohedral (300K) structure with Bi^{3+} ion off-centering. Thus, the BF30BT ceramics revealed the maximum Bi off-center displacement, while the Bi-O bond-length was maintained to minimum. The material softening mechanism is confirmed to be related to Bi^{3+} ion off-centered crystal structure in BF-BT ceramics. Finally, the material design direction was proposed with material softening mechanism caused by Bi off-centering. More detail of results and process will be discussed in the presentation.