MEMBRANE SOCIETY OF AUSTRALASIA

December 2022 Newsletter

What is covered in this issue:

- *Emerging membrane science news*
- *Interviews with academic and industry membranenologists*
- *World's largest Ceramic Membrane-Based Water Treatment Works in Development*

… and many more!

Building a membrane community in Australasia.

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Role of Membranes in Hydrogen Economy

BY Mitra Golgoli

Energy transition

"The only way to avoid a climate disaster is to invest aggressively in clean-energy innovation", Bill Gates, 2022. Hydrogen is pure chemical energy that many think of it as the fuel of the future. The hydrogen production market had a value of $130 billion from 2020 to 2021 and is predicted to grow 9.2% annually through 2030 according to a recent report by The World Bank. The Australian Government has invested more than $1.2 billion into Australia's hydrogen industry to decarbonise its economy by transiting to new energies, The Motley Fool reported. When hydrogen burns, it generates heat and water without any carbon dioxide. This makes hydrogen an important energy carrier for transitioning to a carbon-neutral world. In addition, decreasing the hydrogen cost can make it possible to use hydrogen to replace fossil fuels in various industries (read more).

One currently known process to produce hydrogen is using methane (Blue Hydrogen). The reaction of methane with water generates H_2 and CO_2 followed by separating and capturing of the produced CO_2 in the process, preventing its emission into the atmosphere. This is a crucial step of the process to make it economically competitive. Membrane technology is an energy-efficient process to separate H_2 from CO_2. Membrane technology has played an important role in gas separation and production including hydrogen. Membrane researchers are currently developing high-performance materials with high gas permeability to decrease costs and improve the purity of produced H_2.

Source: Yale Climate Connections

A tailored advanced membrane for hydrogen production

Carbon molecular sieve (CMS) membranes prepared by carbonisation are promising options for gas separation. However, carbonisation at extremely high temperatures (900° to 1200°C) is required to create desirable subnanometer channels for H_2/CO_2 separation. That inevitably makes membranes brittle and impractical for industrial production scale-up. Professor Haiqing Lin and his team at the University of Buffalo have recently developed a CMS membrane through low-temperature pyrolysis (≤600°C) by doping thermolabile cross-linkers. The prepared membrane demonstrated simultaneously high H_2 permeability and H_2/CO_2 selectivity superior to the state-of-the-art polymeric materials. The results of this research was published in the journal Science this year (read more).

Scientific interview

In this new academic engagement section, we are eager to know more about recent discoveries in membrane separation technology. This edition features an interview with Prof. Huanting Wang from Monash University, who is an ARC Australian Laureate Fellow in the Department of Chemical and Biological Engineering and was the Founding Director of the Monash Centre for Membrane Innovation (2018-2022).

Interview between Dr. Amir Razmjou and Prof. Huanting Wang from Monash University

Left: Dr Amir Razmjou, Right: Professor Huanting Wang

Amir: I really appreciate your time and the opportunity that you give us for MSA Newsletter. Well, I think it is probably better to first start with your background and how you end up here in Monash?

Huanting: I completed my undergraduate degree in inorganic materials engineering at the East China University of Science and Technology, Shanghai, China. Then, I worked as a process engineer for three years at a glass factory, which manufactured glass tubes and bottles. After that, I decided to go back to university for my master's study. I joined the University of Science and Technology of China (USTC) to conduct research in polymer chemistry. After graduation, I worked as a lecturer at Anhui Jianzhu University for one year and then went back to USTC to continue my research as a PhD student. My PhD thesis was about ceramic membranes. I guess I was probably one of the first PhD students in the area of ceramic membranes in China. Only up to that point, I started feeling that doing research would be something that I want to do for my future career.

Amir: Why you chose membrane area?

Huanting: Well, I worked a bit on the polymer membrane for dialysis during my master's study and became so interested in membrane science and technology. Luckily, I had an opportunity to continue research into membranes for my PhD degree. I successfully developed the extrusion process for the fabrication of single- and multi-channel ceramic membranes for the first time in the lab in China. Many people at that time had not even seen the ceramic membranes, and it was truly cool for me.

Amir: Interesting, other researchers around you didn't have any idea on what a tubular ceramic membrane looks like?

Huanting: Yes, I think so. I managed to make some novel membranes on a lab scale, which was quite important step for the research group. The work led to two patents. After I left, my supervisor decided to establish a new company and manufacture ceramic membranes. This company manufactured ceramic membranes for over 10 years before it was acquired by another company.

Amir: Probably back then, ceramic membranes were just in their infancy. I think, later on, with your development it became something else.

Huanting: Yes, I developed ceramic membranes in China around 1997 which were then produced on an industrial scale. In 1998, I joined Caltech as a postdoctoral researcher working on glass and carbon molecular sieve membranes for hydrogen purification for two years. Then, I moved to The University of California, Riverside, and stayed there for two years and eight months. After that, I joined the University of Hong Kong as a Research Assistant Professor in November 2002 and was awarded an ARC Queen Elizabeth II (QEII) Fellowship in 2003. In 2004, I migrated to Australia, taking up my Fellowship at the University of Sydney, and then moved to Monash University as a Senior Lecturer in 2005.

Amir: Yes, it's very interesting. I think being in different places made it possible for you to have a very vast network of researchers and collaborators.

Huanting: Definitely, one of the important points from moving around in different places is that you can learn a lot. You know, doing research in different environments helped me expand our research areas and build collaboration and gain confidence. Those experiences are certainly invaluable for me.

