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EDITORIAL BOARD
Dear readers,
I am very glad to introduce the “ITM NEWSLETTER” with the objective of disseminate and report the main research activities, events, projects, bilateral exchanges and published articles, chapters, books of the Institute on Membrane Technology of the National Research Council of Italy.
The ITM Newsletter has a long history and it can be considered one of the first digital newsletter in our field, being the first one dated 2007 (https://www.itm.cnr.it/index.php/it/newsletter).
Today the ITM Newsletter returns in a new edition with a restyled format visible on different electronic devices (PC, tablet and mobile). It will be out every three times a year, and the current edition of May 2019 will cover the CNR-ITM activity period of November 2018 – April 2019. It has been totally produced in-house at ITM with the support of the new Editorial board, made of ITM researchers and the ITM web designer, who took part to this initiative with enthusiasm and professionality. A special thanks goes also to all ITM researchers, technicians and ITM visitors who actively contributed to the content of this issue.

Enjoy the read and stay tuned with our ITM NEWSLETTER!

Dr. Msc. Alberto Figoli
Director
Institute on Membrane Technology (CNR-ITM)
Tel.: +39 0984 492027 / 402706 Fax: +39 0984 402103
www.itm.cnr.it - E-mail: a.figoli@itm.cnr.it - alberto.figoli@cnr.it
Simultaneous production of biomethane and food grade CO$_2$ from biogas: an industrial case study

A team of researchers from ITM, in collaboration with Tecnop Project Industriale Srl, studied the possibility to recover not only pure methane from raw biogas but also pure CO$_2$ (https://www.raiplayradio.it/audio/2019/03/MIRACOLO-ITALIANO-5dba92dd-6948-47f0-bdf5-39b78bf054eb.html).

The case study was carried out on the first large-scale industrial biogas upgrading process with simultaneous purification of methane and CO$_2$ in one of Europe's largest biogas production and purification plants (>5000 m$^3$/h), located at Montello's organic household waste treatment plant in Northern Italy. The role of ITM was to monitor the composition of the various gas flows in the three-stage membrane process (scheme below). With a final purity of 99.9 vol%, CO$_2$ was found to be chemically and microbiologically suitable for food applications. Its microbiological purity was found to be abundantly within the limit values defined in the European Collaborative Action. With a purity of 96.3 vol%, methane respects the purity requirement for injection into the household network. This study demonstrates that organic waste material can be fully recycled into valuable products, reducing fossil fuel consumption and CO$_2$ emission into the atmosphere, thus contributing to a more sustainable society. It was published in the prestigious journal Energy & Environmental Science.

Scheme of the three-stage membrane process for the final purification of raw biogas into pure grid-quality methane and food-grade CO$_2$.

Bi₂Se₃-assisted membrane crystallization

Researchers from Institute on Membrane Technology (CNR-ITM) explored the potentialities of a composite Bi₂Se₃-PVDF membrane in membrane distillation (MD) and in membrane assisted crystallization (MCR) for the recovery of better-quality minerals. Bismuth selenide crystals were confined inside hydrophobic polymeric frameworks and were used as active sites for water uptake from clusters of Na⁺ and Cl⁻ ions and water molecules. The inclusion of Bi₂Se₃ in PVDF enhanced the NaCl rejection with a shift from 99.96% for pristine PVDF to 99.99% for Bi₂Se₃-PVDF membrane when NaCl solutions at 0.6 M -the typical salt concentration in seawater- were processed. Interestingly, MCR tests proved narrower-sized crystals with a higher regularity and predominance in the cubic shape.

It is conceivable that the capture of water molecules by adsorption at vacancies and edges of the Bi₂Se₃ surface favors a faster achievement of the saturation conditions. The rapid water removal produces a shrinking of the ionic core preceding the crystallization while the ion–water potential energy is reduced as an effect of assisted water exclusion from ion–water clusters. Attractive ion–ion Coulomb interactions take place upon shrinking and crystallization of the ionic core, thus leading to bigger and better distributed minerals.

This discovery sheds light on a new application capability of chalcogenide materials beyond the state of the art. As an example, Bi₂Se₃ vacancies can be suitably managed to promote quicker ion aggregation and growth, resulting in the formation of highest-quality crystals and minerals.

The results of this research were achieved within the frame of the Joint ITALY-CHINA Great Relevance Collaborative Research Project 2DMEMPUR (MAECI-NSFC) and were published in the prestigious scientific journal Materials Horizons.

**Gas permeable membrane bioreactor for the co-culture of human skin derived mesenchymal stem cells with hepatocytes and endothelial cells**

A gas permeable membrane bioreactor consisting of two flat-sheet fluorinated ethylene propylene (FEP) membranes separated by a microporous polycarbonate (PC) membrane, was developed in order to establish interconnected co-cultures for tissue engineering applications. In particular, a human vascularized liver tissue was created in the bioreactor by co-culturing primary human hepatocytes (hHeps) and human endothelial cells (hECs) in adhesion on FEP membrane, and interconnecting them with mesenchymal stem cells isolated from human dermis (hSSCs), through the PC membrane. FEP membranes ensured the mass transfer exchange of \( \text{O}_2 \) and \( \text{CO}_2 \) between cells and external environment, while PC membrane allowed the cellular compartmentalization and the selective transport of molecules secreted by cells, avoiding the direct contact.

The bioreactor configuration mimicked the natural hepatic lobules as highlighted by the formation of biliary ducts and vascular capillaries tightly distributed among liver cells. The mutual biochemical communication between the different compartments improved both the liver specific functions and induced hSSCs differentiation in hepatocyte phenotype expressing specific hepatocyte markers. The organotypic membrane bioreactor offered interesting opportunities for the design of bioartificial livers with high morpho-functional and long-term performance, and, in the meantime, for the production of differentiated hSSCs-derived cells that could be harvested as autologous cell source for personalized therapies.

