

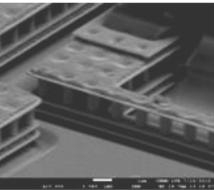
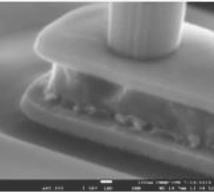
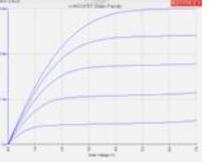
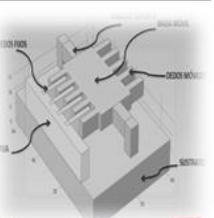
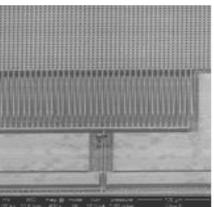
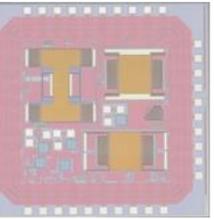
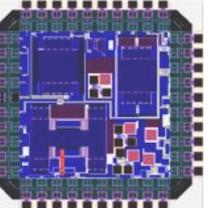
GRUPO DE SISTEMAS VLSI
Dr. Mario Alfredo Reyes Barranca

mreyes@cinvestav.mx

Tel.: +(52) 55 5747 3776

Línea de Investigación

Dispositivos y Sistemas MEMS



10kV

x3,700

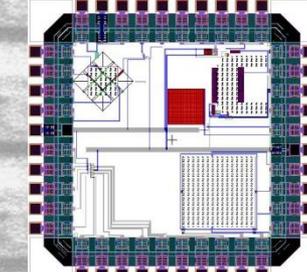
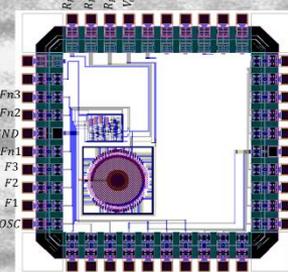
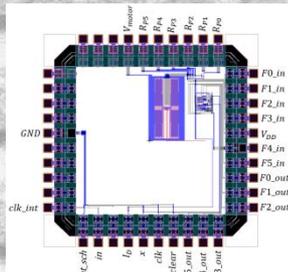
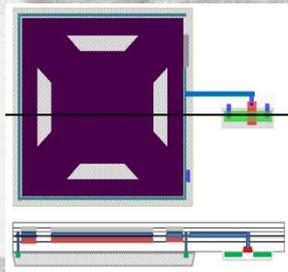
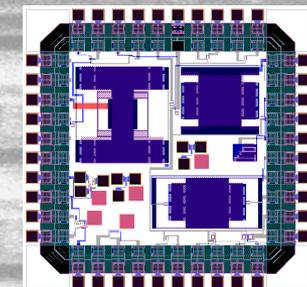
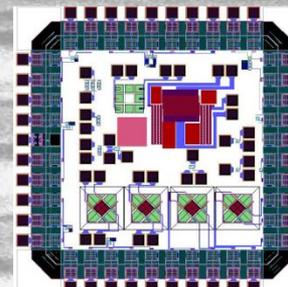
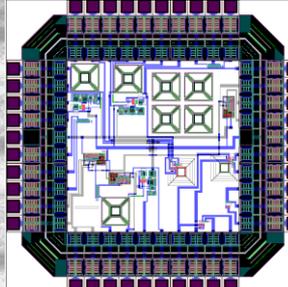
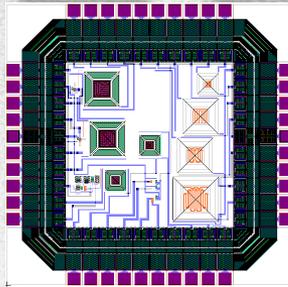
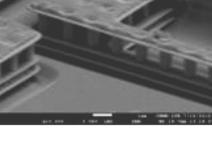
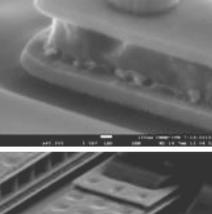
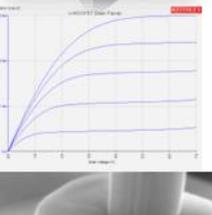
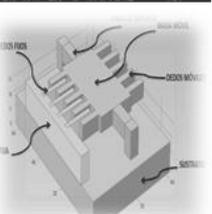
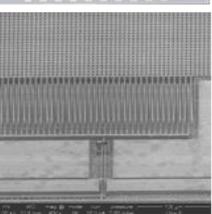
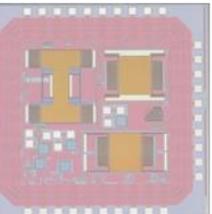
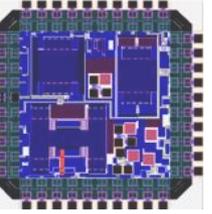
5μm

2015/07/08

18 40 SEM_SEI

Línea de Investigación

Diseño, fabricación y caracterización de MEMS



10kV

x3,700

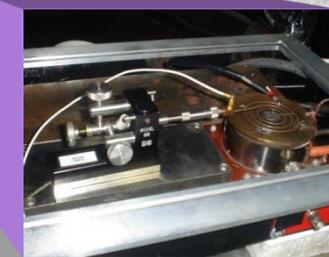
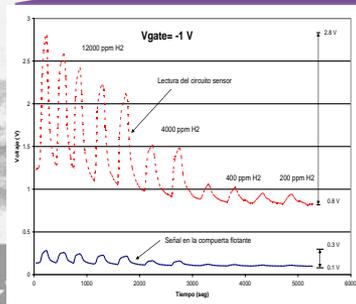
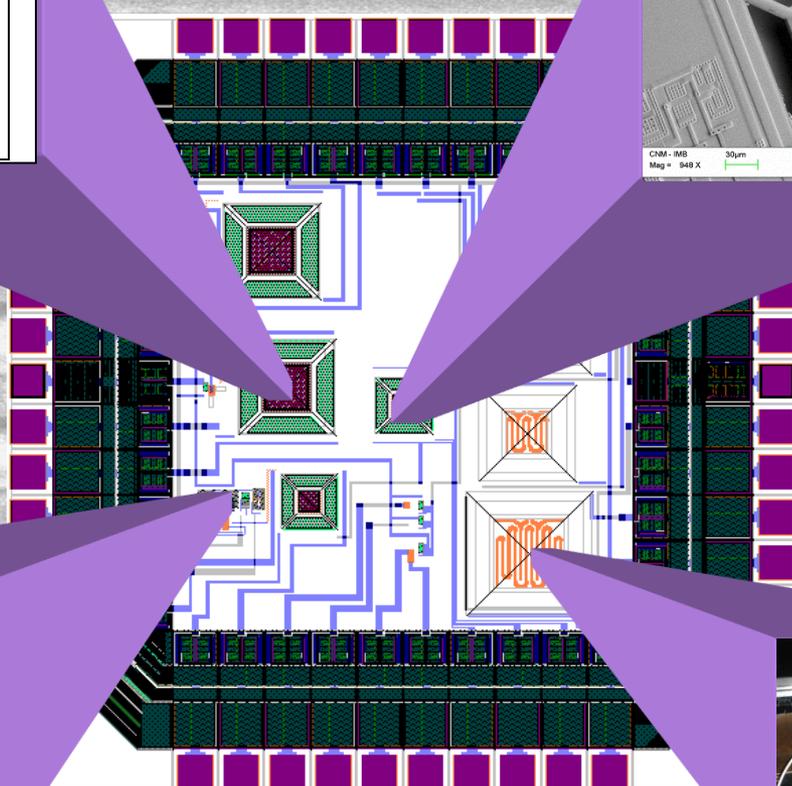
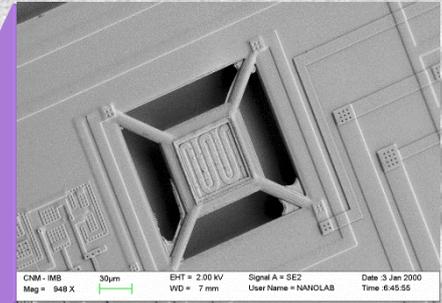
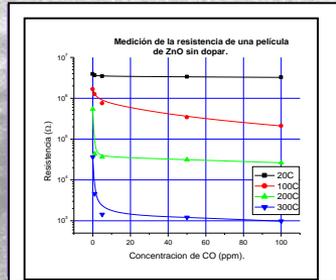
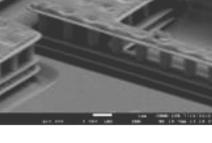
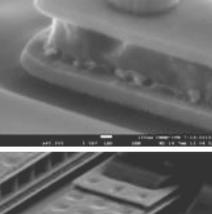
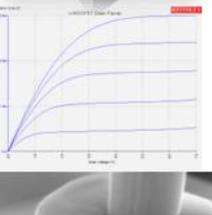
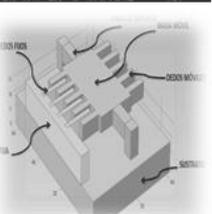
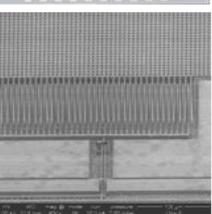
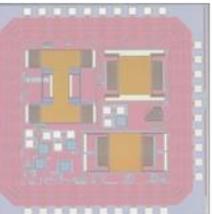
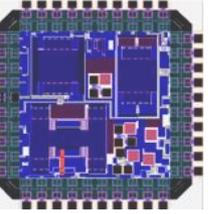
5 μ m

2015/07/08

18 40 SEM_SEI

Línea de Investigación

Dispositivos y Sistemas MEMS.