Amir: So we know since 2005 that you joined Monash. You literally supervised many students and postdocs. So how many PhD and Postdocs so far have you supervised?

Huanting: I didn't count exactly. I think it's probably over 50 PhD students and also about 40 post-doc fellows and visiting researchers. Many of them have now become academics and held various positions at different universities.

Amir: Huanting, we know you have already managed to acquire a lot of funds. Could you please briefly explain how you started getting funds particularly in Australia? And would you please give us advice for early and mid career researchers to know how they could start with the small grants and then aim for large ones?

Huanting: Well, as mentioned earlier, I actually got my first ARC fellowship grant when I was in Hong Kong. The support from my then colleagues at the administering organisation of the University of Sydney was crucial for the success. I wanted to emphasise how important the collaboration was. The QEII Fellowship program was part of a Discovery Project (DP), and I had a privilege in inviting a senior academic to be a CI and lead the project. The project was about zeolite-polymer membranes for gas separation based on my work in the US and then in Hong Kong. At that time, I did not know much about the Australian funding system and how to write a compelling grant application. I was so fortunate and privileged to have a senior academic as a collaborator and mentor.

I should note that the QEII fellowships were quite competitive, and only 15 fellowships were awarded per year. After joining the University of Sydney, a colleague of mine invited me to be a CI on his DP application. Therefore, I got my second DP in Australia. I am always so grateful to all the colleagues who have helped and mentored me. After moving to Monash University, I started leading grant applications. The past two successful grant applications gave me enough confidence and made the third application much easier. I invited one of my colleagues in the department to join me, and finally, we got the grant.

Amir: I think it is interesting to know how long did it take from the time you joined Monash and your first independent discovery projects (DP) grant as a senior lecturer?

Huanting: Well, I had two DPs (including my QEII Fellowship) when joining Monash. It took about two years until I became eligible to apply for a new DP. Late 2007, I started preparing a DP proposal as the lead chief investigator (CI) and won this grant in 2008.

Amir: Was it the time that you jumped to the water research area and desalination processes?

Huanting: Exactly. I started extending my research to desalination membranes because of a great opportunity to be part of the CSIRO Water for a Healthy Country Flagship program. I saw a call for proposals and sent an e-mail to the program leader to express my interest. To be honest, I was not quite sure whether I would be invited to join the program because I didn't have any experience in the water area. I was so grateful and excited when the program leader wrote back to me and invited me to join the program.

Amir: I think the key point here is the collaboration again.

Huanting: Yes, sure, if you want me to choose one word, it is collaboration because it can help you learn and achieve what you are unable to do on your own especially in regard to large grants.

Amir: I also remember, when I joined your team, you had a DP on forward osmosis using hydrogel draw agents collaborating by George Simon. Am I right?

Huanting: Yes, we used to have regular meetings with George Simon in the Department of Materials Science and Engineering, which ensured project progress. That project led to several collaborative projects with George.

Amir: So, basically for early-mid career researchers, there are currently three important sort of schemes that they can benefit from to build up their academic career. One is DECRA, the other ones are future fellowship and industry fellowship that is recently being announced. Would you have any advice on DECRA, future and industry fellowships?

Huanting: I guess early career researchers should try to get support from an established academic in their field. The one who can guide them through DECRA application. I mean, finding the right mentor who can host you and help you with right directions. When someone applies for the first time, they need that kind of mentor to understand everything and help them to write a good proposal.

The future fellowship will be a quite different story. In future fellowships, the candidate already has much experience. However, they need to have support from the university. I think the research environment is also important because they need to find the right place where they can get support from in terms of research expertise and facilities.

Amir: Any advice on industry fellowship?

Huanting: Well, industry fellowship is pretty new. Honestly, I don't really have any idea about the industry fellowship and how to become competitive in this area. I think we will have a lot more on this next year.

Amir: Back to membrane, as you know, the membranes started with reverse osmosis and shifted to inorganic, polymeric, nanocomposite, mixed matrix, and thin film composite membranes. Now, I see there is a sort of movement towards ion separation resource recovery and you are currently one of the pioneers in using membranes for lithium extraction, and lithium recovery. To what extent do you think that ion selective membranes are mature enough? And what would be your perception of the future direction of ion-selective membranes? Do you see any other new emerging types of membranes?

Huanting: That is a hard question for me because we all know that it is very hard to predict the future. Membrane separation is truly interesting and has great potential for many emerging applications. Therefore, in regard to lithium ion separation, I think membrane can play a very significant role because of the potential for lower cost and environmental impact. However, we have limited knowledge in this area regarding how we should design membranes and materials and tune membrane parameters for practical lithium separation membranes. Therefore, much fundamental research is required in this area. This would probably be a very important driving force to advance membrane science technology. I think this area would be active in the coming years. In addition, given that electrodialysis has been widely used on quite large scales, it is maturing for different applications. I guess that could be a really good idea to incorporate specific ion-selective membranes into the electrodialysis process. We are not far from that point to being ready to implement such processes for some industrial applications.

