

Microelectronics Institute of Barcelona – National Centre for Microelectronics (IMB-CNM, CSIC)



CNM-IMB and ICTS buildings located in Bellaterra (UAB Campus)

1. Introduction

Centro Nacional de Microelectrónica (CNM) is the largest public microelectronics research and development centre in Spain. It belongs to the *Consejo Superior de Investigaciones Científicas* (CSIC). Founded in 1985, CNM is constituted by three Institutes: *Instituto de Microelectrónica de Barcelona*, CNM-IMB, *Instituto de Microelectrónica de Madrid*, CNM-IMM, and *Instituto de Microelectrónica de Sevilla*, CNM-IMSE. Each one of the institutes has a different orientation, complementary in some way and, although coordinated, they operate in an autonomous and independent way.

CNM/IMB activities started in 1985. Once defined its research objectives, first years efforts were focused towards researchers training and infrastructures design. Spec-IMB facilities, with 7000 m² surface and over 60M€ cost, were inaugurated in 1991. From this year the research effort pointed to the development of a full CMOS technology and the design and fabrication of Silicon based devices. The CNM-IMB Clean Room was labelled “Large Scale Facility” by the European Union; “Gran Instalación Científica y Tecnológica” by the Spanish CICYT, and “Instalación Científica y Tecnológica Singular” (ICTS), by the Spanish Ministry of Education and Science.

In 1995, CNM-IMB created the company D+T Microelectrónica AIE, an association of economical interest shared by CSIC and a Spanish companies group, with the objectives of supporting technological transfer aspects, exploiting the tech-

nological capabilities of CNM-IMB facilities and producing small and medium microelectronic device series.

In the nineties, the incorporation of first technological advances on Silicon micro-mechanization materialized. Those processes were designed as highly compatible with the CMOS traditional design and with the R+D applications, highlighting the biomedical applications.

From 2002, another standing up technological advance was the nano-technological processes development in a Clean-Room annexe, nano-lithography processes in particular, which made feasible the starting up of a new micro- and nano-technological based research line on device nano-fabrication.

At present, the CNM-IMB Clean Room is working on a renewal and re-organization process. A 44% enlargement in surface, the renovation of part of the equipment and the adding of new equipment and processes has been carried out. The equipments and processes not only will devote to micro- and nano-technologies, but an special care has been taken in developing the capability to working jointly, in such a way that the “new” facility represents an Integrated Clean Room for Nano- and Micro-fabrication, with more than 140 equipments, where simultaneously coexist compatible micro- nano-technologic processes, making feasible micro- and nano fabrication of micro- and nano-systems. The enlargement and remodelling of the Clean Room will finish during 2008, with a cost of 22 M€.

2. CNM-IMB research activity

CNM-IMB is a centre devoted to research, development and application of innovative technologies as well as the scientific and technologic education in microelectronic and emergent micro-nanotechnology area, in order to meet industry and European social settings needs. CNM-IMS aims to be extensively known and recognized, at national and international level, as a reference for other similar centres, for the academic scene and for the industrial sectors, based on its capacity for leading I+D national and international projects and its skills for giving fast and effective solutions answering the specific needs of any industrial or academic sector on microelectronics and emergent micro-and nanotechnologies fields. CNM-IMB splits into two Departments including six research lines on which I+D projects are developed and whose open structure allows interactions between them. These six lines are complementary, making feasible the development of research projects with global objectives within the activities of either or both Departments.

* Francesc Serra. National Centre for Microelectronics. Director. Campus UAB. Cerdanyola del Vallès. E-08193 Barcelona, Catalonia. EU. Tel. +34 935947700. Fax +34 935801496. E-mail: francesc.serra@imb-cnm.csic.es
Website: www.cnm.es

The Large Scale Facility, acknowledged by the Spanish Ministry of Education and Science, is made up of the Clean Room and the related Support Units. Regarding its operation, it is considered as another CNM-IMB Department, although formally is considered as a large service unit.

2.1 Micro-nanosystems department (DMN)

The DMN research activity deals with three research lines:

- **Silicon-based micro- nano-technologies (MNS)**
Includes research projects on nano-fabrication processes, pointing to Micro-nanotechnologies and integration of micro-nanotechnological process steps with CMOS
- **Micro-nano devices (MND)**
Sensors, actuators and other micro-nanoelectronic devices. Topics in this research line are, among others, micro and nano-electromechanical devices, micro-nano-sensors, electrochemical transducers, integrated optical transducers, radiations detectors and CNT based nano-electronic devices.
- **Specific applications Micro-nanosystems (DAE)**
Micro-nanosystems for gas phase elements and molecules detection, for (bio) chemical analysis and micro-nano- systems for high frequency circuitry applications.

