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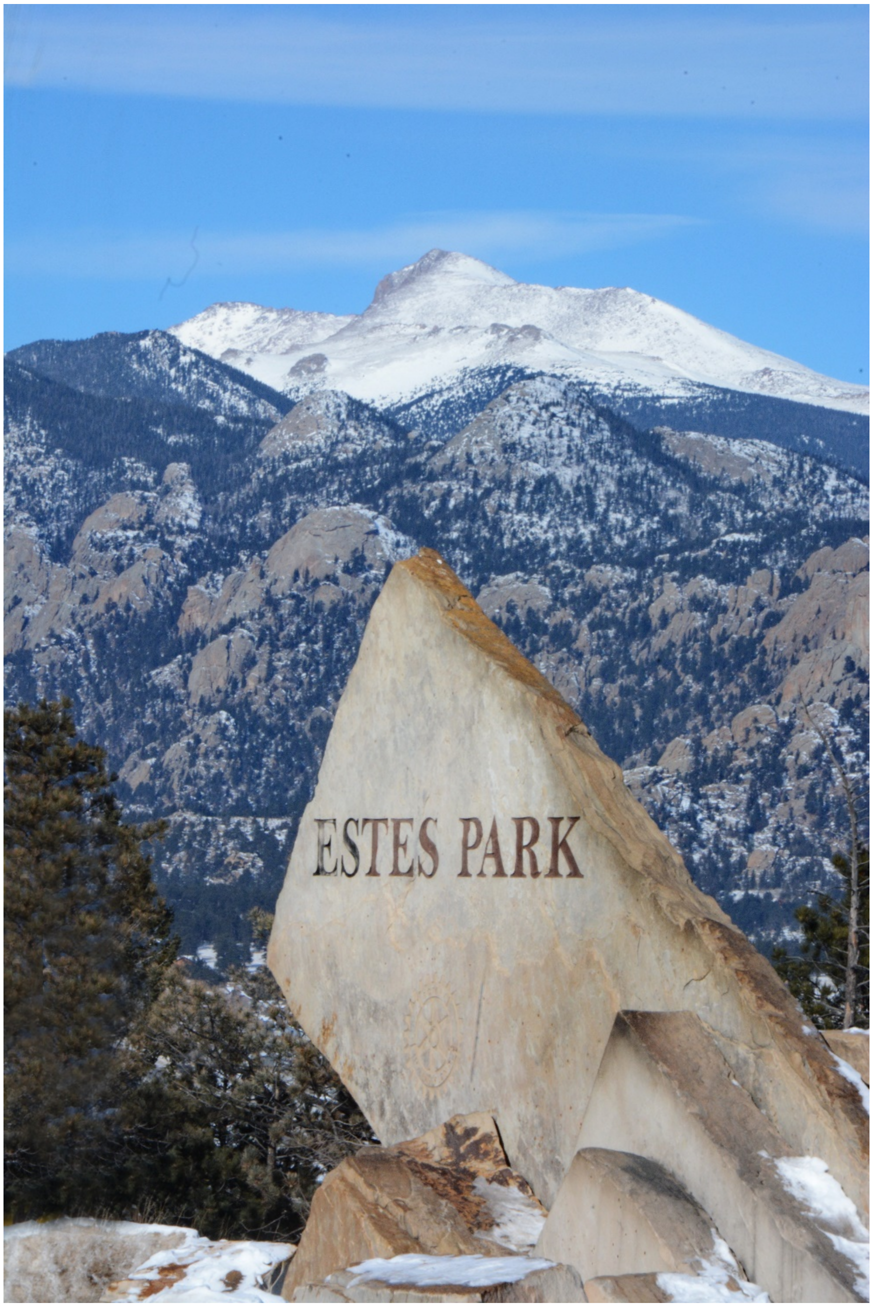

North American Membrane Society

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Contents

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Front cover image: Estes Park, Colorado. Site of NAMS 2021

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Message from the President

As we deal with the consequences of living through this global pandemic, we all continue to adjust to new ways of living, working and connecting. NAMS has been no exception.

Many thanks, once again, to Manish Kumar and Mary Laura Lind, for organizing a virtual NAMS meeting in May! After a lot of hard work to prepare for a traditional meeting, as travel restrictions increased, they quickly pivoted and provided us all with the opportunity to connect virtually so we could experience the great membrane science and technology of our community. At the meeting, we presented our first Education Innovation Fellowships. Congratulations to David Latulippe of McMaster University and Daniel Anastasio and Marissa Tousley of Rose-Hulman Institute of Technology. For more information about their exciting education initiatives, see the article in this issue of the Membrane Quarterly.

Another exciting development is the members-only section of the NAMS website. We will leverage this channel to connect with our members throughout the year. We're also excited to announce our newest initiative, recently added to the website. In our first NAMS members-only webinar, Marie-Eve Langevin, from Ameridia Innovative Solutions, Inc., gives an informative overview of electrodialysis. We plan to add a new webinar to the NAMS website each quarter to serve our mission of fostering the development and dissemination of knowledge in membrane science and technology. While you're visiting the website, you can also check out selected talks from 2020 NAMS annual meeting, covering a wide range of topics in membrane science and technology. Another fantastic resource that you can find on the website is a virtual issue of classic membrane papers from the Journal of Membrane Science. These articles are open access to our members and are a great way to get an overview of some of the most important topics and developments in our field.

Behind the scenes, we are planning other initiatives to improve connectivity and interaction. And, work is well underway to prepare for NAMS 2021 in Estes Park, Colorado. I hope that we will once again be able to meet in person and that I will see you all there, face-to-face!

Take care,

Tina Carbrello

President, North American Membrane Society

NAMS 2020 Student Award Winners

As we begin to look ahead to the 2021 awards cycle, I would like to look back and congratulate the 2020 NAMS Student Fellowship and Young Membrane Science Award recipients one last time. This year's program honored 10 exceptional individuals, and you can learn a little more about each below.

