



**Castilla-La Mancha**

PLAN DE RECUPERACIÓN,  
TRANSFORMACIÓN Y RESILIENCIA

#PlanEspañaPuede

**Área:** MATERIALES AVANZADOS

**Título del Programa:** MATERIALES CON FUNCIONALIDADES AVANZADAS PARA LA NUEVA TRANSFORMACIÓN TECNOLÓGICA

**Coordinador de la propuesta en el Gobierno de la Comunidad**

Ricardo Cuevas Campos

Junta de Comunidades de Castilla-La Mancha

**Coordinador científico**

Ester Vázquez Fernández-Pacheco

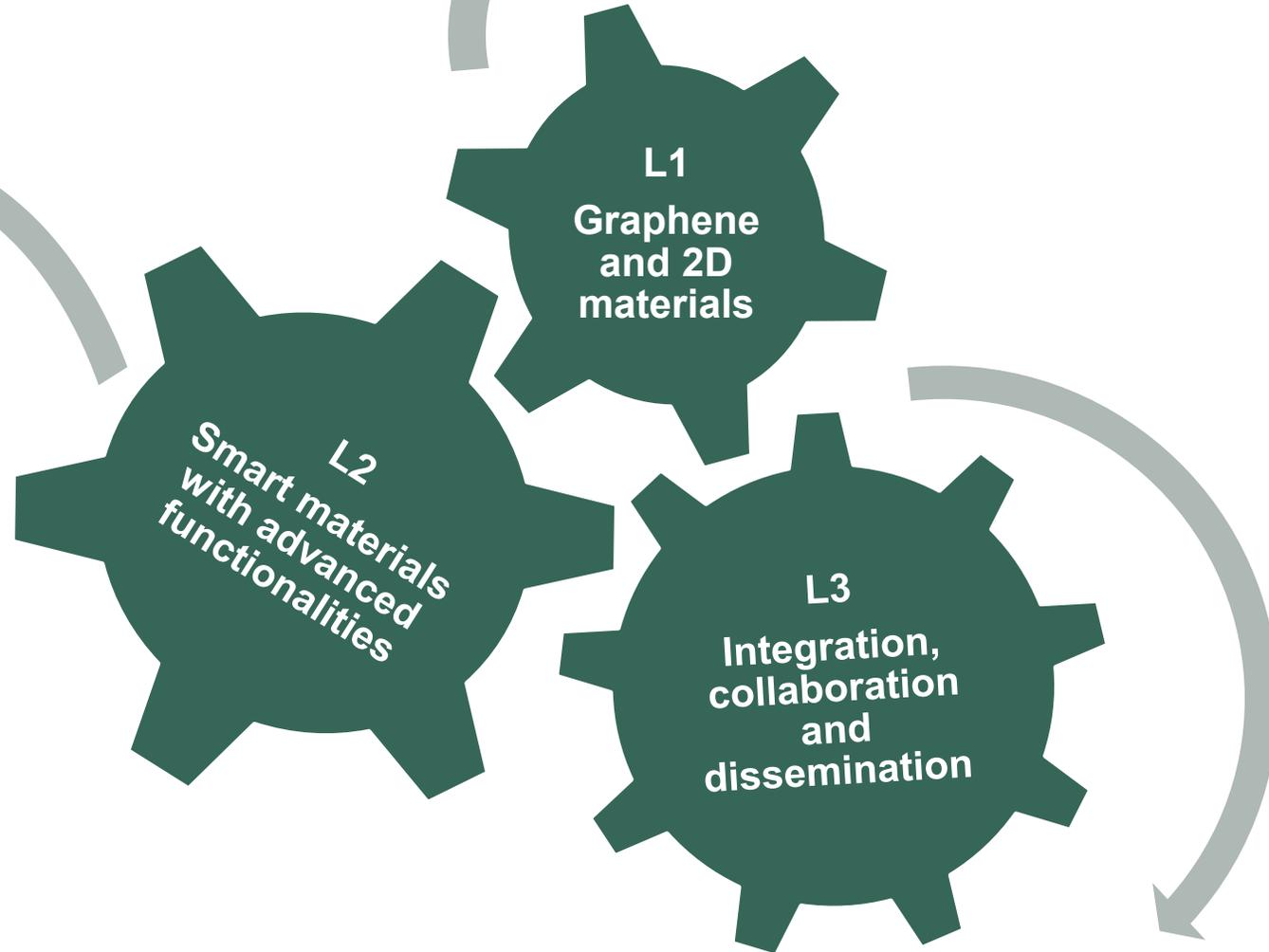
Instituto Regional de Investigación Científica Aplicada (IRICA)

UCLM

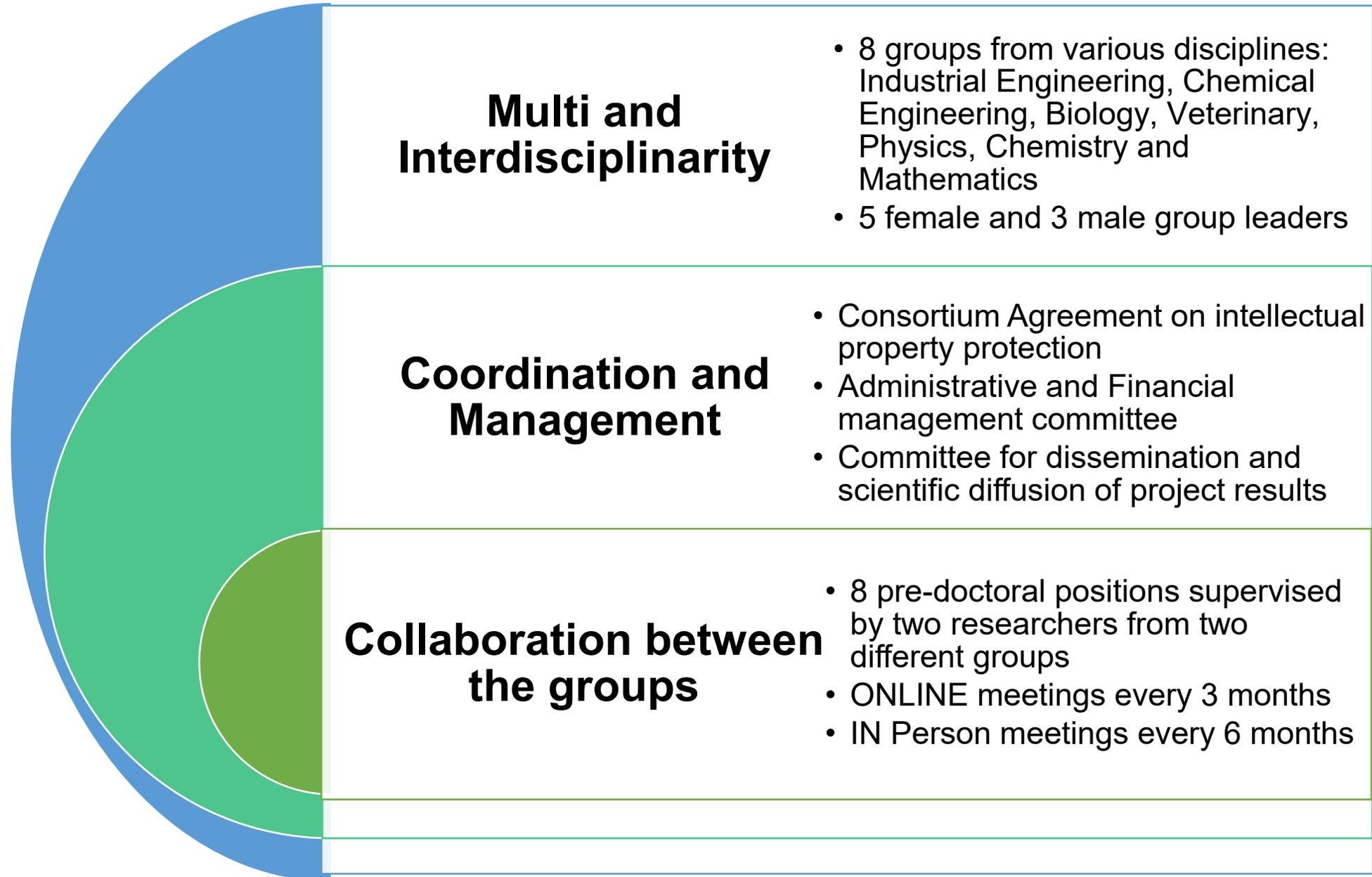
# CLM CONSORTIUM

Basic and sustainable research.  
Safe by design.  
Life cycle.

