COLFEED4Print

MTE 3D printing of catalytic membranes and supports for cleaning AOPs in water

Pablo Ortega Columbrans
Junior Research Assistant (PhD Candidate) / Production
pablo.ortega@colfeed.com

ULTIMATE

WATER SMART INDUSTRIAL SYMBIOSIS

COLFEED 4PRINT

WHO ARE WE?

ICV Instituto de Cerámica y Vidrio

CSIC

colloidal processing

INNOVATIVE SME

Valid until Mar 8th 2026

GOBIERNO DE ESPAÑA

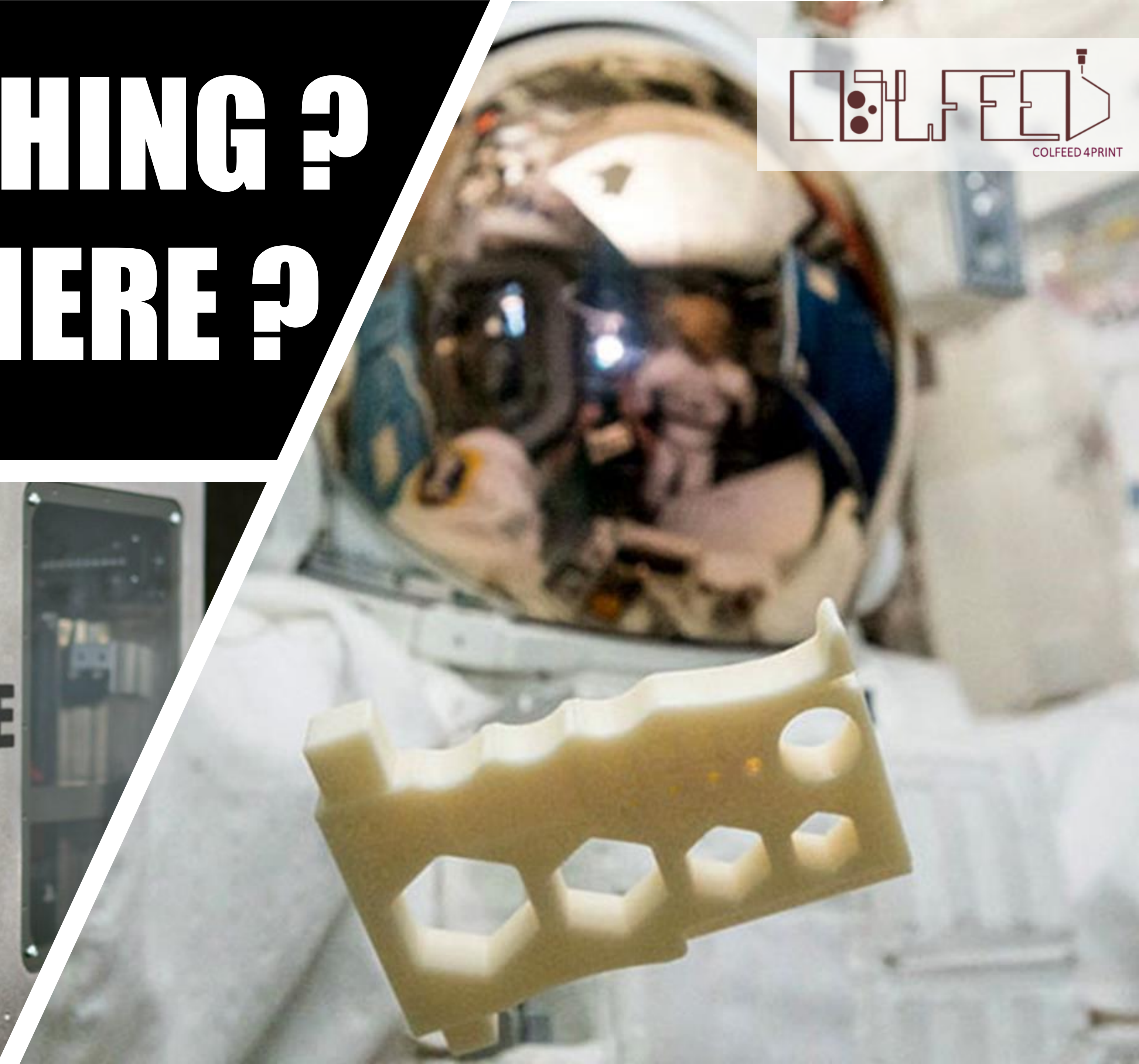
MINISTERIO DE CIENCIA E INNOVACIÓN

COLFEED4Print

We are a CSIC technology-based firm, TBF-CSIC, founded in February 2020, with the aim of providing (solutions of) innovative products for 3D printing in markets with high technological impact

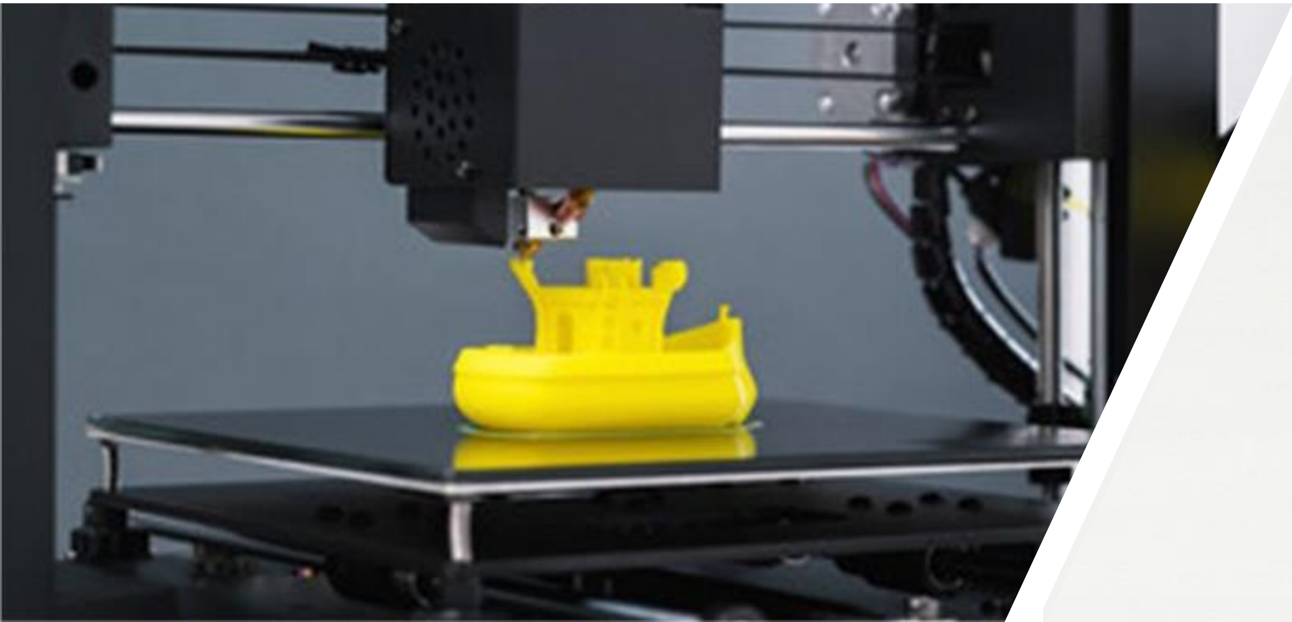
We manufacture filaments/ granules of **functional materials** for 3D printing by material thermal extrusion (MTE).

DESIGN ANYTHING ?
MAKE ANYWHERE ?



DESIGN ANYTHING
MAKE ANYWHERE
MAKE ANYTHING

COLFEED 4PRINT



Material Thermal Extrusion

Additive Manufacturing

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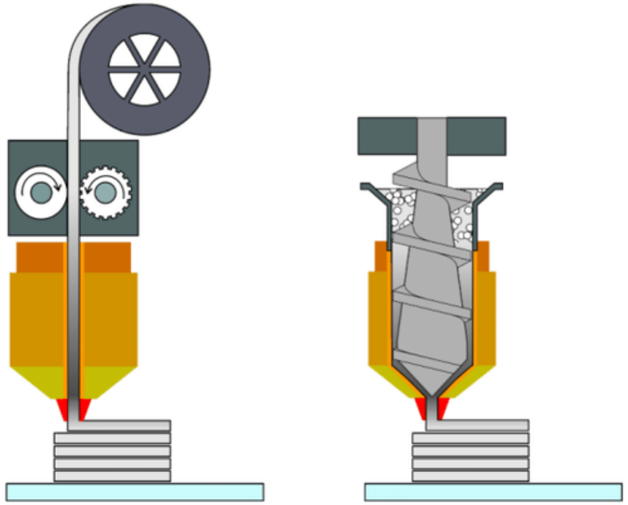
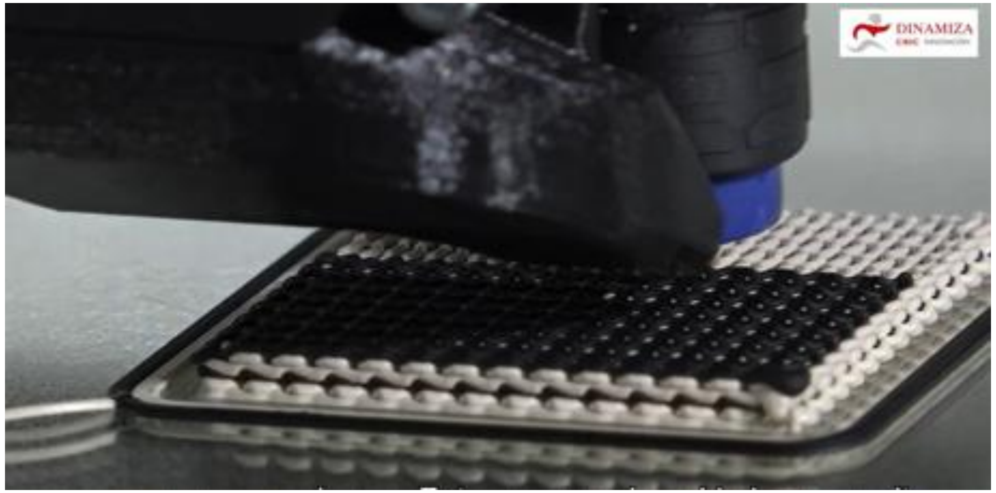