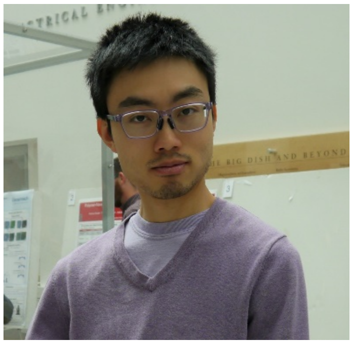
Thank you to all the reviewers that make the awards program possible! The application deadline for this year's awards is January 8, 2021. I look forward honoring another class of recipients next year.

Caleb Funk
DuPont Water Solutions
NAMS Awards Committee Chair

Student Fellowship Award Winners

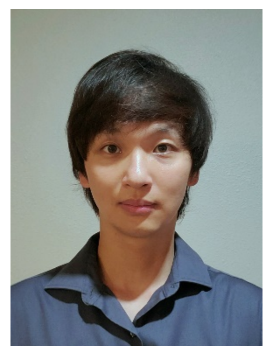
Abhishek Dutta is a fourth-year Ph.D. student under the supervision of Dr. Jongho Lee in the Department of Civil Engineering at the **University of British Columbia, Vancouver**. Originally from India, he completed his M.Sc degree from Yale University in Chemical and Environmental Engineering prior to his time at UBC. Abhishek is carrying out his research in the water-energy nexus, exploring the applicability of membrane systems for energy and resource harvesting from wastewater. Outside research, he has been involved with the BCWWA student chapter since 2017, as well as acting as chair of the WEST conference in 2019. Abhishek is also a recipient of the Vanier Canada Graduate Scholarship (2018) and has been an UNLEASH global talent, 2019.

Dr. Jaime Idarraga-Mora is a Senior Process Engineer at Dow. In 2015, he moved from Colombia to the US to start his graduate studies at Clemson University where he worked in Dr. Scott Husson's research lab and graduated in 2020. His graduate research was focused on elucidating the role of the mechanical properties of thin-film composite membranes in their performance in osmotic processes, particularly in pressure-retarded osmosis. Currently, Jaime provides technical support in process engineering, more specifically chemical separations, for different **Dow** businesses. Jaime joined NAMS in 2016 before attending the Annual Meeting in Bellevue, WA, and since then, he has been a regular member and attendee of NAMS and its meetings. During this time, Jaime realized the potential that membrane separations have to increase the sustainability of chemical separations, and he hopes to see more membrane-based separations being successfully implemented in the chemical industry.



Dr. Holden Lai is a Vagelos Institute for Energy Science and Technology postdoctoral fellow in the labs of Karen Winey and Chinedum Osuji at the **University of Pennsylvania**. He received a B.A. in chemistry with High Honors and physics, and a B.Mus in percussion performance from Oberlin College & Conservatory. He received his Ph.D. in Chemistry from Stanford University with Yan Xia and was an NSF Graduate Research Fellow. His research interests include polymer synthesis and developing membrane materials for gas separation, ion transport, and nanofiltration.

Hongxi Luo is a 5th-year graduate student in the Chemical Engineering Department at the **University of Virginia** (UVA). Originally from Wuhan China, he completed his bachelor's degree in chemical engineering at the University of Missouri - Columbia and began his doctoral studies in membranes at UVA. His thesis research focuses on understanding the relationships between the membrane structure and the membrane small molecule transport properties in desalination and ion separation membranes. His other research interests include designing mixed-matrix membranes and conducting economic and life-cycle analyses on membranes-based processes. As part of the UVA research community, Hongxi is committed to promoting the involvement of undergraduate researchers in the membrane-related studies. During the COVID-19 outbreak in Wuhan, he also worked on the consulting panel as a specialist to make suggestions on the medical/municipal wastewater treatment for Wuhan Water Authority.

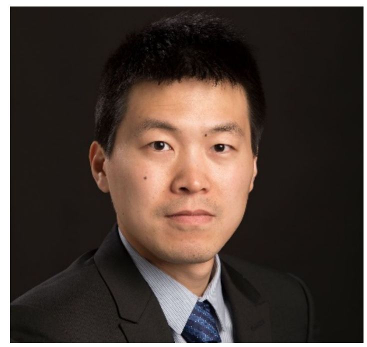


Woochul Song is a fifth-year Ph.D. student at McKetta Department of Chemical Engineering, **the University of Texas at Austin**. He earned B.S. and M.S. degrees from the School of Chemical Engineering, Sungkyunkwan University in South Korea in 2014 and 2015, respectively. After one year of internship at Korea Institute of Science and Technology (KIST), he started Ph.D. study at Penn State in 2016 and moved to UT Austin in 2019 following his research advisor Prof. Manish Kumar. Currently, he is being co-advised by Prof. Manish Kumar and Prof. Benny D. Freeman. His research focuses on exploring biomimetic membranes for efficient water filtration, and now he is trying to expand this knowledge into scalable polymer membranes for gas separations. After defending his thesis in 2021 spring, he will start his professional research career as a postdoctoral researcher, applying for a tenure-track academic position.

Young Membrane Scientist Award Winners

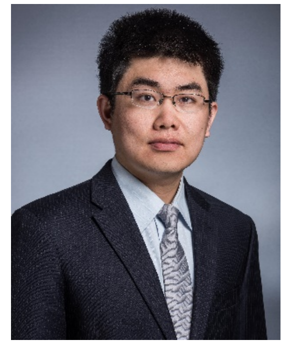
Dr. Giuseppe Genduso is a Research Scientist at **the King Abdullah University of Science and Technology** in Saudi Arabia. Originally from Italy, where he graduated with a Bachelor's and Master's degree in Chemical Engineering at the University of Palermo, he obtained a Doctoral degree at the KULeuven in Belgium in 2016. Currently, he analyzes the sorption and diffusion behavior of CO_2-based and light olefins mixtures in rubbery, glassy, and inorganic-amorphous films. His interests also include gas and liquid separations, advanced functional polymers, novel desalination methods, carbon molecular sieve membranes, and the study of the fundamentals underpinning thin-films for membranes. Besides various study scholarships, he was the recipient of the KAUST postdoctoral fellowship, and one oral and one poster best presentation award. He is also fairly involved with academic chemical engineering teaching and is an enthusiastic windsurfer.

