MEMS, microfludics and microfabrication for science and technology

Micromagnetometers, actuators, radiation detectors, viscometers

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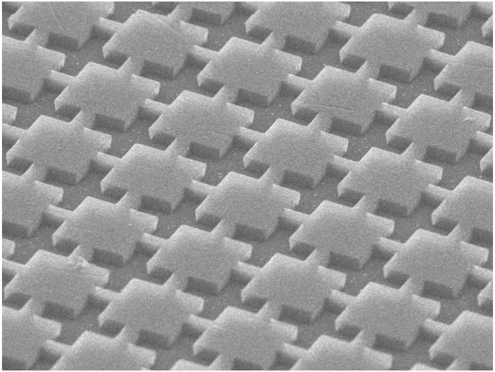
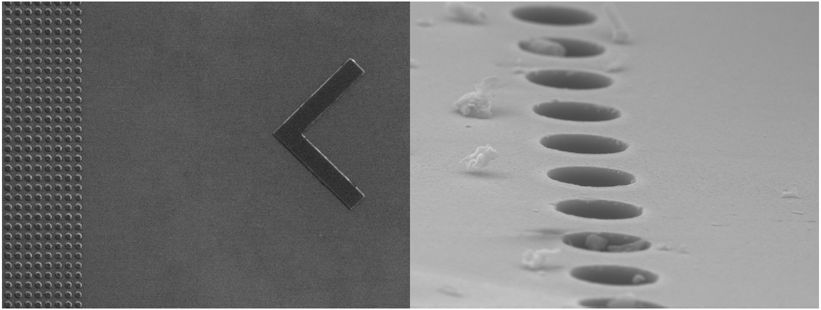
Bariloche

April 27, 2018

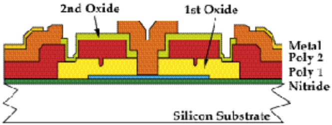


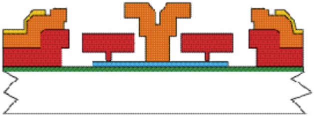
Technique to transfer patterns to flat surfaces.
Limitations: difraction (light $\lambda \approx 0{,}3\mu$m)
Proximity effect (electrons 15 nm).

Microfabrication
Thin films & etching



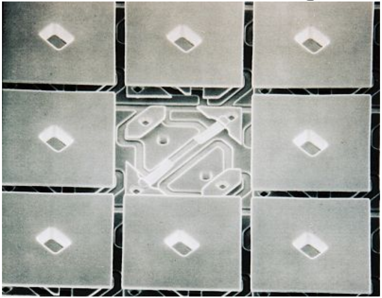
How MEMS are done

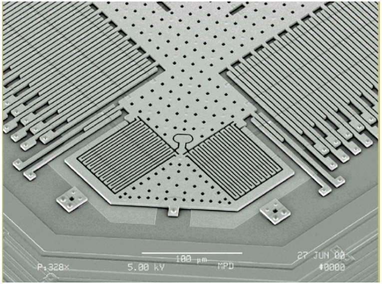




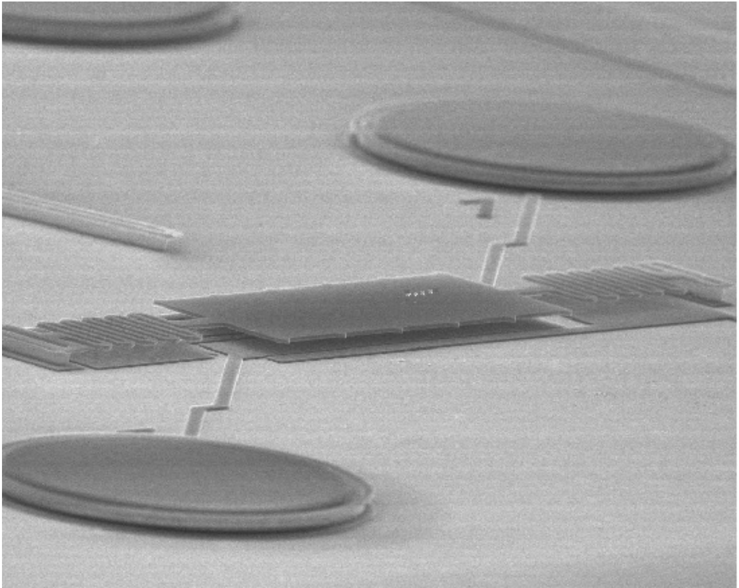
Some chemistry magic...
Layers of different materials (each one patterned separately).
And then a selective etching of one of them.
Result: some parts become released"from the underlying layers

