Post-annealing and quenching effect on electrical property in $BaTiO_3$-$Bi(Mg_{1/2}Ti_{1/2})O_3$-$BiFeO_3$ piezoelectric ceramic

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Lead-based piezoelectric materials have been widely used in various applications for their excellent properties. However, the worldwide environmental regulations have restricted lead-based materials. Therefore, it is important to find lead-free piezoelectric ceramics. Recently, the $BiFeO_3$ (BF)-based ceramics is being considered as replacements for lead-based piezoelectric materials. However, in Bi-based ceramics, the presence of the charged defect complexes greatly affects the piezoelectric and ferroelectric properties because they can pin domain walls as reported by Rojac et al. But these electrical properties were enhanced by the post-annealing and subsequent quenching process because of domain wall de-pinning. [1].

In this work, the effect of A site / B site molar ratio, post-annealing temperature and holding time, and quenching on the ferroelectric and piezoelectric properties was investigated for Mn-added $0.3BaTiO_3$-$0.1Bi_x(Mg_{1/2}Ti_{1/2})O_3$-$0.6BiFeO_3$(BT-$B_x$MT-BF, x=0.95, 1.00, 1.03, 1.05, 1.08) piezoelectric ceramics. The BT-B_xMT-BF ceramics were prepared by solid state synthesis of $BaTiO_3$ (BT), $BiFeO_3$ (BF), Bi_2O_3, MgO, and TiO_2 powders. These powders were mixed according to the chemical formula and calcined at 700°C for 10h. Here, a $0.3BaTiO_3$-$0.1Bi(Mg_{1/2}Ti_{1/2})O_3$-$0.6BiFeO_3$ (BT-BMT-BF) powder produced by Nippon Chemical Industrial was also used for comparison. Then, a mixture of the BT-B_xMT-BF or BT-BMT-BF powder and a 0.05wt% MnO_2 powder were sintered at 1000°C for 2h. The ceramics were post-annealing at T_a=600~1000°C for 1~20h, and then furnace-cooled or quenched to room temperature. The Polarization – Electric field (*P*-*E*) hysteresis loops and Strain – Electric field (*S*-*E*) curves were measured by a ferroelectric characteristic system. Figure 1 shows P_r and E_c of as-sintered BT-BMT-BF ceramics and BT-BMT-BF ceramics post-annealed at T_a=600~1000°C for 20h and then quenched. With the post-annealing and quenching treatment, well-developed P-E loops were observed at $T_a \geq 700$°C. The remanent polarization was tended to increase with T_a, while the coercive field was increased up to T_a=700°C and then saturated. The effects of the holding time and the A/B ratio in the BT-B_xMT-BF ceramics will be also presented.

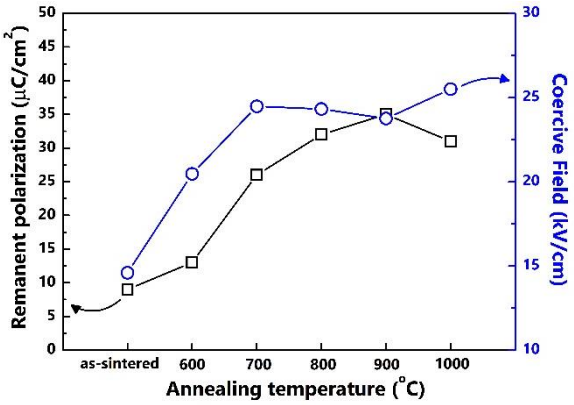

Figure 1. P_r and E_c value as a function of post-annealing temperature

References

[1] Tadej Rojac, Marija Kosec, Bojan Budic, Nava Setter and Dragan Damjanovic, *Journal of Applied Physics*, 108, 074107 (2010)