MARIE SKŁODOWSKA-CURIE POSTDOCTORAL FELLOWSHIPS 2023

EXPRESSION OF INTEREST FOR HOSTING MARIE CURIE FELLOWS

HOST INSTITUTION

CENIMAT|i3N at NOVA School of Science and Technology

RESEARCH GROUP AND URL

Advanced Functional Materials for Micro and Nanotechnologies (AFMMN)

SUPERVISOR (NAME AND E-MAIL)

Dr. Emanuel Carlos (e.carlos@fct.unl.pt)

SHORT CV OF THE SUPERVISOR

Dr. Emanuel Carlos is a research area leader on flexible and sustainable electronics at CENIMAT|i3N. Also, he is a permanent Assistant Researcher at NOVA-FCT and co-PI of two exploratory projects SUPREME-IT (EXPL/CTM-REF/0978/2021) and GAMBIT (2022.01493.PTDC) through FCT national funding. He received his PhD in 2021 in Nanotechnologies and Nanosciences at NOVA University Lisbon. He has been working in solution-based metal oxide electronics since 2015, focusing on sustainable materials and technologies for printed electronics. In 2017, he was selected to the IDS-FunMat-Inno program financed by EIT Raw Materials where had the opportunity to acquire important soft skills (Technology Intelligence; Material Selection and Processing; Scientific Communication; Entrepreneurship and Innovation; Life Cycle of Materials; Project and Risk Management) and do two internships at the Nottingham Trent University (UK) and VTT (Finland). His work involves the design, deposition, and characterization of solution-based metal oxide thin films, fabrication, and characterization of electronic devices (transistors, memristors, diodes, among others) on flexible substrates. He is the author and co-author of more than 21 (10 as the first author) peer-reviewed papers (h-index=14, 971 citations, May 2023) in high-impact journals and 4 book chapters in this area. He has been participating in national (Neuroxide, IDS Paper, ThermalTrace, PRR - BE.NEUTRAL and R2U Technologies) and international (Merck Chemicals, i-Flexis, 1D-NEON, SUPERSMART, FOXES, EMERGE,

SYNERGY, TERRAMETA, SUPERIOT) research projects in the area, with academia and industry. Regarding science dissemination, he has presented his work at renowned conferences in the materials science field and won several national and international awards.

5 SELECTED PUBLICATIONS

- **Carlos, E.**; Leppäniemi, J.; Sneck, A.; Alastalo, A.; Deuermeier, J.; Branquinho, R.; Martins, R.; Fortunato, E. **Printed, Highly Stable Metal Oxide Thin-Film Transistors with Ultra-Thin High-κ Oxide Dielectric**. *Adv. Electron. Mater.* **2020**, *6* (3), 1901071. https://doi.org/10.1002/aelm.201901071.

- **Carlos, E.**; Deuermeier, J.; Branquinho, R.; Gaspar, C.; Martins, R.; Kiazadeh, A.; Fortunato, E. **Design and Synthesis of Low Temperature Printed Metal Oxide Memristors**. *J. Mater. Chem. C* **2021**, *9* (11), 3911–3918. https://doi.org/10.1039/D0TC05368F.

- **Carlos, E.**; Branquinho, R.; Martins, R.; Kiazadeh, A.; Fortunato, E. **Recent Progress in Solution-Based Metal Oxide Resistive Switching Devices**. *Adv. Mater.* **2021**, *33* (7), 2004328. https://doi.org/10.1002/adma.202004328.

- **Carlos, E.**; Branquinho, R.; Jansson, E.; Leppäniemi, J.; Menezes, J.; Pereira, R.; Deuermeier, J.; Alastalo, A.; Eiroma, K.; Hakola, L.; Fortunato, E.; Martins, R. **Printed Zinc Tin Oxide Diodes: From Combustion Synthesis to Large-Scale Manufacturing**. *Flex. Print. Electron.* **2022**, *7* (1), 014005. https://doi.org/10.1088/2058-8585/ac4bb1.

- **Carlos, E.**; Martins, R.; Fortunato, E.; Branquinho, R. **Solution Combustion Synthesis: Towards a Sustainable Approach for Metal Oxides**. Chem. – A Eur. J. 2020, 26 (42), 9099–9125. https://doi.org/10.1002/chem.202000678.

PROJECT TITLE AND SHORT DESCRIPTION

Printed two-dimensional memristors: a demand for high energy efficiency.

Solution-based two-dimensional (2D) memristors is one of the most promising emerging technologies to serve the areas of artificial intelligence (AI) and data storage in an efficient and sustainable approach. These devices can offer a high-power efficiency due to the high densification capability and non-volatile behaviour retaining the stored information even after power is removed. However, the production of these materials usually requires toxic solvents which negatively impact the environment and energy efficiency. Also, the

current main deposition method is spin-coating or drop-casting being a critical setback for their individualization and scale-up to the printing industry.

In this project, we aim to develop fully printed and patterned self-rectifying 2D memristors on flexible substrates at low temperatures using solvents with lower environmental impact and abundant materials. After proving the device reliability, they will be implemented in crossbar arrays to perform security or neuromorphic classification tasks.

To support and guarantee the success of this proposal, the work will be performed at the research unit CENIMAT|i3N evaluated as Excellent (highest grade) by FCT which belongs to the institute for nanostructures, nanomodelling and nanofabrication (i3N). At CENIMAT the labs' facilities, materials and equipment's required for the project activities are available. Within CENIMAT, the AFMMN (Advanced Functional Materials for Micro and Nanotechnologies) group is devoted to nanotechnology, electronics and optoelectronics, using sustainable materials and processing routes. This proposal is correlated with these strategic research fields of sustainable micro and nanotechnology, and energy efficiency in conjunction with green processing technologies.

SCIENTIFIC AREA WHERE THE PROJECT FITS BEST*

Chemistry (CHE) | Information Science and Engineering (ENG) | Physics (PHY)