Microstructure Control of BT-BMT-BF Piezoelectric Ceramics by Dopant Engineering

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[Introduction] Although lead zirconate titanate (PZT)-based piezoelectric ceramics are commonly used for many applications because of their excellent piezoelectric and dielectric performance, these ceramics contain a substantial amount of Pb which can harm the environment and health. Therefore, we attempt to develop lead-free ceramics with a potential to replace the PZT. To achieve high piezoelectric performance, we have tried to reduce domain size of ferroelectrics to the nano-size and to increase the domain-wall density. We have reported for $BaTiO_3$-$Bi(Mg_{0.5}Ti_{0.5})O_3$-$BiFeO_3$ (0.3BT-0.1BMT-0.6BF) piezoelectric ceramics with the nano-domain structure, and they exhibit the high piezoelectric response, d_{33} of 799 pm/V. We also demonstrated that vanadium-doping is the effective way to suppress the current leakage of BT-BMT-BF ceramics [1], though the effect of doping on microstructures and electrical properties has not been understood. In this study, we attempted to reveal the effect of the dopants.

[Experimental Procedure] The calcined BT-BMT-BF powders were mixed with 2 mol% of dopant, ZnO, TiO_2, CuO, Bi_2O_3, or SiO_2 by ball-milling. Then, these mixed powders were pressed into compacts and were sintered at 1000 and 1050°C for 10 hours with a heating rate of 300°C/h. The chemically polished surfaces of the sintered ceramics were observed by SEM.

[Results and Discussion] Figure 1 shows the effect of dopants on microstructures of the BT-BMT-BF ceramics. The average grain size of the ZnO-doped BT-BMT-BF is the largest than the other doped and the undoped BT-BMT-BF ceramics.

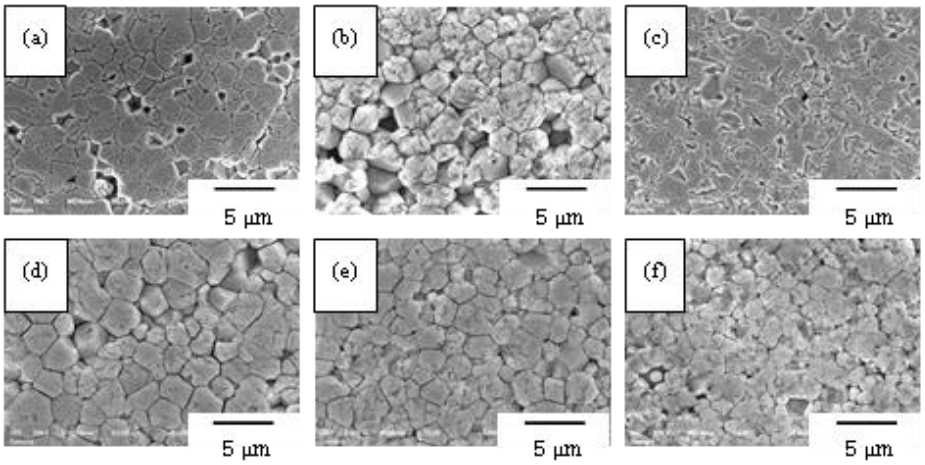

Figure 1 SEM images of the BT-BMT-BF ceramics sintered at 1000°C for 10 h (a) without dopant and with dopants of (b)ZnO, (c)TiO_2, (d)CuO, (e)Bi_2O_3 and (f)SiO_2.

[1] I. Fujii *et al.*, J. Ceram. Soc. Jpn., 121, 589-592 (2013).