10kV

5µm

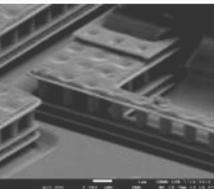
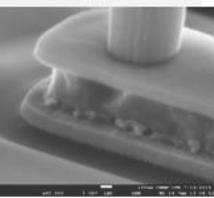
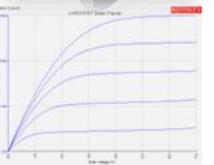
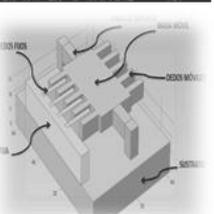
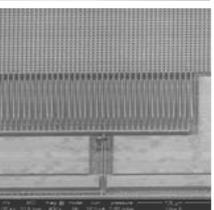
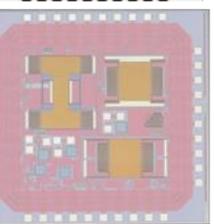
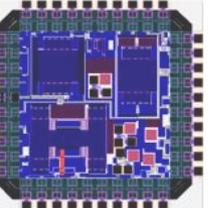
2015/07/08

10.10.CNM_SEI

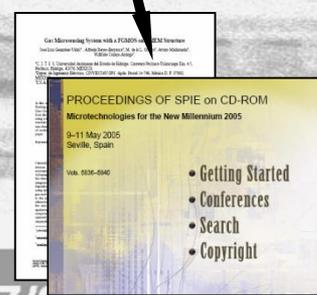
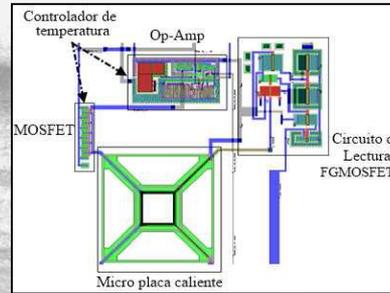
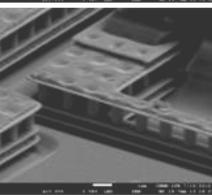
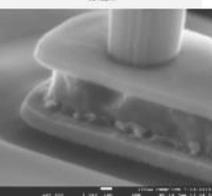
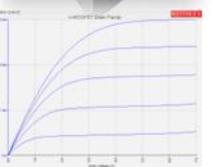
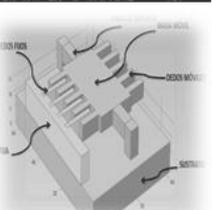
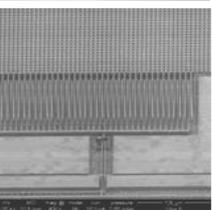
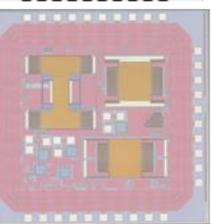
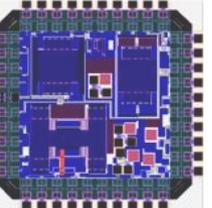
Línea de Investigación

Sistemas con Sensores MEMS y Dispositivos con FGMOS.

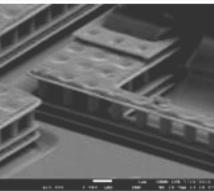
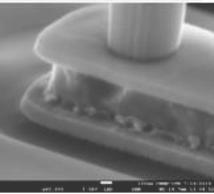
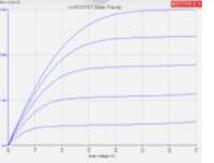
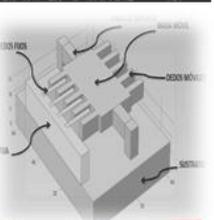
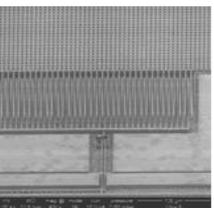
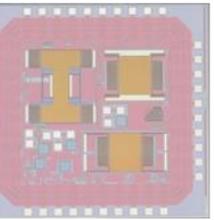
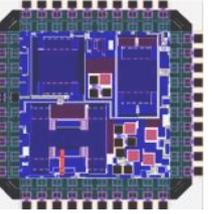
- Ejemplo de lo que son MEMS
- Sistema de detección de gases
- Acelerómetro CMOS-MEMS
- Micro-celdas sobre FGMOS
- Transistores MOS de Compuerta Flotante



DISEÑO DE ESTRUCTURAS CON BASE AL FGMOS



DEPARTAMENTO DE INGENIERIA ELECTRICA SECCION DE ELECTRONICA DEL ESTADO SÓLIDO



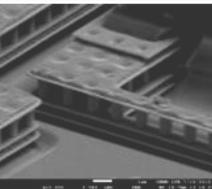
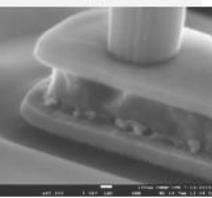
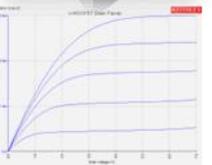
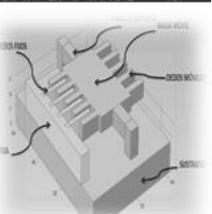
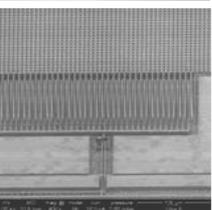
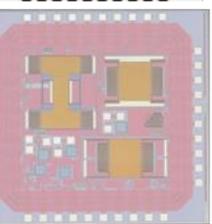
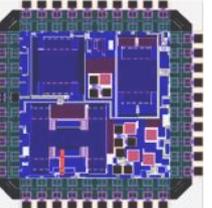
10kV

x3,700

5 μ m

2015/07/08

18 40 SEM_SEI



GRUPO DE SISTEMAS VLSI

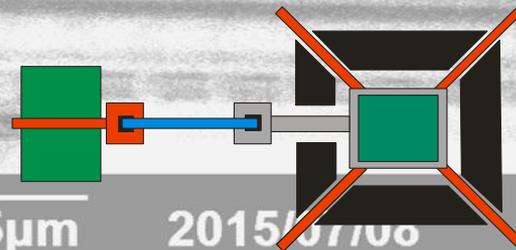
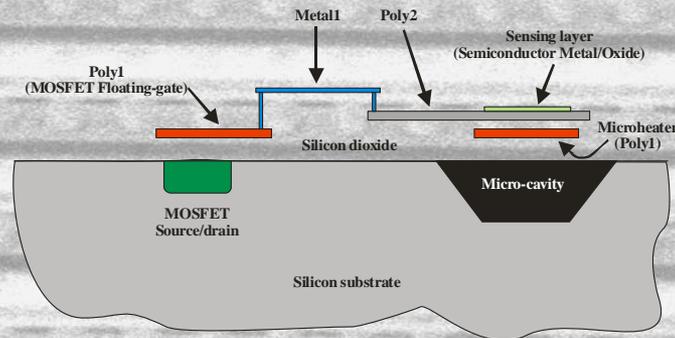
Dr. Mario Alfredo Reyes Barranca

mreyes@cinvestav.mx

Tel.: +(52) 55 5747 3776

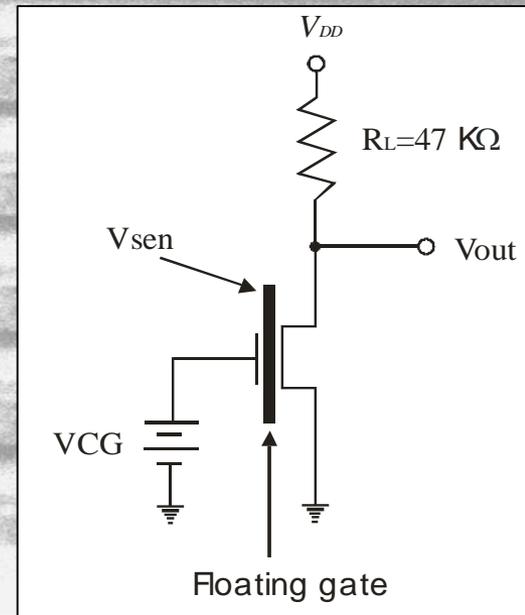
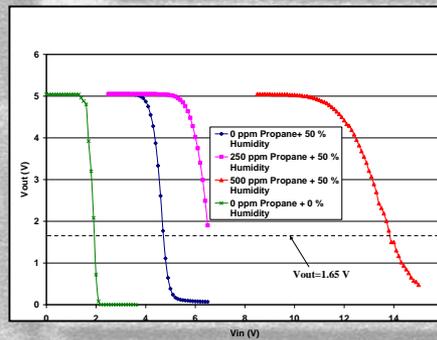
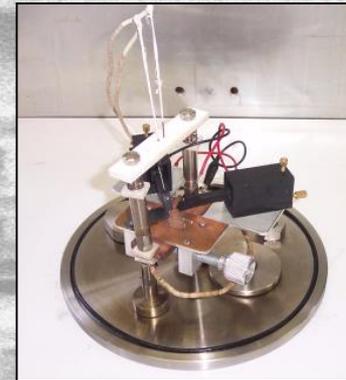
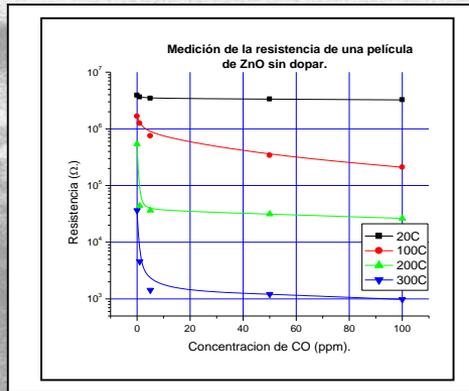
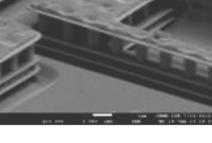
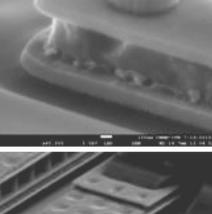
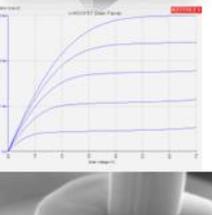
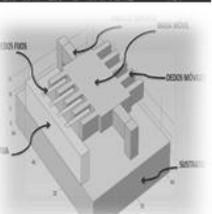
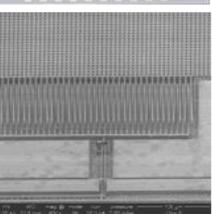
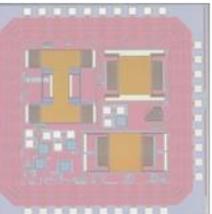
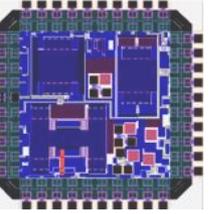
Dispositivos

- Diseño de los dispositivos y fabricación tecnológica
- Sensores de gas
 - Gases inorgánicos
 - Aromáticos
- Microplaca caliente (calefactor)



