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Controlling microstructure and film growth of relaxor-ferroelectric thin films for high break-down strength and energy-storage performance

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Abstract:

The relaxor ferroelectric $\text{Pb}_{0.9}\text{La}_{0.1}(\text{Zr}_{0.52}\text{Ti}_{0.48})\text{O}_3$ (PLZT) thin films were deposited using pulsed laser deposition, and their microstructures, break-down field strengths and energy storage performances were investigated as a function of the buffer layer and electrode. A large recoverable energy-storage density (U_{reco}) of 23.2 J/cm^3 and high energy-storage efficiency (η) of 91.6% obtained in the epitaxial PLZT film grown on $\text{SrRuO}_3/\text{SrTiO}_3/\text{Si}$ are much higher than those in the textured PLZT film ($U_{\text{reco}} = 21.9 \text{ J/cm}^3$, $\eta = 87.8\%$) on $\text{SrRuO}_3/\text{Ca}_2\text{Nb}_3\text{O}_{10}$ -nanosheet/Si and the polycrystalline PLZT film ($U_{\text{reco}} = 17.6 \text{ J/cm}^3$, $\eta = 82.6\%$) on $\text{Pt}/\text{Ti}/\text{SiO}_2/\text{Si}$, under the same condition of 1500 kV/cm and 1 kHz, due to the slim polarization loop and significant antiferroelectric-like behavior. Owing to the high break-down strength (BDS) of 2500 kV/cm, a giant U_{reco} value of 40.2 J/cm^3 was obtained for the epitaxial PLZT film, in which U_{reco} values of 28.4 J/cm^3 (at BDS of 2000 kV/cm) and 20.2 J/cm^3 (at BDS of 1700 kV/cm), respectively, were obtained in the textured and polycrystalline

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