

# ERC Grants

## CENIMAT|i3N



European Research Council  
Established by the European Commission



# i3N

INSTITUTE FOR  
NANOSTRUCTURES,  
NANOMODELLING AND  
NANOFABRICATION

RESEARCH, INNOVATION AND  
ENGINEERING APPLICATIONS

Since its creation in 2006, i3N has established itself as a leading national and international institute, in the area of advanced materials and nanotechnologies. Pioneering fields such as photovoltaics, thin-film microelectronics, and transparent electronics. With an interdisciplinary structure, i3N comprises six research groups addressing strategic challenges, including sustainable nanotechnology and biomedical engineering. I am proud to highlight the eleven ERC grants already achieved, reinforcing our leadership in Materials Science and Nanotechnology in Portugal.

At i3N, we believe that the collective strength of a collaborative team far exceeds the sum of its parts, particularly in a multidisciplinary field like Nanotechnology. Beyond advancing research, we are also training the next generation for academia, industry, and entrepreneurship. With state-of-the-art tools available at i3N, the sky is no more the limit!

*Rodrigo Martes*

<https://i3n.org>



This work is funded by National Funds through the FCT - Fundação para a Ciência e a Tecnologia, I.P., and the Ministério da Educação, Ciência e Inovação under the scope of the projects LA/P/0037/2020, UIDB/50025/2020 and UIDP/50025/2020



i3N wet labs has received in 2025 the certification from "My Green Lab Certification", as a commitment to Sustainable Science! My Green Lab Certification is considered the gold standard for laboratory sustainability best practices around the world and was recognized by the United Nations Race to Zero campaign as a key measure of progress towards a zero-carbon future.

2025

## The Impact of ERC Grants on Europe, Portugal, and CENIMAT|i3N

The European Research Council (ERC) represents the highest standard of scientific excellence in Europe, and globally. Its competitive, curiosity-driven funding empowers researchers to pursue breakthrough ideas with boldness and independence, advancing fundamental knowledge and addressing the applied challenges of the future.

In Portugal, ERC-funded projects have become a cornerstone of scientific excellence and international recognition. At NOVA University Lisbon, 39 ERC grants have been secured to date, a major national achievement. Of these, 12 were awarded to researchers at CENIMAT|i3N, representing an impressive 31% of the university's total.

This success goes far beyond numbers. ERC grants have profoundly transformed our Associate Laboratory, strengthening complex research infrastructures, enabling the formation of world-class multidisciplinary teams, and enhancing the international reputation of CENIMAT|i3N.

Recognising the strategic value of the ERC programme, Portugal established the ERC Portugal initiative, coordinated by the Fundação para a Ciência e a Tecnologia (FCT). This national effort comprises several pillars aimed at supporting researchers in preparing competitive ERC proposals, reinforcing institutional capacity, and ultimately boosting Portugal's ability to attract and retain top scientific talent, while fostering a sustainable culture of research excellence.

These projects are not only advancing frontier science, they are actively shaping the future. At CENIMAT|i3N, our focus on advanced materials research contributes directly to Europe's competitiveness and technological sovereignty. The ERC stands not only as a funding mechanism, but as a true source of inspiration, for researchers, institutions, and nations committed to scientific ambition and excellence.

For all these reasons, we are deeply grateful to the ERC, the world's best science funding programme. As Maria Leptin so rightly said: "A stronger Europe starts with science."

## MISSION **i3N**

i3N conducts research in the strongly multidisciplinary field of advanced materials, nanotechnology and nanosciences.

The mission of i3N is:

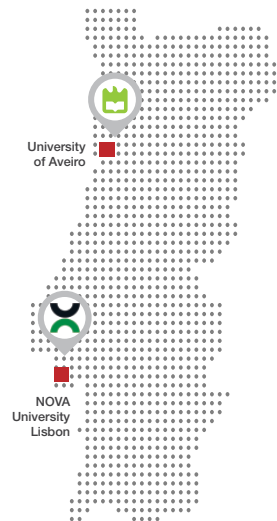
- Promoting scientific excellence and innovation in Sustainable Functional Advanced Materials, using green technologies, to serve a plethora of fields and for socio-economical ends, aligned with the Sustainable Development Objectives and the Green Deal.
- Pushing the international leading edge of research by fostering breakthrough concepts and exploiting materials and device properties at nanoscale level.
- Promoting practical applications of R&D+I results, including their transfer to the industry.
- To provide access of the institute facilities and equipment to the technical-scientific community and lending assistance to industry.
- Training and enabling the continuous education of scientific personnel (including MSc and PhD students) and technical researchers, enabling them to overcome the future challenges of science and technology cross cutting fields.
- Fostering public awareness, engagement and understanding of advanced materials, nanoscale science, engineering and nanotechnology.
- Providing scientific and technical evidences in order to sustain the Public Policies for the changes of the future.

## GOALS **i3N**

i3N focuses on three main issues to pursue its mission:

- To create a top environment for international scientific talent.
- To create strong multidisciplinary cohesion within the infrastructure.
- To be a national leader and international key player in nanotechnology and advanced materials.

