Journal of Chromatography Research

Large electrocaloric effect of relaxor thin film on LaNiO3/Pt composite electrode with the coexistence of nanoscale antiferroelectric and ferroelectric phases in a broad temperature range

Biaolin Peng1,2,3, Qi Zhang3*, Yinong Lyu2, Laijun Liu2, Xiaojie Lou4, Christopher Shaw3, Haitao Huang2*, Zhonglin Wang5*

1Guangxi Key Laboratory for Relativistic Astrophysics, School of Physical Science & Technology, Guangxi University, Nanning 530004, China
2Department of Applied Physics, The Hong Kong Polytechnic University, Kowloon, Hong Kong SAR
3School of Aerospace, Transport and Manufacturing, Cranfield University, Cranfield, Bedfordshire, MK43 0AL, United Kingdom
4Frontier Institute of Science and Technology, State Key Laboratory for Mechanical Behavior of Materials, MOE Key Laboratory for Nonequilibrium Synthesis and Modulation of Condensed Matter, Xi'an Jiaotong University, Xi'an 710049, China
5School of Materials Science and Engineering, Georgia Institute of Technology, Atlanta, GA 30332-0245, USA

Abstract

Ferroelectric/antiferroelectric thin/thick films with large electrocaloric (EC) effect in a broad operational temperature range are very attractive in solid-state cooling devices. We demonstrated that a large positive electrocaloric (*EC*) effect (maximum $\Delta T \sim 20.7$ K) in a broad temperature range (~ 110 K) was realized in $Pb_{0.97}La_{0.02}(Zr_{0.65}Sn_{0.3}Ti_{0.05})O_3$ (PLZST) relaxor antiferroelectric (AFE) thin film prepared using a sol-gel method. The large positive *EC* effect may be ascribed to the in-plane residual thermal tensile stress during the layer-by-layer annealing process, and the high-quality film structure owing to the utilization of the $LaNiO_3$/Pt composite bottom electrode. The broad *EC* temperature range may be ascribed to the great dielectric relaxor dispersion around the dielectric peak because of the coexistence of nanoscale multiple FE and AFE phases. Moreover, a large pyroelectric energy density (6.10 Jcm^{-3}) was harvested by using an Olsen cycle, which is much larger than those (usually less than $10^{-4}Jcm^{-3}$) obtained by using direct thermal-electrical, Stirling and Carnot cycles, etc. These breakthroughs enable the PLZST thin film an attractive multifunctional material for applications in modern solid-state cooling and energy harvesting.

Biography

Qi Zhang is a senior lecturer in Cranfield University, UK and a professor in Wuhan University of Technology, Wuhan, China. He has his expertise in functional materials. He was one of the initiators of the thin film electrocaloric effect, which could develop. He has authored or co-authored over 200 papers, edited one book and 10 book chapters. He has an h factor of 30. He is a fellow and charted scientist in IOM3. His main areas of research are within synthesis of nanomaterials for electrochemical energy storage, fabrication of transparent conducting thin films and sol-gel synthesis and structural characterization of ferroelectric thin films for electrocaloric cooling. He was the recipient of the Royal Society Brian Mercer Feasibility Award.

Publications

1. Surfactant-assisted doctor-blading-printed FAPbBr3 films for efficient semitransparent perovskite solar cells, Frontiers of Optoelectronics
2. Phase-transition induced optimization on electrostrain, electrocaloric refrigeration and energy storage of LiNbO3 doped BNT-BT ceramics, Ceramics International
3. Facile synthesis of TiN nanocrystals/graphene hybrid to chemically suppress the shuttle effect for lithium-sulfur batteries
4. Facile synthesis of 2D ultrathin and ultrahigh specific surface hierarchical porous carbon nanosheets for advanced energy storage, Carbon
5. Efficient gas adsorption using superamphiphobic porous monoliths as the under-liquid gas-conductive circuits, ACS Applied Materials and Interfaces

10th World Congress on Chemistry and Medicinal Chemistry, Prague, Czech Republic, July 20-21, 2020

Citation: Qi Zhang, *Large electrocaloric effect of relaxor thin film on LaNiO3/Pt composite electrode with the coexistence of nanoscale antiferroelectric and ferroelectric phases in a broad temperature range*, 11th World Congress on Chemistry and Medicinal Chemistry, Prague, Czech Republic, July 20-21, 2020, 2165 7904-10:05-03