MEMS are everywhere

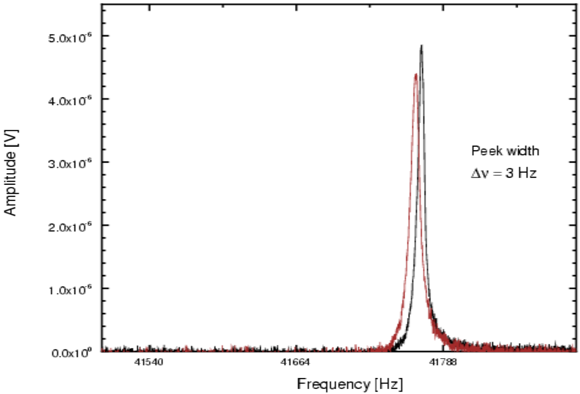




Torsional Oscillators



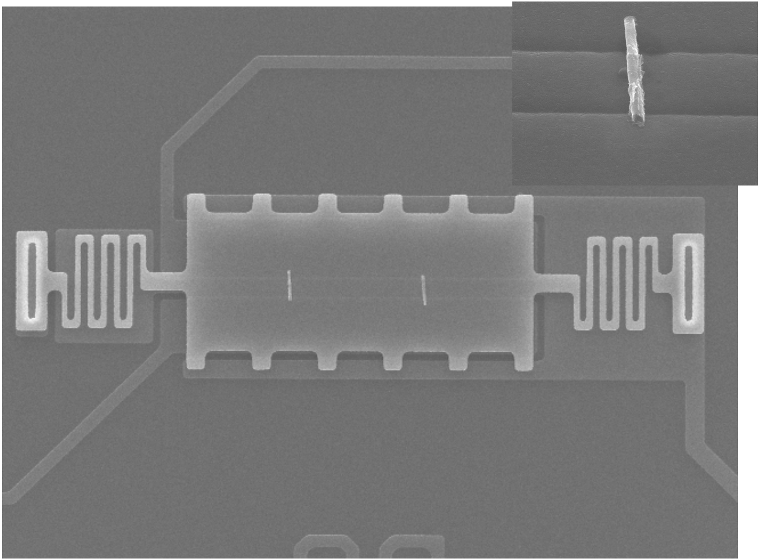
Torsional Oscillators



M. Dolz, D. Antonio & H. Pastoriza, Physica B **398** (2007) 329

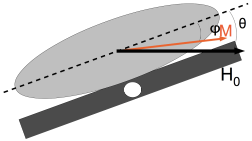
W. Bast, H. Pastoriza & M. Dolz, Proc EAMTA 2006 (2007) 7–10

Ferromagnetic Nanotubes



Ferromagnetic Nanotubes

$$k = \frac{d^2E}{d\theta^2}$$



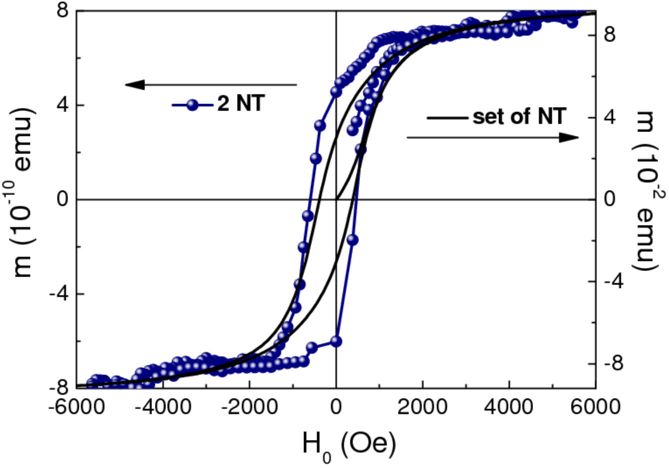
$$E = \frac{1}{2}NM^2(H)\sin^2(\varphi) - M(H)H_0\cos(\theta)$$

$$\frac{dE}{d\varphi_{\mathrm{eq}}} = 0 \Longrightarrow \varphi_{\mathrm{eq}} \simeq \frac{H_0}{MN + H_0}$$

$$\frac{d^2E}{d\theta^2} = \frac{MNH_0\left[M(MN+H_0) + \frac{dM}{dH}H_0(MN+2H_0)\right]}{(MN+H_0)^2}.$$