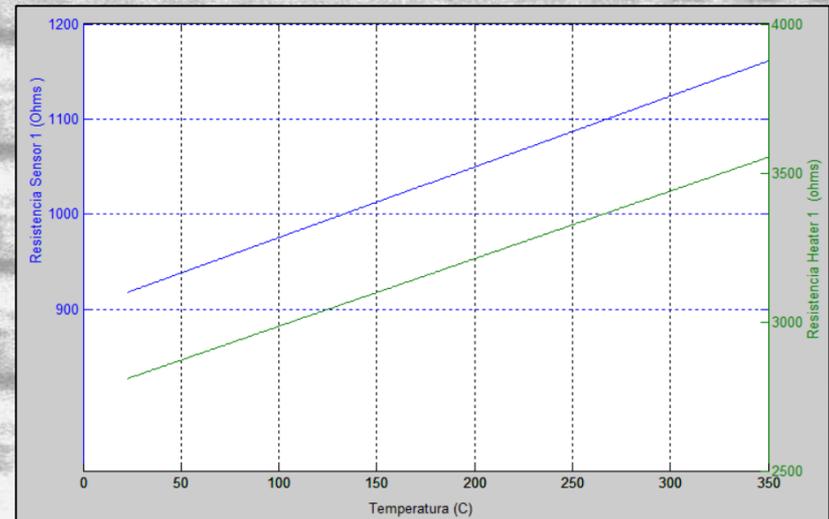
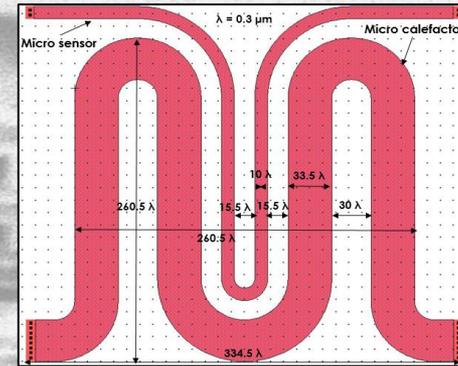
Caracterización

Propiedades de óxidos semiconductores (Estática y Dinámica)



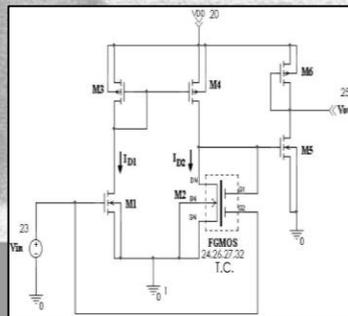
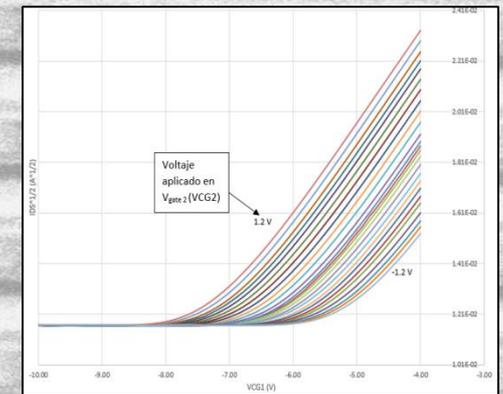
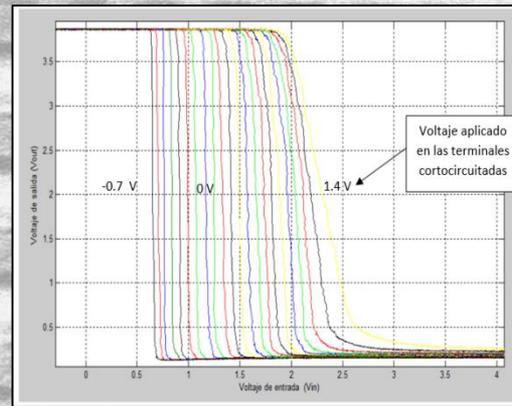
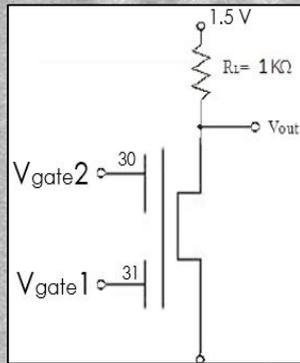
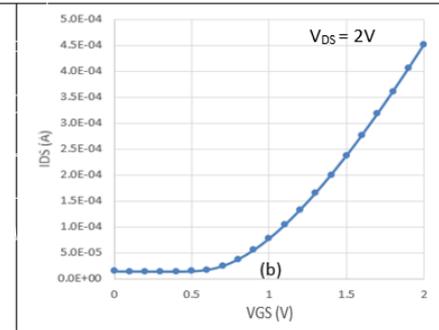
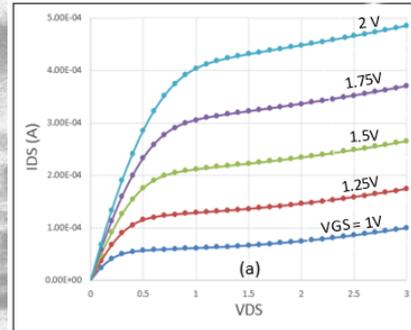
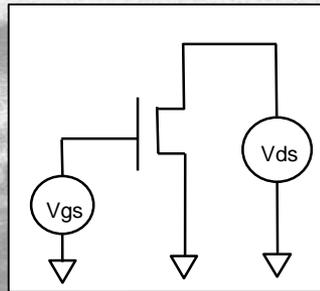
Caracterización

Coeficiente de Resistencia Térmica (TCR) de materiales calefactores y sensores



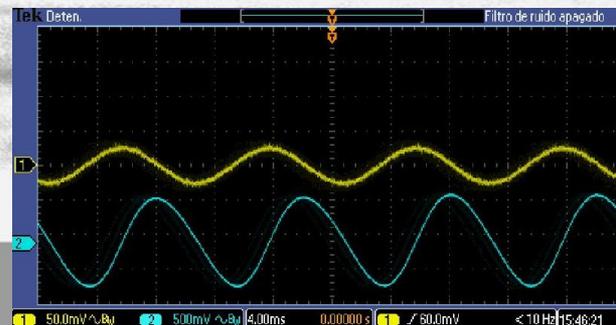
Caracterización

Características I-V de los dispositivos integrados y de los sistemas sensores



10kV

5μm

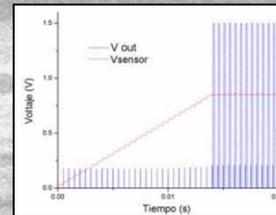
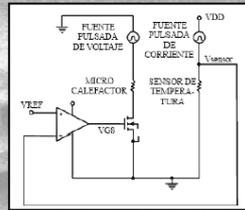


40 SEM_SEI

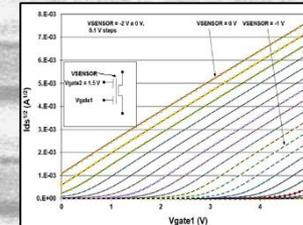
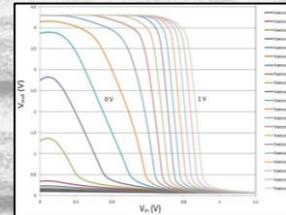
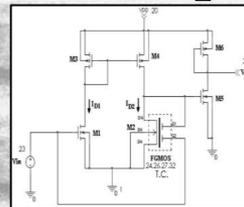
Simulación por computadora

■ Sistema electrónico (PSPICE)

- Circuitos de control térmico

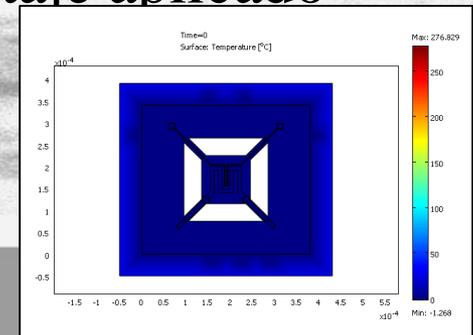
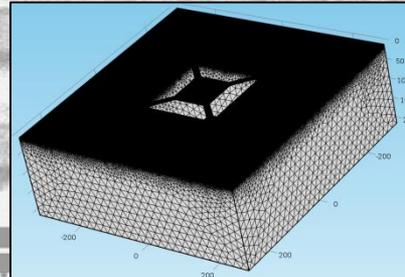
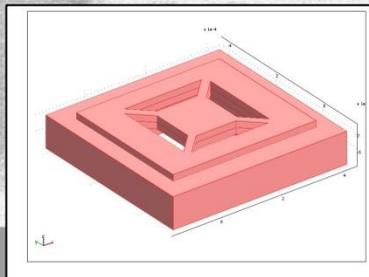


- Circuitos de procesamiento de señal



■ Comportamiento electro-térmico (COMSOL)

- Respuesta térmica de los materiales
- Temperatura en función del voltaje aplicado



10kV

x5,700

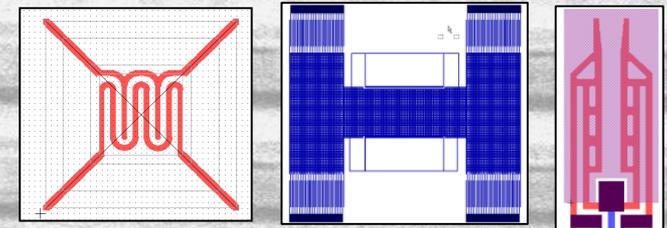
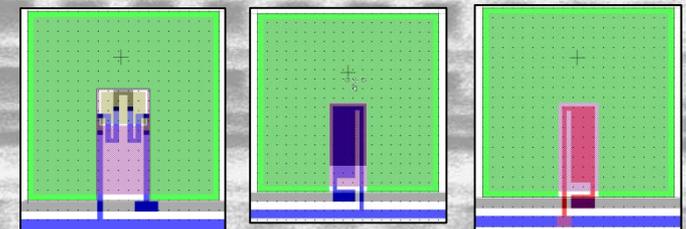
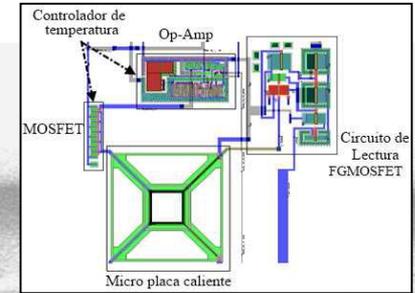
5µm

2015/07/00

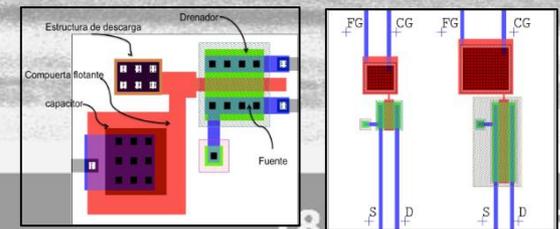
SEI

Diseño topológico

- Amplificadores
- Circuitos de procesamiento de señal
 - Digitales
 - Analógicos
- Motivos de prueba
- Microcalefactores, acelerómetros (sensores) y micropinzas (actuadores)