## ORGANIZATIONAL STRUCTURE **i3N**



### University of Aveiro Hub



**José Fernando Mendes**  
Vice-Coordinator  
RG6 Research Group Leader  
Theoretical and Computational  
Physics Group



**Florinda Costa**  
TL3 Thematic Line Coordinator  
Nanomaterials Engineering and  
Functional Interfaces



**João Veloso**  
TL4 Thematic Line Coordinator  
Biomedical Devices and Systems



**Paulo Antunes**  
RG2 Research Group Leader  
Nanophotonics and Optoelectronics



**Manuel Graça**  
RG3 Research Group Leader  
Physics of Advanced Materials and  
Devices

### NOVA University of Lisbon Hub



**Rodrigo Martins**  
Coordinator  
TL2 Thematic Line Coordinator  
Green and Clean Energy Systems



**Pedro Barquinha**  
TL1 Thematic Line Coordinator  
Sustainable Micro and Nanofabrication  
RG1 Research Group Leader  
Materials for Electronics, Optoelectronics  
and Nanotechnologies



**João Paulo Borges**  
RG4 Research Group Leader  
Soft and Biofunctional Materials

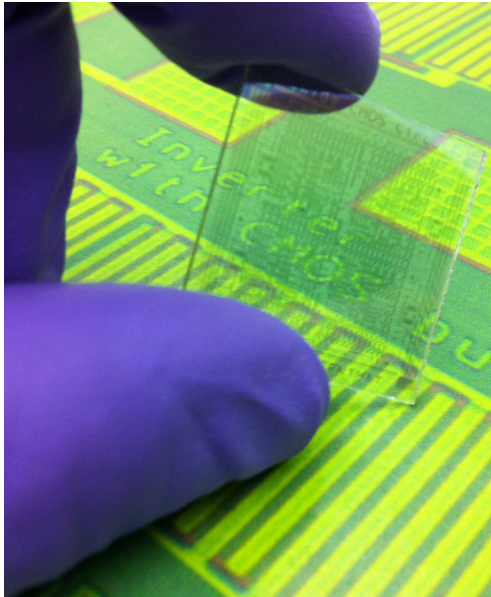


**João Pedro Oliveira**  
RG5 Research Group Leader  
Structural Materials



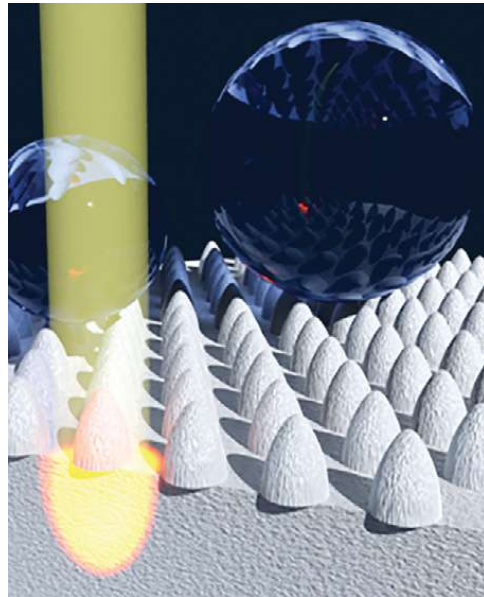
**TL1**  
**SUSTAINABLE MICRO  
AND NANOFABRICATION**

Since 2003, i3N has been a leader in oxide thin-film transistors (TFTs). While materials like indium-gallium-zinc oxide (IGZO) are explored industrially, i3N pursues breakthrough advances, on more sustainable semiconductors.



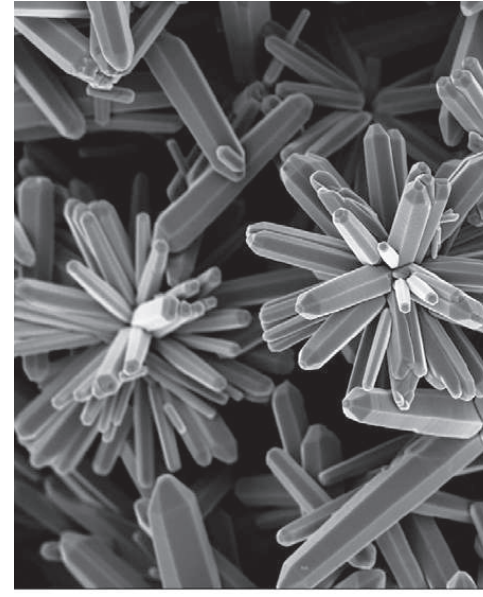
**TL2**  
**GREEN AND CLEAN ENERGY SYSTEMS**

We focus on consumer-oriented renewable power systems exploring cost-effective energy harvesting (e.g. photovoltaics improved with photonics, mechanical from motion, thermal) and storage (e.g. batteries and supercapacitors, solar fuels) aiming for a fully decarbonized society.



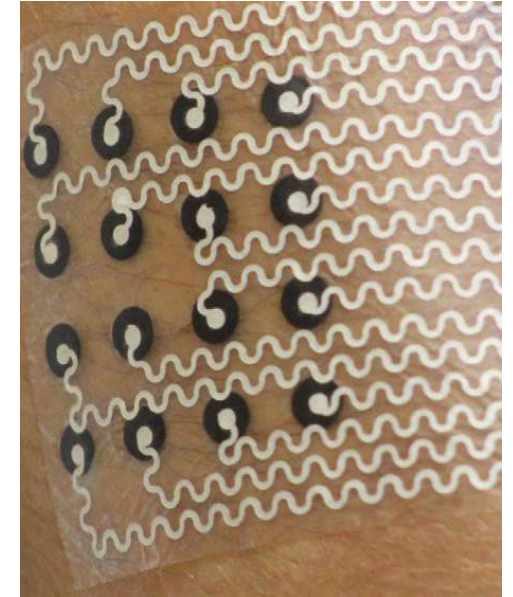
**TL3**  
**NANOMATERIALS ENGINEERING AND  
FUNCTIONAL INTERFACES**

Our emphasis is on developing materials and nanoparticles for energy, optoelectronic, electronic, and bio applications. We also functionalize interfaces for diverse applications.



