INNOMEM

Open Innovation Test Bed
for nano-enabled Membranes

Updates from the INNOMEM project

CERFLEXFILT
Flexible Ceramic Filter Media

Flexiramics pure cer amic non-woven mats excel in separating microparticles at high fluxes even in extreme conditions due to their submicron fiber structure and high porosity of up to 95%. These mats offer a unique combination of microparticle retention, high fluxes, and chemical stability, surpassing competing solutions. Further development is needed to enhance the microstructure, focusing on adjusting porosity and pore size to cater to various applications, as well as grafting new materials onto the mats to impart additional physicochemical properties required for specific applications. This is the focus of the CERFLEXFILT project.

Flexiramics material

University of Twente and EMI Twente leveraged their expertise in conducting physical tests and analyses of Flexiramics' material. Drawing upon their proficiency in physical sciences, the researchers thoroughly analyzed the material's physical properties. By clarifying these physical attributes, the collaborative efforts led to the potential for further developing the materials towards enhanced performance, unlocking possibilities for new applications. Fraunhofer IKTS focused its efforts on exploring surface modification techniques for Flexiramics' material. Leveraging their deep understanding of chemical treatments and surface engineering, researchers at the institute collaborated closely with Flexiramics to develop novel methods for enhancing the material's chemical properties.

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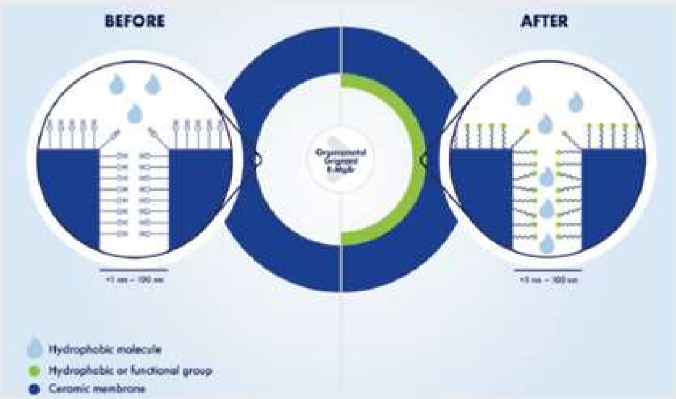
Quic
Quality control in Industrial grafting of Ceramic Membranes

Quic aims to benchmark the new production quality and in-line quality control method of the young licensee company A-membranes, to that of the license provider and INNOMEM partner Vito. A-membranes is a startup company which has acquired the rights to the technology to graft ceramic membranes using organometal (Grignard) chemistry, partially owned by INNOMEM partner Vito. A-membranes is currently investing in the development and implementation of an industrial process for the grafting at high MRL level, and their process differs significantly from the benchmark process used by Vito. Also, Vito's quality control procedure, based on off-line application testing of the grafted membranes, which is a destructive method, is industrially not appealing. Also here, A-membranes has developed entirely new, nondestructive in-line QC- procedures. With this project, A-membranes seeks to benchmark the production quality of their new and different installation and method to the quality obtained on Vito's pilot equipment. Moreover, they aim to benchmark/correlate the outcome of their new quality control procedures used/developed at A-membranes with/to the Vito off-line test methods.



Effect of Grignard grafting of native ceramic membranas, leading to membranas with increased apolare solvent fluxes, decreased fouling or tuneable surface chemistry (a-membranes.com)

The results of the Quic project will allow A-membranes to:

- Launch the industrial production of grafted membranes.
- Offer first volumes of grafted membranes commercially.
- Commission the first industrial production line, increasing the TRL level from 6/7 to 8.
- Apply their technology and modify membranes directly in the production plants of ceramic membrane producers, allowing for larger volumes of identical ceramics / organic group combinations.
- Focus in their production unit on tailoring of membranes for specific smaller volume applications with high added value.

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SolTex
Solvent Recovery in the frame of a textile recycling Project

SolTex aims to develop a circular resource optimization in the frame of a Danish, mixed textiles fibre-to-fibre recycling project. The SolTex project focuses particularly on solvent recovery and re-use. The SolTex project partners will study to recycle DMSO with membrane technology in particular, as energy consumption of traditionally used distillation is not sustainable. The use of ceramic membranes in the DMSO process is considered the best option, in view of membrane durability and the high treatmenttemperature (90°C). To guarantee good removal of dye components, specifically commercially available ceramic nanofiltration membranes will be tested. These can be native membranes, or newer Grignard grafted for better solvent performance. The grafting method was already developed and upscaled by INNOMEM partner VITO (INNOMEM Pilot Line 3), and the resulting membranes recently entered the market.

SolTex will identify the optimal membrane and membrane process, perform Proof of Concept at intermediate scale. Subsequently, it will perform a first valuable Techno Economic Evaluation allowing to define the next step for piloting and upscaling of the process.

