Universität Basel

Research Project

QUSTEC PhD fellowship Hsieh

Third-party funded project

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Phonons are responsible of heat transport in condensed matter. The capability to control heat transport at the nanoscale is relevant for different technological applications ranging from thermoelectric to heat management. In particular, thermal management in nano-electronics and other nano-systems has become the bottleneck for device scaling and performances in electronics.

Due to the wavelengths and mean free paths of phonons, thermal transport at the nanoscale can be significantly different from thermal transport at the macro scale. Furthermore, the progress in nanofabrication enables the design and fabrication of nanostructures that can control heat transport by means of interference effects, achieving coherent phonon transport, and allowing exciting experiments (see e.g. Nature **503**, 209 (2013)).

In the frame of this project, we propose nanowires as platform for investigating and designing the phonon interference effects because they offer unique possibilities in terms of heterostructuring (i.e. combining materials that cannot be joined in 2D because of lattice mismatch and realizing crystal phase superlattices). Specifically, we want to explore superlattice nanowires and nanowires junctions. Both systems are ideal platforms for exploring phonons interference effects.

We will perform pump-probe inelastic light scattering experiments, which gives important information on the time scale of phonon dynamics. It allows a direct determination of the absolute phonon mode population and of its temporal evolution. We will also perform pump-probe experiments in a spatially resolved manner in order to measure the phonon mean free path and coherence length of (selectively) excited phonon modes. Pump-probe experiments will also be conducted on nanostructures integrated in devices consisting of suspended SiNx membranes with implemented metallic coils, which can be used both as heaters and thermometers. In this way, we will be able to probe the time evolution of both coherent and incoherent excitations.

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