



Open Innovation Test Bed
for nano-enabled Membranes



The Innomem project goes on!

The Innomem Project is now entering its fourth year of implementation, and the first 42 months have seen numerous accomplishments!

Explore this newsletter to discover the progress made by the consortium and to learn about the upcoming steps.

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WP1 - Development and organisation of the OITB: Upgrade of facilities (incl. in-line quality control), specs and services

WP1 was defined to build and organise the OITB, by upgrading the membrane synthesis pilot facilities within INNOMEM and elaborate the specifications and services to be offered to the market. WP1 has resulted in:

- The definition of an appropriate Sustainability Manufacturing Framework (SMF), the diagnosis of this SMF in all Pilot Lines (PLs) of the OITB, and the definition of customized improvement plans to increase the manufacturing sustainability in all PLs.
- Upscaling and upgrading the 14 PLs in relation to production rate and in-line control. All PLs are presented in the OITB Service Catalogue on the INNOMEM website.
- Creation of a working Virtual Labs for Characterization, gathering the capabilities of all partners, and defining common protocols and report layouts
- Creation of a working Virtual Lab for Modelling, gathering the capabilities of all partners, and agreeing on common procedures for modelling and reporting. A procedure to connect clients to appropriate modelling partners was defined.
- A preliminary analysis of the regulatory, economic and technical barriers of the OITB

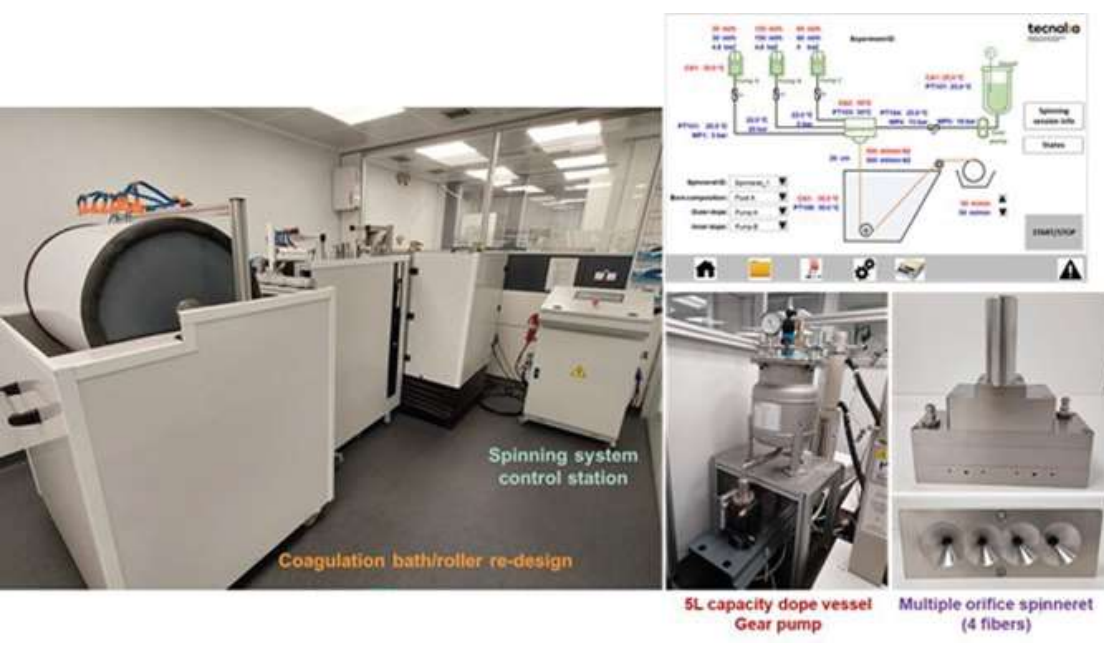


Figure 1. PL1 - Dual layer MMM HF1 (Tecnalia)



Figure 2. PL2
Tubular thin Pd membranes (Tecnalia)



Figure 3. PL3
Grafted tubular ceramic membranes (VITO)



Figure 4. PL4
Nanostructured inorganic microtubular membrane (IC/AU)



Figure 5. PL5
Flexible flat sheet
polymeric membranes /Heraon)

Figure 6. PL6
Tubular zeolite
membranes (FHG)



Figure 7. PL7
Roll-to-Roll Coating of Advanced Nanophase-Segregated
Ion-Exchange Polymer Membranes