Filament-based Screw-based

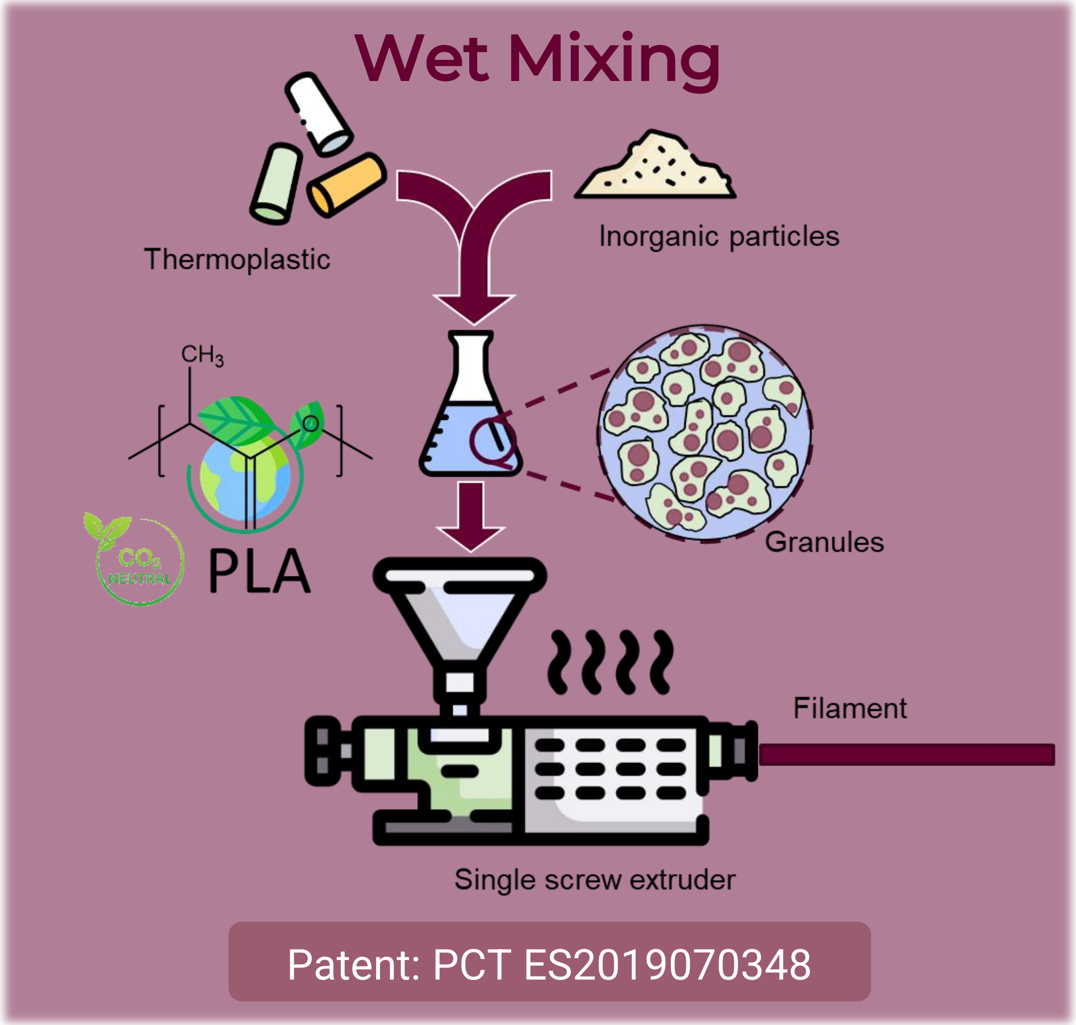


✔ Advantages vs. other 3D Printing Technologies

- Economical and accessible
- Less materials restrictions
- Easy to change material
- Room conditions printing
- MultiPrinting and Printing of different final 3D parts
- Low know-how requirements for digital designs
- Expanded in the medical sector (hospital and clinical)

What makes us UNIQUE

Our patented technology allows us to obtain feedstock to print any material



Unique Features

- Functional Composites & 100% Inorganic Pieces
- Easy to print
- High resolution
- Unique 3D components
- Added value

Ecological Commitment

- Low energy production
- Recyclable Filaments Circular Economy – Zero Waste
- We use Biomass, Our process is Zero Carbon Footprint

Our Catalogue

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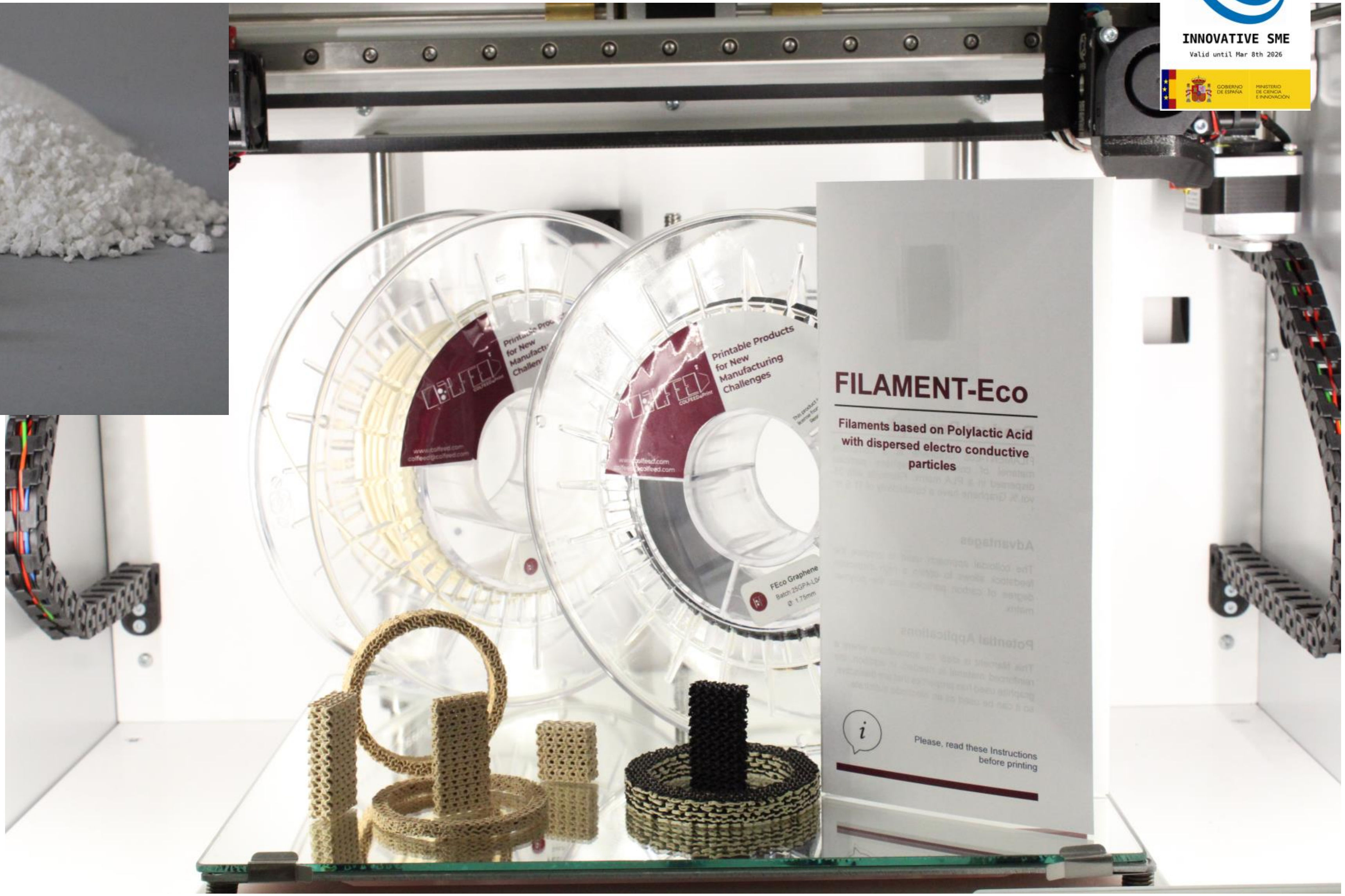

Our Catalogue

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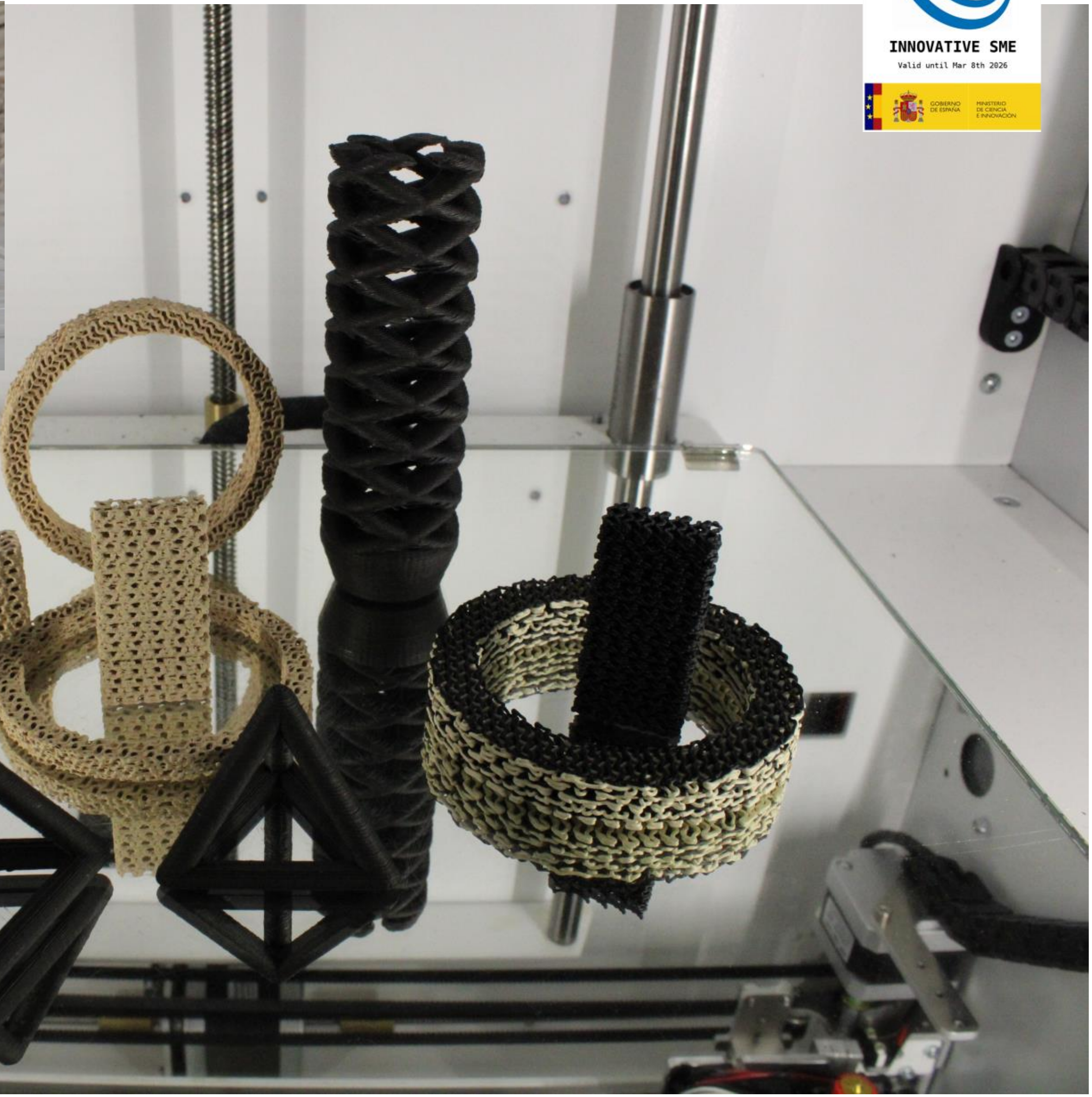
FILAMENT-Eco

