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Thermal strain induced 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

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 $\text{Pb}_{0.97}\text{La}_{0.02}(\text{Zr}_{0.65}\text{Sn}_{0.3}\text{Ti}_{0.05})\text{O}_3$ (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 LaNiO₃/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.

Speaker Biography

Qi Zhang is an academic staff at Cranfield University and a visiting professor at Wuhan University of Technology. He joined Cranfield University as a research fellow in 1996 following the completion of a PhD at Monash University in Australia. He is a fellow in IOM3 and has sat on the EPSRC Peer Review College since 2006. He became a Senior Research Fellow in 1998 and then Senior Lecturer in 2007. He is currently supervising PhD students from the UK, EU, China, Iraq and Thailand. He has a strong background in ferroelectric thin and thick films and their applications in ferroelectric memory, pyroelectric and electrocaloric effect in the synthesis of nanofunctional materials and their applications in ink-jet printing, surface modifications and nanomaterials for energy storage, etc.

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