Electrocaloric Effect of Perovskite High Entropy Oxide Films

Y. Son, W. Zhu, S. Trolier-McKinstry

This paper describes two perovskite high entropy oxide (PHEO) compositions: $Pb(Hf_{0.2}Zr_{0.2}Ti_{0.2}Nb_{0.2}Mn_{0.2})O_3$ (Mn PHEO) and $Pb(Hf_{0.2}Zr_{0.2}Ti_{0.2}Nb_{0.2}Al_{0.2})O_3$ (Al PHEO). Powders are prepared by conventional solid state sintering by first pre-reacting the B-site oxides, then adding PbO. Phase pure Mn PHEO powder is obtained following calcination of the mixed powders at 750 ÅãC for 240 min; however, secondary phases persisted in Al PHEO for heat treatments from 750 ÅãC to 1200 ÅãC. The Mn PHEO undergoes an entropy-driven phase transformation. Thin films of these compounds are synthesized by pulsed laser deposition (PLD) on a lead zirconate titanate seed layer on Pt-coated SiO_2/Si. The dielectric response of the Mn PHEO films show some contribution from space charge polarizability; in contrast, the Al PHEO films show a slim ferroelectric hysteresis loop and relaxor-like characteristics. The Al PHEO has a dielectric permittivity of ≈2000 with a loss tangent <0.05 from 100 Hz to 100 kHz; it has a dielectric maximum at 105 Å} 0.5 ÅãC and a Burns' temperature of 234 Å} 0.5 ÅãC. Indirect measurements based on the Maxwell-relations yielded a maximum electrocaloric temperature change of 8.4 K at 180 ÅãC under the applied electric field of 1186 kV cm^{-1}.