Electrocaloric Effect in BNKT-based and $PbZrO_3$-based cCeramics

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The electrocaloric effect is investigated through indirect measurement in lead-free and lead-containing perovskite ceramics. Two lead-free $[Bi_{1/2}(Na,K)_{1/2}]TiO_3$-based ceramics that were previously reported to display giant electro-strains were first investigated. In the Nb-doped ceramic, denoted as BNKT-2.5Nb, a decent temperature change of $\Delta T = 1.85$ K and an electrocaloric responsivity of $\Delta T/\Delta E = 0.37$ ($10^{-6}KmV^{-1}$) are found around room temperature (32 ^oC). While in the Ta-doped ceramic, BNKT-1.5Ta, a wide operation temperature range ($T_{span} \sim 55$ K) is observed near room temperature. Additional electrical measurements, as well as transmission electron microscopy experiments, were performed to identify the mechanisms of the electrocaloric effect in both ceramics.

In the lead-containing ceramics, two $PbZrO_3$-based compositions with opposite phase transition sequences were focused. In PNZST 43/8/2, the sequence is ferroelectric – antiferroelectric – paraelectric during heating. In contrast, it is antiferroelectric – ferroelectric – paraelectric during heating in PNZST 13/2/2. The electrocaloric effect associated with the antiferroelectric ↔ ferroelectric phase transition is comparatively studied in both ceramics via indirect measurement. PNZST 43/8/2 is observed to display a positive electrocaloric effect, while PNZST 13/2/2 exhibits a negative effect. Direct correlations of the electrocaloric effect with phase transition sequence is hence established.