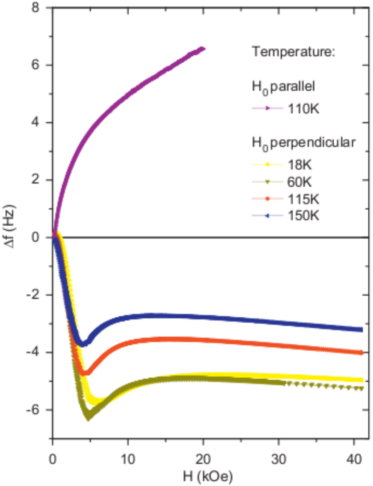
At high fields: $-\frac{1}{k} = \frac{1}{MH_0} + \frac{1}{NM^2}$

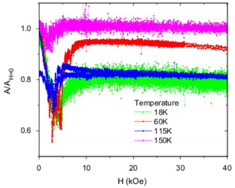
Ferromagnetic Nanotubes

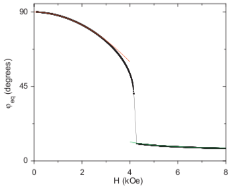


M. I. Dolz, W. Bast, D. Antonio, H. Pastoriza, J. Curiale, R. D. Sánchez & A. G. Leyva, J. Appl. Phys. **103** (2008)

Perpendicular Ferromagnetic Nanotubes







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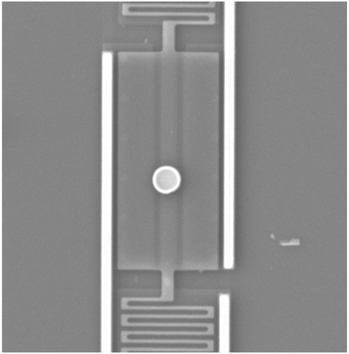
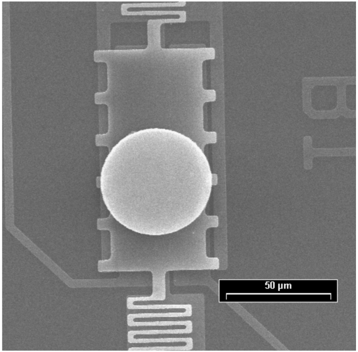
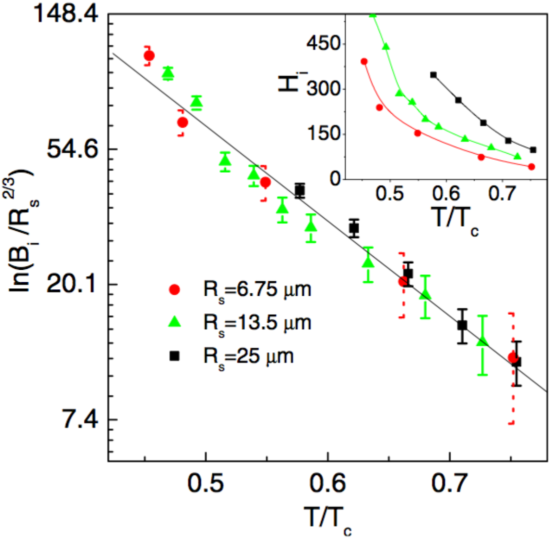
Measurements in Superconductors



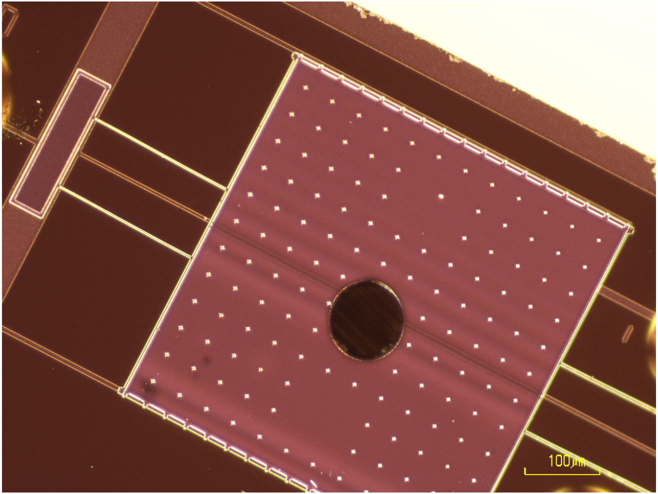


M.I. Dolz, A. K. Kolton, & H. Pastoriza, Phys. Rev. B **81**, 092502 (2010)