Dr. Xiaoli Ma is an Assistant Professor in the Department of Materials Science and Engineering at **University of Wisconsin-Milwaukee**. He completed his B.S. and M.S. at Tongji University, Ph.D. at Arizona State University, and did postdoc research at the University of Minnesota. His research group works on advanced microporous membranes, with a focus on metal-organic framework and covalent-organic framework based membranes for chemical separation, water treatment, and desalination. His group also develops porous sorbent materials for the removal of waterborne contaminants. Xiaoli is actively involved in teaching and service, including serving as the mentor for the McNair Scholars Program at UWM.



Dr. Hee Jeung Oh is an assistant professor of Chemical Engineering and the Institute of Energy and Environment at the **Pennsylvania State University**. The Oh group focuses on connecting the chemistry, processing, structure, and transport properties of polymer membranes for energy-efficient separations and biomedical devices to address challenges in the Water-Energy nexus and in health. Hee Jeung earned her BS in Chemical Engineering from the Korea Advanced Institute of Science and Technology (KAIST), completed her PhD in Chemical Engineering in Profs. Benny Freeman and Don Paul research groups at the University of Texas at Austin, and did her postdoctoral training in Prof. Nitash Balsara group at University of California, Berkeley. Hee Jeung has 15 peer-reviewed publications and one issued patent and has been recognized with numerous awards including the University of Texas at Austin Professional Development Award and Doh Wonsuk Memorial Award. Hee Jeung is also actively involved in mentoring research projects for underrepresented students as well as community outreach programs for various groups of K-12 students.

Dr. Tiezheng Tong is an Assistant Professor in Civil and Environmental Engineering at **Colorado State University** (CSU). Prior to joining CSU in 2017, he was a postdoctoral research associated at Yale University. Originally from Qingdao, China, he obtained his PhD degree from Northwestern University and holds a M.S. degree from Tsinghua University. His research focuses on the design and development of membrane materials for sustainable water supply, fundamental understanding of the mechanisms and mitigation strategies for mineral scaling, as well as the applications of membrane technologies to the treatment of hypersaline wastewater. He is also interested in resource recovery from wastewater and environmental applications of nanotechnology.



Dr. David Warsinger is an Assistant Professor at **Purdue University** in Mechanical Engineering. David's research focuses on the water-energy nexus, with approaches from thermofluids and nanoengineering, including desalination, water-energy systems integration, membrane nanomaterials, and nanoscale membrane physics. David completed his PhD in Mechanical Engineering at MIT (2012-2015), and his B.S. and M.Eng at Cornell (2006-2010), and did Postdoctoral research at MIT and Yale. David is also actively involved in advising, fundraising, and consulting for several startup companies. David is a coauthor of over 60 scientific contributions, comprising journal papers, conference papers, patents, and book chapters. Notable awards David has earned include MIT technology review's 35 Innovators under 35, a national dissertation award from UCOWR, and several teaching or mentoring accolades.

Membrane & Member News

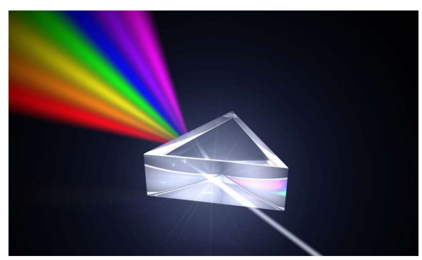
Our Colleagues and Community

Pennsylvannia State University group, led by Bruce Logan, inserted a thin, semipermeable membrane, originally developed for purifying water in the reverse osmosis (RO) treatment to replaced the ion-exchange membrane commonly used in water electrolyzers to allow direct use of seawater for electrolysis (https://doi.org/10.1039/D0EE02173C). With the RO membrane inserted, seawater is kept on the cathode side, and the chloride ions are too big to pass through the membrane and reach the anode, averting the production of chlorine gas. The researchers received a $300,000 grant from the National Science Foundation (NSF) to continue investigating sea water electrolysis. Logan hopes their research will play a critical role in reducing carbon dioxide emissions around the world.

Winston Ho and Yang Han, from **The Ohio State University**, have received $4 million in U.S. Department of Energy National Energy Technology Laboratory funding to expand that transformational carbon dioxide capturing process beyond the lab to the next step toward commercialization. The energy department has supported Ho's work with more than $12 million since 2012. The most recent funding will enable expansion of this research to a project 18 times the size of current bench-scale laboratory work, where he has proven that the purity of that captured CO_2 is at least 95%, important because demand for quality carbon dioxide is growing in the oil, chemical and food industries.

The **Department of Energy's (DOE) National Energy Technology Laboratory (NETL)** researchers have developed a method to custom-formulate low-cost membranes to more effectively separate carbon dioxide (CO2) from nitrogen in a high volume of flue gas. This ability to achieve both high selectivity and high permeability during post-combustion carbon capture operations is one of the most difficult problems facing membrane researchers today. The NETL group solved the challenge by chemically binding multiple membrane components with different critical properties into one high-performance material that can be easily scaled up to reduce the costs of large-scale carbon capture operations. (Elsaidi et al, Cell Reports Physical Science, Volume 1, Issue 7, 100113 https://doi.org/10.1016/j.xcrp.2020.100113)

King Abdullah University of Science and Technology (KAUST) and Incheon National University researchers developed an artificial intelligence (AI) based predictive methodology that will fast track the industrial implementation of membranes in organic media. They performed data mining to yield the largest dataset, comprising more than 38,000 datapoints in the field. Instead of approaching the problem of prediction from a fundamental mathematical perspective, they have broken away from conventions by exploiting AI. While an experienced membrane researcher can interpret complex membrane data in three dimensions (four dimensions at best), AI can analyze multidimensional data and extract hidden trends and correlations very effectively. To elucidate the key parameters governing membrane performance (e.g., selectivity and permeability), they performed a thorough principal component analysis with 18 dimensions. They applied machine learning algorithms such as artificial neural networks, support vector machines, and random forest models that predicted separation performance with an unprecedented accuracy of 98% for permeance and 91% for selectivity. This research outcomes pave the way toward better membrane design and development (Hu et al. Journal of Membrane Science, 619, 2021, 118513). **KAUST** researchers also produced membranes composed of the MOF embedded in a polymer, which they claim can achieve outstanding performance in the separation of propylene gas from propane. The team's findings have been published in *Nature Materials* (Knebel et al., Nat. Mater. (2020). https://doi.org/10.1038/s41563-020-0764-y). These crystalline materials are difficult to process, but this team have developed a way to solubilise the MOFs. "If the current energy-intensive propane-propylene separation technologies, based on distillation, could be replaced by our MOF membrane technology, then this could save about 0.1 per cent of global energy consumption," said co-author Shuvo Datta.



