BOOK OF ABSTRACTS

SupraLife First School

19 - 24 March 2023

University of Aveiro, Portugal

ORGANIZERS:

COMPASS

ENGINEERING LIFE GUIDED BY NATURE

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WELCOME LETTER

Dear Colleagues,

It is our pleasure to welcome you to the pleasant city of Aveiro for the First School of the Horizon Europe EU funded Twinning project SupraLife.

The First School includes a very strong scientific program from 19-21 March focusing on teaching fundamental-to-advanced concepts on the molecular design, synthesis, development, and advanced characterization of functional supramolecular polymeric biomaterials for biomedicine. The program will consist of 14 plenary/tutorial lectures by world-renowned scientists well-known for their extensive expertise and experience in the supramolecular biomaterials' chemistry field, who will present a comprehensive overview of the research activities headed by their own research groups and in collaboration with other research groups, industry or clinical practitioners. The lectures will cover the topics of functional supramolecular polymers, bioinspired polymers, biomimetic strategies, molecular modelling and molecular dynamics simulations, bioinstructive platforms/matrices, dynamic self-assembled biomaterials, supramolecular hydrogels, adaptive life-like molecular systems, and their use in drug/therapeutics delivery, diagnostics, tissue engineering or regenerative medicine. The scientific program will encompass poster sessions mostly devoted to students and young researchers to allow them to present and discuss their work, interact closely and exchange ideas, and network with peers in an informal environment.

Moreover, the First School will also include a soft transferable skills training program from 22-24 March which aims to advance the professional development and widen the career perspective of students and early-career researchers, irrespectively on their background and research domain. The training program will consist of 4 distinct workshops on the topics of grant writing, career development, science communication, and scientific writing and publishing and 12 invited speakers, experts and highly skilled professionals on the topics, who will provide the students and researchers with the skills to thrive in their professional duties and career paths. Moreover, we will host two roundtable discussions on the topics of grant writing and science communication which will be moderated by experts in the field.

We would like to express our sincere thanks to the Plenary and Invited Speakers, and Chairs and Moderators of the different sessions/workshops for their kind availability and for sharing their work and expertise, to the Poster presenters for sharing their work, as well as to all Attendees for joining us in Aveiro for the SupraLife First School!

Moreover, we are also very grateful to the SupraLife's consortium partners, Associate Laboratory CICECO – Aveiro Institute of Materials, Department of Chemistry, University of Aveiro, as well as to all Sponsors for their invaluable support.

Last, but not least, a special thanks to the Local Organizing Committee for their extraordinary effort, commitment, and extremely important contribution to the success of the event.

We hope that you all find the SupraLife First School stimulating and that you enjoy your stay and the pleasant atmosphere of the beautiful city of Aveiro!

The Chairs of the SupraLife First School,

João F. Mano

João Borges

UNIVERSITY OF AVEIRO
CAMPUS MAP

Central and Rectorate Building
Auditorium Renato Araújo

14 minutes
walk to canteen

Lunch Breaks
Crasto Canteen Complex

SCIENTIFIC PROGRAM

19th March
Auditorium Renato Araújo – Central and Rectorate Building

15:00 - 17:00 Registration

17:00 - 17:15 **Opening Ceremony**

Artur Silva (Vice-Rector for Research, Innovation and 3rd Cycle of the University of Aveiro, Portugal)

João F. Mano & João Borges (Coordinators of the SupraLife project at the University of Aveiro, Portugal)

Chairs: João F. Mano & João Borges (University of Aveiro, Portugal)

17:15 - 18:00 **PL1. E. W. "Bert" Meijer** (Eindhoven University of Technology, The Netherlands)

Dynamic biomaterials using dilution-induced supramolecular polymerizations and the clustering of ligands and receptors

18:00 - 18:45 **PL2. Patricia Dankers** (Eindhoven University of Technology, The Netherlands)

Engineering bio-communication into supramolecular polymer materials

19:00 - 21:30 **Welcome Reception**

20th March
Auditorium Renato Araújo – Central and Rectorate Building

8:00 - 9:00 Registration

Chairs: Alvaro Mata (University of Nottingham, United Kingdom)
Iva Pashkuleva (University of Minho, Portugal)

9:00 - 9:45 **PL3. Sébastien Lecommandoux** (University of Bordeaux, France)

Biomimetic glyco- and lipo-protein bioconjugates for biomaterials and artificial cells design

9:45 - 10:30 **PL4. Helena Azevedo** (University of Porto, Portugal)

Biomaterials inspired by biology: from molecules to self-assembly

10:30 - 11:00 **Coffee Break & Poster Session 1**

Chairs: Helena Azevedo (University of Porto, Portugal)
E. W. "Bert" Meijer (Eindhoven University of Technology, The Netherlands)

11:00 - 11:45 **PL5. Alvaro Mata** (University of Nottingham, United Kingdom)

Engineering of advanced biomaterials by harnessing biological organization principles

11:45 - 12:30 **PL6. Zaida Álvarez** (Institute for Bioengineering of Catalonia, Spain)

The effect of bioactive scaffolds with enhanced supramolecular motion on neuronal modelling and regeneration

12:30 - 14:30 **Lunch Break**

20th March
Auditorium Renato Araújo – Central and Rectorate Building

Chairs: **Thomas Hermans** (University of Strasbourg, France)
Patricia Dankers (Eindhoven University of Technology, The Netherlands)

14:30 - 15:15 **PL7. Francesco Ricci** (University of Rome Tor Vergata, Italy)

Reorganization of self-assembled DNA-based polymers in higher ordered structures

15:15 - 16:00 **PL8. Roxanne Kieltyka** (University of Leiden, The Netherlands)

Spatial and temporal control over mechanics in dynamic biomaterials

16:00 - 17:00 **Coffee Break & Poster Session 2**

Chairs: **Zaida Álvarez** (Institute for Bioengineering of Catalonia, Spain)
Sébastien Lecommandoux (University of Bordeaux, France)

17:00 - 17:45 **PL9. Iva Pashkuleva** (University of Minho, Portugal)

Enhancing the selectivity and functionality of supramolecular biomaterials by glycan incorporation

17:45 - 18:30 **PL10. Andreas Walther** (Johannes Gutenberg University Mainz, Germany)

Metabolic DNA systems Inspired from life: protocells and materials with lifecycles

21st March
Auditorium Renato Araújo – Central and Rectorate Building

Chairs: **Andreas Walther** (Johannes Gutenberg University Mainz, Germany)
Roxanne Kieltyka (University of Leiden, The Netherlands)

9:00 - 9:45 **PL11. Ghislaine Vantomme** (Eindhoven University of Technology, The Netherlands)

Synthesis of supramolecular polymeric materials – the interplay between covalent and non-covalent bonds

9:45 - 10:30 **PL12. Thomas Hermans** (University of Strasbourg, France)

Controlling self-assembly by chemical fuels and light

10:30 - 11:00 **Coffee Break & Poster Session 3**

Chairs: **Ghislaine Vantomme** (Eindhoven University of Technology, The Netherlands)
Francesco Ricci (University of Rome Tor Vergata, Italy)

11:00 - 11:45 **PL13. Manuel Melle-Franco** (University of Aveiro, Portugal)

Computing your way out of experimental problems: a critical perspective

11:45 - 12:30 **PL14. Claudio Perego** (University of Applied Sciences and Arts of Southern Switzerland, Switzerland)

Molecular modelling towards understanding the dynamic, responsive behaviour of synthetic supramolecular materials

12:30 - 13:00 **Closing Ceremony, Poster Awards & End of the Scientific Program**

João F. Mano & João Borges (University of Aveiro, Portugal)

13:00 - 14:30 **Lunch Break**

14:30 - 18:30 **Social Program**

INVITED SPEAKERS

SHORT BIOS | ABSTRACTS

LIST OF PRESENTATIONS

E. W. “Bert” Meijer

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E. W. “Bert” Meijer *is Distinguished University Professor in the Molecular Sciences, Professor of Organic Chemistry at the Eindhoven University of Technology. After receiving his PhD degree at the University of Groningen with Hans Wynberg, he worked for 10 years in industry (Philips and DSM). In 1991 he was appointed in Eindhoven, while in the meantime he has part-time positions in Nijmegen, MPI-Mainz, Santa Barbara, CA and Sydney. Bert Meijer is a member of many editorial advisory boards, including Advanced Materials and is Associate Editor of the Journal of the American Chemical Society. Bert Meijer has received several awards, including the Spinoza Award (2001), the ACS Award for Polymer Chemistry (2006), the AkzoNobel Science Award (2010), Cope Scholar Award of the ACS (2012), the Prelog Medal (2014), the Nagoya Gold Medal (2017), the Chirality Medal (2018) and the Van ‘t Hoff and Staudinger Medal in 2022. In 2020 he is knighted by the king to be Commander in the Order of the Netherlands Lion. He is na honorable member of several academies and societies, including the US National Academy of Sciences and Royal Netherlands Academy of Sciences, where he is appointed to Academy Professor in 2014.*

ABSTRACT

Dynamic biomaterials using dilution-induced supramolecular polymerizations and the clustering of ligands and receptors

Eindhoven University of Technology, Institute for Complex Molecular Systems, Department of Chemical Engineering and Chemistry, Laboratory of Macromolecular and Organic Chemistry, PO Box 513, 5600 MB Eindhoven, The Netherlands

The concept of supramolecular polymerization is well accepted by now. Next to macromolecules they have become an integral part of the field of polymer science and engineering. These supramolecular polymers possess many properties like macromolecules except that they possess a tunable dynamic exchange due to the supramolecular nature of the non-covalent bond between the monomers. Polymerization in solution is typical achieved by lowering the temperature, changing the solvent composition, or increasing the concentration of monomers. However, upon the addition of components that can interfere with the supramolecular polymers and/or monomers, unconventional properties can be observed. One of them leads to supramolecular polymerizations upon decreasing the concentration: the so-called dilution-induced supramolecular polymerization. In the lecture, we will show that fundamental insights into the dynamic nature of these multi-component supramolecular systems will afford novel properties that can create functions and how these concepts can be used to form functional biomaterials. As an example, we will show their opportunities in the clustering of ligands and receptors by using the reciprocity in dynamics of these supramolecular biosystems.

Patricia Dankers

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Patricia Dankers *is professor in Biomedical Materials & Chemistry at the Eindhoven University of Technology (TU/e). She studied chemistry in Nijmegen, The Netherlands. Her PhD studies were performed at TU/e, on supramolecular biomaterials (2006). She worked for SupraPolix, and the University Medical Center, Groningen. Her second PhD thesis work was performed in medical sciences on kidney regenerative medicine, in Groningen (2013). She worked at Northwestern University, Chicago, USA (2010). She climbed every step on the academic ladder, starting in 2008, ending in 2017 as full professor. She received Veni, Vidi (2008, 2017) and ERC starting, ERC PoC (2012, 2017) grants. She has been awarded the KNCV Gold Medal (2020) and the Ammodo Award for Fundamental Science (2021). She is a co-founder of the spin-off company UPyTher (2020). Recently, she was one of the main applicants on the funded Gravitation Program to found the Research Center for Interactive Polymer Materials (IPM), in Eindhoven (2022).*

ABSTRACT

Engineering Bio-communication into Supramolecular Polymer Materials

Eindhoven University of Technology, Institute for Complex Molecular Systems, Department of Biomedical Engineering, Eindhoven, The Netherlands | www.dankerslab.nl

The extracellular matrix (ECM) is a complex, hierarchical assembly of various molecules held together via both covalent and noncovalent interactions. In order to make materials with comparable properties it is proposed that supramolecular materials based on hydrogen bonding units are eminently suitable. An important challenge in the synthesis and formulation of a synthetic ECM is besides the balance between Dynamics and robustness, the introduction of complexity. This complexity might originate from hierarchical structures formed by assembly of our supramolecular monomers, or from bioactive molecules co-assembled with these monomers. Both parameters will heavily influence the function of the materials when brought into contact with cells. The bioactive function in our supramolecular systems is based on small synthetic peptides, large ECM proteins, or carbohydrates. Here we show how to engineer these supramolecular materials into synthetic ECM matrices for the culture of cells and organoids. Besides complexity in composition, communication of cells with their surroundings is very important. This communication determines various cellular processes such as cell fate, and ultimately tissue function. Therefore, our proposal is to engineer bio-communication into our materials using supramolecular approaches.

Sébastien Lecommandoux

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France

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Sébastien Lecommandoux *received his Ph.D. (1996) in Physical Chemistry from the University of Bordeaux. After a postdoctoral experience at the University of Illinois (UIUC, USA) in the group of Prof. Samuel I. Stupp, he started his academic career at the Laboratoire de Chimie des Polymères Organiques as Associate Professor in 1998 and was promoted to Full Professor at Bordeaux INP in 2005. He is currently Director of the Laboratoire de Chimie des Polymères Organiques (LCPO-CNRS) and is leading the group "Polymers Self-Assembly and Life Sciences". His research interests include the design of bio-inspired polymers for biomaterials design and tissue engineering, especially based on polypeptide, proteins and polysaccharide-based block copolymers self-assembly, the design of polymersomes for drug-delivery and theranostic, as well as biomimetic approaches toward design of synthetic viruses and artificial cells. He published over 200 publications in international journal, 6 book chapters and 12 patents (2 being licensed), with over 16000 citations (h-factor 63, Google Scholar). He is also co-director of the joint laboratory LCPO-L'OREAL and co-founder of Emissary Cosmetics. Sébastien Lecommandoux is recipient of the CNRS bronze medal (2004), Institut Universitaire de France Junior Chair (IUF 2007), Fellow of the Royal Society of Chemistry RSC (2017), Seqens Award of the French Academy of Science (2019), Member of the Academia Europaea (2020). He has been Editor-in-Chief of Biomacromolecules (ACS) since 2020 after serving as Associate Editor since 2013. He is also in the Editorial Advisory Board of several international journals, including Bioconjugate Chemistry (ACS), Polymer Chemistry (RSC) and Biomaterials Science (RSC).*

ABSTRACT

Biomimetic glyco- and lipo-protein bioconjugates for biomaterials and artificial cells design

V. Ibrahimova, M. Levêque, H. Zhao, E. Ibarboure, E. Garanger, S. Lecommandoux

Université de Bordeaux, CNRS, Bordeaux INP, LCPO, UMR 5629, ENSCBP, 16 Avenue Pey-Berland, Pessac F-33600, France

We report here an overview on the design of Elastin-Like Polypeptides (ELPs) based conjugates and their applications in nanomedicine, biomaterials and artificial cells. We pay special attention to their modification with saccharides [1], polysaccharides [2] and lipids [3], aiming at mimicking both the structure and functionality of glycoproteins and lipoproteins. We developed synthetic strategies for the design of glycosylated polypeptides and polysaccharide-polypeptide biohybrids with controlled placement of sugar functionality. The ability of these systems for different biomedical applications, from drug-delivery to inhibitor, will be presented [4]. In addition, the design of a new class of lipoproteins based on ELPs with unique thermo-responsive character will be proposed. These biosynthetic lipoproteins can self-assemble into lipopolymersomes, with tunable membrane permeability, opening avenues in drug delivery and artificial cell design [3]. Finally, our most recent advances in the design of complex, compartmentalized and functional artificial cells will be presented. Such a system is a first step towards the challenge of structural cell mimicry and functionality, and could act in the future as an autonomous artificial cell capable of detecting and healing in situ any biological deregulation [5,6].

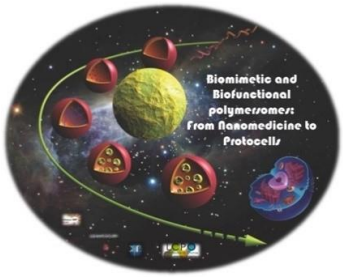

Figure 1. Biomimetic polymersomes for nanomedicine and as functional artificial cells and organelles.

[1] L. M. B. Anaya, *et al*. Biomacromolecules **2021**, 22, 1, 76–85
[2] M. Levêque, *et al*. Biomaterials Science **2022**, 10, 6365-6376
[3] V Ibrahimova, *et al*. Chem. Int. Ed. **2021**, 60, 15036-15040
[4] H. Duan, *et al*. Chem. Int. Ed. **2020**, 132 (32), 13693-13698
[5] H. Zhao *et al*. Chem. Int. Ed. **2020**, 132 (27), 11121-11129
[6] H. Zhao, *et al*. Advanced Science **2021**, 2102508

Helena Azevedo

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Helena Azevedo *is an ERA Chair in Molecular Bioengineering at the Institute for Research and Innovation in Health (i3S, University of Porto, Portugal) where she is leading the Molecular Biomaterials Group. Before, she was a Reader in Biomedical Engineering & Biomaterials at the School of Engineering & Materials Science in Queen Mary University of London (QMUL) where she took different roles and responsibilities. She was the Programme Director of the undergraduate and postgraduate degrees in Biomedical Engineering (2016-2022) and was the Director of Operations of the Institute of Bioengineering at QMUL (2015-2017). She is a Fellow of the Royal Society of Chemistry (FRSC) since 2017 and was appointed Member of the Materials Chemistry Division Council (RSC) in 2021. In 2021 she also became Member of the Editorial Advisory Board of Journal Peptide Science (Wiley) and has been a Member of the Advisory Board of the RSC journal Molecular Systems Design & Engineering since 2016. Her work focuses on self-assembling biomaterial platforms for cell culture, drug delivery, regenerative medicine, and biosensing. She is author of >100 publications, including papers in Science, Nat Chem, Nat Comm, Adv Funct Mater, Nano Lett, Adv Health Mater, and has edited 3 books on natural-based biomaterials, self-assembling biomaterials and soft matter for biomedical applications.*

ABSTRACT

Biomaterials inspired by biology: from molecules to self-assembly

i3S - Instituto de Investigação e Inovação em Saúde, Universidade do Porto, Portugal
INEB - Instituto de Engenharia Biomédica, Universidade do Porto, Portugal

The extracellular matrix (ECM) of tissues can take different formats and topology, but contains essentially water, proteins and polysaccharides. However, each tissue has an ECM with a unique composition, which is highly organized as a result of the intrinsic properties of its components and their interactions, as well as the activities of resident cells[1]. The abundance of protein-based molecules (collagens, glycoproteins, proteoglycans) in the ECM makes peptides obvious choices to engineer synthetic ECMs. Recently, we reported the fabrication of 3D hyaluronan (HA) hydrogels formed by supramolecular crosslinking of native HA via self-assembly of cationic beta-sheet peptides and showed the possibility to tune hydrogel structural and mechanical properties through the peptide sequence[2]. These 3D supramolecular peptide-HA hydrogels can serve as ECM surrogates for cell culture or as in vitro models. For example, human mesenchymal stem cells (MSCs) cultured on the hydrogels form spheroids, suggesting the possibility to modulate cell-microenvironment interactions. This presentation will highlight our efforts in developing supramolecular biomaterials, combining native HA and self-assembling peptides, and their potential biomedical applications.

Acknowledgments:

H.S.A. thanks the MOBILIsE project funded by the European Union's Horizon 2020 research and innovation programme under Grant Agreement no. 951723.

References:

[1] H. S. Azevedo, Encyclopedia of Tissue Engineering and Regenerative Medicine, **2019**, 109-117.

[2] Y. Yuan, et al. Mater. Today Bio, **2023**, 19, 100598.

Alvaro Mata

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Alvaro Mata *is Professor in Biomedical Engineering and Biomaterials in the School of Pharmacy and the Department of Chemical and Environmental Engineering at the University of Nottingham. He holds a Bachelor's Degree from the University of Kansas, a Master's Degree from the University of Strathclyde, and a Doctor of Engineering Degree from Cleveland State University working with Prof. Shuvo Roy at the Cleveland Clinic. He conducted his postdoctoral training with Prof. Samuel Stupp at Northwestern University. His group focuses on bioinspired and biocooperative strategies to build with biomolecules by integrating biological organization processes with engineering principles. His work has led to eight patents or patent applications; publications in journals including Nature Chemistry, Nature Communications, and Science Advances, and recognitions such as a Welcome Trust Frontiers Innovation Award, a Ramon y Cajal Fellowship, and an ERC Staring Grant. He is President-elect of the Mineralized Tissue Group of the International Association of Dental Research, Co-chair of the Manufacturing, Commercial and Regulatory Committee of the UK Regenerative Medicine Platform (UKRMP2) - Smart Materials Hub, and Chief Innovation Officer of the company Ourobionics.*

ABSTRACT

Engineering of advanced biomaterials by harnessing biological organization principles

School of Pharmacy, Department of Chemical and Environmental Engineering, University of Nottingham, NG7 2RD Nottingham, UK

Living systems have evolved to grow and heal through biological organization principles (BOPs) capable of organizing molecular and cellular building-blocks at multiple size scales. These BOPs emerge from cooperative interactions and chemical networks between multiple components, which allow biological systems to diversify, respond, and optimize. This talk will present our laboratory's efforts to combine supramolecular events found in nature such as self-assembly, disorder-to-order transitions, or diffusion-reaction processes with engineering processes to design bioinspired materials and devices (Figure 1). I will also describe recent efforts aiming to go beyond "bioinspiration" and into "biocooperation". I will describe methodologies to develop a) dynamic hydrogels and in vitro models for cancer [1,2], b) self-assembling fluidic devices [3,4], and c) regenerative implants [5,6].

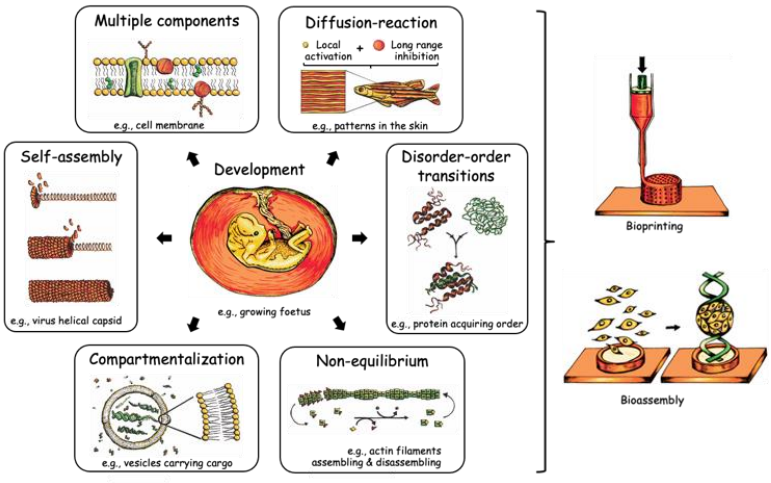

Figure 1. A supramolecular biofabrication toolkit.[7]

References:

[1] Hedegaard et al, Science Advances **2020**, 6, eabb3298.

[2] Osuna de la Peña et al, Nature Communications **2021**, 12, 5623.

[3] Inostroza-Brito et al, Nature Chemistry **2015**, 7, 897–904.

[4] Wu et al, Nature Communications **2020**, 11, 1182.

[5] Okesola et al, ACS Nano **2021**, 15, 7, 11202–11217.

[6] Wu et al, Advanced Functional Materials **2022**, 32, 2205802.

[7] Azevedo & Mata, Biomaterials & Biosystems **2022**, 6, 100039.

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Zaida Alvarez *is currently a Ramon y Cajal and leading investigator of the biomaterials for neural regeneration group at the Institute for Bioengineering of Catalonia (IBEC), Spain. She earned her PhD degree in Biomedical Engineering with Prof. Elisabeth Engel at Polytechnic University of Catalonia in 2014. In 2015, as a self-funded postdoc she joined Professor Samuel Stupp's laboratory, at Northwestern University in Chicago to work on peptide amphiphiles for neural regeneration where she published more than 15 papers in high impact factor journals. In 2019, she was promoted as an assistant professor at the department of medicine, at Feinberg Medical school at Northwestern University where she continued her research supramolecular materials for spinal cord regeneration and iPSCs modelling. She is also consulting engineering in a couple of companies in the USA, she has 4 patents already transferred to AmphixBio Incorporation and got numerous awards such as Young Baxter investigator award in 2019, and Rafael Hervada award in 2021.*

ABSTRACT

The effect of bioactive scaffolds with enhanced supramolecular motion on neuronal modelling and regeneration

Z. Álvarez [1,2,3*], J. A. Ortega [4,5], K. Sato [2,6], I. R. Sasselli [2], E. Engel[1], S. I. Stupp [1,2,3,6,7], E. Kiskinis [3,4]

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[2]Simpson Querrey Institute for BioNanotechnology, Northwestern University, Chicago, USA
[3]Department of Medicine, Northwestern University, Chicago, USA
[4] Department of Pathology and Experimental Therapeutics, University of Barcelona, Barcelona,Spain
[5]The Ken & Ruth Davee Department of Neurology, Northwestern University, Chicago, USA
[6]Department of Chemistry, Northwestern University, Evanston, USA
[7]Department of Materials Science and Engineering, Northwestern University, Evanston, USA

Over the past decades, biomaterials have been continuously tested as key players in a variety of central nervous system (CNS) strategies. Current biomaterial approaches are inconsistent, cost inefficient, and ultimately fall short in their ability to promote neuronal maturation and repair. This is due in part to the lack of synergistic cues derived from the architecture, chemical composition, and molecular dynamics of the native extracellular matrix. We report here on peptide-amphiphile supramolecular nanofibers that contain distinct bioactive signals on their surface and differ in the intensity of molecular motion within the fiber[1,2]. By mutating the monomers of their non-bioactive domains, we enhanced the motions of the molecules within the scaffolds, resulting in enhanced bioactivity in an iPSC-derived motor neuron model as well as in a mouse model of spinal cord injury (SCI). Proteomic, biochemical and functional assays show that scaffolds with highly mobile molecules lead to increased mature electrophysiological activity of neurons. When tested in a mouse model of SCI, this resulted in remarkable differences in vascular growth, axonal regeneration, and functional recovery. Our work highlights the importance of supramolecular motion in the design of bioactive scaffolds to improve function and dysfunction in the CNS.

