# International workshop on

# "Women Scientists Working on Membranes"

**Date: 05 Oct. 2021**

**Time: 10:00-13:00 (Central Europe Time, CET)**
**/ 11:00-14:00 (Turkey) / 17:00-20:00 (Japan)**

**Place: Online (Zoom)** (Registration required)

**Scope:**

International cooperation is essential to tackle global challenges and to deliver the goals agreed in the 2030 Agenda for Sustainable Development (SDGs). Membranes are getting more attention as they can play key roles in various applications related to the challenges above. This workshop is organized to reinforce the international network in the membrane research area and to integrate young researchers. The workshop also celebrates the publication of a special issue entitled "*Women in membrane science*" in the Journal of Membrane Science and Research*.

* *http://www.msrjournal.com/news?newsCode=518*

**Co-sponsored by:**

Chemical Engineering Association, Yamaguchi division
Faculty of Engineering, Yamaguchi University
Core Clusters of Research and Education for Chemical Process Intensification (CPI), Yamaguchi University

**Registration:**

1. Please register by 28th September at https://forms.gle/xAqDBacv6kdKBtyU9 (registration is for free of charge)
2. The invitation to a meeting place will be announced around 25th September.

Contact:
Izumi KUMAKIRI, Yamaguchi University, Japan
e-mail: izumi.k@yamaguchi-u.ac.jp

# Program (tentative)

| Time (in CET) | Topics | Presenter |
|---|---|---|
| 10:00 (Spain) / 11:00 (Turkey)/ 17:00(Japan), Opening | | |
| **Invited lectures,**<br>Chair: Izumi Kumakiri, Yamaguchi University, Japan | | |
| 10:10-10:40 | "Reclamation of geothermal water by membrane processes" | Prof. Nalan Kabay<br>EGE University, Turkey |
| 10:40 – 11:10 | "Sustainable membranes for $CO_2$ capture and utilisation" | Prof. Clara Casado<br>Cantabria University, Spain |
| **Student/Young researcher presentations, Part 1,**<br>Chair: Nazely Diban, Cantabria University, Spain | | |
| 11:10 – 11:25 | "Graphene-based nanomaterials scattered on biopolymeric membranes for in vitro neural and cancer models" | Marian Mantecón,<br>Cantabria University, Spain |
| 11:25 – 11:40 | Effect of Membrane Type on Salinity Gradient Energy Generation by Reverse Electrodialysis (RED) | Esra Altıok,<br>EGE University, Turkey |
| 11:40 – 11:55 | "Synthesis and application of novel anion exchange membrane for salinity gradient energy production by reverse electrodialysis" | Mine Eti,<br>EGE University, Turkey |
| **Student/Young researcher presentations, Part 2,**<br>Chair: Haruyuki Ishii, Yamaguchi University, Japan | | |
| 11:55 – 12:10 | Photocatalytic decomposition of organics by Ag-$TiO_2$ membrane and inhibition behavior of salt ions | Azzah Nazihah,<br>Yamaguchi University, Japan |
| 12:10 – 12:25 | Ionic liquid Role in mixed matrix membranes for $CO_2$ capture - a molecular dynamics study | Paloma Ortiz,<br>Universidad Nova de Lisboa, Portugal |
| 12:25-12:40 | "Advances on the modelling of ternary polymer systems to predict phase separation membrane morphology" | Marta Romay,<br>Cantabria University, Spain |
| 12:40-12:55 | Round table / Open discussion | |
| - 13:00 | Closing | |

# Short abstract

# Invited lectures

## "Reclamation of geothermal water by membrane processes"

**Nalan Kabay** *[1], Yakubu Abdullahi Jarma[1], Aslı Karaoğlu[1,3],
Islam Rashad A.Senan[1], Özge Tekin[1], Alper Baba[2]

[1]Ege University, Faculty of Engineering, Department of Chemical Engineering, 3510 Bornova-Izmir, Turkey

[2]Izmir Institute of High Technology, Department of International Water Resources, 35430 Urla-Izmir, Turkey

[3]Ege University, Graduate School of Sciences, Division of Environmental Sciences, 35100 Bornova-Izmir, Turkey

(*nalan.kabay@ege.edu.tr)

Geothermal water is used mostly for heating purposes, greenhouses, agriculture, for generation of hot water, therapeutic and recreational purposes and to generate electricity in power stations. After extracting the thermal energy, the cooled water turns to be a problematic fluid due to its salinity and contents of some elements such as boron, arsenic, fluoride, heavy metals, hydrogen sulphide etc. Management of such fluids is a great challenge due to the stringent environmental regulations.

In this research, we focused on application of pressure driven membrane processes such as nanofiltration and reverse osmosis for reclamation of geothermal water using pilot-scale treatment systems. Our target is to produce water for agricultural irrigation.