Also, in Suzana Nunes group at **KAUST,** researchers developed smart covalent organic networks (CONs) with "on-off-on" light-switchable pores for molecular separation. The azobenzenes were implanted as light switches to bridge the flexible cyclen building blocks. The smart covalent organic network membranes fold and unfold as origami that can be photo-switched between on-state (large) and off-state (small) pores. The cis membranes with off state under ultraviolet (UV) light have higher dye rejection than trans membranes with on-state channels. By controlling the trans-to-cis azobenzene isomerization via UV/Vis light, the pore size can be remotely controlled at the molecular level and the solvent permeance and dye rejection can be dynamically tuned. From the viewpoint of stereochemistry, the cyclen rings suffer a corresponding chair-to-boat stereoisomerism change in response to the trans-to-cis azobenzene isomerization under UV light. The synergistic isomerization induces pore geometrical changes. Clearly, the membranes with on-off-on light-switchable pores have unique merits, such as in situ size tunability, precise molecular sieving, high solvent permeance, good mechanical flexibility, and fabrication simplicity, which may pave the way to remote control of molecule separation, reactant supply, and valuable drug purification from the pharmaceutical industry. This work is published in Science Advances (Liu et al., Science Advances, 2020, Vol. 6, eabb3188).

Massachusetts Institute of Technology (MIT) scientists developed a new membrane system that could provide a way of continuously removing carbon dioxide from a stream of waste gases, or even from the air. The key component is an electrochemically assisted membrane whose permeability to gas can be switched on and off at will, using no moving parts and relatively little energy. The membranes are made of anodized aluminum oxide, have a honeycomb-like structure made up of hexagonal openings that allow gas molecules to flow in and out when in the open state. However, gas passage can be blocked when a thin layer of metal is electrically deposited to cover the pores of the membrane. The work is described in the journal *Science Advances* (Liu et al., *Science Advances*, 2020; 6 (42): eabc1741), in a paper by Professor T. Alan Hatton. This new "gas gating" mechanism could be applied to the continuous removal of carbon dioxide from a range of industrial exhaust streams and from ambient air.

Ultrafiltration membranes have been made from recycled polyester terephthalate (PET) bottles by researchers at **Swiss German University** in Tangerang, Indonesia (Kusumocahyo et al., J. Env. Chem. Eng., 2020, doi.org/10.1016/j.jece.2020.104381.

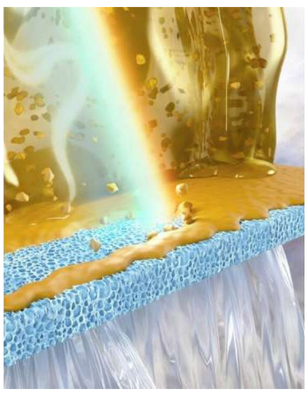
Also using polyester, this time layered atop a conventional polyamide thin film composite membrane, **Yale and Nanjing University of Science and Technology** have created a chlorine resistant desalination membrane — what the researchers call “the holy grail of the industry” — that could significantly advance the field to better meet global water supply challenges (Yao, et al., Nature Sustainability https://www.nature.com/articles/s41893-020-00619-w).

École Polytechnique Fédérale de Lausanne (EPFL) researchers in collaboration with KAUST synthesized molecular-sieving zeolitic membranes by the assembly of building blocks, avoiding the hydrothermal treatment which is highly desired to improve reproducibility and scalability. The state-of-the-art zeolitic membranes are manufactured by a lengthy and complex crystallization process. Unfortunately, this method has proved difficult to reproduce. Also, it lacks in producing efficient gas-separation membranes, especially when it comes to the separation of hydrogen and carbon dioxide, which is necessary for pre-combustion carbon capture from power plants. A team of chemical engineers led by Kumar Agrawal have now successfully simplified the chemistry behind zeolite membrane synthesis, making it straightforward, reproducible, and scalable. The achievement of the longstanding goal is published in *Nature Materials* (Dakhchoune et al. Nat. Mater., 2020 DOI: 10.1038/s41563-020-00822-2). The scientists developed a new material chemistry that eliminates the lengthy crystallization process altogether. "We built Lego-like crystals—nanosheets—and bonded them on top of each other using silanol condensation chemistry," says Agrawal. The resulting membrane shows ideal hydrogen-carbon dioxide separation performance, with selectivity up to 100 at 250-300 degrees Celsius. The authors conclude, "The scalable synthesis of high-temperature hydrogen-sieving zeolitic membranes is expected to improve the energy-efficiency of pre-combustion carbon capture."

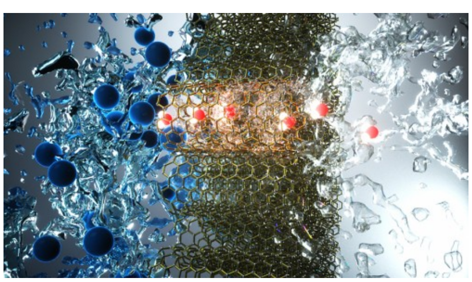
Newcastle University researchers developed a new class of self-forming membrane to separate carbon dioxide from a mixture of gases. The team believe that the system may be applicable for use in carbon dioxide separation processes, either to protect the environment or in reaction engineering. By growing the expensive part of the membrane—made from silver—during membrane operation, they dramatically reduced the demand for silver and the cost of the membrane. The work is published in *Energy and Environmental Science* (McNeil et al., Energy & Environmental Science, 2020; DOI: 10.1039/c9ee03497h) and Dr. Greg Mutch, explains, "We didn't build the entire membrane from silver, instead we added a small amount of silver and grew it within the membrane adding the functionality we desired. "Most importantly, the performance of the membrane is at the level required to be competitive with existing carbon capture processes—in fact, it would likely reduce the size of the equipment required significantly and potentially lower operating costs." In this method, aluminium oxide supports in pellet and tubular form were used to grow the silver membrane. Silver was added to the membrane, and the conditions experienced during operation forced the silver to grow within the membrane, bestowing higher performance. Using X-ray micro-computed tomography, the team were able to look inside the membrane and confirm that the permeation of CO_2 and O_2 stimulated self-assembly of silver dendrites. The permeability of the membrane was one order of magnitude higher than that required, and the flux of CO_2 was the highest reported for this class of membrane. This membrane relies on a unique transport mechanism and avoids the limitations of most membrane materials and go far beyond the upper bound.