*Salerno S., Curcio E., Bader A., Giorno L., Drioli E., De Bartolo L., Gas permeable membrane bioreactor for the co-culture of human skin derived mesenchymal stem cells with hepatocytes and endothelial cells, Journal of Membrane Science, 2018, 563; 694-707. [https://doi.org/10.1016/j.memsci.2018.06.029](https://doi.org/10.1016/j.memsci.2018.06.029)*
New frontiers in sustainable membrane preparation: Cyrene™ as green bioderived solvent

Dihydrolevoglucosenone (Cyrene™), a biosolvent synthesized from renewable cellulose in two steps was used for the first time for the production of polyethersulfone (PES) and polyvinylidenefluoride (PVDF) membranes in order to develop a more sustainable membrane preparation. The green solvent perfectly responds to the necessity for membrane preparation procedure to meet ever more stringent environmental regulations for human health and environment protection. Moreover, the similarity of Cyrene™ with solvents of very high concern, such as dimethyl-formamamide (DMF) and N-Methylpyrrolidone (NMP) which have been recently added to the restricted compounds list by the European Commission, offers a solution for an innovative polymeric membrane fabrication without penalizing membrane properties.

PES and PVDF were used as polymeric materials for obtaining membranes for microfiltration (MF) and ultrafiltration (UF) applications, without the addition of any co-polymer or pore former agent. Thermodynamic investigations revealed that Cyrene™ manifests stronger interaction with PES rather than PVDF, thus strongly affecting, together with kinetic factors, the final membrane structure and characteristics.

By simply acting on the preparation procedure and, in particular, by exposing the nascent films to different intervals time through a combination of Vapour- with Non-solvent Induced Phase Separation (VIPS and NIPS, respectively) PES and PVDF membranes with a pore size 0.02-0.12 μm and 0.03-0.55 μm were obtained, respectively.

Cyrene as safer bio-solvent opened novel perspectives for the preparation of polymeric membranes, constituting not only a more sustainable choice for both PES and PVDF, but representing for PVDF a more effective solvent in comparison to DMF and NMP for the fabrication of porous membranes with a bi-continuous morphology.

Advanced Membranes for BIOgas upgrading and high added VALUE compounds recovery

BioValue, a three years project, was recently approved in the framework of MERANET joint calls 2018, and cofounded by Regione Calabria (Italy) and Technology Agency of the Czech Republic.

The Consortium, coordinated by CNR-ITM, includes the University of Calabria, Calabra Maceri & Servizi s.p.a., MemBrain s.r.o. and the University of Chemistry and Technology of Prague.

BIOVALUE project will use membranes - advanced nano-structured functional materials - for driving environmental-friendly and little energivorous novel separation processes valorizing waste as required by circular economy dictates.

Bio-digester gas streams contain valuable products such as bio-methane and VFA whose recovery has important advantages for the environment protection, energy saving and waste valorization. BIOVALUE focuses on the development of a membrane-based innovative process for the treatment of biogas produced by a real bio-digester. Advanced membrane units will valorize the biogas by separating its various components, i.e., bio-methane, VFA, water, etc.

The research CNR-ITM team is composed by Dr. Ing. Giuseppe Barbieri (scientific responsible for CNR-ITM) and Dr. Ing. Adele Brunetti.

More information (soon) at www.itm.cnr.it/BioValue or contact giuseppe.barbieri@cnr.it
AMECRYS is a research project Coordinated by CNR-ITM and funded by the European Commission under the Horizon 2020 programme, in the framework of Future and Emerging Technologies topic (FETOPEN-RIA), supporting early-stages of the science and technology research and innovation around new ideas toward radically new future technologies (GA 712965).

The project started on October 1st 2016 and will last 48 months. It is coordinated by Dr Gianluca Di Profio, senior researcher at CNR-ITM, Rende (CS), Italy. The AMECRYS network is an interdisciplinary expert group of research scientists from two National Research Organizations, four Academic Institutions and three Industrial partners, from four European Countries:

- Consiglio Nazionale delle Ricerche (CNR-ITM), Italy (coordinator)
- Imperial College London, UK
- Università della Calabria, Italy
- Centre National de la Recherche Scientifique, France
- Université Libre de Bruxelles, Belgium
- University of Strathclyde, UK
- Centre for Process Innovation, UK
- GVS S.p.A., Italy
- Fujifilm Diosynth Biotechnologies, UK

The research team at CNR-ITM is composed by Dr. Gianluca Di Profio, Dr. Enrica Fontananova, Dr. Teresa Poerio, Dr. Teresa Mastroietro and Ms. Carmen Meringolo. Two other CNR Institutes are involved in the Project: the Institute of Crystallography (CNR-IC) (Dr. Rocco Cialiandro, Dr. Benedetta Carrozzini, and Dr. Danilo Belviso) and the Institute for Calculus Applications (CNR-IAC) (Dr. Giovanni Nico), both located in Bari.

The ambitious idea of the AMECRYS project is to enable efficient crystallization of monoclonal antibodies (mAbs), one of the greatest therapeutc/diagnostic modalities in modern medicine, directly from complex solutions, by developing an innovative Continuous Template-Assisted Membrane Crystallization process as a single key-unit operation.

More information at www.amecrys-project.eu or contact (g.diprofio@itm.cnr.it)
Materials & Technologies for Performance Improvement of Cooling Systems performance in Power Plants

MATCHING “Materials & Technologies for Performance Improvement of Cooling Systems performance in Power Plants” is a collaborative project, funded by the EU Horizon 2020 programme, which aims to significantly reduce the demand of water and improve energy efficiency of cooling systems in the energy sector through the use of advanced materials and nano-technology based materials. A broad set of technologies is proposed acting on intake, blowdown, make-up, and evaporated water. Hybrid cooling systems are proposed for the geothermal sector. For the thermal power sector, innovative materials are applied to steam condensers, and membrane-based solutions developed for water treatment and recovery.

