Electrocaloric Effect and the Ground State of the Relaxor Ferroelectrics

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The electrocaloric effect (ECE) has attracted great interest for developing new cooling devices that have the potential to reach better efficiency than the existing cooling technologies [1,2]. Recently, it was shown that it can be exploited in studies of the electric field-temperature phase diagram of relaxor ferroelectrics [3] since the sharp ECE anomaly can be observed at the ferroelectric phase transitions [4,5]. Motivated by the long-standing unresolved enigma of the relaxor ferroelectric ground state, we performed a high-resolution electrocaloric, heat capacity and polarization study of the field-induced phase transition in the relaxor ferroelectric single crystal Pb(Mg1/3Nb2/3)O3 (PMN). We show that the discontinuous evolution of polarization as a function of the electric field or temperature is a consequence of a true first order transition from a glassy to ferroelectric state, which is accompanied by an excess heat capacity anomaly and released latent heat. We also find that in a zero field there is no ferroelectric phase transition in bulk PMN at any temperature, indicating that the nonergodic dipolar glass phase persists down to the lowest temperatures [3]. The high resolution electrocaloric measurements in the lead free BaTiO3 demonstrate that the highest electrocaloric response is achieved always at the temperature corresponding to the TC(E=0). A review of recent ECE findings obtained in perovskite relaxor materials including thick ceramic multilayers, substrate-free thick films and thin films will be given. Besides the recent advances in development of practical cooling devices utilizing different approaches and materials will be presented.

References

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