Measurements in Superconductors



Measurements in Superconductors



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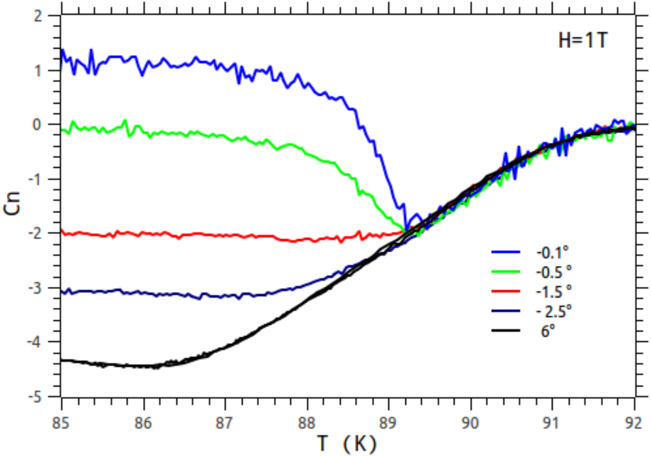
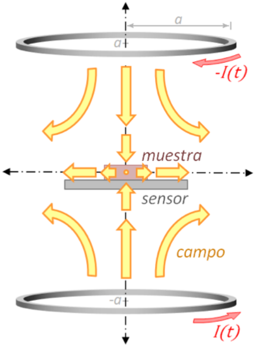
Measurements in Superconductors



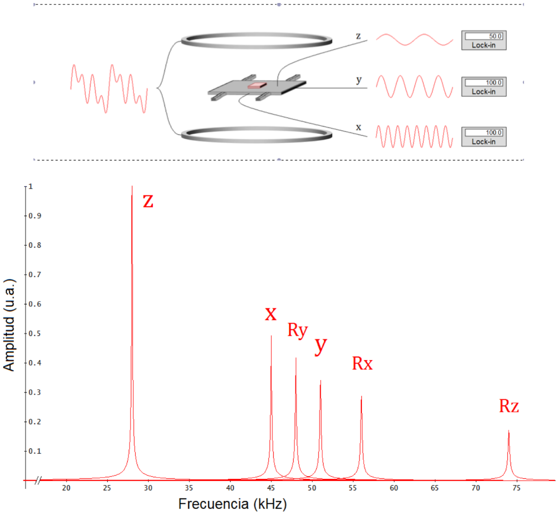
microAGM

Can the measurement become independent of sample shape?

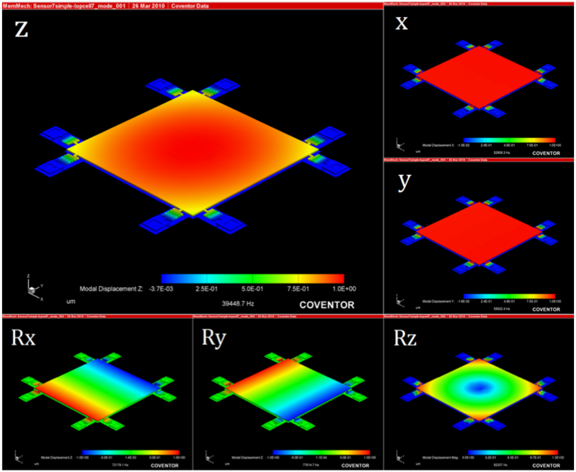


$$\vec{F} = \vec{\nabla}\vec{H} \cdot \vec{m}$$

microAGM


z
y
x
50.0
Lock-in
100.0
Lock-in
100.0
Lock-in
Amplitud (u.a.)
Frecuencia (kHz)
z
x
Ry
y
Rx
Rz
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
20
25
30
35
40
45
50
55
60
65
70
75