Photo- and electroactive materials for catalytic and energy applications

- Photocatalytic TiO_2/ZnO
- Conductive Graphite/Graphene
- Reinforced/Conductive FC-composites



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INNOVATIVE SME

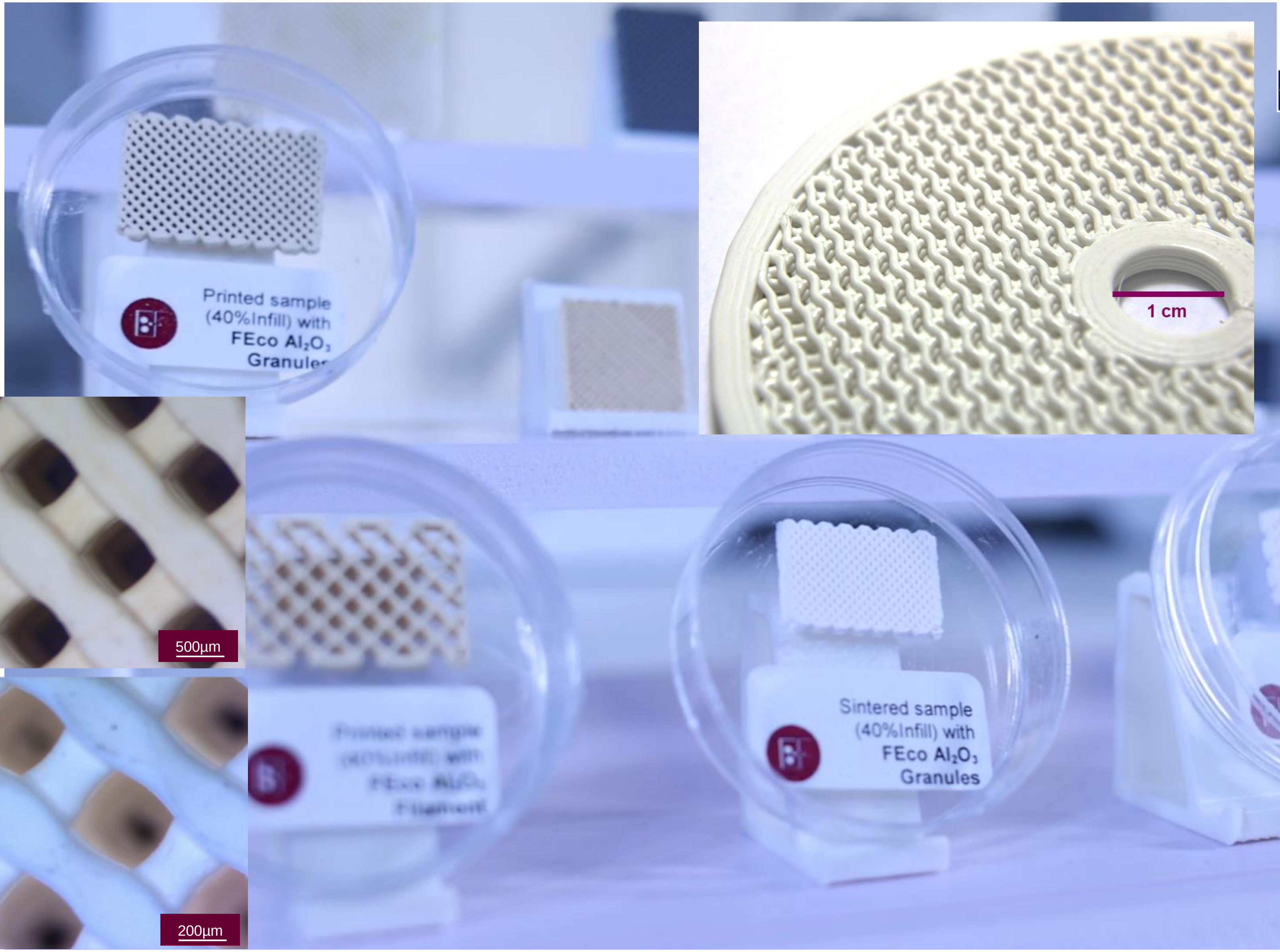
Valid until Mar 8th 2026

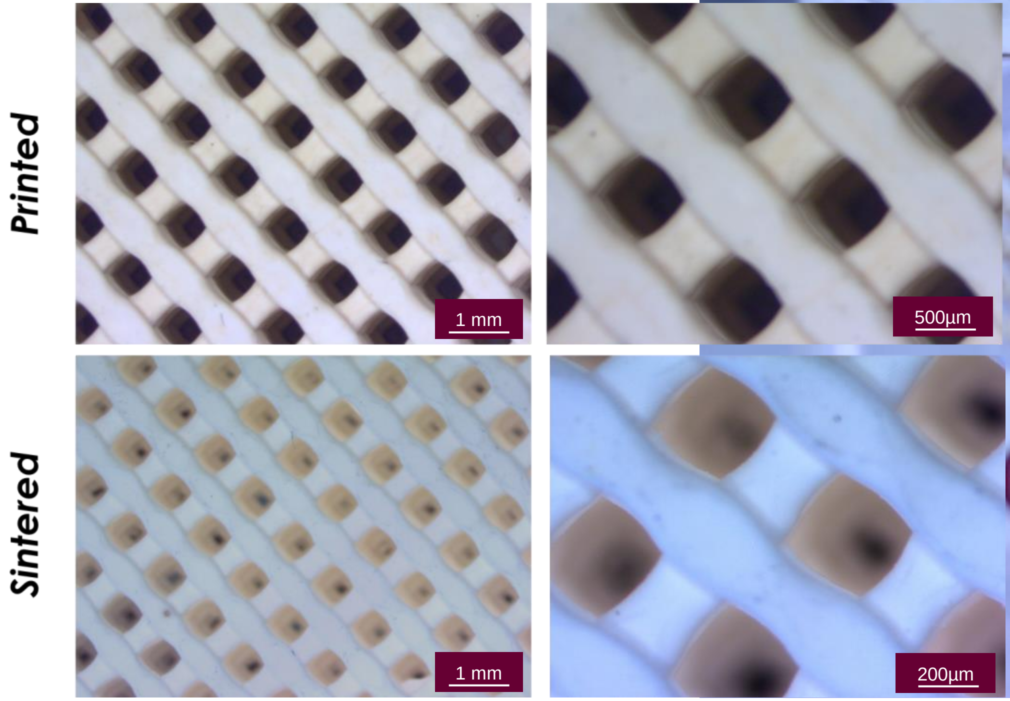
Our Catalogue

FILAMENT-Cer

Ceramics for high temperature and abrasive conditions

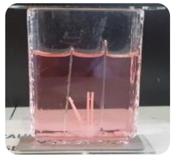
- High Al_2O_3/ZrO_2 content (44 vol.%)
- Conventional debinding/sintering
- 100% ceramic parts