- Transistores MOS de Compuerta Flotante



10kV

x3,700

5µm

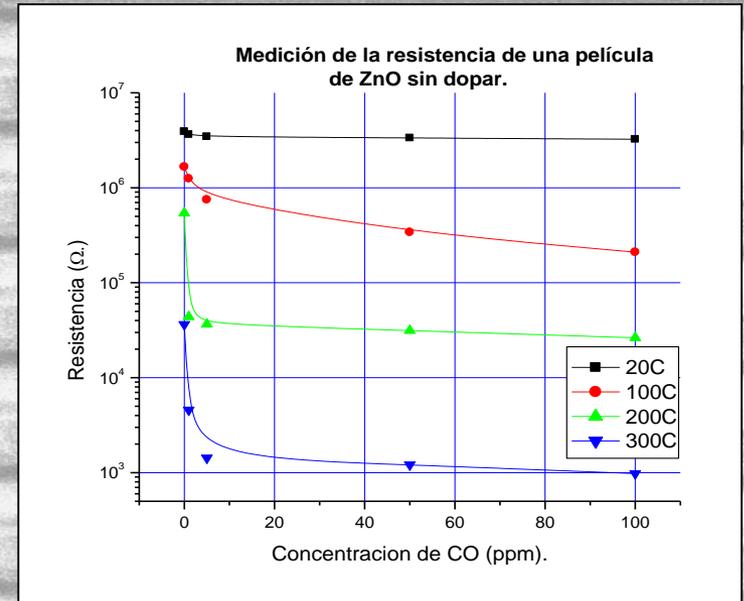
2015/07/08

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Procesos tecnológicos

■ Depósito de películas sensoras

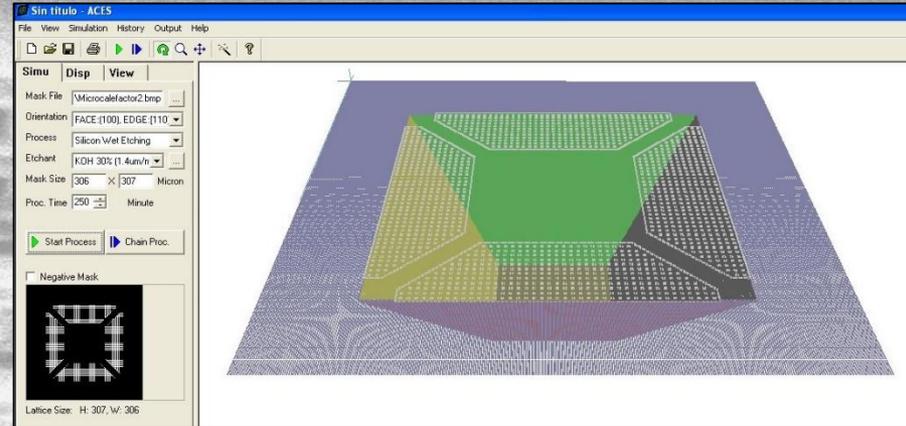
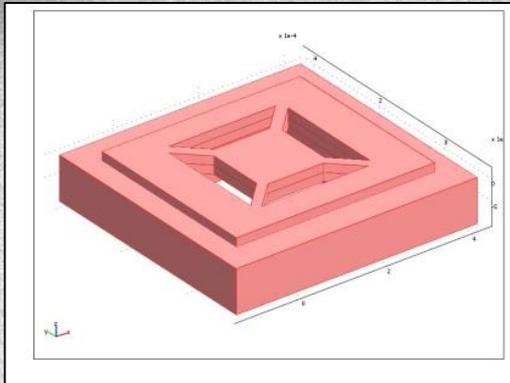
- Óxidos semiconductores
- Ferritas



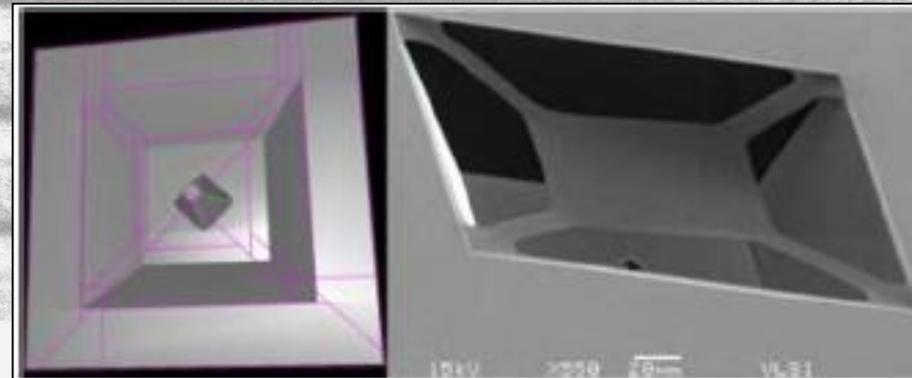
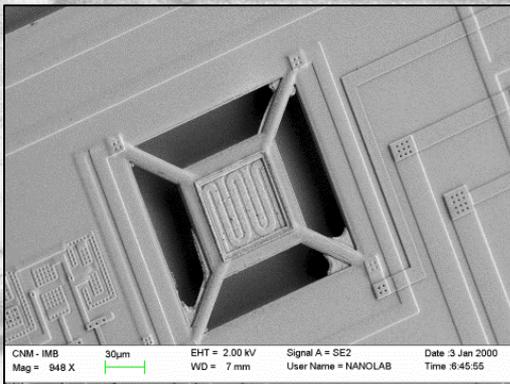
Procesos tecnológicos

■ Micromaquinado Volumétrico

Simulación



Experimental



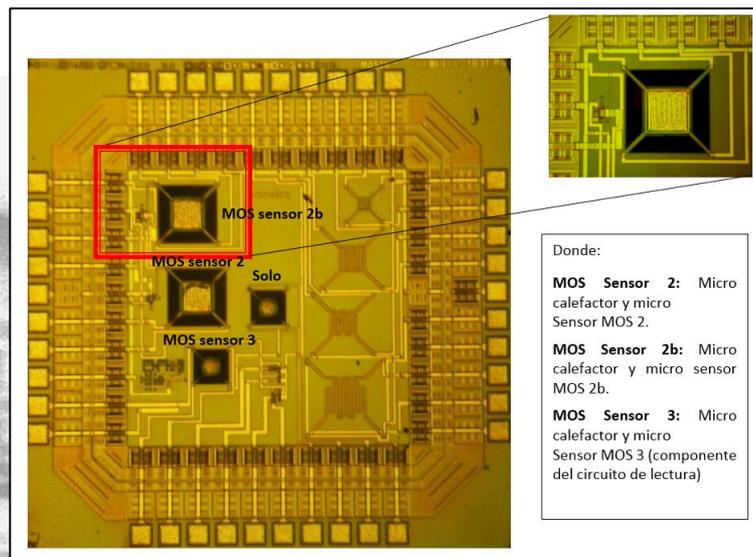
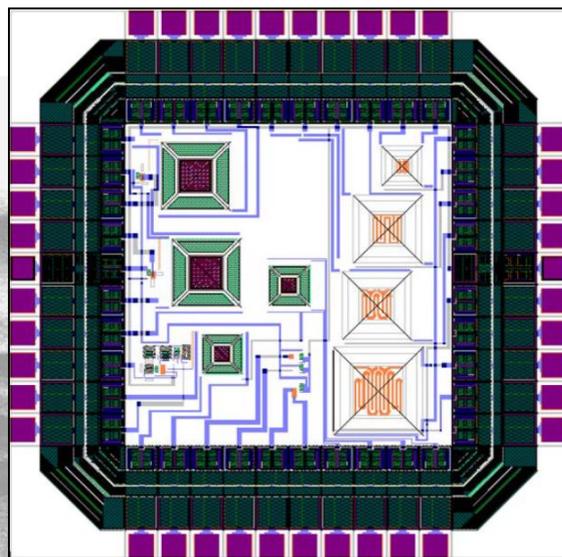
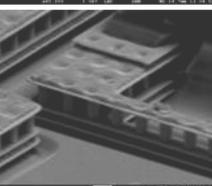
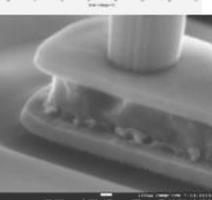
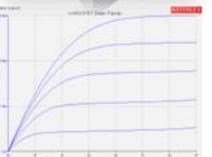
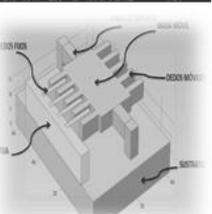
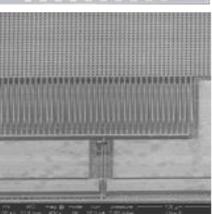
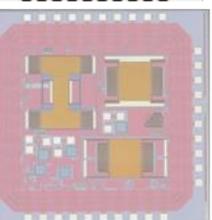
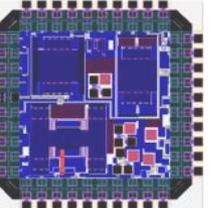
10kV

x3,700

5µm

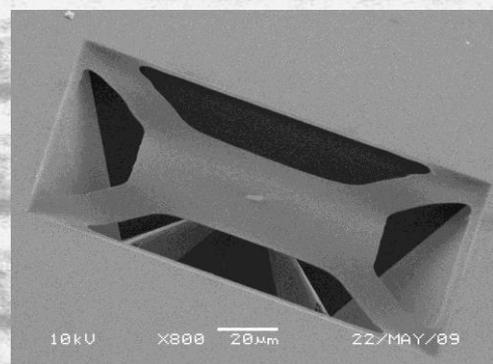
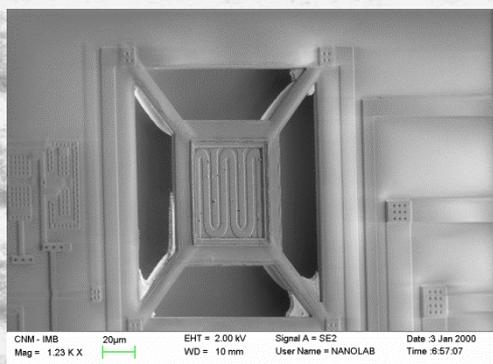
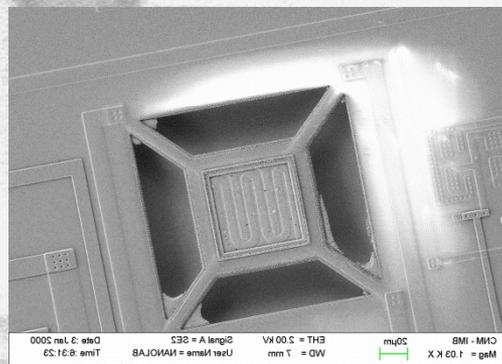
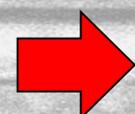
2015/07/08

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Donde:

- MOS Sensor 2:** Micro calefactor y micro Sensor MOS 2.
- MOS Sensor 2b:** Micro calefactor y micro sensor MOS 2b.
- MOS Sensor 3:** Micro calefactor y micro Sensor MOS 3 (componente del circuito de lectura)



