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An electromechanical phononic crystal

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Phononic crystals (PnCs) are one of the most promising candidates for controlling phonon propagation [1]. The periodically modulated elastic structure of the PnC can be used to engineer the underlying band structure which enables the transmission of acoustic phonons to be spatially but passively controlled. This ability has led to the emergence of novel phononic systems in which information signals encoded in phonons can be processed. Here I will describe a unique class of PnCs realized from electromechanical resonators which enables the phonon vibrations to be dynamically controlled at room temperature and in high vacuum.

The PnC waveguide (WG) consists of a one-dimensional array of GaAs/AlGaAs-based membrane resonators as shown in Fig. 1, which are suspended via the periodically arranged air-holes [2]. Ultrasonic phonon vibrations can be excited from the left edge of the WG via the piezoelectric effect and the traveling vibrations are optically measured at the WG's right edge.
By modulating the periodic structure of the PnC WG, the dispersion relations of the underlying phonon bands can be tailored. This enables the phonon propagation to be slowed or even stopped and degenerate phonon channels with differing velocities to become available [3]. On the other hand, the suppression of nonlinear dispersion in the engineered bandstructure can also be used to generate phonons from four wave mixing [4]. Alternatively, by selectively regulating the hole-period in the PnC WG can even create an acoustic cavity which can dynamically switch the phonon transmission [2].

I will describe how these various control parameters of the PnC WG architecture can be harnessed to access new functions with phonons, for instance an all mechanical random access memory [5], and discuss the potential this platform offers for the development of functional phonon-based signal processing devices.

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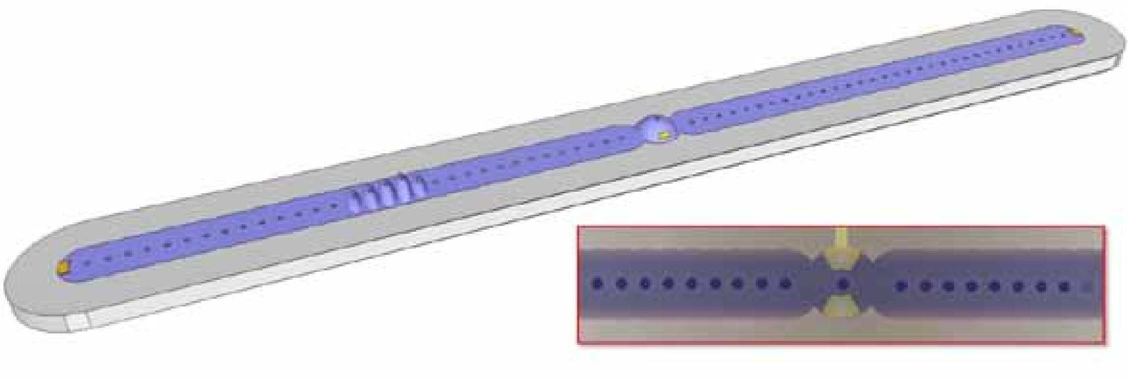

Fig. 1: An animated image of the PnC WG showing the propagation of phonons in the guise of a mechanical vibration. The inset shows a scanning micrograph of a real device.