microAGM



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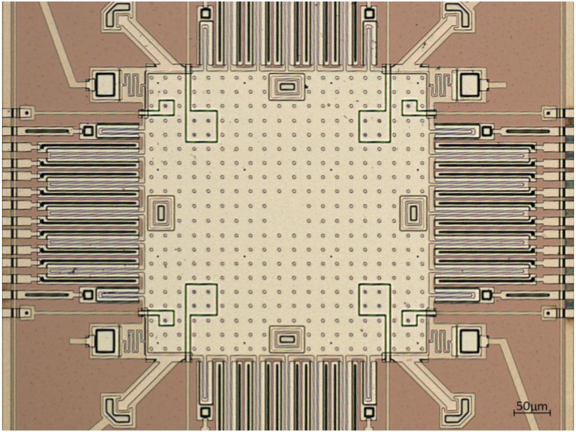
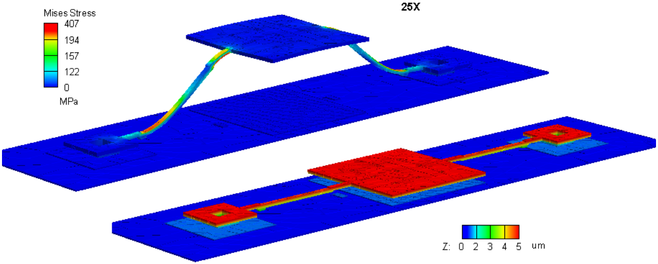
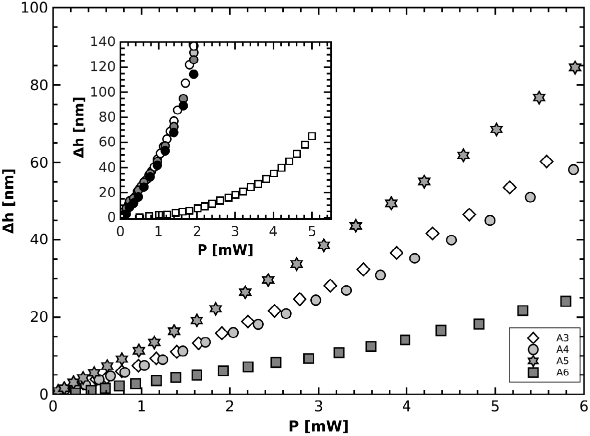
microAGM



