Thesis tittle: Deterministic growth of graphene nanoribbons and their integration into transistor-like nanoelectronic devices

Related project: New methods to integrate Graphene in next-generation elecTRONIC deviceS (GTRONICS) (PID2024-157972OB-C21)

PRINCIPAL INVESTIGATORS

PI1: IÑIGO MARTIN FERNANDEZ **E-mail:** inigo.martin@imb-cnm.csic.es

PI2: FRANCESC PEREZ-MURANO **E-mail:** Francesc.Perez@imb-cnm.csic.es

Institute/Centre: Institute of Microelectronics of Barcelona (IMB-CNM, CSIC)

Research group: Nanofabrication and NEMS (NANONEMS)

Address: C/ dels Til·lers s/n, Campus UAB, 08193 – Bellaterra, Cataluña

Websites: https://www.imb-cnm.csic.es/es, http://nanonems.imb-cnm.csic.es/

DESCIPTIONS

The **Institute of Microelectronics of Barcelona (IMB-CNM, CSIC)** is the largest center in Spain dedicated to research and development in Micro and Nano Technologies and Microsystems. Its Clean Room, the largest facility of its kind in Spain, is the main node of the Singular Scientific and Technical Infrastructure (ICTS) Micronanofabs and has capabilities for silicon-based technologies as well as technologies based on compatible and alternative materials, such as those based on graphene. The institute holds the distinction of María de Maeztu Unit of Excellence.

The activity of the **Nanofabrication and NEMS group (NanoNEMS)** is focused on researching novel technological solutions for future generations of semiconductor circuits with a multidimensional approach. It currently explores two challenges: Low-power, CMOS-like alternative devices, and Semiconductor based quantum technologies. The research is oriented towards device integration (single-electron transistors and stacked transistors), novel devices based on 2D materials (graphene), state-of-the-art nanopatterning (including block copolymer-based nanolithography and vapor-phase infiltration to improve the performance of lithographic resists), as well as electrical characterization. The activity also includes advanced physical characterization methods.

This research on **Growth and integration of graphene-based materials for (nano)electronics** is dedicated to developing solutions for the large-scale integration of graphene-based materials into (nano)electronic devices and exploring their potential in future integrated circuits and electronic systems. The focus is on the controlled growth of advanced graphene forms - including graphene, graphene nanoribbons (GNRs) and laser-induced graphene (LIG) - as well as on establishing reliable methods for their integration. The goal is to design and evaluate devices and circuit demonstrators to validate their performance and scalability.

Selected references:

- D. Zhang et al., Dry Transfer of CVD Graphene Film Using Adhesion Switchable Ferroelectric Polymers, Advanced Materials (accepted)

- M. Navarro-Segarra et al., Designed-by-purpose power sources: a cardboard primary battery for smart packaging, Energy & Environmental Science., 17, 2024, 5639-5652. DOI: 10.1039/D4EE00306C

- A. del Moral et al., CMOS compatible manufacturing of a hybrid SET-FET circuit. Semiconductor Science and Technology, 37, 2022, 125014. DOI: 0.1088/1361-6641/ac9f61

- E Masvidal-Codina et al., Characterization of optogenetically-induced cortical spreading depression in awake mice using graphene micro-transistor arrays, Journal of Neural Engineering, 18, 2021, 055002. DOI: 10.1088/1741-2552/abecf3C

- C. Pinto-Gómez et al., Directed self-assembly of block copolymers for the fabrication of functional devices. Polymers, 12, 2020, 2432. DOI: 10.3390/polym12102432

- A. Moneo et al., Towards molecular electronic devices based on 'all-carbon' wires. Nanoscale 10, 2018, 14128-14138. DOI: 10.1039/C8NR02347F

- JM Fechine et al., Direct dry transfer of chemical vapor deposition graphene to polymeric substrates, Carbon, 83, 2015, 224-231. DOI: 10.1016/j.carbon.2014.11.038

- ES Kulkarni et al., Exploiting the IR Transparency of Graphene for Fast Pyroelectric Infrared Detection, Advanced Optical Materials, 3, 2015, 34-38. DOI: 10.1002/adom.201400374Carbon 2015

- CT Cherian et al., 'Bubble-Free' Electrochemical Delamination of CVD Graphene Films, Small, 11, 2015, 189-194. DOI: 10.1002/smll.201402024

- G. López-Polín et al., Increasing the elastic modulus of graphene by controlled defect creation, Nature Physics, 11, 2015, 26-31. DOI: 10.1038/nphys3183