



MONASH
University

MONASH
MEMBRANE
INNOVATION

Annual Report 2020



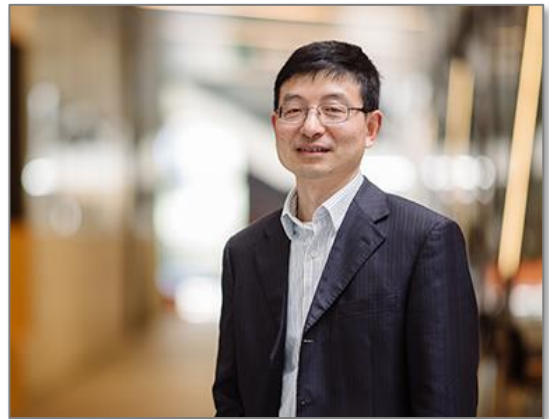
Foreword

Message from our Director

Welcome to the first Annual Report from the Monash Centre for Membrane Innovation. It is my great privilege to lead an exciting new venture at Monash and to report back on the first couple of years of the Centre.

2020 has been a year of monumental and unexpected change, challenge, and for some, tragedy. Out of necessity, we have seen three years of digital transformation achieved in just 9 months – an incredible achievement and one worthy of celebration. In a testing year, COVID-19 has highlighted the great importance of building resilience and future-proofing our local industries and graduates. Membrane technologies play a critical role in each of our daily lives being used for everything from treating our wastewater to pharmaceuticals, dairy products, and chemicals, as well as ensuring we always have fresh water to drink. While membranes are commonplace in several industries, the technology has still so much to offer. New applications, better products, and lower energy costs are just some of the benefits shown in recent breakthroughs.

The Monash Centre for Membrane Innovation brings together leading researchers across the materials and separations science to solve interdisciplinary challenges and deliver



impact. The Centre seeks to build on the broad expertise of our member academics in fundamental science and materials development and offer new translational research capabilities. I am honoured to be working with such a fantastic team of membrane scientists and early career researchers and look forward to helping see our graduates and the Australian membrane industry thrive.

You will find more about our research focus and the mission of our Centre in this report. We also take time to celebrate our recent successes and plans for the coming years.

- Professor Huanting Wang



Our Mission



The **Monash Centre for Membrane Innovation (MCMI)** was established to bring together a multidisciplinary team of researchers to undertake the pilot scale and application-specific de-risking research needed to translate recent advances in membrane materials into industry. MCMI aims to establish itself as a global hub for separations science by collaborating broadly with global experts across a range of related fields. Despite the significant global challenges faced in 2020, the Centre received several major accolades, made significant progress on its development strategy and laying the foundations for future success.

MCMI's aims to make transformative breakthroughs in membrane science, engineering, technology transfer, and innovation by:

- i) Developing novel nanostructured membrane materials
- ii) Applying membranes to processes conventionally undertaken by other separation methods
- iii) Optimising the membrane process design
- iv) Developing advanced models for predicting membrane performance in real conditions; and
- v) Fabrication methods and pilot-scale prototyping to enable commercial uptake of modules based on novel membrane materials