2.2. System integration department (DIS)

The research activities deal with the following lines:

- **Power Device and System Integration (IDSP)**
Si and SiC based devices and power systems, and smart power modules technologies, power systems integration, packaging and thermal management of SiC devices for high-voltage, high-frequency and high-temperature applications.
- **Microelectronic Systems and Circuits Design, Test and Packaging**
R+D projects on analogical, mixed and CMOS low-power RF design for sensors, N/MEMS and Bio Applications and Design, modelling and integration of heterogeneous systems based on flexible SoC/NoC oriented platforms as well as Multi-chip Modules and Advanced Encapsulation Techniques and 3D Integration.
- **Biomedical Technologies, Devices and Systems**
Prototype development, clinical studies and technology transfer on micro-nano-systems. This line is centred on monitoring of biomedical implantable devices, μ -TAS and cellular culture arrays, and micro-nano-electrodes and biosensors analysis.

R&D projects and contracts developed within CNM-IMB departments, besides being important users of micro-fabrication micro-nanocapabilities offered by the Clean Room facilities, dispose of specific resources and equipment, grouped together in the following ten Laboratories

Micro-systems characterisation Laboratory
Chemical transducers Laboratory

Bio-chemical systems characterisation Laboratory
Power devices and systems Laboratory
Thermal characterisation Laboratory
Advanced package Laboratory
Integrated circuits and systems test Laboratory
Physic characterisation Laboratory
General Chemistry Laboratory
Electronic systems integration Laboratory

Among most significant equipments making up the above mentioned laboratories one can find AFM, SEM, Spreading Resistance, PCBs fabrication set, screen printing equipment and a flip-chip/SMD assembly equipment, measurement electronic equipments for low-frequency, RF, high voltage and low power, spectrum and impedance analysis equipment, environmental chamber, static and dynamic circuits characterisation system, IR and LC thermo graphical equipment, thermal conductivity, optical test bench, wide range spectrometer, He-NE laser, polishing machines, optical microscopes, plasma etching equipment, ICs design software, etc.

3. Significant figures

- CNM-IMB staff accounts to 172 persons, 53 out of them are researchers, 44 are pre-doctoral students and 32 are Clean Room researchers and technicians. The rest belong to administration and services staff.
- CNM-IMB budget reaches to 10, 5 M€, with a 50% obtained by researchers, through competitive projects and contracts.
- From the application and transfer point of view and, despite the 2.0 M€ obtained through industrial contracts, 8 International and 4 national patents were obtained.

4. ICTS “Nano- Micro-fabrication Clean Room”

The ICTS is made up by the Clean Room itself and its related Support Units. Regarding its size and operation, complexity, the ICTS can be considered as another CNM-IMB Department.

The Clean Room is a 1.400 m² area with a “house in house” structure, 10 to 10.000 class, depending of zones. The 140 equipments housed inside are used in different processes such as PVC, thermal and CVD, ionic implantation, “nano-imprint” and electron beam lithography, “in-line” test, wafer electric characterisation, mask-less laser photo-lithography, AFM, etching and wet cleaning processes, etc.

These processes are available for samples fabrication, for material characterization or device fabrication / characterisation, either as a “service on request” (performed by Clean Room staff) or as a “qualified self-service”.

Many of the processes can be grouped together constituting a complete technology combining micro and nano aspects, able for fabrication of samples, circuits or complex micro-nanosystems.



Clean Room : Photolithography.

Since 2005 the ICTS runs an External Access Programme, funded by the Spanish “Ministerio de Educación y Ciencia” which supports projects from outside CNM researchers, needing micro and nanofabrication, through The use of ICTS facility. This allows users from Spanish and European public research institutions to submit access projects proposals to the micro-nano fabrication facility capacity, with no cost if the proposal is approved by a Ministerial Commission intended to this purpose.

For past 2005, they reached the following figures:

- 352 runs processed with 7.248 steps on 1.906 wafers (400 runs in 2006)

- ICTS collaboration in 68 research projects from which 17 were European projects
- Within the Ministerial Project for ICTS Access, CNM-IMB facility gave support to 18 projects in 2006 call and 23 projects in 2007 call

5. Nano-science and nano-technology activities

Although from CNM-IMB starting, the “nano” label implicitly appears in many tasks, processes and research projects developed by both CNM-IMB Departments and by its Clean Room, it is from 2001 that this label became thoroughly accepted for some CNM-IMB activities, from the new-creating group, with objectives focused to the joint integration of micro and nanotechnologies and, considering the huge growth of approaches and applications within the Micro-systems and Sensors field, well settled in CNM-IMB, include Nano-Systems and Nano-electronics, “*per se*” o combined with developments in Micro-electronics area, as a new CNM-IMB objective of the group.

The approach to nano fabrication activities is done at system level (nano-device integration in CMOS structures and circuits), at nano-devices level (nano-machining, nano-electronics), and at process level (nano- lithography). In this sense, nano-lithography processes, nano-mechanical structures, nano-tube, nano-wire s and NEMS structures (Nano- electro-mechanical systems) are integrated together with CMOS circuitry.

It must be remarked that the CNM-IMB approach and differential capacity for working in Nano-technology, is founded on the joint integration of micro-nano devices, and micro-nano processes. From this principle, we have a complete certainty that, for an effective exploitation of the new applications offered by the “nano” world, a larger interface with the “real world” is required. Microelectronics nowadays offers the most advanced technology interface.