

IMB-CNM Activities in Radiation Detectors

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<http://www.cnm.es>; <http://www.cnm.es/projects/atlas>

Institut de Microelectrònica de Barcelona Centre Nacional de Microelectrònica

- Largest public microelectronics R+D centre in Spain
- Belongs to CSIC (Spanish Research Council)



IMB-CNM OVERVIEW

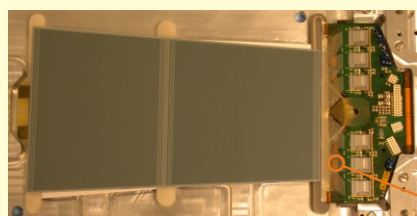
- Departments:
 - + Microsystems and Silicon Technology
 - Silicon sensors and actuators
 - Power devices
 - Nanotechnologies
 - + Electronics System Design
 - Circuits and systems design
 - Biomedical applications



- Facilities:
 - + Clean Room
 - 1000 m², class 100 to 10000
 - + Laboratories
 - Packaging
 - Characterisation and test
 - Reverse engineering
 - Silicon micromachining
 - Simulation
 - CAD
 - Mechanical workshop

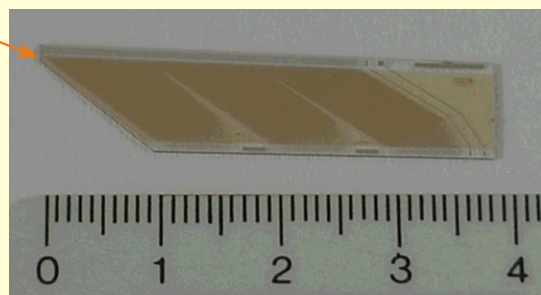
PARTICIPATION IN THE ATLAS COLLABORATION

- Coordinated project with IFIC-CSIC (Valencia)
- Supported by Spanish Ministerio de Ciencia y Tecnologia



ATLAS forward module

- CNM-IMB/IFIC responsibility: Two detector wheels in the forward section of the Semiconductor Tracker at the Inner Detector



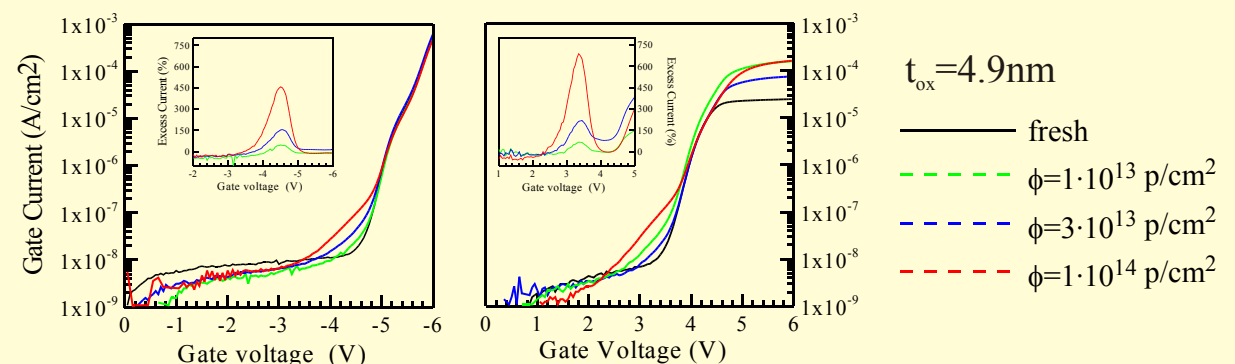
Fan-in for an outer module

- Fabrication of the 8800 fan-ins (pad pitch adapters) for the forward modules
 - + Radiation hardness studies
 - + Bondability control
 - + Optical quality control system

EFFECTS OF RADIATION ON THIN SILICON DIOXIDE

- For space or high-energy physics applications:
 - + Very hostile radiation environment for CMOS devices
 - + Ionizing radiation damages the oxide
 - **Limiting factor to MOS device reliability.**
- At CNM, we investigate the electrical properties of thin oxides irradiated by high-energy protons (24 GeV/c, from the CERN PS)

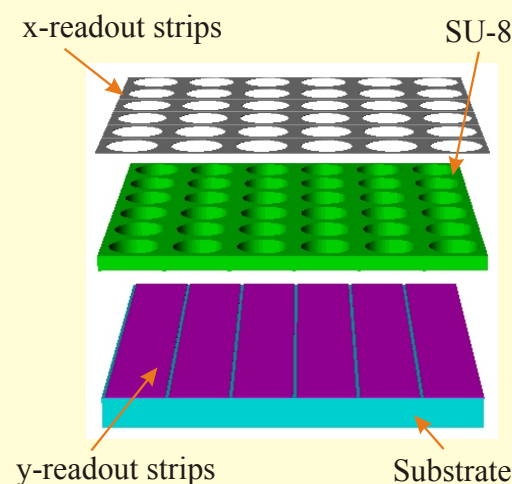
First results:



Peak in the fractional excess current for the **same oxide voltage** at both biasing polarities ⇒ damage can be modelled by a trap level in the oxide, leading to trap-assisted tunnelling dominating at low fields.