Acknowledgments:

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References:

[1] Z. Álvarez, et al., Science **2021**, 374, 848-856.
[2] Z. Álvarez, et al., Cell Stem Cell **2023**, 30, 219-238.

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Francesco Ricci *is a full professor at the Chemistry Department of the University of Rome, Tor Vergata. His research interests lie in the fields of electrochemical sensors, DNA functional nanotechnology, DNA-based sensors, aptamers, conformational switching probes and smart drug-release. After the PhD in Chemistry earned in 2005 at the University of Rome, Tor Vergata, Francesco Ricci spent 2 years as a visiting post-doc researcher at the University of California, Santa Barbara. Francesco Ricci has been awarded an International Marie Curie Outgoing Fellowship (2010), an ERC Starting Grant (2013) and an ERC Consolidator Grant (2019). He is also the recipient of the inaugural 2017 ACS "Advances in Measurement Science Lectureship" Award, the 2017 "Heinrich Emanuel Merck Award on Analytical Science" and the 2021 Luigi Galvani Prize of the Bioelectrochemical Society. Francesco Ricci is author of more than 120 papers in ISI peer-reviewed journals that received more than 6000 citations so far (H-index = 51).*

ABSTRACT

Reorganization of Self-Assembled DNA-Based Polymers in Higher Ordered Structures

Department of Chemistry, University of Rome Tor Vergata, Via della Ricerca Scientifica, Rome 00133, Italy

DNA nanotechnology uses synthetic DNA (or nucleic acids) as a versatile material to rationally engineer tools and molecular devices that can find a multitude of different applications (e.g., in-vivo and in-vitro diagnostics, drug delivery, genetic circuits etc.). During this presentation I will introduce the field of DNA nanotechnology and I will show how to exploit the designability of DNA to fabricate addressable DNA-based polymers that can be specifically and orthogonally assembled or disassembled in response to different molecular inputs. Through a fine modulation of the rate at which these polymers are re-assembled it is possible to carefully control the final composition of the structure and convert a disordered polymer in a higher order polymer, which is disfavored from a thermodynamic point of view. The approaches I will present here suggest a novel route toward the development of biomolecular materials in which engineered chemical reactions support the autonomous spatial reorganization of multiple components.

Roxanne Kieltyka

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Roxanne Kieltyka *was born in Toronto, Canada. She graduated from the University of Toronto with a BSc in Materials Chemistry in June 2003. Shortly thereafter, she joined the group of Prof. Hanadi Sleiman at McGill University in Montreal, where she received her PhD degree in 2009. Her thesis was on the development of novel platinum-based complexes for the targeting of G-quadruplexes as an anticancer therapy. She then performed postdoctoral work in the group of Prof. E. W. "Bert" Meijer on the synthesis of supramolecular polymers for application in the biomedical field. Roxanne is an Associate Professor within the Supramolecular and Biomaterials Chemistry group at the Leiden Institute of Chemistry in Leiden University. In 2018, she was named one of the Talented 12 by C&E News. In 2019, she was awarded a Starting Grant by the European Research Council.*

ABSTRACT

Spatial and temporal control over mechanics in dynamic biomaterials

Department of Supramolecular and Biomaterials Chemistry, Leiden Institute of Chemistry, Leiden University, Leiden, The Netherlands

Cells engage in bidirectional crosstalk with the natural extracellular matrix (ECM) to execute the intricate processes involved in development and disease. Synthetic polymer materials in the form of hydrogels seek to emulate the biophysical and biochemical changes in the matrix that occur in the ECM in vivo to direct cellular behavior in vitro for a wide range of aims in tissue engineering and regenerative medicine. Using non- or dynamic covalent interactions within such hydrogels brings them closer to this natural material by providing access to the complex mechanical characteristics (e.g., viscoelasticity, plasticity, and strain stiffening) needed to facilitate processes such cell differentiation and tissue morphogenesis. In my talk, I will share our efforts in developing supramolecular and dynamic covalent polymer materials whose mechanics can be controlled for various 3D cell culture applications. I will disclose our work on squaramide-based supramolecular materials, where we apply the squaramide motif within amphiphilic monomers to form self-assembled hydrogel materials where their bioactive and mechanical properties can be tuned through the co-assembly of monomers with reactive units. I will also present our findings on the preparation of disulfide-based dynamic covalent polymer materials starting from ring-strained latent macromonomers. In both materials, I will show that their mechanics can be modulated in space and time with and without light to influence the behavior of several cell types used to model development and disease in vitro.

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Iva Pashkuleva *holds PhD in Organic Synthesis from University of Sofia, Bulgaria. In 2008, she received Career Starting Grant under the Portuguese National Program Compromisso com a Ciência to work on surface modification of biomaterials (with emphasis on starch and chitosan) as a way to enhance their biocompatibility. In 2013 and in 2019, she was awarded two Development Career Grants under the Portuguese Program Investigador FCT and the programme for Individual Scientific Employment Stimulus to established a new research line focussed on biofunctional glycans. Currently, she is a principal investigator in 3B's Research group, University of Minho where she leads a small team working at the interface of biomaterials, carbohydrate chemistry and supramolecular systems: the team develops and uses glycan supramolecular systems to gain fundamental insights into extracellular matrix organization, dynamics and function as well as to design adaptive and responsive biomaterials. So far, they have developed new analytical methods and platforms for characterization of challenging to measure glycan-protein and glycan-cell interactions; glycan-based delivery systems; selective cancer therapies based on biocatalytic self-assembly of glycan amphiphiles; and extracellular supramolecular mimics.*

ABSTRACT

Enhancing the selectivity and functionality of supramolecular biomaterials by glycan incorporation

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Glycosylation is a major posttranslational modification that enriches the molecular code of life[1]. The structural diversity of glycans distinguish them from other biomolecules such as proteins and nucleic acids: the stereochemical variety (e.g. epimers, anomers, enantiomers, regioisomers) and ample supramolecular interactome of glycans are used by life systems to enhance the selectivity and specificity of biorecognition and binding processes[2]. In these systems glycan amphiphiles, e.g. glycolipids, are used to build complex and responsive biofunctional structures via avidity, i.e. multivalent non-covalent interactions such as hydrogen bonding, CH-pi interactions, London dispersion forces. This Nature's approach can be copycatted in synthetic supramolecular systems to diversify or alter their properties and bioactivity.

Different examples will be presented during the talk to illustrate the versatility of the glycans in such systems. Self-assembly of peptide and glycopeptide systems will be compared in terms of supramolecular interactions involved and properties of the generated materials[3]. Supramolecular chirality and the possibility to control it by choosing the correct glycostereoisomer will be discussed. The convenience to diversify the structure and properties of biomaterials obtained by enzyme-assisted assembly via the use of different regioisomers will be demonstrated[4].

Finally, challenges associated with the design, synthesis and characterization of supramolecular glycomaterials will be also debated.

Acknowledgments: EU's H2020 program (Forecast 668983, Aptadegrad 101099063) and the Portuguese FCT (PTDC/CTM-REF/0022/2020 OncoNeoTreat)

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Andreas Walther *is a Gutenberg Research Professor and head of the "Life-Like Materials and Systems" lab at the University of Mainz in Germany. His research interests concentrate on developing and understanding hierarchical and metabolic self-assembly concepts inside and outside equilibrium, and on using them to create life-inspired materials systems with the capacity for active, adaptive and autonomous behavior. A. Walther is a two times ERC grantee, a founding PI of the DFG Cluster livMatS, a Max Planck Research Fellow, and a former Senior Fellow of the Freiburg and Strasbourg Institutes for Advanced Studies. He has published ca. 200 publications (h-index 63, ca. 17000 citations) and has been awarded the Bayer Early Excellence in Science Award (for Materials), the Reimund Stadler Young Investigator Award of the German Chemical Society, as well as the Hanwha-Total IUPAC Young Scientist Award awarded at the IUPAC World Polymer Congress.*

ABSTRACT

Metabolic DNA Systems Inspired from Life: Protocells and Materials with Lifecycles

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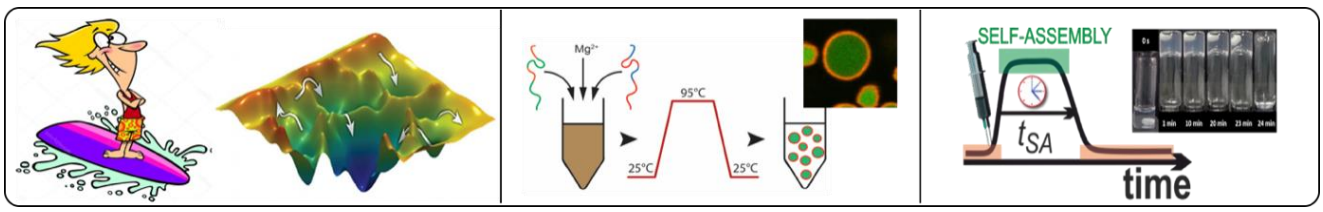
Living self-organizing systems operate far-from-equilibrium and display energy-dependent adaptive functionalities that are orchestrated through feedback loops and metabolic reaction networks to allow tailored response in complex sensory landscapes. These principles serve as an inspiration to promote complexity and life-like functions in soft matter systems, which include for instance to pre-organize temporal behavior or install mechanisms for complex adaptative behavior. The pre-organization of the temporal fate of systems requires new types of internal control mechanisms, such as kinetic control over opposing reactions (built-up/destruction), the integration of feedback mechanisms, or the use of energy dissipation to sustain structures only as long as a chemical fuel is available. Even higher complexity and new functions are in reach by essentially embedding multi-sensory metabolic reaction networks into these systems. In this talk, I will discuss two avenues towards autonomous and adaptive DNA active matter systems with simplistic metabolic reaction networks inside. On the one hand, I will discuss the formation of DNA-based protocell architectures with the ability to house abiotic catalysts driving downstream morphological adaptations. On the other hand, I will discuss the use of ATP as a chemical fuel to drive chemically fueled out-of-equilibrium systems using activation/deactivation networks. The latter allows to program self-assemblies and materials with lifetimes and programmable steady state dynamics.



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Ghislaine Vantomme *is an Assistant Professor in the Department of Chemical Engineering and Chemistry at TU Eindhoven. She studied chemistry at l'Ecole Normale Supérieure de Cachan (France) from 2006 to 2010. After a stay in the laboratory of Prof. Koji Nakanishi and Prof. Nina Berova at Columbia University (New York), she received a M.Sc. from the Université Pierre et Marie Curie (Paris). In 2014, she defended a PhD under the supervision of Prof. Jean-Marie Lehn at the Institut de Science et d'Ingénierie Supramoléculaires, Université de Strasbourg on dynamic covalent chemistry. Switching to materials chemistry, she joined TU Eindhoven as a postdoctoral fellow to work with Prof. Bert Meijer and developed photo-actuators based on liquid crystals networks in collaboration with Prof. Dirk Broer. In 2019, she was appointed Assistant Professor at TU Eindhoven. Her research interests include the understanding of the fundamentals of supramolecular chemistry and their translation into adaptive materials.*

ABSTRACT

Synthesis of supramolecular polymeric materials – the interplay between covalent and non-covalent bonds

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The need for complex functional systems is growing, driven by the interests for device miniaturization, emergence of interactive materials, and efforts to mimic biological processes. Mastering these complex molecular systems ultimately requires control over structure, dynamic and function of supramolecular assemblies at all length scale. However, complexity arising from the sensitivity of these systems to small perturbations, the large number of interacting components and the multiple aggregation pathways by which the systems can evolve makes their construction challenging. Moreover, issues on prediction of the assembled states and reproducibility urge the community for solutions. Inspired by total synthesis in organic chemistry, a paradigm shift from one-step self-assembly to multistep noncovalent synthesis was proposed[1,2]. Instead of assembling multiple components in a single step by mixing, several steps are performed one after another until the complex structure is reached. Thus, novel synthetic strategies in the molecular scientists' toolbox are needed to develop this stepwise approach. In the presentation we illustrate our work towards functional supramolecular materials. The focus is on the synthesis of supramolecular polymeric materials in which molecular events are coupled to macroscopic function.

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Thomas Hermans *is Professor of Chemistry at the University of Strasbourg and group leader of the Laboratory of Nonequilibrium Complex Systems (www.hermanslab.com). He received his PhD from the faculty of Biomedical Engineering under the supervision of Prof. E.W. (Bert) Meijer (2006-2010). Next, he joined the group of Prof. Bartosz Grzybowski at Northwestern University as a postdoctoral fellow (USA, 2010-2013). Prof. Hermans received the ERC Starting Grant 2017, Thieme Chemistry Award 2018, Prix Guy Ourisson 2018, Prix Forcheur J.-M. Lehn 2022, Prix Christiane Dietrich-Buchecker 2022, and is a Young Scientist at World Economic Forum, World Laureates Association 2019-2020, and junior chair at the Institut Universitaire de France 2022-2027. He is coordinating a European (ITN) network 'Creanet' on chemical reaction networks. The main goal of the lab is obtaining adaptive, self-healing, self-replicating and ultimately living materials using molecular self-assembly under far-from-equilibrium conditions. Prof. Hermans is also co-founder and CTO of Qfluidics, a company working on wall-less fluidics for flow chemistry and low-shear magnetostaltic pumping for transport of delicate biologicals.*

ABSTRACT

Controlling self-assembly by chemical fuels and light

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Looking at nature, we see that living materials with biological functionality, such as the actin or microtubule (MT) cytoskeletal network, achieve dynamics as well as supramolecular structures with the same protein building blocks. In other words, the components can assemble, but also react (i.e., tubulin is also an enzyme that hydrolyses guanosine triphosphate GTP), which in turn affects the assemblies. In this way, living systems use chemical fuels (e.g., GTP) and self-assembly to create a built-in chemomechanical interaction. Moreover, such networks operate in sustained out-of-equilibrium states at the onset of oscillations[1–3], which results in rapid response and adaptivity. Here, we present our recent[4–8] reaction cycles in solution and gels, where interesting new behaviors were found, such as supramolecular size oscillations, traveling polymerization, or transient disassembly. We hope such reaction cycles form the basis of new life-like materials where material properties are fuel (and waste) dependent.

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Manuel Melle-Franco *graduated in Physical Chemistry from the University of Santiago de Compostela (Spain, 96) and obtained an M.Sc. in Materials Chemistry from the University of Kent (UK, 97). After that, Manuel took a PhD in Chemical Physics under Alan Chadwick from the University of Kent (UK, 2001) with a year abroad with Gianfranco Pacchioni at the Department of Materials Science in Milan (Italy). After his PhD, Manuel joined the group of Francesco Zerbetto at the Chemistry Department of the University of Bologna (Italy) to later move to Portugal to work at the University of Porto (2008) and the University of Minho (2011) in high-performance computing (2011). He works in CICECO since 2016 leading the Applied Computer Modelling Laboratory as a principal researcher. In his research, Manuel applies, mixes and develops computer models to understand experiments in molecular biology, organic chemistry, materials science and nanotechnology.*

ABSTRACT

Computing your way out of experimental problems: a critical perspective

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Computer modelling has become a key feature to understand experimental problems in current molecular and materials science. From our experience, applying and developing computational models, we will discuss available computer models and how these may be used to yield key information on real problems. This will be illustrated in a non-technical way with examples from our own research, dealing, for instance, with Covalent Organic Frameworks (COFs)[1], chiral nanographenes[2], bio-nano interfaces[3,4].

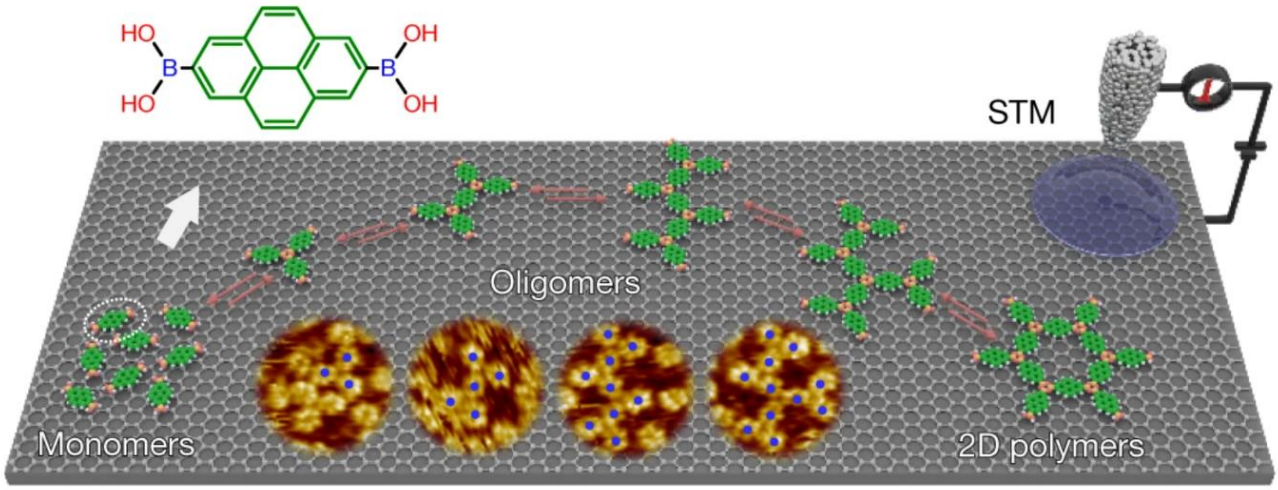

Figure 1. Observation of 2D dynamic covalent polymerization in real time.

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Claudio Perego *holds a background in Theoretical Physics. He obtained his PhD in Physics from the University of Milano-Bicocca (IT), where he studied the theoretical modelling of laser-driven plasma dynamics and ion acceleration. After the doctoral studies, he joined the group of M. Parrinello (USI/ETHZ Lugano, CH) as a postdoc where he developed and applied advanced sampling methods for Molecular Dynamics (MD) of liquids and crystallization from solution. Then, he extended his interests to biopolymer modelling, joining K. Kremer theory group at the Max Planck Institute for Polymer Research in Mainz (DE), as grantee of a Marie Skłodowska-Curie individual fellowship focused on the multi-scale computational study of entangled protein folding. Since 2019, he is part of the group of G. M. Pavan at SUPSI, in Lugano (CH), as tenured researcher. Claudio is involved in a number of research projects regarding the computational modelling of self-assembled supramolecular materials, with a particular focus on their complex monomer dynamics in- and out-of-equilibrium, which is at the basis of the fascinating properties like self-healing, stimuli-responsiveness, and bio-mimetic behaviour, that emerge at the macroscopic scale.*

ABSTRACT

Molecular modelling towards understanding the dynamic, responsive behaviour of synthetic supramolecular materials

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Supramolecular polymer systems, made by units that self-assemble via non-covalent interactions, represent a pivotal ingredient for the development of synthetic, functional materials. The dynamicity of supramolecular bonds is at the basis of properties such as stimuli-responsiveness, self-healing, structural and temporal control, key for uncountable applications in materials and biomaterials science. Due to the intrinsic multiscale character of supramolecular organization, understanding and predicting how collective properties emerge from the monomer dynamics represents a daunting challenge. Molecular simulations can help our understanding of supramolecular materials, providing a viewpoint that complements experiments toward the instructed design of new materials. Combining multiscale molecular models and enhanced sampling techniques we can capture the dynamics of supramolecular systems, bridging microscopic and macroscopic scales. This allows, for example, to characterize monomer exchange in supramolecular homopolymers, unveiling the complex inner dynamics of these materials[1]. Well-suited computational approaches can also highlight how collective properties, such as supramolecular semi-conductivity, can emerge in colloidal crystals, and how they relate with the physics at the sub-molecular level[2].

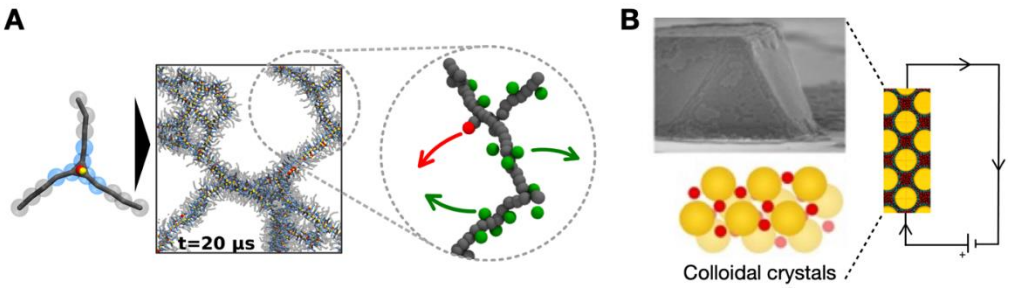

Figure 1. A, modelling of supramolecular dynamics (adapted from[1]). B, molecular simulations of emerging semi-conductivity in colloidal crystals (adapted from[2]).

References:

[1] M. Crippa, *et al*, Nature Commun. **2022**, 13, 2162

[2] C. Lionello, *et al*, ACS Nano **2023**, 17, 275-287

POSTER SESSION 1

ABSTRACTS

Poster Session 1 - 20th March | 10:30-11:00

Auditorium Renato Araújo – Central and Rectorate Building

1 **U. Aizarna-Lopetegui**

Smart-hybrid multifunctional bioinks for a 3D printed pulmonary artery model

2 **P. Zelenovskii**

Deciphering the role of molecular conformation in the piezoelectric properties of diphenylalanine assemblies

3 **B. Ladeira**

Exploring host-guest interactions between cyclodextrins and proteins to produce supramolecular amniotic membrane hydrogels

4 **H. Du**

Peptide amphiphiles: Correlating the supramolecular polymerization, polymorphism, and dynamics

5 **A. Poerio**

Mechanical characterization of 3D printed patterned membranes for cardiac tissue engineering: an experimental and numerical study

6 **R. Cipriano**

Rationalizing aminoacid composition responsible for liquid-liquid phase separation

7 **V. A. Veenbrink**

Screening ECM-protein derived peptide-functionalized ureido-pyrimidinone assemblies using Cell Painting

8 **A. I. Sariol**

Photo-activatable supramolecular double network hydrogels for 3D chondrocyte cell culture

9 **N. Abu Amara**

Characterizing the effect of hydrophilic/hydrophobic block ratio on the self-assembly of tapered BCP-BB in water

10 **M. M. A. Sacramento**

Natural bioinspired adhesives for biomedical applications

11 **C. Redondo-Gómez**

Molecularly-controlled biomaterials using host-guest guided peptide amphiphile self-assembly

12 **N. Konshin**

Discovery of the relationship between biomaterial properties and cell physiology in implant related encapsulation

ABSTRACT 1

Smart-hybrid multifunctional bioinks for a 3D printed pulmonary artery model

U. Aizarna-Lopetegui [1,2*], C. García-Astrain [1,3], C. Renero-Lecuna [1,3], P. Gonzalez [1], L. Liz-Marzán [1,3,4], M. Henriksen-Lacey [1,3], D. J. de Aberasturi [1,3,4]

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We have developed a pulmonary artery model that recreates the physical forces to which cells are exposed to during arterial pulsation. Hybrid multifunctional formulations have been developed including a stimuli-responsive and thermosensitive polymeric ink, and an extracellular matrix-derived bioink. The first ink contains gold nanorods (AuNRs)[1] as stimuli generators for the contraction and expansion of a copolymer mixture of thermoresponsive polymers (N-Isopropylacrylamide (NIPAm) and Poly(ethylene Glycol Diacrylate) (PEGDA)[2,3] – Figure 1. Local heating of the thermoresponsive matrix can be achieved upon irradiation with a laser in resonance with the Localized Surface Plasmon Resonance (LSPR) of the AuNRs. The expansion and contraction of the hydrogel, simulating the pulsatility of arteries, can be obtained by controlling the irradiation time and power of the laser, working at temperatures below and above the Lower Critical Solution Temperature (LCST) of the material. Smooth muscle cells have been embedded in an extracellular matrix-based formulation and endothelial cells suspended in cell media as to prepare the cell-containing bioinks. All inks have been characterized in terms of chemical and mechanical properties, printability, homogeneity, and biocompatibility, after which 3D bioprinting has been used to build the vascular tissue model. The suitability of 3D printing for processing hybrid and diverse multicomponent materials for the fabrication of arterial multilayer 3D model, resembling native tissues and microenvironments, has been verified.

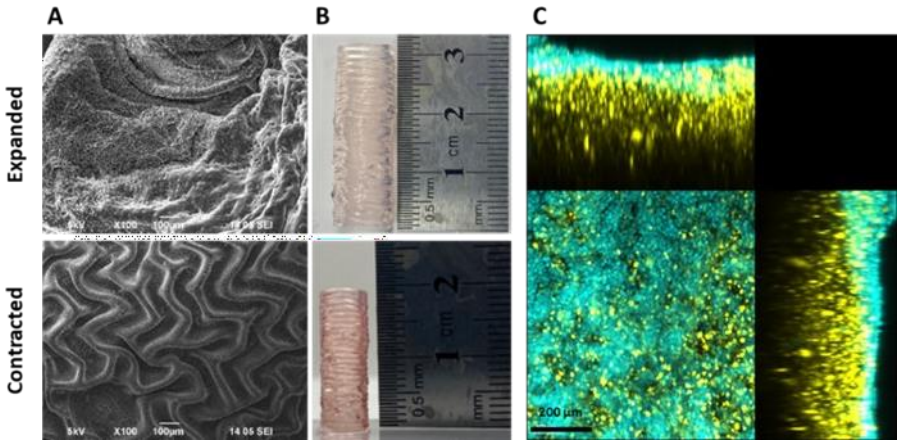

Figure 1. Structural characterization of the thermoresponsive ink showing clear differences in the microstructure studied by SEM (**A**) and macrostructure (**B**) between the expanded and contracted states. Confocal fluorescence imaging of living cells (**C**) of the 3D printed model composed of smooth muscle cells (yellow) and endothelial cells (cyan).

