

Supplementary Materials

for

Indirect evaluation of the electrocaloric effect in PbZrTiO₃ (20/80) based epitaxial thin film structures

Georgia A. Boni, Lucian D. Filip, Radu Cristian, Cristina Chirila, Iuliana Pasuk, Mihaela Botea Ioana Pintilie, Lucian Pintilie

In Figure S1 (a) is represented the remnant hysteresis loops obtained for 250 K, 300 K and 350 K. These loops are obtained by applying two consecutive pulses with positive amplitude and then differentiate the results. Thus this loops represents only switching contribution to the polarization. In Figure S1 b) is represented the variation of pyroelectric coefficient indirect deduced from the variation of polarization with respect to temperature as function of applied voltage, for a totally reversed state.

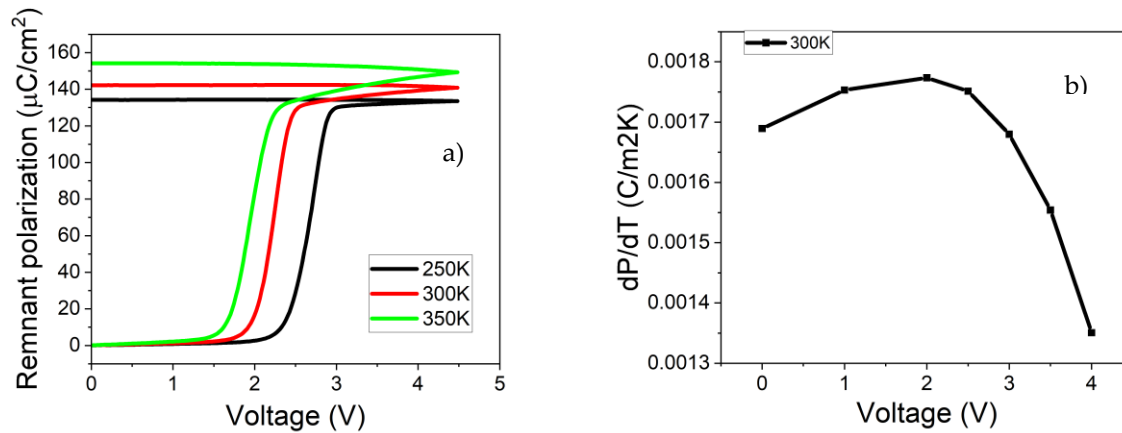


Figure S1 a) The remnant hysteresis for 250K, 300K and 350K for PZT/SRO/STO. b) The dependence of the indirect evaluated pyroelectric coefficient as function of voltage for PZT/SRO/STO.

In Figure S2 a) are represented the hysteresis loops recorded at different temperatures for a PZT20/80 thin films deposited by sol-gel on STO substrate with a thin SRO layer as bottom electrode epitaxial deposited by PLD. In Figure S2 b) are represented the values of polarization as function of temperature for different applied voltages for a totally reversed state. The deposition details for sol-gel deposited thin film of PZT are presented in [45].

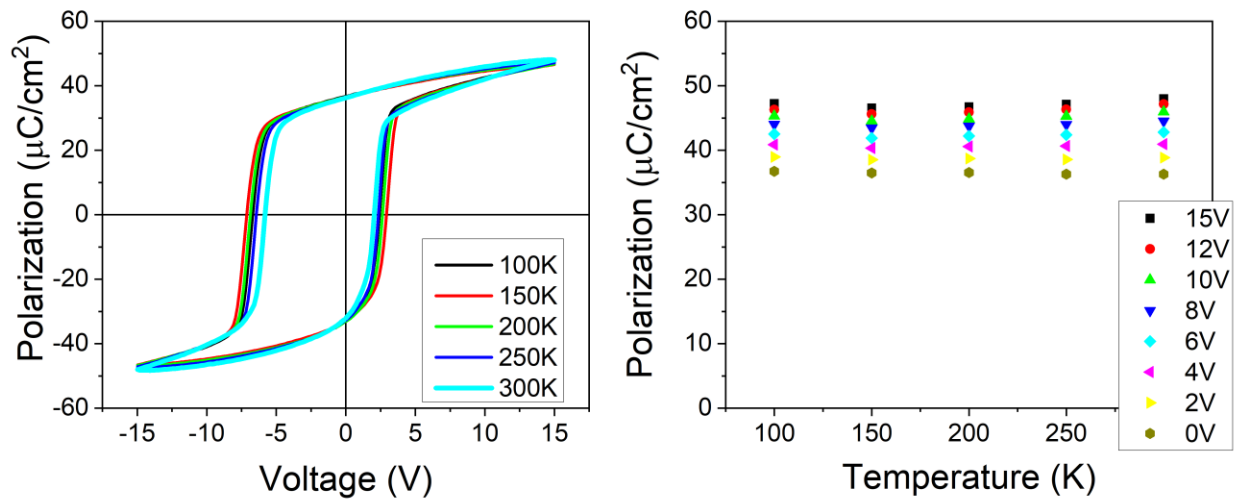


Figure S2. The hysteresis measurements at different temperature between 100 K and 300 K for polycrystalline sol-gel deposited PZT/SRO/STO.