Our People

Centre Director

- Prof. Huanting Wang

Deputy Directors

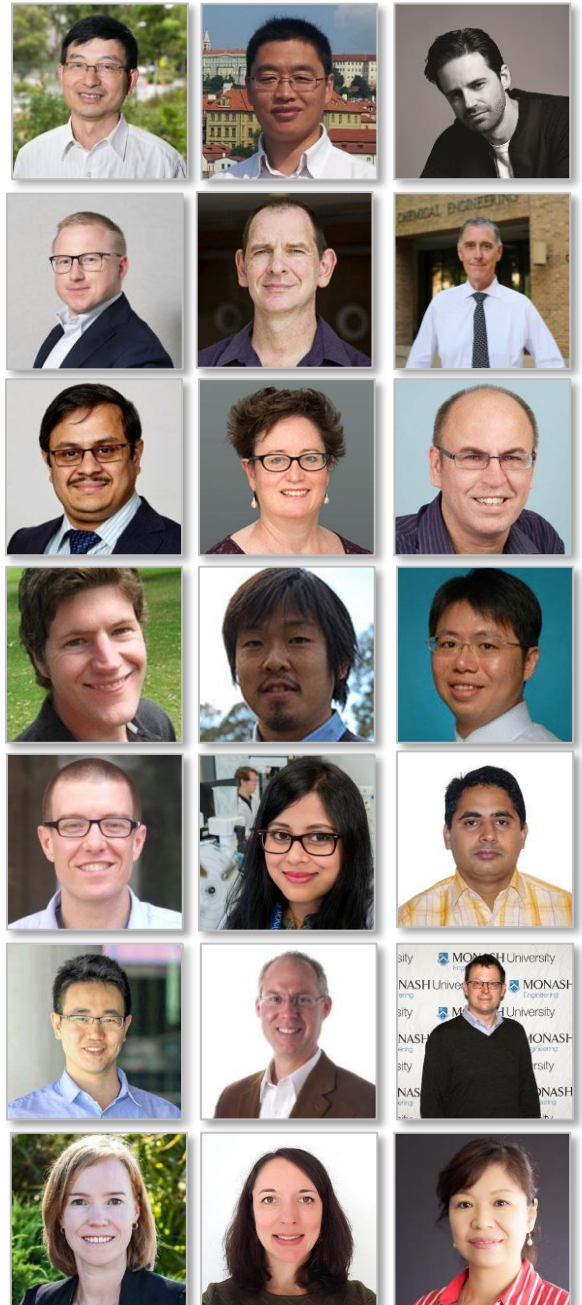
- Prof. Xiwang Zhang
- A/Prof. Matthew Hill

Centre Manager

- Dr. Stefan Smith

Principal Investigators

- Prof. Mark Banaszak Holl
- Prof. Benny Freeman *joined 2021*
- Prof. Mainak Majumder
- Prof. Louise Bennett
- Prof. George Simon
- A/Prof. David McCarthy
- A/Prof. Kei Saito
- A/Prof Victor Chang
- Dr. Parama Banerjee
- Dr. Simon Corrie
- Dr. Zhikao Li
- Dr. Sushil Dhital
- Prof. Gil Garnier *joined 2020*
- A/Prof. Warren Batchelor *joined 2020*
- Dr. Joanne Tanner *joined 2020*
- Dr. Leonie van 't Hag *joined 2021*
- Dr. Zongli Xie (CSIRO) *to join as a Deputy Director of the planned Monash-CSIRO Centre for Membrane Innovation.*



Initiatives and Capabilities

Pilot Scale Membrane Facility

A core focus of the Monash centre for Membrane Innovation is to establish a pilot membrane manufacturing and test facility with the objective to translate discoveries, build prototype modules and perform meaningful, pilot-scale evaluation of emerging membrane technologies. Unfortunately, progress on the necessary infrastructure works for the facility have been on hold due to COVID19.

Historically, membrane Technologies have low margins, stringent quality requirements, and long payback period. Consequently, there have been few sweeping changes to the industry as the benefits offered by advancing technologies must be proven at scale before users will consider trials. MCMI's planned fabrication and testing capabilities available will enable lab-scale breakthroughs to be assessed at more relevant scales, attracting industrial research collaborations, and bridge the gap between academic and commercial membrane research.

Research Innovation Short Course

Working across the faculty of Engineering and Monash College, MCMI is working to establish the Monash Engineering Innovation (MEI) short course, a program focused on providing practical research skills, and English language training to international industry professionals at a postgraduate level.

Student-Run Pilot Plant

The Monash Centre for Membrane Innovation is working closely with the department of Chemical Engineering to build an on-campus Student-Run Pilot Plant for wastewater treatment. The digitally twinned modular plant will be embedded in the Monash Smart manufacturing Precinct and will provide Monash Chemical engineers with the practical experience needed to design and develop process innovations needed by Australian future industries. The student pilot plant is an exciting "co-creation" opportunity where we will collaborate with the Australian manufacturing sector will provide key support for improvement of industry practices and workforce training.

