

## Optomechanical interaction to characterise thermal properties of Si in the nanoscale.

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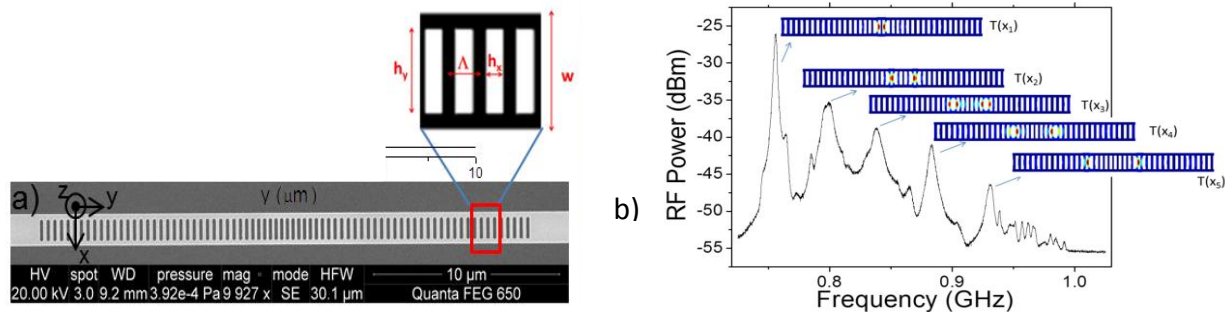
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Optomechanical crystal cavities have been an important field of research in recent years. Some of their many applications are mass spectrometry, quantum information processing, intra-chip metrology and intrachip time keeping. We use the optomechanical interaction as a new way to determine thermal properties of nanostructured materials.

We report a novel technique to extract the temperature spatial distribution in a nanoscaled Si geometry<sup>1</sup>. It exploits the dependence of the mechanical eigenfrequencies on the intensity of the electromagnetic field due to a heating effect. In particular, we study a well-known geometry (Fig1a) that displays a particular family of mechanical modes involving 1-2 cells in the defect region. These very localised modes are known as ‘pinch’ modes<sup>2</sup> (Fig1b) and cover a range of several hundreds of MHz, the eigenfrequencies increase as the modes are localized further away from the centre. Finite element method simulations have been performed to optimise the defect region maximising the number of modes and spectral bandwidth within the experimental spectral range.

The experiment is based on a pump-&-probe technique using two infrared tuneable lasers. The first one is used for pumping a low order optical mode and acts as a localised heating source. The other laser probes a high order optical mode extended over many cells, which allow transducing pinch modes along the whole defect region without introducing extra heating. The eigenfrequencies of the pinch modes are very sensitive to the temperature of just 1-2 cells. Therefore, each mode spectrally drifts by an amount that decreases with its distance from the centre. This effect can be quantified for each pinch mode and associated to a given local temperature. It is thus possible to extract a temperature spatial profile that provides information about the heat conduction properties of the nanobeam.



**Fig 1 a-** SEM image of the OM crystal. The geometrical parameters are  $\Lambda=362$  nm,  $w=1396$  nm,  $h_y=992$  nm,  $h_x=190$  nm, and thickness 220 nm. **b-** Mechanical pinch family. The frequency of each and every mode increases going further away from the centre allowing temperature spatial mapping.

1. D. Navarro-Urrios et al., *Optical and mechanical mode tuning in an optomechanical crystal with light-induced thermal effects*, Journal of Applied Physics **116**, 093506 (2014)
2. M. Eichenfield et al., *Optomechanical crystals*, Nature, **462**, 78-82 (2009)