Electrocaloric Effect of Perovskite High Entropy Oxide Films

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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 Åâ°C for 240 min; however, secondary phases persisted in Al PHEO for heat treatments from 750 Åâ°C to 1200 Åâ°C. 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 $\approx$2000 with a loss tangent $<$0.05 from 100 Hz to 100 kHz; it has a dielectric maximum at 105 Åâ°C and a Burns’ temperature of 234 Åâ°C. Indirect measurements based on the Maxwell-relations yielded a maximum electrocaloric temperature change of 8.4 K at 180 Åâ°C under the applied electric field of 1186 kV cm$^{-1}$. 