A platform for GHz Si phononics: Sources, waveguides and circuits

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The search for new state variables beyond electrons, spins and photons has turned its attention to low energy potential information carriers such as phonons.
We will report our work based on optomechanics and localization to create phonon sources based on co-located phononic and photonic crystals to confine phonons and photons in the same volume via optical and electrical driving by means of optical waveguides and surface acoustic waves, yielding a circuit based on phonons [1] which is CMOS-compatible and operates at room temperature at 2 GHz.
We will show how inherent fluctuations in critical dimensions help to localize phonons and enable phonon lasing at 6.5 GHz mediated by confined phonons modes in a slotted waveguide [2].
Finally, we will show how a phonon waveguide can be realized and characterised to establish modes in the mechanical gap (7-11 GHz) of a phononic crystal-based waveguide [3].

References

[1] D. Navarro-Urrios et al., ACS Photonics **9** (2022) 413.
[2] G. Madiot et al., arXiv:2206.06913v1.
[3] O. Florez et al., Nature Nanotechnology DOI: 10.1038/s41565-022-01178-1, arXiv:2202.02166.

Figures

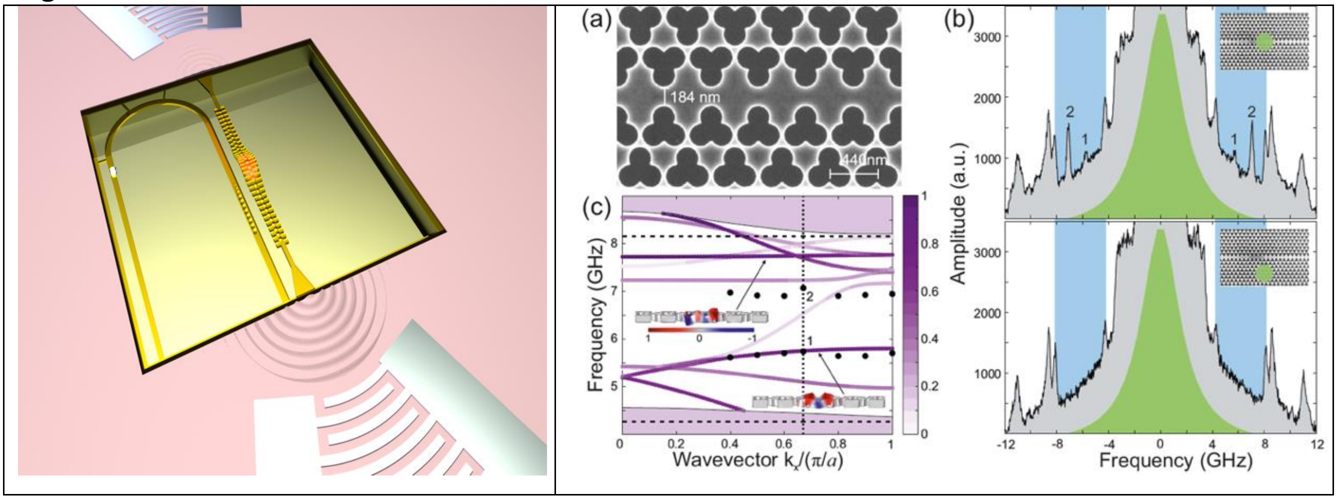

Figure 1: Left: Schematic of the phononic circuit. Right: GHz phononic waveguide. SEM of the line defect waveguide (a). BLS spectra with the mechanical band gap highlighted in blue, where 1 and 2 denote guided phononic modes (b). Band structure showing gap and guided modes (c).