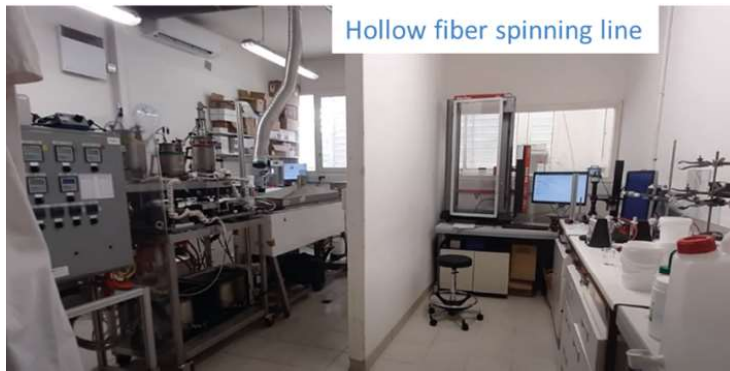


Figure 8. PL8
Surface modification of polymeric hollow fibers by co-co-extrusion or Atomic layer Deposition (ALD)

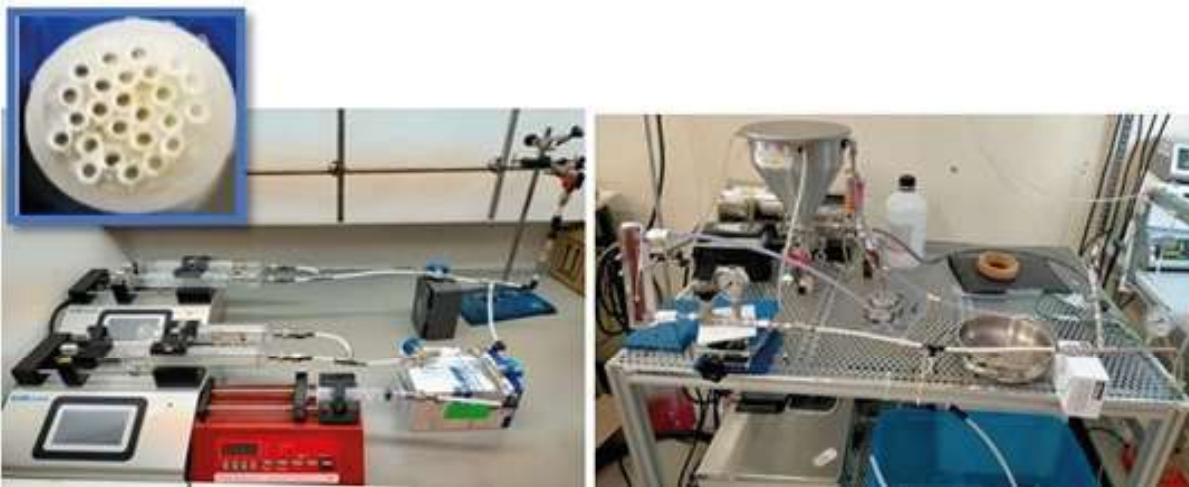


Figure 9. PL9
Modified HF's by microfluidics (University of Zaragoza)



Figure 10. PL10
In-line modification of nanocoatings on polymeric HF's (University of Twente)

Figure 11. PL11
Eco-friendly manufacturing
of oriented GO (or CNTs)
Layer by Layer (LBL)
deposition membranas
(DEMOK)

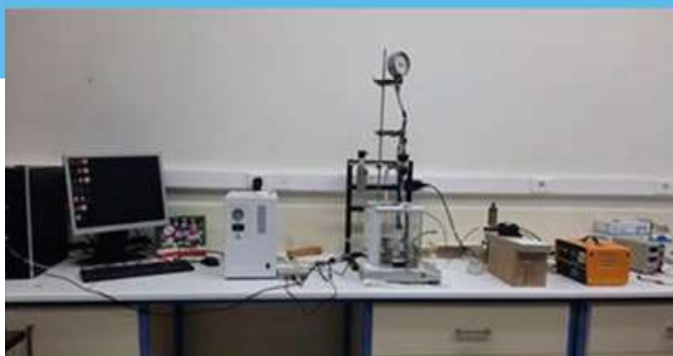


Figure 12. PL12
Up-scaled CVD/ALD deposition
unit for the tailoring of the nanopore size of
ceramic and stainless steel Molecular Sieving
membranes (DEMOK)



Figure 13. PL13
Hollow fiber membrane
spinning with improved geometric features (RWTH)



Figure 14. PL14
Centrifugal potting of polymeric HFs

WP2 Setup of SEP for sustainability and management of the ecosystem

Work Package 2 ended in 2022. The main objective was to establish the operation of the SEP (the way it is going to create and provide value, the organisation structure, appropriate legal entity and governance rules).