Why we nees a more circular textile industry!

The SolTex project was successful and the following conclusions can be drawn:

- Tight ceramic membranes (commercially available from INNOMEM partner RKV) remove the dye impurities from the DMSO process streams originating from textile recycling, up to 90%.
- Proof of concept testing at intermediate scale of membranes, proved the feasibility to recover the DMSO up to 90%.
- The process fouls the membrane but a mild cleaning can recover its process flux up to 100%.
- A first detailed Techno-Economic Assessment revealed a DMSO recovery cost way lower than the purchase cost of new DMSO.

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CO_2PP
Study for the industrial implementation of membrane based SMR CO2 Post-Combustion Capture Plants

Process design and techno-economic analysis of a membrane-based solution for a postcombustion CO2 capture plant in an SMR plant (300 kg/day of H2 product). The goal is to reach 90% recovery with 90% CO2 purity through a technically feasible and economically competitive solution.

The main objective of the Democase CO2_PCCP is to develop the flowsheet of a membrane-based CO2 capture plant able to achieve 90% CO2 recovery and 90% CO2 purity in the post-combustion stream of an SMR plant. The challenge is that the developed solution must be competitive both technically and economically against state-of-the-art solutions (e.g. amines). The proposed solution will be able to be implemented in SR plants that use not only methane as feedstock, but also biomethane, biogas and bioethanol with relatively small modifications.

The two-stage membrane section of the demo-unit designed and developed by HTF and Demokritos

The preliminary results show that it is possible to achieve the targeted CO2 purity and recovery with membrane-based CO2 capture plants.

While 2-stage membrane systems are able to comply with the requested purity, they are not able to reach the desired recovery.

The most promising solutions are those based in 3-stage membrane configuration systems and those based in hybrid systems, combining the membrane unit with a VPSA system, to treat the low CO2 product retentate stream from the first membrane unit.

A detailed techno-economical study is required for each particular case as the selection of the optimum solution varies depending on several factors such as feed composition and scale.

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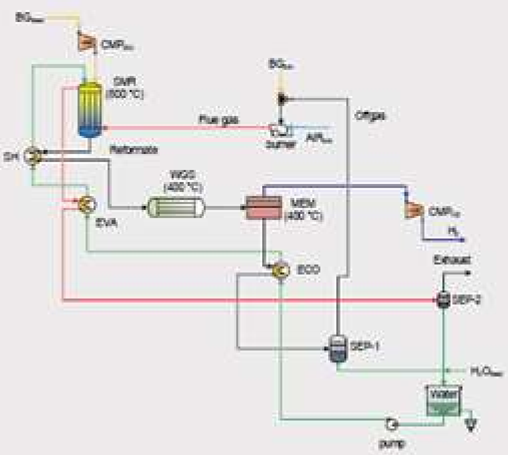
MEREA
Hydrogen production derived from renewable sources

Upgrading of biogas has gained increased attention due to rising oil and natural gas prices and increasing targets for renewable fuel quotes in many countries. New plants are continually being built. The number of upgrading plants was around 100 in 2009. The process of upgrading biogas generates new possibilities for its use since it can then replace natural gas, which is used extensively in many countries. However, upgrading steps increases enormously the cost of biogas production. In this project especially different reactor configurations will be studied with the focus on solutions that can be easily scaled-up and commercialized. This includes not only membrane reactors but also series of reaction and membrane separation to increase flexibility. The project tested several membranes and reactors and made use of detailed modelling for system análisis.



One of the several configurations modelled in the project

The membrane integration inside the reactor is the configuration that most benefit for process intensification (smaller volumes and higher efficiencies).

However, membranes after the reactors are also possible and allow increasing efficiencies as well, also with less stress on the membranes.

Membranes have been scaled up and tested also with news sealings developed at TUE.

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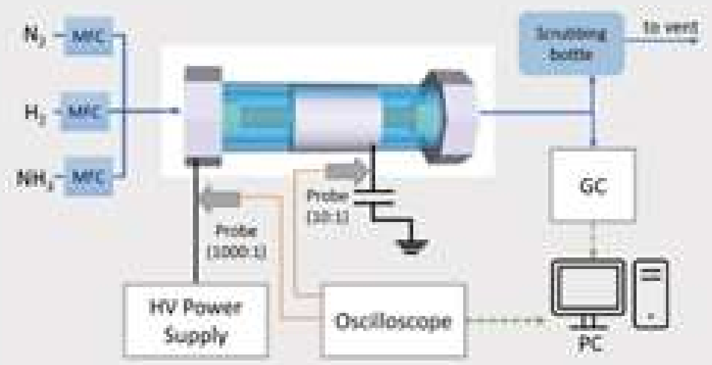
Plasmammonia membranes and plasma reactors for ammonia decomposition to produce pure hydrogen

Ammonia decomposition is becoming a hot topic in the energy transition.