Microfotografías (SEM) de Grabado de Fosos

10kV

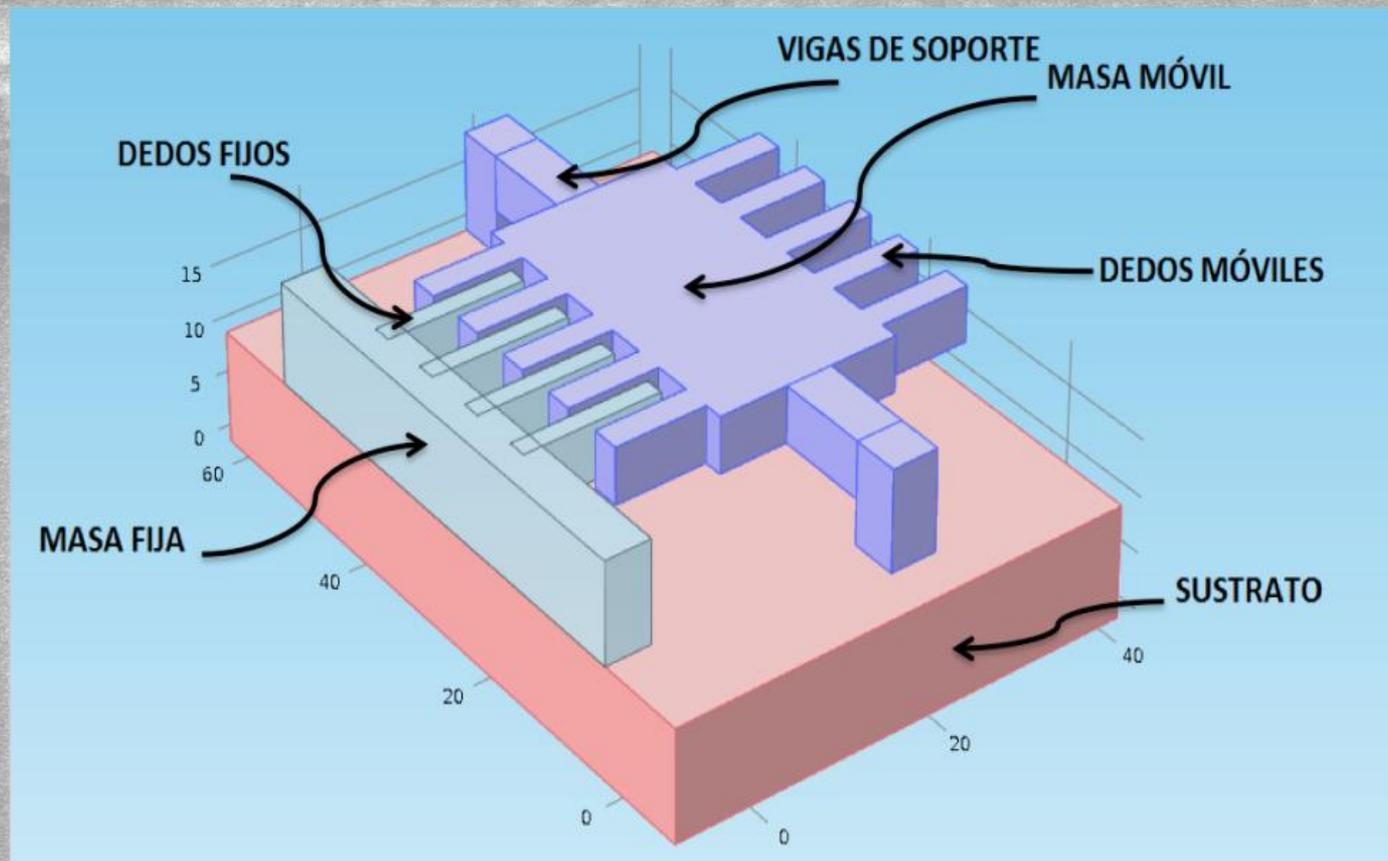
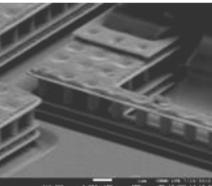
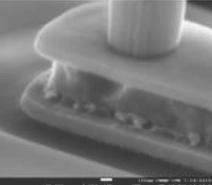
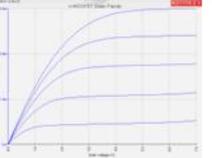
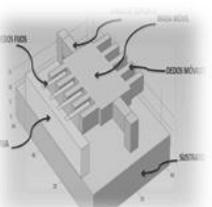
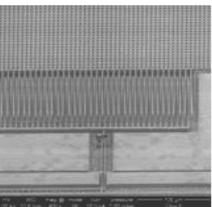
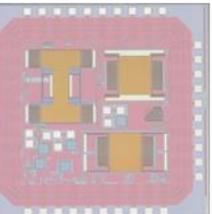
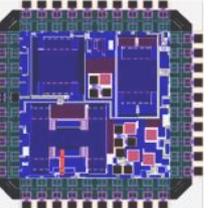
x3,700

5µm

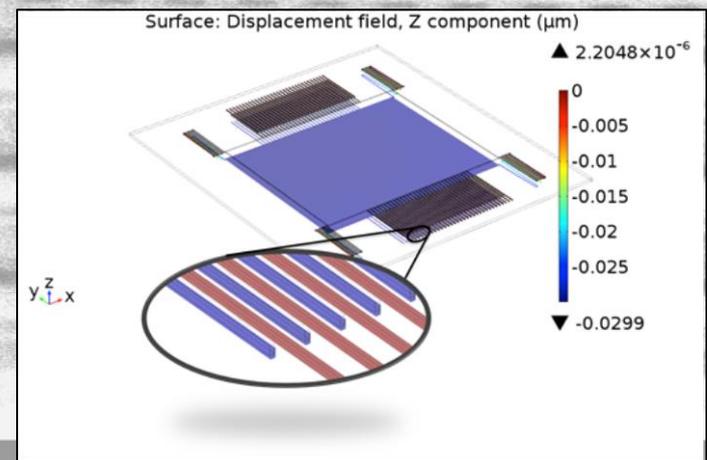
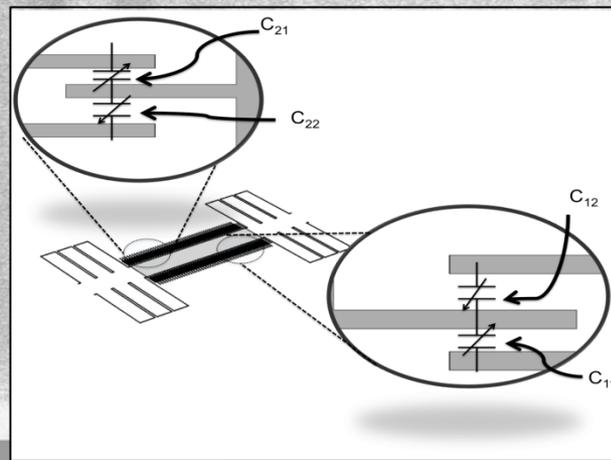
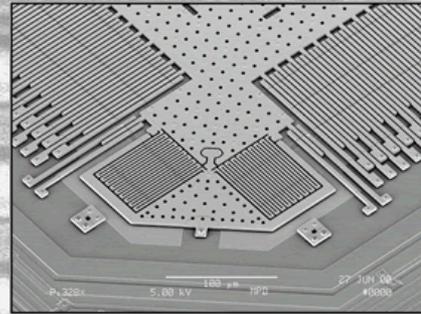
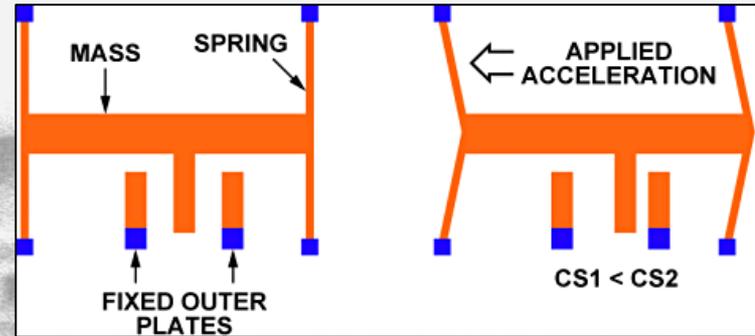
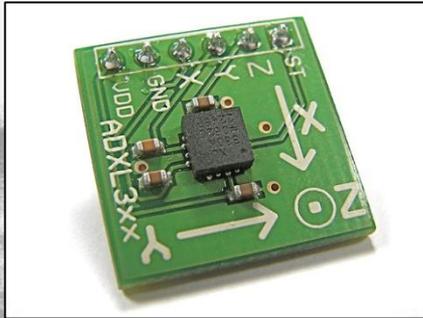
2015/07/08

