Phonon-mediated Nanoscale Thermal Transport

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Phonons play an important role in thermal energy transport in non-metallic solids and in liquids and their study is motivated especially by the need to understand and control thermal transport in the nanoscale [1]. While there are several theoretical approaches, the experimental research has only recently taken off significantly after a slow start. The main reasons have been sample preparation in a controlled manner [2] and the emergence of novel experimental methods [3]. In this talk we will provide an overview and examples of thermal transport in several sample types to illustrate this dynamic and exciting field. The impact of this research encompasses the science of lattice vibrations at interfaces and thin films, coupled state variables as in opto-mechanics, as well as applications in, e.g., thermal interface materials, thermoelectricity and acousto-metamaterials, among others. From Si [3] and MoS_2 [4] membranes to 2D phononic crystals [5] and III-V semiconductor structures [6] we will illustrate key concepts and research issues, such as how the volume-to-surface ratio [7], phononic crystal periodicity, disorder [8] and air convection [7] impact on thermal phonon propagation. We will also discuss perspectives for future research.

References

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Figures

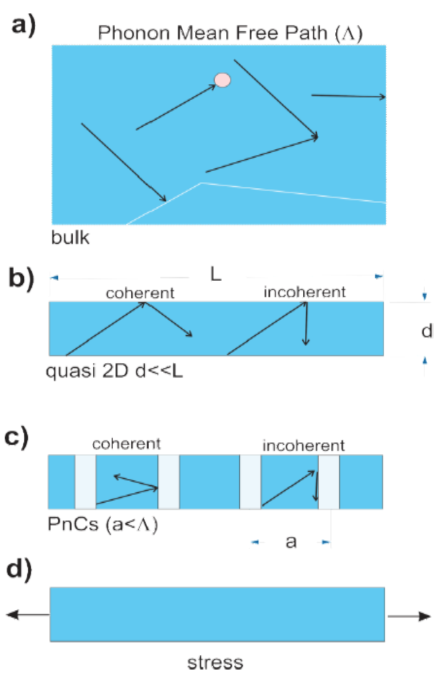

Figure 1: Phonon engineering. Schematics of thermal phonon transport in a bulk (a), a membrane (b) and a 2D phononic crystal (c). Phonons can also be modified by applying

stress thereby modifying their dispersion relations (d).