More precisely:

- Definition of the Single-Entry Point (SEP) (related to task 2.1. M1-M18)
- SEP qualification scheme and quality assurance (related to task 2.2. M3-M24)
- Definition of the SEP governance model (related to task 2.3. M3-M24)
- To materialize the offer of the SEP to the market (related to task 2.4. M3-M24)

All these objectives were successfully accomplished through the following activities:

- SEP value proposition and market analysis: SEP offering was consolidated in a service catalogue, which is aligned with the market needs contained in the market analysis.
- SEP Definition and business model: Consensus building process to materialise the final version of the INNOMEM OITB SEP definition and business model.
- SEP qualification scheme and quality assurance: Framework was defined, thus structuring conditions to be a service provider and quality assurance procedures.
- Governance model definition: Reference governance models were surveyed. An initial proposition was made regarding governance and financial model in alignment with business model.

WP3 - Validation of OITB facilities, capabilities and services: Industrial Showcases

The main objective is to produce the 10 showcases to validate the upscaling and synergies between all PLs. The methodology applied was: 1) Definition of the value chain related to the showcase; 2) Development of the showcase; 3) Validation of the performances of the showcase; 4) Validation of the efficiency of the OITB to answer the showcase.

The planned upgrading of the PLs has been successfully implemented, and here some examples of the results obtained.

Showcase 1. Partners LiqTech and VITO collaborated on grafting ceramic membranes at a commercial scale. The objective was to demonstrate the superior performance of grafted LiqTech membranes compared to native ones in purifying highly fouling wastewater. The wastewater was a metal-processing company's oil/water emulsion with high metal content. The results showed that the grafted membranes had 35% higher permeability and 46% less hydraulic resistance than the native membranes when filtering coagulated machinery wastewater.

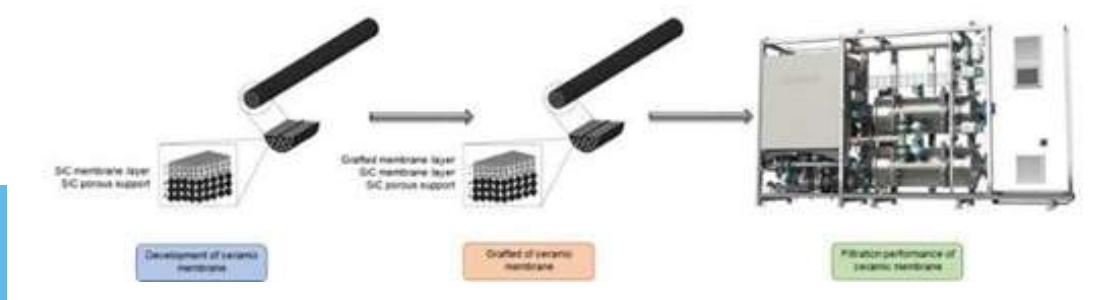


Figure 15. Membranes used in Show Case #1

Showcase 4. Partners H2SITE, TEC, TUE and ENGIE collaborated in the validation of a membrane reactor for hydrogen production (purity level >99,9%) with a capacity of 2 Nm³/h. In this showcase, Pd-based membranes were produced and integrated into a Membrane Reactor based Natural Gas reforming system. The ideal H₂/N₂ selectivity of the prepared Pd membranes was five times higher than the targeted, while KPIs set for the entire system as the mentioned H₂ purity, H₂ production capacity and running hours were validated.



