Silicon chips inserted into living cells

José A. Plaza

Micro- and NanoTools Group IMB-CNM (CSIC)
Welcome to our research group!

Micro and Nano Tools group was created in 2001 within the frame of Micro and Nano Systems Department at the National Microelectronic Institute of Barcelona IMB-CN (CSIC), Cerdanyola del Valles, (Barcelona - Spain). With strong background in MEMS/NEMS, our main goals are the development of micro and nano tools based on semiconductor technology, to provide unprecedented knowledge related to fundamental problems in science.

We are a small but highly multidisciplinary group composed of physicists, engineers and chemists, that allows us to work in different areas of knowledge ranging between design, FEM simulations, fabrication and characterization of microsystems and nanosystems.
2013 Nanowerk's TOP TEN Spotlight:

**Silicon chips inserted into living cells can feel the pressure**


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2010 Nanowerk's TOP TEN Spotlight:

**Future bio-nanotechnology will use computer chips inside living cells**


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- 18 July 2013

**Silicon chips inserted into living cells**

- 24 August 2013

**The Inside of Scoop**
Research activities

Micro and Nano Tools group is divided in two working lines:

- Micro and Nano Tools (Team leader: Jaume Esteve)
- Micro and Nano Tools for Cell Biology (Team leader: Jose Antonio Plaza)

**Micro and Nano Tools**

**Team leader: Prof. Jaume Esteve Tintó**

This group division is focused on technology and processes development; as well as on the design, fabrication and characterization of micro and nano actuators, ranging from accelerometers to force and pressure sensors, piezoresistive resonators, and opto-mechanical actuators based on neumatic elastomers, among others.

Relevant Projects:

- MOEMSWORKS: Development and evaluation of a method to produce MEMS devices in a standard CMOS process. *Euripides project nºEUR 07-402*
- INTRACELL: Intracellular chips to study living cells (2005-2007). *Project CSIC: 2005500241 8*
Micro and Nano Tools for Cell Biology

Team leader: Dr. Jose Antonio Plaza Plaza

This group division englobes the design, fabrication and characterization of micro and nano systems (MEMS and NEMS) and advanced sensing principles for single cells studies, as well as a wide variety of smart particles. For their characterization, we use finite element analysis as well as different physical and biological microscopy techniques, as SEM, FIB and confocal imaging.

Examples of systems developed in this section can be classified depending of their application as:

Intracellular tools:

- Silicon and polysilicon Barcodes for cell labeling, micro and nano particles as multifunctional platforms, drug delivery systems, ...

Extracellular tools:

- Microplpetes, mass and force sensors, cantilevers, membranes, magnetic actuators, ...

Relevant Projects:

MINATE 1: Micro and Nano Tools for atomic force microscopy (2002-2005). This study was financed by the Spanish government through the TEC-2002-04280-C03-02

MINATE 2: Micro and Nano Tools for living cell studies (2006-2008) This study was financed by the Spanish government through the MEC-TEC2005-07996-C02-01.

MINATE 3: Designing and Fabrication of MicroNanotools for study, identification and actuation in living cells (2009-2011) This study was financed by the Spanish government through the MEC-TEC2008-06883-C03-01.

ICCPRESS: Is it possible to fabricate a mechanical microsensor, smaller than a living cell, which can monitor the intracellular pressure? (2010) This study was financed by the Spanish government through the ACC-PIF-EXPLOSA, TEC2009-07687-E.

MINATE 4: Design and Fabrication of micronanotools for life science (2012-2014) This study is financed by the Spanish government through the TEC2011-29140-C03-01.
Most relevant publications

2014


2013

- Rodrigo Gómez-Martínez, Alberto M. Hernandez-Pinto, Marta Duch, Patricia Vázquez, Kirill Zinovlev, Enrique J. de la Rosa, Jaume Esteve, Teresa Suárez & José A. Plaza

Silicon chips detect intracellular pressure changes in living cells

About the Cover:

The development of sophisticated devices to monitor, and eventually interfere with, essential cellular processes is an ongoing challenge. Now, José A. Plaza and colleagues have fabricated silicon chips that are small enough to be internalized inside cells and detect intracellular pressure changes. These devices can be considered the first step towards achieving a broad range of intracellular nanochips. A pseudocoloured scanning microscopy image (on the cover) shows a HeLa cell interacting with a silicon chip pressure sensor.

