Brief description of the Research Group

The Power Devices and Systems Group at IMB-CNM is globally recognized for its expertise in the development and integration of advanced power devices and systems. With nearly 40 years of experience, the group has contributed significantly to the development of Si and WBG devices (SiC and GaN) through various national and European projects and industrial contracts. The group has also been involved in power systems integration projects like GRIDCELLS, HIPERCELLS, and SMARTCELLS, and is currently working on the HE SCAPE project, focusing on chip-embedding integration using German technologies. Additionally, the group contributed to the European iRel40 project on reliability improvement of electronic systems and played a key role in the BepiColombo mission with the European Space Agency (ESA), developing custom SiC Schottky diodes for space applications.

The group's previous national projects have introduced new methods for integrating control circuitry in power modules (INTERMATRIX), conducting electro-thermal characterization at die level (THERMOS, TRENCH-SiC, GRIDCELLS), and developing advanced high-temperature packaging solutions (SMARTCELLS, HIPERCELLS). The proposed project aims to leverage previous expertise to offer an advanced solution for power converters used in electrification. It will benefit from unique chip-level characterization tools and Clean Room capabilities for device development and packaging.

Additional information can be found at: https://power.imb-cnm.csic.es/

Brief description of the Institute's infrastructure and capabilities

The IMB-CNM-CSIC site features Clean Room facilities (ICTS) covering 1500 m² of class 100/10000 space, suitable for VLSI with a full CMOS manufacturing line and nearly 200 micro-nanotechnology processing equipment. The clean room supports the processing of full MOS gate power devices in Silicon (VDMOS, IGBT) and has a high voltage (up to 6kV) planar IGBT technology. Additionally, the IMB-CNM power group has over 24 years of experience with WBG (SiC, GaN) and UWBG (Ga_2O_3) semiconductors, supported by specialized equipment not found in standard Silicon clean rooms. A 40 m² Advanced Packaging Lab is also available with packaging tools for die-attach, wire-bonding, and plasma cleaning.

For reliability assessments, the site has systems for thermal and power cycling, climatic chambers, aging hot plates, a Scanning Acoustic Microscope (SAM), and bond/pull test equipment. The general Electronic Systems Laboratory at IMB-CNM offers PCB development, testing, assembly, and mechanical prototyping

facilities, including an LPKF milling machine, pre-preg press, and Cu electroplating bath.

The Power Devices Electrical Characterization Laboratory can perform electrical tests from nA to 400 A and up to 12 kV, featuring on-wafer measurement stations that can operate at temperatures up to 300°C. The lab also includes a test platform for electro-thermal stress simulations, such as short-circuits and overcurrent scenarios, and a dynamic switching measurement setup for fast power devices. The Thermal Characterization Laboratory is equipped for electro-thermal analysis at the device level, including IR thermography, thermal impedance systems, a thermo-reflectance thermography system, and an IR-laser deflection system. Comprehensive failure analysis is supported by SEM-EDX, FIB, SAM, and die-shear equipment.

Additional information can be found at: https://www.imb-cnm.csic.es/en

Publications related with the research project

[1] M.S. Bhaskar et al. “Power Electronics for green energy conversion”. Wiley (2022)

[2] S. Busquets-Monge and L. C. Diaz, “Switching-Cell Arrays - An Alternative Design Approach in Power Conversion,” IEEE Trans. Ind. Electron., vol. 66, no. 1, pp. 25–36, 2018.

[3] H. Lee, V. Smet and R. Tummala, “A Review of SiC Power Module Packaging Technologies: Challenges, Advances, and Emerging Issues,” IEEE Journal of Emerging and Selected Topics in Power Electronics, vol. 8, pp. 239-255, 2020.

[4] L. Wang, et al. "Review of Topside Interconnections for Wide Bandgap Power Semiconductor Packaging," IEEE Trans. on Power Electronics, vol. 38, no. 1, pp. 472-490, 2023.