Thermal Actuator

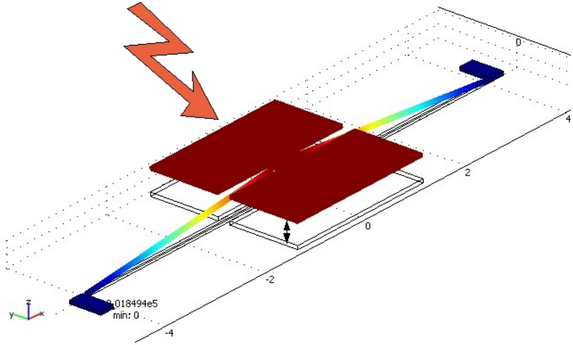


Thermal Actuator



K. Ogando, N. La Forgia, J. J. Zárate, & H. Pastoriza, Sensor and Actuators A **183** (2012) 95–100

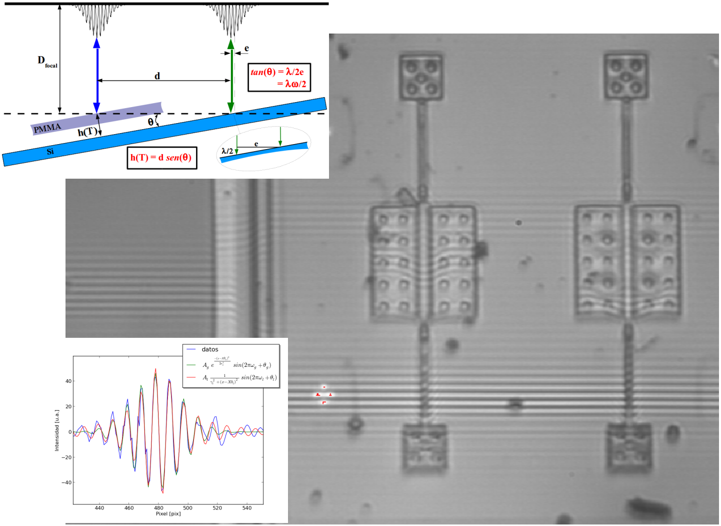
Uncooled Infrared detector



$$\Delta y \approx L\sqrt{2\alpha\Delta T}$$

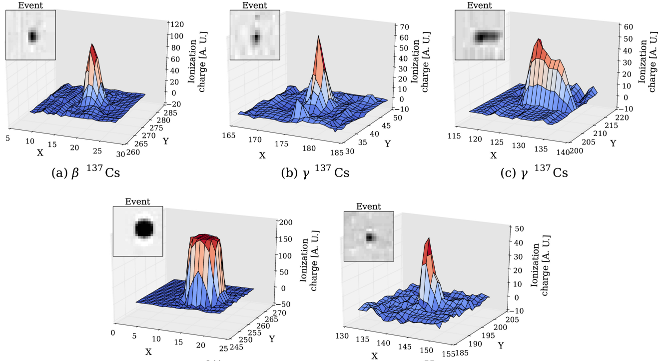
Sensor bolométrico de alta sensibilidad; H. Pastoriza, N. La Forgia, M. Dolz, D. Antonio;Patente Instituto Nacional de Propiedad Intelectual AR 060423B1.

Uncooled Infrared detector



Off the shelf CMOS Image Sensors for Particle Detection

J. Lipovetzky & M. Gómez Berisso

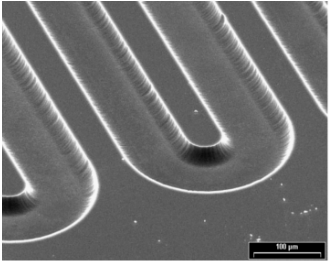


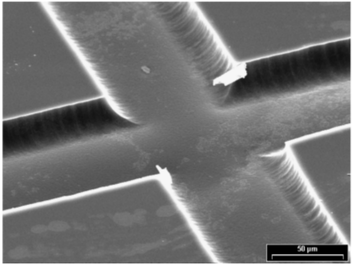
(a) β ^{137}Cs (b) γ ^{137}Cs (c) γ ^{137}Cs

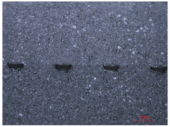
(d) α ^{241}Am (e) X ^{55}Fe

M.Pérez et al. Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment, **827** 171, (2016)

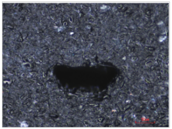
Microviscometer



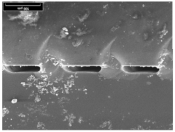




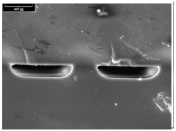
(a) Canal de 50 µm. Escala de 100 µm.



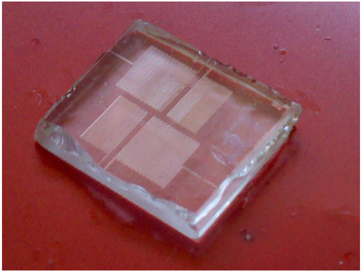
(b) Canal de 50 µm. Escala de 50 µm.



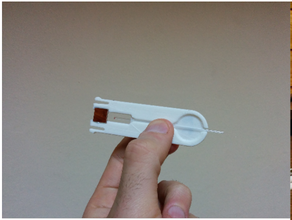
(c) Canal de 100 µm. Escala de 100 µm

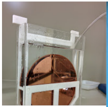


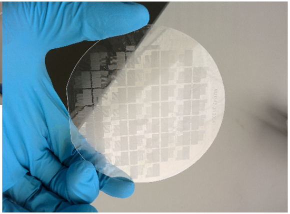
(d) Canal de 100 µm. Escala de 50 µm



Prototype







MZP
TECNOLOGÍA

Some Spin-offs and other works[1]:

- Cryogenics ASIC-CMOS.
- Magnetometer by using MEMS in non-lineal regime.
- Non linearity and syncronization. Frequency lockin
- Devices based in III-V Semiconductors (QWIPs, QCLs, MEMS, Hybrid systems)
- MKIDs
- GEMs
- CMOS Neutron detectors

[1] Glad to answer any question

Thanks!