**TL4**  
**BIOMEDICAL DEVICES AND SYSTEMS**

We work on innovative biomedical solutions for disease prevention and precision medicine, developing medical devices, imaging systems, and regenerative medicine to improve longevity.



## MAIN SCIENTIFIC AREAS OF PUBLICATION

**i3N**

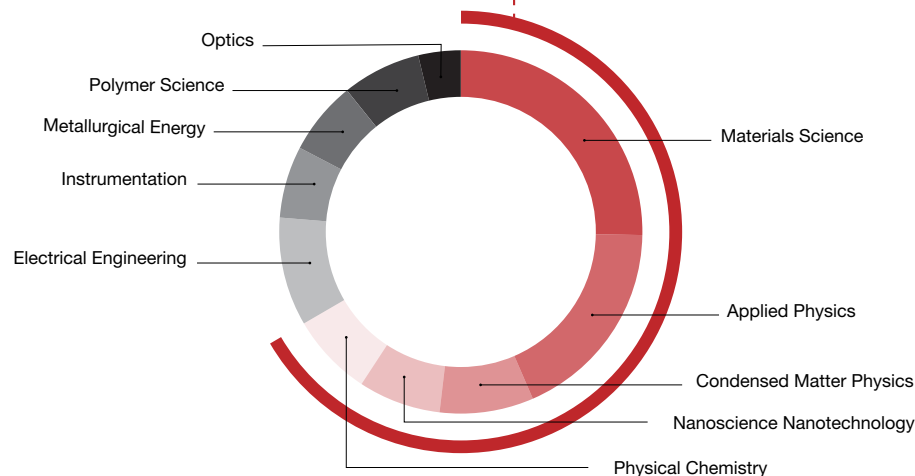
**+70%**

HIGH-RANKING  
JOURNALS

**63%**

INTERNATIONAL  
COLLABORATION

**66%**



## SCIENTIFIC INDICATORS 2018-2023

**i3N**

SCIENTIFIC  
PUBLICATIONS

**+1600**

HIGHLY CITED PAPERS

**42**

PATENTS ISSUED

**58**

HIGH-RANKING JOURNALS

**70%**

INTERNATIONAL  
COLLABORATION

**63%**

CITATIONS

**+60000**

i3N H-INDEX

**111**

CONFERENCE  
ORGANIZATION

**+30**

PLENARY / KEYNOTE

**78**

INVITED

**170**

COMMUNICATIONS

**+1400**

## PROJECTS GRANTED 2018-2023

**i3N**

**+61 M€**

**45**

DEMONSTRATORS/  
PROTOTYPES  
DEVELOPED

**07**

ERC  
2018 — 2023

**102**

PROJECTS

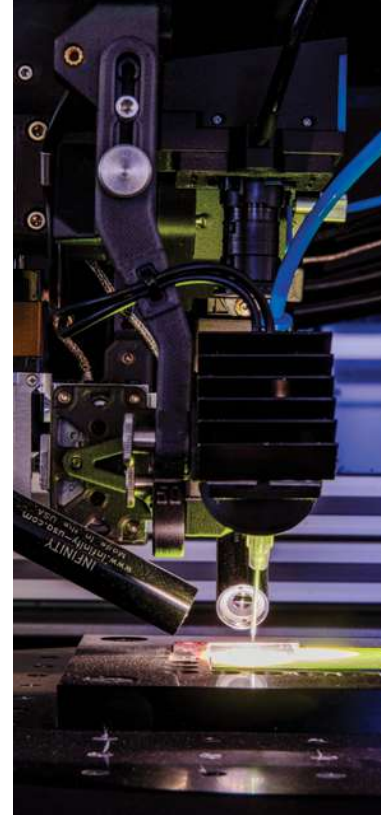
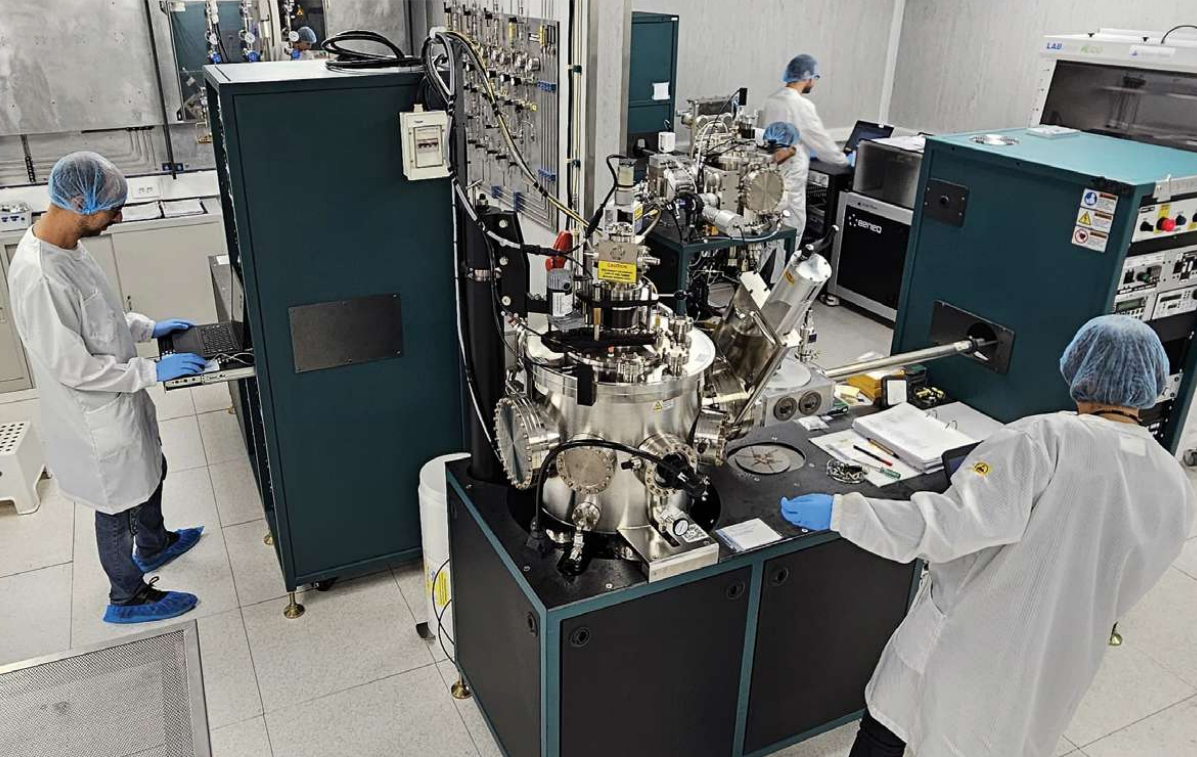