Figure 16. Reactor testing for debugging

Similar progress has been obtained for all the different 10 showcases:

1. Grafted ceramic membranes for wastewater purification (LIQTECH)
2. Zeolite and polymeric membranes in natural gas treatment (DBI)
3. Mixed matrix Membrane for liquid and gas separation (POLYMEM)
4. Advanced membranes for pure H₂ production/purification (ENGIE/H₂SITE/RAUSCHERT)
5. Micro-tubular and micro-monolith ceramic membranes (LIQTECH)
6. Functionalized polymeric HF membranes for aqueous applications (NXF)
7. High flux FO and NF for desalination and wastewater treatment (ECOTECH/HTF)
8. HF membranes for ultrafiltration applications with enhanced performance (FILATECH)
9. Anion-Conducting Membranes for Energy Applications (EVONIK)
10. CVD modified molecular sieving and templated grown CVD membranes (SUK, HTF)
11. sieving and templated grown CVD membranes (SUK, HTF)

WP4 - Validation of the SEP: set up of open calls

The INNOMEM Open Calls have been the main focus of the WP4 activities since the last newsletter! The first cut-off of the second wave of the Open Calls has passed, and we received very interesting applications with highly innovative ideas that have potential to revolutionize their respective markets – with membranes as the star actor. The applications have now all been evaluated by the INNOMEM Evaluation Panel, and we have already selected the successful applicants: they will kick-off the services with us very soon.

The second cut-off is already open, so if you are interested in the INNOMEM services don't miss the chance to apply! The deadline for applications is December 31st 2023.

WP5 - Democases Development

Following the showcases, this summer the democases have started. The showcases allowed us to test the validity of the SEP and the readiness of the upgraded pilot lines. With the democases the goal is to make the services available for companies validating the INNOMEM set-up in a true environment.

Many companies have shown interest, ranging from small spin-offs to large industrial enterprises. All were linked to the process industry and while some of them are manufacturers of membranes, others were interested in the membranes for their process or for process design.

The first company partners of the INNOMEM consortium have started work with is ICI Caldaie. This is an Italian manufacturer that designs and produces boilers for industrial and residential use. Their interest in INNOMEM resides in solving challenges for systems for the production and use of green hydrogen. Another client is Tullia Zucca, Eng., is a small engineering company in Italy, active in industrial and civil engineering, mainly in oil & gas and in chemical process developing.

From the Netherlands, we have Flexiramics, a spin-off from the renowned MESA+ Institute of Nanotechnology at the University of Twente, with activities focused on its core invention: Flexiramics®, a flexible pure ceramic fibre mat. Another client is A-membranes, a Belgian startup company which has acquired the rights to the technology to graft ceramic membranes with organometal grafting.

B4CApS, is a company B4CApS is a Danish company engaged in the development of ceramic membrane solutions for water treatment applications. Finally, Técnicas Reunidas is a large Spanish enterprise, specialized in the process design and simulation of industrial, energy and petrochemical facilities as well as EPC capabilities.

These companies had applied because they had challenges, to be solved through the democases. In all cases, the challenge is taken on by between 2 to 4 partners of the INNOMEM consortium, which demonstrates the added value obtained when collaborating and when offering jointly INNOMEMS' partners' pilot lines and services to industry.

WP6 - Sustainability planning and customer relationship

Work package 6 aims to verify the implementation of defined sustainability aspects within the 14 pilot lines, as well as the implementation of the OITB and SEP. This includes its quality management, customer relationship, and exploitation strategy.

Task 6.1

Every PL owner previously evaluated the sustainability of manufacturing in their pilot lines using the established Sustainable Manufacturing Framework (SMF) methodology, both at start of INNOMEM, and as targeted after their upscaling/upgrading actions. Within Task 6.1 these improvement plans were updated and an Internal Audit defined by VITO and TEC verified the compliance with the defined targets.

Task 6.2

The objective of this task is to take stock on all the experience gathered from the execution of showcases and democases to update the INNOMEM SEP exploitation strategy, ensuring SEP financial sustainability beyond the end of the project. In order to achieve this goal, Tecnia Ventures is currently looking at actual business opportunities provided by the OITB for the involved stakeholders and a detailed analysis of OITB costs (including investments, management, commercial, services, etc.) which will be supported by PNO. A final catalogue of services to be provided by the OITB is currently being finalized and will be available at the end of October 2023.

Task 6.3

Within Task 6.3, Tecnia Ventures is responsible for the updated Quality Management System. This deliverable is a continuation of previously defined SEP Qualification Schemes and SLA, and it builds on the experience which has been gained through the showcases and democases. This updated Quality Management System is currently under review and will be finalized shortly. The final definition of the INNOMEM SEP is to be finalized in October 2024.