The MATCHING consortium includes four utilities (EDF, ENDESA, ENEL, ENEL Green Power), five technology providers (AquaStil, Intesasa, Ionics, Pathema, SPIG) and six research institutes (AIMEN, CNR-ITM, DTI, Laborelec, Materia Nova, VITO). There is also a stakeholder community composed of power industry representatives, European bodies concerned with environment, water and materials, as well as market players in the water treatment field. A total of nine test sites or facilities have been and will be used to prove and develop various different methodologies. CNR-ITM is involved in the application and development of innovative membrane-based technologies for wastewater treatment (such as membrane distillation) and for water recovery from plume of cooling towers (through the use of membrane condenser). The results of the lab-scale activities provided the input for the construction works of:

- an integrated membrane-based water treatment pilot installed in ENEL “Torrevaldaliga Nord” power plant and
- a membrane condenser system integrated in EDF “Pericles” facility.

The research CNR-ITM team is composed by Prof. Enrico Drioli (scientific responsible for ITM), Dr. Adele Brunetti, Dr. Alfredo Cassano, Dr. Alessandra Criscuoli, Dr. Francesca Macedonio, Dr. Elena Tocci.

More information at www.matching-project.eu or contact Prof. Enrico Drioli (e.drioli@itm.cnr.it)
Integrated aquaculture based on sustainable water recirculating system for the Victoria Lake Ban

VicInAqua is a medium size project financed by the EU under the Horizon2020 program (project number 689427). It started on April 2016 and it will end on May 2019. It is a consortium of 11 partners from 7 EU and 4 African countries. The coordinator is Prof Jan Hoinkis from HSKA, Karlsruhe University of Applied Sciences, Karlsruhe, Germany.

Main objective of the project is the development of a sustainable, efficient, innovative and robust technology for water sanitation in Lake Victoria Basin. The innovative aspect of project lies in the integration of new technologies working synergistically in water sanitation and in a recirculating aquaculture system (RAS). The treated wastewater, in fact, is reused in fish ponds (aquaculture) and agriculture (clean water for irrigation). A pilot membrane bioreactor (MBR) unit provides the treatment of wastewaters coming from domestic effluents or fish processing industry (main causes of pollution in Lake Victoria). All the system runs through green energy derived from renewable sources such as photovoltaic panels and biogas. Last November, the pilot in Kisumu (Kenya) has been inaugurated. CNR-ITM is involved in the core part of the project being responsible for the development of a new class of self-cleaning coatings applied on the surface of commercial membranes for MBR technology. The oxygenic activity of inorganic nano-catalysts is explored for an effective self-cleaning of the membrane providing a regenerative and anti-fouling process. The research CNR-ITM team is composed by Dr. Alberto Figoli (scientific responsible for ITM), Dr. Francesco Galiano, Dr. Alessandra Criscuoli, Dr. Giorgio De Luca.

More information at www.vicinaqua.eu or contact (alberto.figoli@cnr.it)
Development of a solar powered, zero liquid discharge integrated desalination membrane system to address the needs for water of the Mediterranean region

The IDEA project was financed in the framework of the call ERANETMED "EURO-MEDITERRANEAN - Cooperation through ERANET joint activities and beyond" – Joint Transnational Call 2016 - Environmental challenges and solutions for vulnerable communities. The project started on September 1st 2017 and will last 36 months. It is coordinated by Dr Andreas Sapidis from the National Centre of Scientific Research "Demokritos" and the Consortium includes the following partners:

- Institute on Membrane Technology (CNR-ITM, Italy)
- Institut Européen des Membranes (France)
- National Research Centre Egypt (Egypt)
- Universite Hassiba Benbouallil de Chlef (Algeria)
- University of Jordan (Jordan)

The objective of the IDEA project is the development of a solar powered, zero liquid discharge, integrated desalination membrane system combining solar assisted MD/MCr unit with NF. The aim is to reduce the energy consumption, increase the water recovery factor, realize an environmental friendly with nearly zero-liquid discharge, reduce fouling and scaling problems using novel nanostructured membranes combined with an innovative process design. The CNR-ITM is actively working on the design and production of high performing and "green" graphene oxide (GO) membranes and the development of a predictive model for the transport through GO membranes.

The research team at CNR-ITM is composed by Dr. Enrica Fontananova (scientific responsible for ITM), Dr. Elena Tocci, Dr. Gianluca Di Profio, Dr. Teresa Poerio and Prof. Enrico Drioli.

More information at [http://www.idea-eranetmed.eu](http://www.idea-eranetmed.eu) or contact Dr. Enrica Fontananova (e. fontananova@itm.cnr.it)
Novel nanostructured 2D materials-based membranes for new-concept fruitful fresh water production and gaseous streams purification

2DMEMPUR is a research bilateral project funded within the frame of the Great International Relevance – ITALY-CHINA Science and Technology Cooperation. It has received grants from the Italian Ministry of Foreign Affairs and International Cooperation (MAECI) and National Natural Science Foundation of China (NSFC). It started on January 2018 and will run until the end of 2020. Dr. Annarosa Gugliuzza from CNR-ITM is the scientific responsible from Italian side, while Prof. Jin Wanqin from Nanjing Tech University is the scientific responsible from Chinese side.

Key objective of the project is the creation of a CNR-ITM-JSMST Joint-Laboratory on shared research issues, including natural resources reuse and reduced eco-impact. Provided that the common ambition is to accomplish new-concept fruitful purification membrane processes, this collaborative research is addressed at exploring the potential of new 2D materials in strategic areas such as water and environment for succeeding highly selective and ultra-fast transport and filling the gap for the creation of novel nanostructured functional interfaces. More specifically, the research is jointly progressing toward proof-of-concepts for feasibility and generality of new membrane materials and connected utility to explore their potential in challenging fields such as water desalination and gas purification at low energy and environment impact. Researchers mobility is also endorsed to strengthen a global and shared vision of contemporary and future environmental urgencies and best practices for collective solutions.

The research CNR-ITM team is composed by Dr. Annarosa Gugliuzza (scientific responsible for ITM), Prof. Enrico Drioli, Dr. Francesca Macedonio, Dr. Elena Tacci.

More information at http://www.2dmempur.it or contact Dr. Annarosa Gugliuzza (a.gugliuzza@itm.cnr.it)
CNR-CAS Bilateral Agreement 2017-2019

The bilateral project, titled “Experimental and Computational studies of polymeric membranes based on ionic liquid crystals for preparation of stimuli-responsive materials” started in 2014 with a first project jointly funded by CNR and CAS, and was renewed in 2017.