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Acelerómetro CMOS-MEMS



Acelerómetro CMOS-MEMS



10kV

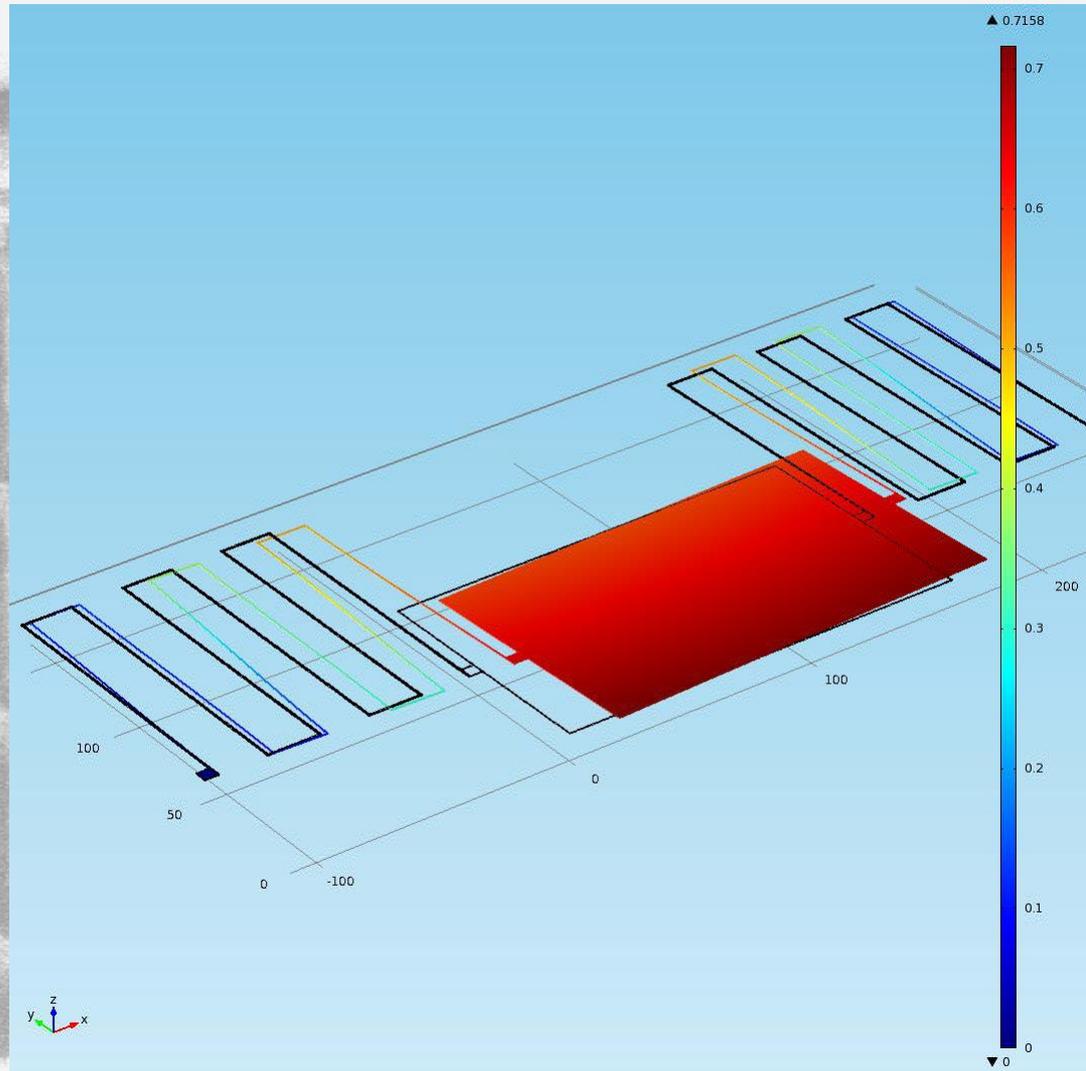
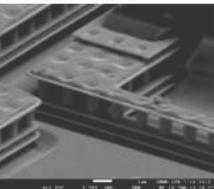
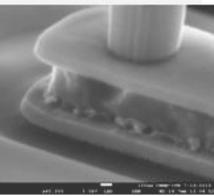
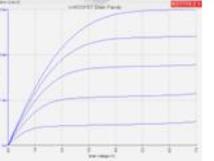
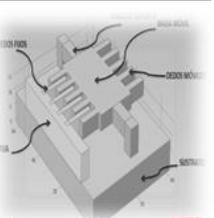
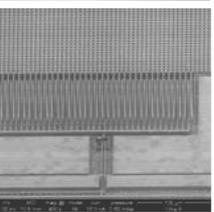
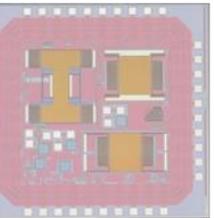
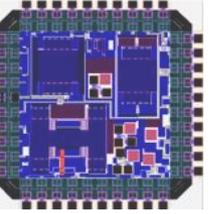
x3,700

5μm

2015/07/08

18 40 SEM_SEI

Acelerómetro CMOS-MEMS



10kV

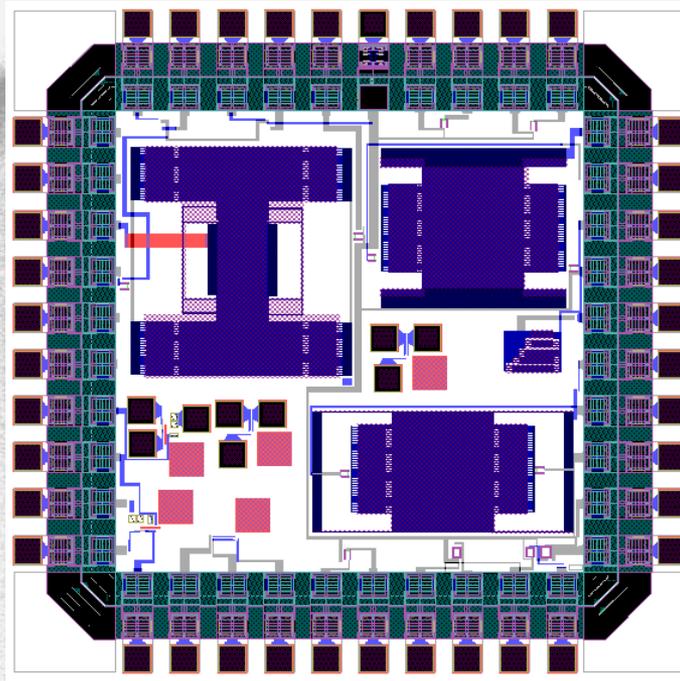
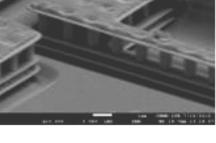
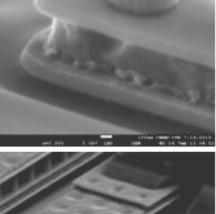
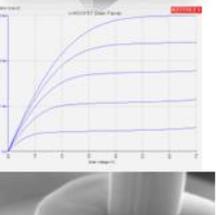
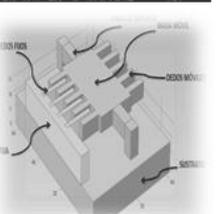
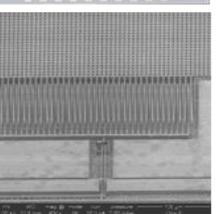
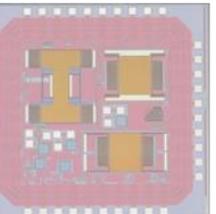
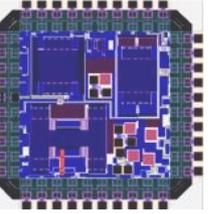
x3,700

5 μ m

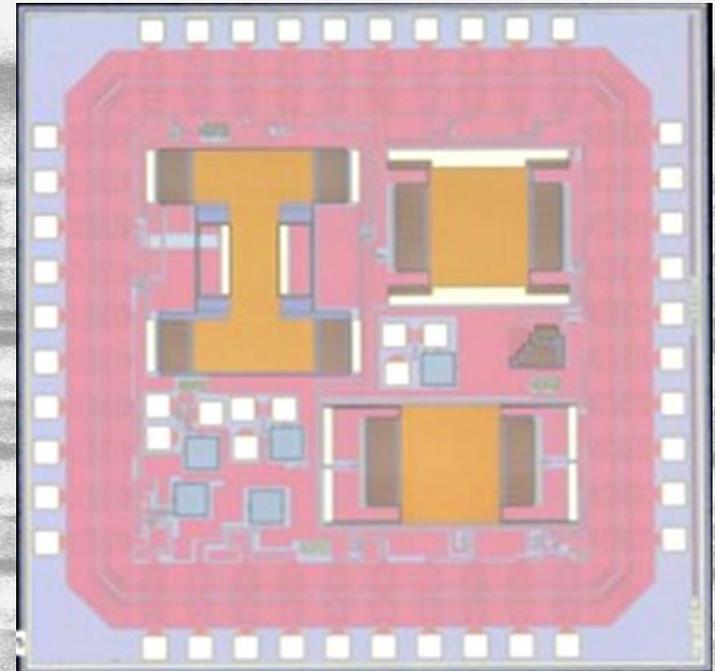
2015/07/08

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Acelerómetro CMOS-MEMS



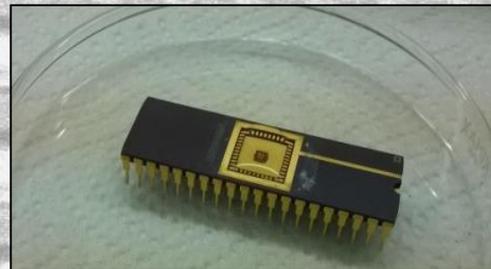
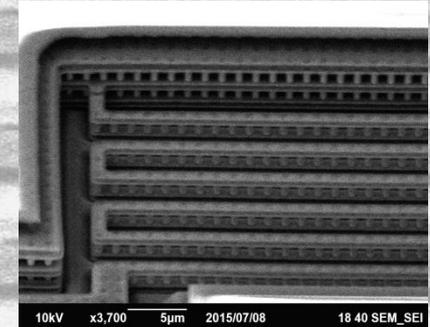
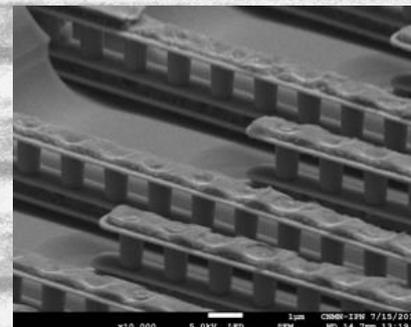
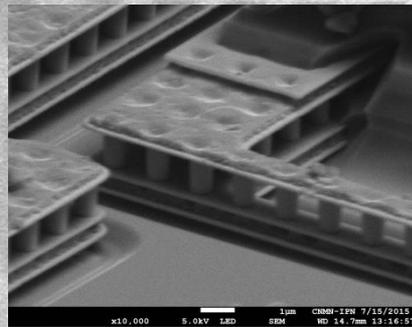
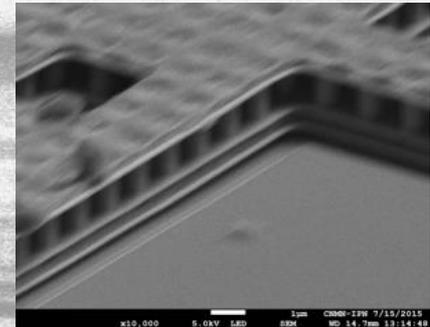
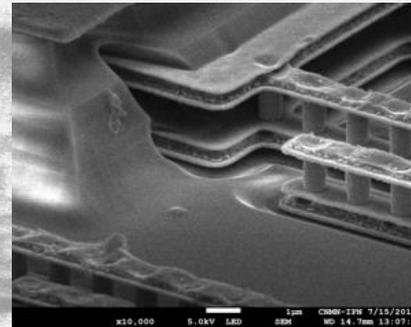
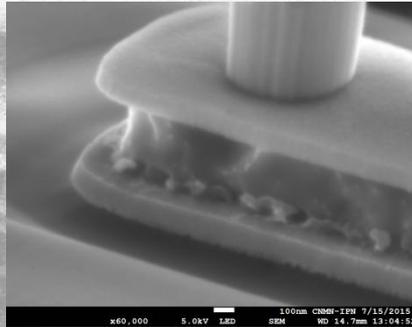
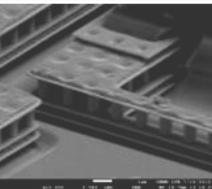
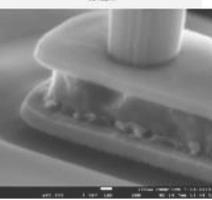
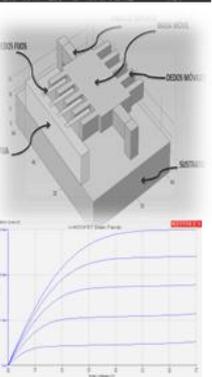
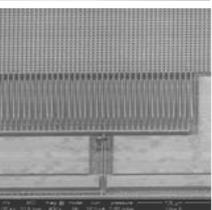
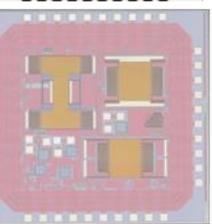
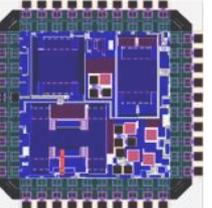
Layout