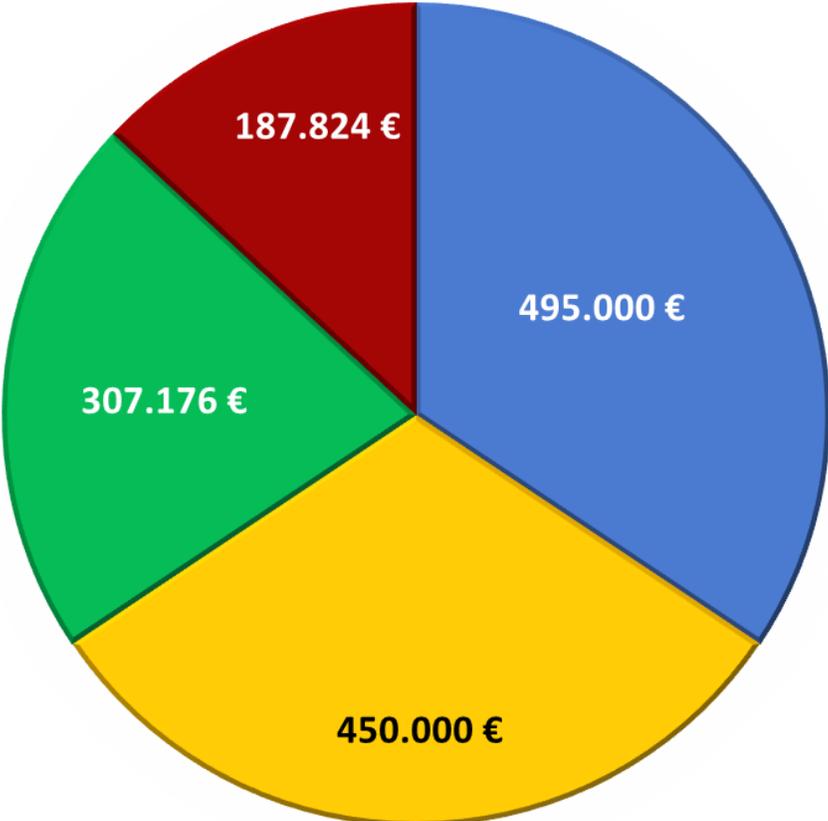
Applications



# THE CONSORTIUM AS A WHOLE



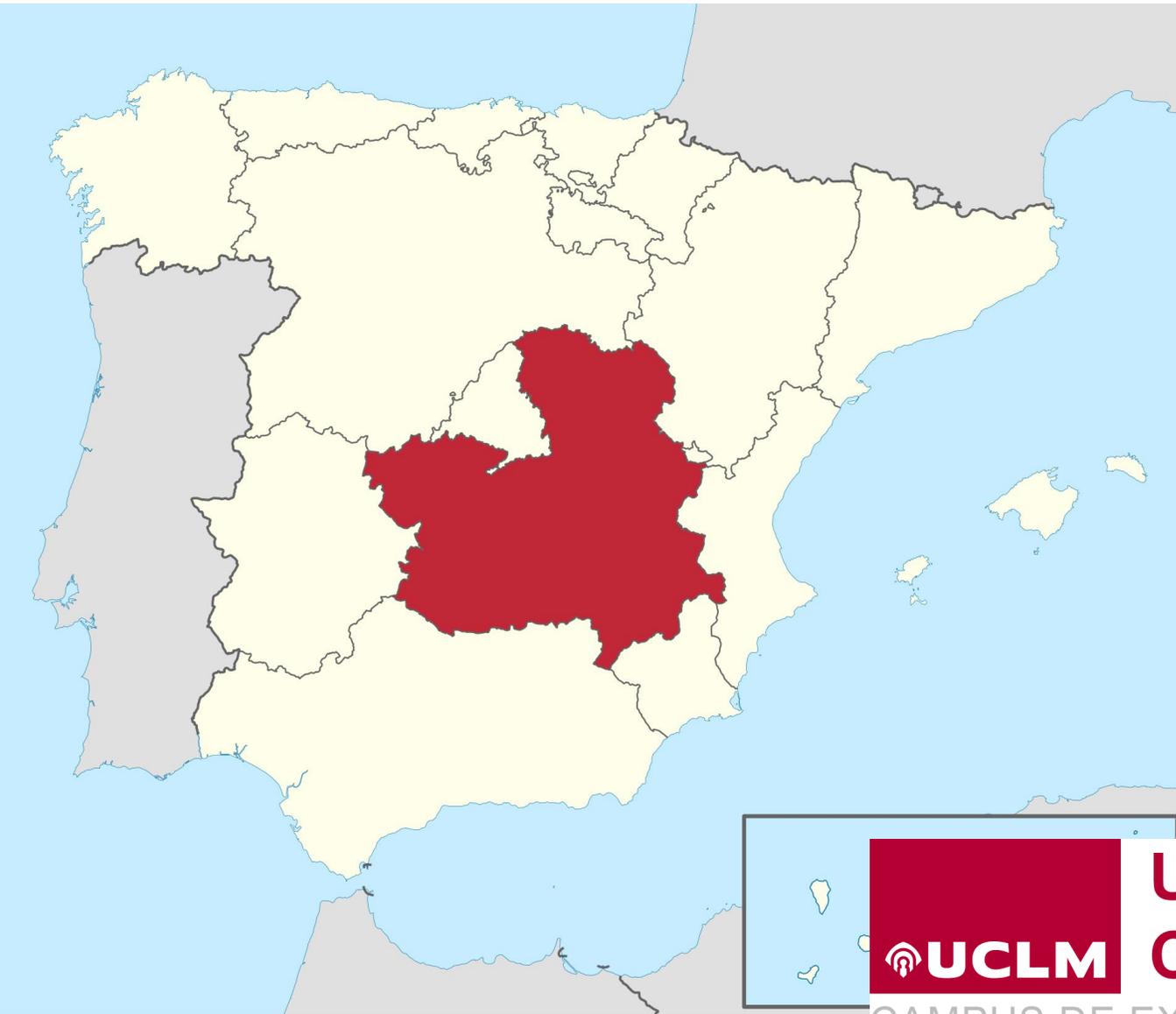
# RESOURCES



## Administrative & Financial management committee

- Personal
- Equipment
- Others expenses
- 15% Indirect costs

8 pre-doctoral positions supervised by two researchers from two different groups



## **TOLEDO**

E.ING. INDUSTRIAL Y AEROESPACIAL  
FACULTAD CC. AMBIENTALES Y BIOQUÍMICA  
ESCUELA DE ARQUITECTURA  
HOSPITAL NACIONAL DE PARAPLÉJICOS

## **ALBACETE**

FACULTAD DE FARMACIA  
E.T.S. ING. AGRONÓMICA Y DE MONTES

## **CIUDAD REAL**

FACULTAD DE CIENCIAS Y TECNOLOGÍAS  
QUÍMICAS  
E.T.S. INGENIERÍA INDUSTRIAL  
IRICA Instituto Regional de Investigación Científica  
Aplicada



**Universidad de  
Castilla-La Mancha**

CAMPUS DE EXCELENCIA INTERNACIONAL

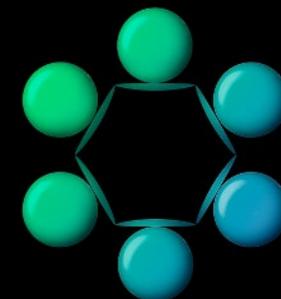
# MSOC NANOCHEMISTRY GROUP



MSOC  
NanoChemistry



**Bio**  
**G**raph  
Solutions



**Spin-off company  
of the UCLM**



**CIUDAD REAL**

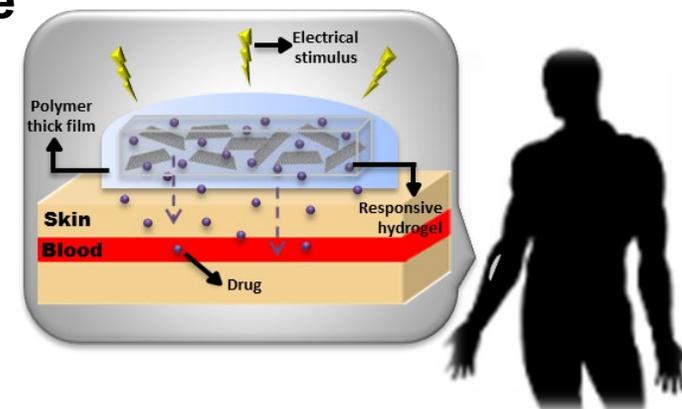
**DEPARTMENT OF ORGANIC CHEMISTRY  
PI: ESTER VÁZQUEZ FERNÁNDEZ-PACHECO**

# EXPERTISE



MSOC  
NanoChemistry

- **Synthesis of 2D materials by mechanochemical treatments avoiding the use of toxic solvents such as DMF and NMP and/or harsh conditions and corrosive acids**
- **Use of microwave radiation and mechanochemical methods for the purification and functionalization of carbon nanostructures**
- **Preparation of aqueous graphene dispersions for biological use**  
**Toxicity studies**
- **Preparation of stimulus-response gels derived from carbon nanomaterials and other 2D materials**

