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Giant electric-field induced thermal switching controlled by phonon scattering in a relaxor ferroelectric

The demand for high energy efficiency drives intense interest in thermal management technology. The active control of heat flow in materials can dramatically enhance device efficiency. Lattice vibrations are a major contributor to heat transfer in solids and controlling them through external stimuli is a key challenge for thermal management. However, altering phonons is difficult due to their weak and complicated interactions with external fields. Here, we report significant changes in phonon spectra and transport with the application of an electric field in commercially used relaxor-based ferroelectric PMN-30PT {(1-x)[PB(Mg1/3Nb2/3)O3]-xPbTiO3(x=30)} using neutron scattering and transport measurements. Phonons sharpen in the direction of the applied poling field and this results in a tripling of the thermal conductivity along the poling direction. We also observe a suppression of nanoscale antiferroelectric fluctuations along the poling direction and argue that this drives the decrease in phonon scattering. This work highlights the potential of relaxor ferroelectrics for realizing solid state heat switching, offering a promising avenue towards high-efficiency thermal management.

Topical Area

Hard matter: energy materials

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