$Bi(Mg_{2/3}Nb_{1/3})O_3$-$BaTiO_3$-$BiFeO_3$ PbO-free Piezoelectric Ceramics

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$Pb(Zr,Ti)O_3$ (PZT) has been widely applied in piezoelectric devices over the past few decades. However, concerns about environmental and health problems are growing because lead has significant toxicity [1]. $BaTiO_3$-$BiFeO_3$ (BT-BF) based materials are promising candidates for lead free piezoelectric materials. Lee reported that BT-BF based ceramics have high piezoelectric coefficient, d_{33} = 402 pC/N coupled with a high T_C = 454ºC after quenching [2]. However, there are challenges in applying quenched BT-BF ceramics for industrial applications such as poor mechanical reliability. Moreover, BT-BF ceramics lack the high temperature reliability needed for high strain/field piezoelectric applications such as fuel injectors for automotive engines. It has been suggested that the high leakage current results from either loss of Bi or formation of Fe^{2+} as opposed to Fe^{3+} during sintering and many researchers reported that some dopants alleviate these problems. However, the detailed mechanism of the dopant effects in BT-BF ceramics is still unclear because both acceptor and donor dopants have been reported to improve the resistivity of BT-BF ceramics [4, 5]. The aim of our work is to investigate the role of dopants and thus improve the piezoelectric properties in BT-BF based ceramics. To this end, we have studied ($Mg_{2/3}Nb_{1/3}$) as a self-compensated dopant in BT-BF ceramics within the solid solution (1-x-y)$Bi(Mg_{2/3}Nb_{1/3})O_3$-(x)$BaTiO_3$-(y)$BiFeO_3$. ($Mg_{2/3}Nb_{1/3}$) successfully unlocks the potential of BT-BF ceramics and (1-x-y)$Bi(Mg_{2/3}Nb_{1/3})O_3$-(x)$BaTiO_3$-(y)$BiFeO_3$ exhibits high strain and low temperature dependence of strain.

References

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