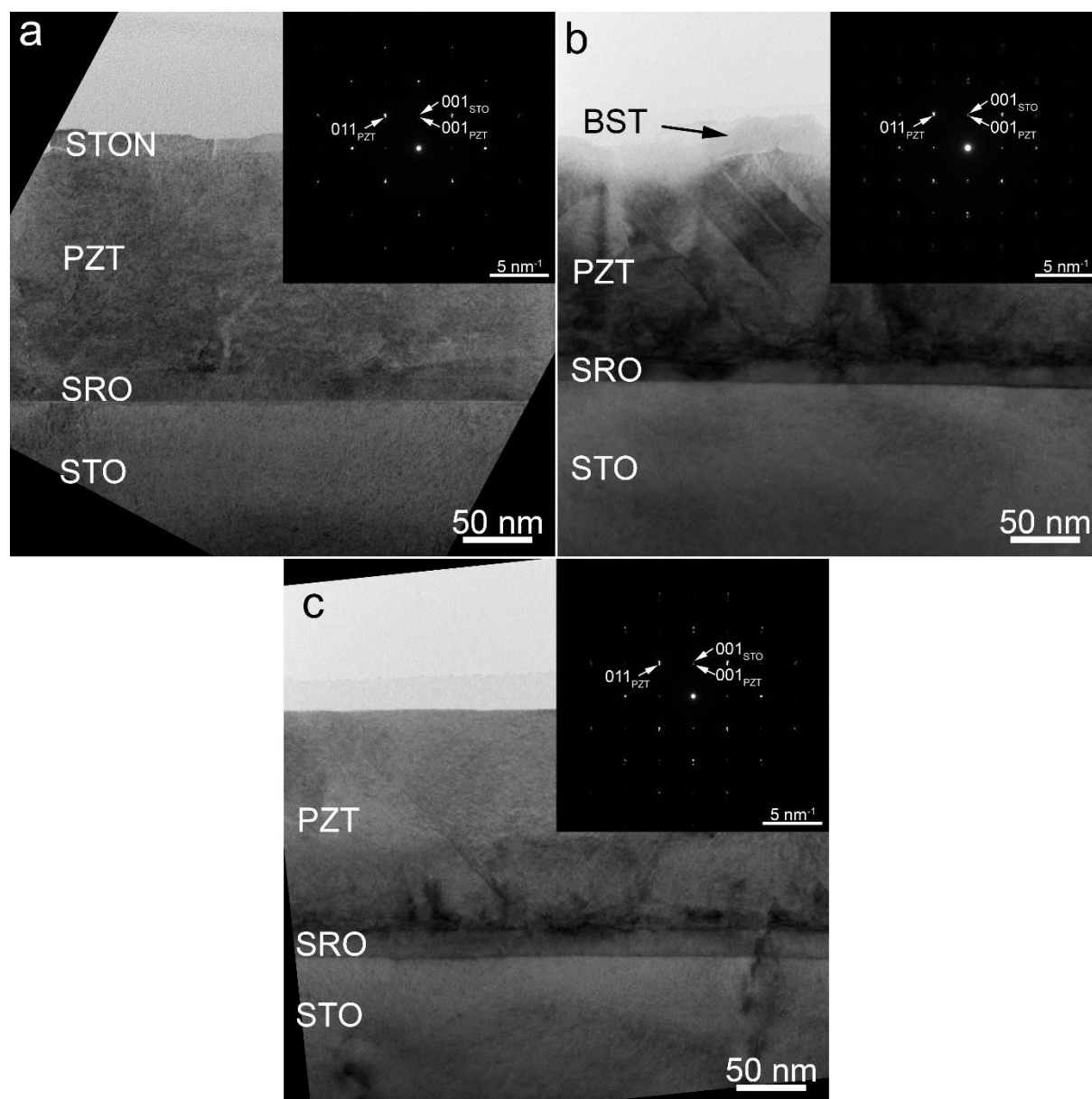


Figure S3. **a)** TEM image at low magnification (200 k) of the STON/PZT/SRO/STO heterostructure (insert: SAED image) **b)** TEM image at low magnification (200k) of the BST/PZT/SRO/STO heterostructure (insert: SAED image) **c)** TEM image at low magnification (200 k) of the PZT/SRO/STO heterostructure (insert: SAED image).

The TEM investigation for all sample reveals good epitaxial quality. The BST/PZT/SRO/STO structure reveals a high density of c/a domains, while for the PZT/SRO/STO sample there are fewer. No c/a domains can be seen in the STON/PZT/SRO/STO sample. From the measurements performed on the SAED figures, there is a clear orientation relationship between the crystallographic planes in the STO substrate and the PZT thin film, namely: $(001)\text{PZT} \parallel (001)\text{STO}$ and $(010)\text{PZT} \parallel (010)\text{STO}$. The thickness of PZT layer is about 150nm and for STON and BST layers about 10-12 nm.