The basic idea behind the project, is to develop novel dense membranes obtained by mixing together suitable polymers with a filler based on Ionic Liquid Crystals (ILCs). ILCs combine the solvent and conductive properties of ionic liquids and the orientational order of liquid crystals. It is therefore expected that, by varying for example an external parameter to induce a phase transition, the properties of the membrane will be strongly affected, thus allowing the realization of a stimulus-responsive material.

The CNR Unit is involved in the synthesis of the ILCs, the preparation and characterization of the membranes and MD simulations. The CAS Unit is involved in the theoretical modeling, Force Field development, both fully atomistic and coarse-grained versions, and MD simulations.

The interplay and complementarity of the two Units is an ideal combination for a successful cooperative work. The ITP-CAS group involved in the project is: Prof. Yanting Wang (PI), Shen Li, Wudi Cao, Jie Yao. The research CNR-ITM team is composed by Dr. Giacomo Saielli (scientific responsible for ITM), Dr. Annarosa Gugliuzza, Dr. Elena Tocci, Prof. Mauro Carraro (CNR associate).

For more information contact Dr. Giacomo Saielli (giacomo.saielli@cnr.it)
Tecnologie e processi per l'Abbattimento di inquinanti e la bonifica di siti contaminati con Recupero di mAterie prime e produzioNe di energia TOtally green

The National Research Council of Italy (CNR) is the coordinator of the Research Project TARANTO (Tecnologie e processi per l'Abbattimento di inquinanti e la bonifica di siti contaminate con Recupero di mAterie prime e produzioNe di energia TOtally green) supported by MIUR within the framework PON 2014-2020 – Ricerca e Innovazione.

The scientific project coordinator is Prof. Vito Felice Uricchio, Director of the Water Research Institute (CNR-IRSA). The Project started on November 2018 and will last 30 months.

The project aims at the development of a number of innovative technologies for the production of renewable energy combined with the decontamination of a specific area in Taranto (Italy). The transformation of waste (sludge, biomass, etc), for obtaining energy in alternative ways of producing and using it, is the main objective of the project.

The Research activities are mainly devoted at the: 1. Developing innovative materials (e.g. nano-catalysts and nano-photocatalysts); 2. Biofuel & Biomass produced and/or derived from wastewater treatment plants; 3. Intensive Treatment for pollutants removal from wastewaters (municipal and industrial) from Taranto Area; 4. Purification and Recovery of Energy from wastewater; 5. LCA of the Innovative Technologies developed in the project.

The research team at CNR-ITM, which is part of the CNR, is composed by Dr. Alberto Figoli (Scientific Responsible for ITM), Dr. Alessandra Criscuoli, Dr. Adalgisa Tavolaro, Dr. Giampiero Chiappetta.

More information at www.taranto.cnr.it
CNR-ITM is an active partner of the Research Project RAVEL (Recovery and Valorization of olive mill wastewaters for new ecofriendly applications in leather manufacturing) supported by Calabria Region within the framework POR CALABRIA FESR-FSE 2014-2020 - ASSE I - Promozione della ricerca e dell’innovazione. The Project, launched on January 2018, is coordinated by ALPA Spa, an Italian Company involved in the production of chemical auxiliaries for leather industry. It aims at developing a R&D activity oriented to an innovative use of olive mill wastewaters, properly treated, in the leather and tanning process. Research activities are mainly devoted at identifying a sustainable process, based on the use of a proper selection and optimization of membrane processes, for the recovery of target compounds from olive mill wastewaters to be reused in specific tanning operations.

Within the leather industry, the project aims to create new formulations, alternative to auxiliaries synthetic and mineral tanning agents, able to provide particular chemical-physical properties to the treated leathers, with high penetration and adsorption capacity by leathers. On the other hand, the valorization of olive mill wastewaters, within a biorefinery concept, allows to find new opportunities to reduce the polluting load of olive oil residues and their related depolluting costs.

The research CNR-ITM team is composed by Dr. Lidietta Giorno, Dr. Alfredo Cassano, Dr. Carmela Conidi, Dr. Teresa Poerio, Dr. Rosalinda Mazzei and Dr. Fabio Bazzarelli.

For more information contact Dr. Lidietta Giorno (l.giorno@itm.cnr.it)
CNR-ITM is partner of the Research Project ASSE (Arsenic Separation from Groundwater by Membrane Processes) supported by Calabria Region within the framework POR CALABRIA FESR-FSE 2014-2020 - ASSE I – Promozione della ricerca e dell'innovazione. The Project started on December 2017.

The Research Project ASSE is coordinated by iENERGY Srl, an Italian Company involved in the production of electrical and hydraulic plants. It aims at developing a R&D activity oriented to development of integrated membrane set-up with solar energy for arsenic separation from groundwater.

Research activities are mainly devoted at the: 1. Mapping of Arsenic contaminated specific area in Sila Massif in Calabria (Department of Biology, Ecology and Earth Sciences (DIBEST), UNICAL, Italy); 2. Development of novel molecules which Arsenic affinity (Department of Chemistry and Chemical Technologies (CTC), Laboratory of Industrial and Synthetic Organic Chemistry -LISOC, UNICAL, Italy); 3. Development of innovative membranes and study on membrane processes for arsenic removal (Institute on Membrane Technology, CNR-ITM, Italy); 4. Arsenic analysis and sensor development (BIOS Alimenti Ambiente s.a.s., Italy); 5. Membrane Prototypes Development (DeltaE Srl and); 6. Plant development integrated with Solar Energy panel (iENERGY Srl, Italy).

The research team at CNR-ITM is composed by Dr. Alberto Figoli (Scientific Responsible for the ASSE project), Dr. Alessandra Criscuoli and Dr. Francesca Russo.