# i3N

## RESEARCH FACILITIES

— material device/  
fabrication

i3N Microelectronics Laboratories are state-of-the-art thin film based semiconductor research and fabrication facilities that support the design, fabrication, and testing of novel devices and systems.



# 03

CLEAN ROOM  
FACILITIES WITH  
1080 m<sup>2</sup>





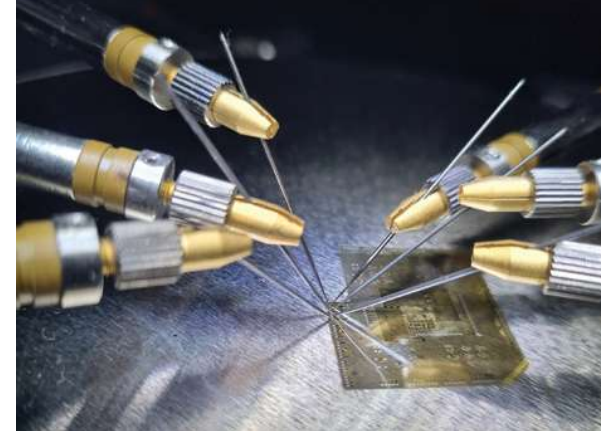
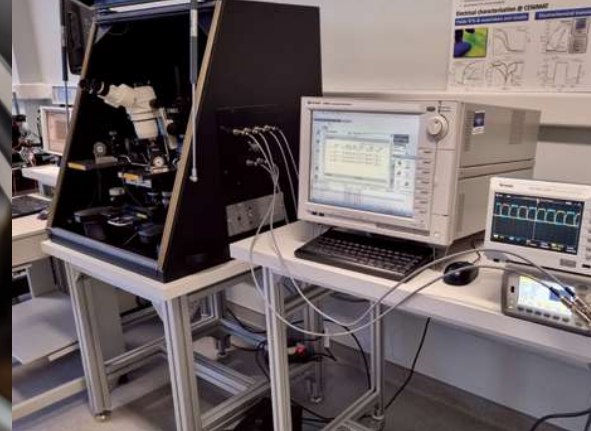
# i3N

## RESEARCH FACILITIES

— material device/  
characterisation

A state-of-the-art infrastructure  
that provides access to advanced  
equipments, ranging from design to  
fabrication and characterisation:

- Advanced Electron Microscopy
- Micro and Nanofabrication
- Nanophotonics & Bioimaging
- Materials Characterisation





i3N

SCIENCE  
& SOCIETY

## PUBLIC AWARENESS

Fostering public awareness, engagement  
and understanding of advanced materials.

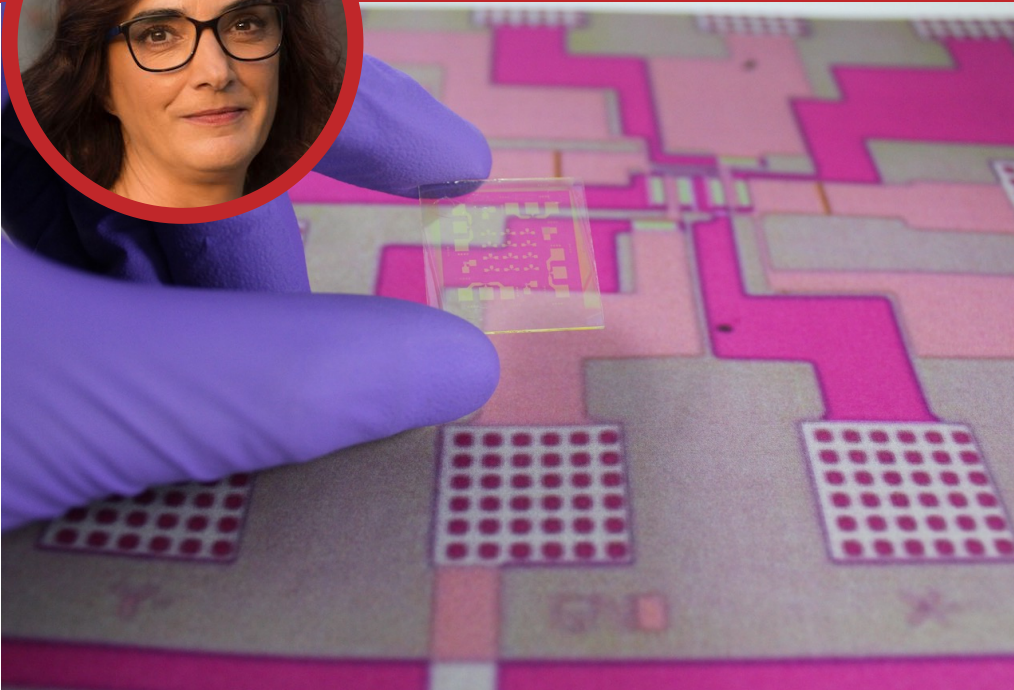
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## INVISIBLE