Vanderbilt University engineers recently designed a simple defect-sealing technique to correct variations in pore size in graphene membranes. The researchers reported a breakthrough in scalable fabrication of graphene membranes with a sealing technology that corrects variations in the pore size so they remain small enough to trap salt ions and small molecules but allow water to pass (Cheng et al., *Nano Lett.* 2020, 20, 8, 5951–5959). One of the most complex engineering challenges when making membranes so thin is to maintain integrity in the uniformity of the pores, which requires drilling atomically precise holes in a one-atom thick sheet of carbon atoms. Kidambi and the other team members designed a simple defect-sealing technique based on a gatekeeper analogy. While most prior studies formed holes in graphene membranes as a final step, this team turned the process around. They formed holes in the graphene first using a low-temperature chemical vapor deposition (CVD) process followed by ultra violet light in the presence of ozone gas and used the size of the holes as a gatekeeper. They show that a polymerization technique after nanopore formation in graphene not only seals larger defects (>0.5 nanometer) and macroscopic tears, but also successfully preserves the smaller sub-nanometer pores. They obtained water permeance 23 times higher than commercially available water treatment/desalination membranes, along with salt rejection greater than 97% and small molecule rejection of about 100%.

A collaboration between the **University of Kansas School of Engineering** and the RAPID Manufacturing Institute for Process Intensification will develop a technology to separate gas using renewable, high-performance furanic-based polymers that were originally developed for replacing PET-based soda bottles. The research is supported by a grant from the Department of Energy (DOE) and includes collaborations with **DuPont, Hills Inc. and Air Products**. The investigation at KU, dubbed "Project H22020," could result in membranes that reduce capital costs by a factor of 10 and increase hydrogen recovery by 20% while reducing both waste and the cost of separation by 20%. Such a breakthrough would be a boon to companies that refine oil and produce hydrogen fuel cells, replacing gas-separation technology used today made from materials developed in the 1970s and 1980s. “These are furanic-based polymer membranes — it’s a new material that the DuPont Company is commercializing,” said Mark Shiflett, Foundation Distinguished Professor at the KU School of Engineering, who is leading the work. The KU researcher said furanic polymers are an ideal material to use for industrial gas separation because they’re largely impermeable to larger gas molecules. However, Shiflett said furanic-based membranes are in a sweet spot because they could allow smaller gas molecules to pass through, making them suitable for industrial-scale gas separation. These polymers are going to be an excellent way of purifying H_2 for a lot of different industries, especially in the refining industry for making cleaner burning fuels, for hydrogen fuel cells and for making electricity. “DuPont is donating the membranes to us,” Shiflett said. “Then, Hills is a company that takes the polymer and spins it into hollow fibers to be used in membrane modules for doing gas separations. Air Products is one of the world leaders in gas separations. They’ll help us with assessing whether the gas separations that we’re studying in our lab are good enough to be used commercially, because that’s what they do for customers like NASA.”



Department of Energy’s (DOE) Argonne National Laboratory have developed a light-activated coating for filtration membranes to make them self-cleaning, eliminating the need to shut down the systems in order to repair them (Zhang et al., Adv. Funct. Mater. 2020, 30, 2002847). Water filtration membranes have been around for years but have always been vulnerable to clogging from organic and inorganic materials that stop up its pores over time, a phenomenon known as fouling. While those who work in the area of water filtration have had some success in removing, cleaning and replacing fouled membranes, the process is far from ideal because it takes the membranes — and sometimes entire water treatment systems — out of service. This team’s new, low-cost advancement is a game-changer for industries that rely on this type of technology. The coating they use is based on titanium dioxide, or TiO2, which has been explored for water treatment applications for years because of its high stability, nontoxicity, low cost and biocompatibility. This team took the technology a step further by adding a bit of nitrogen to the mix. The process, called nitrogen doping, makes the membrane sensitive to visible light. The coating serves as a catalyst that breaks down foulants, releasing them from the membrane, thereby rendering it clean.https://dx.doi.org/doi:10.1002/adfm.201700251



Lawrence Livermore National Laboratory (LLNL) researchers have created carbon nanotube (CNT) pores that are so efficient at removing salt from water that they are comparable to commercial desalination membranes. These tiny pores are just 0.8 nanometers (nm) in diameter. The research appears on the cover of the Sept. 18 issue of the journal *Science Advances* (Li et al., Science Advances, 2020, 6, eaba9966). Biological water channels, also known as aquaporins, provide a blueprint for the structures that could offer increased performance. They have an extremely narrow inner pore that squeezes water down to a single-file configuration that enables extremely high water permeability, with transport rates exceeding 1 billion water molecules per second through each pore. "Carbon nanotubes represent some of the most promising scaffold structures for artificial water channels because of the low friction of water on their smooth inner surfaces, which mimic the biological water channels," said Alex Noy, LLNL chemist and a lead co-author of the report. The team developed CNT porins (CNTPs)—short segments of CNTs that self-insert into biomimetic membranes—which form artificial water channels that mimic aquaporin channel functionality and intrachannel single-file water arrangement. Researchers then measured water and chloride ion transport through 0.8-nm-diameter CNTPs using fluorescence-based assays. Computer simulations and experiments using CNT pores in lipid membranes demonstrated the mechanism for enhanced flow and strong ion rejection through inner channels of carbon nanotubes.

