Sodium Potassium Niobate Based Eco-Friendly Lead-free Piezoeramics: Sintering study

Hüseyin Yılmaz (GYTE) and Erdem Akça (GYTE)

Potassium sodium niobate ($K_{0.5}Na_{0.5}NbO_3$) ceramics are among the few environmentally friendly ferroelectric ceramics which do not contain lead. However, due to their poor piezoelectric properties in the sintered form, widespread commercial use of these lead free piezoelectric ceramics is limited. The main drawback is probably the poor reproducibility associated with the low sinterability. Therefore, in this research, sintering behavior of the neat and ZnO + SnO_2 co-doped $K_{0.5}Na_{0.5}NbO_3$ ceramics in the presence of a liquid phase provider, like $K_4CuNb_8O_{23}$, has been studied in detail. Isothermal sintering studies together with dilatometric measurement were carried out systematically. Sintering kinetics were determined from the dilatometeric measurements of ceramics sintered at different heating rates. The optimum sintering temperatures of the neat and ZnO-SnO_2 co-doped $K_{0.5}Na_{0.5}NbO_3$-0.5mol% $K_4CuNb_8O_{23}$ ceramic were found to be 1120 and 1080°C, respectively, with relative densities more than 98%. Considering the upper bound narrow sintering temperature window of $K_{0.5}Na_{0.5}NbO_3$, lower shift in the sintering temperature of ZnO-SnO_2 co-doped samples by 40°C as compared to that of neat ones was found to be a major achievement. Furthermore, small error bars in the densities at optimum sintering temperatures showed clearly that ceramics in this study have high reproducibility, as well high density. In ZnO-SnO_2 co-doped samples exaggerated grain growth was absent in the temperature range studied, which was a commonly encountered microstructural feature of $K_{0.5}Na_{0.5}NbO_3$ ceramics at high sintering temperatures.

Keywords: Sintering, Lead-free piezoelectrics, $K_{0.5}Na_{0.5}NbO_3$, Dilatometry, Perovskite