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ABSTRACT 2

Deciphering the role of molecular conformation in the piezoelectric properties of diphenylalanine assemblies

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Piezoelectric properties of crystalline organic and bioorganic materials are determined by the dipole moments of individual molecules and their spatial packing. In turn, molecular packing is closely related to the conformation of the molecules, which also determines the polar properties of the molecules. Though most biomolecules possess nonzero dipole moments, in a crystal, these moments can be reduced due to an improper molecular conformation. Here, on the example of diphenylalanine (FF) dipeptide, we studied the relationships between the conformation and polar properties of the individual molecule and the piezoelectric properties of nanostructures they form. We systematically analyzed crystallographic data for FF crystalline structures available in the Cambridge Structural Database and used quantum chemical calculations to determine the energy landscape and dipole moments of the molecules in cis-, trans-, and linear-conformations.

We found that aromatic interaction between phenyl rings in the molecule makes cis- configurations, generally, less stable than trans- ones. Cis-FF molecules correspond to a few local energy minima and form well-known piezoelectric nanotubes, whereas trans-FF molecules tend to form stacks of individual layers with pronounced out-of-plain piezoelectric properties. These crystals can be chemically exfoliated to get separate layers representing 2D piezoelectric nanomaterials suitable for various electromechanical applications.

The linear- conformation still requires a detailed study. However, preliminary analysis showed that the molecules with longer side branches tend to form less ordered crystal structures similar to polymers. Such disordered crystals possess small dipole moments with weak piezoelectric properties. The obtained results uncover the role of molecular conformation on the functional properties of molecular crystals and provide additional functionality for the design of organic piezoelectrics.

Acknowledgments: This work was developed within the scope of the project CICECO-Aveiro Institute of Materials, UIDB/50011/2020, UIDP/50011/2020 & LA/P/0006/2020, financed by national funds through the FCT/MEC (PIDDAC), and the project BioPiezoSensor/2022.03781.PTDC, financially supported by national funds (OE), through FCT/MCTES.

ABSTRACT 3

Exploring host-guest interactions between cyclodextrins and proteins to produce supramolecular amniotic membrane hydrogels

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Human extracellular matrix (ECM) proteins have been emerging as a valuable resource in the development of biosimilar matrices for tissue engineering. The human amniotic membrane (hAM) is a promising source of such proteins, exhibiting anti-inflammatory, anti-fibrotic and anti-microbial properties[1] .In this work, we have explored the use of mono-acryloyl-b-cyclodextrin as a photoresponsive crosslinking agent to generate supramolecular hydrogels from hAM. The cyclodextrin was dissolved alongside hAM to produce host-guest macromers, as previously reported[2]. Through circular dichroism spectroscopy, UV-Visible spectroscopy and quartz-crystal microbalance studies it was possible to confirm the interaction between the proteins and the cyclodextrin. Hydrogels were produced through the addition of a photoinitiator and irradiation with UV light. Occurrence of photopolymerization was confirmed through FTIR spectroscopy. The hydrogels displayed self-healing capability and high moldability. The mechanical properties of the hydrogels were assessed, and their biological performance was evaluated through the encapsulation of human adipose derived stem cells (hASCs). The hASCs were able to remain viable for 14 days, and cell behavior was shown to be influenced by the concentration of hAM and cyclodextrin. These results have shown that human protein-derived supramolecular hydrogels provide a soft and moldable matrix favorable to cell survival and attachment.

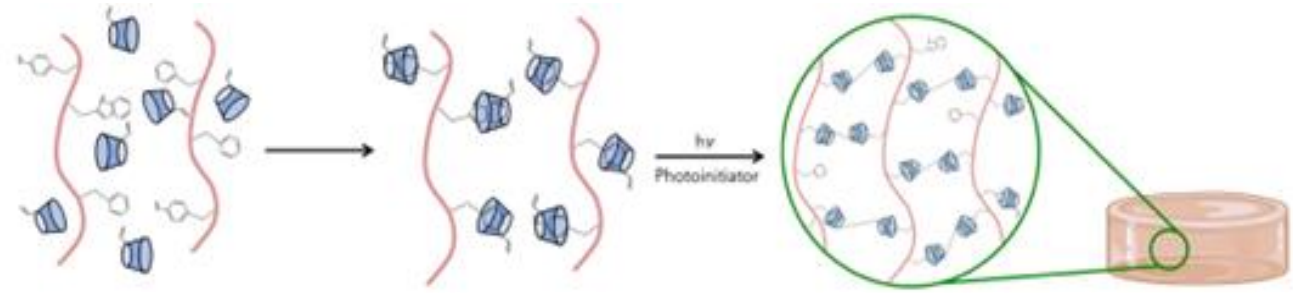

Figure 1. Schematic representation of the production of AMSupraMA hydrogels.

Acknowledgments: This work was financed by European Research Council grant agreement ERC-2017-ADG-883370 for project REBORN and by the Fundação da Ciência e Tecnologia (FCT) through the individual contract 2020.01647.CEECIND, the doctoral grant 2022.10626.BD and in the scope of project "TETRISSUE" (PTDC/BTM-MAT/3201/2020). The authors would also like to thank Dr. Kongchang Wei for gently providing the modified cyclodextrin. This work was also funded by the European Union's Horizon Europe research and innovation programme under the grant agreement No. 101079482 ("SUPRALIFE")

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ABSTRACT 4

Peptide amphiphiles: Correlating the supramolecular polymerization, polymorphism, and dynamics

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Peptide amphiphiles (PAs) are considered one of the most prominent classes of supramolecular polymers for the regenerative medicine application.[1] The dynamics of supramolecular polymers, namely the motion of their constituent monomers, is increasingly recognized as a crucial factor to tailor their function.[2-4] In a recent report of our laboratory,[5] the copolymerization strategy was demonstrated as a highly potential tool to enhance the dynamics and thereby the bioactivity of PA polymers. However, it remains ambiguous how the dynamics of PA polymers is correlated to the polymerization conditions, which control the non-covalent interaction between monomers, as well as the polymorphism in the structure and morphology of the resulting PAs. To fill this gap, we developed a novel methodology that combines titrations with different in-situ and ex-situ characterization tools to identify such correlation. These fundamental insights will open up new possibilities for the design of next generation of supramolecular polymers with tailored dynamics and bio-function.

Acknowledgments: H. Du gratefully acknowledges the financial support from SNSF Early Postdoc. Mobility fellowship (P2ELP2_191667) and Postdoc. Mobility fellowship (P500PN_214226).

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ABSTRACT 5

Mechanical characterization of 3D printed patterned membranes for cardiac tissue engineering: an experimental and numerical study

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A myocardial infarction can cause irreversible damages to the heart muscle. A promising approach for the treatment of myocardial infarction and prevention of severe complications is the application of cardiac patches or epicardial restraint devices. The challenge for the fabrication of cardiac patches is the replication of the fibrillar structure of the myocardium and in particular of its anisotropy and local elasticity [1]. In this study, we developed a chitosan-gelatin-guar gum based biomaterial ink and fabricated, by 3D printing, patterned anisotropic membranes and evaluated their mechanical properties through tensile tests. Experimental results were then used to develop a numerical model able to predict the elastic properties of additional geometries, which shoes that the elasticity of a membrane can be easily tuned by varying the size of the pores. Furthermore, by knowing the properties of the biomaterial ink (*e.g.* it's Poisson's ratio), this model could be easily adapted to several materials.

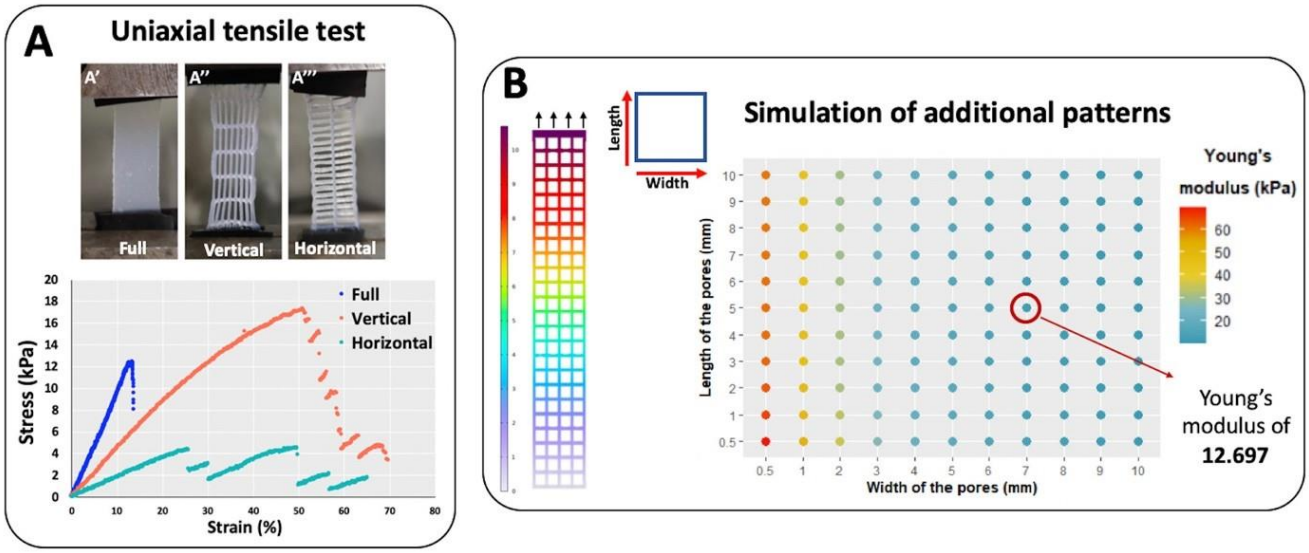

Figure 1. (A) Uniaxial tensile testing of CH-Gel-GG full membranes (A' - blue), vertical (A'' – orange) and horizontal (A'''- green) membranes. (B) Numerical simulation of tensile test of membranes with different size of pores.

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ABSTRACT 6

Rationalizing aminoacid composition responsible for liquid-liquid phase separation

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Compartmentalization is essential in eukaryotic cells, allowing for the overall organization and functionality. However, membraneless organelles, with similar functions to the membrane-bound organelles, are equally present in cells and are formed by liquid-liquid phase separation (LLPS), a reversible molecular process, making these organelles supramolecular assemblies constituted of proteins, RNA, DNA and other molecular components. Membraneless organelles, also known as biomolecular condensates or coacervates, are defined by a differential concentration of molecules inside their structure as opposed to the surrounding environment, originating a phase barrier that allows for great efficiency and control of several reactions that occur by diffusion[1-3].

Biomolecular condensates can be formed by proteins capable of performing phase separation such as intrinsically disordered proteins (IDPs) by homotypic interactions amongst themselves, or by heterotypic interactions with nucleic acids by complexation of oppositely charged molecules. IDPs are biomolecules with high flexibility, lack of a defined three-dimensional structure, and contain repetitive low-complexity regions important for the LLPS mechanism. The ability of a specific protein to undergo phase separation seems to be encoded in its aminoacid sequence, with various studies showing an enrichment in uncharged polar side chains aminoacids, charged aminoacids and aromatic residues[1,3,4].

The main objective of this project was the identification of the type of aminoacids present in IDPs capable of undergoing LLPS, by analysis of disordered and ordered regions in these proteins, as well as overall aminoacid composition, by using Python. Results showed a clear enrichment of certain aminoacids in regions with the propensity to phase-separate, namely glycine, serine and proline. Additionally, we identified a higher percentage of polar aminoacids in the same regions and a lower percentage of aromatic residues.

The identified aminoacids will be used in a rational designed combinatorial library to generate different combinations towards the creation of peptide linkers to drive LLPS.

Acknowledgments: This work was supported by FCT – Fundação para a Ciência e a Tecnologia, I.P., through MOSTMICRO-ITQB R&D Unit (UIDB/04612/2020, UIDP/04612/2020) and LS4FUTURE Associated Laboratory (LA/P/0087/2020)

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ABSTRACT 7

Screening ECM-protein derived peptide-functionalized ureido-pyrimidinone assemblies using Cell Painting

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One of the holy grails in the field of biomaterials is a synthetic extracellular matrix (ECM) mimic. To this end supramolecular materials are being investigated. Our approach is using supramolecular materials based on the ureido-pyrimidinone (UPy) moiety[1]. UPy compounds can make supramolecular assemblies through quadruple hydrogen bonding, π-π interactions and hydrophobic interactions. These assemblies can be made bioactive by introducing peptide-functionalized UPy compounds. Due to the modular nature of supramolecular interactions, it is possible to rapidly create libraries of assemblies with novel combinations of multiple peptide-functionalized UPy compounds. This makes it possible to tailor a material to its application. However, identifying novel combinations of multiple peptide-functionalized UPy compounds with desirable properties requires a robust screening method. Therefore, the goal of this study is to develop a high throughput screening method for investigating the effects of peptide-functionalized UPy assemblies on cells. To this end a technique based on the Cell Painting protocol developed by the BROAD institute of MIT and Harvard was investigated[2]. Cell Painting is a high throughput morphological screening method that creates cell level morphological profiles. These profiles are generated by collecting up to 1477 unique measurements across eight cellular compartments stained with six dyes. It was demonstrated that exposing A549 cells to UPy assemblies consisting of multiple peptide-functionalized UPy compounds resulted in unique morphological profiles. Therefore, the modified Cell Painting protocol is suitable for screening the effect of peptide-functionalized UPy compounds on the morphology of cells. In future, the method will be used to screen libraries of peptide-functionalized UPy materials to identify those with biochemical properties that are analogous to naturally occurring ECM.

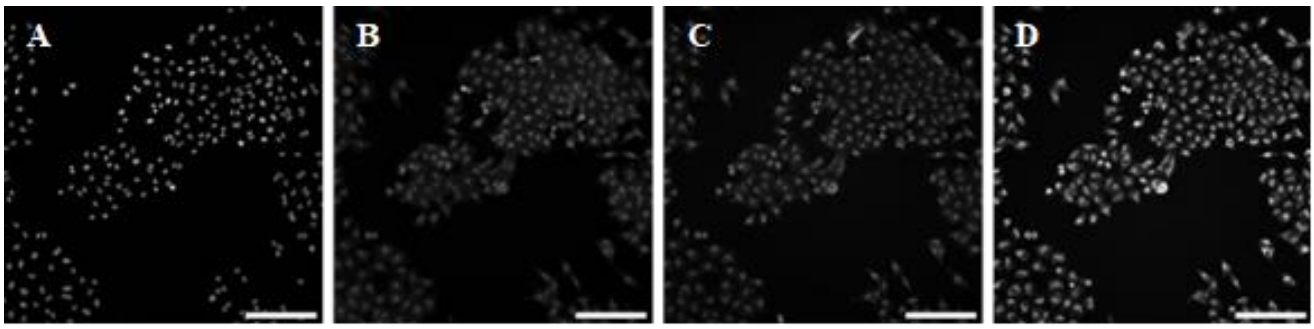

Figure 1. Example images of A549 cells stained with the Cell Painting dyes. Cells were stained with Hoechst (DNA)(A), phalloidin (actin cytoskeleton) and wheat germ agglutin (golgi and plasma membrane)(B), concavalin-A (endoplasmic reticulum)(C) and Mitotracker DeepRed (mitochondria)(D). Scale bar: 200 µm.

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ABSTRACT 8

Photo-activatable supramolecular double network hydrogels for 3D chondrocyte cell culture

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Hybrid double network (DN) hydrogels comprised of supramolecular and covalent polymers provide a promising scaffold for mimicking the extracellular matrix (ECM) in 3D cell culture. Due to the unique characteristics of cartilage, mimicking the fibrous structure of native proteins and the high mechanical strength in a hydrogel can be difficult. Fibrous DN hydrogels provide a highly tunable material for articular cartilage engineering with distinctive mechanical properties, such as self-healing and energy-dissipation, which make the material amenable for mechanical loading. In this study, photo-activatable cyclic 1,2-dithiolanes (DT) were incorporated to crosslink the supramolecular and covalent polymeric networks, providing spatiotemporal control over the stiffness of the material; additionally, the incorporation of an RGD peptide offers bioactive cues for cell adhesion. High cell viability of encapsulated NIH 3T3 fibroblasts and human primary articular chondrocytes (hPACs) was achieved under different conditions, such as UV light exposure time. Furthermore, hPACs encapsulated in DN hydrogels were mechanically loaded, demonstrating increased levels of sulphated-glycosaminoglycans (sGAGs) when compared to unloaded controls. Differences in gene expression levels of collagen type I and II (COL1A1, COL2A1) and matrix metallopeptidase 13 (MMP13) were seen between loaded and unloaded samples. For example, there was a clear increase in COL2A1 production relative to COL1A1, which becomes more pronounced with mechanical loading and over time. Ultimately, designing hybrid synthetic scaffolds which can bear mechanical loads offers a new avenue for understanding articular cartilage and related diseases.

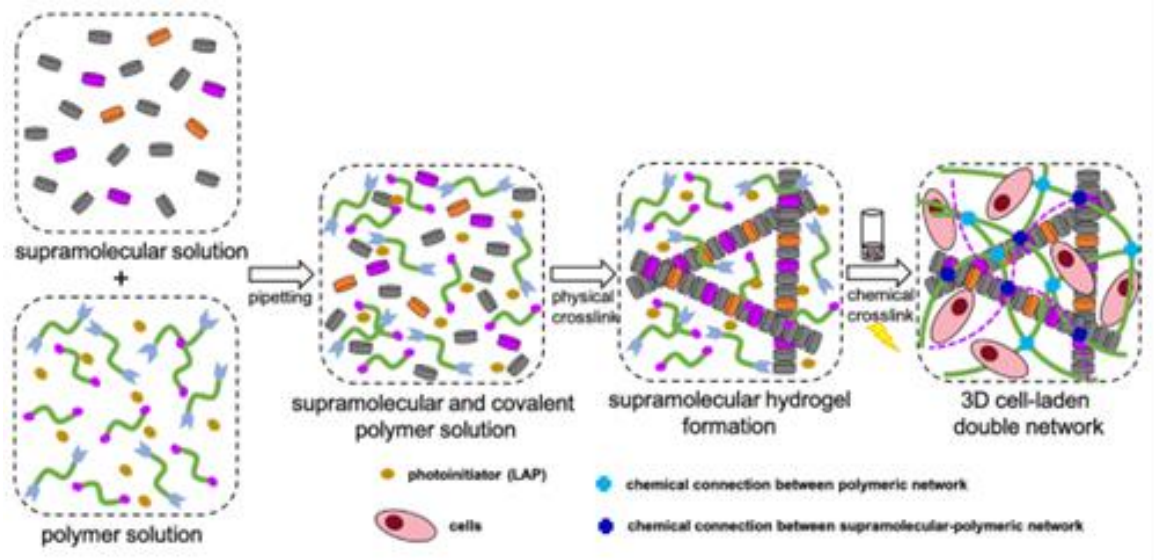

Figure 1. Squaramide based supramolecular monomers and PEG-based polymeric monomers are used in a one-pot preparation of 3D cell-laden double network hydrogels.

ABSTRACT 9

Characterizing the effect of hydrophilic/hydrophobic block ratio on the self-assembly of tapered BCP-BB in water

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Amphiphilic tapered bottlebrush block copolymers (BCP-BBs) are a class of molecules consisting of a linear polymer backbone grafted with two different types of side-chain polymers, one hydrophilic and the other hydrophobic, that exhibit a systematically increasing molecular weight, resulting in a cone-shaped macromolecule. Previous research in this area has suggested that the self-assembly of cone-shaped molecules holds promise for discovering new assembly motifs and potential new applications[1]. However, the ability to systematically explore the self-assembly of these molecules was limited by the lack of synthetic tools to precisely control cone size, shape, and surface chemistry.

Recently, Prof. Matson's lab developed a synthetic method for preparing amphiphilic tapered BB-BCPs[2,3] and synthesized a series of molecules that have the same linear polymer backbone (DP=150), but a different hydrophobic/hydrophilic ratio. Each block in the molecule is represented as X_z^{yk}, where X = type of side chain (S = PS, A = PAA), yk = side chain molecular weight (in kg/mol), and z = degree of polymerization.

Here we present the effect of the molecular structure of tapered BCP-BB (e.g., hydrophobic/hydrophilic ratio, cone angle) on their self-assembled nanostructures, characterized via Dynamic light scattering(DLS), cryogenic-transmission electron microscopy (cryo-TEM), and small-angle X-ray scattering (SAXS). Regardless of the same packing parameter, these molecules self-assemble into various nanostructures, such as spheres, cylinders, and bilayers.

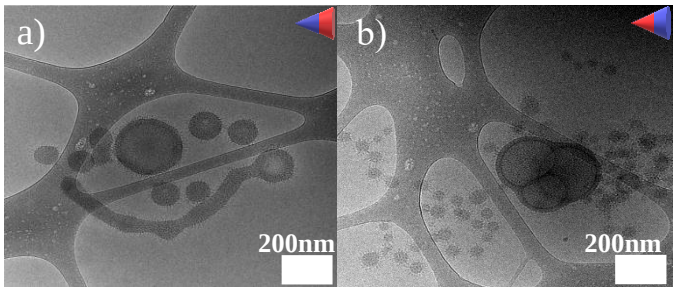

Figure 1. a) cryo-TEM images of 2 amphiphilic tapered BB-BCPs with opposite hydrophobic/hydrophilic ratio. a) $S_{30}^{1K}S_{30}^{2K}S_{30}^{3K}A_{30}^{4K}A_{30}^{5K}$ b) $A_{30}^{1K}A_{30}^{2K}A_{30}^{3K}S_{30}^{4K}S_{30}^{5K}$.

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ABSTRACT 10

Natural bioinspired adhesives for biomedical applications

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Adhesive biomaterials have been explored to surpass the current disadvantages of sutures and staples in surgery, corresponding to a market size valued at USD 1.8 billion in 2015. However, commonly used adhesive biomaterials are still cytotoxic and have proinflammatory potential, while others lack bulk strength and bioactive properties[1]. Mussel-inspired approaches aim at mimicking mussels' strong underwater adhesion through the introduction of catechol groups in the design of adhesive biomaterials. Tannic acid (TA) is a safe and low-cost source of catechol/pyrogallol groups. It allows polymeric crosslinking through hydrogen and ionic bonding, or hydrophobic interactions, improving biomaterials adhesiveness and mechanical performance, while endowing them with antimicrobial and antioxidant properties[2]. One bottleneck of the use of catechol groups is the production of reactive oxygen species (ROS) resultant from their autooxidation[3]. The latter are toxic for cells, hindering the clinical application of this adhesive family. Usually this is surpassed through metal ion coordination, enzymatic crosslinking[4], or self-polymerization upon oxidation[5]. Yet, frequently, these materials present low adhesive capacity and end up with no antimicrobial properties, an important feature for wound healing[6]. Herein, we report the production of a medical adhesive through the supramolecular combination of TA with pullulan, a natural-derived polysaccharide. For improved adhesive cohesion, methacrylated PUL (PUL-MA) was used to increase the hydrophobic interactions between TA and the polymeric fraction of the glue. In addition, a ROS-degrading enzyme – catalase - was introduced in the adhesive, enabling outstanding cytocompatibility, without compromising its antibacterial capacity. The newly proposed adhesives showed superior mechanical properties to the commercialized fibrin sealants and demonstrated safe haemostatic ability. Therefore, the present bioadhesive is promising to be implemented as a soft tissue bioadhesive.

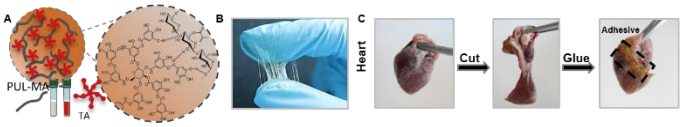

Figure 1. A) Schematic representation of the supramolecular interactions between TA and PUL-MA. B) Adhesive capacity of TAPUL-MA. B) TAPUL-MA ability to glue a cut rabbit heart.

Acknowledgments: Work developed under the project CICECO-Aveiro Institute of Materials (UIDB/50011/2020 & UIDP/50011/2020), financed by national funds through the FCT/MEC (PIDDAC), and within the scope of the project BLUEGLUE (FA_05_2017_031) financed by Fundo Azul Call – N.º 5/2017 and Direção-Geral de Política do Mar (DGMP) do Ministério Português do Mar. This work was also funded by the European Union's Horizon Europe research and innovation programme under the grant agreement No. 101079482 ("SUPRALIFE"). M.M.A.S, M.B.O. and J.M.M.R. gratefully acknowledge FCT for the PhD grant (2020.07156.BD) and individual researcher contracts (2021.03588.CEECIND and CEECIND/01363/2018), respectively.

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ABSTRACT 11

Molecularly-controlled biomaterials using host-guest guided peptide amphiphile self-assembly

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Peptide amphiphiles (PAs) represent a promising self-assembly platform to create biomaterials with structural and molecular precision for mimicking the extracellular matrix (ECM). We report on three different strategies involving non-covalent binding of PA-based supramolecular hydrogels. First, the adamantane (Ada)/β-cyclodextrin (βCD) host-guest system was explored when covalently attached to PA molecules. This resulted in PA self-assembled hydrogels with improved stiffness and resistance to degradation, while retaining excellent in vitro biocompatibility. (Figure 1, Strategy 1).

Second, this Ada/βCD system proved effective at anchoring RGDS cell adhesion signals onto self-assembled nanofibers in a non-covalent fashion. Thorough morphological and rheological characterisation is presented, as well as fibroblast attachment, organization, and spreading when cultured atop these scaffolds (Figure 1, Strategy 2). Third, the formation of a cucurbit[8]uril (CB[8])/aromatic amino-acid-bearing PA homoternary complex is reported. A novel PA hydrogelation mechanism is reported, which endowed hydrogels with hierarchical morphologies and increased stiffness when compared to their conventional ion-based equivalents (Figure 1, Strategy 3).