Researchers at **Mohammed V University in Rabat, Morocco** have tested reverse osmosis paired with PV generation to maximize chlorophenol rejection in wastewater treatment. They said the tech combination can help to reduce energy consumption. The academics demonstrated a reverse osmosis unit with a tubular module containing a spiral wound polyamide thin-film composite membrane and a high-pressure pump. Polycrystalline modules and lithium-ion storage were also included in the modeling. They used an artificial neural network (ANN) method to analyze the operating parameters of reverse osmosis on chlorophenol rejection and energy consumption. These include the feed flow rate, the initial concentration of chlorophenol, the temperature, the initial pressure, and the water recovery rate. The results showed that the optimal values obtained, relating to feed pressure of 9.713 atm, water recovery rate of 40%, operating flow rate of 10−4 m^3/s and temperature of 40 C could remove 91% of chlorophenol with an energy consumption of 0.8 kWh/m^3," the scientists stated. "This consumption allowed us to deduce that photovoltaic solar panel with a peak power of 280 Wp and a battery capacity of 9.22 kWh is sufficient to produce 1 m^3/day.

Membrane Technology, Products, Facilities, Company News

ACS Chemical and Engineering News published on "How membranes are upending chemical separations" in their Sep. 13, 2020 issue. Academic and industrial membrane researchers from **Georgia Tech, Imperial College of London, Queen Mary University of London, and ExxonMobil** were highlighted for their materials innovations towards hyperfiltration of crude oil fractions. Additionally, Hannah Murnen, CTO at **Compact Membrane Systems** mentioned their applications in dehydrating organic solvents, as well as, new efforts towards silver-facilitated transport of olefins. Other new companies mentioned for various efforts in the membrane-based industrial chemical separations milieu include, Ontario-based start-up **Imtex Membranes**; **Via Separations**, in Somerville, MA; **Chemetry** from Moss Landing, CA; and **Ecolectro** (Ithaca, NY) and **Evonik**'s cooperation on AEMs for water electrolyzers.

Aqua Membranes, an Albuquerque startup building commercial technology to make water use more efficient, has raised $2.1 million. Craig Beckman, CEO of Aqua Membranes, said the money will be used to scale up its production capacity with new equipment and employees. It will also spend money on marketing and promotion to gain more attention from clients. The company's Arctic8 cold water element with patented *Printed Spacer* Technology works to combat the productivity loss seen when reverse osmosis elements are used with cold water. The elements can be used to increase output for industrial operations, desalinate sea water and other applications

Delaware's investment board signed off on a $50,000 Delaware Technical Innovation Program (DTIP) grants to **Compact Membrane Systems (CMS)**, a decades-old company led by CEO Erica Nemser, is seeking to advance its work on a membrane that could remove ethylene gas from fruits and vegetables to prolong their freshness. CMS is a DuPont spinoff and now develops its own fluoropolymers for membrane applications. CMS is returning to its work that it began on fruit preservation back in 2006, when its idea was backed with a $296,000 SBIR grant. Last year it received another $100,000 SBIR grant from the U.S. Department of Agriculture to try to solve the problem. Hannah Murnen, CTO, noted that the research was especially timely as the COVID-19 pandemic has affected worldwide food harvests and supply chains and changed consumer habits, convincing many to reduce their number of trips to the store. CMS' membrane could be integrated into a container ship's storage or possibly into the product consumers buy, with patches of the membrane added to bagged apples, for instance. The membrane would keep air from getting into the bag but also allow the undesirable ethylene to flow out.

Swirltex is a Calgary based tech company that has developed a new form of filtration for wastewater. Founder of Swirltex, **Peter Christou**, continue to advance their technology for a wide array of applications. Swirltex has developed a unique membrane filtration system to extract contaminants and solids that are suspended in water. If we consider how wastewater is processed at the industrial level, with their technology implemented, the 'dirty' stream of water is pumped through the system at much lower energy requirements than a traditional membrane system. The liquid is then injected with microbubbles in a rotational manner to create a vortex. The purpose is to create a flotation effect for the contaminants so that they bind to the microbubbles, such that their buoyancy is manipulated increasing their ability to float and separate from the liquid. A permeable wall has the ability to allow liquids to pass through it while containing solid particles within the membrane. The flow pattern used in the Swirltex system forces the water to the outer surface of the membrane where it can be effectively passed through the permeable walls. The solid particles and contaminants are bound by the microbubbles to form a froth that channels to the center of the membrane to reduce any interaction with the permeable wall. High-quality clean water is produced with less pumping power to achieve the same production. Truly unique, this system achieves a far more efficient way to treat wastewater while reducing energy usage.

Honeywell UOP has announced that PETRONAS Carigali Sdn. Bhd. (PCSB), a subsidiary of PETRONAS, will use UOP's modular natural gas processing technology in the development of a 900 million ft^3/d offshore gas purification plant in the Kasawari gas field located in the South China Sea, offshore Sarawak in Malaysia. UOP's acid gas removal technology, which includes UOP's MemGuard™ and Separex™ technologies and adsorbents to remove contaminants such as carbon dioxide, hydrogen sulfide and mercury from natural gas, will be used at the facility. Once built, it will rank among the largest offshore gas treatment systems in the world. The gas processed at Kasawari will be further processed and liquefied at the existing Malaysia LNG complex (MLNG), to be exported globally for power generation. The elements of the membrane system will be produced in UOP's Separex Membrane Manufacturing centre in Penang, Malaysia. UOP Separex membrane systems contain spiral wound membrane elements that remove acid gas and vapour phase water from natural gas streams. To date, more than 130 Separex systems have been installed worldwide.

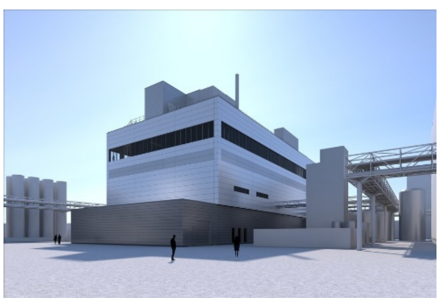
Ecolab has introduced its new precision dispensing system for membranes, an accurate cleaning chemical dispenser that helps improve worker safety, drive productivity and extend asset life for whey processors. The new membrane cleaning system is part of Ecolab's Ultrasil Membrane Program, which provides chemistries, automation and technical support. The system uses advanced flow-based sensors to accurately dispense cleaning chemicals. It has separate dispensing modules for acid and alkaline chemistries to help eliminate non-compatible chemical interactions and can dose cleaning chemicals for up to five membrane systems within a plant. It provides chemical dosing accuracy within +/- 20 ml to maximise cleaning performance. Increased dosing accuracy helps to ensure system cleanliness and improve product quality. The system includes a web-based reporting dashboard that provides details of chemical usage for each membrane system using the dispenser.