More information at www.progettoasse.it or contact Dr. Alberto Figoli (a.figoli@itm.cnr.it)
Final MATChING Workshop

June 25-26, 2019
Liaison agency Flanders-Europe,
Bruxelles, Belgium

The Final MATChING Workshop will be held in Bruxelles, Belgium, at the Liaison agency Flanders-Europe on June 25-26, 2019.
The purpose of the workshop is to share the most relevant results of the Project and to engage an open discussion with the Stakeholders on the current and future scenarios related to the water availability and to technological measures for improving the performance of cooling systems in power plant, in Europe and abroad. We are ready to meet engineers and researchers from either Companies, Universities and Research Institutes.

No registration fee will be charged for the attendance to the Workshop.

Abstract submission is still open!

Visit to the website for additional information at 
https://www.itm.cnr.it/matching_workshop
The kick-off meeting of the Joint Italian-Chinese Great Relevance Collaborative Research Project 2DMEMPUR - Novel nanostructured 2D materials-based membranes for new-concept fruitful fresh water production and gaseous streams purification (http://www.2dmempur.it)- funded under the Memorandum of Understanding between the Italian Ministry of Foreign Affairs and International Cooperation (MAECI) and the National Natural Science Foundation of China (NSFC), took place at the Conference Center of State Key Lab of Nanjing Tech University on 24th to 26th October 2018. Prof. Wanqin Jin opened the meeting welcoming delegates from CNR-ITM and Nicolaus Copernicus University in Torun, involved in a parallel China-Poland Joint Project. Prof. Wanqin Jin and Dr. Annarosa Gugliuzza, coordinators from Chinese and Italian side respectively, gave an introduction on targets, strategies, activities and first results achieved within the frame of the joint MAECI-NSFC project. Among assembled participants, Prof. Enrico Drioli and Dr. Elena Tocci from CNR-ITM as well as Prof. Gongping Liu together with young PhD students from Nanjing Tech University discussed some further accomplishments of the research as a part of the project reports. The official program was closed with a tour, headed by Dr. Ming Zhou, to the site of the Membrane Industry Park wherein large-scale membrane production and modules assembly is currently carried out for commercialization.

The 14 months progress meeting was hosted at headquarters of CNR-ITM from 10th to 12th February 2019. The meeting was opened with the welcome of the Dr. Lidietta Giorno and Dr. Alberto Figoli. After Prof. Enrico Drioli’s remarks about the great opportunity to strengthen the cooperation between CNR-ITM and Nanjing Tech University, Dr. Annarosa Gugliuzza introduced the various delegates and participants and outlined the project contextualizing some highlighted progresses achieved within the frame of 2DMEMPUR project. From Chinese side, Prof. Jin Wanqin illustrated the advancements of the research providing an overview of the activities carried out in his laboratory. Other project participants attending the meeting, Prof. Zhaoling Cui, from Chinese side, Dr. Elena Tocci, Dr. Francesca Macedonio, Dr. Maria Luisa Perrotta, Dr. Mirko Frappa and Dr. Antonio Politano, from Italian side, gave some speeches about the new results achieved when 2D materials membranes are used for water desalination and gas separation purposes.
The **4th progress meeting** (month 26th) of the H2020 AMECRYS Project - Revolutionizing Downstream Processing of Monoclonal Antibodies by Continuous Template-Assisted Membrane Crystallization ([http://www.amecrys-project.eu](http://www.amecrys-project.eu)) - was held at Fujifilm Diosynth Biotechnologies, Billingham, UK, on **November 6th and 7th 2018**. The midterm meeting registered an active participation of all partners with a fruitful discussion of the scientific work carried out and a joint planning of the future steps. Participants took also the opportunity to visit Fujifilm facilities used for monoclonal antibodies production at industrial level. The CNR-ITM is actively working in the project on the design and production of customized membranes specifically designed for membrane crystallization of mAbs and their testing in several operative conditions.

The **midterm meeting** (month 18th) of the international project IDEA - Development of a solar powered, zero liquid discharge integrated desalination membrane system to address the needs for water of the Mediterranean region ([www.matching-project.eu](http://www.matching-project.eu)) - was organized by the Institute on Membrane Technology and held at the University Club of the University of Calabria on **February 14th 2019**. The previous meetings were held in Athens (Greece, kick-off meeting) and Montpelier (France, 6th month meeting). The next meeting will be host in Algeria at month 36th. The midterm meeting registered an active participation of all partners with a fruitful discussion of the scientific work carried out and a joint planning of the future steps in the perspective to realize low-energy solutions for low-cost water desalination based on renewable source of energy.
The *Third General Assembly Meeting* of the collaborative project MATCHING - *Materials & Technologies for Performance Improvement of Cooling Systems performance in Power Plants* (www.matching-project.eu) - was held in Pisa, Italy on March 12-13, 2019. The meeting started on March 12th with an update of the project status, for each WP. It ended on March 13th with the visit at Nuova San Martino installation, that is a geothermal power plant that belongs to ENEL GREEN POWER and is located in the Grosseto Province. In the frame of the project, one tower of the plant has been retrofitted to a hybrid configuration, i.e. comprehend one wet and one dry section.

A seminar on "Artificial Water Channels" was held on 15th February 2019 by Prof. Mihail Barboiu from the Institut Européen des Membranes in Montpellier (France). The seminar offered an exhaustive discussion on the development of novel and interactive water channel systems able to mimic biomolecular process. It was highlighted how the presence of artificial water channels within the membrane structure, resembling the biomimetic scenario, determines the realization of a highly selective and permeable membrane.

On 15th April 2019 Dr. Ing. Bernd Krause, from Baxter International Inc., Senior Director R&D, R&D Site Leader in Baxter Membrane & Dialyzer, Hechingen (Germany), visited our Institute and held a seminar on "Membranes and Membrane Technology in Medical Applications". In particular, he gave an interesting overview in critical aspects related to the development of membranes in the biomedical field, and the challenge in their industrial production on large scale. Particular focus was given to size-exclusion membranes, functionalized membranes, and membrane/absorber beads combination utilized in hemodialysis, therapeutic apheresis, oxygenation, infusion, biohybrid organs and sensor applications. At the end of his speech, an interesting discussion was opened with exciting exchanges of view between Dr. Krause and ITM researchers.
CNR-ITM Seminar Days

"CNR-ITM Seminar Days", the annual meeting that updates advances promoted at the Institute on Membrane Technology of the National Research Council of Italy, took place on 19-20 December 2018 at the Sala Stampa of the Centro Congressi Beniamino Andreotta of the University of Calabria.