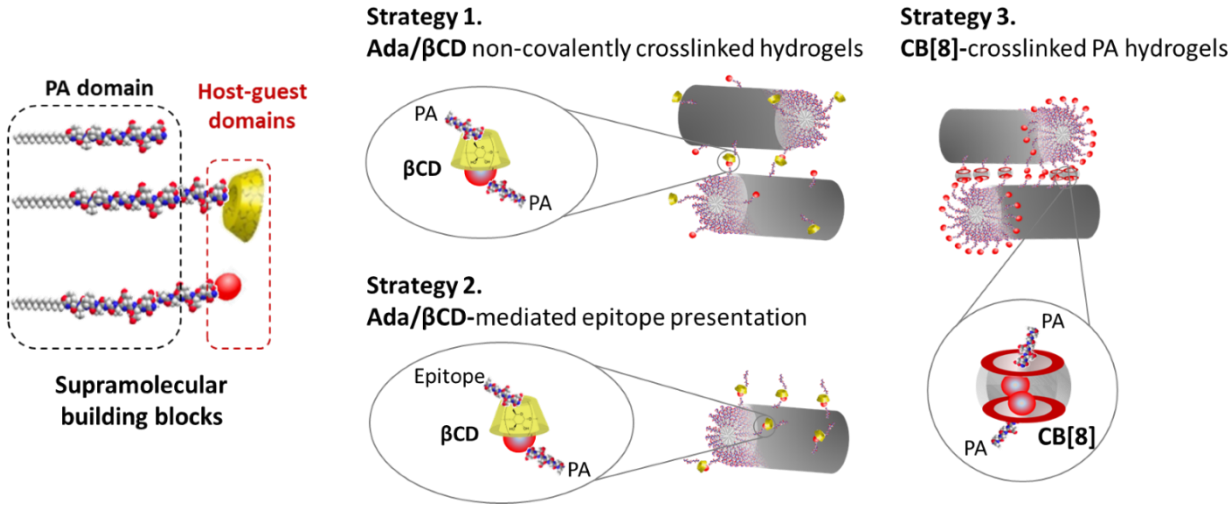

Figure 1. Three host-guest guided peptide amphiphile (PA) self-assembly strategies rendering precisely controlled supramolecular hydrogels are shown.

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ABSTRACT 12

Discovery of the relationship between biomaterial properties and cell physiology in implant related encapsulation

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Introduction: Previous in vitro results for fibroblasts indicated strong and specific cell binding to the ureido pyrimidinone (UPy-) functionalized bioactive materials containing UPy- peptides[1]. In this paper, we assess a cost-effective screening method to uncover their biological mechanism of action. Cell Painting morphological fingerprinting provides quantitative data and distinguishes similarities/differences among samples[2]. UPy polymer-induced shape-based cell profiles can be correlated with repositories of pharmaceutically relevant morphological fingerprints, e.g. Single Cell Databases of Cell Painting Profiles for the Cell Health Project used 59 CRISPR knockouts [3][4]. Materials and methods: A549 cells were seeded on dropcast films of supramolecular polymers based on oligocaprolactone telechelically modified with UPy units, containing 5 mol % of UPy-Lys, UPy-Arg, UPy-Trp additives. A549 cells on glass were exposed to a set of control small molecules NVS-PAK-1-1, FK-866, LY21097. Fixed cells were stained with Hoechst/DAPI (DNA); phalloidin (F-actin), wheat germ agglutinin WGA (Golgi system/plasma membrane, AGP), concavalin A (endoplasmic reticulum, ER), SYTO14 (nucleoli/cytoplasmic RNA) and/or MitoTrackerRed (mitochondria). 6 images/well analyzed with a custom CellProfiler pipeline. Morpheus platform used to generate fingerprints, similarity calculated using Euclidian distance. A small molecule perturbation experiment revealed an overlap between SYTO 14 and phalloidin dyes; SYTO 14 dye was removed. Hoechst and MitoTrackerRed bounded aspecifically to all polymers. A low concentration/low exposure time DAPI staining protocol was created for DNA staining. MitoTrackerRed was removed. Dropcasted UPy polymers exhibit low autofluorescence levels for DAPI, AGP and ER channels compare to glass at 150 ms exposure time. Results: Profound changes in cell morphology were found, induced by the small molecules perturbates (figure 1). Perturbant groups were clustered based on morphological fingerprints, where compound FK-866 showed one outlier, which was visually confirmed as having aberrant cell morphology. Conclusion: Fine-tuned protocol clusters morphological fingerprints from cells perturbed on glass with small molecules. Next phase: improved object segmentation for hundreds of distinct UPy-polymer images to extract fingerprints and compare to repositories[4] discovering molecular mechanisms of action in the context of fibrosis.

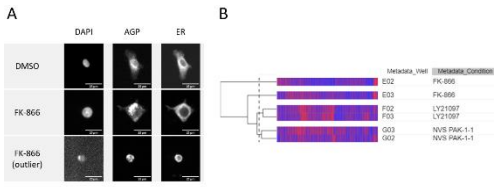

Figure 1. Cell Painting for morphological fingerprinting. (A) Staining of A549 cells perturbed with either DMSO or FK866. (B) Euclidian distance clustering of morphological fingerprints reveals perturbation groups and outliers.

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POSTER SESSION 2

ABSTRACTS

Poster Session 2 - 20th March | 16:00-17:00
Auditorium Renato Araújo – Central and Rectorate Building

13 **F. Sousa-Cardoso**
The impact of graphene composite surfaces on the development and architecture of marine Cyanobacterial biofilms

14 **D. Q. P. Reis**
Peptide-based coacervates as catalytic microreactors

15 **Y. Ren**
Resolving bioactive supramolecular structure formation in live cells by phasor-fluorescence lifetime imaging

16 **L. Rijns**
Synthetic supramolecular hydrogels to steer the polarity of intestinal organoids

17 **B. Moreira**
Electrochemical fabrication of chitosan-aniline molecularly-imprinted films towards C-reactive protein detection

18 **D. Mateus**
Functionalized PLGA-lipid hybrid nanoparticles for targeted drug delivery

19 **J. G. M Aarts**
A hybrid biomaterial screening platform

20 **J. R. Maia**
Engineering nanocomposite inks via interface interaction

21 **A. C. Roque**
Bioindicator to monitor environmental humidity inside packaging

22 **C. Esteves**
Designed ionic liquid-based soft materials for artificial olfaction

23 **A. P. Malafaia**
“Photo-clickable” bioinks – 3D printing intelligent gelling systems for biomedical applications

24 **A. R. Pinho**
Multifunctional and multi-compartmentalized gelatin-based incubator units for in vitro studies

25 **H. Edgar-Vilar**
Production of interconnected microporous gelatin hydrogels by aqueous two-phase enabled emulsion templating

Poster Session 2 - 20th March | 16:00-17:00

Auditorium Renato Araújo – Central and Rectorate Building

26 **J. Almeida-Pinto**

Supramolecular self-assembled bioactive colloidal gels as injectable multi-particle platforms

27 **V. Sousa**

Hyaluronic acid-functionalized G-quadruplex based perfusable hydrogels embedded in photocrosslinkable matrices for regenerative medicine

28 **L. Diana**

Aquatic Gastropoda mucus: an underexplored source of novel biocompounds

29 **J. Fetzer**

Self-assembly in living cells using furin-responsive depsipeptides

30 **J. P. F. Carvalho**

3D bioprinting of skin cells with alginate hydrogel-based composite bioinks for drug-delivery applications

31 **A. D. Das**

Alpha-helical peptide nanoreactors for single-molecule covalent chemistry

32 **N. S. Lameirinhas**

Nanofibrillated cellulose-based bioinks for 3D bioprinting applications

33 **H. Rouco**

Multicompartment environments with tuneable stiffness for 3D cell culture via multi-component self-assembly

34 **A. Venugopal**

Chemically Fueled Lipid Vesicles with Temporal Control

35 **D. Del Giudice**

Autonomous soft robots empowered by chemical reaction networks

36 **B. Pramanik**

Harnessing endogenous growth factors through peptide Amphiphiles towards the design of biocooperative materials

ABSTRACT 13

The Impact of Graphene Composite Surfaces on the Development and Architecture of Marine Cyanobacterial Biofilms

M. J. Romeu [1,2], L. C. Gomes [1,2], F. Sousa-Cardoso [1,2*], J. Morais [3], V. Vasconcelos [3,4], K. A. Whitehead [5], M. F. R. Pereira[2,6], O. S. G. P. Soares [2,6], F. J. Mergulhão [1,2]

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Biofouling is one of the most pressing challenges faced by the marine industry due to its economic and environmental implications, leading to a growing demand for effective antifouling coatings. In this study, the impact of pristine graphene nanoplatelets (GNP)/epoxy resin composites on the formation of cyanobacterial biofilms was analyzed using an in vitro platform capable of replicating realistic conditions found in marine environments. Surface characterization using Optical Profilometry and Scanning Electron Microscopy revealed that the main difference between the GNP/epoxy resin composite and the control surfaces (glass and bare epoxy resin) was in roughness and topography, with the GNP composite displaying a roughness value about 1000 times higher. Biofilm formation assays showed that, after 7 weeks, the cyanobacterial biofilms developed on the GNP composite showed reduced wet weight (44%), thickness (54%), biovolume (82%), and surface coverage (64%) compared to those formed on bare epoxy resin. Additionally, biofilm structure analysis revealed that the GNP-modified surface delayed the development of cyanobacterial biofilms, led to the formation of progressively less porous structures, and showed an increasing antifouling performance as the biofilms matured. Overall, this study contributed to a better understanding of the relationship between surface properties and the growth and structure of cyanobacterial biofilms over time. It also demonstrated the potential of this nanocomposite as a long-term antifouling solution for marine applications.

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ABSTRACT 14

Peptide-based coacervates as catalytic microreactors

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Enzymes' machinery has been hypothesized to be evolved from much simpler functional precursors such as peptides[1]. Peptides are well-implemented as chiral catalysts in organic reactions[2]. However, their use in aqueous reactions is still limited and remains a challenge in molecular engineering, arising from their conformational heterogeneity[3,4]. Cells organize their biochemical reactions in membraneless compartments, formed by liquid-liquid phase separation (LLPS) of intrinsically disordered proteins by specific peptide motifs or by their interaction with nucleic acids. Coacervates, also created by LLPS, are associated with the origin of life as primitive models of protocells[5], and provide mechanisms for shielding and concentrating oligomers from bulk solutions, thus facilitating processes such as catalytic function[5]. Therefore, the compartmentalization of catalytic peptides seems an exciting route to evolve catalytic function in modest peptides by also constraining their conformational flexibility often observed in bulky solutions[4]. In this work, we show the creation of dynamic micro-sized liquid condensates formed by a catalytic peptide, whose primary sequence is composed of phase-separating residues (Arg, Lys, Ser, Pro) and ability to hydrolyze phosphate ester compounds and bind to phosphotyrosine assemblies[6]. Turbidity measurements and optical microscopy revealed that the peptide could phase separate and form coacervates, however, a delicate balance between concentration and environmental conditions could also lead to peptide aggregates. Circular Dichroism and NMR revealed that the peptide presents a fully-folded β-hairpin structure only in the coacervate phase, and the LLPS driven by cation-π and aromatic interactions. The partitioning of the molecules showed to be controlled by charge interactions. Nevertheless, the hydrophobicity character of the catalytic peptides seems to play a role in mediating the partitioning process. Ultimately, these catalytic coacervates-based reactors' efficiency was studied. This work provides a substantial opportunity to leverage the field of catalytic peptides through compartmentalization in aqueous media.

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ABSTRACT 15

Resolving Bioactive Supramolecular Structure Formation in Live Cells by Phasor-Fluorescence Lifetime Imaging

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Supramolecular polymerization creates transient and life-defining functions in complex cellular systems but synthetically driven analogues has been held back by the lack of real-time correlation. Most synthetically assembled nanostructures in cells are studied when structure formation has reached equilibrium, creating a knowledge divide to the events initiated during the dynamic polymerization phase. Fourier transformed fluorescence lifetime fluctuations allow us to observe these molecular events on the fly, enabling the visualization of the monomers, intermediates, nanostructures and secondary cellular interactions on a 2-D phasor plot. We study the time-lapsed polymerization of amyloid-like naphthalene diimide peptides in MDA-MB 231 cells and show that the growth phase shuts ATP production. The cells then react to overcome the initial stress by mounting an increased respiratory capacity as structure formation nears equilibrium. By coupling simple and fit-free fluorescence lifetime responses to supramolecular chemistry, we reliably detail assembly dynamics and their biological effects with spatiotemporal resolution.

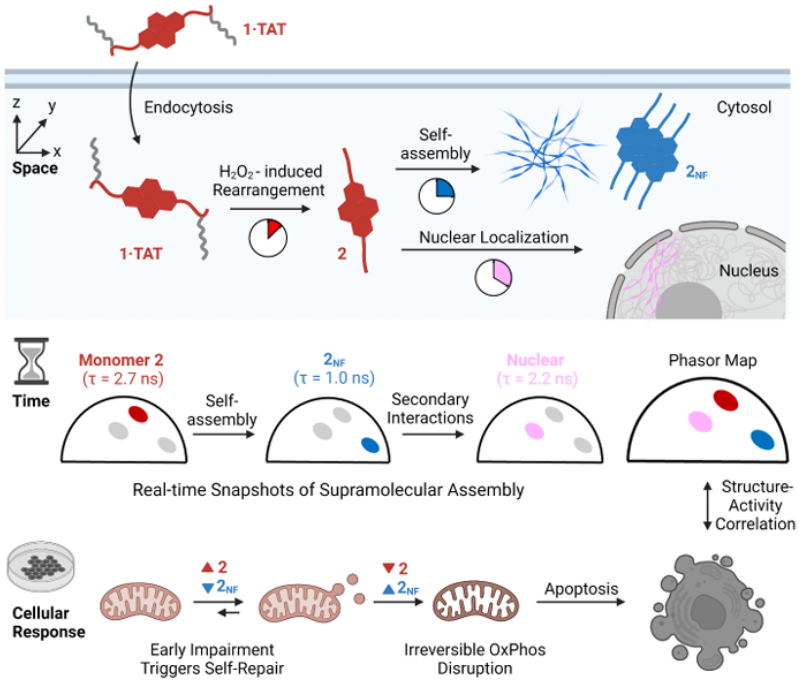

Figure 1. Schematic illustration of intracellular assembly mapping of NDI-peptide conjugates via fluorescence lifetime imaging. Pro-assembling conjugate 1·TAT (τf = 2.7 ns) entered cancer cells via TAT-mediated endocytosis and was converted to self-assembling monomer 2 in the cytosol, which propagates to nanofiber 2NF (τf = 1.0 ns) via self-assembly. Further interaction between 2NF and nucleus was observed (τf = 2.2 ns).

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ABSTRACT 16

Synthetic supramolecular hydrogels to steer the polarity of intestinal organoids

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Intestinal organoids cultured in Matrigel have a correct, apical-in polarity. However, when cultured in suspension, organoids with an inverted, apical-out polarity are formed. To elucidate the mechanisms underlying this epithelial polarity, we propose synthetic, dynamic supramolecular hydrogels based on the ureido-pyrimidinone (UPy) motif to culture these organoids. The hydrogels consist of 3 molecules: monofunctional (M UPy), bifunctional (B UPy) and bioactive, integrin-targeting UPys. Herein, the M UPys form one-dimensional fibers, while the B UPys crosslink the M UPys to create a network with orthogonally controllable mechanical, dynamical and bioactive properties[1]. Here, we investigate the influence of ligand type and hydrogel dynamicity on intestinal organoid polarity.To determine the effect of ligand type on organoid polarity, minimal synthetic sequences derived from the natural ligands fibronectin, collagen and laminin were included as ligands in the UPy gels as UPy-cRGD, UPy-GFOGER or UPy-IKVAV, respectively. Single stem cells were encapsulated inside the different UPy gels (G' ~ 1 kPa) and cultured for 5 days both in presence and absence of an integrin activating antibody (TS2/16). Different cellular structures were formed and classified according to their polarity (Figure 1A). Only in presence of both TS2/16 as well as the laminin-derived UPy-IKVAV, cells could grow into correctly polarized organoids (Figure 1B). Next, the influence of hydrogel dynamicity was investigated with UPy-IKVAV as ligand. Cells were encapsulated in the regular gels containing a ratio of M/B=80/1 (mol) vs. in more dynamic gels with a higher content of B UPy containing a long PEG 10 kDa chain, being M/B=9/1. Interestingly, a higher number of correctly polarized organoids is observed in the more dynamic M/B=9/1 gels (52%) than in the regular M/B=80/1 gels (27%) (Figure 1C). Taken together, we show ligand type and hydrogel dynamicity as influential factors in influencing intestinal organoid polarity.

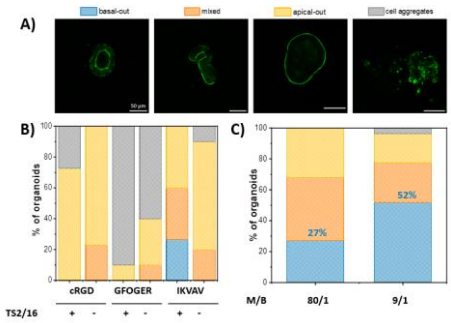

Figure 1. A) Fluorescent confocal images of intestinal organoids cultured for 5 days inside UPy hydrogels, classified according to polarity of the formed cellular structures. B,C) Quantification of the frequencies of the different cellular structures that were formed inside UPy hydrogels (G' ~ 1 kPa.) Green is F-actin, an apical marker. With in B) influence of ligand type on intestinal organoid polarity with UPy-cRGD, UPy-GFOGER or UPy-IKVAV as ligand, in presence and absence of TS2/16. In C) influence of hydrogel dynamicity on intestinal organoid polarity, with M/B=80/1 being the less dynamic gel and M/B=9/1 (mol) being the more dynamic gel. TS2/16 is present in both cases.

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ABSTRACT 17

Electrochemical fabrication of chitosan-aniline molecularly-imprinted films towards C-reactive protein detection

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Inflammation is an adaptive response that is mostly triggered by noxious stimuli and conditions, such as general infection and/ or tissue injury [1]. As a mechanism defense, the immune system activates an inflammatory response by releasing cells and cytokines to fight off these invaders, which can result in pain, redness, swelling, and bruising. Particularly, C-reactive protein (CRP) is a biomolecule produced by the liver in response to pro-inflammatory cytokines that are released during infectious and inflammatory processes [2]. In this context, the development of simple, cost-effective, and easy-to-use diagnostic tools for tracking inflammatory biomarkers can be highly valuable in point-of-care context.

This work aims to develop a highly sensitive electrochemical biosensor with the ability to track CRP. The biosensor is composed by a molecularly-imprinted polymer (MIP) as the biorecognition element, and the assembly occurs through electrochemical polymerization of a mixture of aniline and chitosan, in the presence of the target protein, CRP. Herein, the incorporation of chitosan in the monomer mixture greatly enhances the stability and reproducibility of the biosensor. The electropolymerization was performed using the bulk approach, which provides a simple, quick and one-step procedure to change and analyze different conditions. By varying and modifying parameters such as the scan-rate and the number of cycles during the electropolymerization, it is possible to model and tune the thickness and porosity of the obtained polymeric film. Following the electrochemical synthesis, CRP was removed from the polymeric network with acid-organic mixtures, leading to the successful formation of cavities that are complementary in shape and size to the target molecule. During the optimization of the biosensor assembly, the electrochemical performance was evaluated by means of electrochemical impedance spectroscopy (EIS). Under optimal conditions, the developed electrochemical biosensor showed high sensitivity towards CRP detection down to picoMolar level.

Acknowledgments: This work was financed by national funds from FCT - Fundação para a Ciência e a Tecnologia, I.P., in the scope of the project SmartBioPatch (EXPL/CTM-REF/1095/2021).

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ABSTRACT 18

Functionalized PLGA-lipid hybrid nanoparticles for targeted drug delivery

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Polymeric nanoparticles are today key materials in nanomedicine, especially for controlled drug and gene delivery. The main goals of developing these nanoparticles are to provide improved bioavailability, biodistribution, controlled release kinetics, protection from early degradation in vivo, increased circulation time and specific targeting, therefore reducing off-target-associated adverse events[1]. Despite the challenge of identifying markers expressed only in the target cells, different strategies have been proposed to incorporate targeting ligands into polymeric platforms to direct them specifically to the target. Taking advantage of the high affinity avidin-biotin interaction, various biotinylated ligands can be coupled to the polymeric particle by incorporating avidin into its surface[2]. Among emerging polymers in nanomedicine, poly(lactic-co-glycolic acid) (PLGA) has been widely investigated, due to its biodegradability, biocompatibility and tunable biophysical attributes[3]. Many manufacturing methodologies can be used to prepare PLGA-based nanoparticles and the chosen technique influences particle morphology, surface chemistries, entrapment efficiency and release kinetics[4]. Moreover, lipid-based surface engineering of PLGA can be used to tune drug encapsulation and release, while improving surface ligand display. In this work, an avidin-fatty acid conjugate was prepared and incorporated into PLGA nanoparticles that were further loaded with a hydrophilic molecule. The prolonged presentation of avidin over time is facilitated by the preferential association of the fatty acid with the hydrophobic PLGA matrix. The obtained nanoparticles were characterized in terms of morphology, size, surface charge, drug release kinetics and cytotoxicity. Because of its ease fabrication and flexibility, this supramolecular approach greatly benefits the modification of the PLGA-based nanoparticle surface for targeted drug delivery.

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ABSTRACT 19

A hybrid biomaterial screening platform

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Here, a biomaterial library was created, combining dynamic covalent and supramolecular moieties. Both types of chemistries allow for the introduction of structural and bioactive cues in a modular mix-and-match approach. Combinations of poly(tetrahydrofuran) terminated diamines (pTHF) and bifunctional salicylaldehyde derivatives were polymerized. Raman spectroscopy revealed polymerization by the disappearance of the aldehyde signal at 1651 cm-1 whereas a new signal appeared at 1629 cm-1, that belongs to the imine stretching vibrations (figure 1A). The supramolecular amine-functionalized ureido-pyrimidinone (UPy-amine) was added to 2A, ranging from 5 mol% to 40 mol%. Differential scanning calorimetry (DSC) showed that with the addition of UPy-amine, the polymers Tg increased, an indication of a higher cross-linking density, caused by the dimerization and stacking of the UPy moieties. Furthermore, an additional melting peak was observed with an increased enthalpy change at higher UPy-amine weight percentages, which was ascribed to the crystalline melt of the UPy moieties. Molar ratios of 5%, 20% and 33% of TREN were reacted with 2A to create a set of materials with increasing cross-linking density. DOSY NMR showed the incorporation of TREN into the polymer network by the decreased diffusion coefficient of the signals corresponding to TREN (figure 1E). DSC revealed the Tg's of the cross-linked polymers. As expected, an increase in the Tg was observed with a higher cross-linking density, also in comparison to the linear imine polymer without TREN.1 The DSC graphs showed a decrease in Tm when the cross-linking density is increased, as well as a decrease in enthalpy change. This was attributed to the lower weight percentage of A in the higher cross-linked networks. Finally, a small endotherm was observed for all cross-linked polymers between 85 °C and 89 °C, indicating a new crystalline domain has formed due to the cross-linking of the polymer chains.

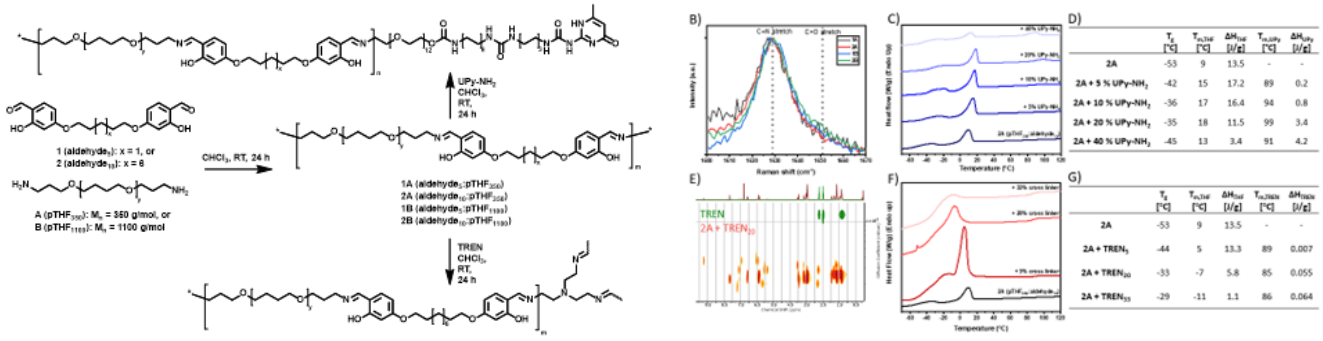

Figure 1. A) Synthesis scheme of dynamic covalent and supramolecular cross-linked networks. **B)** Raman spectra of linear polymers **C)** DSC graphs of supramolecular cross-linked networks. **D)** Table of DSC data of figure 1C. **E)** DOSY NMR of dynamic covalent cross-linked networks. **F)** DSC graphs of dynamic covalent cross-linked networks. **G)** Table of DSC data figure 1F.

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ABSTRACT 20

Engineering Nanocomposite Inks Via Interface Interaction

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Nanocomposites and low-viscous materials lack translation in additive manufacturing technologies due to deficiency in rheological requirements and heterogeneity of their preparation. This work proposes the chemical crosslinking between composing phases as a universal approach for mitigating such issues. The model system is composed of amine-functionalized bioactive glass nanoparticles (BGNP) and light-responsive methacrylated bovine serum albumin (BSAMA) which further allows post-print photocrosslinking. The interfacial interaction was conducted by 1-Ethyl-3-(3-dimethylaminopropyl)carbodiimide crosslinking agent and N-Hydroxysuccinimide between BGNP-grafted amines and BSAMA's carboxylic groups. Different chemical crosslinking amounts and percentages of BGNP in the nanocomposites were tested. The improved interface interactions increased the elastic and viscous modulus of all formulations. More pronounced increases were found with the highest crosslinking agent amounts (4 % w/v) and BGNP concentrations (10 % w/w). All composite formulations could effectively immobilize the BGNP and turn a low viscous material into an appropriate ink for 3d printing technologies, attesting for the systems' tunability. Further, the developed nanocomposites gain improved cytocompatibility and bioactivity, confirmed with hASCs 14-day metabolic activity assay and live/dead imaging showing higher cell activity and spreading in the nanocomposites. Thus, we describe a versatile methodology which can successfully render tunable and light-responsive nanocomposite inks with homogeneously distributed bioactive fillers.