[5] T. Gottwald and C. Roessle, “Minimizing Form Factor and Parasitic Inductances of Power Electronic Modules: The p2 Pack Technology,” in 2018 7th Electronic System-Integration Technology Conference (ESTC), 2018, pp. 1–7.

[6] T. Huesgen, “Printed circuit board embedded power semiconductors: A technology review”, Power Electronic Devices and Components, vol. 3, pp. 1-15, 2022.

[7] R. Roth, H. Schulze, C. Schäffer, F. Hille, F. Umbach, G. Mertens, N. Rohn and D. Bolowski, “Power Cu metallization for future power devices — Process integration concept and reliability,” in 2016 28th International Symposium on Power Semiconductor Devices and ICs (ISPSD), 2016.

[8] M. Buffolo et al. “Review and Outlook on GaN and SiC Power Devices: Industrial State-of-the-Art, Applications, and Perspectives”, IEEE Trans. On Electron Devices. Vol. 71, pp. 1344-1355, 2024.

[9] “ECPE position paper on Power electronics and digitalisation”, online.

[10] J. León, et al., J. Phys. D Appl. Phys., 47(5):05512(9 pp), 2014.

Brief CV of the Project’s IP

First name	**Xavier**	
Family name	**JORDA**	
Gender (*)	Male	
e-mail	xavier.jorda@imb-cnm.csic.es	https://power.imb-cnm.csic.es/dr-xavier-jorda/
ORCID	0000-0003-1967-610X	

Current position

Position	Research Scientist		
Initial date	15/02/2021		
Institution	Agencia Estatal Consejo Superior de Investigaciones Científicas		
Department/Center	Instituto de Microelectrónica de Barcelona – Centro Nacional de Microelectrónica (IMB-CNM)		
Country	Spain	Teleph. number	+34 93 594 77 00
Key words	Power electronics, thermal management, power packaging		

Previous positions (research activity interruptions, art. 45.2.b))

Period	**Position/Institution/Country/Interruption cause**
1995-2004	Contracted Researcher at IMB-CNM
2004-2005	“Ramon y Cajal” contract
2005-2021	CSIC Tenured Scientist

Education

PhD, Licensed, Graduate	**University/Country**	**Year**
Lic. en Ciències Físiques	Universitat Autònoma de Barcelona	1990
Docteur ès Sciences	Institut National des Sciences Appliquées de Lyon (France)	1995

CV SUMMARY

Xavier Jordà (Barcelona 1967). He obtained the Bsc degree in Physics from the UAB (Spain) in 1990 and the PhD degree by the Institut National des Sciences Apipliques (INSA) de Lyon, France, in 1995. During his stay in Lyon, he worked at the Centre de Génie Electrique de Lyon - Equipe de Composants de Puissance et Applications (nowadays Ampere Laboratory) on vector control of three-phase

induction motors, pulse width modulation (PWM) techniques and the design and realization of power inverters for electric vehicles. In 1995 he joined the Power Devices and Systems Group of the Barcelona Microelectronics Institute - Microelectronics National Center (IMB-CNM) of the CSIC, obtaining a permanent position as Tenured Scientist in 2005. Thanks to the experience acquired during his PhD, he led the creation of a new research line on Power Systems Integration and Reliability, focusing his activity on advanced power packaging solutions and thermal management of power devices. In addition, X. Jordà has also developed several methods and circuits for power devices electro-thermal characterization (both, static and dynamic) available today at IMB-CNM. Since the year 2000, he is the responsible of the power devices characterization laboratory of IMB-CNM. He is the author and co-author of 110 research articles in journals and more than 185 scientific conferences, as well as 7 patents (4 of them granted). He has participated or led more than 52 national and European projects and R & D contracts. His current research activity focuses on power packaging techniques for high temperature and smart power systems integration, thermal management, modeling and characterization of power devices and systems, and electro-thermal characterization of power semiconductor devices. Dr. Jordà supervised 8 PhD thesis, 3 of them ongoing. He was the head of the Power Devices and Systems Group of the IMB-CNM from 2012 to 2021 and from 2021 to 2025 was the Deputy Director of IMB-CNM. He also participates in the CSIC's PTI+ TransEner Platform, studying the contribution the power systems can make to the decarbonization of the economy through the electrification of industrial processes. Dr. Jordà is involved in the technical program committees of relevant conferences such as IEEE-ISPSD and THERMINIC and coordinates the participation of IMB-CNM as Competence Center in the ECPE European Cluster in Power Electronics.