The event highlighted the scientific and technological progresses achieved during the year in the field of membrane science and engineering within the framework of bilateral collaborations, national and international projects. The previous Director of the Institute, Dr. Lidietta Giorno opened the activities illustrating the solid growing trend of CNR-ITM in scientific excellence, internationalization, fund rising, personnel increase and public engagement. She gratefully acknowledged people for the huge and high quality work, competitiveness, motivation and unique enthusiasm. The 2018 picture in terms of personnel and visiting scientists from abroad was depicted in Figure 1 and 2, respectively, whilst the trend of CNR-ITM publications in ISI journals in the last 5 years was reported in Figure 3.

The scientific programme of the "CNR-ITM Seminar Days 2018" included 25 oral presentations that covered forefront research topics related to membrane molecular modelling and design, membrane preparation and characterization, membrane operations in gas separation, membrane systems and devices in biotechnology and biomedical applications.

The "CNR-ITM Seminar Days 2018" was a good opportunity for discussing and sharing ideas as well as identifying new horizons.

The event was attended by graduate and undergraduate students, young and senior researchers, visiting scientists and professors associated at CNR-ITM.
Prof. DAHMANI Benamar

Prof. DAHMANI Benamar, PhD in Spectrochemistry and Analysis at Paris 7 University, France, is Director of the Research Laboratory of Spectrochemistry and Structural Pharmacology and Research-Teacher at the Faculty of Sciences, Department of Chemistry, University of Tlemcen, Algeria. In Algeria he is active in several topics such as physical chemistry and analytical, molecular separation by chromatography and membrane, water demineralization, microalgae, nutrition and materials. Since 2015 he is collaborating with the CNR-ITM working on common scientific projects on membranes and microalgae. The collaboration comprises also training of master and PhD students in Physical and Analytical Chemistry. The period of his visit at CNR-ITM was in the period from 10 to 21 December 2018.

Miss Hassina Semghouni

Miss Hassina Semghouni has a Master of Chemical Engineer from Bejaia University, Algeria. She is a third-year PhD student in polymeric membrane contactors for metals removal at the Laboratory of Membrane Processes and Separations and Recoveries Techniques (LPMTSR), of Bejaia University, Algeria. During her PhD program she visited CNR-ITM with two internships in 2017 (January-February) and in 2018 (November-December). Her interests focused on the preparation of polymeric membranes and their application in membrane contactors for Cr (VI) removal. Her research at ITM was performed under the supervision of Dr. Alberto Figoli and she worked on the preparation of polymeric membranes using less toxic solvents.

Shen Li and Jie Yao

Hello! We are Shen Li and Jie Yao come from the Institute of Theoretical Physics, Chinese Academy of Sciences in Beijing (China). We visited CNR-ITM to extend the cooperation between CNR-ITM and ITP-CAS from 20 March 2019 to 16 April 2019. Our research is mainly focus on the membrane containing ionic liquids (Imidazolium) and polymers (PEBAX) for gas separation by MD simulation.

The visit is made within the framework of the bilateral project between CNR-ITM (Italian Responsible Dr. Giacomo Saielli and participants Annarosa Gugliuzza, Elena Tocci and Mauro Carraro – CNR-ITM associate) and CAS - China (Chinese Responsible Prof. Yanting Wang) on Experimental and computational studies of polymeric membranes based on ionic liquid crystals for preparation of stimuli-responsive materials”.

During our cooperation time in ITM working with Dr. Elena Tocci group, we felt that they were very friendly and helpful. We enjoyed our time here!
Lucie Štiková
Hello, my name is Lucie Štiková (the third from the right in the picture) and I come from Prague, Czech Republic where I study at the University of Chemistry and Technology. I was very happy to be accepted by ITM to collect data for my Master thesis from February till May 2019. I prepare double emulsions type of water in oil in water where the water phases are composed of milk proteins, casein or whey proteins, and the organic phase is peanut oil with PGPR. Whey proteins have an interesting ability to gel during heating, and thus I observe especially the influence of gelling on emulsion stability compared to casein. I also investigate a possible application of these proteins in emulsions with encapsulated bio-active compounds. To evaluate the encapsulation efficiency, concentration of pyrocatechol released from the inner water phase into the outer one is measured by HPLC.
I thank you all for your support in my work and friendly atmosphere. I am especially grateful to my supervisors Dr. Emma Piacentini and Dr. Lidietta Giorno as well as Dr. Fabio Bazzarelli, Dr. Giuseppe Vitola, Serena Regina and Roberta Romeo who I share my working space with and who always help me.

Jun Pan
Hi, my name is Jun Pan. I'm a master student from Nanjing Tech University in China. I arrived in CNR-ITM on April 8, 2019, and I will spend about three months here to carry out an educational and practical training in the field of membrane distillation and membrane crystallization for water treatment.
I am working in the Framework of a Research Project between CNR-ITM and Nanjing Tech University, under the supervision of Prof. Enrico Drioli.

Dr. Mustapha Chabane
Dr. Mustapha Chabane is a Lecturer Professor in Chemistry at University Center of Naama (South-west of Algeria) and is Member of the Research Laboratory of Spectrochemistry and Structural Pharmacology at University of Tlemcen (Algeria).
His internship in CNR-ITM was granted by the Ministry of Higher Education and Scientific Research, Algeria, in the period from 4 to 19 March 2019.
His research at CNR-ITM was performed under the supervision of Dr. Alberto Figoli and Dr. Adalgisa Tavolaro and it was mainly devoted on the synthesis of hybrid membranes for water purification.
Roberto Castro-Muñoz

Hello! I am Roberto Castro-Muñoz and I am coming from European Union Joint Doctorate ‘Erasmus Mundus Doctorate in Membrane Engineering (EUDIME), having as home institution University of Chemistry and Technology Prague, Czech Republic (supervisor Prof. Vlastimil Flí). My hosting institutions, University of Calabria and Institute on Membrane Technology (CNR-ITM), Italy and University of Zaragoza, Spain. The first EUDIME mobility was carried out during June-December 2017. The main research activities were oriented to the synthesis and preparation of mixed matrix membranes based on commercial polymers (e.g. polyimides and polyvinyl alcohol) and inorganic fillers (e.g. graphene oxide) for the pervaporative separation of methanol-MTBE.