Figure 1. Graphical abstract showcasing the developed system's crosslinking strategies and composition.

Acknowledgments: This work was developed within the scope of the project CICECO-Aveiro Institute of Materials, UIDB/50011/2020, UIDP/50011/2020 & LA/P/0006/2020, financed by national funds through the FCT/MCTES (PIDDAC). This work was also funded by the European Union's Horizon 2020 and Horizon Europe research and innovation programmes under the grant agreement No. 953169 ("InterLynk") and 101079482 ("SUPRALIFE"), respectively.

ABSTRACT 21

Bioindicator to monitor environmental humidity inside packaging

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Most drugs are moisture sensitive. Humidity compromises drugs efficacy before reaching their shelf life, which can cause medication error due to altered dose, misleading results or change the appearance of the drug. There is a need to monitor humidity in packaging, especially in medicines and nutraceutics. Nowadays, desiccants are placed inside pill bottles to protect drugs from humidity. However, desiccants lose their properties after reaching a certain level of water adsorbed. Thus, it is relevant to monitor the desiccant humidity level inside the packaging to determine when the desiccant is saturated. In this work, we designed a bio-based multilayer material that changes its optical properties as a function of humidity. This bioindicator can produce a visible optical signal in the presence of humidity saturated environments. The signal obtained is easy to view by the user and does not require an electronic equipment to produce the signal. The bioindicator components are widely available, inexpensive and pharma grade. The bioindicator presents low toxicity, is totally biodegradable and sustainable. The results showed that the bioindicator changes colour when the desiccant reaches about 20% of the initial weight, which means that when the desiccant is 20% saturated the bioindicator starts give an alert. The response of the bioindicator is dependent on the humidity percentage that it is exposed to. In an environment with 80% of relative humidity it takes 3 days to change the colour of the bioindicator, while in an environment of 60-70% of relative humidity it takes between 7 to 11 days.

Acknowledgements: The work was developed within the scope of the "SMASUS - Smart and Sustainable Packaging" project (POCI-01-0247-FEDER-047007; LISBOA-01-0247-FEDER-047007), which was co-financed by Portugal 2020, under the Operational Program for Competitiveness and Internationalization (COMPETE 2020) through the European Regional Development Fund (ERDF). The authors also thank support from FCT - Fundação para a Ciência e a Tecnologia, I.P., through projects UIDP/04378/2020 and UIDB/04378/2020 of the Research Unit on Applied Molecular Biosciences - UCIBIO and the project LA/P/0140/2020 of the Associate Laboratory Institute for Health and Bioeconomy - i4HB, as well as project PTDC/CTM-CTM/3389/2021.

ABSTRACT 22

Designed ionic liquid-based soft materials for artificial olfaction

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Artificial olfaction is an emerging field with the capability of probing odors and volatile organic compounds (VOCs) in a fast and non-invasive manner. Artificial olfaction mimics the sense of olfaction using electronic noses, devices that combine arrays of semi-selective gas-sensitive materials with machine learning and automatic classification tools. Supramolecular self-assembly provides the possibility to generate modular and tunable materials with self-powered stimuli-responsive properties. Ionic liquid-based soft materials, or ionogels present non-volatility, high ionic conductivity and thermal, chemical and electrochemical stability. The molecular self-assembly mechanisms of bio-based molecules in ionic liquids are complex and still poorly understood, as ionic liquids themselves present self-assembling properties. The versatility of the ionic liquids can be matched to the properties of the gelator molecules, leading to rationally designed structured materials[1]. Furthermore, ionogels can incorporate liquid crystal compartments, resulting in hybrid gels with electrical and optical responses to VOCs. In this work, ionogels and hybrid gels are studied as gas sensing materials in dry and humid environments in a custom-built optical signal transducer[1]. Furthermore, hybrid gels' signals obtained upon VOC exposure were used to implement a dedicated automatic classifier based on support vector machines to identify 12 VOCs from different chemical classes[2]. Alternatively, the optical textures created by the liquid crystal component of hybrid gels upon VOC exposure can be video-recorded and used as a VOC fingerprint. In this case, deep convolutional neural networks (CNN) were employed as pattern recognition systems to analyse the optical textures and generate automatic VOC classifiers[3].We show also that the developed device can be used in the quantification of ethanol in automotive fuel[4] or in fish spoilage monitoring[5]. The versatility shown by the developed opto-electronic gas sensing soft bio-based materials opens a wide range of applications within biological, medical and industrial fields.

Acknowledgments: This work was supported by funding from the European Research Council (ERC) under the EU Horizon 2020 research and innovation programme (grant agreement No. SCENT-ERC-2014-STG-639123, 2015–2022 and grant agreement No. 101069405 — ENSURE — ERC-2022-POC1) and also by national funds from Fundação para a Ciência e a Tecnologia, I.P. (FCT), in the scope of the project UIDP/04378/2020 and UIDB/04378/2020 of the Research Unit on Applied Molecular Biosciences – UCIBIO and the project LA/P/0140/2020 of the Associate Laboratory Institute for Health and Bioeconomy – i4HB.

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ABSTRACT 23

"Photo-clickable" bioinks – 3D printing intelligent gelling systems for biomedical applications

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Nowadays, great efforts are focused on reproducing biomimetic and heterogenous tissue analogues due the lack of appropriate biomaterials and technologies that can accurately reproduce tissue architecture and functionality[1]. However, recently developed bottom-up three-dimensional (3D) bioprinting techniques have been able to overcome some of these challenges, with the development of structures that can precisely mimic cellular placement and extracellular milieu[2]. Moreover, it is an enabling technology for personalized medicine, since it can be tailored to the demands of individual patients for specific tissue defects. When selecting a bioink material, it is important to consider the specific bioprinting method, the type of cells, the final application, as well as the target tissue. Hydrogels are ideal materials to be employed as bioinks, since they are tunable and consist of water absorbent polymer networks, providing excellent environments for cell adhesion, growth, spread, and differentiation[3]. They can be composed of natural or synthetic polymers; however, natural polymers can be more advantageous due to their inherent biodegradability, cytocompatibility and resemblance with human extracellular matrix. Among the gelation methods, thiol-ene click chemistry is a novel and promising photocrosslinking technique[4]. It is typically cell-friendly, very fast, has high yields, and takes place under mild conditions. Herein, we propose the development of photoclickable hydrogel-based bioinks for 3D extrusion bioprinting, based on the conjugation of modified natural polymers, namely polysaccharides (hyaluronic acid) and proteins, using thiol-ene click chemistry. The resulting materials are expected to demonstrate improved mechanical and biological properties. Finally, we envision to implement the bioinks as therapeutic biomaterials for personalized medicine.

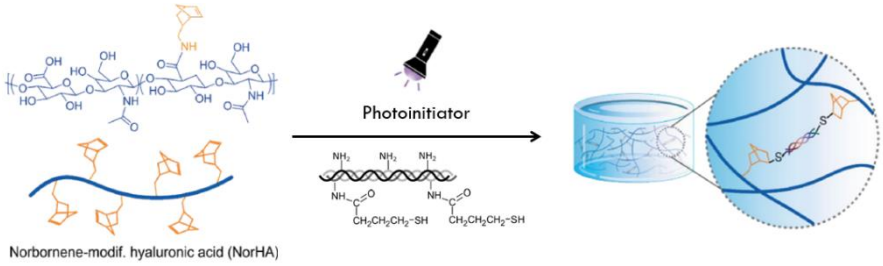

Figure 1. Schematic representation of norbornene functionalized hyaluronic acid (NorHA) and proteins to produce a "photo-clickable" bioink.

Acknowledgments: Work developed under the project CICECO – Aveiro Institute of Materials (UIDB/50011/2020, UIDP/50011/2020 and LA/P/0006/2020), financed by national funds through the FCT/MEC (PIDDAC). This work was also funded by European Union's Horizon 2020 and Horizon Europe research and innovation programmes under the grant agreements No. 953169I (NTERLYNK) and No. 101079482 (SUPRALIFE). J.M.M.R. gratefully acknowledge FCT for the individual researcher contract (CEECIND/01363/2018).

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ABSTRACT 24

Multifunctional and multi-compartmentalized gelatin-based incubator units for in vitro studies

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Standardizing 3D in vitro study models requires combining a versatile, low-cost, scalable, and easy-to-translate platform for every tissue and study. In this context, a designed gelatin-based liquid capsule [1] was investigated as an incubator unit for the establishment of an in vitro multifunctional model. These liquid capsules, which are made by combining catechol analogue-modified gelatin (Hydroxypyridinone-HOPO) with iron, have biocompatible and self-healing properties that are valuable for cellular studies. Self-healing capsules provide the development of an in vitro system capable of enabling the injection of living and non-living microsystems without compromising the capsule' structure. In this sense, gelatin-HOPO capsules were optimized to obtain a robust structure capable of being injected multiple times with diverse microstructures, validating the self-healing capability. The capacity to inject any microstructures at different times inside this semi-confined environment is critical for the creation of hierarchical cellular/structural co-culture systems that can get us closer to understanding the complexity of tissues.

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ABSTRACT 25

Production of Interconnected Microporous Gelatin Hydrogels by Aqueous Two-phase Enabled Emulsion Templating

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Generally, hydrogels consist of a nanoporous hydrophilic polymer network that limits cell motility, cell-cell interactions and the diffusion of nutrients, oxygen, and waste, thus limiting their potential in tissue engineering applications. To mitigate these issues there has been an increased interest on interconnected microporous hydrogels. Such scaffolds provide improved nutrient diffusion, allow proper cellular motility, promoting cell spreading, proliferation, cell-cell interactions and allow for tissue ingrowth into the implanted hydrogels [1,2]. The production of these hydrogels however often requires the use of cytotoxic porogens, leaching agents that are not citocompatible. Emulsion templating is a simple and highly versatile alternative technique for manufacturing interconnected microporous hydrogels. This approach is based on the mixing of a pre-gel with an immiscible liquid porogen to form an emulsion where the porogen phase is volumetrically suspended throughout the pre-gel. Originally the porogen phases used were toxic organic solvents such as toluene or chloroform, but recently aqueous two-phase systems (ATPSs), have been replacing organic porogens as they are significantly more environmentally sustainable and mild, allowing for cells to be included in the pre-gel solution and further simplifying the construction of the scaffold [1-3]. ATPSs are based on the mixing of solutions containing hydrophilic polymers whose supramolecular interactions makes their mixing thermodynamically unfavorable, forming instead separate phases [1,2]. Herein we explored, ATPS-enabled emulsion templating to produce porous Gelatin-methacrylate (GelMA) hydrogels through the use of Poly(ethylene oxide) (PEO) and dextran based porogens. Different volumetric fractions ranging from 10 to 50% were investigated. The obtained hydrogel constructs exhibit different microarchitectures and interconnected pores with sizes ranging from 10 to 50 µm. Overall, the PEO/dextran porogens were successfully leveraged to produce GelMA hydrogels with intrinsic cell adherent features that are to be further explored for tissue engineering and disease modelling applications in the foreseeable future.

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ABSTRACT 26

Supramolecular Self-Assembled Bioactive Colloidal Gels as Injectable Multi-Particle Platforms

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Comprised by nanosized building blocks capable of self-organizing into hierarchically complex supraparticle 3D networks, colloidal gels constitute a highly attractive platform for biomedical applications[1]. Leveraging on intrinsic supramolecular mechanisms (e.g., Van der Waals forces, magnetic interactions, and electrostatic forces), these versatile platforms present attractive physicochemical properties, including self-healing, multimodal degradation, viscoelasticity or shear-thinning, that can be useful for potentiating advanced tissue engineering applications[2,3]. Moreover, due to their superior drug delivery properties, including higher cargo load capacity, prolonged lifespan, and focalized delivery, colloidal gels constitute an attractive drug delivery system capable of overcoming the concerns regarding the rapid clearing of freely administrated nanotherapeutics[1]. Herein, colloidal gels were generated via supramolecular, electrostatically-driven self-assembly of oppositely charged nanoparticles of poly(D,L-lactide-co-glycolide)-polyethylenimine (PLGA-PEI) and zein-hyaluronan (zein-HA). The resulting colloidal gels were exploited as versatile bioactive 3D platforms for focalized and autonomous release of bioactive Quercetin flavonoids to bioinstruct processes in macrophages. Overall, the generated fully nanostructured gels revealed autonomous multiparticle shedding, providing a focalized and efficient delivery of bioinstructive cues, capable of reducing key proinflammatory biomarkers (nitrite) in pro-inflammatory macrophages.

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ABSTRACT 27

Hyaluronic acid-functionalized G-quadruplex based perfusable hydrogels embedded in photocrosslinkable matrices for regenerative medicine

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DNA is not only one of the most intriguing macromolecules in nature but also an unprecedented building block to precisely assemble sophisticated supramolecular bionanostructures. Among them are the G-quadruplex which are noncanonical four-stranded structures that are formed in guanine-rich DNA sequences and serve multiple biological functions.[1-3]. Herein, a novel dynamic hyaluronic acid (HA)-functionalized G-quadruplex hydrogel with self-healing, thermo-reversible, injectable and conductive properties was developed at physiological pH via hydrogen-bonding and π-π interactions between guanosines coupled via dynamic boronate ester bonds to the 3-aminophenylboronic acid functionalized HA and stabilized by K^+ ions, as demonstrated by a combined experimental-computational study. The well-known instability of the G-quadruplex structures was used to produce interconnected, size and shape tunable perfusable hollow microchannels embedded in virtually any kind of photocrosslinkable supporting matrices. The microchannel-embedded 3D constructs showcased a higher number of viable cells than the 3D bulk constructs. Moreover, the cells migrated toward the perfusable microchannels, holding great promise for being use as artificial vessels for enabling the diffusion of nutrients and oxygen essential for cell survival. The versatility imparted by the proposed approach opens new avenues in drug delivery, tissue engineering and regenerative medicine.

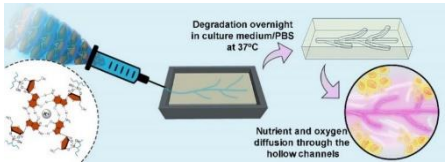

Figure 1. Schematic representation of bioengineered perfusable 3D constructs obtained by the supramolecular self-assembly of HA-functionalized G-quadruplex hydrogels as sacrificial materials.

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ABSTRACT 28

Aquatic Gastropoda mucus: an underexplored source of novel biocompounds

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Gastropoda is a class of the phylum Mollusca that makes up most of the animals found in this phylum. It is a very versatile class that inhabits two contrasting habitats on Earth: terrestrial and aquatic[1]. These animals are covered with a sticky substance called mucus[2]. The composition of this substance and its biological function differ from species to species. In gastropoda, the mucus has several important functions: reproduction, locomotion, nutrition, regeneration and defence of the animal[3]. It consists largely of water and, to a lesser extent, of compounds of bioactive proteins, sugars, collagen, elastin and other substances[4]. These compounds have great utility and applicability in the fields of scientific research and human health. These applications are already known, and some are already being used. It presents a promising potential in several areas of biomedical interest, such as: antioxidant, antimicrobial and antitumour activities[5-6]. This work highlights the functions of mucus in the pharmaceutical and medical fields, with some examples of its clinical use. Application of mucus samples with biomaterials already for human health is discussed and how this mixture can aid the drug delivery.

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ABSTRACT 29

Self-Assembly in Living Cells using Furin-Responsive Depsipeptides

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The formation of self-assembled structures can be observed in almost every biological process and is therefore fundamental for cellular life. By mimicking such processes, synthetic supramolecular structures can be built within the cell with a major focus on controlling the complex dynamics of self assembly[1]. This can be realized by incorporating stimulusresponsive structural elements into the molecular design of an assembly precursor[2,3] – Figure 1. Specific biological or chemical components or processes within the cellular environment can trigger the transformation of the precursor molecule into an active monomer capable of self-assembly. Herein, we developed a new system for enzyme-induced intracellular self-assembly to achieve the stimulusresponsive formation of nanostructures inside cancer cells. For this purpose, a peptide sequence that is cleavable by the enzyme furin was incorporated into the molecular design of a nonassembling precursor. We analyzed the enzyme-induced self-assembly of furin-responsive peptides to study their bioresponsiveness and the kinetics of the enzyme-triggered reaction cascade, as well as the supramolecular properties of the resulting self-assembling monomers. Additionally, cell studies with furin-overexpressing breast cancer cells were carried out showcasing the efficient in vitro conversion of the precursor and the formation of intricate intracellular nanostructures. These artificial structures were shown to exhibit low cytotoxicity making them highly interesting for various applications in synthetic biology and nanomedicine.

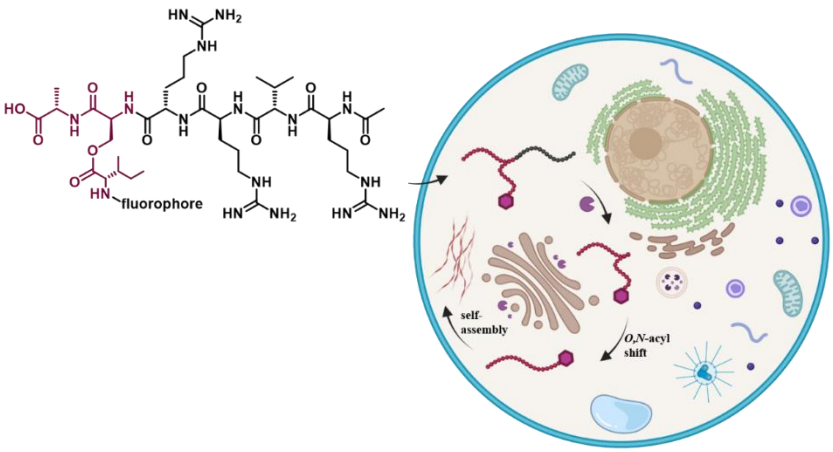

Figure 1. Multistep reaction cascade of furin-responsive depsipeptides for intracellular self assembly.

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ABSTRACT 30

3D bioprinting of skin cells with alginate hydrogel-based composite bioinks for drug-delivery applications

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The biofabrication of tissue analogs via 3D bioprinting using cell-laden biomaterials (bioinks) is an area of great versatility, with unlimited potential for biomedical applications[1,2]. In this work, alginate hydrogels were combined with curcumin-loaded cellulose based particles and laden with HaCaT keratinocyte cells to produce new composite bioinks, envisioning the fabrication of living 3D structures with drug-delivery abilities that may be used for skin tissue regeneration (e.g., wound healing). The cellulose based particles, with sizes of 740 ± 147 nm, reveal no cytotoxicity against HaCaT cells, while increasing the rheological properties (viz. shear viscosity and shear stress) and preserving the original mechanical and viscoelastic properties of the alginate hydrogels. Furthermore, the incorporation of the drug-loaded particles in the alginate formulations reduces the degradation rate of the fully crosslinked hydrogels in cell culture medium after 3 days. The 3D printed constructs obtained using these composite inks show increased printing definition (Pr = 0.9) when compared with the pristine alginate hydrogels (Pr = 0.8), and have the ability to release curcumin, with a maximum 70% cumulative release in phosphate buffered saline (PBS, pH 7.4) after 24 h.

The 3D bioprinting of the corresponding HaCaT-laden bioinks (1.2×106 cells mL-1) results in living constructs with high cell viability (nearly 90%, up to 7 days after bioprinting), which confirms the potential of this approach for the development of drug-releasing living constructs for wound-healing applications.

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ABSTRACT 31

Alpha-helical peptide nanoreactors for single-molecule covalent chemistry

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The significant progress made in membrane protein engineering has enabled the redesign of protein nanopores for specific applications in biotechnology[1]. While several advances have been made with ß-barrel pores, there has been increasing interest in developing transmembrane pores based on α-helices[2]. Chemically synthesized peptides that self-assemble to form membrane-spanning alpha-helical barrels provide a promising platform for the development of synthetic nanopores with desired functional properties [3]. In addition to functioning as detectors for stochastic sensing, variation in ionic current through a nanopore can be used to examine chemical reactions occurring within the pore at the single-molecule level[4]. In our study, we introduce an alpha-helical transmembrane pore as a nanoreactor to examine site-specific chemical modification via single-molecule electrophysiology. The results of targeted covalent modification were further applied to determine the orientation of the synthetic peptide pores in lipid bilayers.

We built a synthetic analogue of porin PorACj comprising two cysteine mutations at the 24th and 40th position by solid phase peptide synthesis. The peptides spontaneously self-assemble to form large, well-defined, cation selective pores in lipid membranes. Site-specific chemical modification of the cysteine groups upon the addition of activated thiol reagents results in high amplitude current blockages that are reversed upon cleavage of the disulphide bonds by dithiothreitol. Asymmetric current blockages were observed upon cis-side and trans-side addition, providing evidence for the preferred pore orientation in the lipid membrane. The reported system provides a platform for the development of alpha-helical barrels as nanoreactors that can be built from short, synthetic peptides. The facile chemical synthesis is also promising for the introduction of additional side chains which are difficult to incorporate in biological nanopores, thus expanding the range of single-molecule covalent chemistry that can be investigated.

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ABSTRACT 32

Nanofibrillated cellulose-based bioinks for 3D bioprinting applications

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Three-dimensional (3D) bioprinting is promoting significant advances in many fields, including diseases research and drugs investigation, among others[1]. This technique consists on the deposition of bioinks (biomaterials and cells) in a previously defined pattern following a layer-by-layer approach. Many polymeric materials (synthetic and natural) can be used for the development of the bioink formulations[2]. Yet, most biopolymeric materials, such as hydrogels, lack long-term mechanical properties. One way to overcome this limitation is to develop nanocomposite hydrogel-based bioinks using reinforcing agents such as nanofibrillated cellulose (NFC)[3]. Herein, NFC was combined with different biopolymers, viz. gellan gum (GG) [4] or gelatin (Gel) to produce hydrogel-based bioinks with improved mechanical and rheological properties. Both hydrogel-based inks were characterized in terms of their rheological behavior, and the fully crosslinked hydrogels were evaluated regarding their rheological and mechanical properties, as well as their stability in two different media (Dulbecco's Modified Eagle's Medium (DMEM) and Phosphate Buffer Saline (PBS)), morphology, and cytotoxicity towards HaCaT (for NFC/GG) and HEPG2 (for Gel/NFC) cell lines. The obtained results showed that NFC improved the rheological and mechanical properties of these hydrogel-based inks. It was also observed an increase of the stability of the fully crosslinked hydrogels in DMEM and PBS promoted by the NFC. Also, a non-cytotoxic effect of the fully crosslinked hydrogels towards the chosen cell lines was detected. Furthermore, bioprinting the cell-laden hydrogels was not harmful to the different cells since their viability was considerably high throughout the evaluated days (up to 7 days). The obtained results highlight that the combination of NFC with GG or Gel is a promising strategy for developing novel hydrogel-based bioinks for 3D bioprinting purposes.

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ABSTRACT 33

Multicompartment environments with tuneable stiffness for 3D cell culture via multi-component self-assembly

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Multicomponent self-assembly constitutes a powerful tool to develop complex and hierarchically structured hydrogels [1]. Here, we report on the use of peptide amphiphiles (PAs) to electrostatically interact and co-assemble with either platelet lysate (PL) (a source of multiple proteins and growth factors), photo-crosslinkable PL (synthetized via PL-methacrylic anhydride reaction)[2]; or gelatin-HOPO (modified with hydroxypyridinone (HOPO) moieties, a catechol analogue with oxidant-resistant properties)[3]. These platforms were used to develop three different single or multi-compartment hydrogel-based environments for complex 3D cell culture.

PA-PL hydrogels consisted of a single co-assembled compartment integrating PA and human PL. PA-Photo-PL hydrogels consisted of two different compartments including a co-assembled PA-Photo-PL core and a solid Photo-PL shell. Finally, PA-Gel-HOPO hydrogels consisted of a co-assembled PA-Gel-HOPO core and a solid Gel-HOPO shell, having some liquid non-coordinated gelatin in between. All platforms were obtained through co-assembly, alone or in combination with ultraviolet (UV) crosslinking or chemical coordination, in order to generate gels with single or multiple compartments.

First, co-assembling PA-PL hydrogels resulted in soft homogenous matrices displaying good biocompatibility, as evidenced by the spreading of mesenchymal stem cells (MSCs) throughout the 3D single-compartment matrix. Second, multi-compartment PA-Photo-PL platforms, displaying a higher stiffness in the core, were obtained by co-assembly followed by UV crosslinking, resulting in biocompatible hydrogels, able to maintain MSCs viability from their initial inclusion in the Photo-PL, prior to the co-assembly, to the obtention of the final matrices after the UV treatment. Finally, multi-compartment PA-Gel-HOPO hydrogels were prepared by co-assembly followed by Gel-HOPO coordination with iron, resulting in a biocompatible matrix able to support MSCs growth, after their inclusion either in the PA or in the Gel-HOPO solutions, prior to the co-assembly process. In the first scenario, cells were found to remain in the stiff self-assembled core, while in the second one, they seem to adhere to the outer Gel-HOPO shell due to the fluid nature of the non-coordinated gelatin at 37ºC.

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ABSTRACT 34

Chemically Fueled Lipid Vesicles with Temporal Control

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Living systems exhibit the art of forming dynamic self-assembled structures on demand by maintaining processes out-of-equilibrium (OOE), through the consumption of chemical fuel. Inspired by nature's outstanding control, a drive towards the development of synthetic out-of-equilibrium systems has emerged [1]. This has resulted in various excellent chemical fuel-driven assemblies with transient formation/breakdown of nanostructures[2-4]. However, fuel-driven self-assembly of lipid molecules into vesicles remains largely unexplored. Here we present the self-assembly of synthetic lipid molecules and the regulation of their lifetime. We have designed a hydrophilic phospholipid mimic with terminal aldehyde which in presence of an amino ester fuel can convert to an imine. These imines having a lipid-like amphiphilic structure eventually leads to the formation of lipid vesicles through self-assembly. Moreover, the hydrolysis of amino ester results in the disassembly of vesicles, therefore requiring a constant supply of fuel to sustain the vesicles. We, therefore, have successfully designed and developed lipid vesicles that can only be maintained by a constant fuel supply and can quickly adapt their configuration in the presence of an external stimulus.