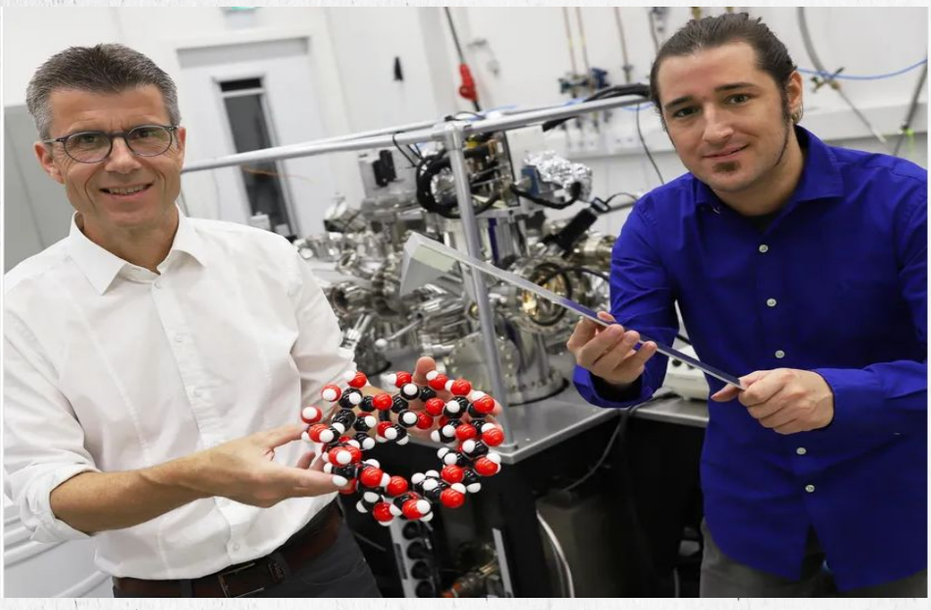
Amir: If you had the chance to go back and choose another career other than academic, what would be your choice?

Huanting: If I did not become an academic or I did not have the opportunity to go to the university, I think I would probably be a very good carpenter. From a very young age, I liked making things from wood for myself.

Amir: Thank you very much Professor Huanting Wang for your time.

Innovative macrocycle membranes for high-value pharmaceutical separations

BY Mohadeseh Najafi



Professor Dr. Dario Anselmetti of Bielefeld University with a sphere model of a cyclodextrin molecule — the basis of the new nanomembranes.

Doctoral student Niklas Biere holds the model of the force sensor used to scan the membrane.

Source:
Universität Bielefeld/C. Pelargus

Cannabidiol oil plays a vital role in treating anxiety, depression, and cancer. Therefore, the demand for the production of cannabidiol oil has snowballed, with a global forecast market of US$2 billion by 2022. On the other hand, 45 to 55 percent of the total energy consumption of pharmaceutical industries during production is used in molecular separations. Thus, these processes need to be partially or wholly replaced in order to make these processes more efficient, cost-effective, environmentally friendly, and, therefore, sustainable.

A team from Bielefeld University, Queen Mary University of London, Imperial College London, and Northwestern University in Evanston have synthesised selectively functionalised macrocycles with differentiated reactivities preferentially aligned to create well-defined pores across ultrathin nanofilms. This orientated architecture enabled direct visualisation of subnanometer macrocycle pores in the nanofilm surfaces, with the pore size tailored to angstrom precision by varying the macrocycle identity.

These aligned macrocycle membranes have been applied to high-value pharmaceutical separations for enriching cannabidiol oil. The developed membranes have shown higher ethanol permeance and molecular selectivity compared to commercially available polyamide nanofiltration membranes, making them a competitive candidate for enriching cannabidiol oil. ‘Our nanomembranes are only a few molecular layers thin, more defined by their architecture, and therefore much more energy efficient and selective.’ says **Professor Dr. Dario Anselmetti** from the Faculty of Physics at Bielefeld University.

‘Thanks to nanomembrane technology, such filtration can perhaps be implemented manually or with a simple solar heat system’ says Dario Anselmetti. (Read more here)

The study was published in the scientific journal “Nature”, 609, pages 58–64 (31 August 2022).

World's Largest Ceramic Membrane-Based Water Treatment Works in Development

The United Kingdom's South Staffs Water, a regulated clean-water company, serving 1.3 million people and 35,000 businesses, is upgrading its Hampton Loade Water Treatment Works using PWNT's CeraMac technologies. Once completed in August 2024, it will be the world's largest ceramic membrane-based water treatment works.

The upgraded Hampton Loade water treatment works, near Bridgnorth in Shropshire, produces 210 MLD and serves up to 700,000 customers. It is the first retrofit of its kind in an existing water treatment works and the largest deployment of ceramic membrane technology in the United Kingdom. Part of a £55M rebuilding and refurbishment project at Hampton Loade water treatment works, it will be based on an innovative and environmentally sustainable ceramic membrane-based water-filtration system using technology provided by PWNT, part of Saur Group's Industrial Water Solutions (IWS) division.

With a focus on improving water quality sustainably, specialist engineering service company Ross Shire Engineering (RSE) is working closely with technology solution provider Nijhuis Saur Industries (NSI) UK & Ireland who will deliver the complete water treatment process stream, including the proprietary CeraMac technology, in partnership with recently acquired PWNT. The CeraMac technology has already been utilised in full-scale at plants in the UK, Singapore, Switzerland, Scotland and The Netherlands. PWNT's ceramic membrane-based water-filtration solution will further enhance water quality, increase efficiency and reliability, as well as significantly reduce energy consumption, assisting with the water sector's ambition to achieve net-zero carbon emissions by 2030. The uniquely designed pressure vessels to hold the ceramic membranes are being manufactured by Unidro, also part of Saur's IWS division.