I had the pleasure to be followed by Dr. Alberto Figoli, and Dr. Francesco Galiano. My amazing, fruitful and friendly experience in Dr. Figoli´s group encouraged me to come back once again on October-November 2018. During our cooperation time in ITM, we also carried out joint contributions with Prof. Joaquín Coronas from University of Zaragoza (Nanoscience Institute of Aragon). I really enjoyed my time at CNR-ITM!

Yufan Ji

Hello! I am Yufan Ji from the Nanjing Tech University, Jiangsu, China. I visited CNR-ITM from February 18 to March 14, 2019 working in Dr. Annarosa Gugliuzza's laboratory. My stay was within the frame of the researcher mobility funded by a grant from the Italian Ministry of Foreign Affairs and the National Natural Science Foundation of China (NSFC). As a part of the Great Relevance International Projects Italy (MAECI)-China (NSFC) 2018–2020, this project involves the Institute on Membrane Technology and the Key Laboratory of Material-Oriented Chemical Engineering, Nanjing Tech University, and focuses on Novel nanostructured 2D materials-based membranes for new-concept fruitful fresh water production and gaseous streams purification – 2DMEMPUR. My work at CNR-ITM concerned new membranes designed to water desalination. I was very happy to take this great opportunity and I hope I can back at ITM soon. I really enjoyed my time in ITM.
Guining Chen
Hi! I am Guining Chen from the Nanjing Tech University, Jiangsu, China. I have just arrived at CNR-ITM on February 18, 2019 to spend three months working with Dr. Annarosa Gugliuzza’s group. My stay is within the frame of the Great Relevance International Project Italy (MAECI)-China (NSFC) 2018–2020 - Novel nanostructured 2D materials-based membranes for new-concept fruitful fresh water production and gaseous streams purification – 2DMEMPUR, which is funded by a grant from the Italian Ministry of Foreign Affairs and international Cooperation and National Natural Science Foundation of China (NSFC). The focus of my research is to functionalize membranes with advanced materials for water desalination purpose. It is my honor to have the opportunity to come to ITM. The laboratory is very organized and colleagues and professors here are very nice. I really enjoy my time in ITM.

Miss Alice Coleman (second in the picture from the right) is a second-year Chemistry student from the University Institute of Technology (IUT) in Rennes, France, finishing a course on organic and analytical chemistry. She is doing an eleven weeks internship from 10 April to 21 June in the CNR-ITM supervised by Dr. Alberto Figoli. She is working on bio-polymer membrane preparation using eco-friendly solvents.

Miss Asma Msahel (second in the picture from the left) is doing an internship for 3 months from 16 April to 10 July 2019 in CNR-ITM working under the supervision of Dr. Alberto Figoli. Her research interests focus on the hybrid membranes preparation for Pervaporation (PV) process. She holds a Master’s degree in Analytic Chemistry in University of Tunis, Tunisia and she is a first year PhD student from the faculty of Chemistry Sciences of Tunis (FST).

Miss Safa Saidi (the one in the middle) holds a Master of Analytic Chemistry in the University of Tunis, Tunisia. She is a first year PhD student from the faculty of Chemistry Sciences of Tunis (FST) and she is doing an internship in CNR-ITM supervised by Professor Enrico Drioli from 16 April to 10 July 2019. She is working on polymeric membranes preparation for membrane distillation (MD) and membrane contactors.
Emilia Gontarek

As a PhD student from Gdansk University of Technology, in Poland, it was an enriching experience for me to cooperate within six-month internship (October 2018 – March 2019) with one of the most recognized European Membrane Institute, Institute on Membrane Technology in Italy (ITM). During the internship I joined the research group supervised by Dr. Annarosa Gugliuzza. By working with this highly educated team in the membrane technology, I was able to gain not only technical expertise but also a range of transferrable and communication skills. The research objective was focused on the preparation and characterization of new graphene-based membranes, with specific properties (hydrophobicity, porosity, permeability, etc.) and their application in process of industrial interest, like desalination using membrane distillation.

CNR-ITM hosts researchers from all over the world. I joined the multicultural team which provided me with unique opportunity to know new research routines and procedures. During my internship I gained a practical knowledge and skills used in preparation and characterization of membranes and I had an opportunity to use advanced techniques and set-ups for membrane testing.

I would like to thank to Dr. Annarosa Gugliuzza and to Dr. Lidietta Giorno for inspiring me with so many suggestions and comments, to Maria Luisa Perrotta for her invaluable help with everyday works and to all ITM staff for creating scientifically charged and friendly atmosphere.

From 11 to 16 November 2018 Elisa Esposito, Alessio Fuoco and John Jansen visited the laboratory of Dr. Pavel Izák at the Institute of Chemical Process Fundamentals of the Czech Academy of Science in Prague.

They prepared and tested new membranes in the frame of the 2016-2018 bilateral CNR/CAS project Innovative polymeric membranes for pervaporation and advanced gas and vapour separations.
Membrane Engineering

E. Drioli, I. Giorno, F. Macedonio - 2019
Walter de Gruyter GmbH & Co KG
ISBN 978-3-11-028140-8
The purpose of this multi-authors book is to provide a description of membrane structures and membrane processes in various fields, from mass separation to (bio)chemical reactors, energy conversion and storage. It is the ideal introduction for engineers working in membrane science and applications (wastewater, desalination, adsorption, and catalysis), process engineers in separation science, biologists and biochemists, environmental scientists, and most of all students.