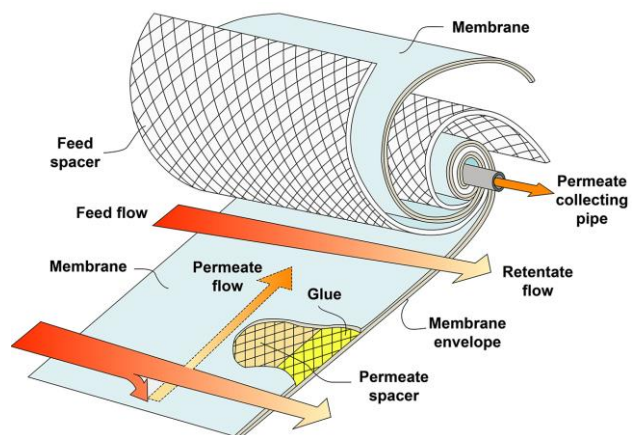


Figure: Structure of a spiral wound membrane module. Compared to laboratory experiments which can be undertaken using less than 1 cm², membranes for testing at pilot scale test are much larger and are much more complex to fabricate.

Outreach and Engagement

Marketing

For 2020, the marketing goal for the centre focused on building awareness of MCMI among the Australian membrane community. This was achieved through links with the Membrane Society of Australasia, social media, and supporting events in the membrane community, both as a sponsor and as a co-organiser. Events held in 2020 that MCMI either sponsored or organised include :

- **Feb:** Sponsored IMSTEC2020
- **Feb:** Sponsor of the MSA Early Career Researcher Symposium 2020
- **Feb:** Attended MSA Membrane Industry Workshop
- **Feb:** Lead Organiser of the Monash CSIRO Sustainable Membrane R&D Mini-Symposium.
- **Jun:** Co-organised the Membrane Technology in Food Industry, webinar.
- **Jul–Dec:** Co-organiser and Session chair for the Science &+ Industry Webinar Series (10 Webinars)
- **Nov:** Co-organised the Membrane Society of Australasia Annual Meeting conference,
- **Dec:** Sponsor for ICOM2020 (UK).†

International Engagement

This year, our ability to engage potential collaborators and clients overseas as well as attend international conferences was impacted by travel restrictions. Correspondingly, activities planned to build MCMI's international reputation were redirected to local initiatives. Our plans to grow MCMI into a global hub for separations science will recommence once international borders re-open.

Social Media

A MCMI Twitter account was established in June 2020 and had 135 Followers as of 31 Dec 2020. MCMI's social media presence will be expanded to include a LinkedIn company page in the coming year. Options to compile the works and impact of MCMI researchers is currently being investigated.



@mcmi_membranes



Under development





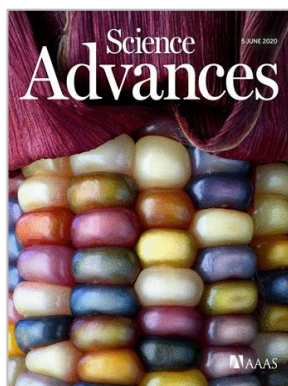
Research Impact

266 Journal Publications

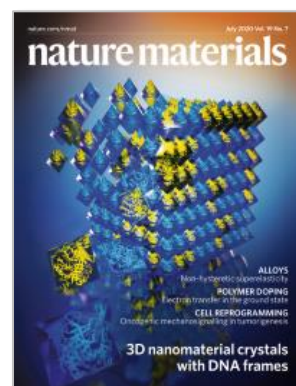
4 Papers in Nature & Science

4 Patents issued

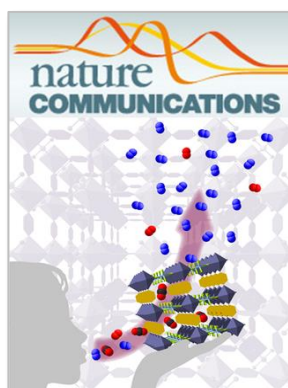
In 2020, MCMI Principal Investigators published four articles in Science and Nature journals in the field of membrane and separation science and were also issued 4 patents in the field. Collectively, MCMI researchers authored 266 articles in leading journals such as Advanced Materials, Accounts of Chemical Research, Angewandte, the Journal of American Chemical Society, and the Journal of Membrane Science.[†] This result increased the Centre's publication rate by 66% (or 47% excluding member growth) on the 160 articles in 2019.



Science Advances 6, 23, eaay3998 (2020)



Nat. Mater. 19, 767–774 (2020).



