

# Hybrid CMOS-MEMS/NEMS technologies at IMB-CNM

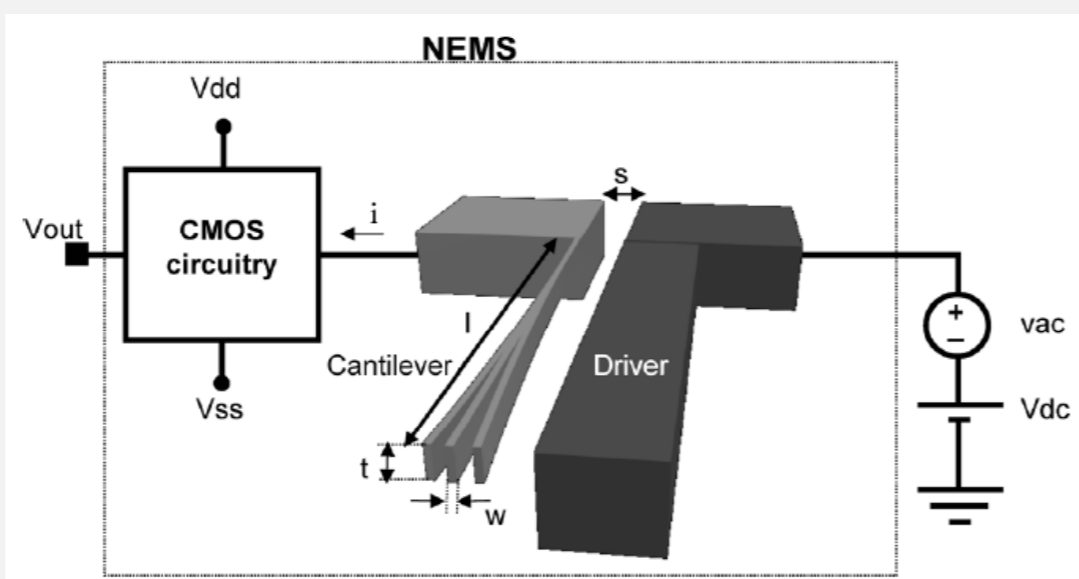
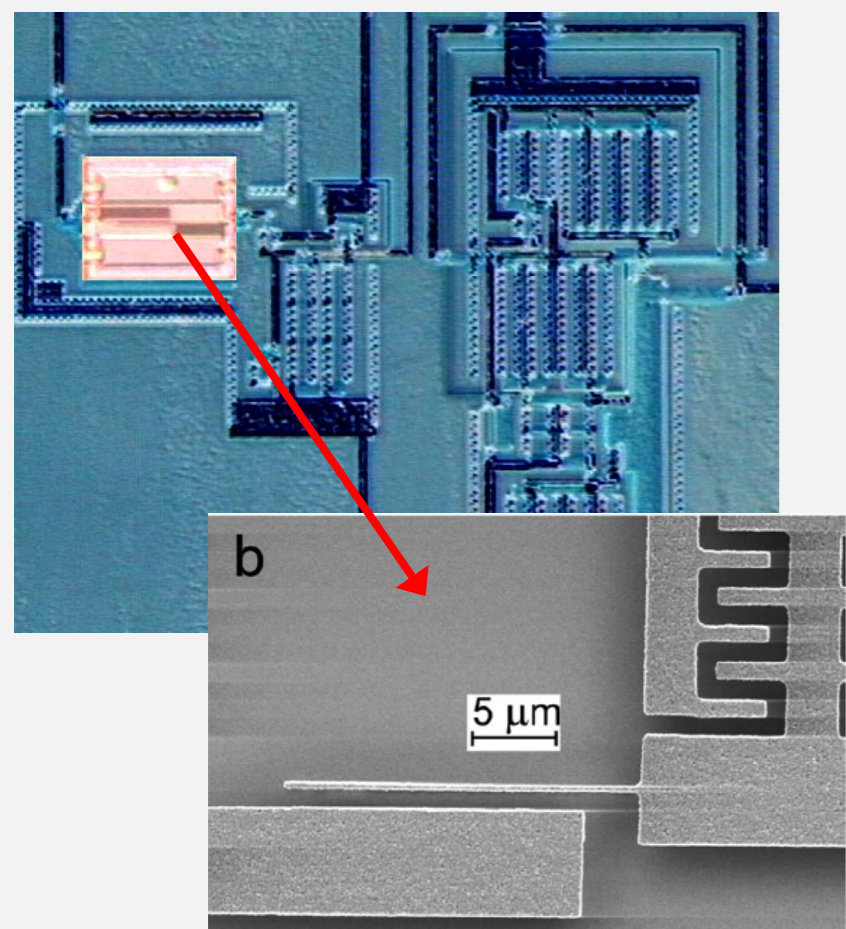
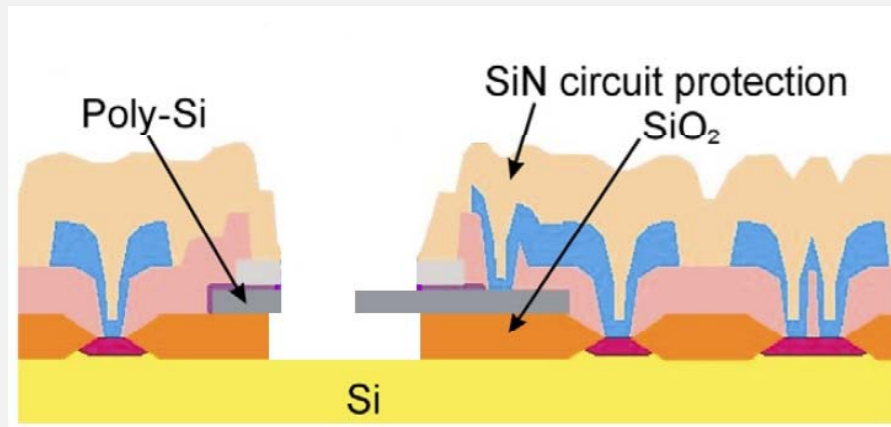
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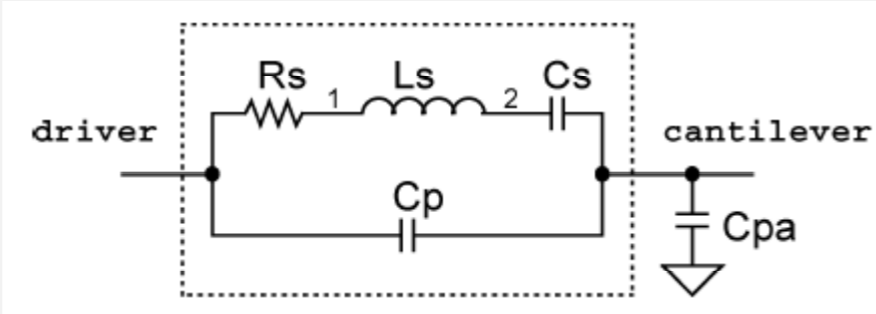
The main activity of IMB-CNM is research on silicon-based micro/nano integrated systems. This includes sensors, MEMS/NEMS devices and systems integration. Some results on hybrid CMOS-MEMS/NEMS technologies and systems are presented.