Acknowledgments: This research is supported by "la Caixa" Foundation (ID 100010434) and the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No. 847648 (LCF/BQ/PI21/11830035). We also acknowledge the Proyectos de Generación de Conocimiento 2021 grant from the Spanish Ministry of Science and Innovation (PID2021-126244NA-I00).

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ABSTRACT 35

Autonomous soft robots empowered by chemical reaction networks

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Activated carboxylic acids are acids able to undergo base catalyzed decarboxylation under mild conditions. These acids have been used so far as chemical fuels to control in a dissipative fashion the operation of several pH responsive supramolecular systems, such as molecular machines, DNA nanodevices, and host-guest systems, allowing to finely tune their properties over time[1]. In this work, we translated such programmability from the molecular level to the macroscopic one. This has been achieved by coupling fueltriggered transient pH variations to the operation of hydrogel based soft robots[2]. We designed hydrogel actuators able to (de)swell in response to pH change, exploiting the chemical energy provided by an activated carboxylic acid to perform mechanical motions – Figure 1. Bilayer actuators able to perform autonomous operation under fueled conditions were developed, showing how the magnitude of their bending can be controlled by employing different fuel amounts. The unique benefits of this system were demonstrated by designing devices capable of fire and forget operation, or actuators featuring more sophisticated self-regulation behaviour by means of chemomechanical feedback, exploiting a mechanically-activated compartmentalized urea/urease reaction.

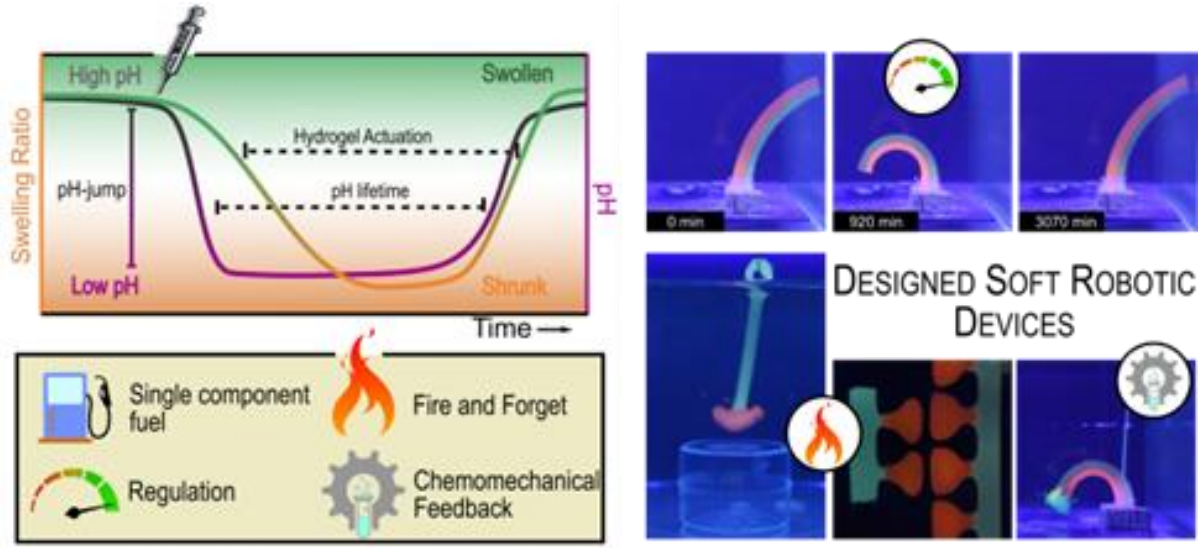

Figure 1. Transient control of solution pH exploited to achieve autonomous operation of several pHresponsive soft robotic devices. Such system is based on a single component fuel and can be exploited to easily regulate both the duration and the amplitude of hydrogel's actuation. Devices able to operate in a fire and forget mode were designed, as well as actuators capable of self-regulation through chemomechanical feedback.

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ABSTRACT 36

Harnessing Endogenous Growth Factors Through Peptide Amphiphiles Towards the Design of Biocooperative Materials

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Growth factors (GFs) are the most vital morphogenetic proteins, naturally secreted from cells to direct cell behaviors and guide tissue repair and renewal[1]. However, the use of GFs in clinical therapies remains a significant challenge due to their poor stability, low recombinant expression yield, suboptimal efficacy, cost, and potential adverse side effects. To address this, we report on peptide amphiphiles (PAs) designed to harness intrinsic biological processes such as the production of GFs[2] to assemble into "biocooperative materials" capable of harnessing endogenous molecules as building-blocks.

Here, we designed and synthesized two PA molecules using different solid phase peptide synthesis (SPPS) techniques to generate PA biomaterials containing the transforming growth factor β1 (TGF-β1) binding domain HSNGLPL.The synthesized PAs have the same amino acid sequence but differed in the presentation of the HSNGLPL peptide, with one displaying it in the C-terminus and the other in the N-terminus. We hypothesized that the presence of HSNGLPL peptide would enhance the concentration of endogenous TGF-β1, and these two PAs would display different binding affinity towards TGF-β1.

Spectroscopic and microscopic techniques were used to characterize PA self-assembly and the PA-TGF-β1 interactions. The results demonstrated that the epitopes' position affected the GF binding affinity. Circular dichroism, Fourier-transform infrared spectroscopy, dynamic light scattering, zeta potential, isothermal titration calorimetry, and surface-enhanced Raman spectroscopy were also used to investigate PA-TGF-β1 interactions in more detail. We envision the use of these PAs as implants capable of recruiting, concentrating, and modulating the release of GFs in regenerative applications.

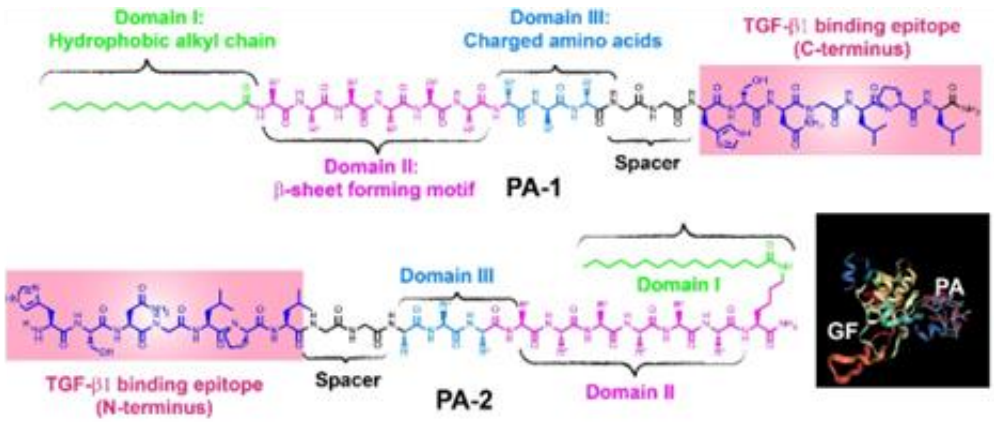

Figure 1. Schematics of the two peptide amphiphiles designed to optimize binding of TGF-b1.

Acknowledgments: Funding was provided by the ERC Proof of Concept Grant NOVACHIP.

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POSTER SESSION 3

ABSTRACTS

Poster Session 3 - 21st March | 10:30 - 11:00
Auditorium Renato Araújo – Central and Rectorate Building

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Enabling the electrostatic-driven LbL assembly of neutral marine polysaccharides via chemical functionalization

38 **C. F. V. Sousa**
Marine-origin polysaccharides based free-standing multilayered membranes for controlled therapeutics delivery

39 **R. Meyer**
Directing supramolecular assembly pathways by photolytic redox cycles

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Patterned mussel-inspired freestanding membranes as stem cell carrier devices for early-osteoarthritis treatment

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Enzyme-living hydrogel as a strategy to sculpt customize channels within a tissue mimetic hydrogel

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Investigation of protein condensates in E. coli as a strategy for engineering spider silk proteins

49 **J. Goncalves**
Exploring the potential of multifunctional Magnetic Chitosan-Based Scaffolds towards Bone Cancer Treatment and Regeneration

50 **J. M. S. P. Leite**
Cellulose based nanosystems for cancer theranostics

ABSTRACT 37

Enabling the electrostatic-driven LbL assembly of neutral marine polysaccharides via chemical functionalization

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The Layer-by-Layer (LbL) assembly technique has emerged as a simple, cost-effective, and highly versatile technology for coating surfaces and fabricating multifunctional multilayered assemblies at the nanoscale[1]. The intricate landscape of intermolecular interactions has been widely scrutinized over the years, with a particular emphasis on the role of electrostatic interactions between oppositely charged polyelectrolytes[2]. Natural cationic and anionic polysaccharides have been widely studied in LbL assemblies, while neutral ones have been overlooked due to their low chemical versatility. Herein, we explore the potential of marine-origin neutral polysaccharides, namely laminarin (LAM) and pullulan (PUL) as building blocks in electrostatic-driven LbL assemblies for various biomedical applications. We present a novel approach to functionalize LAM and PUL with charged peptides (positively charged – K6; negatively charged – D6) through Cu(I)-catalyzed azide–alkyne cycloaddition to synthesize positively and negatively charged polysaccharide-peptide conjugates – Figure 1. The electrostatic-driven LbL build-up of either LAM-D6/LAM-K6 or PUL-D6/PUL-K6 multilayered thin films was monitored in situ by quartz crystal microbalance with dissipation monitoring, revealing the successful multilayered film growth and the enhanced stability of the PUL-based films. The construction of the PUL-peptide multilayered thin film was also assessed by scanning electron microscopy and its biocompatibility demonstrated in vitro towards L929 mouse fibroblasts. We anticipate that this work could enable the inclusion of any kind of small molecules in the multilayered assemblies, thus extending the usefulness of neutral polysaccharides and opening new avenues in the biomedical field, including in controlled drug/therapeutics delivery, tissue engineering and regenerative medicine strategies.

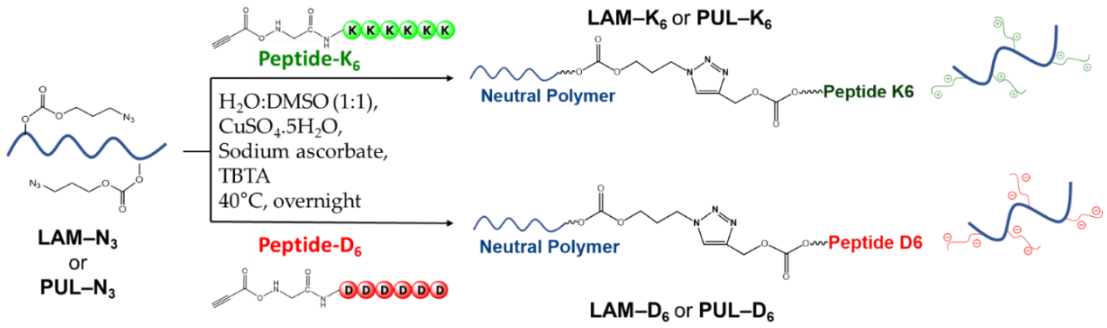

Figure 1. Chemical route used to couple the charged peptides to the marine polysaccharide.

Acknowledgments: This work was developed within the scope of the project CICECO-Aveiro Institute of Materials (UIDB/50011/2020, UIDP/50011/2020 and LA/P/0006/2020), financed by national funds through the FCT/MEC (PIDDAC) and in the scope of the projects COP2P (PTDC/QUIQOR/30771/2017 – POCI-01-0145-FEDER-30771) and SUPRASORT (PTDC/QUI-OUT/30658/2017 – CENTRO-01-0145-FEDER-030658). L.P.G.M., J.B. and J.M.M.R. gratefully acknowledge FCT for the individual PhD grant (2020.06767.BD) and individual researcher contracts (2020.00758.CEECIND and CEECIND/01363/2018), respectively.

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ABSTRACT 38

Marine-origin polysaccharides based free-standing multilayered membranes for controlled therapeutics delivery

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The Layer-by-Layer (LbL) assembly technology is a simple, inexpensive and highly versatile bottom-up approach to precisely engineer robust architectures, with tunable properties and functions at nanoscale, by resorting to a myriad of building blocks denoting complementary intermolecular interactions[1]. Among the different ingredients, marine-origin polysaccharides have been appointed as a particularly attractive class of natural polymers for the bottom-up assembly of LbL multifunctional systems owing to their bioavailability, biocompatibility, biodegradability, non-cytotoxicity, and non-immunogenic properties[2]. In particular, chitosan (CHT) and alginate (ALG) biopolymers have been assembled into a wide array of multilayered devices, denoting different sizes and geometries, by exploring attractive electrostatic interactions between positively charged CHT and negatively charged ALG[3]. However, the insolubility of CHT in physiological conditions limits the employment of CHT-based LbL structures in bioapplications.

Herein, we propose the development of two step-ups of free-standing membranes made of water-soluble quaternized CHT (Q-CHT) and ALG to study the influence of the film structure in the release of a model hydrophobic drug molecule. The model drug fluorescein isothiocyanate-labeled bovine serum albumin (FITC-BSA) was used as an intrinsic building block [(Q-CHT/ALG/Q-CHT/FITC-BSA)100] or added after the assembly of the membranes [(Q-CHT/ALG)200/Q-CHT/FITC-BSA]. The morphology, thickness, release rate and in vitro biocompatibility of both free-standing membranes towards human umbilical cord-mesenchymal stem cells were studied and compared. Furthermore, the mechanical properties of the membranes enclosing unmodified and quaternized CHT were also evaluated. This work provides new insights on the use of a water-soluble CHT derivative for the build-up of CHT-based multilayered devices under physiological conditions, thus opening new perspectives in the biomedical and biotechnological fields.

Acknowledgments: The financial support by the FCT through the PhD grants (2020.04408.BD, C.F.V.S.; 2020.06767.BD, L.P.G.M.), and individual Junior Researcher (CEECIND/01363/2018, J.M.M.R.) and Assistant Researcher (2020.00758.CEECIND, J.B.) contracts is gratefully acknowledged. This work was developed within the scope of the project CICECO – Aveiro Institute of Materials, UIDB/50011/2020, UIDP/50011/2020 & LA/P/0006/2020, financed by national funds through the FCT/MEC (PIDDAC). This work was funded by the European Union's Horizon Europe research and innovation programme under the grant agreement No. 101079482 ("SUPRALIFE").

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ABSTRACT 39

Directing supramolecular assembly pathways by photolytic redox cycles

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The ability to control the assembly of peptide nanostructures and their morphology is not only crucial in nature but also allows for tailor-made synthetic materials with various applications in biomedical or material science. Precise nanostructures require a facile and accessible synthetic platform that offer a dynamic control over assembly and morphology.

To achieve this, we designed a pro-assembling peptide that can perform a photolytic reaction cascade with different redox pathways, which determine the molecular, as well as the supramolecular structure – Figure 1. The redox state of the peptide can be modulated by introducing different thiols to either stop the cascade at the thiol level or delay its oxidation to the disulfide. Furthermore, this reaction cascade generates hierarchical assemblies different of those produced by direct dissolving of compounds.

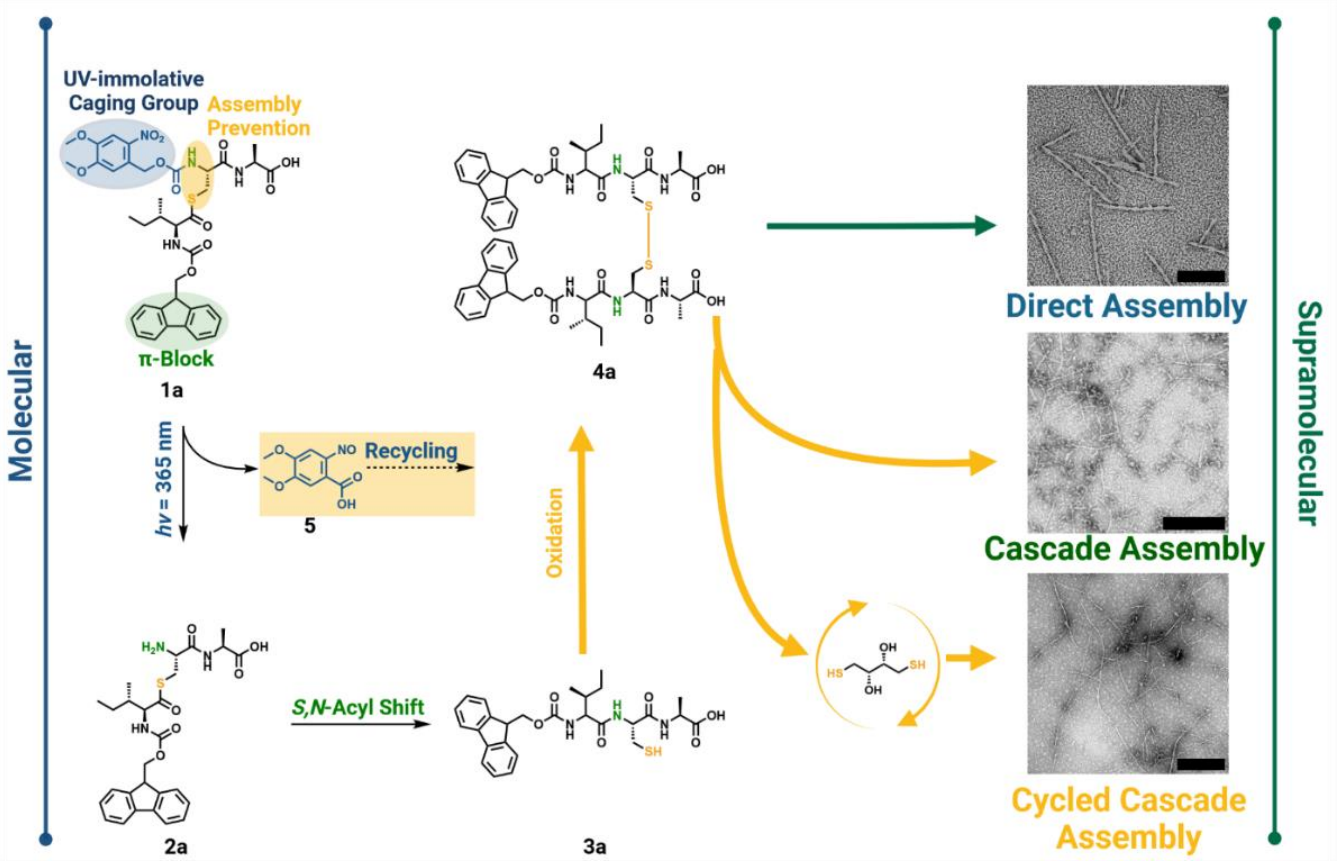

Figure 1. Iso(Fmoc-l)nvocCA 1a forms the decaged iso-peptide 2a after irradiation, which then rearranges in an S,N-acyl shift to 3a. The cleaved nvoc group oxidizes 3a to the disulfide 4a. On a supramolecular level, 4a can adopt different structures depending on the process of generation. Created with BioRender.com.

ABSTRACT 40

Patterned mussel-inspired freestanding membranes as stem cell carrier devices for early-osteoarthritis treatment

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Articular cartilage injuries caused by aging, trauma or diseases are currently one of the world's top health concerns owing to its limited capacity of self-renewal, thus raising the economic burden in the healthcare system. Cell implantation strategies resorting to a suitable delivery platform hold a great promising approach to increase cell engraftment at the damaged cartilage. Regarding their immunomodulatory potential, adipose-derived mesenchymal stem cells (ASCs) have been widely explored in cell therapies for the treatment of different inflammatory or autoimmune pathologies. Therefore, we herein propose the fabrication of functional cell carrier multilayered membranes with on-demand hASCs retention to transport and delivery those cells into superficially damaged human cartilage - Figure 1. Using the bottom-up layer-by-layer (LbL) technology, oppositely charged natural origin biopolymers with structural similarity to glycosaminoglycans (GAGs) were combined in a multilayered fashion with catechol-functionalized hyaluronic acid (HA-DOPA) onto a nanogrooved low surface energy substrate, allowing the multilayer formation of self-adhesive and patternable freestanding membranes in a seamless interface. Results have shown that the combination of nanotopography and catechol molecular cues in one single platform significantly augmented cell adhesion at the membrane surface. After cell-seeded membranes' application onto human chondral discs models, cells were able to migrate and engraft at the cartilage interface, repopulating the superficial cartilage furrows. These hASCs delivery devices hold great prospects to treat superficial wear and abrasion cartilage defects, thus attenuating osteoarthritis disease.

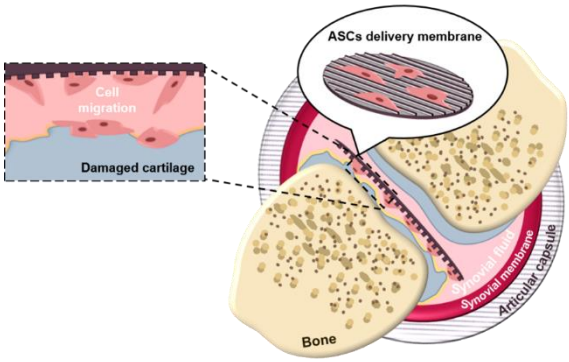

Figure 1. Axial view of a joint region (not drawn to scale), highlighting the multilayer membrane cultured with cells placed over the region of the cartilage defect.

Acknowledgments: This work was developed within the scope of the project CICECO – Aveiro Institute of Materials (UIDB/50011/2020, UIDP/50011/2020 & LA/P/006/2020), financed by national funds through the FCT/MEC (PIDDAC).

ABSTRACT 41

Enzyme-living hydrogel as a strategy to sculpt customize channels within a tissue mimetic hydrogel

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A critical goal in Tissue Engineering and Regenerative Medicine is the development of relevant tissue constructs with appropriate vasculature, able to supply oxygen and essential nutrients throughout the 3D architecture while removing metabolic waste. Approaches to design 3D perfused materials have been attempted and mostly rely i) on the patterning with cell-adhesive molecules, growth factors, or metalloproteinases, or ii) on the incorporation of microchannel-like structures within hydrogels, which is generally achieved through sacrificial molding, 3D (bio)printing, or by the combination of 3D bioprinting with layer-by-layer assembly technology[1,2]. Nonetheless, the recreation of vascular structures using the aforementioned techniques are effortful and costly.[2] Distinctly, we have developed a simple strategy wherein a single enzyme-living microgel is used to produce a custom-sculptured pattern within a mimetic hydrogel tissue of methacrylated gelatin (GelMA). Collagenase (known to degrade GelMA) and magnetic nanoparticles labelled with Rhodamine B were crosslinked into microgels-shape and encapsulated at one of the extremes of photocrosslinkable GelMA hydrogels. The final constructs were placed on the opposite side of the magnetic field to force the hydrogel engravement. By simply changing the magnet position and/or the size of the living microgel, we were able to create different topographies within the mimetic GelMA hydrogel. Additionally, the velocity of the sculpturing process was also investigated by varying the intensity of the magnetic field or the concentration of magnetic nanoparticles within the enzymatic microgel. With this, we demonstrate the ability of creating a simple and innovative strategy to create perusable channels within 3D hydrogels, that relies in the combination of the magnetic field and in the accurate protein:enzyme pairing. Such cutting-edge technology opens new insights for the effective delivery of cells, relevant biomolecules or even theragnostic agents for several biomedical applications, overcoming the diffusion problems of conventional 3D hydrogels.

Acknowledgments: This work was funded by the European Union's Horizon Europe research and innovation programme under the grant agreement No. 101079482 ("SUPRALIFE"). This work was also developed within the scope of the project CICECO-Aveiro Institute of Materials, UIDB/50011/2020, UIDP/50011/2020 & LA/P/0006/2020, financed by national funds through the FCT/MCTES (PIDDAC)." The authors would also acknowledge the FCT project "PROMENADE"-PTDC/BTM-MAT/29830/2017, the doctoral grant SFRH/BD/146740/2019 and the individual contract 2021.02196.CEECIND (A. Sofia Silva).

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ABSTRACT 42

Highly robust human-derived hydrogels for Tissue Engineering applications

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Hydrogels have been widely explored in the field of Tissue Engineering (TE) and Regenerative Medicine due to their unique features that include high water content - which provides an ideal environment for cell survival; the ability to maintain a distinct and biocompatible 3D structure - providing mechanical support for encapsulated cells; and the ability to simulate the native extracellular matrix. Despite these advantages, hydrogels softness makes them prone to mechanical failure and brittleness, limiting their use in applications that require high levels of mechanical stability[1]. In this sense tough double network (DN) hydrogels have been designed to address the mechanical limitations of soft hydrogels, making them less prone to failure under stress[2] Still, the limited diffusion of nutrients through DN hydrogels may hinder cell survival and proliferation. Additionally, the lack of control over the degradation rate of these hydrogels can further affect nutrient diffusion and the viability of cells encapsulated[3]. In this sense, we propose the development of a human derived DN hydrogel of methacryloyl platelet lysates (PLMA) and chitosan to yield a material with enhanced mechanical properties, but still, suitable for the cell survival of encapsulated cells. Also, owing the well described properties of PLMA we envision that this human derived DN system may also promote cell proliferation and tissue formation within the hydrogel. We envision that this multimodal hydrogel could likely be used for the repair of load-bearing soft tissues or as an encapsulation platform for several biomedical applications, including disease modeling for the screening of new therapeutics in more mimetic environment.