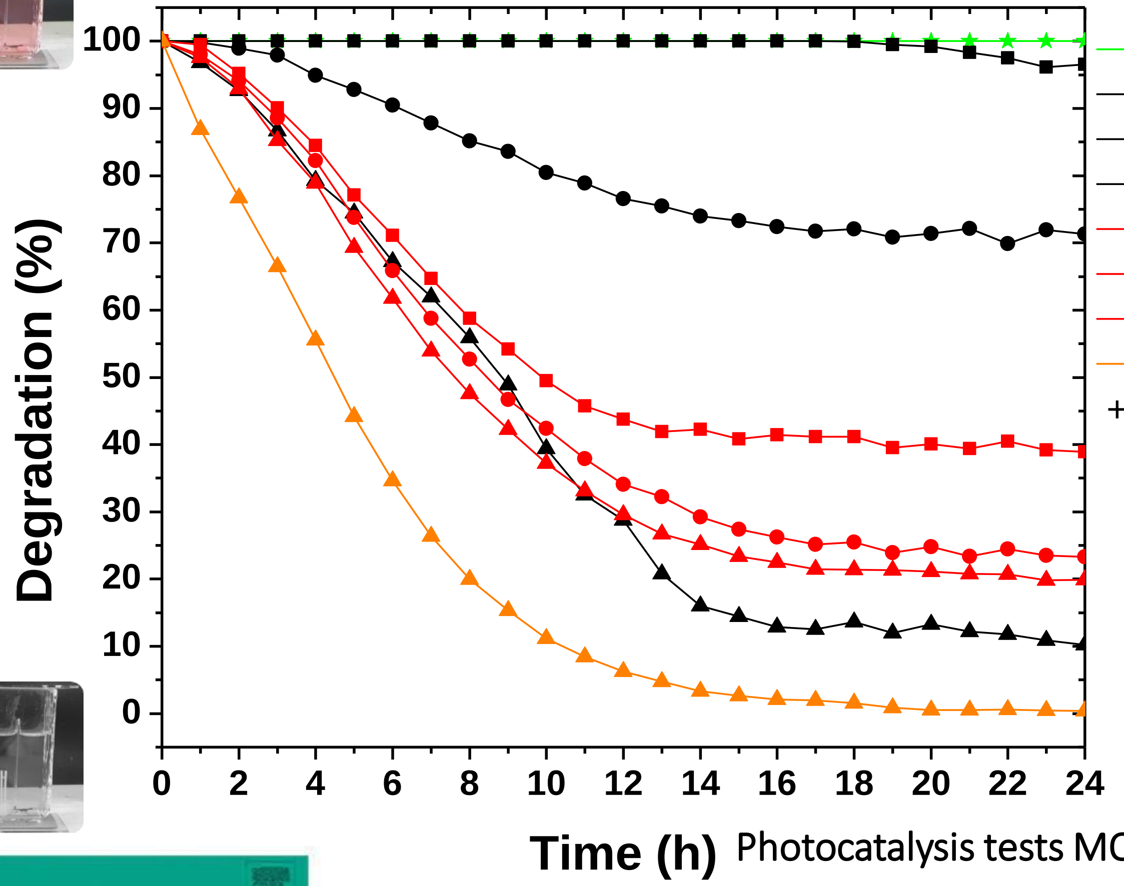


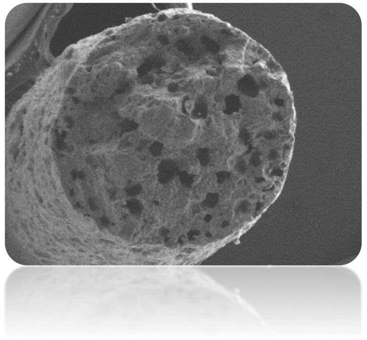


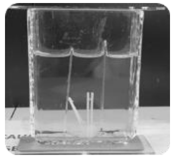
AM & Colloidal Materials: Inks for Filament Fabrication

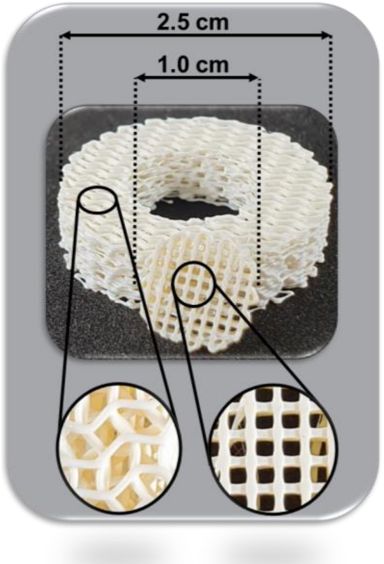
Material Extrusion: FFF of Photoactive composites











Photocatalysis tests MO (C_0 = 3ppm || pH =2)

P. Ortega-Columbrans, A. Ferrandez-Montero, J. Yus, A.J. Sanchez-Herencia and B. Ferrari. Processing of membranes and 3D scaffolds based on n-TiO2 colloidally dispersed on a thermoplastic matrix for photocatalytic pollutant removal. Catalysis Today. Manuscript number: CATTOD-D-23-00122

Double Green H_2 Production

The Challenge of Flow Reactors Engineering, with immobilized photocatalysts, fabricated through an Environmentally Friendly Technology

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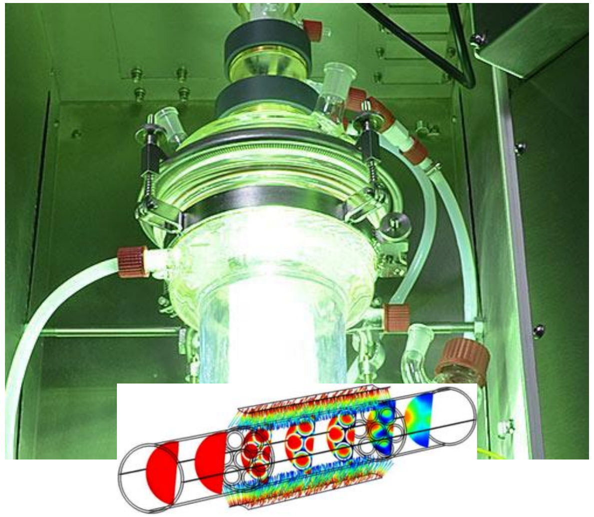
- Represents 1.7% of the world's annual energy consumption
- Only 1% is generated from green energy sources
- Most of it is obtained from natural gas and coal, emitting **830 million tons CO_2/year**
- Alternative: **membrane photoreactors** (PMR) for water splitting under sunlight



Photoreactor from Peschl Ultraviolet GmbH
COMSOL predictive model

Problem

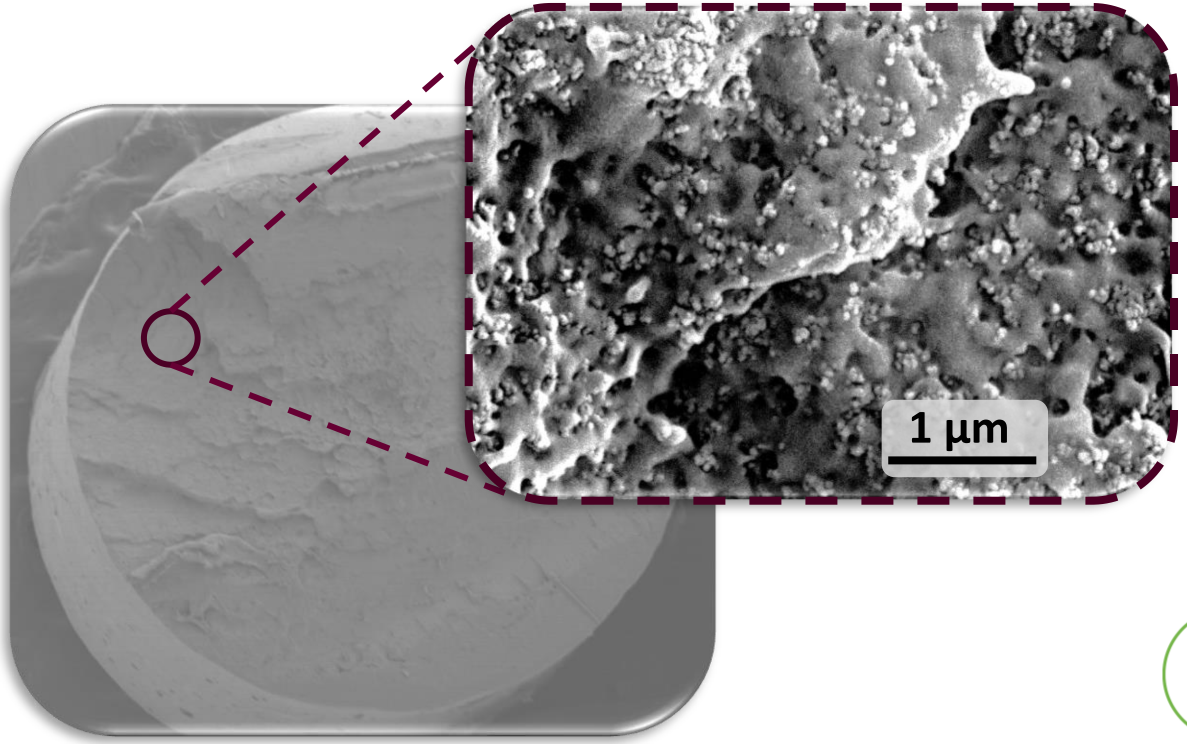
- ✗ PMR configurations are not resolved yet
- ✗ New materials are still under study
- ✗ Photocatalyst dosage and light exposition is limited
- ✗ Low surface to volume ratio of membranes
- ✗ Limited performance

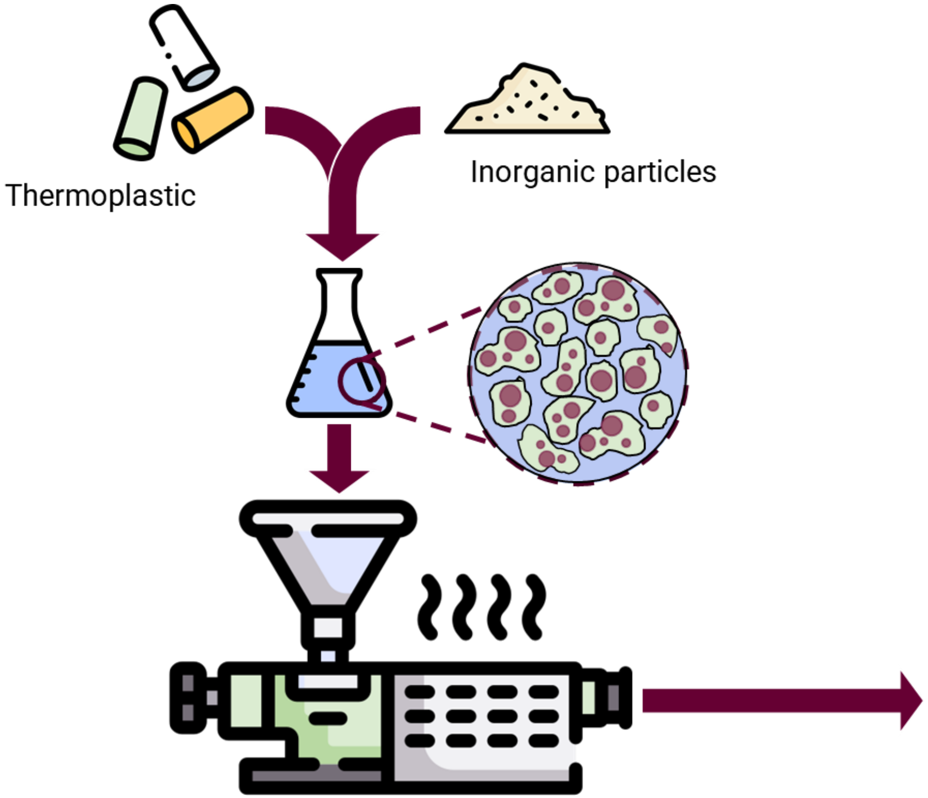
Need

- ✓ Geometries and Porosities to assure the contact with fluids
- ✓ **Configurations of self-standing membranes, able to favor light exposure and fluid flux**
- ✓ Testing bench for extremely efficient materials and compositions

COLFEED4Print: Feedstock & 3D printing of heterostructures in self-supported membranes for <u>DOUBLE</u> green H_2 generation

We are the only company able to introduce large quantities of **nanoparticles** in printing feedstock, <u>maximizing photocatalytic activity or sintering 100% inorganic parts for full-solid-state based technologies</u> (PEM & SOEC).