Nat Commun 11, 927 (2020).



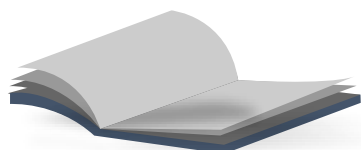
Nat Sustain 3, 1052–1058 (2020)

(19) **United States**
 (12) **Patent Application Publication** (10) Pub. No.: US 2020/0384454 A1
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 WANG et al. (43) Pub. Date: Dec. 10, 2020



+28% Growth in citation rate[†]

[†] Source: Total from Google Scholar, including co-authorship.

Awards and Recognition

Australian Laureate and Honour Roll

Prof. Huanting Wang was awarded an Australian Laureate Fellowship to develop membrane technologies that can efficiently separate ions from solutions and reduce the environmental impact of current processes. This project builds on Prof. Wang's recent discoveries in MOF-based ion-selective membranes that showed unprecedented selectivity for lithium over sodium and magnesium.

In recognition of his leadership and collegiality toward academic excellence, Prof. Wang was added to the Monash University Honour Roll this year. He was conferred with the Membrane Society of Australasia's highest honour, the Tony Fane Award.

Public Service Medal.

A/Prof. Matthew Hill received a Public Service Medal for his outstanding public service to the development of materials for industry and the Australian Defence Force.



Matthew Hill celebrating his Public Service Medal.

ARC Discovery Projects

We are proud to recognise that MCM I Academics were involvement in Four successful ARC Discovery Project proposals in the 2021 round.†

- **Hydrogen Carrier Separators:** A team lead by A/Prof Matthew Hill will develop MOF-Polymer composites that can isolate liquid hydrogen carrier molecules before and after their release of hydrogen. The project is expected to ease issues in hydrogen transportation and support the transition to a hydrogen economy.
- **Chiral-Selective Membranes:** Prof Huanting Wang and team will address the urgent challenge of separating chiral molecules for pharmaceuticals and agrochemicals. The project expects to generate new knowledge regarding how membrane chemistry and architecture can be used to achieve highly selective, fast chiral molecule transport.

The other two Discovery Projects were awarded to teams including Prof. Mark Banaszak Holl and Prof. Gil Garnier. Prof. Banaszak Holl will study bacteriophage chemistry as a route to more effective anti-microbial surfaces, while Prof. Garnier will explore the use plastic-free cellulose microcapsules in agriculture and consumer products. While not directly in the area of membranes, these projects may help advance membrane anti-fouling performance and sustainability.



Looking Forward

Finance and Resourcing

COVID-19 had an enormous impact on people's lives and the Australian Tertiary education sector. MCMI is resourced by seed funding from the Monash University Department of Chemical Engineering, Faculty of Engineering, and the Monash Office of the Vice Chancellor. As with many other University initiatives, several of MCMI's strategic development activities were put on-hold early in 2020 due to funding restrictions. While the pandemic has delayed the Centre's mission, we anticipate funding opportunities will return as the world emerges out of lockdown and economies begin to recover. Membrane technology and its applications is expected to play an increasingly important role in achieving several of the UN's sustainability Development goals

The Executive Team remains proactive in exploring alternate approaches to supporting membrane research and sources of funding to develop the Centre's capabilities and supporting MCMI researchers achieve impact. The Centre has several projects pending final approval and contracting, as well as several opportunities in the pipeline.

ARC Centre of Excellence 2023

Under the Directorship of Prof. Huanting Wang, the Monash Centre for Membrane Innovation is currently preparing a proposal for an ARC Centre of Excellence in 2023. The planned Centre of Excellence will bring together leading researchers in computational modelling, chemistry and materials development, membrane science, and the humanities to advance knowledge on the precise separation of valuable resources and the forces driving industry in the future.

IMSTEC2022

MCMI is excited to be working with the Membrane Society of Australasia (MSA) and the ARC Hub for Energy Efficient Separation (ARC-EESep) to hold the 11th International Membrane Science and Technology Conference at Monash in December 2022. Details of the event, including abstract submissions and registration details will be announced mid/late 2021 www.imstec2022.org.

Monash Centre for Membrane Innovation

Director: Prof. Huanting Wang

 @mcmi_membranes

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