Acknowledgments: This work was funded by the European Union's Horizon Europe research and innovation programme under the grant agreement No. 101079482 ("SUPRALIFE"). This work was also developed within the scope of the project CICECO-Aveiro Institute of Materials, UIDB/50011/2020, UIDP/50011/2020 & LA/P/0006/2020, financed by national funds through the FCT/MCTES (PIDDAC)." The authors would also acknowledge the doctoral grant 2022.13351.BD and the individual contract 2021.02196.CEECIND (A. Sofia Silva).

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ABSTRACT 43

Bioinstructive Peptide-based Supramolecular Multilayered Nanobiomaterials for Stimulating Neurite Outgrowth

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Bioengineering soft, hydrophilic, and dynamic extracellular matrix (ECM)-mimetic constructs, able to capture the multitude of physicochemical signals of the native neuronal microenvironment, is a major goal of neuronal tissue engineering. Recently, the emerging field of supramolecular chemistry together with advances in tissue engineering and regenerative medicine have opened new avenues on the use of innovative ECM-mimetic supramolecular biomaterials, enlisted with biochemical and structural features, able to modulate cell behavior and grow functional neural tissues [1,2]. In this context, peptide amphiphiles (PAs) are very appealing building blocks due to their fibrillar topography and high-density of bioactive cues, needed to instruct the growth and guidance of neuronal projections across hostile lesion environments [2,3].

Herein, we report the development of peptide-based supramolecular multilayered assemblies as bioinstructive platforms to stimulate neurite outgrowth. Biopolymers, namely hyaluronic acid (HA) and poly(*L*-lysine) (PLL), were layer-by-layer (LbL) assembled onto gold-coated substrates into multilayered thin films and functionalized with an outer layer of bioactive laminin-mimetic PA (K_2PA-IKVAV) aiming to recreate the soft, hydrated and fibrillar neural ECM microenvironment. The co-assembly of positively charged PA molecule with the oppositely charged HA revealed the formation of well-ordered β-sheet secondary structures, denoting a 1D nanofibrous network. The *in vitro* data revealed that the bioactive ECM-mimetic nanofilms promote higher viability, enhance overall morphology, and stimulate neurite outgrowth of primary cortical neurons when compared to the non-bioactive biopolymeric formulation. Moreover, the versatility imparted by the LbL technique enabled the translation of the multilayered thin film concept into more robust free-standing membranes after crosslinking via carbodiimide coupling chemistry, enhancing their stiffness and stability under physiological conditions, aiming for being used as an implantable biomaterial. These results support the potential of the bioinstructive peptide-based multilayered systems to be used in neuronal regeneration.

Acknowledgments: This work was funded by the European Union's Horizon Europe research and innovation programme under the grant agreement No. 101079482 ("SUPRALIFE"), and by the Programa Operacional Regional do Centro-Centro 2020 (FEDER) and national funds via FCT/MCTES in the scope of the projects "SUPRASORT" (PTDC/QUI-OUT/30658/2017) and "JumpIN" (PTDC/BTM-MAT/4156/2021). M.L., C.F.V.S., M.T., S.G.P. and J.B. acknowledge FCT for the PhD grants (2020.05210.BD, 2020.04408.BD, SFRH/BD/146754/2019) and Assistant Researcher contracts (2020.00366. CEECIND, 2020.00758.CEECIND), respectively. This work was developed within the scope of the project CICECO – Aveiro Institute of Materials, UIDB/50011/2020, UIDP/50011/2020 & LA/P/0006/2020, financed by national funds through the FCT/MCTES (PIDDAC).

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ABSTRACT 44

Direct C-H arylation of dithiophene-tetrathiafulvalene: tuneable electronic structure and 2D self-assembled molecular networks at the solid/liquid interface

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Due to their electron-donor and redox-active properties tetrathiafulvalene (TTF) and its derivatives have received a lot of attention in the field of molecular electronics [1]. Therefore, are important scaffolds for the synthesis of metal-organic frameworks (MOFs), and covalent organic frameworks (COFs) [2]. In particular, dithiophene-tetrathiafulvalene (DT-TTF) derivatives, are active materials for organic field-effect transistors (OFETs) because of its high charge carrier mobility [3,4]. However, the direct functionalization of these building blocks to tune its electronic structure has not yet been reported. Herein, we describe the direct C-H arylation of DT-TTF (1) to synthesize derivatives bearing different electron-donor or electron-withdrawing groups in order to modify its electrical structure - Figure. 1. Finally, the formation of DT-TTF-tetrabenzoic acid (H_4DT-TTFTB, 5) 2D self-assembled networks were also studied using scanning tunneling microscopy (STM).

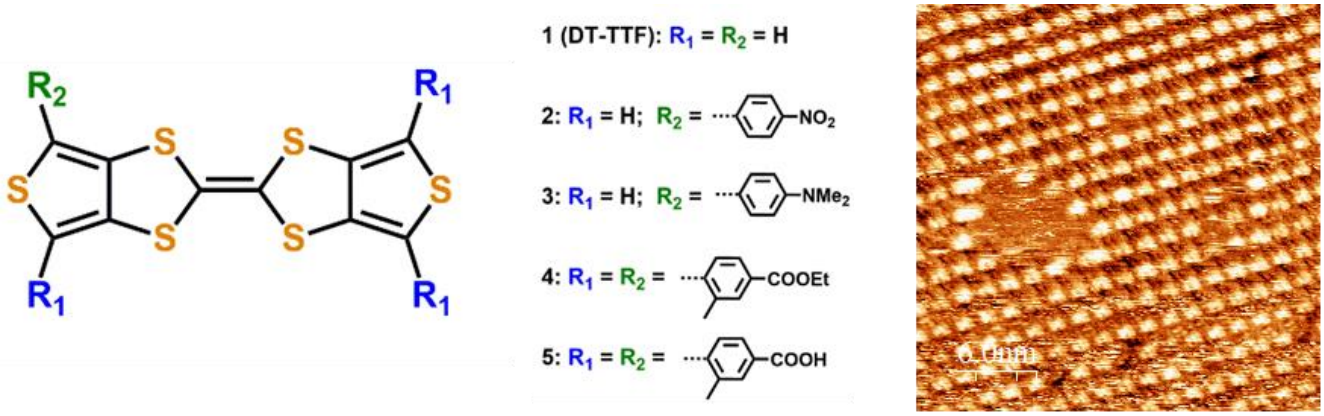

Figure 1. a) Molecular structures of arylated DT-TTF derivatives and b) STM image of physisorbed monolayer of **5** on HOPG.).

Acknowledgments: This work has received funding from the European Research Council (ERC) under the European Union's Horizon Europe Framework Programme (ERC-2021-Starting Grant, grant agreement no. 101039748-ELECTROCOFS). This work was developed within the scope of the project CICECO-Aveiro Institute of Materials, Grants UIDB/50011/2020 and UIDP/50011/2020, financed by national funds through the FCT/MEC and when appropriate co-financed by FEDER under the PT2020 Partnership Agreement. We thank FCT for funding the project PTDC/QUI-ELT/2593/2021.

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ABSTRACT 45

Peptide-based poly(diphenylacetylene)s: Impact of the elastin sequence on their chiroptical properties

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Biopolymers having helical structures are ubiquitous in nature, where their inherently chiral architecture is key to develop the crucial tasks such as catalysis, recognition, or storage of genetic.[1] With the idea of mimicking these functions and including many others like sensing, spin-filtering or circular polarized luminescence (CPL) sources, artificial helical polymers were developed. Our group has recently mastered the synthesis[2] and chiral induction[3] trough non-covalent interactions and further "memory" of macromolecular helicity of symmetrically substituted helical poly(diphenylacetylenes), giving rise to unique examples of CPL active species based on supramolecular chiral induction and memory. This protocol allowed us to prepare helical templates with desired macromolecular handedness (plus, *P*; minus, *M*; racemic, *Rac*), that can be easily modified afterwards by classical carboxylic acid reactivity.[4]

Herein we report the post-polymerization modification of a PDPA derivative (Figure 1) by grafting different elastin peptide sequences (VPGVG).[5] Interestingly, grafting the natural peptide sequence or the inverted one (VPGVG and GVGPV respectively) give rise to the induction of opposite-handed PDPA backbones —after thermal annealing— thus displaying different chiroptical properties both in ground and excited state (ECD response and CPL emission respectively). Finally, is remarkable that despite the fact of being negatively charged species, these polymers can cross the cell membrane due to the peptide cover surrounding the polymeric skeleton representing, to our knowledge, one of the scarce examples of CPL active sources inside living cells.

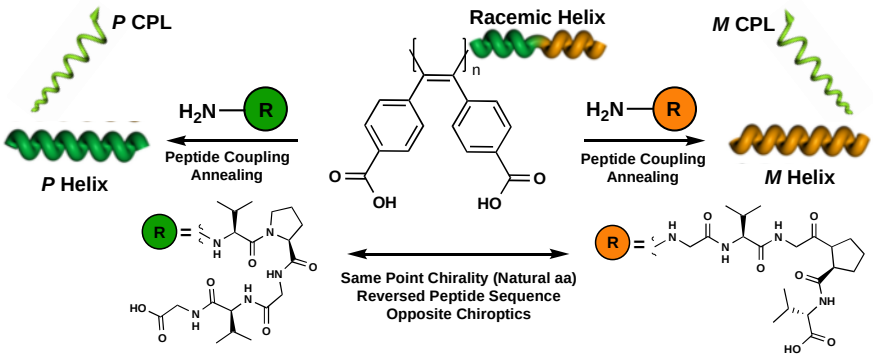

Figure 1. Sequence dependent chiroptical properties of elastin-based PDPAs.

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[5] R. Rodríguez, *et al.*, Manuscript in preparation

ABSTRACT 46

PPA-Metal coordination equilibrium: Temperature Switchable Role and Helix Inversion

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The influence of temperature on polymer-metal complexes[1] was investigated using a library of five distinct poly(phenylacetylene)s (PPAs) with anilide or benzamide functional groups as linkers on the pendants. The metals provide switchable dissociation as the temperature drops, which endlessly alters the helicity and the function of the monomers.[2] We used the experimental and theoretical DFT data to do thermodynamic calculations to determine the force that altered the chemical equilibrium between the two species (Figure 1).

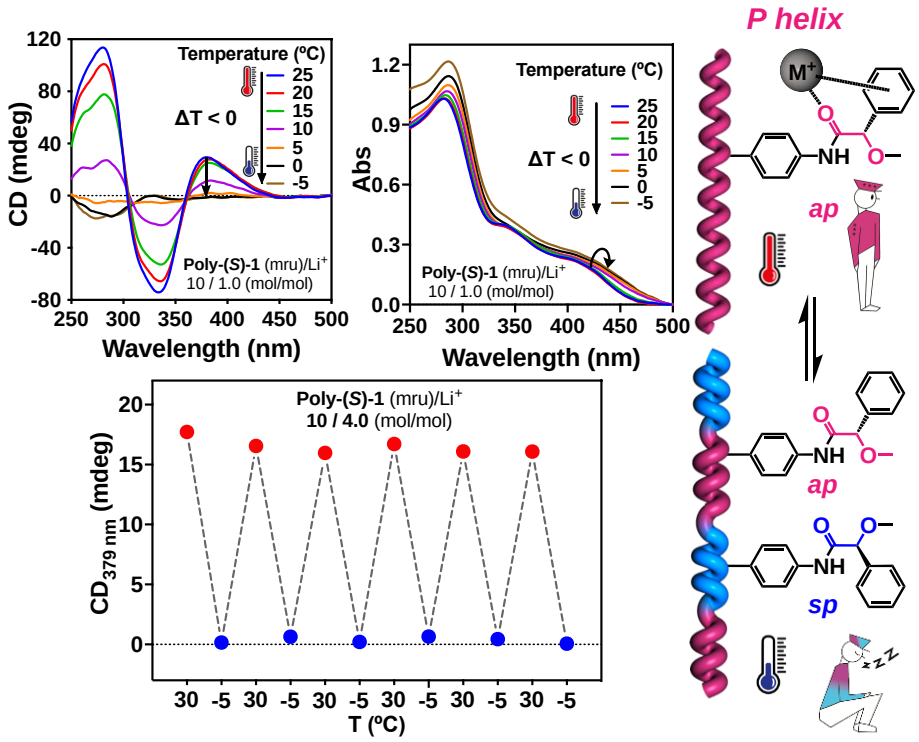

Figure 1. VT-CD and UV-Vis cooling curves of poly-(*S*)-**1**/Li^+ and Thermal scan cycles of poly-(*S*)-**1** in the presence of 0.4 equivalents of $LiClO_4$.

References:

[1] S. Arias *et al., Polym. Chem.* **2015**, 6, 4725-4733,

[2] J. Bergueiro *et al., Chem. Sci.* **2014**, 5, 2170-2176.

ABSTRACT 47

Anion recognition by sulphonamide-functionalized poly(phenylacetylene)s

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Anion recognition is an area of growing interest in supramolecular chemistry due to its potential biological and environmental applications.[1],[2] Sulfonamide-based receptors for anions are an important class of anion receptor that have been broadly investigated due to their enhanced acidity relative to analogous secondary amides and hence their potential to form stronger hydrogen bonds with anions.[3] In this sense, poly(phenylacetylene)s (**PPA**s) bearing sulfonamide groups at the pendants are a suitable sensor due to the possibility of tuning their helical structure once the polymer is synthesized. [4] That is, these type of polymers exhibits simultaneous changes in both the optical and chiroptical properties in response to specific molecular recognition events. [5] Herein, we present here a novel dynamic **PPA** whose chirality arises from an allene moiety in the pendant groups as a source of axial chirality (Figure 1). Furthermore, this allene moiety was functionalized on one of its substituents with a sulfonamide group as a recognition point.

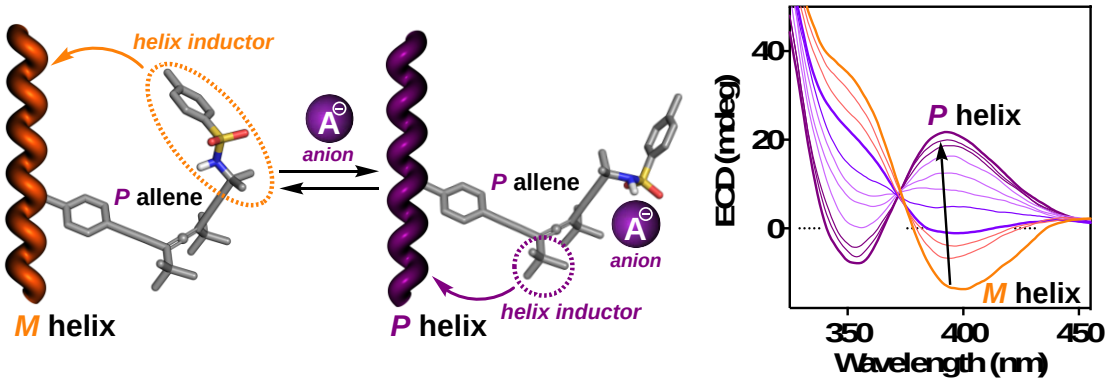

Figure 1. Schematic representation of axial chirality transfer to the polymer backbone, inducing a specific helical sense and helix inversion of the PPA after anion binding.

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[1] C. Caltagirone and P. A. Gale, *Chem. Soc. Rev.* **2009**, 38, 520–563.

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[3] P. A. Gale *et al., Coord. Chem. Rev.* **2018**, 333-372.

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[5] S. Leiras *et al., Giant*, **2021**, 100068.

ABSTRACT 48

Investigation of protein condensates in *E. coli* as a strategy for engineering spider silk proteins

F. B. Gabryelczyk [1], F.-E. Sammalisto [1*], J.-A. Gandier [1], J. Feng [1], G. Beaune [2], J. V. I. Timonen [2], M. B. Linder [1]

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Native spider silk proteins have a complex primary structure that poses challenges for recombinant expression in bacteria (*E. coli*). Extensive protein sequence optimization is needed to find a suitable variant exhibiting high expression yield and ability to form silk fibers in a biomimetic spinning process. This procedure is tedious and time consuming since it involves recombinant expression, purification, and analysis of many protein variants before a suitable one is found.

Protein condensates formed through liquid-liquid phase separation (LLPS) have been shown as key precursors involved in the spider silk fibre assembly. It has also been demonstrated that recombinant silk proteins undergo LLPS during overexpression in *E. coli*. Recently, we have shown that characterization of material properties of the protein condensates *in vivo* can be used as a basis to assess whether a given spider silk variant exhibits the ability to form fibers *in vitro* (after purification).[1] Using this approach, we are currently developing a combinatorial engineering strategy to select spider silk protein sequences able to form silk fibers with improved material properties (Figure 1). Our strategy eliminates the time-consuming steps of *in vitro* characterization of individual protein variants currently limiting progress in the field. In addition, it creates a possibility to introduce directed evolution to bioinspired material engineering.

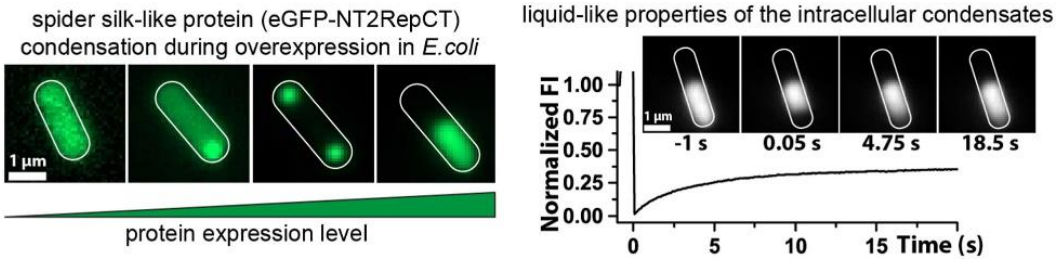

Figure 1. Left: localization of spider silk protein via LLPS in *E. coli* throughout expression. Right: fluorescence recovery after photobleaching of intracellular spider silk protein condensates.

References:

[1] B. Gabryelczyk *et al., Mater. Today Bio* **2022**, 17, 100492.

ABSTRACT 49

Exploring the potential of multifunctional Magnetic Chitosan-Based Scaffolds towards Bone Cancer Treatment and Regeneration

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In this study, we developed magnetic chitosan-based scaffolds through freeze-drying, which have the potential to promote bone regeneration and kill residual cancer cells using magnetic hyperthermia. Chitosan was selected as the primary matrix due to its biocompatibility and antibacterial behavior. However, its poor mechanical properties and low bioactivity limit its application in bone regeneration. [1] To address these issues, we incorporated co-precipitated spherical magnetite nanoparticles (Fe_3O_4 NP) with a Specific Loss Power of 98 W/g, into the chitosan matrix at different quantities (10% and 20% w/w), to be used as heat mediators in magnetic hyperthermia therapy (MHT). We also added nano-hydroxyapatite (n-HA) at a 60/40% w/w chitosan-n-HA ratio to improve the scaffolds' bioactivity. The incorporation of the fillers enhanced the scaffolds mechanical properties, with an increase in the compressive modulus and strength from 1.3 and 0.1 MPa, for pristine chitosan scaffold, to 4.7 and 0.4 MPa, respectively, for the scaffolds with 20% w/w of Fe_3O_4 NP and n-HA. This was accomplished without compromising the degree of scaffold porosity (>80%), which is crucial for cell proliferation. After 24 h of immersion in the culture medium, all the scaffolds exhibited a high swelling capability (> 800%), which increases the pore size, promoting cell attachment and growth. After 21 days of immersion in PBS with lysozyme, the pristine chitosan exhibited an exponential degradation rate with a mass loss of approximately 70%. However, the incorporation of the fillers retarded scaffold degradation, with a 10% mass loss observed for the scaffold with 20% w/w of Fe_3O_4 NP and n-HA. Trough an indirect MTT assay and using osteosarcoma cell line Saos-2, the scaffolds revealed a cell viability greater than 80%. Overall, the magnetic chitosan-based scaffolds exhibited a highly porous structure, and the addition of Fe_3O_4 NP enabled the production of biocompatible scaffolds that are more robust and have a lower degradation rate in culture media. Therefore, those scaffolds have potential for addressing both bone defect regeneration and the eradication of residual cancer cells through MHT.

Acknowledgments: This work was developed within the scope of the projects CICECO - Aveiro Institute of Materials, UIDB/50011/2020, UIDP/50011/2020 & LA/P/0006/2020, and CESAM, UIDP/50017/2020, UIDB/50017/2020 & LA/P/0094/2020, financed by national funds through the FCT/MEC (PIDDAC). The authors acknowledge to FCT/MEC for the financial support of the project “Coccolitho4BioMat” (POCI-01-0145-FEDER-031032). JG, HO and PF thank FCT for the grants 2020. 06654.BD, CEECIND/04050/2017 and IF/00300/2015, respectively. CN is grateful to Portuguese national funds (OE), through FCT, I.P., in the scope of the framework contract foreseen in the numbers 4, 5 and 6 of the article 23, of the Decree-Law 57/2016, of August 29, changed by Law 57/2017, of July 19.

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[1] G. Turnbull *et al., Bioact. Mater.*, **2018**, 3, 278–314.

ABSTRACT 50

Cellulose based nanosystems for cancer theranostics

J. M. S. P. Leite [1]*, B. M. Neves [2], C. Vilela [1], C. S. R. Freire [1]

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The last decade set a turning point for the era of biopolymeric nanomaterials, which have gained relevancy in many diagnosis, therapy, and imaging applications, due to their biocompatibility, biodegradability, potential for chemical modification, and overall versatility. These features are especially relevant in cancer research for the development of innovative approaches that allow the precise delivery of therapeutic agents, while monitoring the treatment response. Hence, multifunctional biopolymer-based nanoparticles are promising candidates for cancer treatment strategies[1,2]. Herein, cellulose-based nanobeads with a diameter of 180 ± 34 nm were prepared via nanoprecipitation, and functionalized with curcumin, gold nanoparticles (AuNPs), magnetite nanoparticles (FeNPs) and folic acid (FA) – Figure 1. This multi-step assembly originated cellulose-based nanosystems with imaging and photothermal features, magnetic guidance, and selectivity towards folate receptors in cancer cells. The nanosystems were characterized regarding morphology, stability, and biological features.

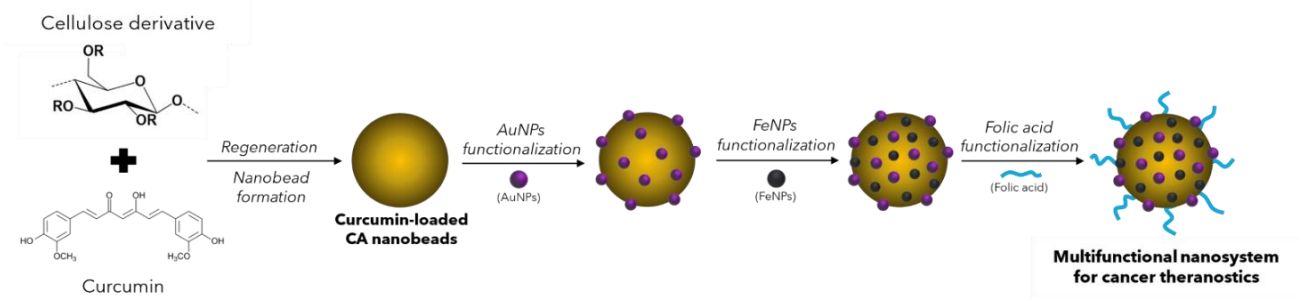

Figure 1. Schematic representation of the assembly process of cellulose-based nanosystems**.**

Acknowledgments: This work was developed within the scope of the project CICECO – Aveiro Institute of Materials, UIDB/50011/2020, UIDP/50011/2020 & LA/P/0006/2020, financed by national funds through the FCT/MCTESMEC (PIDDAC) and project Cell4Janus: Engineering self-propelled cellulose-based Janus microrobots (PTDC/BII-BIO/1901/2021), financially supported by national funds (OE), through FCT/MCTES. FCT is also acknowledged for the doctoral grant to J.M.S.P.L. (2021.06004.BD).

