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Towards generation and detection of sub-terahertz coherent phonons without the need for lasers

The development of the field of nanophononics as a tool for probing nanostructures, controlling thermal process in nanodevices, generation and manipulation of terahertz (THz) electromagnetic signals and as a potential new concept for quantum technology would be advanced through the development of a range of acoustoelectric devices for THz frequencies. Such devices could replace the large and costly femtosecond laser setups currently used for generating and detecting coherent phonon beams. They also form interface between the phononic and electronic domains, and are the phononic analogue of the optoelectronic devices, e.g. lasers and photodiodes, in nanophotonics.

Acoustoelectric effects are widely exploited in technology nowadays. Applications include: transducers for audio and ultrasonic frequencies and radiofrequency components such as surface acoustic wave (SAW) delay lines and band pass filters for used in communications devices. However, the maximum working frequency of current technologies is in the gigahertz (GHz) range.

We have been investigating electronic devices based on semiconductor nanostructures for the generation and detection of sub-THz coherent phonons. These include saser (or sound laser) devices [1] for generation, and detectors based on the piezojunction and high-frequency acoustoelectric effects in electron tunnelling devices [2, 3] and Schottky junctions [3]. In this talk I will explain the physical principles of operation of a few of these devices and show an example of how they can be integrated in a single-chip nanophononic device for the amplified detection of sub-THz coherent phonons.

References:

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