Douglas County Public Utility District in Washington State is excited to work with **Cummins' Fuel Cell and Hydrogen Technologies** on their 5-megawatt hydrogen electrolyzer project, said Gary Ivory, general manager of Douglas County Public Utility District, in a statement. "This hydrogen plant will create efficiencies for our Wells Hydroelectric Project and create a new renewable hydrogen gas resource for our community. As the first renewable hydrogen production plant in Washington State, we understand the importance of great partners, and we believe Cummins' will help us build a successful project."

In late August, **H_2O Innovation Inc**. announced it had received six (6) new municipal and industrial projects in North America. These new contracts, totaling $17.8 M included surface water of a river by ultrafiltration ("UF") followed by nanofiltration ("NF"). The initial treatment capacity will be 34.5 MGD (5,440 m^3/hour) for the UF system and 27.6 MGD (4,350 m^3/hour) for the NF system; a 6-train reverse osmosis ("RO") system to treat 6.0 MGD (1,140 m^3/hour) for a customer in the food and beverage industry located in Ohio; as well as, other multimedia, membrane, and membrane bioreactor systems for municipal wastewater. More recently, it has won the Water Company of the Year award at the 2020

Global Water Awards. This is the highest honor in the international water treatment industry and the first time a Canadian company has received this award.

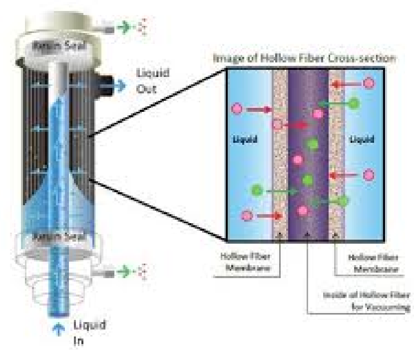
The U.S. Chamber of Commerce Foundation named **DuPont Water Solutions**, a finalist in the 21st Annual Citizens Awards, a longstanding program that honors businesses for the impact they make in communities around the world. DuPont was nominated for the Best Corporate Steward category for its efforts to help global communities thrive through increased access to safe, clean water. The annual awards program recognizes the most innovative and impactful corporate citizenship initiatives raising the bar on social responsibility and spearheading the transformation to a strong, healthy and sustainable future. DuPont is being honored for the social impact of its products, operations, and community partnerships in support of clean water and water stewardship. A leader in water purification and separation technologies, DuPont's products purify, conserve, or reuse more than 25 million gallons of water every minute around the world. Its projects have, among other outcomes, helped a U.S. auto company convert 90 percent of wastewater into reusable water, dramatically reduced clean water costs in a Kenyan community, and ended the need for women to walk hours to collect safe drinking water in Serdo, Ethiopia.



MilliporeSigma celebrated the topping-out ceremony for its new membrane production plant in Darmstadt, Germany. With the new facility, the company plans to expand manufacturing of Millipore Express membranes, which are critical components in Millipore Express filters and help ensure the sterility of biological drug products. The project with a volume of more than $165 million is part of the $1.2 billion investment in its global headquarters until 2025 that MilliporeSigma's parent company, Merck KGaA, Darmstadt, Germany, announced last year. The new membrane production plant is expected to create approximately 55 new jobs. Construction began in March and is expected to be completed in 2022, followed by production process validation and commercialization. The new, four-story membrane plant will incorporate immersion membrane casting equipment, quality control laboratories and offices. Express membranes from MilliporeSigma will be manufactured at the new facility in Darmstadt, then processed into filters for pharmaceutical production at MilliporeSigma's existing device Center of Excellence in Jaffrey, New Hampshire.

Baxter International Inc., a global innovator in renal care, today announced the U.S. Food and Drug Administration (FDA) has granted the De Novo application for Theranova, the company's novel dialysis membrane. Theranova was designed to deliver expanded hemodialysis (HDx) therapy, which filters a wider range of molecules from the blood than traditional hemodialysis (HD) filters, like high-flux membranes, by targeting effective removal of conventional (500 Da to 25 kDa) and

large middle molecules (25 kDa to 45 kDa). These middle molecules may be associated with inflammation and cardiovascular disease in patients with kidney failure. By granting a De Novo application, the FDA is establishing a new class of dialyzer technology with unique performance standards. The FDA utilizes the De Novo pathway for low and moderate risk medical devices that have no existing predicate in the United States; such designations are rare in the dialysis space. In fact, less than 1% of devices granted marketing authorization under De Novo have been for the care of patients with kidney failure since the pathway’s inception in 1997.



DuPont Water Solutions has entered into an exclusive global partnership with Sun Chemical and its parent company, the DIC Corp., to bring membrane degasification modules to market. The degasification of liquids is becoming increasingly critical to several water treatment processes, including industrial demineralization, oil and gas production, microelectronics manufacturing, pharmaceutical production, and drinking water treatment. The membrane degassing modules — branded Ligasep — are now part of DuPont’s portfolio of water purification and separation technologies, including ultrafiltration, reverse osmosis and ion exchange resins. The Ligasep™ product line utilizes a PMP (polymethylpentene) hollow fiber membrane which is used to remove dissolved gases, such as oxygen and carbon dioxide, from water to prevent oxidation and reduce the ionic load on downstream processing equipment. Control of these gasses is an integral part of producing high quality water used in the power generation, industrial manufacturing and semiconductor industries. These modules can be installed in series within the same water treatment system, ensuring sufficient degasification and achieve ppb levels of dissolved gasses for a range of flowrates in water treatment applications.