*This research work was financially supported by an international bilateral research project of TÜBITAK-NCBR (Project No: 118Y490) between Poland and Turkey.*

# "Sustainable membranes for $CO_2$ capture and utilisation"

**Clara Casado-Coterillo***, Andrea Torre-Celeizabal, Aurora Garea

[1]University of Cantabria, Graduate School of Industrial Engineering, Department of Chemical and Biomolecular Engineering, 39005 Santander, Cantabria, Spain

(*clara.casado@unican.es)

Membrane technology can be considered as a green alternative process for the separation of $CO_2$ according to the Process Intensification Strategy, meeting sustainability concepts as low energy consumption and footprint. However, yet commercial $CO_2$ separation membranes are based on conventional oil-derived polymer materials whose fabrication is still chemical or energy intensive. Biopolymers and materials from other renewable sources have been long studied as a potential alternative to produce environmentally friendly membranes of comparable permeability, selectivity and stability as existing membranes. They may thus offer the possibility to narrow the gap between laboratory research and larger scale implementation in the light of the climate and sanitary emergency faced by 21st century human society.

In this research, we focused on chitosan biopolymer and its combination by hybridization with non-toxic or low-cost wide range of materials (selected ionic liquids, layered silicates, zeolites, MOFs) to fabricate mixed matrix membranes and thin film composite membranes and the experimental and theoretical evaluation of their $CO_2$ separation performance.

*This research work was financially supported by a national research project of the Spanish Ministry for Science and Innovation (Project ID: PID2019-10813RB-C31).*

# Student/Young researcher presentations

## "Graphene-based nanomaterials scattered on biopolymeric membranes for *in vitro* neural and cancer models"

**M. Mantecón-Oria**[*,1], N. Diban[1,2], M.J. Rivero[1], O. Tapia[2,3], A. Urtiaga[1,2]

[1]Department of Chemical and Biomolecular Engineering, ETSIIyT, University of Cantabria, Avda. Los Castros s/n, 39005 Santander, Spain; [*]manteconma@unican.es

[2]Instituto de Investigación Marqués de Valdecilla (IDIVAL), Cardenal H. Oria s/n, 39011 Santander, Spain

[3]Centro de Investigación Biomédica en Red sobre Enfermedades Neurodegenerativas (CIBERNED), 528031 Madrid, Spain

Our research is focused on searching for novel membranes based on biocompatible polymers functionalized with graphene-based nanomaterials for biomedical applications. The biopolymeric membranes are synthetized by phase inversion with a casting knife or a dry-jet wet spinning system, to obtain either 2D flat or 3D hollow fiber membranes, respectively. These membranes incorporate adequate physicochemical, mechanical, electrical and transport properties to improve cell proliferation and to modulate the differentiation process. The assembly of these membranes into a perfusion bioreactor system would facilitate the nutrients supply to the cells and metabolites removal while simultaneously incorporate mechanical stimuli. The results obtained so far have shown the great potential of the synthetized membranes to act as migrastatic agents to modulate tumor microenvironments for anticancer therapy and to achieve regeneration of functional tissue from the central nervous system to be used as neural model for research and drug screening tests [1,2].

[1] Diban, N.; Mantecón-Oria, M.; Berciano, M. T.; Puente-Bedia A.; Rivero, M. J.; Urtiaga, A.; Lafarga, M.; Tapia, O. Non-homogeneous dispersion of graphene in polyacrylonitrile substrates causes a migrastatic response in breast cancer cells mediated by epigenetic mechanisms. *Cancer Nanotechnology*. **2021.** Submitted.

[2] Mantecón-Oria, M.; Diban, N.; Berciano, M. T.; Rivero, M. J.; David, O.; Lafarga, M.; Tapia, O.; Urtiaga, A. Hollow Fiber Membranes of PCL and PCL/Graphene as Scaffolds with Potential to Develop In Vitro Blood—Brain Barrier Models. *Membranes (Basel).* **2020**, *10* (8), 161.

## “Effect of Membrane Type on Salinity Gradient Energy Generation by Reverse Electrodialysis (RED)”

**Esra Altıok**[1*], Tuğçe Zeynep Kaya[1], Enver Güler[2], Nalan Kabay[1]

[1]Ege University, Chemical Engineering Department, Faculty of Engineering, Turkey
[2]Atılım University, Department of Chemical Engineering, Faculty of Engineering, Ankara, Turkey

The reverse electrodialysis (RED) is an efficient technology to harvest SGE, in other word blue energy. By the help of a stack formed of alternating anion and cation exchange membranes, free energy is generated by combining fresh water with saline water, thereby transforming the chemical potential of low salinity water and high salinity water into electrical energy.