## CMOS-integrated NEMS cantilever resonators for ultrasensitive mass sensing

Technology: CNM - CMOS twin well, 2 poly, 2 metal, 2.5  $\mu\text{m}$ .

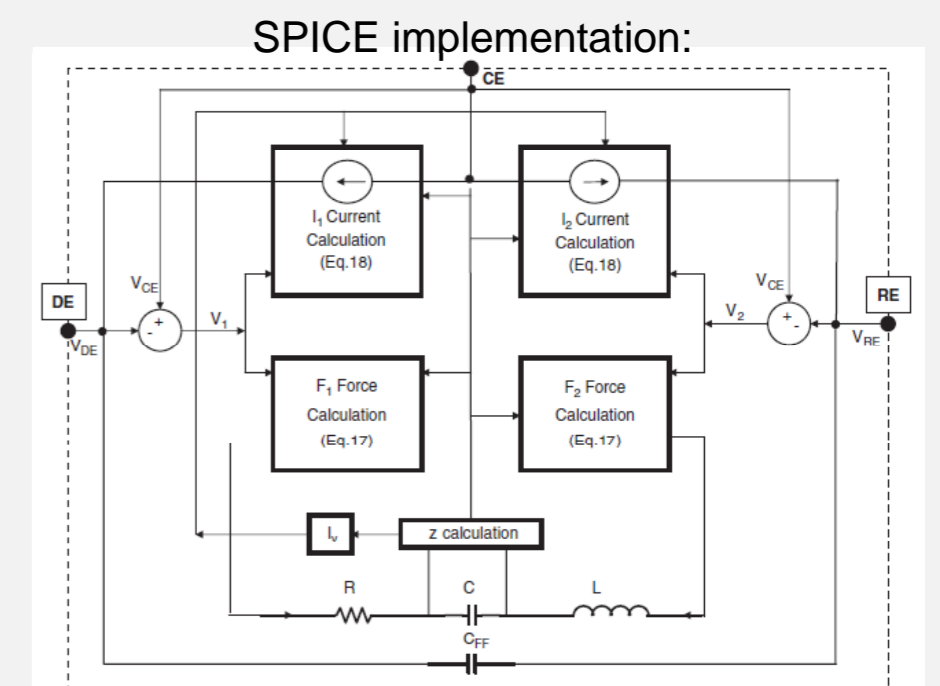
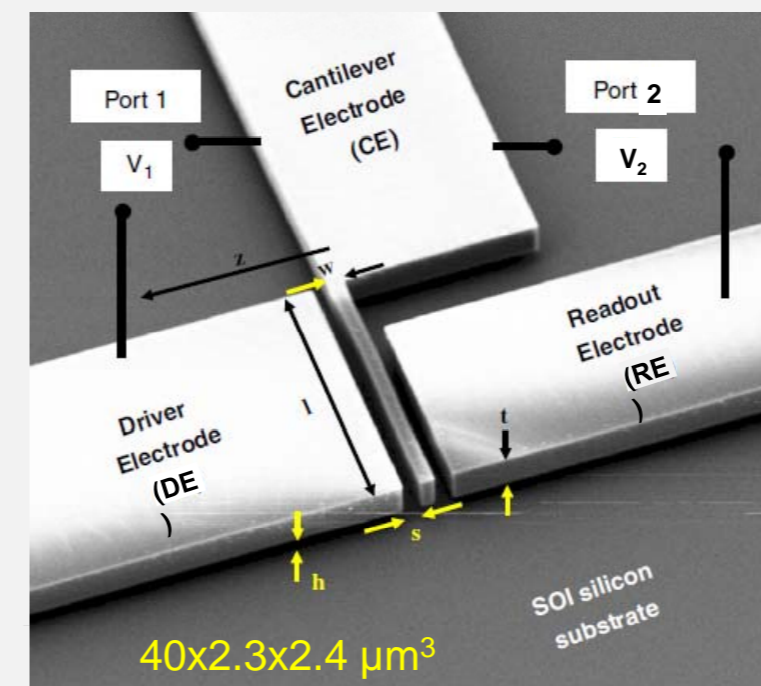


Electromechanical model of the cantilever-driver system:



Cantilever dimensions: 425 nm-600 nm-20  $\mu\text{m}$   
 Res. Frequency: 1.5 MHz  
 Mass sensitivity: 4  $\pm$  1 ag/Hz.

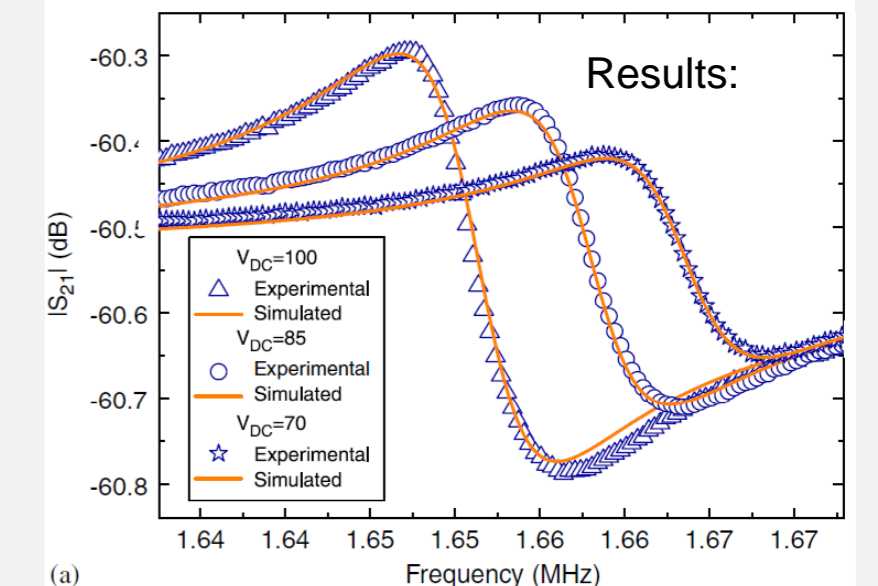
## SOI-based resonators for mass sensors