### Advanced Amorphous Multicomponent Oxides for Transparent Electronics

Imagine having a fully transparent and flexible, foldable, low cost, displays or at the glass window of your home/office, a transparent electronic circuit, do you believe on that? Maybe you are asking me if I am writing science fiction. No I am not. In fact this is a very ambitious objective but is tangible in the framework of this project due to the already acquired experience in the development of transparent thin film transistors using novel multifunctional and multicomponent oxides that can behave as active or passive semiconductor materials.

This is an interdisciplinary research project aiming to develop a new class of transparent electronic components, based on multicomponent passive and active oxide semiconductors (n and p-types), to fabricate the novel generation of full transparent electronic devices and circuits, either using rigid or flexible substrates.

The emphasis will be put on developing thin film transistors (n and p-TFTs) and integrated

circuits for a broad range of applications (from inverters, C-MOS like devices, ring oscillators, CCDs backplanes for active matrices, biosensor arrays for DNA/RNA/proteins detection), boosting to its maximum their electronic performances for next generation of invisible circuits. By doing so, we are contributing for generating a free real state electronics that is able to add new electronic functionalities onto surfaces, which currently are not used in this manner and that silicon cannot contribute. The multicomponent metal oxide materials to be developed will exhibit (mainly) an amorphous or a nanocomposite structure and will be processed by PVD techniques like rf magnetron sputtering at room temperature, compatible with the use of low cost and flexible substrates (polymers, cellulose paper, among others). These will facilitate a migration away from tradition silicon like fab based batch processing to large area, roll to roll manufacturing technology which will offer significant advantages.

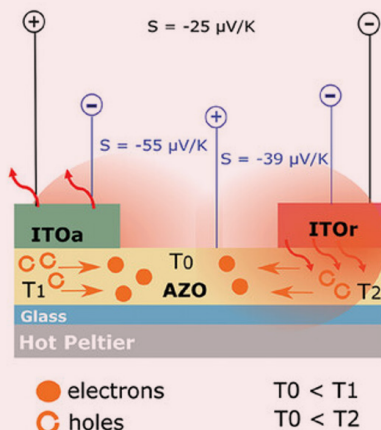
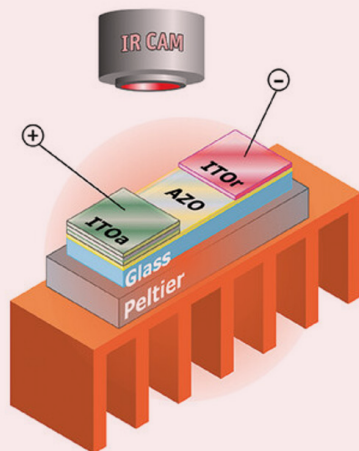


Fully recyclable and low cost electronic goods are still far from reality. My interest is in creating environmental friendly advanced functional materials and processes able to result in new class of paper based electronic products. This represents a reborn of the paper millenary industry for a plethora of low cost, recyclable and disposable electronics, putting Europe in the front line of a new era of consumer electronics.

While the vision of the proposal is a very ambitious one, my ground-breaking research work to date related with oxide based transistors on paper (from which I am one of the co-inventors) has contributed to the basic technological breakthroughs needed to create the key elements to establish a new era of paper electronics. Field effect transistors (FETs), memory and CMOS devices, with excellent electronic performance and using paper as substrate and dielectric have resulted from my recent work. What I am proposing now is to reinvent the concept of paper

electronics. In NEW\_FUN I want to develop a completely new and disruptive approach where functionalized cellulose fibers will be used not only as dielectric but also as semiconductor and conductor able to coexist in a multilayer paper structure. That is, assembling paper that can have different functionalities locally, on each face or even along its entire thickness/bulk. This way issues such as failure under bending, mechanical robustness and stability can be minimized. Doing so, electronic and electrochemical devices can be produced not only on paper but also from paper. The outputs of NEW\_FUN will open the door to turn paper into a real electronic material making possible disposable/recyclable electronic products, such as smart labels/packages (e.g. food and medicine industry), sensors for air quality control (car, house and industry environments); disposable electronic devices such as bio-detection platforms, lab-on-paper systems, among others.




 $S = -25 \mu\text{V/K}$ 


## CapTherPV

Integration of Capacitor, Thermoelectric and PhotoVoltaic thin films for efficient energy conversion and storage

The possibility of having a unique device that converts thermal and photonics energy into electrical energy and simultaneously stores it, is something dreamed by the PI since the beginning of her research career. To achieve that goal, this project aims to gather, in a single substrate, solar cells with up-conversion nanoparticles, thermoelectrics and graphene super-capacitor, all made of thin films.

These three main components will be developed separately and integrated sequentially. The innovation proposed is not limited to the integration of components, but rely in ground-breaking concepts:

- 1) thermoelectric elements based on thin film (TE-TF) oxides;
- 2) plasmonic nanoparticles for up conversion of near infrared radiation to visible emission in solar cells;
- 3) graphene super-capacitors;

4) integration and optimization of all components in a single CapTherPV device.