Recent publications.

1. E.Solà, M. Raya, P. Lasserre, D. Sánchez, J. Rebollo, M. Vellvehi, X. Perpiñà and X. Jordà. ***Chip-Level Interconnection Techniques for Chip Embedding Integration of SiC MOSFETs.*** 37th Inter. Symposium on Power Semiconductor Devices and ICs, Kumamoto, Japan, 2025, pp. 473-476. DOI: 10.23919/ISPSD62843.2025.11117506
2. M. Raya, E. Solà, M. Vellvehi, X. Perpiñà, P. Lasserre, S. Busquets and X. Jordà. ***SiC MOSFET Chip Embedded Switching-Cell for Multilevel Converters.*** 37th International Symposium on Power Semiconductor Devices and ICs (ISPSD), Kumamoto, Japan, 2025, pp. 473-476, DOI: 10.23919/ISPSD62843.2025.11118194
3. C. Ferrer, O. Aviñó, M. Vellvehi, X. Jordà and X. Perpiñà. ***Die-Level Transient Thermal Imaging Based on Fourier Series Reconstruction for Power Industrial Electronics***. IEEE Transactions on Instrumentation and Measurement, vol. 72, (2023). DOI: 10.1109/TIM.2023.3322477
4. M. Fernandez, X. Perpiñà, M. Vellvehi, O. Aviñó-Salvadó, S. Llorente, X. Jordà. ***Power Losses and Current Distribution Studies by Infrared Thermal Imaging in Soft- And Hard-Switched IGBTs under Resonant Load.*** IEEE Transactions on Power Electronics (ISSN: 0885-8993), Vol 35, No. 5 (2020), Pp. 5221-5237
5. A. Matallana, E. Ibarra, I. López, J. Andreu, J.I. Garate, X. Jordà and J. Rebollo. **Power module electronics in HEV/EV applications: New trends**

in widebandgap semiconductor technologies and design aspects. Renewable and Sustainable Energy Reviews, Vol. 113 (2019), pp. 1-33

Conferences

X. Jordà. **Power Systems Integration: Key Enabling Technology for Electrification.** International Semiconductor Conference CAS 2022, Poiana-Brasov (Romania), October 12-14, 2022. **Invited Talk**.

Projects

1. **Switching-Cell-Array-based Power Electronics conversion for future electric vehicles (SCAPE).**
   HORIZON EUROPE HORIZON-CL5-2021-D5-01-02
   CNM principal investigator: Dr. Xavier Jordà. Work Package 4 leader.
   Date/duration: July 2022. 4 years. Budget: 777.950 Euros.
2. **Selective deposition of metal layers on microelectronic chips for power systems integration (METALCHIP).**
   PDC2022-133790-I00 “Pruebas de Concepto 2022” Ag. Estatal de Investigación
   Principal investigator: Dr. Xavier Jordà
   Date/duration: December 2022 – March 2025. Budget: 126.500 Euros

Patents:

X. Jordà, X. Perpiñà, M. Vellvehi, D. Sanchez, P. Godignon, **Self-aligned metal mask assembly for selectively depositing thin films on microelectronic substrates and devices, and method of use**, EP 2 239 769 B1. Owner: CSIC. Prioriy: Spain. Extended to Europe. Exploited by: CSIC.