Source: South Staffs Water

Industry Engagement

In this edition of the industry engagement series, we interview Dr. Geoffrey Johnston-Hall from DuPont Water Solutions. Geoffrey has provided excellent contributions to the MSA for industry engagement, and he formerly also served as the Vice President of MSA. He has decided to step down from the MSA board of directors, and we would like to thank him for his many years of service to MSA.

If you would like to nominate a person to be featured in this section, please contact our Newsletter Coordinator and Editor or Associate Editor at amir.razmjou@ecu.edu.au / milton.chai@uq.edu.au.

Interview with Geoffrey from DuPont Water Solutions

Dr Amir Razmjou (left) interviewing Dr Geoffrey Johnston-Hall (right)

Amir: Hi Geoffrey, I really appreciate your time for this interview. Can we start with your bio, about your background and journey in the industry?

Geoffrey: Thanks, Amir. For my background, I studied an applied science degree at UTS in Sydney and graduated in 2002. After my degree, I ended up working for a few different companies. I worked as a Research Scientist for a company manufacturing slurry pumps, doing polymer and metallurgical materials development for them. Then I moved to another company doing materials development with adhesives, packaging materials, lots of plastics development and again some metallurgy as well. After that, I worked in a biotech company doing materials and polymer development, making membranes for protein and biomolecule separations. That was the point where membranes really jumped into my career in 2002-2003.

Working there was a really good experience for me. I got to work with a really broad team of people; biochemists, engineers, and a world leading polymer chemist. We were trying to develop a product, and the membrane technology that went into that product for doing biomolecule separations.

Afterwards, I ended up going back to University to do a PhD in fundamental polymer chemistry. I was at UNSW in the Cluster for Advanced Macromolecular Design, with Tom Davis, Martina Stenzel and Christopher Barner-Kowollik in 2004-2005. Then I shifted to the University of Queensland and did my PhD there with Professor Michael Monteiro, who has been instrumental for me and my career. I spent 4 years doing very fundamental polymer chemistry with him then interviewed for a membrane research scientist role with Siemens Water Technologies; as it was called at that time. I quickly realised that fundamental science is actually very applicable to lots of things, and all the work that I had done made me really well suited for a Membrane Chemist role. Since then, I have stayed in the Memcor business unit, which over the years has been bought and sold by a few different owners. We went from Siemens Water Technologies to Evoqua and now DuPont. My career has changed over time, and I have learnt more people and project management skills.

My role at the moment is R&D Manager in DuPont Water Solutions. We are very much focused on using innovation and science to develop more sustainable water treatment technologies and membrane separation technologies.

For me, my career has been a great journey from fundamental materials chemistry, to product development, filtration applications and process development, through to people and business leadership.

Amir: There are some discussions that membrane technology is pretty much mature. In your R&D mindset, what other areas in membrane technology do you think the industry can invest more time in, and how can academic membrane researchers help?

Geoffrey: There are already a lot of membrane technologies out there and it is definitely something to be aware of in the water industry which is very conservative. As a researcher in industry, I always have to keep that in mind because developing something great does not mean that a customer will be willing to try it out.

Within the water industry, there are a few things going on in the world that people can think about, such as corporate responsibility. Companies all around the world, whether it is water utilities or manufacturers like ourselves, are really increasing our interest in and adopting more responsibility in our corporate operations. Our environmental footprint is now front and center, and we are looking at how we can design our products so that energy and chemical usage are lower, or how we can reduce the weight of our products so that the transport costs are less, like the Environmental, Social and Governance (ESG) concept.

For membrane researchers, what you can do to make a big difference quickly is that

you can integrate new processes with membranes, so coupling membranes to other technologies to add value. For example, finding out how membrane technologies can plug in to other processes like lithium recovery.

Amir: In terms of research direction, would you place more emphasis on material development, process optimisation or integration of membrane into other processes?

Geoffrey: I am looking at the whole value chain, such as materials, membranes, manufacturing methods, product design, system design, system integration and operating process. I would not say to any researcher that you should focus on one or the other, but realistically, if you are working in membrane research and you are developing new membranes and materials, you have to be finding new applications where those sorts of existing products are not really present, or maybe they are only present in a very small amount.

Amir: What do you think about the commercial viability of processes like MD or FO?

Geoffrey: They both have applications and are being used around the world in niche but valuable applications. I think they have a future for sure. For example, FO has been commercially used for quite some time. However, widespread application of membrane distillation is going to be more challenging. It is limited to low flux and has the complexity of requiring management of a nearby heat source.

While there is a challenge for acceptance as a mainstream process, I do think that it has a future for some niche high value applications like resource recovery or crystallization applications. In addition, we can integrate membrane distillation with renewable energy like waste heat for a smaller scale production which would be an area of exploration.

Amir: What advice can you give to ECR Researchers looking to approach or engage with the industry, in a way that will result in some tangible collaboration?

Geoffrey: Collaborations are based on good relationships, and relationships are built over time. The important thing about relationships are that the collaborations are mutually valuable to both parties. Sometimes the exciting technologies or applications are not necessarily cutting-edge research, but they are business innovation. Think about the long-term relationships, it is not just short-term transactions. Listening and understanding what businesses need is important.

The other one is starting small. I think different people approach it differently, and I suppose it is probably a bit of a personal way that I like to work, but I like to start off with small thing; like small or short-term projects. Those things are great because you learn from one another, which is the mutual understanding. You finish off that small project, learn for a few months, and later maybe you think of a bigger project that is even more mutually valuable to the two of you. You can really build on that.