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SOFT TRANSFERABLE SKILLS TRAINING PROGRAM

22nd March

Auditorium Renato Araújo – Central and Rectorate Building

8:00 - 8:30 **Registration**

8:30 - 9:00 **Welcome and Opening Remarks**

João Borges, Ana Soares, Daniela Ribeiro, Alexandra Monteiro, Joana Pereira, Luísa Sal (University of Aveiro, Portugal)

Grant Writing Workshop – Marie Skłodowska-Curie Actions (MSCA)

Chairs: João Borges & Daniela Ribeiro (University of Aveiro, Portugal)

9:00 - 9:50 **Amélie Delmon** (EU R&I Grants Officer at the University of Bordeaux, France)

Tips and tricks on how to write a successful MSCA Doctoral Networks

9:50 - 10:30 **Nuno Gonçalves** (MSCA Postdoctoral Fellow at CICECO/University of Aveiro, Portugal)

Experience and tips for a successful MSCA Postdoctoral Fellowship proposal

10:30 - 11:00 **Coffee Breack**

Grant Writing Workshop – Widening Actions & European Research Council (ERC) Grants

Chairs: Luísa Sal & Ana Soares (University of Aveiro, Portugal)

11:00 - 12:30 **Rui Munhá** (Science Officer at Fundação para a Ciência e a Tecnologia, Portugal, and Coordinator of the NCPs in the Pillar of Scientific Excellence and in the Widening & ERA Part of Horizon Europe)

Widening in Horizon Europe: empowering people and institutions

11:30 - 12:00 **Gabriela Dima** (Project Manager and Policy Advisor at the Eindhoven University of Technology, the Netherlands)

Best practices on how to write successful ERC grants

12:00 - 12:30 **Manuel Souto** (Principal Researcher at CICECO/University of Aveiro, Portugal)

My personal story to obtain an ERC grant: some tips and useful resources

12:30 - 13:30 **Roundtable**

Moderator: **João Rocha** (Full Professor at CICECO/University of Aveiro, Portugal)

13:30 - 14:30 **Lunch Breack**

Career Development Workshop

Chairs: Ana Soares & Daniela Ribeiro (University of Aveiro, Portugal)

14:30 - 16:00 **Jonathan Yewdell** (National Institutes of Health, USA)

How to succeed in science

16:00 - 18:00 **Internal session – Twinning projects**

23rd March
Auditorium Renato Araújo – Central and Rectorate Building

Science Communication Workshop

Chairs: Alexandra Monteiro & Joana Pereira (University of Aveiro, Portugal)

09:00 - 09:30 **Catarina Moura** (Science Communication Officer at the International Iberian Nanotechnology Laboratory, Portugal)

Bringing science to life

09:30 - 10:00 **Paulo Sérgio Santos** (Communications Manager at the Católica Porto Business School, Portugal)

The importance of written and oral communication skills in science communication

10:00 - 10:30 **Coffee Break**

10:30 - 11:00 **Bárbara Pinho** (Freelance Science Communicator, Portugal)

Communicating science (*aka* bursting the bubble)

11:00 - 11:30 **Adriano Cerqueira** (Science Journalist & Producer of the podcast '90 Segundos de Ciência', Portugal)

Communicating science in less than 90 seconds: challenges and opportunities

11:30 - 12:00 **Pedro Pombo** (Director of Fábrica Centro Ciência Viva de Aveiro, Portugal)

New Challenges for science communication: the case of Fábrica

12:00 - 13:00 **Roundtable**

Moderator: **Adriano Cerqueira**
(Science Journalist & Producer of the podcast '90 Segundos de Ciência', Portugal)

13:00 - 14:00 **Lunch Break**

14:00 - 17:00 **Internal session – Twinning projects**

24th March
Auditorium Renato Araújo – Central and Rectorate Building

Scientific Writing & Publishing Workshop

Chairs: João Borges & João F. Mano (University of Aveiro, Portugal)

09:30 - 10:30 **Nesma El-Sayed Ibrahim** (Associate Editor at Nature Reviews Bioengineering, Germany)

Publishing your research – and a new Nature journal

10:30 - 11:00 **Coffee Break**

11:00 - 12:00 **Nesma El-Sayed Ibrahim** (Associate Editor at Nature Reviews Bioengineering, Germany)

From the lab to editorial – a career in scientific publishing

12:00 - 12:30 **Closing Remarks**

João F. Mano & João Borges (University of Aveiro, Portugal)

INVITED SPEAKERS

SHORT BIOS | ABSTRACTS

LIST OF PRESENTATIONS

GRANT WRITING WORKSHOP

Amélie Delmon

EU R&I Grants Officer at UBx
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Amélie Delmon *is working as an EU Research & Innovation grants officer at the University of Bordeaux (Marie Skłodowska-Curie Actions (MSCA) and other Horizon Europe projects). She is specialized in the MSCA Doctoral Networks programme. Amélie has worked with the Erasmus + France Agency as a grants project manager (action 2: cooperation among organisations and institutions). She also has 3 years of experience in various project management and project development (Alliance française in Edmonton, Canada and Fédération des aînés franco- albertains in Edmonton, Canada).*

ABSTRACT

Tips and tricks on how to write a successful MSCA Doctoral Networks

Université de Bordeaux, 351 cours de la Libération, 33405 Talence, France

MSCA Doctoral Networks (MSCA DN) are part of the pillar I “Excellent Science” of Horizon Europe funding. The action aims to implement innovative and excellent doctoral programmes. These programmes should: (i) support and respond to various needs in R&I areas, (ii) offer training with a combination of research related and transferable competences, and (iii) expose researchers both to the academic and non-academic environment through international, interdisciplinary and international mobility. This talk will focus on sharing tips and tricks, and practical advice to write your MSCA DN proposal. The tips and tricks will be illustrated by comments from some of the European Commission’s evaluators. By the end of the talk, you will understand the three main sections of the proposal template (Excellence, Impact, Implementation) and know the common pitfalls to avoid. Questions and interactive discussions will be encouraged during and at the end of the talk.

Nuno Gonçalves

MSCA Postdoctoral Fellow at CICECO/UAVR

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Nuno Gonçalves *is a Marie Skłodowska-Curie Postdoctoral Fellow (MSCA PF 2021) at the Department of Chemistry/CICECO at University of Aveiro focusing his activities on the development of new 3D-printed photoactive materials for water treatment. Recently, he was awarded a Junior Researcher Grant (CEEC 2022) by Portuguese Foundation for Science and Technology. He obtained the MSc in Chemistry from the University of Coimbra (2010). After, he worked as a researcher and development chemist in a spin-off (Luzitin, SA) from the University of Coimbra focused on the development of new biologically active substances and participated in the development of the first Portuguese oncological drug candidate. In 2021 he obtained his PhD in Chemical in Materials Sciences from the University of Turin in the frame of a Marie Skłodowska-Curie Actions (ITN) focused on a multidisciplinary approach to develop new technologies for the oxidation/reduction of contaminants of emerging concern from water. During this project, he also had short-term scientific missions at Aalborg University, LiqTech Inc. (Copenhagen), École Polytechnique and CNRS/Université Clermont Auvergne. His main current research interest is the development of innovative sustainable materials for the removal of water pollutants.*

ABSTRACT

Experience and tips for a successful MSCA Postdoctoral Fellowship proposal

Department of Chemistry, CICECO-Aveiro Institute of Materials, University of Aveiro, 3810-193 Aveiro, Portugal

The Marie Skłodowska-Curie Postdoctoral Fellowships (MSCA-PF) is a prestigious research funding programme that supports researchers' careers and foster excellence in research. The programme aims to strengthen the innovative potential of doctoral researchers who want to enhance their skill set, knowledge, and career prospects through advanced training, international and interdisciplinary mobility. As a recipient of this fellowship, I will share my personal experience and tips for prospective applicants to increase their chances of being awarded the fellowship. In this talk, the scope of the MSCA-PF programme will be discussed, which includes funding for research projects, training, and networking opportunities. The three funding award criteria: "Excellence", "Impact" and "Implementation" will be explored. It will be also highlighted the importance of developing a strong research proposal that aligns with the programme's goals and selecting a suitable host institution and supervisor. Furthermore, I will share tips on how to build a network of mentors and collaborators, which can provide invaluable support and guidance during the postdoctoral fellowship, as well as the need to develop transferable skills and engage in public engagement activities to enhance one's career prospects. By sharing my experience and tips for success, I aim to inspire and guide prospective applicants towards a successful MSCA-PF application and, ultimately, a fulfilling and enriching postdoctoral experience.

Acknowledgements:
Nuno Gonçalves acknowledges the funding from the European Union's Horizon Europe research and innovation programme under the Marie Skłodowska-Curie grant agreement No. 101065059.

Rui Munhá

Science Officer at FCT

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Rui Munhá *has been a Science Officer in the Department of International Relations of the Portuguese Foundation for Science and Technology (FCT) since 2014. In 2020, he was appointed Coordinator of the National Contact Points in the Pillar of Scientific Excellence and in the Widening & ERA Part of Horizon Europe. Rui Munhá is also a National Delegate/ National Contact Point for the European Research Council and for Widening & ERA, and he is a member of the Governing Board and Executive Board of the COST Association (European Cooperation in Science and Technology). He is also a contact point for the dialogue between FCT and the Associations of the Diaspora. Rui Munhá obtained a PhD in Chemistry 2011, and he developed his scientific activity at the University of Lisbon, University of British Columbia (Vancouver, Canada), University of California (Irvine, USA) and the University of Aveiro, co-authoring 20 articles in international journals with over 500 citations, in addition to several invited oral communications. Rui was born in Lisbon, in 1979.*

ABSTRACT

Widening in Horizon Europe: empowering people and institutions

Fundação para a Ciência e a Tecnologia, I. P., Portugal

Widening Participation and Strengthening the ERA (WIDERA) encourages leadership and the fulfilment of the collective and individual R&I potential through mentoring, networking, communication, and partnering activities[1]. It assumes the role of pre-portal to successful applications in other highly competitive EU funding schemes (e.g., European Research Council or Marie Skłodowska-Curie Actions), but it also contributes to the internationalization process of the scientific communities, at all stages of their careers. In a more ambitious and strategic dimension, the Widening part of the WIDERA programme represents a steppingstone towards systemic transformations of the national R&I ecosystems, institutional reforms, and a mechanism to strengthen (or to build new) collaborations between the academic and non-academic sectors. In this talk, it will be discussed the advantages of participating in networking and capacity building activities, and how the Widening programme may be the right answer to institutional growth or to career development.

References:

[1] Widening Participation and Strengthening the ERA (WP2023-2024): https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/wp-call/2023-2024/wp-11-widening-participation-and-strengthening-the-european-research-area_horizon-2023-2024_en.pdf

Gabriela Dima

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Gabriela Dima *obtained a master's degree in physical chemistry from the University of Bucharest in Romania in 1991. Between 1991 and 1996 she worked at the Institute of Environmental Protection in Galati (Romania) as the head of the regional environmental monitoring department. From 1996 till 2002, she was assistant professor at Department of Chemistry at the University of Bucharest. She obtained a PhD degree in the field of electrochemistry in 2002. Between 2002 and 2008, she was involved in different EU research projects as researcher at the department of Chemical Engineering and Chemistry of Eindhoven University of Technology (TU/e). In 2009, she decided to focus on project management within the same department. She took care of the daily management of the Top Research School NRSC-Catalysis in the 2009-2016 period and the Netherlands node of the EU Network of Excellence IDECAT (2009-2010). Currently, she is a project manager and policy advisor at the department of Chemical Engineering and Chemistry at TU/e.*

ABSTRACT

Best practices on how to write successful ERC Grants

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The European Research Council (ERC) is the premier funding organization of the European Union that fosters excellent frontier research. It aims to fund the most creative researchers of any nationality and age based in Europe. Due to its nature, the funding schemes within ERC, which include Starting Grants, Consolidator Grants, Advanced Grants and Synergy Grants, are highly competitive. Proper understanding of the key requirements for submitting a successful ERC proposal is therefore pivotal. In this talk, the main aspects of the ERC will be discussed such as the different grant schemes, eligibility conditions, deadlines, proposal structure and the evaluation process. Besides, best practices from grant applications at the Eindhoven University of Technology (TU/e) will be highlighted that can aid in writing a successful ERC grant.

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Manuel Souto Salom *(Valencia, 1988) is an Assistant Professor/Principal Researcher at CICECO-Aveiro Institute of Materials and at the Department of Chemistry of the University of Aveiro. He holds a double degree in Chemistry and Chemical Engineering from the University of Valencia and from the École de Chimie, Polymères et Matériaux (ECPM) de Strasbourg. He also earned a Master's degree in Molecular and Supramolecular Chemistry (2011) from the University of Strasbourg conducting his Master thesis at Instituto Superior Técnico (IST, Lisbon). He obtained his PhD in Materials Science at Institut de Ciència de Materials de Barcelona (ICMAB-CSIC) in 2016 conducting two research stays at the National University of Singapore (NUS) and at the University of Antwerp. In 2017, worked as postdoctoral researcher at the Institute of Molecular Science/University of Valencia (ICMol-UV). Since 2019 he was an Assistant Professor at the University of Aveiro and in 2022 he was promoted to Principal Researcher. His research interests encompass molecular electronics and electroactive polymers. His main current research interest is the design and synthesis of new functional electroactive porous frameworks (e.g., COFs & MOFs) based on redox-active organic building blocks for applications in electronics and energy storage.*

ABSTRACT

My personal story to obtain an ERC grant: some tips and useful resources

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European Research Council (ERC) Starting Grants are among the most competitive and prestigious grants in Europe. They are devoted to fund high risk/high gain project for five years with generous funding (1.5-2 M €) and allow the creation of new research groups.1 In this presentation, I will show an overview of the different ERC grant schemes and the proposal evaluation process. I will also present how my ERC StG proposal preparation and interview process went (from a personal point of view) as well as some tips that were useful to me during the writing process and interview preparation. Finally, I will give some resources (repositories of winning proposals, blogs, videos, articles, etc.) that may be useful when preparing an ERC proposal.

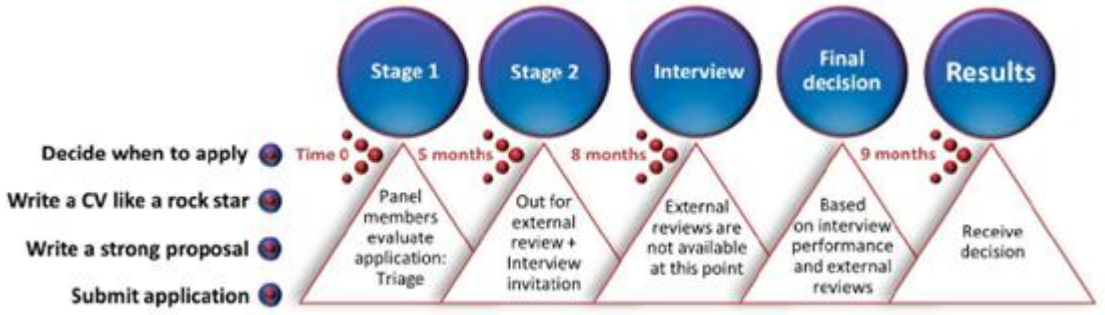

Figure 1. Summary and timeline of the important steps during and ERC StG application[1].

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[1] A. Anastasaki, Angew. Chem. Int. Ed**. 2022**, 61, 202206303.

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João Rocha *is Full Professor of Inorganic Chemistry at the Department of Chemistry at the University of Aveiro (UAveiro), Portugal, since 1999 and was Director of the Associated Laboratory CICECO - Aveiro Institute of Materials between 2002-2021. Currently, he is the Coordinator of the Council of Associated Laboratories representing ca. 9,500 researchers. He is a member of the European Academy of Sciences (EURASC), Académie Royale des Sciences, des Lettres et des Beaux-Arts de Belgique, and Lisbon Academy of Sciences, and Fellow of the RSC and Chemistry Europe. He received the Romão Dias (2021) and Ferreira da Silva (2017) prizes from the Portuguese Chemical Society, the French-Portuguese prize from the Société Chimique de France (2020), the prize for Scientific Excellence from the Portuguese Science Foundation (2005), among others. He has been a member of evaluation panels of the prestigious ERC Starting and Advanced Grants and Coordinator of the Materials Engineering evaluation panel of the ERC Consolidator Grants (2021, 2023).*

CAREER DEVELOPMENT WORKSHOP

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Jon Yewdell *graduated from Princeton University in 1975 with an AB in biochemistry and received MD and immunology PhD degrees from the University of Pennsylvania in 1981. After a post-doctoral fellowship at Imperial College in London, he spent 4 years as an Assistant Professor at the Wistar Institute in Philadelphia. In 1987 he joined the Laboratory of Viral Diseases, NIAID, establishing the Cellular Biology Section that uses influenza A, CoV2 and other viruses as a convenient excuse to study basic elements of cell biology, virology, and immunology. He has written a book providing advice for young scientists that can be obtained grátis by emailing him.*

ABSTRACT

How to succeed in science

Cellular Biology Section, Laboratory of Viral Diseases, National Institute of Allergy and Infectious Diseases, Bethesda, Maryland 20892, USA

In this workshop I will talk about how to set and follow goals in a science-driven career path aiming to pursue your career prospects. I will provide practical advice and guidance to assist undergraduate and graduate students, as well as young scientists on choosing a research topic and the right laboratory and supervisor/mentor for pursuing their career goals and boosting their career development, designing, performing, and interpreting an experiment, promoting their professional growth, and making conscious career choices [1,2].

References:

[1] J. W. Yewdell, Nat. Rev. Mol. Cell Biol. **2008**, 9, 413.
[2] J. W. Yewdell, Nat. Rev. Mol. Cell Biol. **2008**, 9, 491.

SCIENCE COMMUNICATION WORKSHOP

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Catarina Moura *is the Science Communication Officer at INL, within Research, Technology and Innovation Office. Catarina has an active role in supporting the INL research community to carry out research-oriented activities of relevance for communication. She also coordinates science communication initiatives that range from the organisation of scientific events to the establishment of relationships with the media, scientific experts, universities, and other research organizations. Catarina has worked as a scientist in the past years. Catarina studied Bioengineering at the Faculty of Engineering of the University of Porto, and she was awarded a PhD in biomedical sciences from the University of Southampton, UK, where she investigated novel diagnostic imaging techniques for bone and cartilage repair. Throughout her career, Catarina has always been involved in science communication. Catarina was part of an itinerant platform designed to help researchers share their work with the general public, and she participated in many international festivals like Glastonbury, working at the Science Tent, and the Cheltenham Science Festival. Catarina also worked at the Doctoral College in the UK, and her main responsibilities included the organisation of scientific activities for researchers as well as for non-scientific audiences.*

ABSTRACT

Bringing science to life

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Science communication is essential for many reasons: to address urgent issues (such as the climate crisis), to educate and inform the public and decision-makers, to make science more transparent, and to inspire communities and the next generations. There is still a communication gap between scientists and society, and that is why communicating science is so important. It is crucial that we, scientists, are more open about how research works and about the uncertainties and doubts that are involved. The general public is not aware that science is not a collection of facts that tell us what we know about the world. Science is a method of discovery. Scientists make hypotheses, derive predictions, and then carry out experiments based on those predictions. And we need to combine our efforts to better communicate science and engage different audiences, in a range of different formats from news pieces and books, to videos, podcasts, and music. In this workshop I will talk about my career path, why I decided to focus on science communication, and how I am working towards bringing science to life.

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Paulo Sérgio Santos *currently works as communications manager at Católica Porto Business School. He graduated in Biology and earned an MSc in Ecology – Specialization in Advanced Ecology and an MSc in Teaching Biology and Geology. However, it was in writing and journalism (written and radio) that he found his passion. He started as Jornal Universitário de Coimbra's Editor-in-Chief and news editor at Rádio Universidade de Coimbra. Then, he worked as press officer for the Faculty of Medicine of the University of Coimbra and Clube União 1919, a historic club from the city of students, and scientific content creator at Take the Wind. He also worked with brands such as Licor Beirão at the marketing agency 10.digital and taught regular, professional, and higher education classes. He has a passion for animal behavior, in particular primates, science communication, Lego, Harry Potter, and African Violets, which remind him of sunny afternoons at his grandmother's house.*

ABSTRACT

The importance of written and oral communication skills in science communication

Católica Porto Business School, Universidade Católica Portuguesa, Rua Diogo Botelho 1327, 4169-005 Porto, Portugal

Science communication, in its many and varied forms, is the most effective way of translating the complexity of difficult topics into a simpler formulation. We can think of the most diverse vehicles: an exhibition, a book, a lecture, a play, a newspaper article, or a video. At the basis of each of these instruments is the language in its written and oral forms. There is an obligation to master the language so that communication is as effective as possible so that it is easy to transform concepts, to use comparisons or metaphors to convey ideas. When we write, clarity is essential for the message to get through. Taking the example of Portuguese, the adoption of a second language, as I call journalism, can significantly improve the understanding and comprehension of science by society in general. Journalism has some basic rules of style that, when used in science, allow the reader a greater familiarity with the subject. Adverbs of manner ending in "-mente" (in Portuguese) require more cognitive effort for their perception and decrease the readability of the text. Abolishing those long words is one of these rules. Orality also depends on language proficiency. But the presence and cadence of the speech are often more important than the content itself. Mastery of voice, posture, and clarity of thought are key to asserting credibility with our audience. Self-mastery, more than mastering an audience, allows the message to get through in the best possible way. Avoiding verbal noises and repetition of words, or being able to tell a story, are some points that should always be present. Communicating is a fundamental design for universities. So, it is necessary to try to do it better and better. In this workshop, I will talk about some simple principles that can boost written and oral interaction with a broader audience.

Bárbara Pinho

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Bárbara Pinho *is a science communicator with experience working with scientists and magazines like National Geographic, Chemistry World, Discover, and more. She specializes in science writing, social media management and consulting and is particularly interested in telling stories about technology, climate science and health. Bárbara earned a BSc degree in Biomedical Science from the University of Aveiro, Portugal, in 2018, and a MSc in Science Communication from the University of Sheffield, UK, in 2020, where she developed notable work in science writing for diverse audiences, communication skills, research methods and public relations.*

ABSTRACT

Communicating science (aka bursting the bubble)

Freelance

The work of everyday scientists can influence the world as we know it. Yet, to have such an impact, scientists need to find ways to burst out of their “bubbles” and reach wider audiences. This talk will drive an audience of scientists around best practices to communicate science independently. I will highlight the importance of science communication while providing practical tips to scientists.

Adriano Cerqueira

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Adriano Cerqueira *is a science journalist and producer of the podcast '90 Segundos de Ciência'. He has over ten years of experience in the field of science communication, having previously worked in journalism, media relations, design, and documentary filmmaking. Adriano is the author of the popular science book 'Porque Flutuam os Meus Cereais?', and holds an MSc degree in Multimedia from the Faculty of Engineering of the University of Porto, and a graduate degree in Communication Sciences.*

ABSTRACT

Communicating science in less than 90 seconds: challenges and opportunities

NOVA FCSH, Av. de Berna 26C, 1069-061 Lisboa, Portugal

What are the challenges to communicating scientific information to the general public? What role can the media play in helping scientists reach a brother audience? And can we explain big scientific topics in a short amount of time? Since 2016 «90 Segundos de Ciência» a short format portuguese language podcast has provided a platform for scientists working in Portugal to promote their research to the general public through their own voice, by taking on the challenge of trying to explain complex scientific concepts in under 90 seconds. This talk will focus on effective ways to communicate science to a broader audience, particularly to the media. We will discuss the principles of effective science communication, including using simple language, avoiding jargon, and providing relatable examples. Through the perspective of a science journalist we will talk about what the media is looking for in a story, and how scientific research can fit in the editorial values of broadcast media. We will also provide tips on how to better adapt your language to a broader audience. Overall, this talk will go behind the scenes of «90 Segundos de Ciência» to provide a comprehensive guide to communicating science to the media. «90 Segundos de Ciência» is a radio show and podcast produced by ITQB NOVA and NOVA FCSH. It airs from Monday to Friday at Antena 1, a radio channel produced by the Portuguese public broadcasting entity RTP.

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Pedro Pombo *is Director of Fábrica Centro Ciência Viva de Aveiro and teacher at the Department of Physics at the University of Aveiro. Pedro is an expert on Holography and Science Communication. In the field of laser optics, he develops research on pseudocolor holograms and educational holography. In the field of science communication, he develops science content for exhibitions, science shows, labs, Maker Spaces and he has been the coordinator of several projects focused on public engagement on science and technology and on STEAM learning.*

ABSTRACT

New challenges for science communication: the case of Fábrica

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We live in an information and communication society, based on technology and in a digital world. Science is an activity that promotes socio-economic development, generating knowledge and technology, which promotes full citizenship and improves the life of each citizen. The lack of scientific culture creates various constrains in society and it can facilitate disinformation, false information or pseudoscience. Science communication plays an important role in promoting scientific culture and bringing science closer to the general public, contributing not only to the appropriation of scientific knowledge, but also to present the work of scientists, reinforcing the importance and implications of research in science. This can be done based on two models: one related with the dynamics of communication[1] and the other related with the interaction with the public[2]. In 2004, the University of Aveiro has created a professional science communication unit focus on two main goals: to connect and bring closer the scientific community of the University of Aveiro and the society and to promote science dissemination actions among the general public and, in particular, school audiences. This unit is Fábrica Ciência Viva Science Center. Several challenges and new realities have transformed Fábrica, forcing it to adapt to new goals and to develop different growth models. Recent transformations in society have put the sustainability and functioning models of different science communication structures to the test. Some of these challenges turned into opportunities for the development and consolidation of Fábrica. In this communication, the case of Fábrica will be analyzed and results obtained will be presented and discussed.

References:

[1] D. Brossard, B. Lewenstein, Communication **2009**, 16, 11-39.

[2] T.W. Burns, *et al*, Public Understanding of Science **2003** 12, 183-202.

SCIENTIFIC WRITING & PUBLISHING WORKSHOP

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Nesma El-Sayed Ibrahim *received her BSc and MSc in pharmaceutical sciences from Alexandria University in Egypt. She then completed her Ph.D. studies at Saarland University, Germany, investigating theranostic gelatin nanoparticles for antigen delivery and strategies for transcutaneous applications. During her Postdoc in the lab of Helder Santos at the University of Helsinki, Finland, she studied microneedles as platforms for drug delivery. Nesma joined Springer Nature in May 2022 for the launch of Nature Reviews Bioengineering. Nesma is based in Berlin, Germany.*

ABSTRACT

Publishing your research – and a new Nature journal

Nesma El-Sayed Ibrahim

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Publishing research is a crucial step for researchers to share their findings and insights with the scientific community and advance their careers. However, it can be a challenging process that requires careful planning, attention to detail, and excellent writing skills. Among the recently released journals from Nature group is Nature Reviews Bioengineering[1], which focuses on publishing Reviews and Commentaries on the latest advances in bioengineering for biomedical and environmental applications. The journal provides a platform for researchers, engineers, and clinicians to publish their findings and share their insights on the intersection of biology and engineering. The journal covers many topics, including biomaterials, synthetic biology, tissue engineering, drug delivery, imaging, and computational biology. As an editor in Nature Reviews Bioengineering, I aim to introduce the vision of our new journal and the publication process, highlighting the stages of manuscript handling and the role of authors and reviewers together with the editors to finalize high-quality publications.

References:

[1] Nature Reviews Bioengineering, www.nature.com/natrevbioeng/

ABSTRACT

From the lab to editorial – a carrier in scientific publishing

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Transitioning from a research lab to a career in scientific publishing offers an exciting and rewarding opportunity for those seeking alternative paths outside of academia. Those interested in pursuing such a career should possess relevant academic qualifications and experience in scientific research, along with a keen interest in scientific communication. As an editor, having a passion for science is crucial for making a significant contribution to advancing scientific knowledge and shaping the scientific landscape. Having worked in both academia and scientific publishing, I have personally experienced the transition from the lab to an editorial career. Through this transition, I gained valuable expertise and insights into the world of scientific publishing that could be beneficial to others considering a similar career path.

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