MARIE SKŁODOWSKA-CURIE POSTDOCTORAL FELLOWSHIPS 2021

EXPRESSION OF INTEREST FOR HOSTING MARIE CURIE FELLOWS

HOST INSTITUTION

NOVA University Lisbon | School of Science and Technology

RESEARCH GROUP AND URL

Soft and Biofunctional Materials Group
https://www.cenimat.fct.unl.pt/rd-id-teams/soft-and-biofunctional-materials-group/soft-and-biofunctional-materials-group-sbmg

SUPERVISOR (NAME AND E-MAIL)

Pedro Marques de Almeida
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SHORT CV OF THE SUPERVISOR

Pedro Marques de Almeida has PhD in Materials Science Engineering (2004 from NOVA University of Lisbon) and a 5 years Degree in Materials Science Engineering (1997 from NOVA School of Science & Technology). He is a Physics Professor at the Lisbon Superior Institute of Engineering (ISEL) of the Lisbon Polytechnic Institute (IPL). He is an integrated Researcher at NOVA University of Lisbon (i3N - Institute for Nanostructures, Nanomodelling and Nanofabrication) and a Collaborator Researcher at University of Lisbon (Center for Advanced Materials Engineering and Physics). He is a member of the Soft and biofunctional materials group of i3N and Head of the NMR lab in CENIMAT, equipped with a solid state 300MHz wide bore spectrometer, capable of performing solid state spectroscopy, diffusion and micro-MRI. His research is focused on liquid crystals, liquid crystal applications, polymeric materials, bio-medical applications, bio-materials and bio-inspired materials. He has published around 70 articles in specialized scientific journals. He published 4 patents. Received 7 prize (s) and / or honours. He has participated in several national and international research projects, having leaded two as principal investigator. In his professional activities, he interacted with over 150 collaborators in co-authoring of scientific works, having an h-index of 18.
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5 SELECTED PUBLICATIONS

- J. Oliveira, A. Belchior, V.D. Silva, A. Rotter, Ž. Petrovski, P.L. Almeida, N.D. Lourenço, S.P. Gaudêncio, "Marine environmental plastic pollution: mitigation by microorganism degradation and recycling valorization", Frontiers in Marine Science, **2020**, 7, 567126 (IF = 3.66).
- A.P. Almeida, J.P. Canejo, U. Mur, S. Čopar, P.L. Almeida, S. Žumer, M.H. Godinho, "Spotting plants microfilaments morphologies and nano structures", PNAS, **2019**, 116(27), 13188–13193. (IF=9.41)
- R. Portela, C.R. Leal, R.G. Sobral, P.L. Almeida, "Bacterial Cellulose - a versatile biopolymer for wound dressing applications", Microbial Biotechnology, **2019**, 12(4), 586–610. (IF=5.33).
- A.P.C. Almeida, J.P. Canejo, S.N. Fernandes, C. Echeverria, P.L. Almeida, M.H. Godinho, "*Cellulose-based Biomimetics and their Applications*", Advanced Materials, **2018**, 1703655. (IF=25.81).
- S.N. Fernandes, P.L. Almeida, N. Monge, L.E. Aguirre, D. Reis, C.L.P. Oliveira, A.M.F. Neto, P. Pieranski, M.H. Godinho, "Mind the micro-gap in iridescent cellulose nanocrystal films", Advanced Materials, **2017**, 29, 1603560. (IF=21.95)

PROJECT TITLE AND SHORT DESCRIPTION

Bacterial cellulose Dressings for biomedical applications

The skin is the fundamental barrier that protects internal tissues, prevents pathogen invasion, and maintains the body fluid equilibrium. But the skin functions are compromised upon traumas, such as incisions and burns. The healing process of surgical wounds and burn wounds is costly to treat and usually hindered by the patient's physiological conditions, like associated diseases, inflammation and external factors, namely bacterial infections. These are of special concern in the hospital environment, that benefits the thrive of multidrug- resistant bacterial strains. This Project primary aim is to answer these global health challenges by developing new bacterial cellulose (BC) - based membranes to be applied as dressings for healing purposes. We will produce hydrated BC membranes to be used as burn and surgical healing pads, with therapeutical features such as anti-inflammatory and anti-bacterial properties. Another main societal issue of current times is the amount of waste that is continuously generated, namely due to disposable, non-degradable, absorbent items, as diapers and menstrual pads. To answer this pressing global problem, we will develop superabsorbent biodegradable dressings to be used as exudative wound pads, diapers filling or menstrual pads filling, contributing to lower the volume of non-degradable waste.

One major advantage of BC is purity, as it is free from other chemical species of lignocellulosic materials, a requirement for health-related applications. As a natural-derived polymer, it has several advantages in comparison with synthetic ones, such as biocompatibility and biological activity. BC is also an attractive biomaterial due to its unique structural characteristics such as high porosity, high water retention capacity, high mechanical strength in the wet state, low density, and biodegradability. BC is thus capable of creating a skin barrier of exceptional performance becoming the first line of the immune defense.

We will use a BC high-producing strain of Komagataeibacter rhaeticus to construct mutants capable of producing BC with improved properties, such as altered crystallization patterns and altered structural composition. Through this strategy we will obtain BC functionalized with mannose and with human defensins, both described to have anti-inflammatory and antimicrobial properties. Also, BC nanocomposites will be produced by "in-situ" and "ex-situ" modification processes. The produced hydrogels will act as an artificial skin mimicking its barrier function (prevent dehydration and bacterial infection). We will add carboxymethylcellulose, a biodegradable biocompatible polymer, and inorganic compounds, such molybdenum nanoparticles, to provide antimicrobial activity to BC fibres.

As new formulations are produced, the membranes will be physically and chemically characterized by advanced methods such as FTIR, NMR, FIBSEM, XRD or MRI, among others. After producing hydrated membranes, we will obtain dehydrated membranes for applications that require fluid absorbance and will address their performance through dedicated porosity and water-absorption assays.

There will be a close collaboration with a molecular biology group of the Department of Life Sciences (NOVA School of Science & Technology) which will construct mutants that produce BC with enhanced properties and will provide BC for all downstream studies.

The aim of the project is fundamental and applied-oriented research to obtain innovative dressing BC-based products, to address major societal challenges in global health and waste management. The project results will set the foundation for hugely improved burn and surgical wound care and other types of wounds that affect the ever-increasing ageing population and will also reduce the amount of global waste since BC is biodegradable.

SCIENTIFIC AREA WHERE THE PROJECT FITS BEST*

Physics (PHY)