Interview with Geoffrey from DuPont Water Solutions

Amir: How can we understand what the industry needs are? Industry people are often very busy and hard to reach, do you have any personal experience and what is your advice?

Geoffrey: I think probably all of us work in increasingly hectic lifestyles. If someone does not answer your e-mail or respond to your phone call the first time around, it is not because they are trying to ignore you. So just being patient but persistent. Reaching out personally can also be great, like going to conferences, networking events, stopping by and having a chat. You do not necessarily need to have an exchange of value or ideas when you are networking, it can just be having a cup of coffee and saying hello.

Amir: We heard that industries nowadays are transitioning away from patents. Can you tell us a little more about that?

Geoffrey: Patents are super valuable for start-up companies or an early stage venture. As companies mature and get larger, patents are not necessarily critical, and maybe not viewed as valuable. As companies mature, often they will protect information by just keeping it in house as a trade secret.

Amir: There are more job opportunities in the industry these days after COVID and it seems that undergraduate students are jumping straight into the industry after their graduation rather than doing a PhD. Do you think it is temporary, or is it going to be a change in the direction in the mindset of the new generation?

Geoffrey: As an employer, it is very hard to employ good people at the moment but I do hope that gets a little better. I think it would be a massive loss if we have less people doing Masters and PhDs. Innovation and technology development is one of our pillars for the future, and there will be a massive gap if we have less PhD graduates in Industry.

Amir: Out of curiosity, what key things do you always check on first as an employer?

Geoffrey: People skills, like ability to work with other people, and relate well to other people, as well as teamwork and the ability to resolve conflicts.

Amir: We have a tradition of some rapid-fire questions at the end of our interview. If you can pick a city to go for holidays, which one would it be? If you could go back in time and picked a different career, what would you see yourself doing now?

Geoffrey: Probably Paris as it is a lovely city. If it was 25 years ago, I would probably be an outdoor adventurer who is sponsored to climb mountains and explore strange places.

Global Water Awards - 2022

Category: **Desalination Plant of the Year**
Award Winner: **Atacama Desalination Plant, Chile**

A 38,880 m^3/d SWRO plant serving more than 210,000 people in the Copiapó region in the Atacama, the world's driest non-polar desert. It is Chile's largest desalination plant designed solely for drinking water production to date.

The plant was delivered on a design-build-operate basis by a team comprising GS Inima (65%) and Claro Vicuña Valenzuela (35%) and funded entirely by the Chilean state through sanitation company Empresa Concesionaria de Servicios Sanitarios. Water is supplied to local utility Nueva Atacama. Energy recovery devices were supplied by ERI and process pumps by Flowserve while membranes came from LG Chem (RO) and Inge (UF).

The innovative use of an in-line process design and an adaptable intake setup that maximises seawater pump efficiency means the plant operates at an energy performance level that can be as low as the 2.63kWh/m3 achieved during the performance test, an astonishing new benchmark for the industry.

With a sensitive local environment, and a rocky cliff seafront location, the project had major challenges just to connect to the sea. The use of micro tunnelling minimised the impact on an environmentally sensitive area and allowed the creation of a subsea intake that ensured high quality raw water, while the use of a booster pump to iron out pressure differences allowed an even flow in a marine area that can see rapidly shifting water quality and salinity levels.

The construction was delivered on a breakneck 30-month schedule, with construction shrugging off the impact of the pandemic to deliver a desperately needed facility in an area that is in the grip of a critical ongoing water crisis.

Source: GS Inima

Global Water Awards - 2022

Category: **Water Project of the Year**
Award Winner: **Zhangjiagang No.4 WTP, China**

It is an RMB920 million ($150 million), 100,000 m^3/d renovation and upgrade of a 400,000 m^3/d water treatment plant – significantly increasing the operating capacity and introducing ultrafiltration (UF) and nanofiltration (NF) treatment to help serve 1.5 million residents in the city of Zhangjiagang, Jiangsu Province in China.

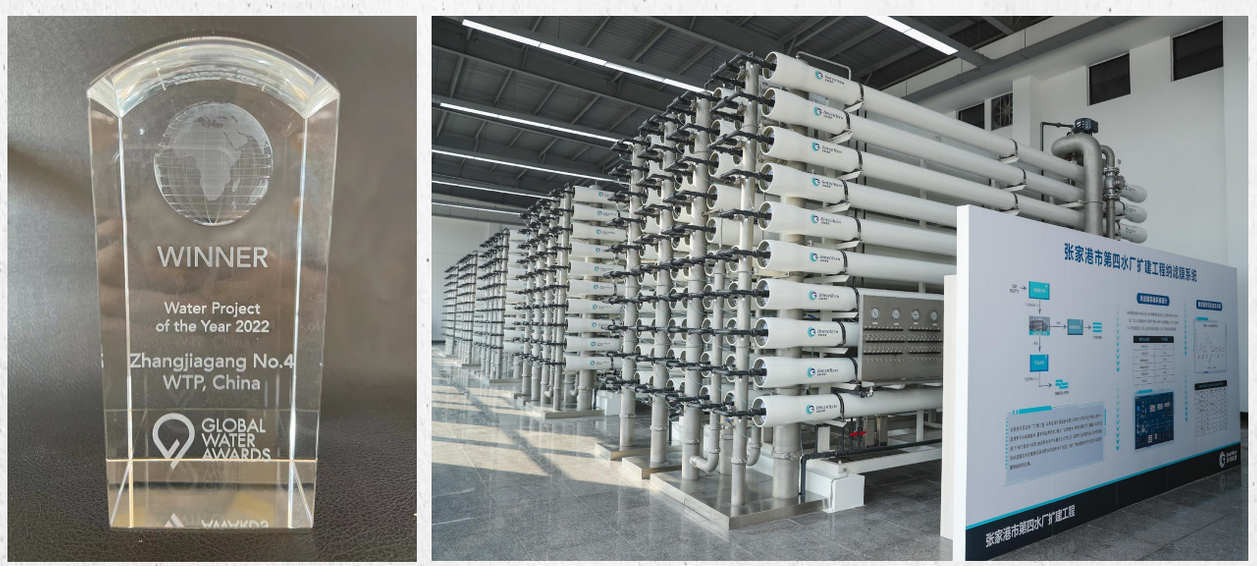
The project was delivered on an EPC basis by GreenTech Environmental for local utility Zhangjiagang Water Company. Shanghai Municipal Engineering Design Institute was responsible for the process design of the plant. Membranes were supplied by DuPont (NF) and local brand Litree (UF).