IMAGE: MARTA DUCH AND JOSÉ A. PLAZA, COVER DESIGN: ALEX VING

* Post in Nanowerk - the premier and most popular source for nanotechnology information.
Michael Berger, Silicon chips inserted into living cells can feel the pressure (w/video), July 18 15, 2013

- Klaudia Czaniakóvá, Húria Torras, Jaume Esteve, Igor Krupta, Peter Kasák, Ewa Pavlová, Ivan Chodák, Mária Omastová

Nanocomposite actuators based on ethylene vinyl acetate copolymer filled with carbon nanotube

- Antoni Sanchez-Ferrer, Húria Torras, Kirill Zinovlev and Jaume Esteve

Liquid-Crystalline Elastomer Micropillar Array for Haptic Actuation

- C.J. Camargo, A. Melendez, J. Robles, J. Esteve and I. Ramos

Electrospun nanobridges towards self-heated gas sensors with enhanced sensitivity

- H. Campanella, C.J. Camargo, J. Esteve and JM. Tsai

Sensitivity of thin-film bulk acoustic resonators (FBAR) to localized mechanical forces
2012

  Efficient Biofunctionalization of Polysilicon Barcodes to the Zona Pellucida of Mouse Embryos

- A. Etchier, M. del Álamo Ruiz, A. Bachtold, J. A. Plaza
  Strong coupling between mechanical modes in a nanotube resonator
  Physical Review Letters, 109, 025503 (2012)

- E. Coronado, A. Forment-Allaga, E. Pinilla-Cienfuegos, S. Tatay, L. Catala, J. A. Plaza
  Nanopatterning of Anionic Nanoparticles based on Magnetic Prussian-Blue Analogues

- D. Naumenko, V. Smitka, M. Duch, N. Torras, J. Esteve
  Stress mapping on the porous silicon microcapsules by Raman microscopy
  Microelectronic Engineering, 98, 488-491 (2012)

  Batch fabrication of optical actuators using nanotube-elastomer composites towards refreshable Braille displays.

- Jean Marshall, Yan Ji, Núria Torras, Kirill Zinoviev, Eugene M. Terentjev
  Carbon-nanotube sensitized nematic elastomers for IR-visible photo-actuation
PhD Thesis

PhD thesis

Supervisor: Dr. Jose Antonio Plaza

- Title: MicroNanoDispositivos electromagnéticos de corrientes parasitarias para aplicaciones en bioquímica y biología celular / Electromagnetic MicroNano Devices base on Currents parasites for Biochemical and Cellular biology applications (2012).
  PhD Student: Roberto Raúl Robaina Hernández
  University: ISPJAE, Electric Engineering Faculty, Microelectronic Investigations Center (CIME), La Habana, Cuba.
  PhD Student: Elisabet Fernández Rosas
  University: Autonomous University of Barcelona (UAB), Barcelona
- Title: MicronanoHerramientas para las ciencias de la vida / MicroNanoTools for life sciences (2008).
  PhD Student: Maria Jesús López Martínez
  University: Autonomous University of Barcelona (UAB), Barcelona
- * Title: Desarrollo de microestructuras de vidrio/silicio para la fabricación de sensores de gases con circuitería CMOS asociada / Designing and fabrication of glass/silicon microstructures for on-chip integration of CMOS electronics and gas sensor array (2004).
  PhD Student: María Jesús López Bosque
  University: Autonomous University of Barcelona (UAB), Barcelona
- * Title: Study and applications of ferrofluids in microfluidics (2003).
  PhD Student: Ing. Raquel Pérez Castillejos
  University: Electronic Engineering Department, Polytechnic University of Catalunya (UPC), Barcelona
  PhD Student: Ing. Estrella González Rodríguez
  University: ISPJAE, Electric Engineering Faculty, Microelectronic Investigations Center (CIME), La Habana, Cuba

