Journées J3N Nationales en Nanosciences et en Nanotechnologies

Giant piezoresistance at surfaces and interfaces for ultra-sensitive strain detection

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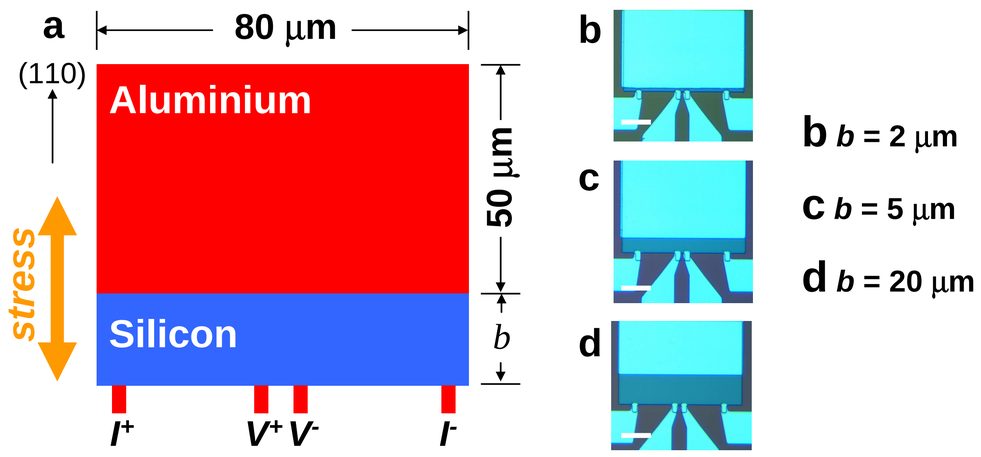
SUISSE

Goal: study and understand the giant piezoresistance (i.e. change in resistance with applied mechanical stress) at semiconductor interfaces and surfaces. Apply these phenomenon to the detection of nano-scale strains in microsystems.

Piezoresistive switch

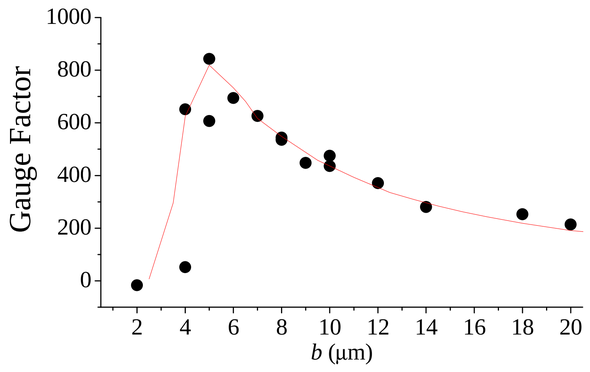
What is a metal-semiconductor hybrid?



What is the effect of a uni-axial tensile strain?

$$\sigma = \sigma_0 \begin{bmatrix} 1 - \frac{X}{2}(\pi_{11} + \pi_{12} - \pi_{44}) & 0 \\ 0 & 1 - \frac{X}{2}(\pi_{11} + \pi_{12} + \pi_{44}) \end{bmatrix}$$

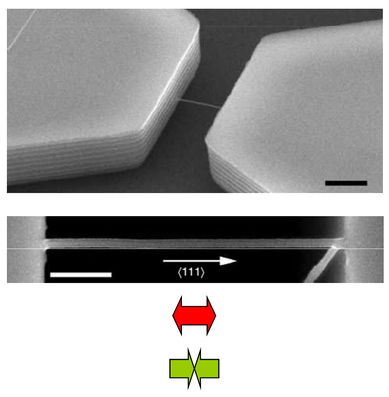
for p-type silicon
π_{11} = 6.6 x 10^{-11} Pa^{-1}
π_{12} = -1.1 x 10^{-11} Pa^{-1}
π_{44} = 138.1 x 10^{-11} Pa^{-1}