The expansion makes the plant the joint largest nanofiltration membrane drinking water facilities in China on top of its existing capabilities, not only marking a new level of success for the technology, but setting the stage for its deployment in advanced drinking water treatment across the country.

A further capacity phase of 200,000 m^3/d is now under construction, which will make the facility the largest of its kind in the world.

The NF upgrade enables the plant to provide a far higher quality of drinking water, originally sourced from a polluted downstream area of the Yangtze River which faces high turbidity and potential micropollutant risks. The plant defeats these environmental challenges, removing microorganisms, organics and disinfection by-products, to lay a solid foundation for the city's ambition to provide universal potable water coverage from taps.

Innovative digital technologies including digital twins featuring building information modelling (BIM) systems were adopted during the plant's construction and operation phases, hugely improving the efficiency of building and operations, and enabling a stable performance with a market-beating high water recovery rate of 90%.



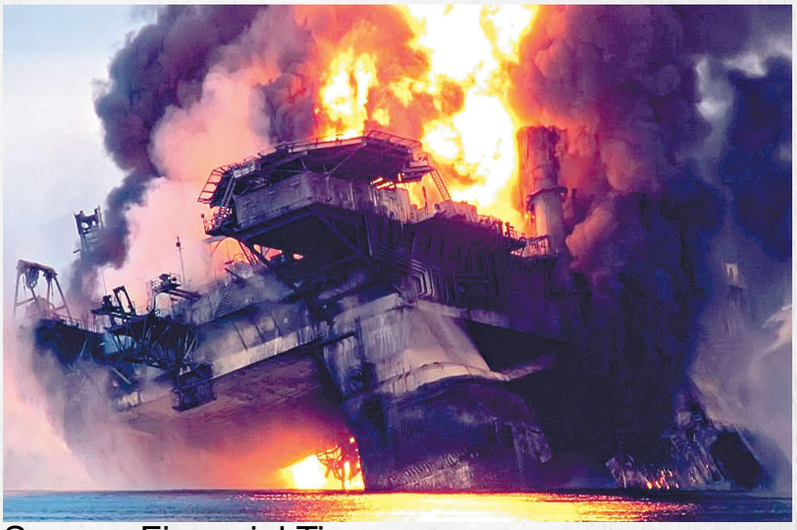
Source: GreenTech

New membrane generation; a potential solution to mitigate oil spilling

Story by Javad Farahbakhsh

Deep Horizon oil spill disaster!

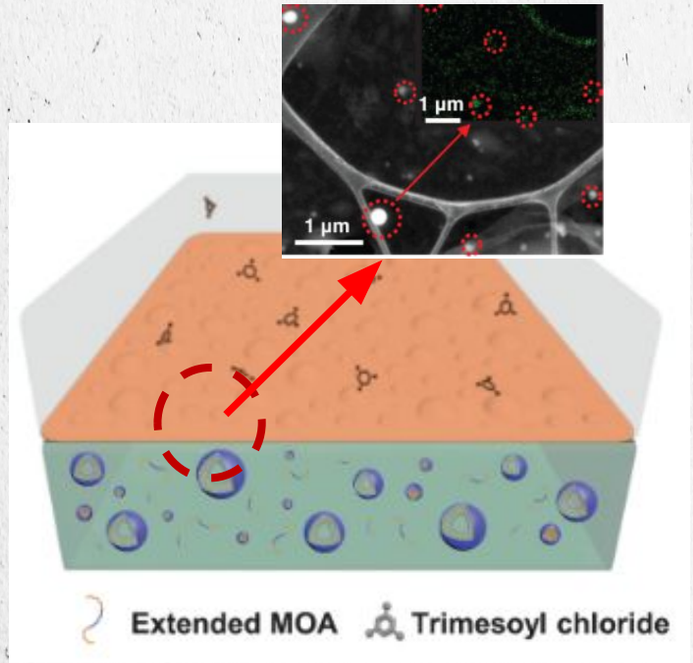
As you probably know, deep horizon was a spill oil disaster in the history of petroleum industry which is also considered as one of the largest environmental disasters. According to the United States federal government, the total estimated oil discharged was at 4,900 Mbl (210 million US gal; 780,000 m^3). Due to the months-long spill, along with adverse effects from the response and clean-up activities, extensive damages to marine and wildlife habitats and fishing and tourism industries was reported.