Chip fabricaco

Procesos tecnológicos

■ Micromaquinado Superficial



10kV

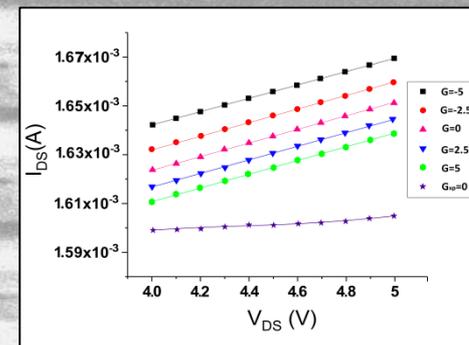
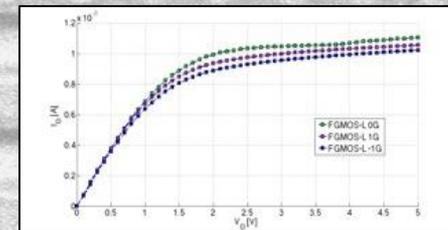
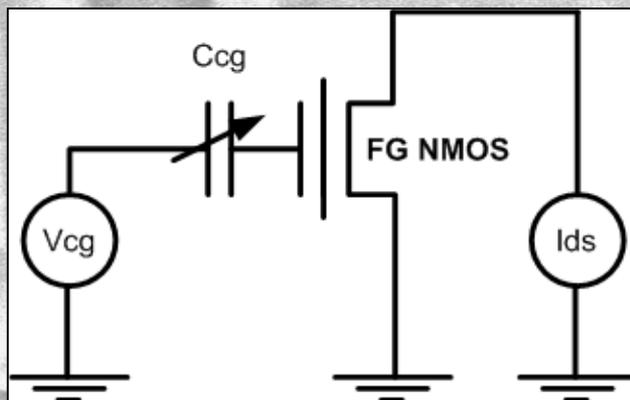
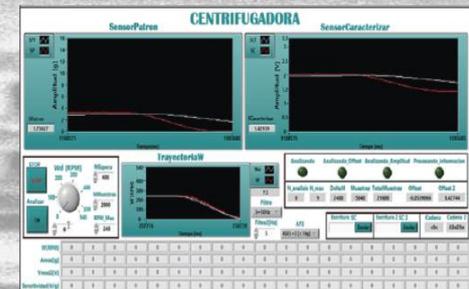
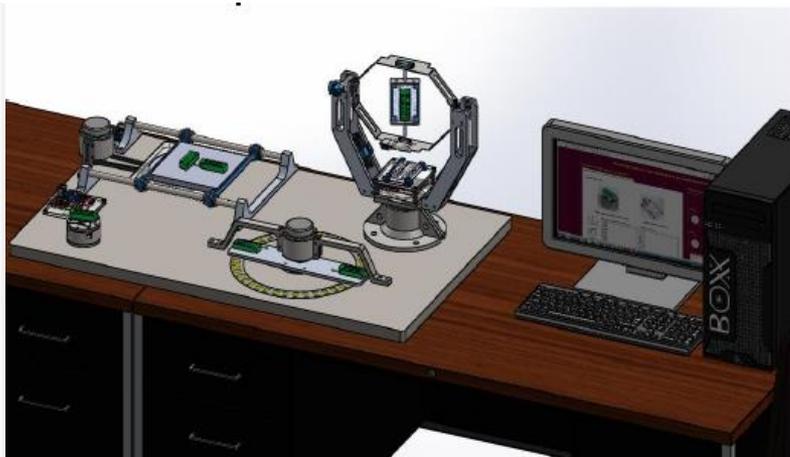
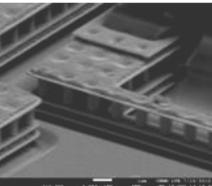
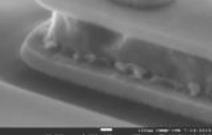
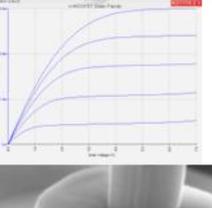
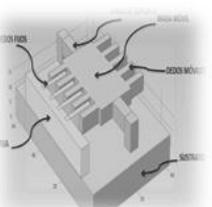
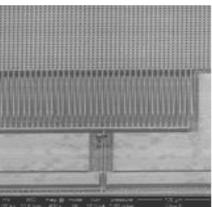
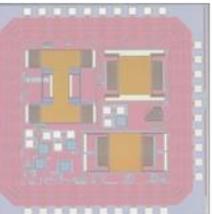
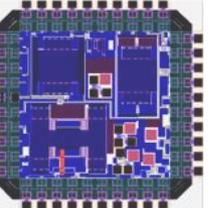
x3,700

5µm

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Caracterización eléctrica



10kV

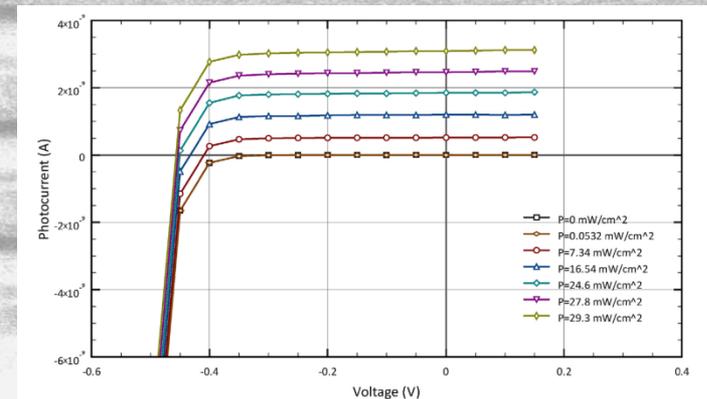
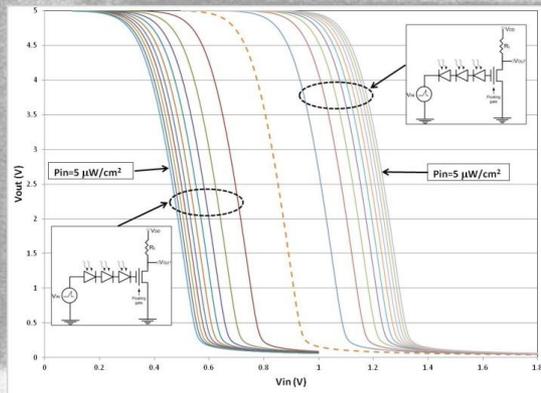
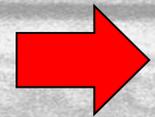
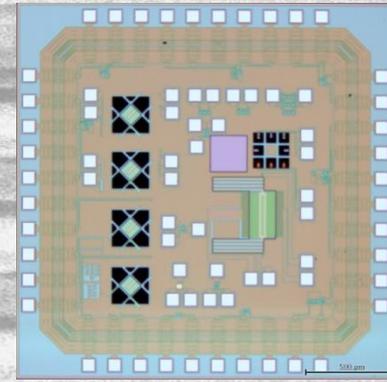
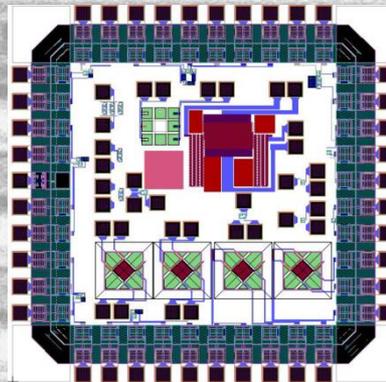
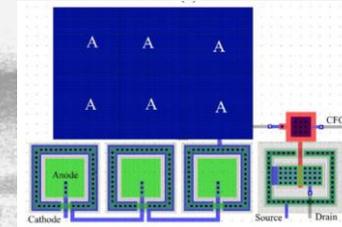
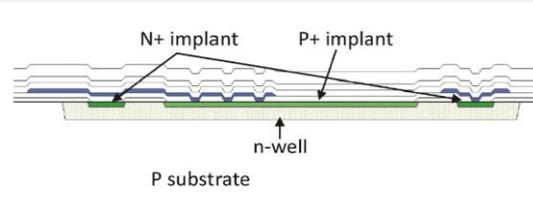
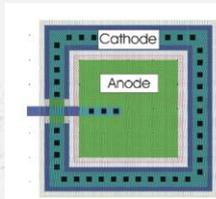
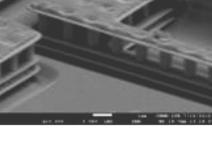
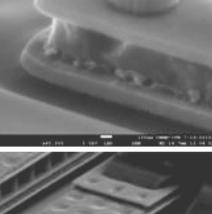
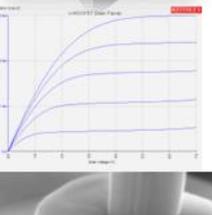
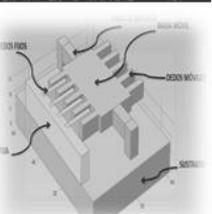
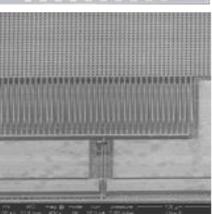
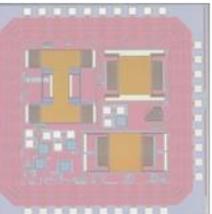
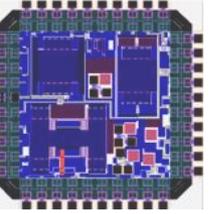
x3,700

5 μ m

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Foto sensor como compuerta de control de un FGMOS