Ethanol: Science and Engineering

A. Basile, A. Iulianelli, F. Dalena, T. Nejat Veziroglu - 2019
Elsevier Science Publishing Co. Inc.,
Ethanol Science and Engineering reviews the most significant research findings in both ethanol production and utilization in combination with the production of clean energy and green hydrogen through alternative approaches such as the membrane reactor technology. The book explains the chemical reactions involved during the conversion of ethanol to more complexed molecules and continues with an in-depth discussion of methods and direct links to potential use. The book also outlines the modeling of various chemical processes (catalytic reforming processes), the economic and environmental benefits of using ethanol to produce other chemicals and fuels as well as its utilization as renewable source in membrane reactors (both packed and fluidized bed configuration) to produce hydrogen via reforming reactions. By presenting the most advanced production processes, technologies, applications and modeling with a critical discussion of the significant economic role that this alcohol currently plays, Ethanol: Science and Engineering represents a crucial resource for both academic and industry researchers and engineers.

Functional Nanostructured Membranes

Enrico Drioli, Lidietta Giorno, Annarosa Gugliuzza - 2019
Pan Stanford Publishing Pte. Ltd.
ISBN 978-981-4774-79-6 (Hardcover), 978-1-351-13511-5 (eBook)
This book contains insightful contributions from scientists with long experience in membrane science and technologies and working at CNR-ITM in the field of nanostructured materials membranes, including selected materials and practices for manufacturing high-defined functional interfaces with ability to transport mass, charge and energy. Herein, the reader can find the description of appropriate techniques for monitoring molecular scale events, which regulate the assembly of organic and inorganic materials on different length scales needed to the accomplishment of developed applications. The book covers different fields, including nanostructures concepts, breakthrough membrane fabrication and modeling as well as connected use in environment, energy, water, textiles, biomedical and bioengineering areas.
Membrane Desalination Systems: The Next Generation

*Angelo Basile, Inamuddin, Efrem Curcio* - 2019
Elsevier
ISBN: 978-0128135518

Membrane operations based on renewable energy

*Angelo Basile, Alfredo Cassano, Alberto Figoli* - 2019
Elsevier
ISBN: 978-0128135457

Membrane Processes in the Pharmaceutical and Biotechnological Field

*Angelo Basile, Catherine Charcosset* - 2019
Elsevier
ISBN: 978-0128135457

Second and Third Generation of Feedstocks. The evolution of biofuels

*Angelo Basile, Francesco Dalena* - 2019
Elsevier
ISBN: 978-0-12-815162-4
Membrane Science and Engineering. A tribute to the Enrico Drioli’s Pioneering Vision

**Journal of Membrane Science and Research**
Guest Editors: *Alfredo Cassano, Alessandra Criscuoli, Alberto Figoli*

The Special Issue aims to give an overview Prof. Drioli’s pioneering work who strongly contributed to the worldwide growth, spread and dissemination of membrane science and technology in a broad range of applications.


**Virtual Special Issue Membrane Systems and Devices for Bioartificial Organs and Tissue Engineering**

**Journal of Membrane Science**
Guest Editors: *L. De Bartolo, E. Drioli and L. Giorno.*

This Virtual Special Issue aims to provide a valuable overview on membrane systems and devices that can be applied to the entire biomedical field, from bioartificial organs to regenerative medicine to tissue engineering and to drug delivery and diagnostic systems. Papers present recent progress in the field of membranes and membrane devices reported in the Journal of Membrane Science.


**Hydrogen Separation/Purification via Membrane Technology**

**International Journal of Hydrogen Energy**
Guest Editors: *Adolfo Iulianelli, Angelo Basile.*

**Membrane and Membrane Reactors Operations in Chemical Engineering**

**ChemEngineering**
Guest Editor: *Adolfo Iulianelli.*

Modeling and Simulations for Membrane Processes of Industrial Interest

*Applied Sciences*
Guest Editors: *Enrico Drioli, Elena Tocci.*

Recent Publications - Special Issues

Integrated Membrane Operations

*Membranes*
Guest Editors: *Alfredo Cassano, Alberto Figoli*

**Deadline:** May 31, 2019

New Advances in Membrane Technologies for CO₂ Separation

*Membranes*
Guest Editors: *Giuseppe Barbieri, Adele Brunetti.*

**Deadline:** May 31, 2019
State of the Art Reviews on Membrane Engineering

*Journal of Membrane Science and Research*
Guest Editors: *Enrico Drioli, Francesca Macedonio, Elena Tocci.*

**Deadline:** May 31, 2019

Sustainability in membranes production and membrane operations

*Molecules*
Guest Editor: *Teresa Poerio.*

**Deadline:** July 31, 2019

Hydrogen generation from renewable sources via membrane reactor technology

*Membranes*
Guest Editors: *Adolfo Iulianelli, Kamran Ghasemzadeh, Angelo Basile.*

**Deadline:** July 31, 2019

New Trends in Membrane Preparation and Applications

*Molecules*
Guest Editors: *Alberto Figoli, Francesco Galiano.*

**Deadline:** October 31, 2019.
Recent Publications: Research Articles


Recent Publications: Research Articles


Gugliuzza A., Macedonio F., Politanò A., Drioli E., Prospects of 2D Materials-based Membranes In Water Desalination, *Chemical Engineering Transactions*, 2019, 73, 265-270. [https://doi.org/10.3303/CET1973045](https://doi.org/10.3303/CET1973045)


Recent Publications: Research Articles


Macedonio F., Politano A., Drioli E., Gugliuzza A., Bi_2Se_3-assisted membrane crystallization, Materials Horizons. 5 (2018) 912-919, DOI: 10.1039/c8mh00612A


Recent Publications: RESEARCH ARTICLES

Tavolaro P., Catalano S., Tavolaro A., Anticancer activity modulation of an innovative solid formulation of extra virgin olive oil by cultured Zeolite scaffolds, Food Chemical Toxicology, 124 (2019) 139-150.
https://doi.org/10.1016/j.fct.2018.11.061

https://doi.org/10.3390/app8112145


Recent Publications: PATENTS


Recent Publications: HIGHLIGHTS ON OPEN CALLS

A selection of open and forthcoming calls on membrane topics by CNR-ITM: Highlights on Open Calls
Recent Publications: Book Chapters


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Recent Publications: Book Chapters