In this study, two different ion exchange membranes comprised of commercial ion exchange membranes Neosepta (AMX and CMX) and Ralex (CMH-PES and AMH-PES) were tested to determine the effect of membrane properties toward the efficiency of power generation via RED system. The RED tests were carried out by changing feed flow rates, number of membrane pairs in RED stack and salt ratio between dilute and concentrated salt solutions.

*This research work was financially supported by an international bileteral research project of TÜBITAK-NCBR (Project No: 117M023) between Poland and Turkey.*

## “SYNTHESIS AND APPLICATION OF NOVEL ANION EXCHANGE MEMBRANES FOR SALINITY GRADIENT ENERGY PRODUCTION BY REVERSE ELECTRODIALYSIS”

**Mine Eti[1],** Ezgi Karakoç[2], Esra Altok[1], Tuğçe Zeynep Kaya[1], Aydın Cihanoğlu[1], Enver Güler[2], Nalan Kabay[1]

[1]Ege University, Department of Chemical Engineering, Faculty of Engineering, Izmir, Turkey
(e-mail: eti.mine91@gmail.com)
[2]Atılım University, Department of Chemical Engineering, School of Engineering, Ankara, Turkey

Reverse electrodialysis (RED) is a technology to generate electrical power by mixing waters with different salinity. In this work, novel anion exchange membranes were synthesized and applied for salinity gradient energy production by the RED system. The properties of the anion exchange membranes such as ion exchange capacity, swelling degree, fixed charge density and electrical conductivity were determined using the standard methods. The SEM and FTIR analyses

were performed to examine the morphology and chemical structure of the anion exchange membranes synthesized. In RED system applications, the anion exchange membranes synthesized in this study were coupled with the commercial cation exchange membranes (Neosepta CMX). The results obtained were compared with the effectiveness of commercial Ralex membranes (AMH-PES and CMH-PES) employed using the similar conditions.

*This research was supported by Concert-Japan project (Project no. TÜBİTAK 118M804).*

## "Photocatalytic decomposition of organics by Ag-$TiO_2$ membrane and inhibition behavior of salt ions"

**Azzah Nazihah**, Izumi Kumakiri

Yamaguchi University, Japan

Dissolved organics in produced water from the oil and gas industry can be challenging to treat. Silver deposited on $TiO_2$ has shown remarkable results in photocatalytic oxidation of these contaminants. However, there are limited studies on behavior of this catalyst with salts ions commonly available in produced water.

$TiO_2$ and Ag-$TiO_2$ membranes were prepared on porous ceramic disks and tubes. Membrane performance was examined by the oxidation of formic acid dissolved in water. Influences of Ag amount and salt ions in the solution, e.g. NaCl, $MgCl_2$, $MgSO_4$, on the catalytic membrane performance were investigated.

*This work was supported by JST SICORP Grant Number JPMJSC18C5, Japan.*

## "Ionic liquid Role in mixed matrix membranes for $CO_2$ capture - a molecular dynamics study"

**Paloma Ortiz-Albo**[1], Luís Cunha-Silva[2], Hiromitsu Takaba[3], Izumi Kumakiri[4], Joao Crespo[1], Luísa A. Neves[1]

[1]Universidade NOVA de Lisboa, Portugal

[2] University of Porto, Portugal

[3]Kogakuin University, Japan

[4]Yamaguchi University, Japan

Greenhouse gas $CO_2$ capture has become of great importance for industrial processes due to environmental adverse effects. Among the emerging technologies, mixed matrix membranes (MMMs) are an attractive alternative for $CO_2$ effective separation as they combine the advantages of inorganic/hybrid fillers with a versatile polymeric matrix.

In this work, MMMs comprising metal-organic frameworks and ionic liquids were prepared and characterized, and the experimental results obtained were compared with insights from molecular dynamics simulations.

Different membrane microstructures combining these materials and potential preparation methods have been modeled to determine the most favorable material arrangement as a function of IL location, loading and $CO_2$ affinity.

*This work has been supported by Fundação para a Ciência e Tecnologia (PhD grant SFRH/BD/139389/2018), Associate Laboratory for Green Chemistry – LAQV (UIDB/50006/2020 and UIDP/50006/2020) and Chugoku Regional Innovation Research Center, Japan.*

## "Advances on the modelling of ternary polymer systems to predict phase separation membrane morphology"

**Marta Romay**, Nazely Diban, Ane Urtiaga

Cantabria University, Spain

The morphology of polymeric membranes synthesized by non-solvent induced phase separation strongly depends on the synthesis variables. Developing a suitable mathematical model could result in reliable predictions of the membrane morphology before its fabrication. This work presents the advances in the development of thermodynamic and kinetic models for several ternary polymeric systems as well as their validation. Furthermore, as an application, it will be addressed the material design to the development of tissue engineering scaffolds and photocatalytic membranes.