

# BOSSEBOEUF LAB.

## [Top-down fabricated Si nanowire strain gages]

A. Bosseboeuf<sup>1,2</sup>, P.E. Allain<sup>2</sup>, F. Parrain<sup>2</sup>, X. Leroux<sup>2</sup>, S. David<sup>2</sup>, A. Walther<sup>3</sup>

<sup>1</sup>Centre for International Research on MicroNano Mechatronics

<sup>2</sup>IEF, CNRS- Université Paris –Sud, France <sup>3</sup>CEA-LETI, France

### Fundamental Microsystems Engineering

## Objective

Owing to their small cross section and their potential giant piezoresitivity, Si nanowires are promising for mechanical strain integrated detection. Electro-thermo-mechanical properties of Si nanowires fabricated by surface micromachining of thinned SOI and MEMS motion detection with a nanowire strain gage were investigated for this application.

- ◆ Fabrication of Si nanowires with a width down to 25nm and a length to width aspect ratio  $L/W$  up to 150: Evidence of a high compressive stress related to wafer thinning leading to nanowire buckling for  $L/W > 50$
- ◆ Development of a 4 point die bending system compatible with a cryogenic probe station for nanowire piezoresistance measurement
- ◆ MEMS motion measurement with a nanowire strain gage up to 180 nm with a resolution better than 0.2nm owing to a demultiplying spring
- ◆ Evaluation of effective thermal conductivity versus temperature by TCR and  $3\omega$  method measurements

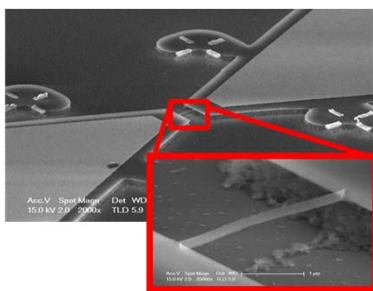


Fig.1 Si nanowire device fabricated by SOI wafer thinning, e-beam lithography and HF vapor release

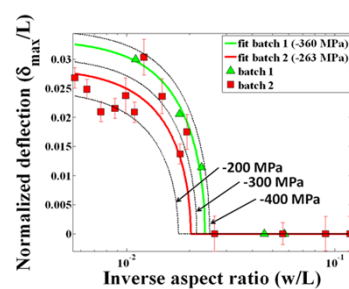


Fig.2 Post-buckling of Si nanowires evidencing a high compressive stress generated during SOI wafer thinning

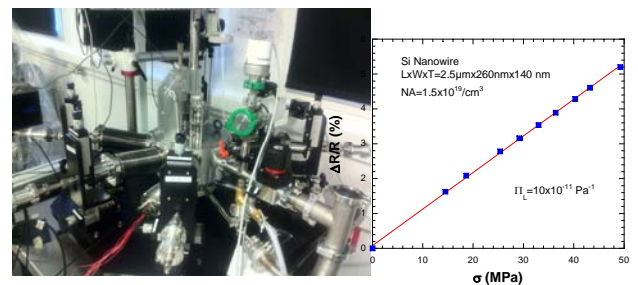


Fig.3 Piezoresitivity measurement by direct four point die bending in a cryoprobe station. Measurement system and example of measurement

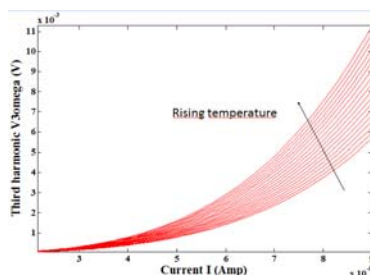


Fig.4  $3\omega$  thermal conductivity measurement on a Si nanowire.  $L \times W \times h = 2.5 \mu\text{m} \times 160 \text{ nm} \times 140 \text{ nm}$

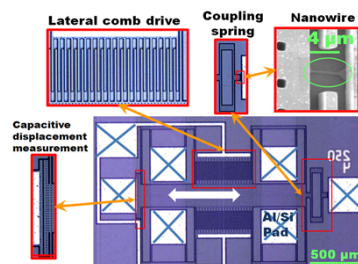


Fig.5 MEMS Tang resonator with Si nanowire and capacitive motion detection

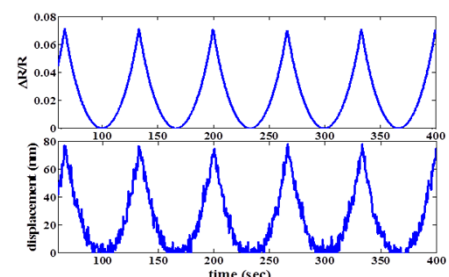


Fig.6 Comparison of Si nanowire strain gage and capacitive MEMS measurement