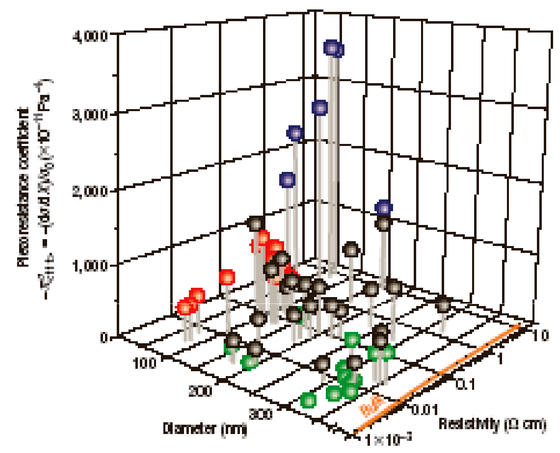
Physical Review Letters **100**, 145501 (2008)

Piezopinch effect

Bottom up silicon nanowires.

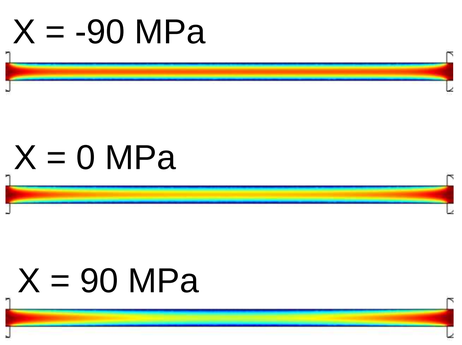


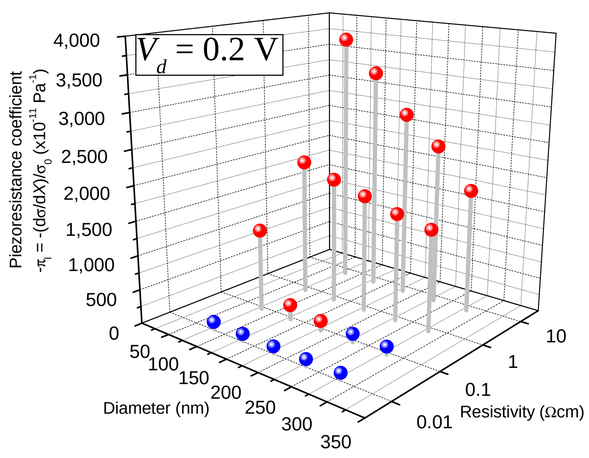
Diameter: 80 nm➞300 nm
Resitivity: 0.001 Ωcm ➞10 Ωcm



From He & Yang, Nature Nanotech. **1**, 42 (2006)

Surface depletion and stress: the piezo-pinch effect.





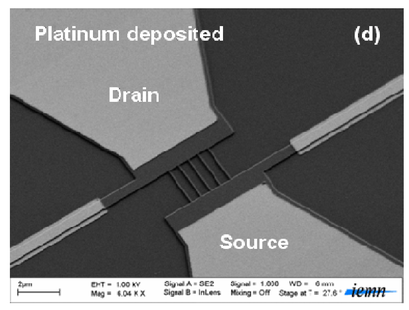
Nature Nanotechnology **3**, 311 (2008)

➪ Towards a microsystem with integrated hybrid strain gauge.

- confidential whitepaper study completed with a major player in the semiconductor industry.
- potential exploitation of the French Patent # 05 12740 , *Micro-electromechanical system with an integrated strain sensor*
- recruitment of a post-doctoral scientist to aid with prototype development.

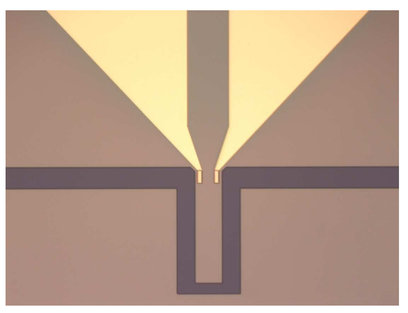
➪ Investigation of giant piezoresistance in depleted films and top-down fabricated nanowires.

- nanowire collaboration with J.P. Raskin (Université Catholique de Louvain, Belgique) and E. Dubois (IEMN)



Top down silicon nanowires fabricated at IEMN by V. Passi and S. Arscott

- on-cantilever integrated devices fabricated.



Piezopinch device integrated onto a silicon microcantilever

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