Modeling of the Giant Electrocaloric Effect of Relaxor Ferroelectric Thinfilms

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Abstract: Since the recent discovery of giant electrocaloric effects (ECEs) in thinfilms of both relaxor ferroelectrics and ferroelectric polymers, all-solid-state refrigeration based on such unusual ECEs is recognized as a promising replacement of the well-established vapor-compression air-conditioning market and realization of the on-chip cooling integration with miniaturized processors and microelectronics. In the present work, the Master equation is adopted to distinguish the dielectric and polarization properties between the two intrinsic functional elements in relaxors, i.e., static and dynamic polar nanoregions (PNRs), and hence for modelling the overall ECE-cooling performance of relaxor thinfilms. Our theoretical findings tally well with the existing indirect and direct experimental ECE results in various relaxor and polymer thin-films, which may shed new lights on tuning and optimization of their ECE cooling properties and on the industrial practice of scalable solid-state refrigeration devices.