Existing ammonia production plants produce 100-3000-ton NH3/day with a worldwide production capacity estimated to 180 million tons per year, mainly used in agriculture as fertilizer (80% of the total production). However, ammonia could meet the transport needs of H2 for long distances due to its high hydrogen volumetric density, and thus enable the use of hydrogen in distributed applications. Estimations show that 500,000 tonnes per year of green hydrogen could be produced in 2037 from the cracking of green ammonia. In recent years, Gallucci et al. and other authors have shown that the use of hydrogen selective membranes inside the reactor allow converting ammonia into pure hydrogen at lower temperatures compared to conventional reactors.



Scheme of the plasma reactor used for ammonia decomposition testing.

The cold plasma reactor used is a DBD reactor packed with insert spheres of alumina.

The invention of Tullia Zucca, uses a plasma source to split the ammonia into hydrogen and nitrogen, thus avoiding the use of a catalyst and allowing direct contact of ammonia with the thermal source.Tecnalia has developed several membranes for the testing with ammonia hydrogen mixtures.

The results show that membranes can be used downstream the plasma zone (provided that the reactor is hot enough) to separate hydrogen with high purity.

Pressure increases the membrane flux, thus the higher the pressure of the reactor the lower the amount of membranes to be used.

The plasma reactor can convert ammonia. However room temperature plasma can reach only 10-12% conversion. Higher temperatures can reach up to 99% conversion. High temperature plasma allows integration of membranas.

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INNOMEM

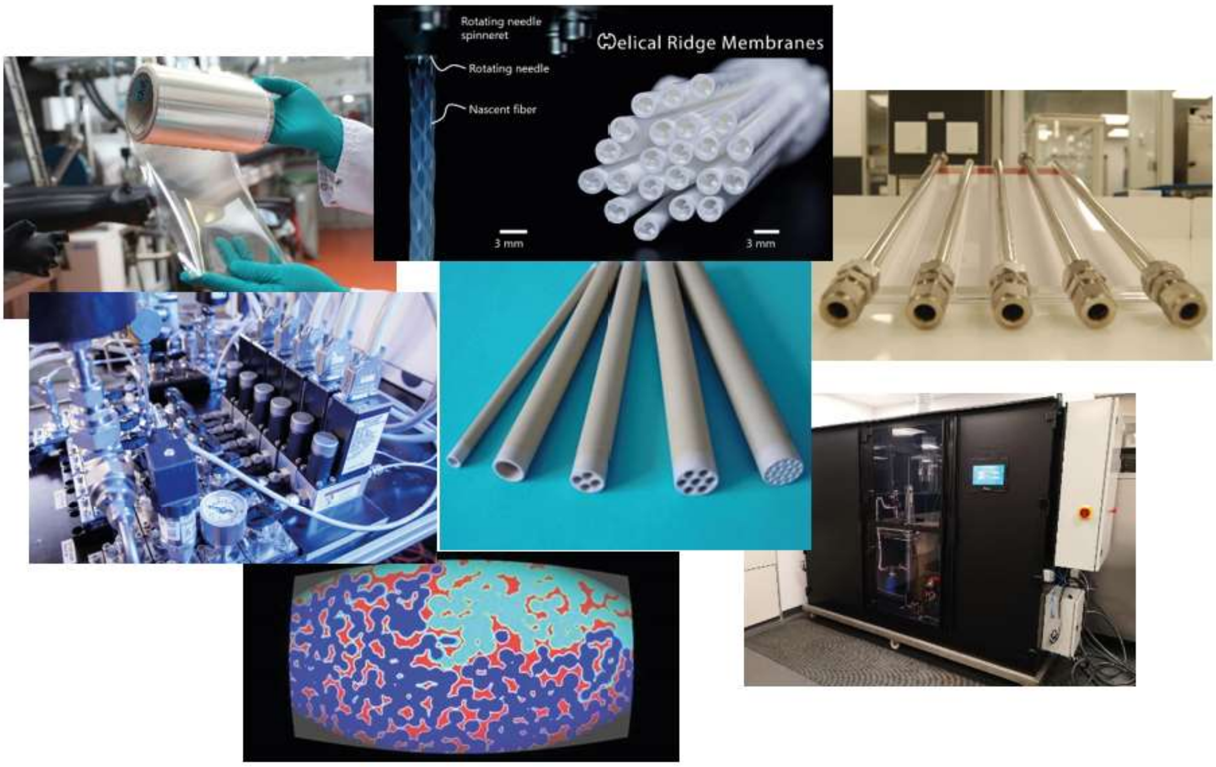
Final Workshop

Discover the opportunities of the 1st European single entry point for all your membrane related questions!

10 September 2024 14:00 – 18:00

Prague Congress Centre Chamber Hall, Prague (CZ)

www.innomem.eu



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INNOMEM Consortium

Project details

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