MARIE SKŁODOWSKA-CURIE POSTDOCTORAL FELLOWSHIPS 2022

EXPRESSION OF INTEREST FOR HOSTING MARIE CURIE FELLOWS

HOST INSTITUTION

Universidade Nova de Lisboa

RESEARCH GROUP AND URL

Advanced Functional Materials for Micro and Nanotechnologies (AFMMN) – https://www.cenimat.fct.unl.pt/rd-id-teams/materials-electronics-optoelectronics-and-nanotechnologies/advanced-functional-materials-micro-and-nanotechnologi

SUPERVISOR (NAME AND E-MAIL)

Dr. João Carlos Mesquita Coelho (jcm.coelho@fct.unl.pt)

SHORT CV OF THE SUPERVISOR

In 2012 I started my PhD in the field of two-dimensional nanomaterials for energy storage applications under the supervision of Prof. Valeria Nicolosi at Trinity College Dublin (Ireland). During this period (in 2015) I was awarded the AMBER (Advanced Materials and BioEngineering Research, Ireland) Innovation Award for the development of fully functional ink-jet printed micro-supercapacitors. After completing my doctoral studies in 2016, I remained in prof. Nicolosi's team is in a post-doc position for the study of lithium-sulfide high energy density battery cathodes. Part of this project resulted in a paper on Nature Energy (Impact Factor (IF) - 60.858). In 2020, I became a junior researcher under the prestigious Portuguese Individual Call to Scientific Employment Stimulus program at Prof. Elvira Fortunato Laboratory (CENIMAt|i3N, Portugal). I am working on the sustainable design of energy storage devices by ink jet printing and direct laser engraving. At this stage I also got my first co-supervision of a PhD student, who is working on flexible supercapacitors. More recently, I was awarded the Santander/NOVA 2021 Collaborative Research Award. This one year -project, which I am the PI, aims at developing graphene-based platforms for biomedical applications. It has been established between NOVA School of Science and Technology and NOVA Medical School, demonstrating my capabilities to establish bridges between groups with different backgrounds.

All my research and achievements have been disseminated through journal publications and conferences. I have a total of 36 articles (11 first author and 1 co-authorship) in international peer-reviewed scientific journals and a book chapter (first author) leading to an h-index of 19 and a total of 2632 citations up to May 2022 (source-Scopus). 20 of these works were published in the last 5 years. Additionally, a publication focused on 2D nano inks was recently accepted on Nature Reviews Materials (IF:66.31) showing the relevance of my knowledge for this proposal.

5 SELECTED PUBLICATIONS

- Pinilla, S., **Coelho, J.**, Li, K., Liu, J. and Nicolosi, V., 2022. Two-dimensional material inks. Nature Reviews Materials, pp.1-19. https://doi.org/10.1038/s41578-022-00448-7

- **Coelho, J.**, Kremer, M.P., Pinilla, S. and Nicolosi, V., 2020. An outlook on printed microsupercapacitors: Technology status, remaining challenges, and opportunities. Current Opinion in Electrochemistry, 21, pp.69-75. https://doi.org/10.1016/j.coelec.2019.12.004

- Kelly, A.G., Hallam, T., Backes, C., Harvey, A., Esmaeily, A.S., Godwin, I., **Coelho, J.**, Nicolosi, V., Lauth, J., Kulkarni, A. and Kinge, S., 2017. All-printed thin-film transistors from networks of liquid- exfoliated nanosheets. Science, 356(6333), pp.69-73. https://doi.org/10.1126/science.aal406

- **Coelho, J.**, Pokle, A., Park, S.H., McEvoy, N., Berner, N.C., Duesberg, G.S. and Nicolosi, V., 2017. Lithium titanate/carbon nanotubes composites processed by ultrasound irradiation as anodes for lithium-ion batteries. Scientific reports, 7(1), pp.1-11. https://doi.org/10.1038/s41598-017-06908-3

- **Coelho, J.**, Mendoza-Sánchez, B., Pettersson, H., Pokle, A., McGuire, E.K., Long, E., McKeon, L., Bell, A.P. and Nicolosi, V., 2015. Manganese oxide nanosheets and a 2D hybrid of graphene– manganese oxide nanosheets synthesized by liquid-phase exfoliation. 2D Materials, 2(2), p.025005. https://doi.org/10.1088/2053-1583/2/2/025005

PROJECT TITLE AND SHORT DESCRIPTION

Flexible Microsupercapacitors for Smart Sensing Platforms

The advent of additive manufacturing (AM) along with the development of nanomaterials processing techniques, is creating new avenues for technological applications. For instance, nanomaterials have widely used in a plethora of flexible substrates, resulting in a rapid development of thin, light and conformable systems. However, there are pertinent problems regarding the development of these platforms and their commercialization, which are mainly related to energy autonomy. External sources, such as solar energy, motion and heat generated by the human body can be converted into electricity. However, in situations where the energy source is intermittent, energy storage is needed to ensure the proper functioning of the devices. Additionally, a lot of these devices are developed and tested individually without considering the circuit/platform requirements. In this context, microsupercapacitors (MSC) have been pointed out as the most suitable device to store energy from the environment and to be implemented in these new flexible and wearable applications. Therefore, there have been many advancements on of nanomaterials based MSC, exhibiting very promising electrochemical performances.

This project aims to set of eco-friendly approaches for the development of nanomaterial-based components for multiple IoT applications. In this case, the work will focus on the deposition of interdigitated MSC as proof of concept, exploring layer by layer deposition or by designing multi material inks, which reduces the overall printing time. Other available methods, namely direct laser writing and screen printing can also be considered. Regarding substrates, parylene will be used due to its flexibility and mechanical robustness, chemical resistance, being able to support the most varied fabrication techniques, opening the possibility for further integration and hybrid electronics platforms. Furthermore, parylene is biocompatible and can be easily adapted to any surface since it can produce ultra-thin and mechanically robust membranes. As sustainable substrates, paper and cork will also be explored as suitable options for the ink-jet printing of MSC. As an exploratory project, the first and main outcome of this work will be the development of suitable inks based on eco-friendly solvents. The successful printing of MSC will be a good indication for further platform developments. In fact, due to its versatility, the interdigitated configuration can also be used for sensing, thus indicating once again the applicability and versatility of the proposed method. These sensors can then be used to test the integration of different components and platform designs.

SCIENTIFIC AREA WHERE THE PROJECT FITS BEST*

Chemistry (CHE)/

Physics (PHY)

***Scientific Area where the project fits best** – Please select/indicate the scientific area according to the panel evaluation areas: Chemistry (CHE) • Social Sciences and Humanities (SOC) • Economic Sciences (ECO) • Information Science and Engineering (ENG) • Environment and Geosciences (ENV) • Life Sciences (LIF) • Mathematics (MAT) • Physics (PHY)