This ambitious project will bring new insights at large area, low cost and flexible energy harvesting and comes from an old idea of combining energy conversion and storage that has been pursued by the PI. She started her career in amorphous silicon thin film solar cells, later she started the development of thin film batteries and more recently started a research line in thermoelectric films.

If approved, this project will give financial support to consolidate the research being carried out and will give independence to the PI in terms of resources and creative think. More importantly, will facilitate the concretization of the dream that has been pursued with hard work.



## TREND

### Transparent and flexible electronics with embedded energy harvesting based on oxide nanowire devices

The Internet of Things is shaping the evolution of information society, requiring an increasing number of objects with embedded electronics, sensors and connectivity. This spurs the need for systems where summing to performance and low cost, multifunctionality has to be assured. In this context, TREND aims to take transparent electronics into as-of-yet unexplored levels of integration, by combining on flexible substrates transparent and high-speed nanocircuits with energy harvesting capabilities, all based on multicomponent metal oxide nanowires (NWs).

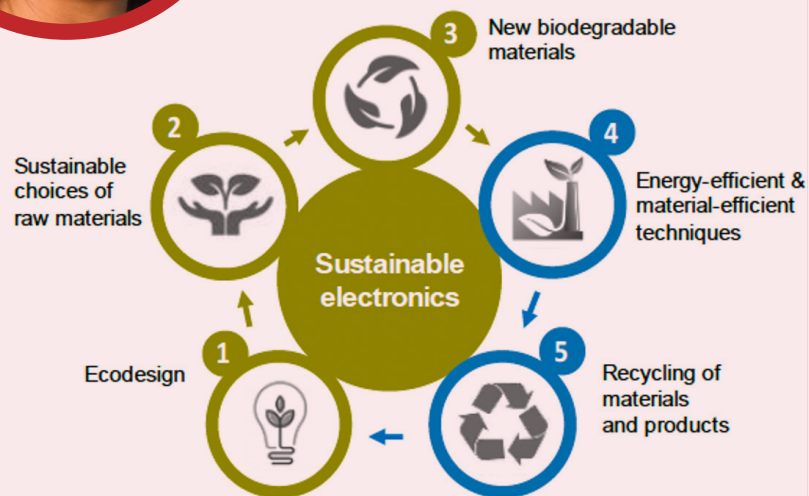
For this end, sustainable and recyclable materials as ZnO, SnO<sub>2</sub>, TiO<sub>2</sub> and Cu<sub>2</sub>O will be synthesized in different forms of heterostructured NWs, using low-temperature and low-cost solution processes. For precise positioning, NWs will be directly grow on flexible substrates using seed layers patterned by nanoimprint lithography. This will be crucial for integration in different nanotransistor structures, which will be combined into digital/analog nanocircuits following planar and

3D approaches. Energy will be provided by piezoelectric nanogenerators with innovative structures and materials. Final platform of nanocircuits+nanogenerators will make use of NW interconnects, bringing a new dimension to the systems-on-foil concept.

The research will be carried out at FCT-UNL, in a group pioneering transparent electronics. My PhD on oxide materials/devices and proven expertise on circuit integration, oxide nanostructure synthesis and nanofabrication/characterization tools will be a decisive contribute to the implementation of the proposal.

TREND is an ambitious multidisciplinary project motivating advances in materials science, engineering, physics and chemistry, with impact extending from consumer electronics to health monitoring wearable devices. By promoting new ideas for practical ends, it will contribute to place Europe in the leading position of such strategic areas, where sustainability and innovation are key factors.





DIGISMART creates new avenues into two main areas:

1) processing nanomaterials/nanostructures applied to electronic devices by exploring a new digital multifunctional direct laser writing (LDW) method for in situ synthesis of small-sized nanomaterials/nanofilms micro-patterned growth by selective photothermal decomposition of semiconductors, dielectrics and conductors precursors, and

2) provide simultaneously multifunction to single based metal oxide devices (like thin film transistors, the workhorses for large area electronics having electron, charge and color modulation), as the basic unit to promote systems' integration by exploring the use of new advanced materials with unique multifunctionalities using low cost process solutions.

This new fabrication process will be very useful for low-cost, eco-friendly, and efficient fabrication of nanostructures and thin films-integrated microelectronic devices

due to its low-power, simple setup as well as excellent reliability. This new and disruptive concept will be achieved with low cost and non-toxic materials (new metal oxides, MO semiconductors, conductors, dielectrics and electrochromics free of In and Ga) associated to a low cost process multifunctional platform technology (ALL-IN-ONE TOOL) well supported by high-resolution nano-characterization techniques.

With DIGISMART new and unexplored materials will be produced as well as to boost the original properties of conventional materials in order to contribute to the needs for low cost and flexible electronics. If we succeed to embed some level of intelligence in every object, this would change electronics and it would change society, ranging from embedded window displays to a wide range of biomedical electronics, just to mention a few and this is what the Internet of Things is looking for.