A forced damped oscillator is used to model the cantilever, and converted to an electrical model:

$$L\dot{I}_v + RI_v + \frac{1}{C} \int_0^t I_v dt = U_{Eff-1} + U_{Eff-2}$$

Where  $U_{eff}$  are obtained by slicing the cantilever in N components, plus a fringing field correction.



Mass sensitivity: 0.3 fg/Hz

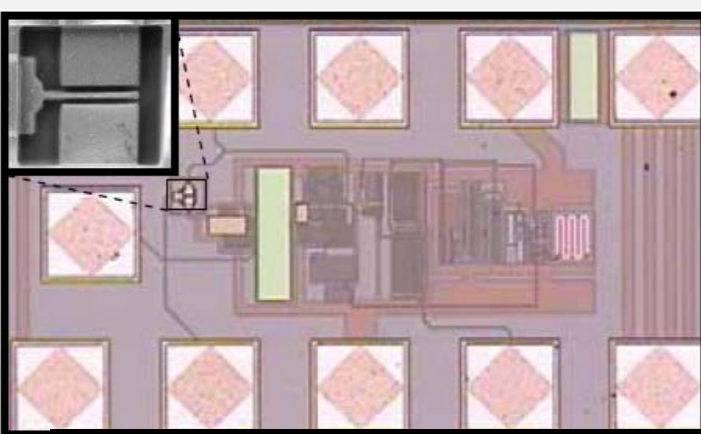
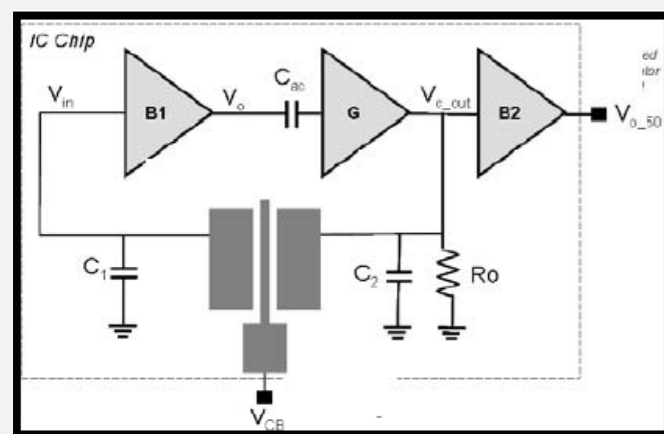
J. Teva et al., Ultramicrosc. 106 (2006) 800

## Integrated NEMS resonators with full-wafer nanostencil lithography

Technology: CNM - CMOS twin well, 2 poly, 2 metal, 2.5  $\mu\text{m}$ .