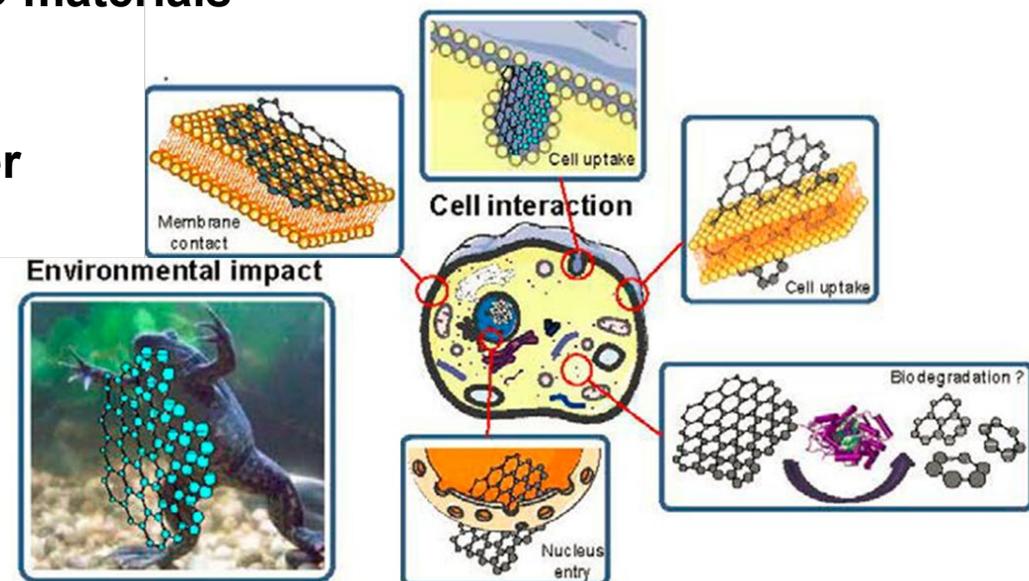


# ONGOING RESEARCH



MSOC  
NanoChemistry

- Soft functional prototypes for applications in robotics and biomechanics, trying to emulate the characteristics of living organisms. 4D Printing
- Self-healing soft materials
- Sustainable and safe development of 2D materials, considering the assessment and prediction of human health and environmental risks of 2D materials
- OECD guidelines applied to 2D materials
- Detection and quantification of 2D material traces in water



# DESIGN AND PROCESSING OF ADVANCED MATERIALS

# DYPAM

*Diseño y procesado avanzado de materiales  
Design and processing of advanced materials*



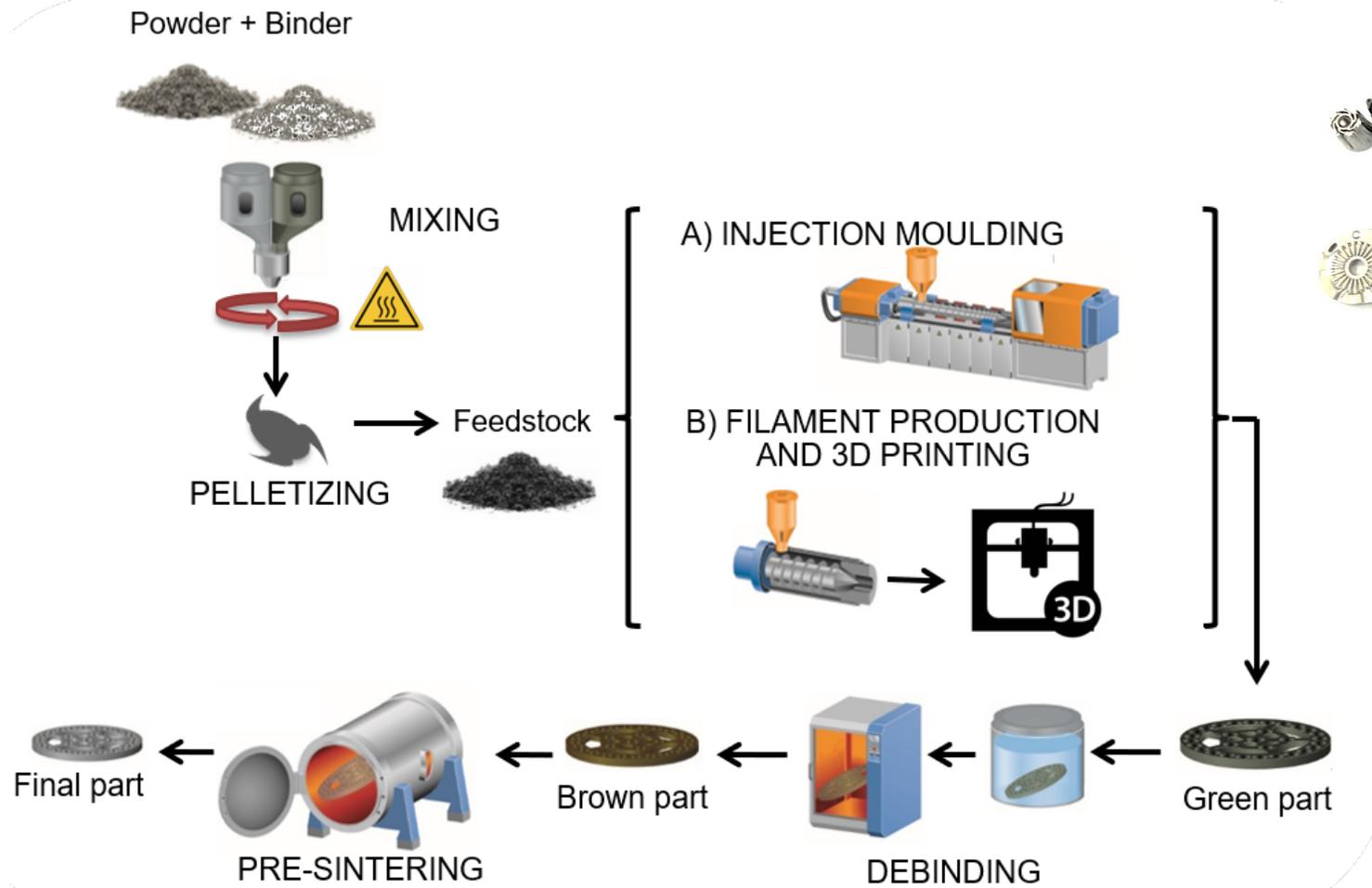
**BLESOL·TECH**  
BLENDING SOLUTIONS

Technology-based spin-off to transfer to the market the most successful DYPAM research mixtures

**CIUDAD REAL  
DEP. APPLIED MECHANICS  
PI: GEMMA HERRANZ SÁNCHEZ-COSGALLA**



## EXPERTISE: PIM (POWDER INJECTION MOULDING) & 3D PRINTING



- ✓ Parts with complex geometries and reduced size.
- ✓ High dimensional accuracy.
- ✓ High control over the microstructure.
- ✓ Applications in many sectors