By a zero-carbon footprint and low energy **production process**, integrated in the circular economy frame

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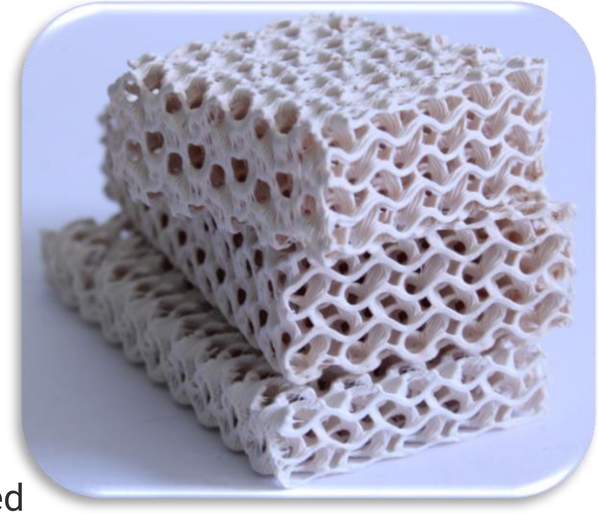
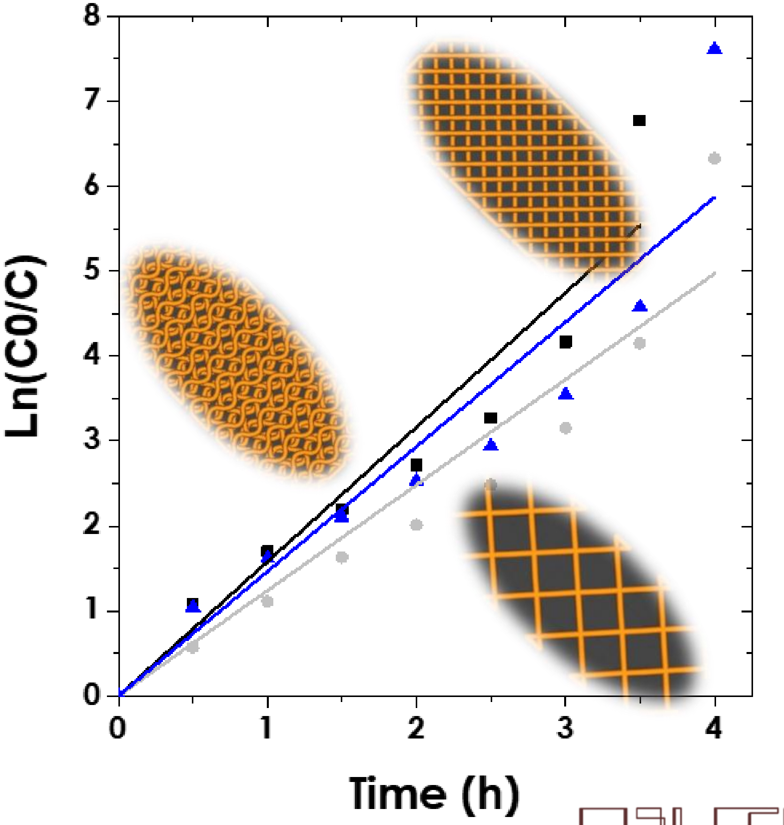
CAD-Designed porosities & configurations of components for **multiprinted structures** with different functional materials: photocathode/anode + collectors and/or heterojunctions for H_2 generation.



By a zero-carbon footprint and low energy **production process**, integrated in the circular economy frame

Membranes with designed geometries and photocatalytic activity

FEco TiO_2 / FEco ZnO



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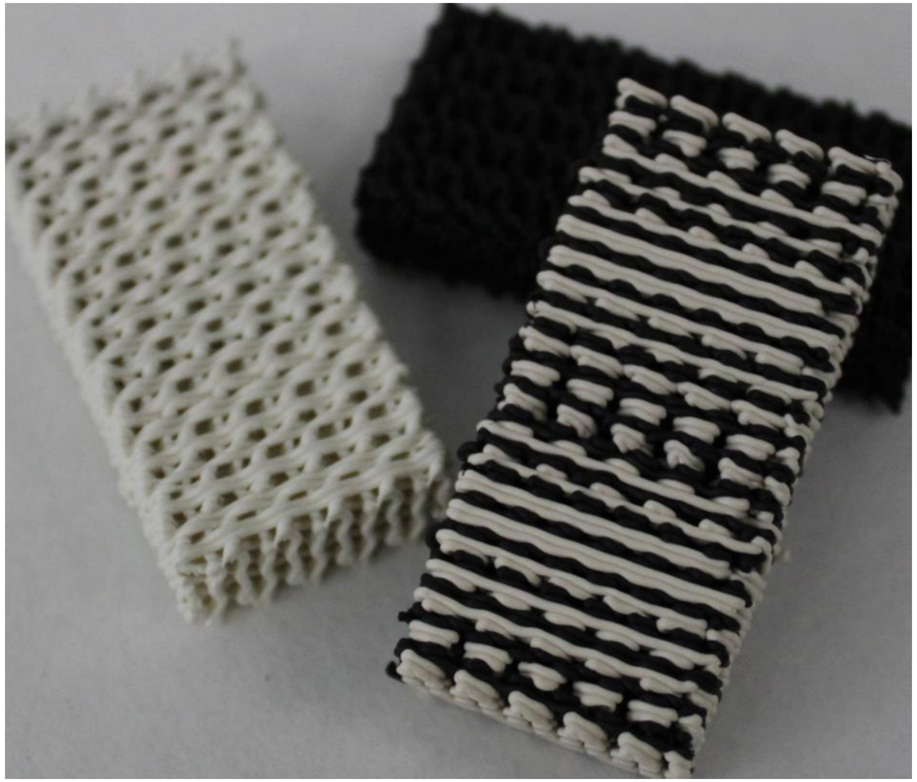
Small batches for testing **nanoengineered compositions** improved with synthesis particles that increase photocatalysis performance as well as electrical conductivity

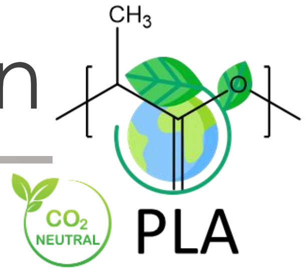
By a zero-carbon footprint and low energy **production process**, integrated in the circular economy frame

Membranes where photocatalysts joint adsorbents lead to excellent results

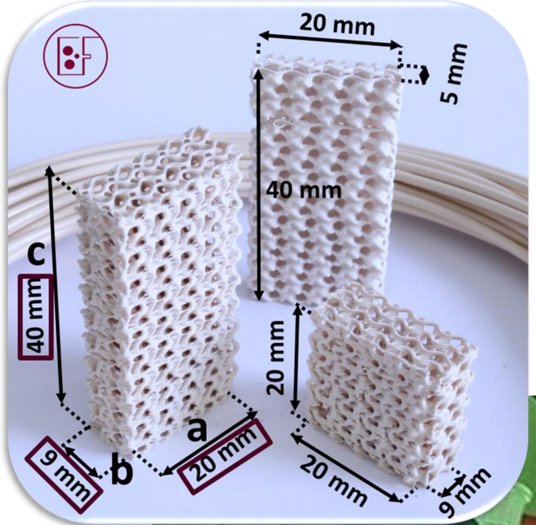
FEco TiO_2 / FEco ZnO / FEco Graphene / FEco Al_2O_3 / FEco ZrO_2

