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Engineering thermal conductance using a two-dimensional phononic crystal

ILARI MAASILTA, Department of Physics, University of Jyvaskyla, Finland

Controlling thermal transport has become very relevant in recent years, in light of the strong push to develop novel energy harvesting techniques based on thermoelectricity, the need to improve the heat dissipation out of semiconductor devices, and the push to increase the sensitivity of bolometric radiation detectors. Traditionally, this control has been achieved by tuning the scattering of phonons by including various types of scattering centers in the material (nanoparticles, impurities etc.). Recently we have taken another approach and demonstrated that one can also use coherent bandstructure effects to control phonon thermal conductance, with the help of periodically nanostructured phononic crystals. Working at around 1 Kelvin where the wavelength of the dominant thermal phonons is more than two orders of magnitude longer than at room temperature, we have created phononic crystals with a period of 1 μm that strongly reduce the thermal conduction. In addition, we performed theoretical calculations that accurately determine the ballistic thermal conductance in a phononic crystal device, showing full quantitative agreement with the experiments.