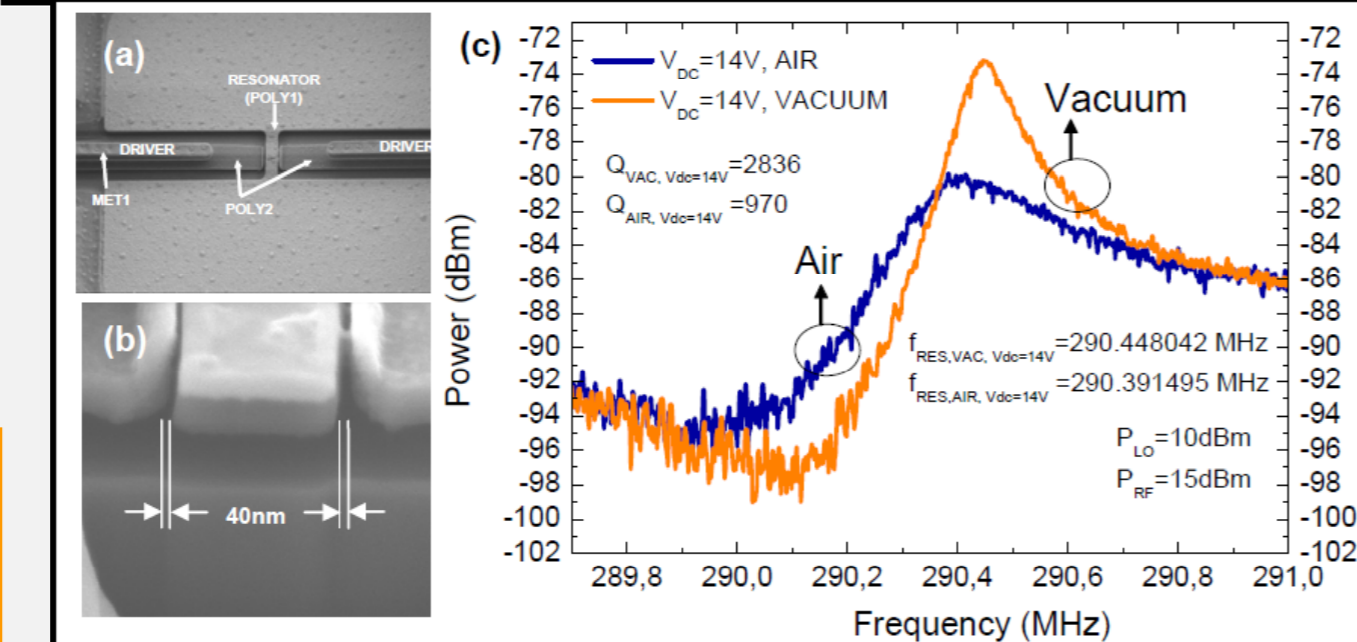
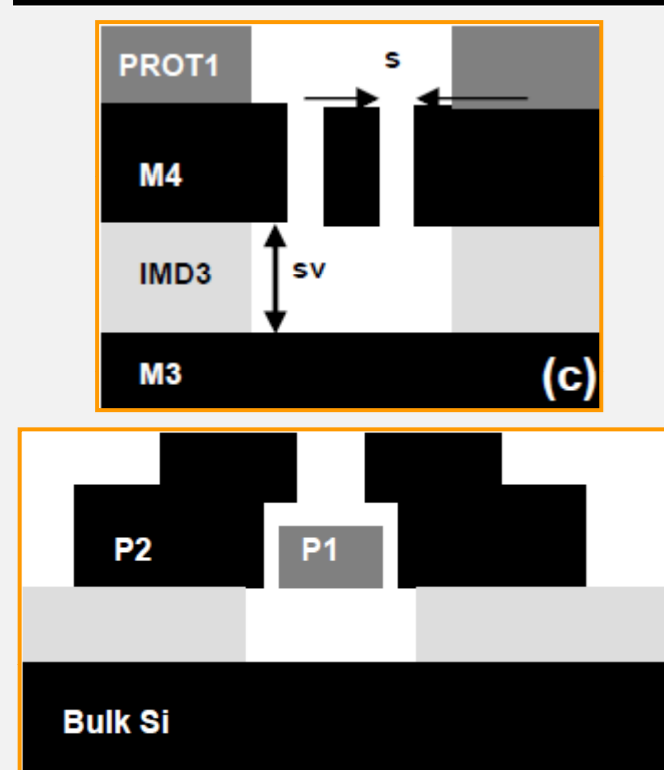
J. Verd et al., IEEE Electron Dev. Lett. 29 (2008) 146

## Post-processing of commercial CMOS for MEMS



Austriamicrosystems  
 0.35  $\mu\text{m}$  CMOS  
 + oxide etching post-process

Also 180 nm CMOS



## About IMB-CNM



## Facilities

The IMB-CNM integrated micro and nanofabrication clean room has a total surface of 1500 m<sup>2</sup>. It is a Spanish large scale facility (ICTS).

- Open access
- Contract prototyping development capabilities



## Access programme

The GICSERV programme, funded by MICINN, provides financial support for limited-scope projects accessing the ICTS (for users from EU and Latin America). Started in 2006, it operates by annual calls and up to 2010 it has supported 212 projects in many application fields.