10kV

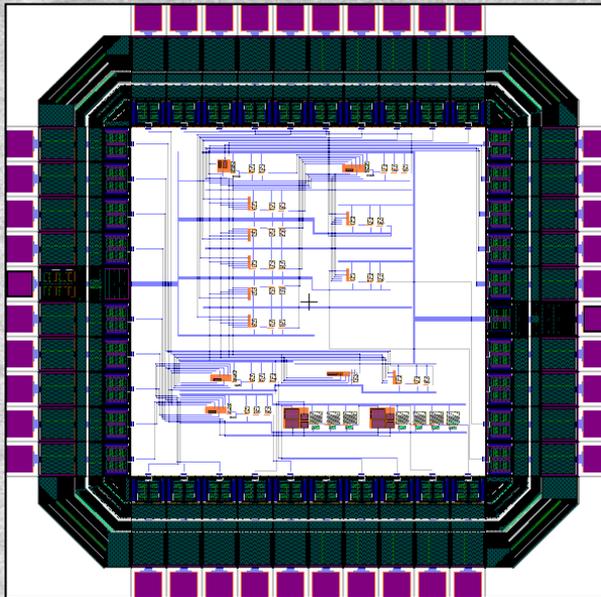
x3,700

5 μm

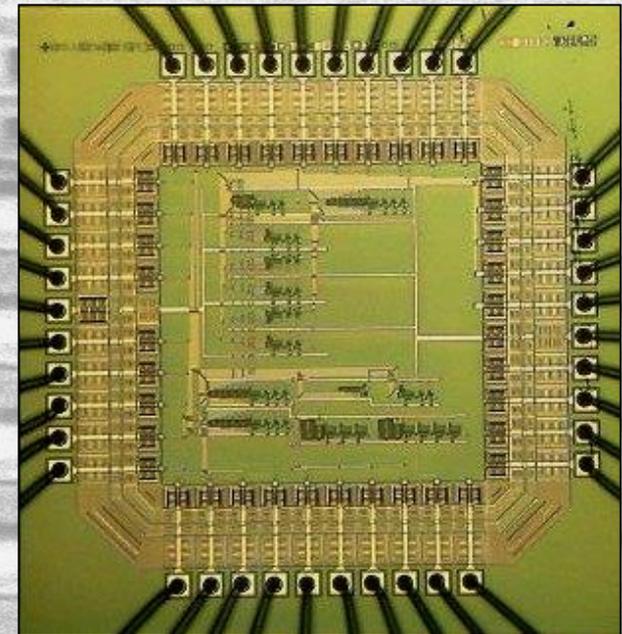
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Línea de Investigación: Transistores MOS de Compuerta Flotante

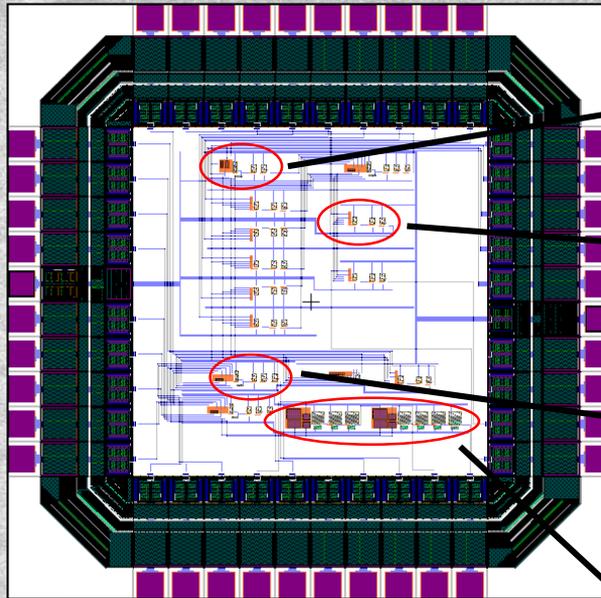


Diseño topológico de un circuito v-MOS con compuerta flotante

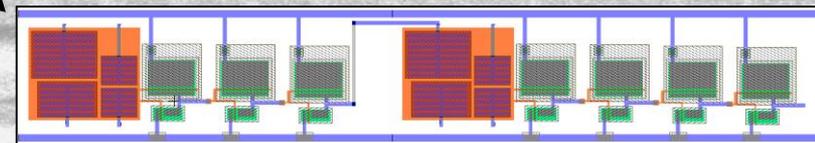
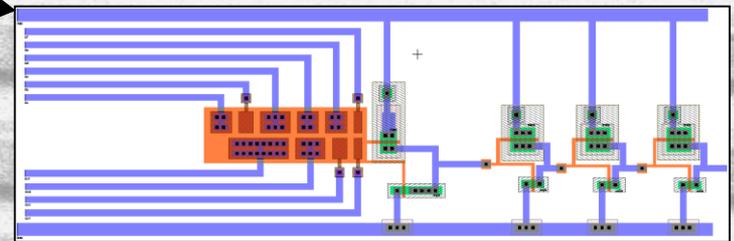
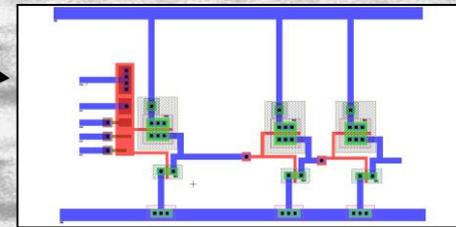
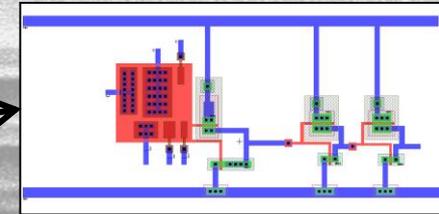


Microfotografía del circuito v-MOS con compuerta flotante, fabricado con tecnología de 1.5 μm

Línea de Investigación: Transistores MOS de Compuerta Flotante



Diseño topológico de un circuito v-MOS con compuerta flotante



Celdas integradas conteniendo transistores v-MOS

10kV

x3,700

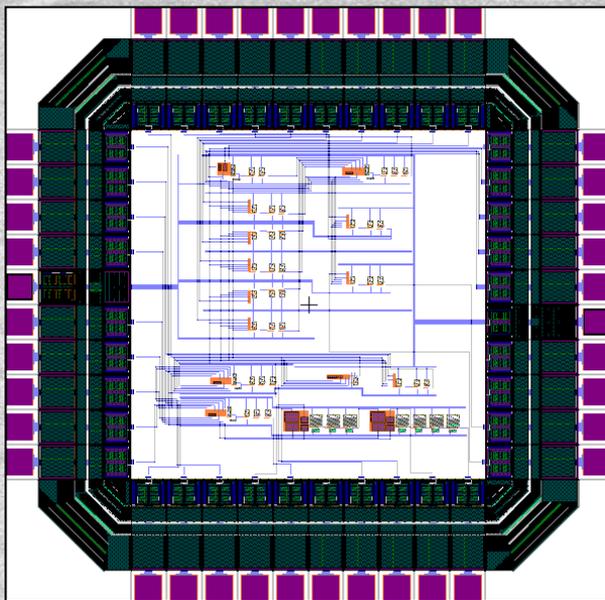
5 μ m

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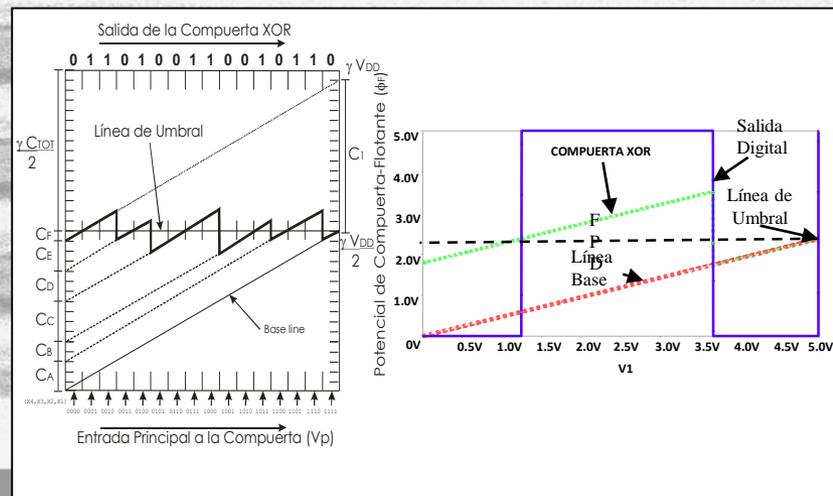
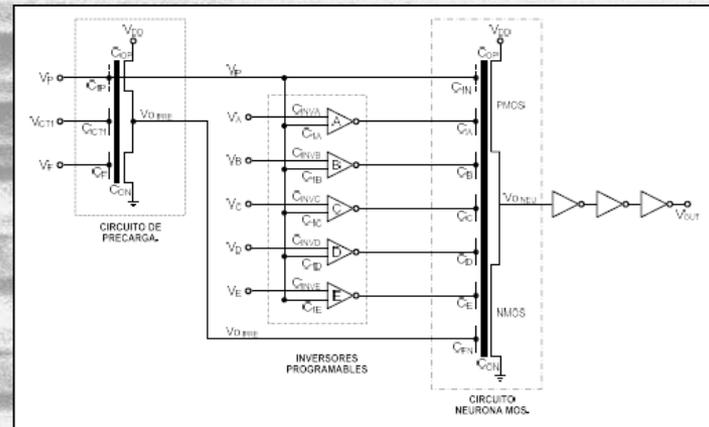
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Línea de Investigación: Transistores MOS de Compuerta Flotante

Esquemático de una compuerta Universal programable

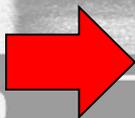


Diseño topológico de un circuito γ -MOS con compuerta flotante



10kV

x3,700



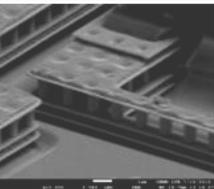
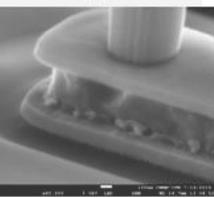
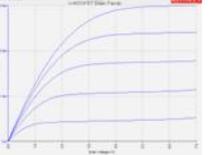
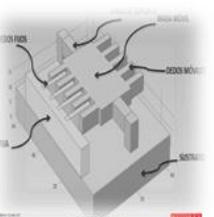
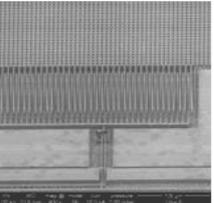
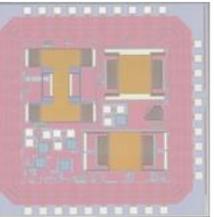
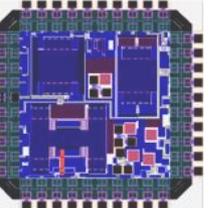
5 μ m

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Diagrama de Potencial en Compuerta Flotante y respuesta de una compuerta XOR de cuatro bits

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Video demostrativo de los MEMS



10kV

x3,700

5 μ m

2015/07/08

18 40 SEM_SEI