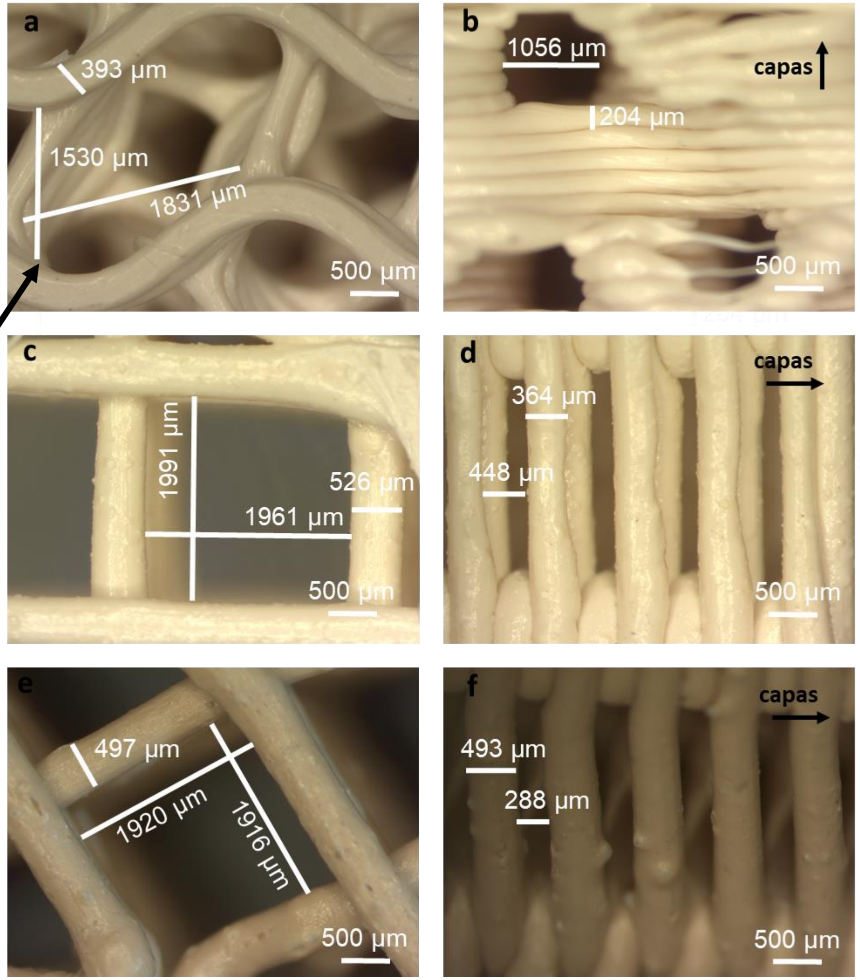


AM & Colloidal Materials: Inks for Filament Fabrication

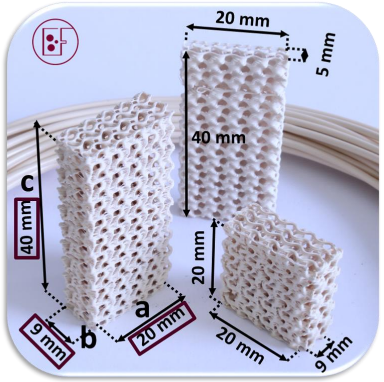


Material Extrusion: **FFF of Photoactive composites**

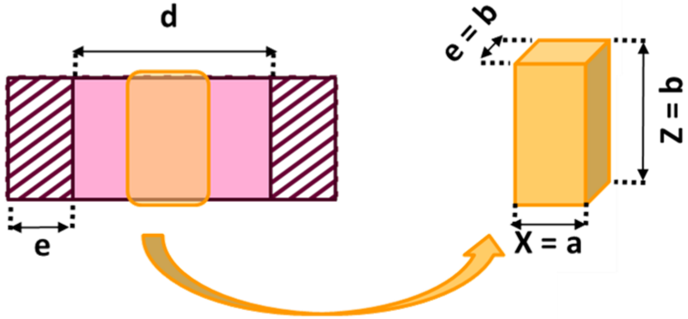


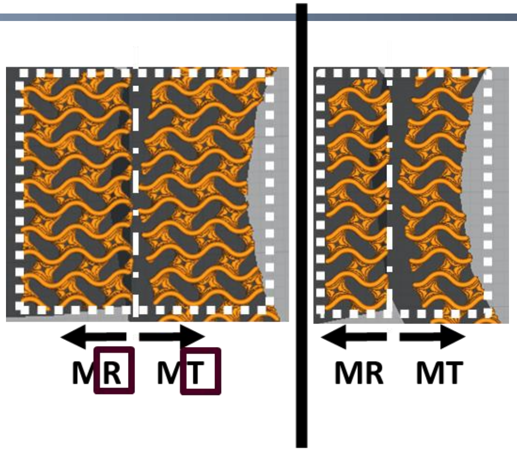


Design of porous structures with high specific surface area and photocatalytic activity



MR A





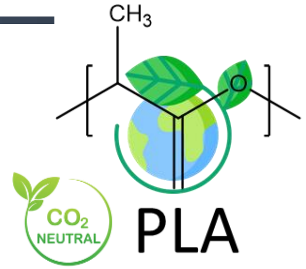
MT A → 60x50x10 mm

PLA

Sample	Dimensions (mm)	$t_{100\%}$ (h)	$t_{50\%}$ (h)	k (h^{-1})	Catalyst (g)	k ($h^{-1}\cdot g^{-1}$)
A-01	20x9x20	-	-	4,05 10^{-2}	0,16	2,46 10^{-1}
A-02	20x**5**x40	12	3	6,35 10^{-2}	0,19	3,23 10^{-1}
A-03	20x**9**x40	2	1	1,01 10^{0}	0,38	2,62 10^{0}
A-04	20x9x40	2	1	0,95 10^{0}	0,32	2,96 10^{0}

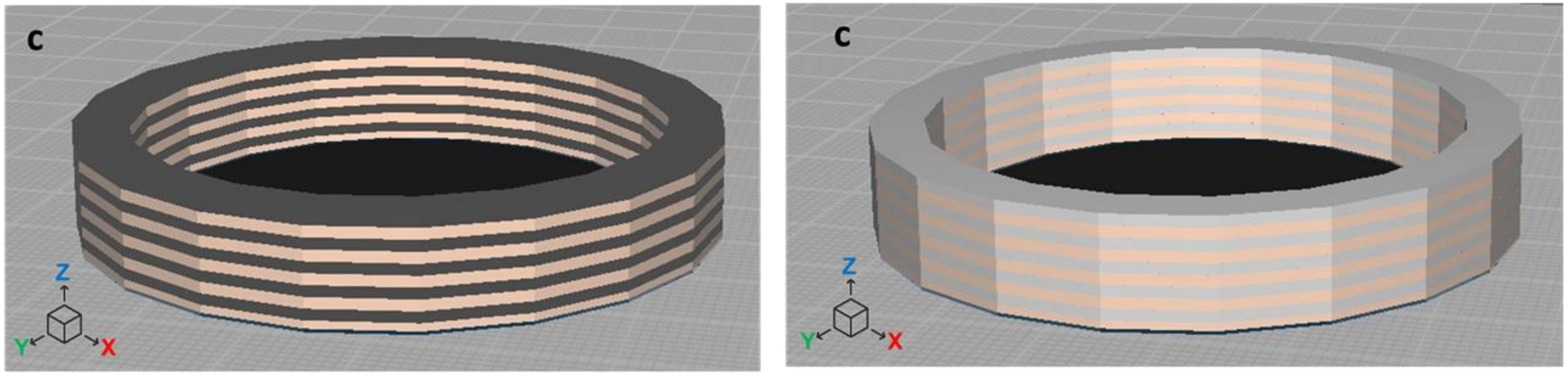
Kinetic limitation in the **thickness** of the membranes

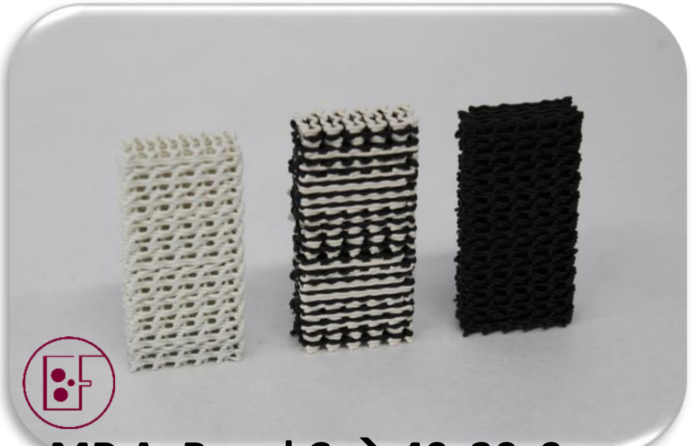
Design and printing of porous co-catalytic heterostructures



Photoactives composites filaments

MT A, B and C → 60x50x10 mm





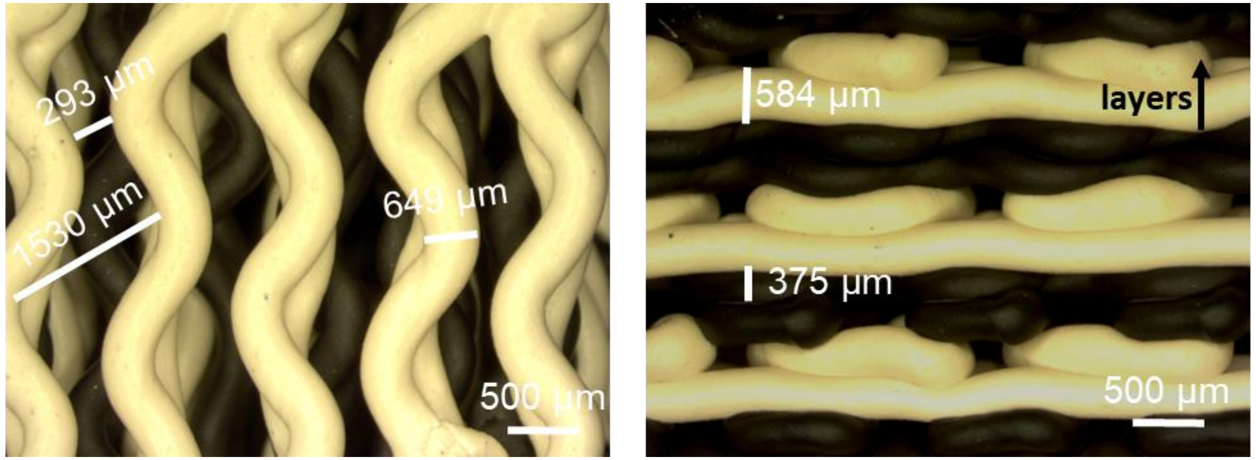
MR A, B and C → 40x20x9 mm

Catalytic Heterostructures Design

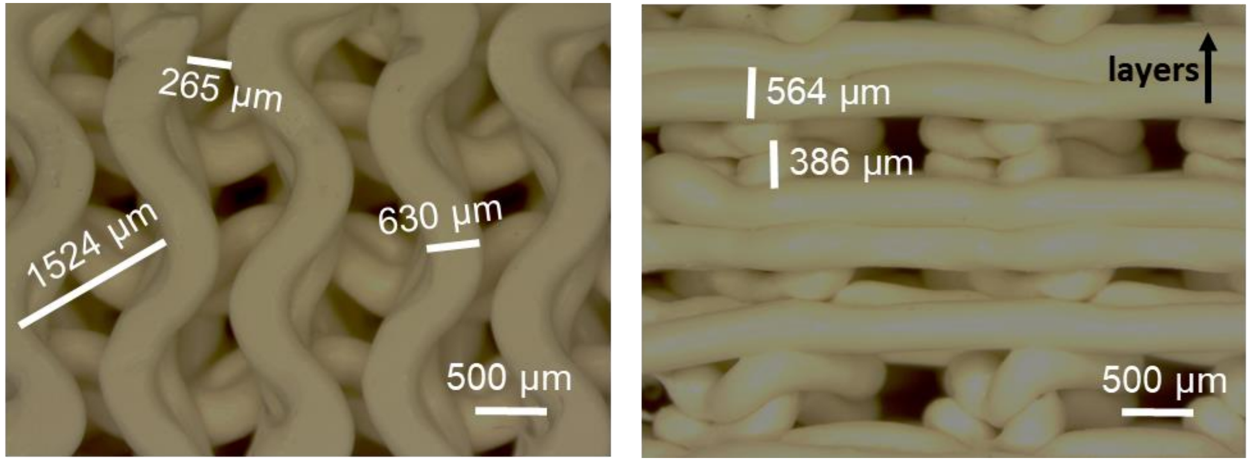
Design and printing of porous co-catalytic heterostructures