# ONGOING RESEARCH

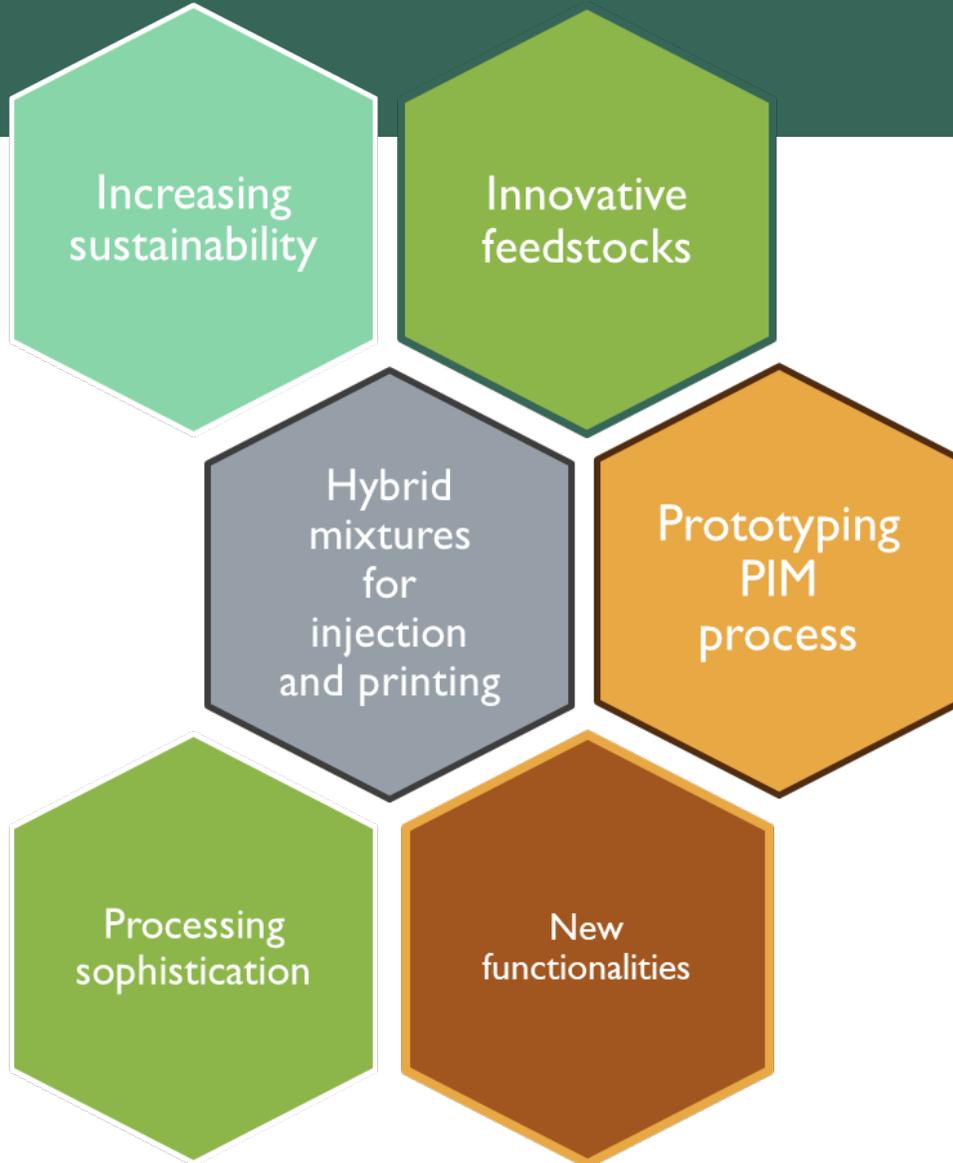
# DYPAM

*Diseño y procesado avanzado de materiales*  
*Design and processing of advanced materials*

New materials

New markets

Optimization of the processing steps



## STRUCTURAL APLICACIONES



## BIOMATERIALS



## ENERGY SECTOR



## FUNCTIONAL MATERIALS



# CHARACTERIZATION, DEVELOPMENT AND FOOD BIOTECHNOLOGY

**PROBIO-Q**  
group

## YEASTS BIOTECHNOLOGY

**PROBIO-Q**  
group

irica



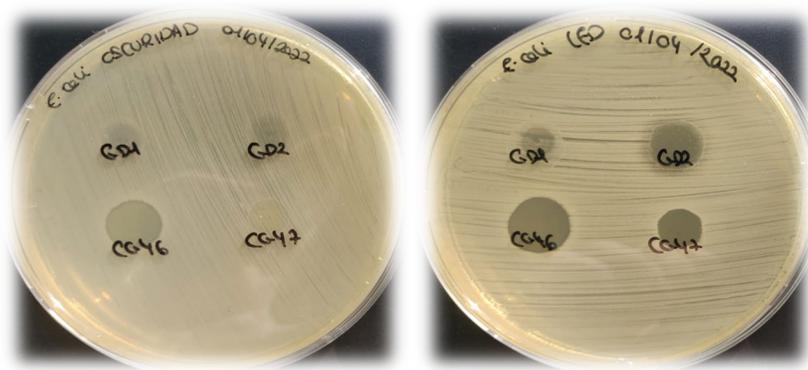
CIUDAD REAL  
DTO. ANALYTICAL CHEMISTRY AND FOOD TECHNOLOGY  
PI: MARÍA ARÉVALO VILLENA

- ❑ Study of **microbiological biodiversity** from different ecosystems (**Food and Enviromental** origin).
- ❑ Use of **non thermal technologies** for **activating** or **inactivating** microorganisms.
- ❑ **Yeast** technology and biotechnology **characterization** for using in the **development** of new **products** and **applications**

# ONGOING RESEARCH

**PROBIO-Q**  
group

- ❑ Study of **microbiological stability** of the **2D material**
- ❑ **Antimicrobial treatment** for final devices
- ❑ Use of **microorganisms** and/or **2D materials** for **biological control** in the different applications.



# OPTIMAL EXPERIMENTAL DESIGN

OED GROUP



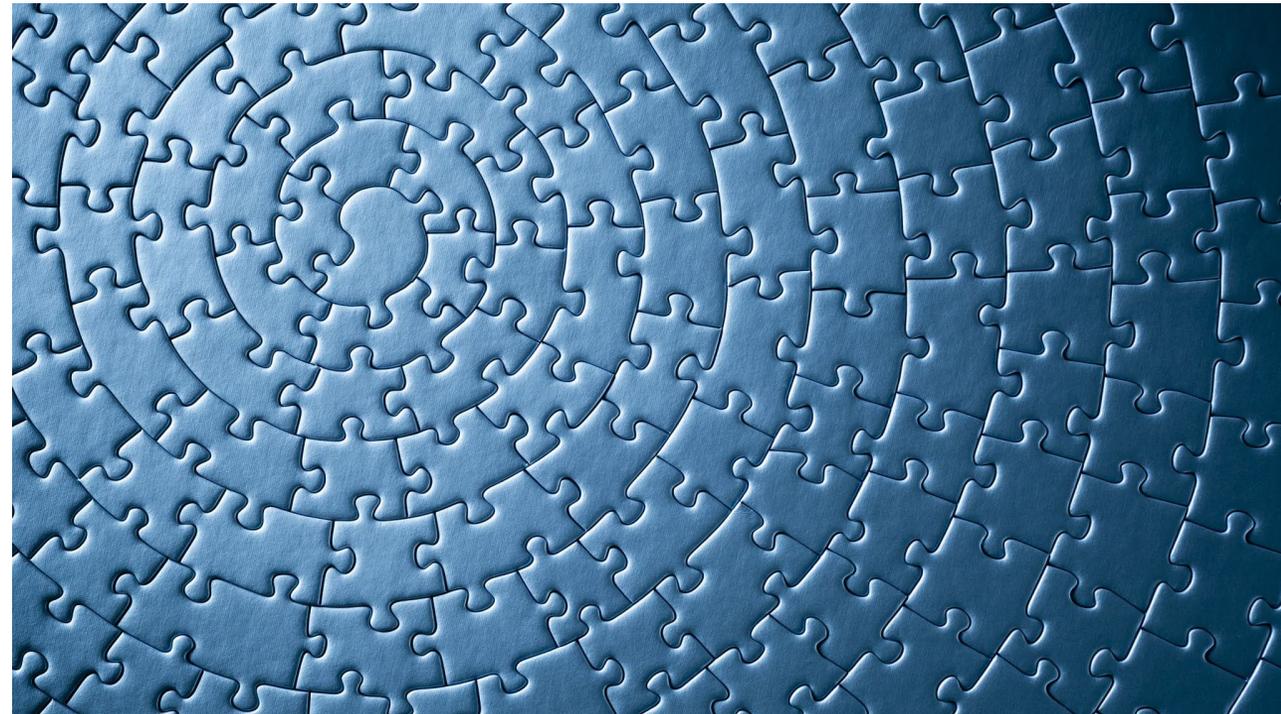
TOLEDO  
DEPARTMENT OF MATHEMATICS

PI: IRENE GARCÍA CAMACHA

## EXPERTISE

## OED GROUP

- Optimal experimental design
- Data analysis
- Statistical software
- Biostatistics
- Survival analysis
- Optimization algorithms
- Applied statistic



## OPTIMAL EXPERIMENTAL DESIGN

- To anticipate the data collection in order to prevent that data does not report quality information:

*“Data analysis will be informative only if data itself is informative”*

(Rodríguez-Torreblanca and Ortíz-Rodríguez, 2000)

- How? Determining how many observations are necessary and where these values should be collected to optimally estimate the model parameters or the predicted response.