## CAPSEL

### Cellulose Aluminium Polymer multi-ions composite Solid-electrolyte

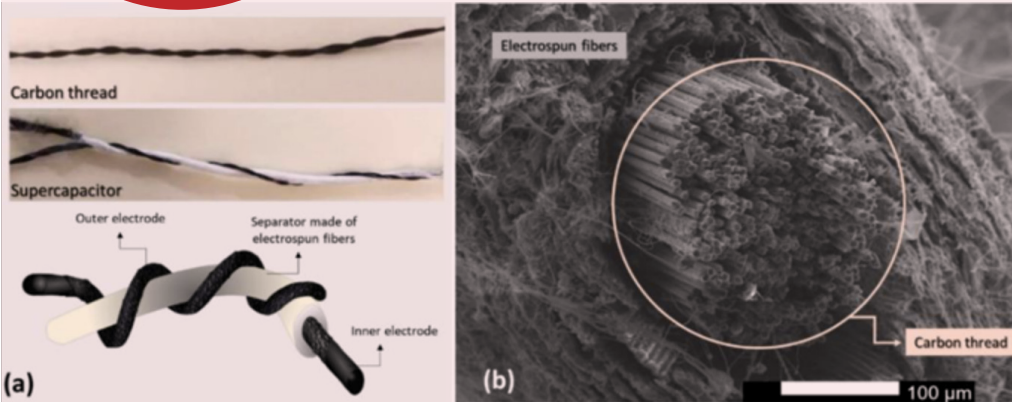
Efficient batteries rely heavily on liquid electrolytes and lithium. The EU-funded CAPSEL project developed a new solid electrolyte that can efficiently replace liquid electrolytes. It contains selected cellulose, aluminium and ions.

These materials are more abundant than lithium, cause no harm to the environment and can be recycled through conventional processes.

Aluminium is also a cheaper and less reactive metal than lithium.

Besides solving many of the safety risks in commercially available batteries, solid electrolytes allow a significant reduction in battery size and weight. The proof-of-concept system holds important implications for low-cost, disposable applications, such as electronic paper, smart labels and smart packing.





The management of solar intermittency relies on costly and polluting external storage systems. The EU-funded INSOLENSYS project proposes an integrated approach to the production and storage within photovoltaic cells, which is flexible and adaptable to all types of solar cells, from home systems to large-scale industrial installations.

It ensures around-the-clock generation of stable energy and eliminates the need for

external storage. It also facilitates the greater widespread of the renewable energy, uses eco-friendly and available raw materials, and it is in line with the goals of the EU's Green Deal.

The project will prove its viability on a pre-industrial level through extensive testing and validation, investigate its commercial potential and increase its Technology and Investment Readiness Levels.



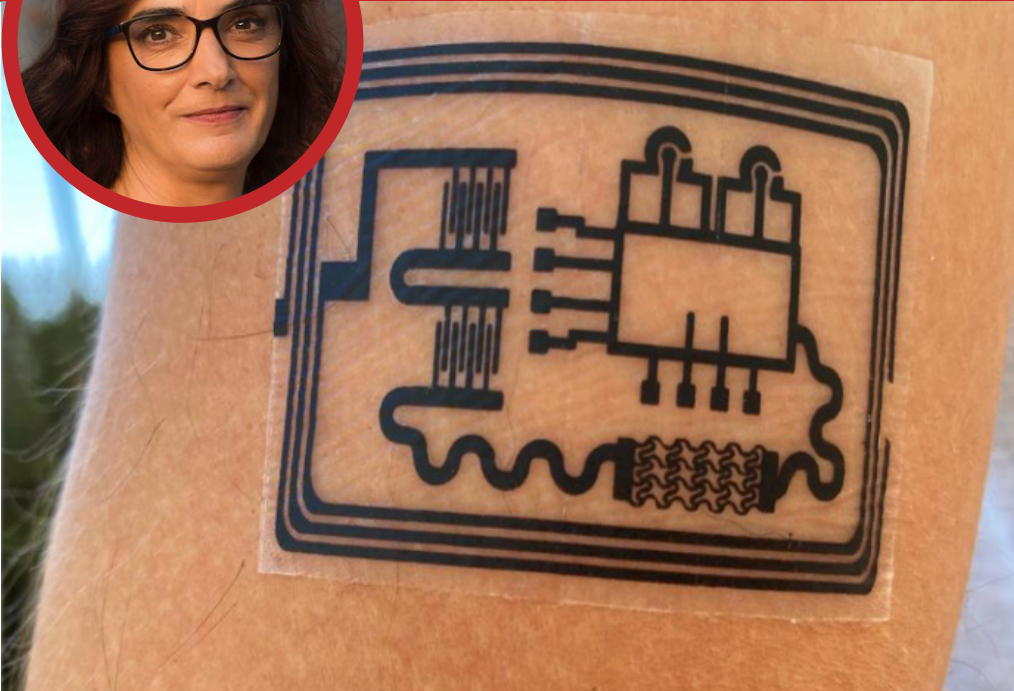
2021 | Proof of Concept | Elvira Fortunato

e-GREEN

From forest to electronics: green graphene

150 000 €

Physical Sciences and Engineering



2021

Proof of Concept | Elvira Fortunato

**e-GREEN**

**From forest to electronics: green graphene**



E-waste is one of the fastest-growing waste streams on the planet and represents a strong bottleneck for our society, concerning lack of raw materials and excess of high-tech trash produced, for which we expect harmonious growth with comfort and prosperity. So far, it has been produced around 50 million tons per year of e-waste! This constitutes to the electronics industry a critical challenge: how to balance, decreasing supplies with growing volumes of e-waste, where printing circuit boarding are a major and essential part?

The solution is the use of new sustainable approaches, either in terms of materials or technological processes. e-GREEN project aims to answer to these concerns by the direct formation of high conductive 3D graphene-based patterns as printed circuits on recyclable

flexible substrates, avoiding the need to use scarce and non-environmentally friendly metallic materials apart from expensive, pollutant and time-consuming processes.

The objective of this project is so, to develop a proof of concept towards market applications prototypes with a small series production in order to evaluate the electrical performances over time, as well as to perform an extensive market analysis, in order to establish an accurate and robust business plan.