Task 6.4

This task has the sole objective of determining the structure of the SEP after the end of the EC-funded INNOMEM project. In order to achieve this goal, a 6-point plan was established:

1. Finding out which partners are interested in continuing with INNOMEM OITB SEP activities after the end of the EC-funded project.
2. Organising a meeting with those partners who are interested to let them know about the process we intend to follow.
3. Presenting the different options for the SEP.
4. Choosing the preferred legal entity for the OITB.
5. Hiring legal firm to draft Collaboration Agreement
6. Defining the terms of the agreement.

A first version of the agreement was drafted and is currently under review by the partners. At present, 13 partners have shown interest in participating in the OITB SEP after the end of the project. After multiple iterations, the final version of this Collaboration Agreement is expected in April 2024.

Task 6.5

Task 6.5 entails training and transfer of technology through educational content and the creation of a catalogue of for content. The Technical University of Eindhoven has been preparing multiple educational short videos on modelling of membranes. The first video is on modelling of palladium membranes, which is currently being post-processed and is to be published in the following weeks.

Task 6.6

Task 6.6 focuses on access to investors and aims at bridging the gap between investors and additional funding prospects within the OITB ecosystems and actors. To date, PNO has screened and analysed private investment operations in membrane technologies within EU over the last decade. As a result, over 300 potential investors (e.g. seed, early and later stage, business angels and accelerators/incubators) have been identified all of which are highly relevant and beneficial for INNOMEM's objectives.

WP7 - Dissemination, Clustering and Exploitation

WP7 aims at disseminate, communicate and exploit the most interesting results of the Project. To this purpose the activities within the WP have been mainly dedicated to:

- Disseminate the know-how on various levels and setup communication activities targeted to broad public, through social pages and website.
- Establish contacts with stakeholders and similar initiatives aiming to enlarge the list of service providers, through dedicated special sessions, participation with dedicated booths at conferences, and a workshop.
- Evaluate the market potential and determine product opportunities for the new INNOMEM showcases and democases, including monitoring of new IPR creation inside (opportunity) and outside (exploitation threat) of the consortium
- Use the standardization system to facilitate the acceptance and utilisation by the market of the developed solutions and ensure compatibility with what already exists in the market.
- Promote the Open Calls.

In the last six months Innomem has been present in various events!

Some examples...

On October 10th, the Area della Ricerca di Cosenza celebrated CNR centenary with a day dedicated fully to science and technology for a sustainable and resilient future! INNOMEM was one of the sponsors of the conference and was present with a dedicated stand and actively during the round table on Hydrogen for a decarbonized future!



The INNOMEM Project was showcased with oral presentations and invited lectures at various conferences such as the 14th edition of ECCE: the European Congress of Chemical Engineering, the International Conference of Sustainable Environmental Technology (ISET) 2023, the ChemEngDayUK2023, the International Conference on Membranes (ICOM2023).



INNOMEM Project was one of the sponsor of the 16th International Conference on Membrane Reactors, where it was present with a dedicated booth and several presentations about the key developments of the project!

October 16 – 18, 2023 in Donostia-San Sebastián, Spain

16th International Conference on Catalysis in Membrane Reactors

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INNOMEM

DRAFT PROGRAM AVAILABLE

Two best presentation awards will be granted by Processes.

Selected papers from ICCMR16 will be published in a Special Issue in Processes.



The INNOMEM second wave of Open Calls has been launched on May 1st. Do you want to learn about the technical feasibility of membrane for your application? Are you innovating in technologies for liquid/gas separation, water treatment, H₂ purification, or CO₂ capture? **Then this call is for you! Apply now to the wide range of services that INNOMEM has to offer!**

The call will be open until December 31st, with intermediate evaluation points. Funding is limited, so we encourage all applicants to apply as early as possible.



- Do you want to learn about the technical feasibility of membrane technology for your application?
- Are you developing and/or deploying solutions using membranes in the environmental, health, petro-chemical or energy sectors?
- Are you innovating in technologies for liquid/gas separation, water treatment, H₂ purification, or CO₂ capture?
- Do you need support in process design or modeling involving membrane technologies?



OPEN CALL

WHO

WHAT

**SUBMIT
your application
from
May 1st**



The call is open
to **industry**
both large and SMEs.



All successful applicants to the INNOMEM Open Call will get **free access to a network of 14 Pilot Lines facilities** and services of a covering the full value chain of products based on nano-enabled membranes.



See how
to apply here



Discover
all the available
services in our
Catalogue



Check out <https://www.innomem.eu/open-calls/> or reach out to us via opencall-helpdesk@innomem.eu for more information.

INNOMEM Consortium



Project details

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