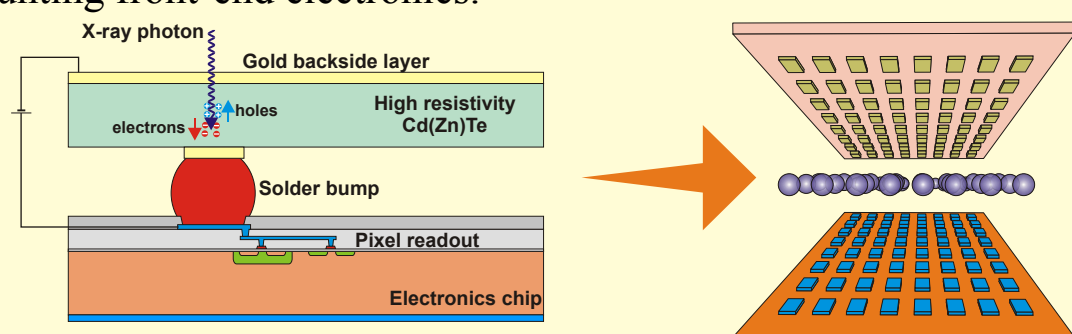
GAS MICROSTRUCTURE RADIATION DETECTORS

- Development of gas amplification microstructures using SU-8 epoxy-based photoresist
- Devices include single- and multi-layer monolithic gas electron multipliers with vertical sidewalls
- Focus on synchrotron detectors for dynamic small and wide angle scattering (SAXS, WAXS)

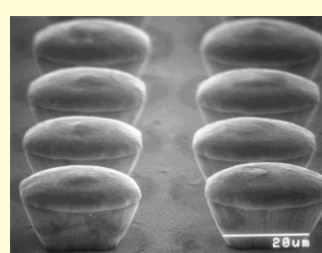


MEDICAL APPLICATIONS: DIGITAL MAMMOGRAPHY

- The CNM-IMB is a partner in the "Dear-Mama" (Detection of Early Markers in Mammography) European Project.
 - + Dose 50 times smaller than that needed with photographic film
 - + Counts photons instead of integrating current ⇒ low noise
 - + Pixel size 55x55 μm ⇒ high resolution
- Based on Cd(Zn)Te pixel detectors bump-bonded to photon counting front-end electronics.



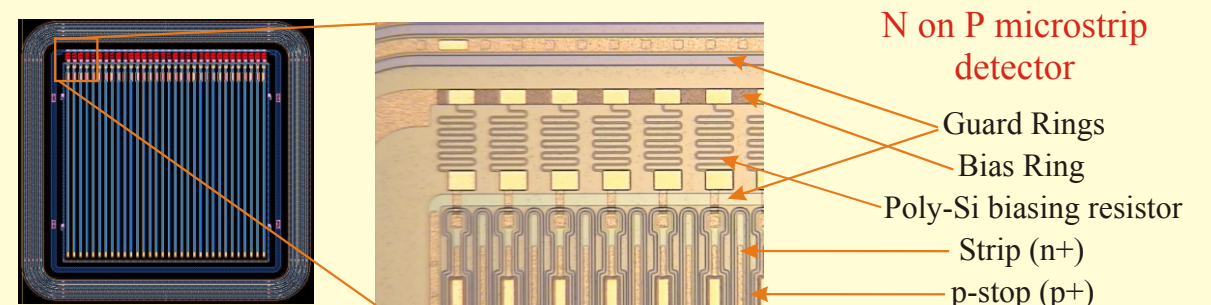
- Related activities at CNM:
 - + High density bump-bonding (40 μm pitch)
 - Collaboration with TUB (Berlin, Germany)
 - CIRRUS EC project
 - + Bump yield studies:
 - Very good quality for Si-Si
 - CdTe-Si studies ongoing



CNM bonds

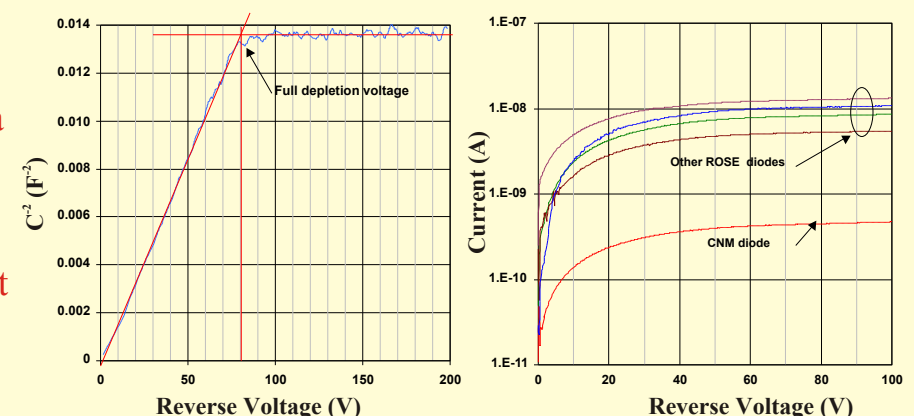
FABRICATION OF SILICON DETECTORS

- Detection of X-rays, gammas, charged particles or heavy ions with good energy resolution and very low dark current
- Based on diodes fabricated on very high resistivity substrates
- They can be fabricated on very large silicon areas or segmented into strips to allow position sensing.
- **Silicon oxigenation** increases their radiation hardness



- N on P, P on N, and N on N technologies developed.

C-V and I-V characteristics of a P on N pad detector:
- Oxygenated Si
- ROSE mask set



- Members of the RD50 collaboration at CERN
 - + Development of radiation hard semiconductor tracking detectors for very high luminosity colliders
 - + <http://rd50.web.cern.ch/rd50/>