Source: Financial Times

Novel membranes as a solution!

A significant amount of crude oil is globally processed with conventional oil separation methods, which may lead to such disasters with high environmental impact. To avoid such issues, a scientific group at Queen Mary University fabricated a new specific type of membrane which separates oil with low energy consumption and minimum environmental impact. “The aim of our research is to provide low energy alternatives,” says Andrew Livingston, of Queen Mary University London, leader of the international research team. He says the work benefitted greatly from the assistance of researchers at KAUST led by world-leading membrane scientist, Suzana Nunes.



Source: Science

The innovation is based on ultra-thin films composed of polyamide molecules that can be designed to let small organic molecules of crude oil pass through while blocking larger ones. The membrane must be sufficiently robust to withstand the pressures needed to push the separated molecules through. “We were amazed to see that little balls of monomer that formed in solution turned up in the final films as half spheres that I was sure would be a weak point, but amazingly they could take high pressure without deforming”, Livingston says.

These polyamide nanofilms provide transport of hydrophobic liquids more than **100 times** faster than that of existing membranes. In the fractionation of light crude oil, manipulation of the film thickness down to ~10 nanometers achieves a permeance of one order of magnitude higher than that of the current hydrophobic membranes while retaining comparable size- and class-based separation (read more).

ARC DECRA 2023 Funding Success

This year, the ARC funding outcome was released for 2023 funding commencement. A number of membrane separation and materials researchers have done very well to secure ARC Future Fellowships, Australian Laureate Fellowship, and a Discovery Early Career Researcher Award. MSA would like to say many congratulations to you and your colleagues on being awarded a 2023 ARC Grants. That is a great achievement for the membrane community. A compiled snapshot list of membrane separation related projects is provided in this newsletter and their results can also be found at the ARC outcome website here in this link.

Discovery Early Career Researcher Award (DECRA)

The University of Queensland

Zhe Yang

Novel interlayered membrane for highly efficient separation processes

The project aims to develop high-performance membranes with excellent permeability and selectivity to allow efficient separation processes with reduced energy consumption and products with high purities that cannot be achieved by conventional membranes. By introducing the functionalized interlayer, the novel membrane can achieve up to an order of magnitude higher solvent permeance with significantly enhanced solvent-solute selectivity. Machine learning algorithms will be applied to search for the ideal interlayer based on a newly-launched online and comprehensive database. This project will contribute to accelerating Australia's progress towards net-zero carbon emission and allowing a sustainable environment.

ARC DECRA 2023 Funding Success

Discovery Early Career Researcher Award (DECRA)

The University of Queensland

Rijia Lin

Glassy metal-organic framework membranes for CO2 separation and conversion

This project aims to develop a new class of glassy metal-organic framework (MOF) membranes for CO2 separation and conversion. By constructing membrane reactors, it is expected to simultaneously separate CO2 from gas mixture and subsequently convert it into value-added chemicals in a continuous single operating unit. The expected outcomes include fabrication techniques for ultrathin MOF glass membranes, cutting-edge knowledge in advanced MOF membrane design, a new generation of MOF devices, and efficient membrane reactors for CO2 conversion with mixed gas feed. This project expects to accelerate the development of low-carbon technologies and provide significant benefits in mitigating the adverse effects of anthropogenic CO2 emissions.

Jun Lu

Novel Hydroxide Ion Conductive Membranes for Advanced Ammonia Fuel Cell

This project aims to address a longstanding challenge in the development of direct ammonia fuel cells for utilization of ammonia as a green energy carrier. It proposes to develop advanced hydroxide ion conductive membranes based on novel porous framework materials to achieve high hydroxide ion conductivity and lower ammonia crossover simultaneously, thereby substantially enhancing the energy efficiency of direct ammonia fuel cells. The proposed research expects to create new knowledge in the fields of membrane science and energy. The successful development of advanced membranes will improve the efficiency of storage of intermittent and fluctuating renewable resources, thereby contributing to the reduction of carbon footprint in Australia.

Monash University

ARC DECRA 2023 Funding Success

Discovery Early Career Researcher Award (DECRA)

The University of Melbourne

Luis Francisco Villalobos

Developing tunable nanoporous graphene membranes for resource recovery

This project aims to advance the development of atom-thick nanoporous graphene molecular filters (membranes) to tackle challenging separations in the chemical industry and open new pathways to recover valuable materials from waste streams. The extreme thinness of these membranes allows them to separate molecules with a fraction of the energy typically used by commercially available technologies. The proposed electrochemical platform is expected to fabricate and operate fit-for-purpose membranes with unprecedented control. Significant new knowledge in the areas of material engineering, nanofluidics, and membranes is expected from exploiting this platform to study ion transport under confinement and make membranes for resource recovery.

Yun Liu

Bio-inspired nanomaterials with tunable drug loading and controlled release

This project aims to develop new platform technologies for making bio-inspired nanomaterials with tunable drug loading and controlled release. This project will revolutionise current approaches to make lipid nanoparticles camouflaged with natural cell membranes for delivery of both insoluble and soluble drugs. Significant outcomes will include a novel commercially relevant salt-induced nanoprecipitation platform technology for making precisely engineered nanomaterials with tailored functions for applications in controlled release and targeted delivery. Benefits include securing a sustainable future for Australia, with new nanotechnology strategies for advanced manufacturing.

