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Phase Transition and Energy Storage Behavior of Oriented Epitaxial Antiferroelectric PLZT Thin Films

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Abstract

Thin films of 300-nm-thick $(Pb_{0.98}, La_{0.02})(Zr_{0.95}, Ti_{0.05})O_3$ (PLZT) were epitaxially deposited on (100), (110), and (111) $SrTiO_3$ single crystal substrates by pulsed laser deposition. X-ray diffraction line and reciprocal space mapping scans were used to determine the crystal structure. Tetragonal ((001) PLZT) and monoclinic M_A ((011) and (111) PLZT) structures were found, which influenced the stored energy density. Electric field induced antiferroelectric to ferroelectric (AFE→FE) phase transitions were found to have a large reversible energy density of up to 30J/cm^3. With increasing temperature, an AFE to relaxor ferroelectric (AFE→RFE) transition was found. The RFE phase exhibited lower energy loss, and an improved energy storage efficiency. The results are discussed from the perspective of crystal structure, dielectric phase transitions, and energy storage characteristics. Besides, unipolar drive was performed, providing notably higher energy storage efficiency values due to low energy losses.

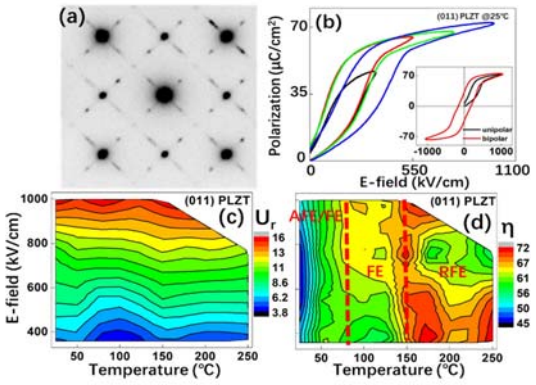

Figure (a) selected area electron diffraction patterns of the (011) PLZT thin film measured by transmission electron microscopy; (b) unipolar P-E curves of the (011) PLZT thin film at room temperature; (c) and (d) are the calculated energy storage density and efficiency as the functions of temperature and E-fields, respectively

Biography

Min Gao is a PhD candidate in Materials Science and Engineering, advised by Dr. D. Viehland. He started his PhD study at Virginia Tech in fall 2015. His research interest involves the magnetoelectric oxide thin film materials. He has published two papers last year, and had a presentation at the MS&T 2017.