# SOFT ROBOTICS AND EDUCATIONAL ROBOTICS



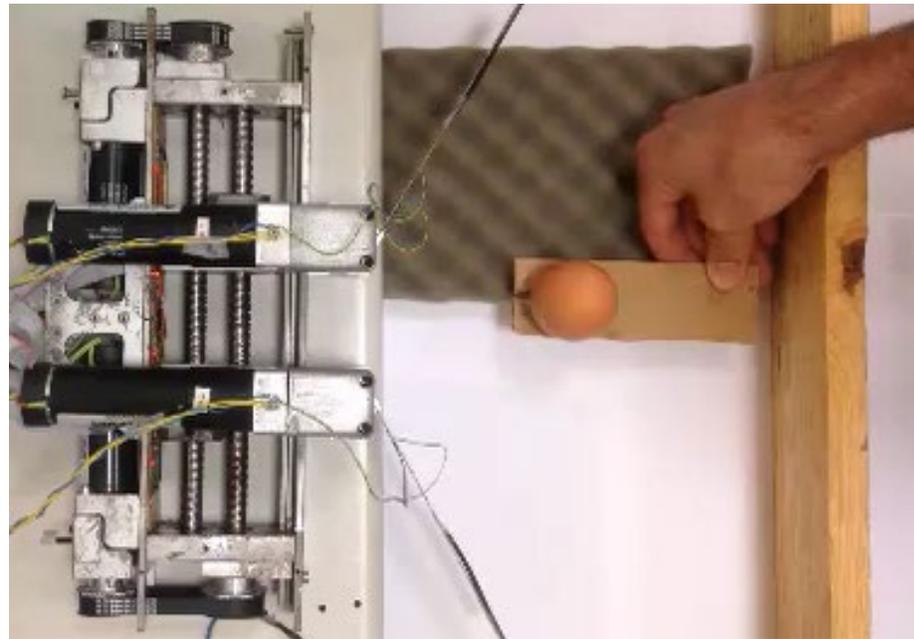
**TOLEDO & CIUDAD REAL**  
Department of Electrical  
Engineering, Electronics,  
Automation and Communications.

**PI: ISMAEL PAYO GUTIÉRREZ**  
Collaboration with  
**HOSPITAL NACIONAL DE  
PARAPLÉGICOS**

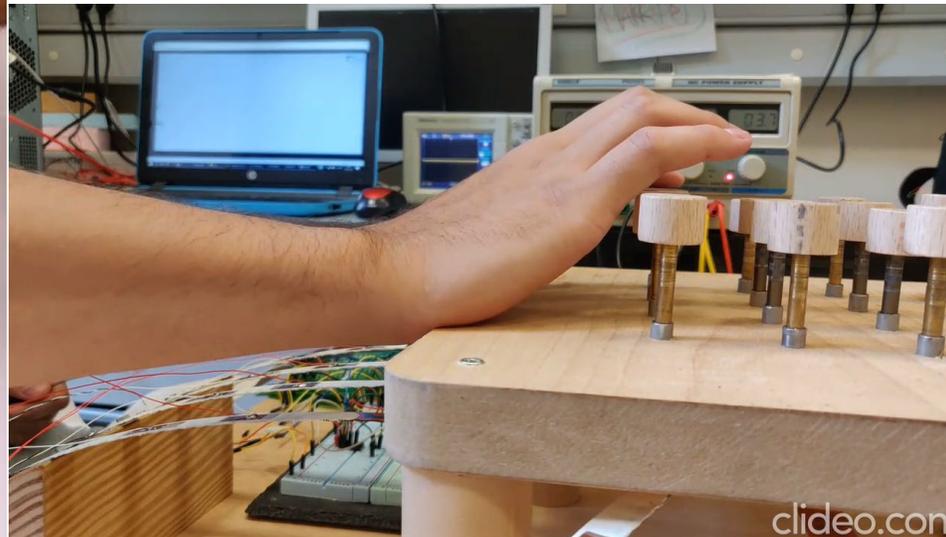
# EXPERTISE



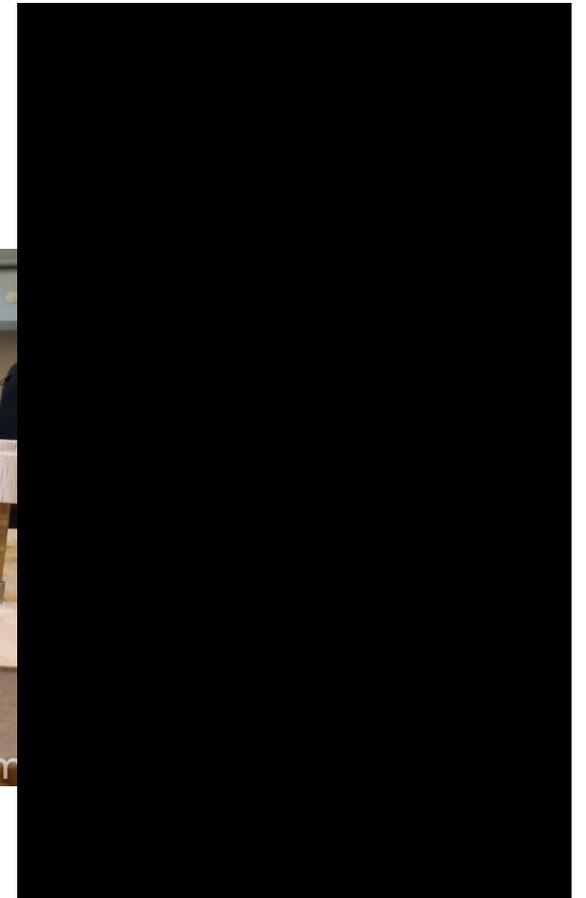
**Flexible robotics  
and sensors based on flexible  
structures**



**Rehabilitation devices based  
on piezoelectric materials**



**Collaborative Robots**



# ONGOING RESEARCH

Soft Robotic Applications



**Self-Healing McKibben Muscle**  
**Self-Healing Bending Actuator**  
**Self-Healing Robotic Hand**

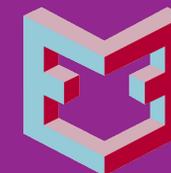


**Soft Modular Robots**



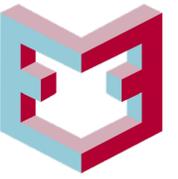
RESEARCH GROUP TEQUIMA -  
**T**ecnología **Q**Uímica **M**edio**A**mbiental  
(ENVIRONMENTAL & CHEMICAL TECHNOLOGY)