*Co-supervisor.
Supervisor: Prof. Jaume Esteve

- **Title:** FBAR technology and applications (2008).
  PhD Student: Humberto Campanella
  University: Autonomous University of Barcelona (UAB), Barcelona

- **Title:** Tecnologías de micromecanización y su aplicación a la fabricación de componentes para microfluídica / Micromechanization technologies and its application for microfluidic components fabrication (1998).
  PhD Student: María Cruz Acero
  University: University of Barcelona (UB), Barcelona

- **Title:** Microacelerómetros de silicio / Silicon microaccelerometers (1997).
  PhD Student: Jose Antonio Plaza
  University: Autonomous University of Barcelona (UAB), Barcelona

- **Title:** Puesta a punto de una tecnología de micromecanización superficial y su aplicación a la fabricación de sensores y actuadores / Surface micromachining: technology implementation and application for the fabrication of sensors and actuators (1996).
  PhD Student: María Ángeles Benítez
  University: Autonomous University of Barcelona (UAB), Barcelona

- **Title:** Design, fabrication and characterization of resonant silicon accelerometers (1995).
  PhD Student: Christopher Burrer
  University: Autonomous University of Barcelona (UAB), Barcelona

- **Title:** Fabricación y caracterización de sensores de pH tipo ISFET con contactos posteriores / Fabrication and characterization of ISFET type pH sensors with back contacts (1993).
  PhD Student: Ángel Merlos
  University: Autonomous University of Barcelona (UAB), Barcelona
Patents

- Title: Enchufe inteligente para uso doméstico e industrial en redes eléctricas inteligentes / Intelligent switch for domestic and industrial uses, for intelligent electric network (September 2011).
  Id number: P2011131491
  Titularity: CSIC

- Title: Encoded microparticles (October 2010).
  Id number: PCT/ES2010/054/256
  Titularity: UAB, CSIC

- Title: Device for generating electric power from small movements (In process of patent transfer).
  Id number: EP10789045.1
  Titularity: CSIC, UB

- Title: Micro electromechanical systems (MEMS) package for semiconductor integrated circuit (P).
  Id number(s): US2008079142-A1, EP1908727-A1, JP2008091334-A
  Titularity: SEIKO EPSON CORP.

- Title: Acelerómetro óptico integrado / Integrated optic accelerometer (April 2002).
  Id number: ES9700154
  Titularity: CSIC, Ikerlan

- Title: Cubeta tubulat con sensores químicos de estado integrados para aplicación a sistemas de análisis / Tubular tray with integrated chemical sensors for system analysis applications (February 2001).
  Id number: ES2152763
  Titularity: CSIC, UAB, Biosensores SL

- Title: Procedimiento de fabricación de capas de carburo de silicio (SiC) mediante implantación iónica de carbono y recocidos / Procedure for the fabrication of silicon carbide (SiC) layers through carbon ionic implantation and annealings (March 2000).
  Id number: 2000000813
  Titularity: CSIC, UB

- Title: Método no destructivo para la determinación de la calidad de la soldadura anódica y mejora de contactos / Non-destructive method to determine the quality of the anodic bonding and contacts improvement (March 2000).
  Id number: ES2141008
  Titularity: CSIC

- Title: Acelerómetro triaxial / Triaxial accelerometer (December 1999).
  Id number: ES2137847
  Titularity: CSIC

- Title: Soluciones para el ataque de obleas de silicio y método para el ataque con tales soluciones / Solutions for Silicon wafers etching and etching methods using those solutions (December 1999).
  Id number: ES9300156
  Titularity: CSIC
• PhD student
• Post Doc
Contact Information

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