

## CONSEJO SUPERIOR DE INVESTIGACIONES CIENTÍFICAS (CSIC) NATIONAL MICROELECTRONICS CENTER (CNM)

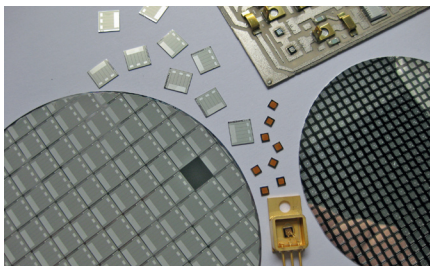
### Overview

CNM is an institute of the Spanish Research Council (CSIC) devoted to nano/microelectronics. Among its 10 research teams, the Power Devices and Systems (PDS) Group focuses on the design, fabrication, characterization and integration of power semiconductor devices, optimized for developing reliable and energy efficient converters and electronic systems, operating even in harsh environments (high temperature, radiation hard, etc.).



### Power Devices and Systems

The devices are developed and packaged in the 1500 m<sup>2</sup> Clean Room of CNM, based on different semiconductors (Si, SiC, GaN, diamond, Ga<sub>2</sub>O<sub>3</sub>) and are electro-thermally characterized in the specific labs of the PDS Group.

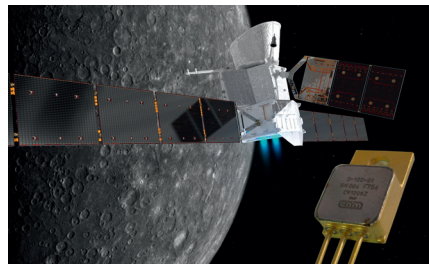


### Key Research Lines

#### • Wide Band Gap Semiconductors

The WBG research line currently focuses on new semiconductor materials suitable for developing high-power devices, such as diamond and Ga<sub>2</sub>O<sub>3</sub>. In parallel,

the more mature SiC technology is continuously improved and applied at higher TRL's, including for example protection diodes designed and manufactured for ESA exploration missions to the Inner Solar System (-170/+300°C). Other SiC devices developed at CNM include bipolar, Schottky and JBS diodes, trench JFETs, MOSFETs, BJTs, JFET-based current limiters, gas sensors, biomedical devices, etc. Another research activity that emerged initially from the SiC technology is the growth and transfer of graphene layers used in different applications.



#### • Silicon Power Devices

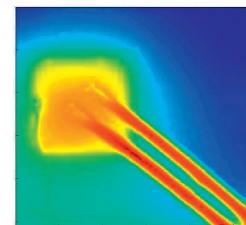
The group has a wide experience on the design and fabrication of Silicon power devices for medium and high power converters: low voltage VDMOS transistors, up to 6.5 kV IGBTs with monolithically integrated voltage and current sensors, MOS-controlled thyristor structures, HF LDMOS transistors, SOI-based devices, TVS protection devices, etc. This knowledge allowed also the collaboration with industrial partners for improving Silicon-based power devices manufacturing processes. Recently, CNM Si power devices

technology is applied to the development of new high gain diodes (2D and 3D configuration) used in accelerator detectors.

#### • Power Systems Integration and Reliability

The main goal of this line is the development of solutions to improve integration, robustness and reliability in power electronic systems, focusing on four fields:

- i) Packaging Technologies: Design and development of power modules with higher levels of integration, improving their capabilities in terms of power, operating temperature, switching speed and reliability.
- ii) Thermal Management: Design of new modules and packages with improved thermal behavior, based on 3D thermal simulation and experimental validation.
- iii) Electro-Thermal Characterization: Development of accurate electro-thermal characterization systems at chip level, based on advanced set-ups for surface thermography based on optical (thermo-reflectance) and infrared methods. Specific methods for chip level internal electro-thermal characterization.



- iv) Reliability: New methods for the analysis of the operation limits, failure mechanisms and reliability of power devices.