Porosity and microscopy of FFF printed membranes

B **Co-catalytic structure**



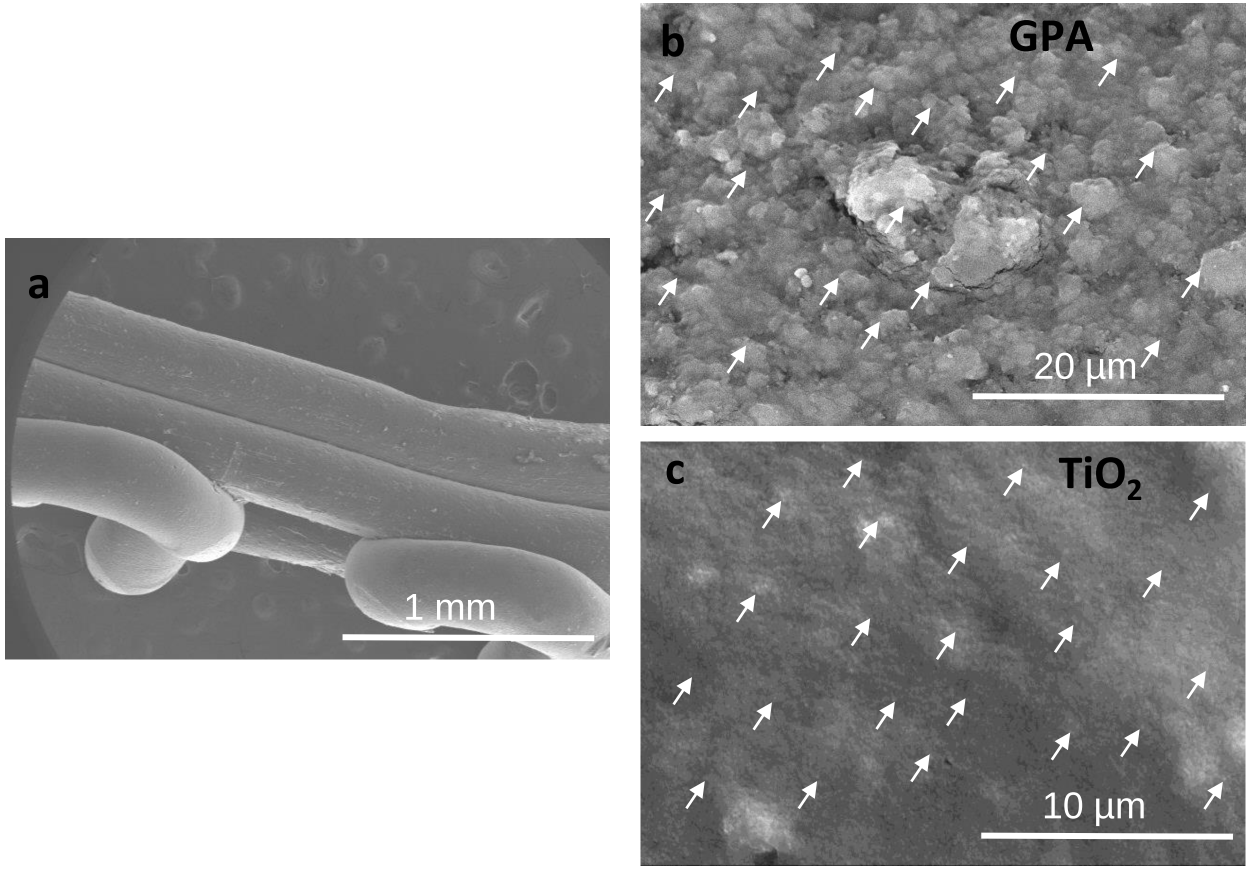
C **Adsorbent Catalytic heterostructure**



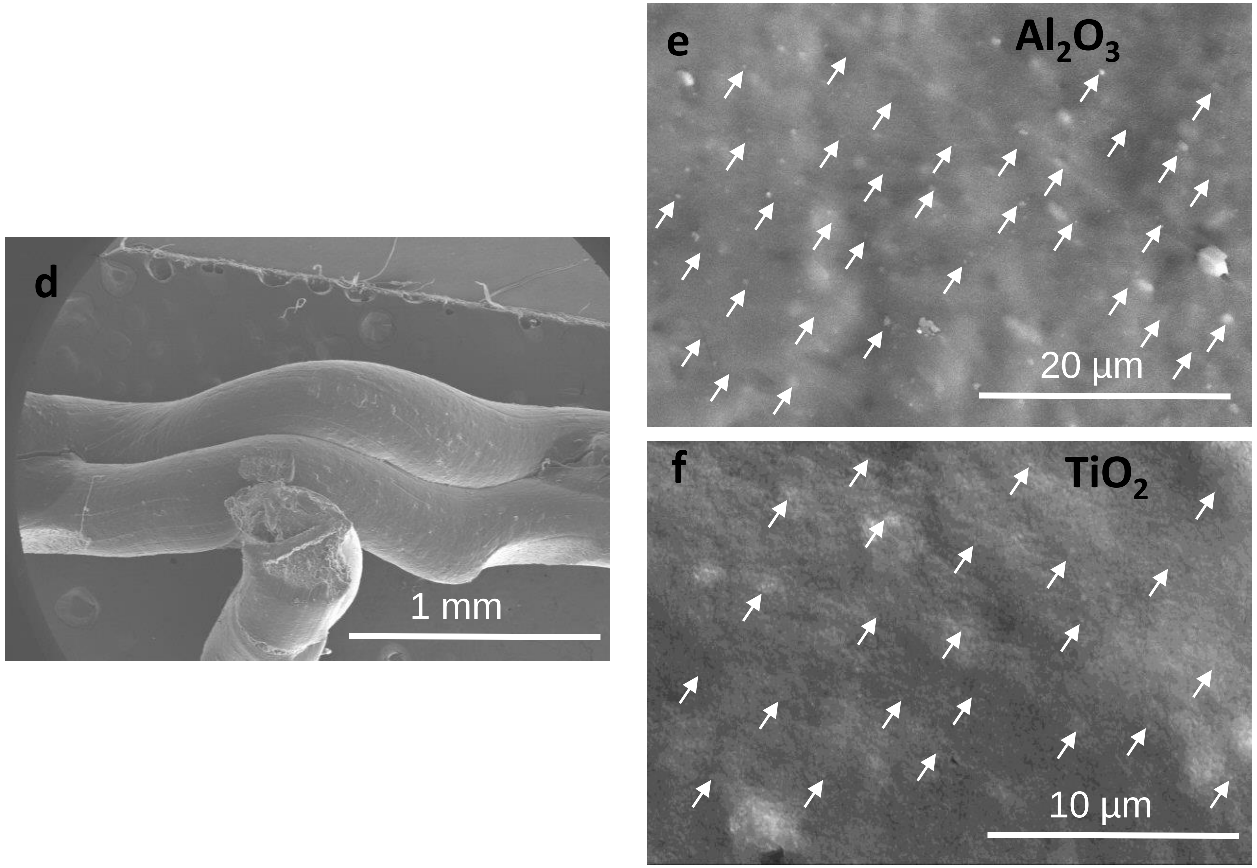
Design and printing of porous co-catalytic heterostructures