The University of Adelaide

ARC DECRA 2023 Funding Success

Discovery Early Career Researcher Award (DECRA)

RMIT University

BIPLOB PRAMANIK

Metal organic framework-based membrane for nanoplastics removal

The aim of this project is to understand the fundamental science governing the removal of nanoplastics from wastewater by developing an innovative dually charged metal organic framework based nanocomposite ultrafiltration membrane. The project expects to lead to a breakthrough in our scientific understanding of how nanoplastics and other pollutants can be efficiently removed from wastewater using membranes. The expected outcome is a process that can be used to convert wastewater into freshwater suitable for household, industrial and agricultural use. Such removal could also be of significant environmental benefit, as secondary effluent is a significant source of nanoplastics entering the aquatic environment.

Upcoming Membrane Events

CURRENT EVENTS	DATE OF EVENT	ABSTRACT SUBMISSION
AMTA/AWWA Membrane Technology Conference Knoxville, TN, United States www.awwa.org/Events-Education/Membrane-Technology	21 – 24 Feb 2023	**Registration open now!** (Abstract deadline past)
32nd North American Membrane Society Annual Meeting Tuscaloosa, AL, United States https://membranes.org/	13 – 17 May 2023	TBD
13th International Congress on Membranes and Membrane Processes Makuhari Messe, Chiba, Japan www.icom2023.jp	09 – 14 Jul 2023	**Registration open Jan 2023!** (Submit abstract by 31 Jan 2023)
The 10th International Water Association (IWA) Membrane Technology Conference & Exhibition for Water and Wastewater Treatment and Reuse Washington University in St. Louis, USA www.sites.wustl.edu/mtc2023	23 – 26 Jul 2023	**Registration open Jan 2023!** (Abstract deadline past)

NAMS
The North American Membrane Society

American Water Works Association
Dedicated to the World's Most Important Resource®

IWA
the international water association

MSA Newsletter Taskforce

Dr. Amir Razmjou (amir.razmjou@ecu.edu.au**)**

Dr Amir Razmjou is a tenured lecturer at Edith Cowan University (ECU) and Editorial board member of the Journal of Desalination. He has supervised more than 20 HDR students, has held leadership roles in several industrial projects. He has over 10 years of expertise in surface nanoengineering and membrane technologies with more than 150 high-impact refereed journals (>5800 citations and an h-index of 38 and h10 of 89, April 2022). Dr Razmjou's current research focuses on direct lithium extraction, ion selective membranes, sensors and machine learning for material discovery.

Dr. Masoumeh Zargar (m.zargar@ecu.edu.au)

Dr. Masoumeh Zargar is a tenured lecturer, an ARC DECRA Fellow, and a Vice-Chancellor Research Fellow at the School of Engineering, Edith Cowan University (ECU). She has extensive experience in membranes and nanomaterials science and technology and has been working with several industry partners on industry-led research projects over the past five years. She currently leads an active research group encompassing more than 10 HDR students and research associates. Her current research focuses on the development of functional materials and membranes for water and wastewater treatment, desalination, solar distillation, water resource recovery, circular plastic economy, and the removal of emerging contaminants from water (e.g., microplastics, nanoplastics, PFAS).

Dr. Milton Chai (milton.chai@uq.edu.au)

Dr. Milton Chai is a postdoctoral research fellow at the University of Queensland working under the supervision of Dr. Jingwei Hou and Prof. Vicki Chen. He received his PhD in Chemical Engineering from the University of New South Wales in 2019. He has extensive experience in thin film metal-organic framework (MOF) membrane development, biocatalysis and ion selective membranes. His current research focuses on MOF membranes for critical minerals recovery.

MSA Newsletter Taskforce

Ms. Mitra Golgoli (m.golgoli@ecu.edu.au)

Mitra Golgoli is currently a PhD candidate at Edith Cowan University (ECU) under Dr. Masoumeh Zargar's supervision. Her main research interest includes polymeric membrane fabrication/modification and performance/fouling evaluation. She is currently working on forward osmosis membranes.

Mr. Javad Farahbakhsh (j.farahbakhsh@ecu.edu.au)

Javad Farahbakhsh is in his 2nd year of Ph.D. program at the Edith Cowan University under Dr. Masoumeh Zargar's supervision. His main research interest includes microplastics fouling measurements with forward osmosis and ultrafiltration membranes. He is also working on membrane surface modification methods using hydrophilic nanomaterials.

Ms. Mohadeseh Najafi (m.najafiarani@ecu.edu.au)

Mohadeseh Najafi is currently a 1st year Ph.D. student at the Edith Cowan University under Dr. Masoumeh Zargar's supervision. Her main research interest lies in the surface modification of various membranes for water and wastewater treatment.

Ms. Weonjung Sohn (Weonjung.Sohn@student.uts.edu.au)

Weonjung Sohn is currently a 1st year PhD student at University of Technology Sydney under Prof. Hokyong Shon's supervision. Her main research interests include biological nitrification process in membrane bioreactors, and reverse osmosis technology for nutrients recovery in a circular economy from blackwater such as urine.

Mr. Vedant A. Joshi (che18va.joshi@stumarj.ictmumbai.edu.in)

Vedant A. Joshi is currently a 4th year student pursuing Integrated M.Tech. in Chemical Engineering with Specialization in Petroleum and Petrochemical Technology from Institute of Chemical Technology Mumbai MarJ. His research interest lies in the domain of Enhanced Oil Recovery, Aromatic Extraction and Process Modelling and Simulation.