We strong believe that this disruptive technology process will open new opportunities for sustainable electronics alongside with advantages in terms of cost, time with clear environmental benefits.



2022 | Proof of Concept | Pedro Barquinha

FLETRAD

Flexible and transparent platform based on oxide transistors for detection and readout of ionizing radiation

150 000 €

01/10/2022 | 30/06/2024 | Physical Sciences and Engineering



2022

Proof of Concept | Pedro Barquinha



## FLETRAD

**Flexible and transparent platform based on oxide transistors for detection and readout of ionizing radiation**

Ionising radiation, high-energy radiation that can remove electrons from atoms or molecules causing them to become ionised, can damage cells and their DNA. Monitoring the dose of ionising radiation in applications from energy and healthcare to civil security is of utmost importance.

Flexible and wearable X-ray detectors are an emerging potential solution in next-generation

technologies, yet no innovation currently combines portability, high resolution, low cost and complexity and other desired traits.

The EU-funded FLETRAD project will develop a flexible and transparent platform addressing all current challenges by exploiting patented oxide transistors as direct ionising radiation detectors.





2023 | Consolidator Grant | Manuel Mendes

X-STREAM

Power-to-X: STREAMing Hydrogen from 3-Band Solar Cells boosted with Photonic Management

1 999 608 €

01/05/2029 | 30/04/2029 | Physical Sciences and Engineering



2023

Consolidator Grant | Manuel Mendes



## X-STREAM

**Power-to-X: STREAMing Hydrogen from 3-Band Solar Cells boosted with Photonic Management**

Conventional photovoltaic technologies, while effective at harnessing solar energy, suffer from limited efficiency in converting sunlight into electricity, while also lacking energy storage capability.

Funded by the European Research Council, the X-STREAM project aims to revolutionise sustainable energy deployment with innovative photovoltaic systems capable of storing energy through coupling with electrochemistry. The research will develop technology

to pronouncedly boost the efficiency of nanostructured solar cells by converting a wider range of sunlight into electricity.

Moreover, it will utilise electrochemical flow cells to power the electrolysis of water and synthesise hydrogen fuel, thereby supporting an environmentally friendly hydrogen economy. Ultimately, X-STREAM aims for industrial deployment with customisable prototypes.



2023 | Proof of Concept | Luis Nunes Pereira

EXCELL

CELLulose nanocomposite separators for the nEXt generation of smart batteries

150 000 €

01/06/2023 | 30/12/2024 | Physical Sciences and Engineering



2023

Proof of Concept | Luis Nunes Pereira



EXCELL

CELLulose nanocomposite separators for the nEXt generation of smart batteries

The growing popularity of electric vehicles is accompanied by the challenge of managing the increasing number of end-of-life batteries, with projections showing 2 million tonnes worldwide by 2030.

Additionally, battery production suffers from high scrap rates, especially during ramp-ups, while the scarcity of raw materials adds pressure on Europe to localise supply chains.

These challenges underscore the urgent need for greater sustainability in the battery

value chain. In this context, the ERC-funded EXCELL project will introduce a revolutionary battery separator made from 100 % natural cellulose nanocomposites.

With tunable mesopores and the ability to integrate sensing elements, this new separator will enhance the lifespan and recyclability of batteries, paving the way for smarter, eco-friendly cell components.



2024 | Synergy Grant | Helena Godinho\*

ALCEMIST

A typical Liquid Crystal Elastomers: from Materials Innovation to Scalable processing and Transformative applications

2 336 961 €

2025 | 2029 | Physical Sciences and Engineering



\* Together with Jan P.F. Lagerwall from University of Luxembourg and Eugene M. Terentjev from University of Cambridge

2024

Synergy Grant | Helena Godinho



## ALCEMIST

**A typical Liquid Crystal Elastomers: from Materials Innovation to Scalable processing and Transformative applications**

Traditional engineering relies on passive static components, such as beams, wires, and joints, which are driven by active dynamic elements like motors, dampers, and sensors. This approach limits the potential for more integrated, flexible systems.

The ERC-funded ALCEMIST project seeks to improve this by combining the functionalities of both passive and active components in a single material. The project focuses on liquid crystal elastomers (LCEs), which are unique, responsive materials that change shape, colour, and properties in response to stimuli.

ALCEMIST's sustainable, cost-effective LCEs, made from polysaccharides, will be reprocessable and reusable, opening up innovative applications in areas like adaptive building elements, medical devices, and smart materials, with a transformative approach to large-scale industrial use.

ALCEMIST challenges the conventional engineering mindset where passive static components (beams, wires, joints) are driven by active dynamic ones (motors, dampers, sensors); our innovative materials enable the

combined functionality in a single component. This bold ambition is feasible because our research will unlock the full potential of liquid crystal elastomers (LCEs), unique responsive materials that reversibly change shape, colour, adhesive or damping properties, triggered by stimuli like heat, light, humidity or strain.

We propose a radically new sustainable materials platform based on polysaccharides, functionalising precursors such that anyone using click chemistry can make LCEs that are powerful yet biocompatible and biodegradable, at one tenth of the cost of state-of-the-art LCEs. Further, using bond-exchange chemistry, ALCEMIST LCEs will be re-processable and re-usable.

We also present a ground-breaking processing approach based on flow patterning to make large-scale LCEs of complex shapes and actuation modes. The synergy of three perfectly complementary and highly productive scientists, each a recognised leader in their field, enables this transformative approach to making atypical LCEs.



Notes


Notes




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## CENIMAT|i3N



**universidade de aveiro**  
theoria poiesis praxis