Electrochemical &  
Environmental  
Engineering Lab

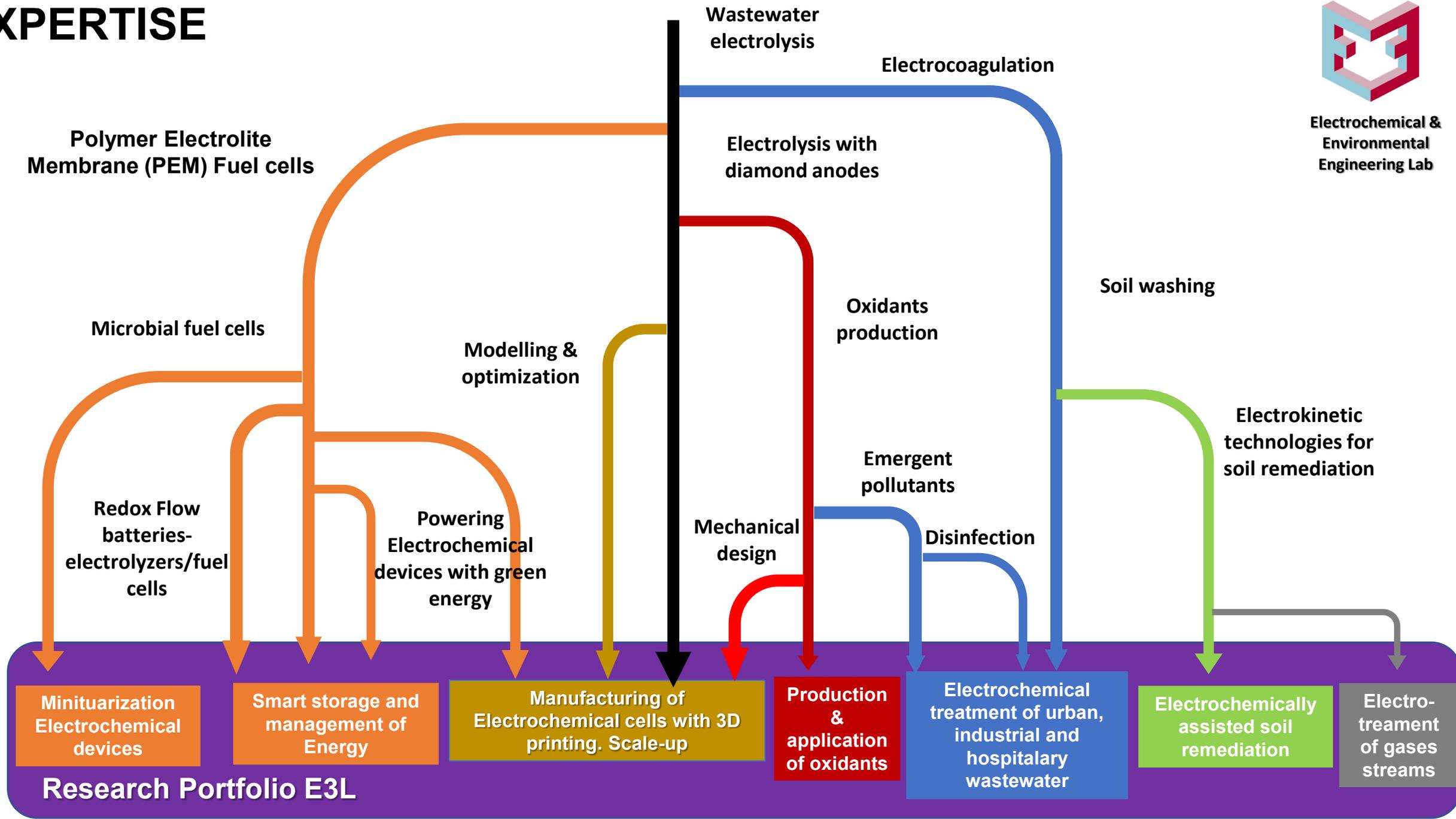


**DEPARTMENT OF CHEMICAL ENGINEERING – CIUDAD REAL**  
**PI: MANUEL ANDRÉS RODRIGO RODRIGO**

# EXPERTISE

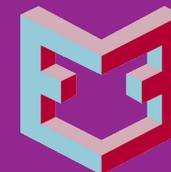


Electrochemical &  
Environmental  
Engineering Lab



# ONGOING RESEARCH

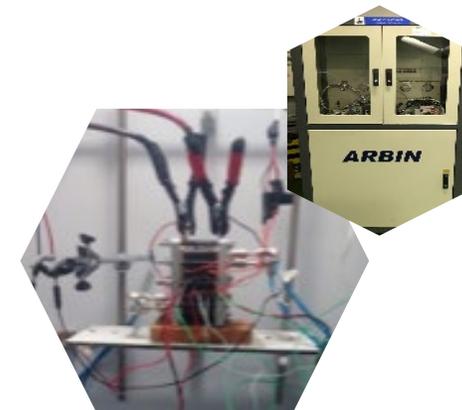
Electrochemical &  
Environmental  
Engineering Lab



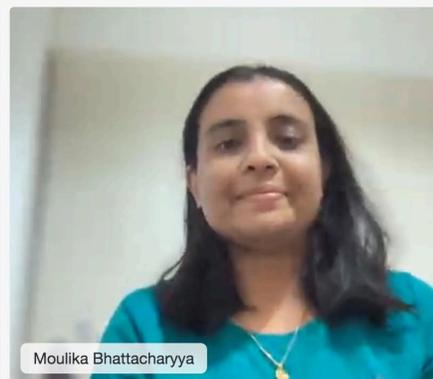
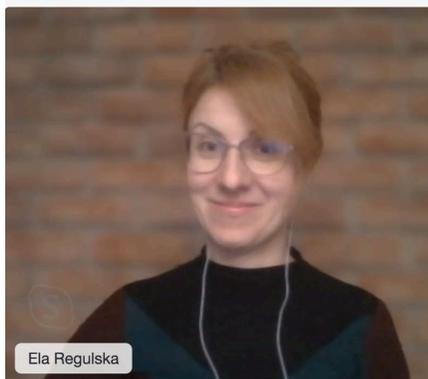
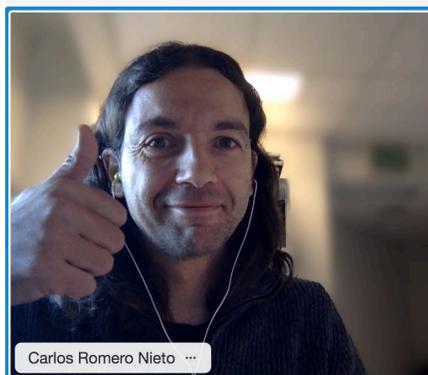
**Electrokinetic transport to favor the mobility of artificial organs assisted by the application of electric fields.**

**Formulation of novel flexible electrodes using electrospray techniques**

**Development of bioelectrochemical systems for the production of electricity to power electrochemical and electrokinetic processes: microbiological cells to obtain electrical energy using microorganisms**



# ROMERO-NIETO GROUP



Facultad de Farmacia

**ALBACETE  
DEPARTMENT OF ORGANIC CHEMISTRY  
PI: CARLOS ROMERO NIETO**

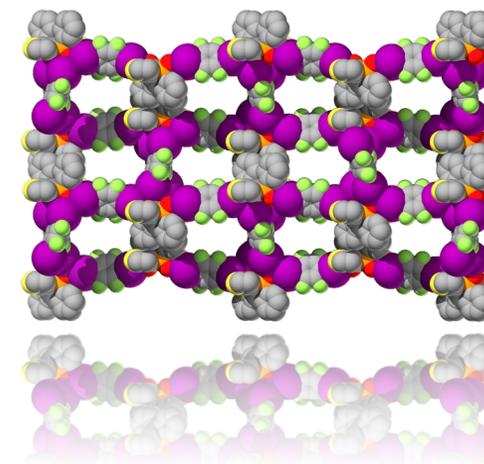
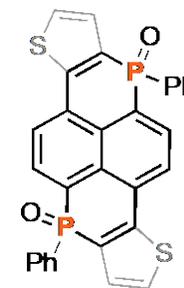
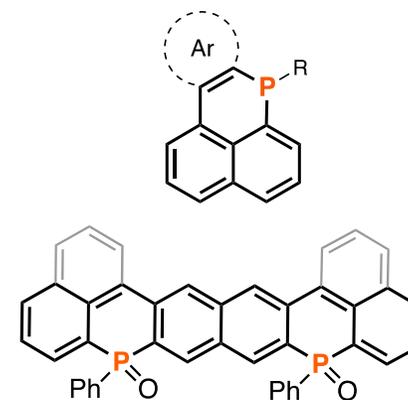
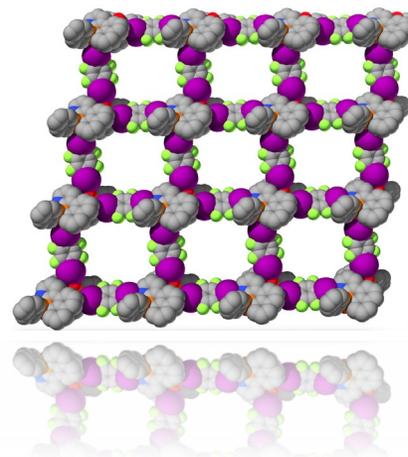
# EXPERTISE

- Synthesis of organophosphorus materials for:

Optoelectronic applications  
Anti-cancer drugs

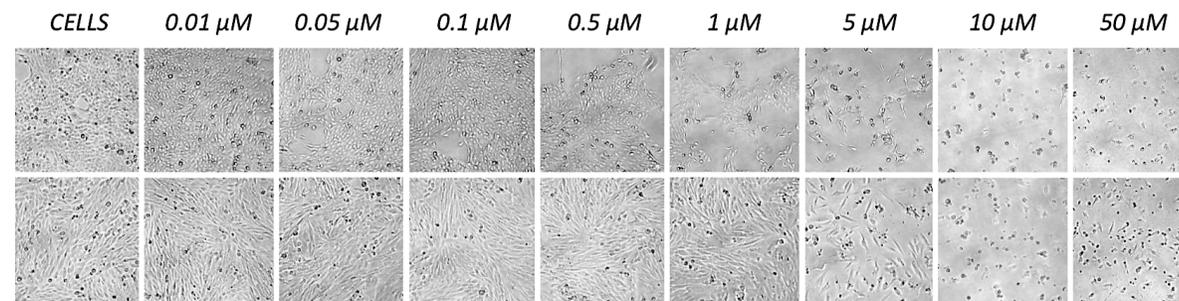
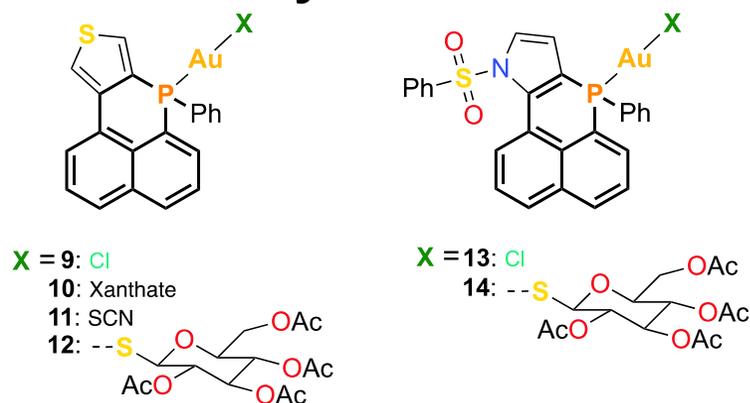
- Development of colorimetric detectors
- Spectroscopic investigation of novel materials
- Electrochemical characterization of organic/inorganic systems
- Fabrication of proof-of-principle devices:

Photoelectrochemical cells  
Fluoro-electrochromic setups

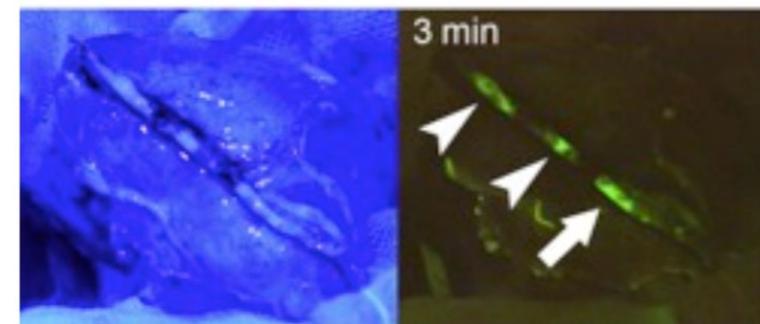
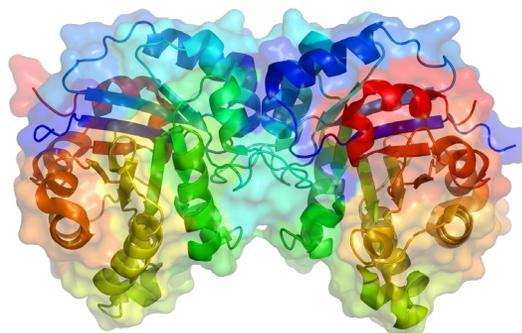


# ONGOING RESEARCH

Development of chemotherapeutic agents against brain cancer based on phosphorus heterocycles



Development of colorimetric/luminescent molecular detectors for the monitoring of specific enzymes



# HEALTH AND BIOTECHNOLOGY: SABIO GROUP



✓ Health



✓ Biotechnology

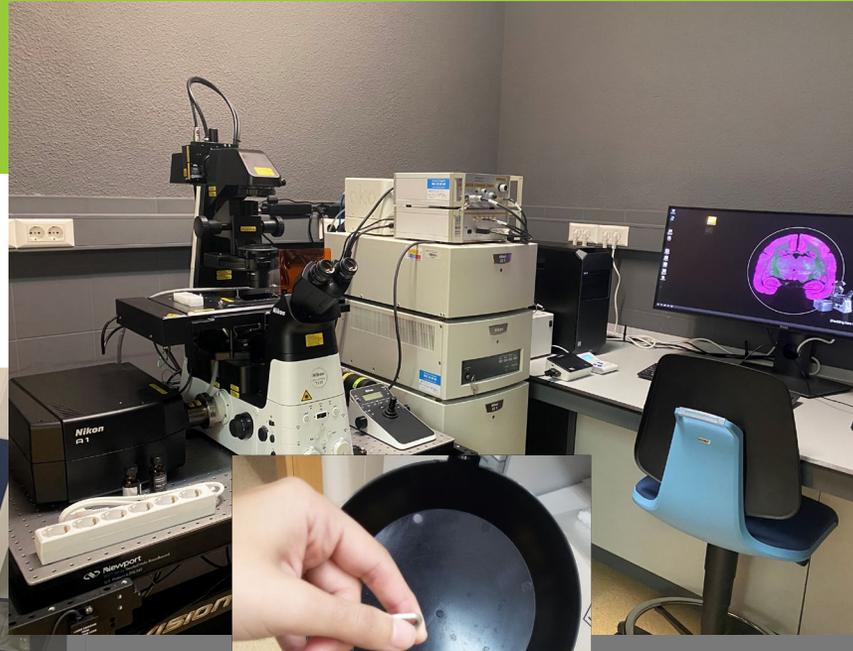
✓ Reproduction



**ALBACETE  
DEPARTMENT OF GENETIC SCIENCE AND TECHNOLOGY  
PI: ANA JOSEFA SOLER VALLS**

# EXPERTISE

## Embryology lab



**Germplasm bank**



- **Artificial insemination**
- **Sperm sexing**
- ***In vivo* and *in vitro* embryo production**
- **Gamete cryopreservation**

# ONGOING RESEARCH



**SABIO**

Sanidad y Biotecnología  
Health and Biotechnology



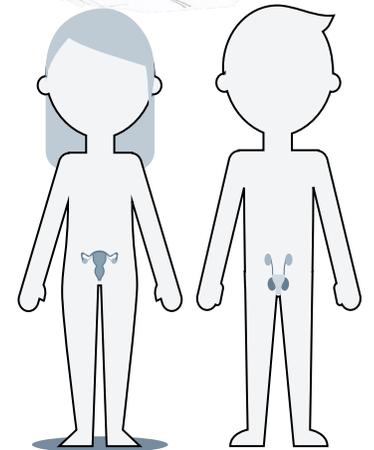
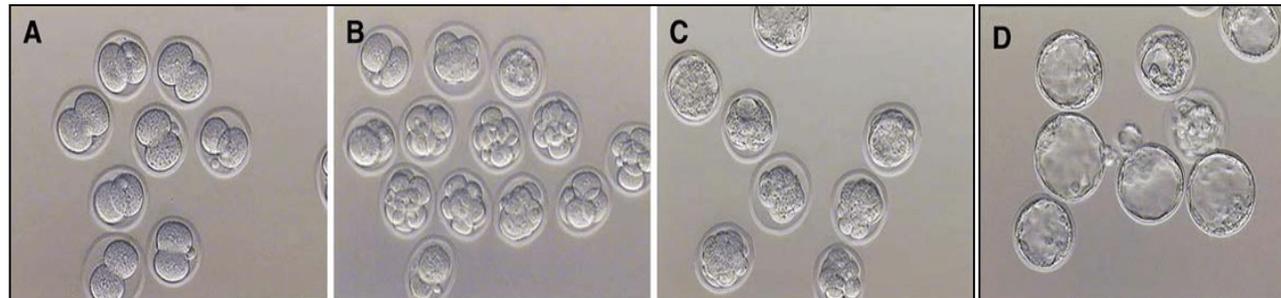
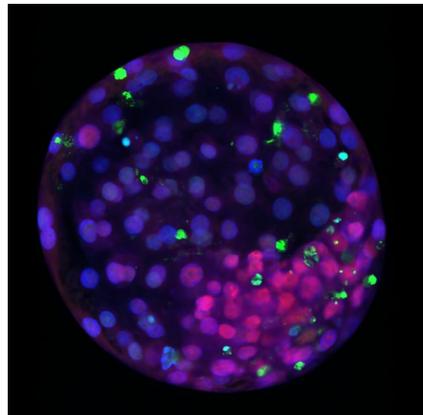
## Development and implementation of Assisted Reproductive Technologies (ARTs)

WILDLIFE CONSERVATION

FERTILITY TREATMENTS

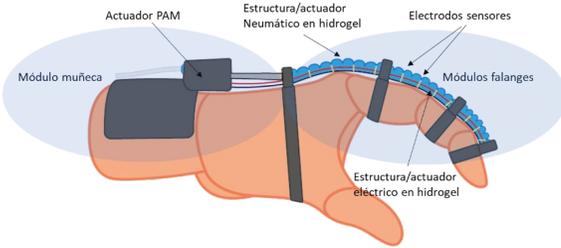


## Smart materials for 3D bio-mimicking systems



# WORK PLAN

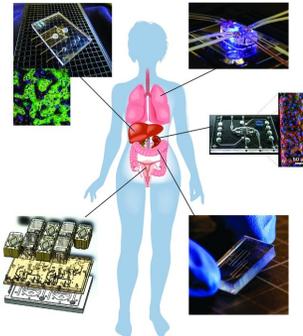
## L2.1: Soft robotics and biomechanical devices