Porosity and microscopy of FFF printed membranes

B Co-catalytic structure

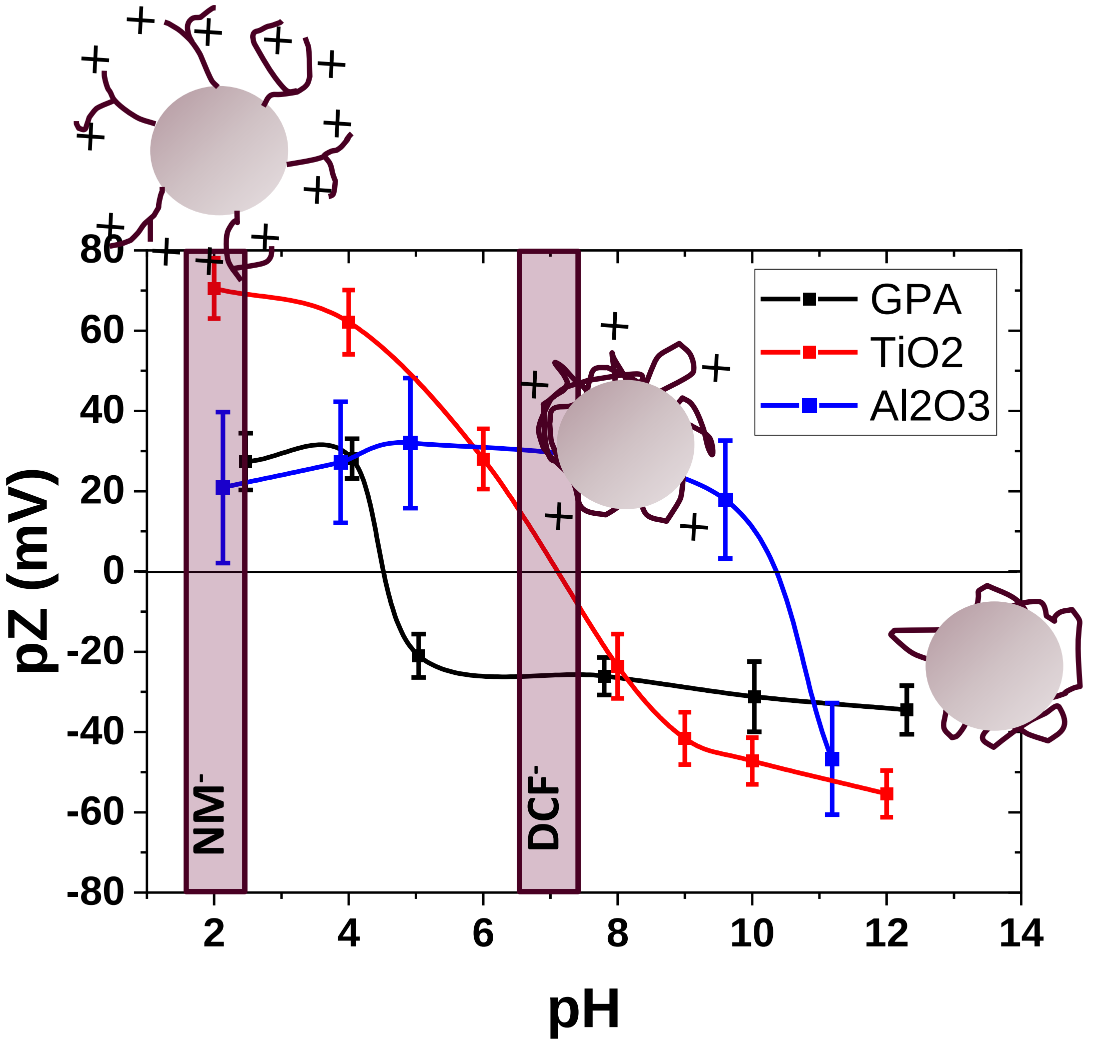


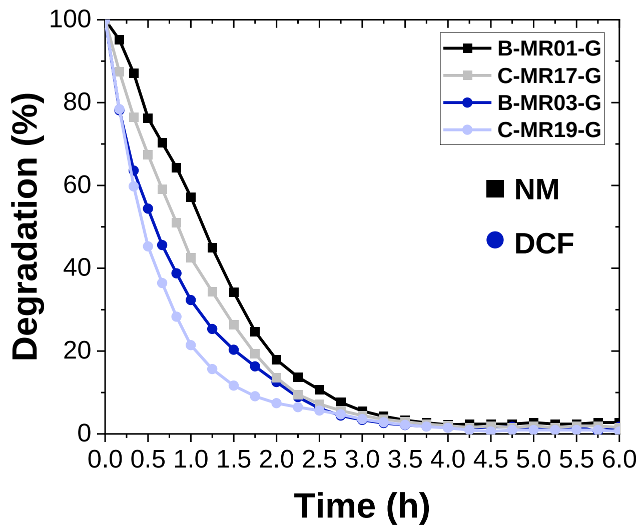
C Adsorbent Catalytic heterostructure

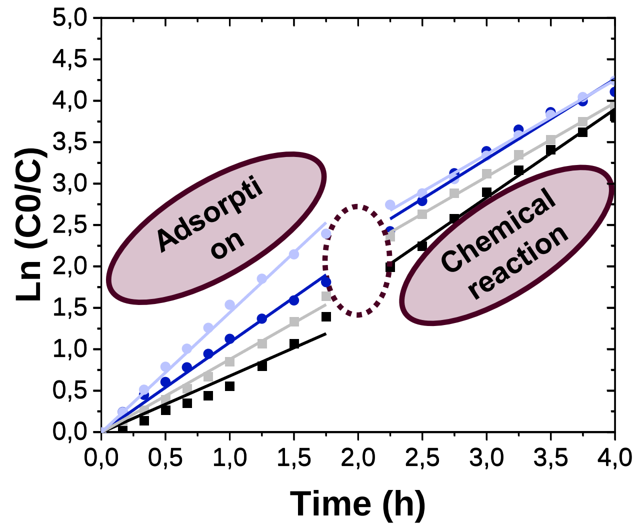


Reaction mechanism, photocatalytic activity and kinetics

Surface charge study (zeta potential)







K'' ($h^{-1} \cdot g^{-1}$)

k_{ads} ($h^{-1} \cdot g^{-1}$)

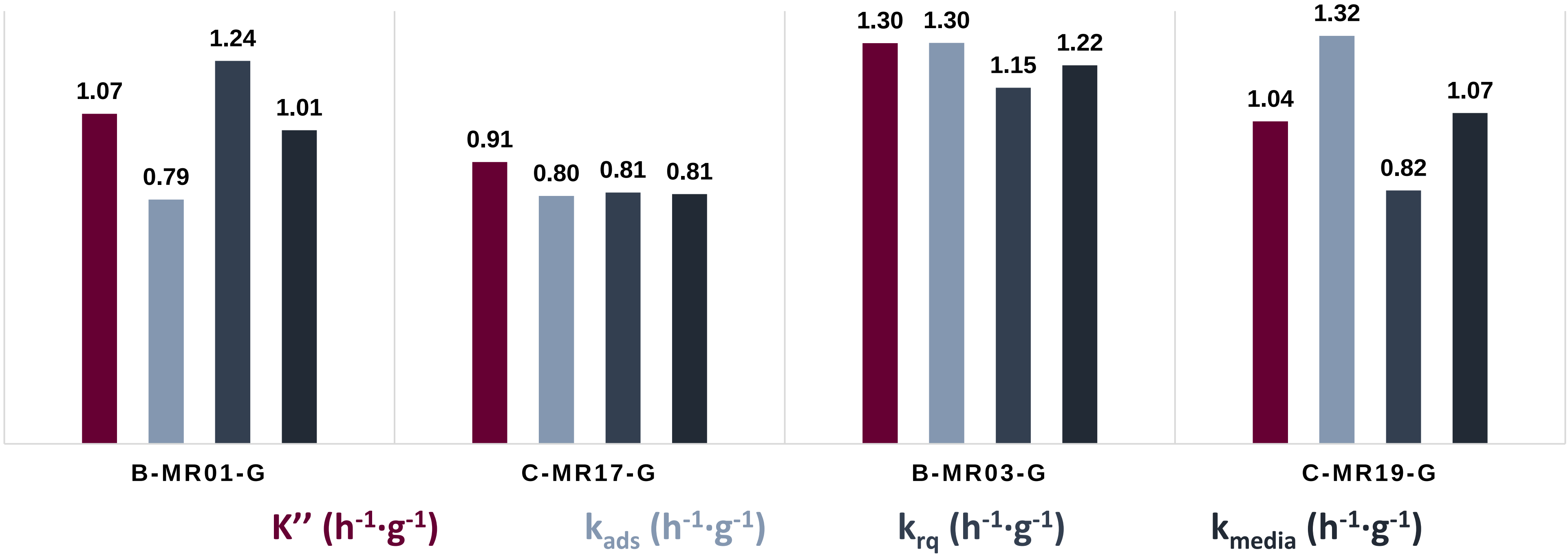
k_{rq} ($h^{-1} \cdot g^{-1}$)

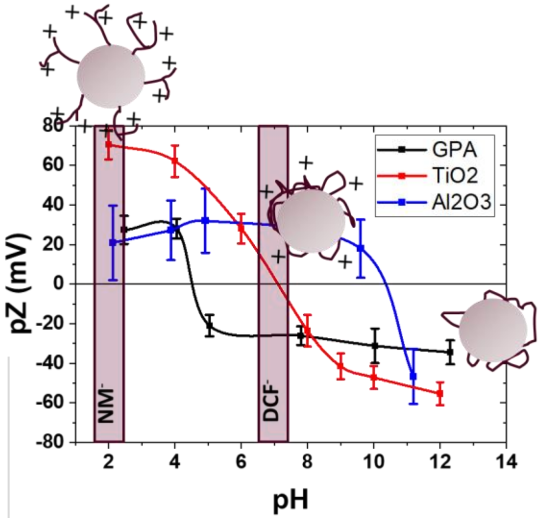
k_{media} ($h^{-1} \cdot g^{-1}$)

Reaction mechanism, photocatalytic activity and kinetics

Kinetic constant's different reaction mechanisms

NM (pH=2) | **DCF (pH=7)**

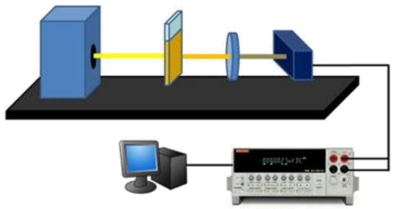




aqualia

Degradations achieved according to time and reactor type

Reactor / Sample composition	A	k ($h^{-1}\cdot g^{-1}$)	B	k ($h^{-1}\cdot g^{-1}$)	C	k ($h^{-1}\cdot g^{-1}$)
Flow Reactor (2h)	10%	$7,4\cdot10^{-1}$	40%	$4.4\cdot10^{-1}$	20%	$2.4\cdot10^{-1}$
Batch Reactor (2h)	10%	$1.1\cdot10^{-0}$	80%	$1.3\cdot10^{-0}$	90%	$1.04\cdot10^{-0}$
Flow Reactor (6h)	25%	$3.2\cdot10^{-1}$	-	-	-	-
Batch Reactor (6h)	25%	$7.6\cdot10^{-2}$	100%	$1.3\cdot10^{-0}$	100%	$1.0\cdot10^{-0}$
Flow Reactor (100h + refill)	85%	$1.5\cdot10^{-2}$	-	-	-	-
Batch Reactor (72h)	-	-	100% (72h)	$9.3\cdot10^{-1}$	100% (72h)	$8.1\cdot10^{-1}$



Batch Reactor

$$\text{Irradiance} = \frac{\text{Incident power (W)}}{\text{Exposed area (m}^2\text{)}}$$

	Flow rate (m^3/h)	HRT (s)	Irradiance (mJ/cm^2)	Exposed area (cm^2)	Power (W)
Batch reactor	0,00E+00	600	2,81E+07	3,6	150
Flow reactor	1,08E+00	5	2,50E+01	100	0,5
	9,00E-03	**600**	**3,00E+03**	100	0,5
	1,00E-06	5400000	**2,70E+07**	100	0,5
	8,00E-04	6750	1,01E+07	100	**150**

Flow Reactor

Flow reactor → irradiating with 0.5 W vs. 150W → 100 cm^2 vs. 3.6 cm^2 → lower irradiances

Highlights

- **COLFEED's high-tech feedstock** for MTE 3D printing of photocatalytically active membranes **has been validated in the scalability and printing of custom geometries tested** in a flow reactor at AQUALIA's pilot plant.

- **From the design** of the geometries and their optimization we **can improve the catalytic activity without compromising** too much the **fluid dynamic problems** that the tested membranes may cause.

- The prepared **co-catalytic structures** show **better degradation rates** in the degradation of the studied pollutants **than the catalytic heterostructures.**

- Therefore, **we have achieved a geometry that gives good catalytic yields** for the AQUALIA flow reactor **and good stability results** in the different media and tests.

Our Team

Dr. Juan A Escribano
CEO, Chemist, MBA
BD | Finance | Sales

Pablo Ortega
Material Sci. & Tech.
Printing Service | Junior Researcher

Esther Miguélez
Lab. Analysis & Quality Control
Production | Quality Control

Dr. Hossein Besharatloo
Material Sci. & Tech.
R&D NEOTEC

Dr. Begoña Ferrari
COO, Mining Eng.
Production | R&D

Dr. Caterina Chirico
Material Sci. & Tech.
P&D | Metals

Dr. Javier Sánchez
Chemistry
PM | Ceramics

Dr. Ana Ferrández
Material Sci. & Tech.
PM | Biomaterials

Dr. Zoilo González
Chemistry Sci. & Eng.
PM | Functional Mat.

Dr. Joaquín Yus
Material Sci. & Tech.
PM | Sea Materials

50% of the founding partners are members of the research group, with an additional 10% from our CEO and the remaining 40% from external investors.

COLFEED4Print

Technological Spin-off from CSIC

PRINT YOUR FUTURE IN 3D

colfeed@colfeed.com

www.colfeed.com