## L2.2: Biodegradability and self-healing



## L2.3: Biomedical Applications: Biosensors and 3D bio-mimicking systems



## Basic and sustainable research

### L1.1: Synthesis and modification of 2D materials

- ❖ Sustainable technologies
- ❖ Characterization and quantification
- ❖ Safe by design
- ❖ Bactericidal properties

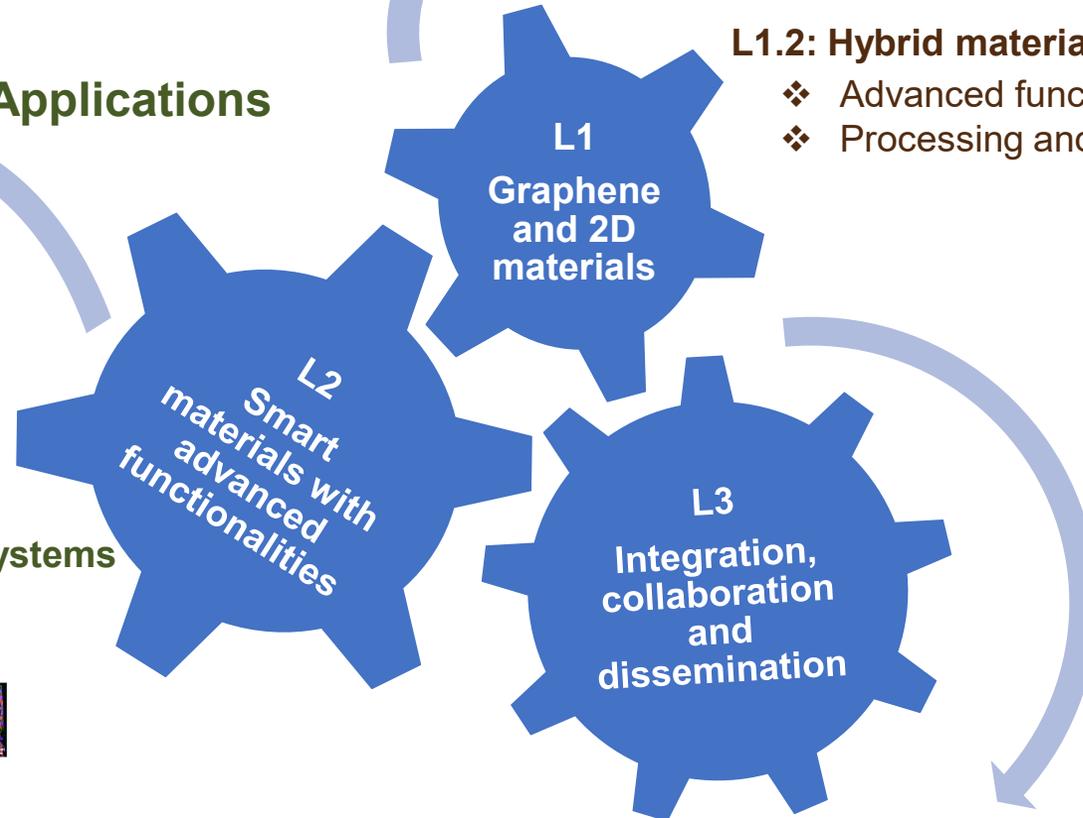


### L1.2: Hybrid materials based on 2D materials

- ❖ Advanced functionalities
- ❖ Processing and manufacturing. 4D printing



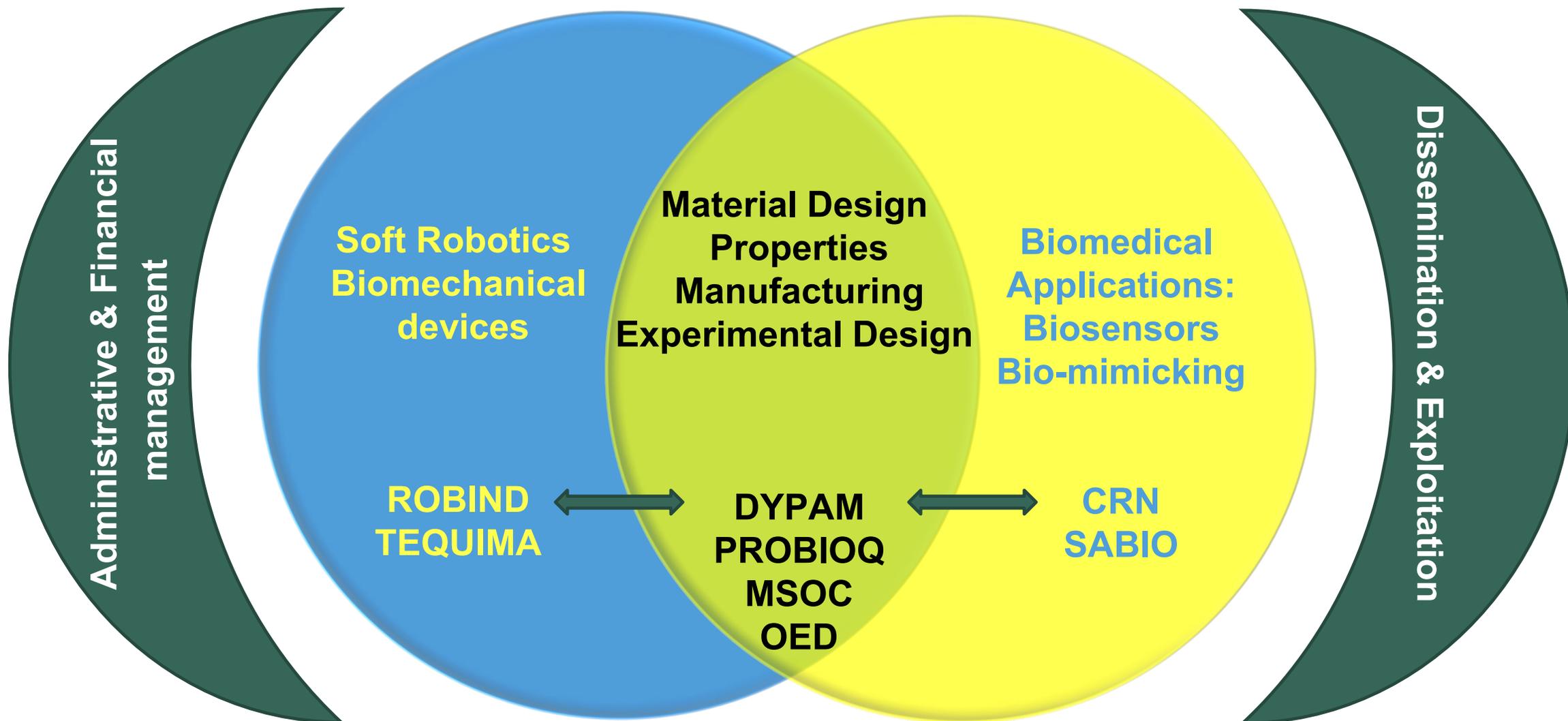
## Applications



### L3.1: Training and visualization

### L3.2: Dissemination

# WORK PLAN



## EXPECTED RESULTS

- **New protocols for the synthesis and modification of 2D nanomaterials following sustainability principles**
- **Generation of methodologies for detection, quantification and testing of 2D materials in biological media, enabling their use in commercial applications.**
- **Improvement in the processing and fabrication of complex geometries based on 2D hybrid materials.**
- **Transfer of the technologies developed to the different groups working in the program, studying toxicity and ecological impact**
  
- **Biomechanical systems based on intelligent materials acting as artificial skins.**
- **Prototyping of robotic systems based on soft self-repairing materials**
  
- **Development of prototypes of artificial tissues**
- **Biosensors based on molecular materials**



## **EXPECTED RESULTS**

- **Organization of National Schools in Advanced Materials**
- **Participation in an inter-university Master in Advanced Materials .**
- **Participation in the National Conferences on Advanced Materials ).**
- **Organization of specialized meetings to favor synergy between the participating groups from the different regions**
- **Organization of biannual meetings between the different participating groups within CLM.**
- **Organization of dissemination conferences for the general public.**
- **processes.**
- **Organization of dissemination conferences for the general public**