Evonik is expanding its business in high-selectivity membranes for efficient gas separation and organic solvent nanofiltration. The Germany-based company has developed a membrane technology for separation of volatile organic compounds (VOCs) and is launching this on the market under the brand name PuraMem VOC. With PuraMem VOC, Evonik offers an innovative polymer-based membrane technology for efficient separation of long-chain hydrocarbons from a natural gas or nitrogen mixture. The spiral-wound membrane module has been optimized for specialty applications such as natural gas treatment, emission control in tank farms, and in the chemical and process industries. It is distinguished by consistently high selectivity over a long period under demanding operating conditions. The new membrane technology functions on the basis of the different molecular sizes of the substances to be separated: The gas mixture streams through the membrane at a pressure of up to 80 bar; the larger VOC molecules pass through the membrane while the smaller gas molecules are retained. The specialty chemicals company can adjust this key separation property, the selectivity, already at the polymer level.

Steven Coker, of duPont Water Solutions, highlighted Orange County Water District's (OCWD)

successful 30 MGD RO expansion in 2015 as an example of a community using wastewater reuse as a creative solution for preserving groundwater reserves and protecting aquifers from seawater intrusion. The OCWD Groundwater Replenishment System (GWRS) relies on RO membrane technology to replenish natural freshwater barriers to saltwater intrusion and to provide much needed aquifer recharge with secondary treated effluent from local municipalities. Today, at full operation, the OCWD facility purifies more than 100 million gallons of treated wastewater a day to provide clean, high-quality drinking water for north and central Orange County.

ZEN Graphene Solutions Ltd. is pleased to announce that the Naval Material Technology Management (NMTM) section of the Royal Canadian Navy (RCN) has partnered with ZEN and **Evercloak Inc**. (Evercloak) as a testing organization, and has agreed to provide in-kind donations of test services from the Naval Engineering Test Establishment (NETE). The tests will compare the efficiency of an HVAC unit produced with the Evercloak dehumidification membrane technology to the incumbent HVAC system that is currently in use on the RCN's Halifax-class frigates. Evercloak is evaluating the advantages of its dehumidification membrane technology against the current dehumidification system used by the RCN. Based on lab testing and modelling, Evercloak estimates up to 75% energy savings and anticipates that the equipment will have a smaller footprint and also require minimal maintenance as there will be fewer parts to replace. Evercloak and ZEN were recently awarded $125,000 each as part of a Next Generation Manufacturing Canada (NGen) Project. The project entitled "Advancing Large-Scale Graphene and Thin-Film Membrane Manufacturing" will support the scale up of graphene oxide (GO) production by ZEN to supply GO to Evercloak for their scale up and optimization activities.

By: Surendar Venna (DOW Chemical Co.) and John Pellegrino (CU-Boulder)

Please send your news and information for posting to the column editor:

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NAMS Board Candidate Statements

The NAMS board of directors election will be held December 7, 2020 – January 7, 2021. The election will be online. All NAMS members will receive an email December 7 with a link and instructions on how to vote.

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In May 2003, as a graduate student just finishing his first year at the University of Colorado, I attended my first NAMS meeting in Jackson, WY. It was immediately clear to me that the membrane community was one that was welcoming and open, even to those who were just starting their education and careers in membranes. At that time, I had barely set up a functioning gas separation membrane system and was still struggling to get my first polymer membrane loaded to get permeation data – however, I felt that I was a part of the group and my fellow NAMS attendees were interested in what I had to say. Having attended many NAMS meetings since then and now sending my own graduate students and postdocs to NAMS, I still feel the same way about our unique organization. As a member of the NAMS Board, I will work to help the next generation of students entering membrane science by supporting programs that highlight the importance of membranes to energy efficiency and sustainability, as well as the inherent interdisciplinary training that is created by working in membrane science. Those interested in membrane science will also benefit the opportunity to becoming a well-rounded scientist/engineer who is broadly skilled in separation processes, polymer science, synthetic chemistry, simulations/computations, and beyond. It would be my mission to promote NAMS as a society where diversity of people, ideas, and skills are truly valued and new perspectives are appreciated. Thank you for your support and it will be an honor to contribute to NAMS as a member of the Board of Directors.

Alyson Beldon, PhD

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I attended my first NAMS meeting when I was in graduate school, where I had the privilege to actually meet, in person, many of the authors I had read and cited from literature. I was amazed at how approachable even some of the “giants” in the field were. I still see this openness today when I attend a conference, albeit not as a student, but as a member of industry. As a development engineer at Air Products, I have the privilege to continue to push the boundaries of membrane capabilities to help solve a variety of different problems, including economical upgrading of biogas to CNG and reducing energy requirements in SMR processes. I am also passionate about deepening interactions between industry and academia because our students and professors are on the cutting edge of research, and industry is the pathway to bring those technologies to the world. Personally, I have participated in I-Corps interviews, written letters of support for grants, judged both NAMS student fellowship award applications and student posters, and even facilitated the production of full-scale prototypes for a developing membrane I saw in a NAMS presentation, all because I want to see membranes advance and succeed. As a member of the NAMS board, I would work to further increase the connection between academia and industry, so we can learn from each other and strengthen innovation overall. One step towards that goal would be to organize a panel discussion for a future NAMS meeting to address major drivers in business decisions and how they relate to research needs. Another step would be to create a directory of industrial contacts open to participating in efforts such as I-Corps interviews or proposal support. There are so many possibilities; I hope I have the pleasure of contributing by serving you as a member of the NAMS board.

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I am an associate professor in the Chemical and Biological Engineering Department at Tufts University. My group uses polymer self-assembly to develop new membrane materials for various applications including wastewater treatment, bioseparations, and molecular filtration. My focus on membrane research, however, dates back to my Ph.D. studies at MIT, where I developed fouling-resistant filtration membranes. NAMS has been an incredibly inspiring, supportive, and collaborative community for me since then, when I attended my first meeting in 2006.

Since becoming a faculty member in 2012, I have enjoyed the opportunity to contribute more to this community. At the NAMS 2015, 2016, and 2018 meetings, I organized various parts of the student programming including Lunch with Legends, the Student Workshop, and the poster session. I served on the Student Workshop Panel in 2019. I served on the Board of Directors between 2016-2019, where I served on the Communications Committee and helped draft a Code of Conduct to ensure our community stays a safe space for all. I have co-chaired several sessions at NAMS. I would like to continue contributing to this community throughout my career.

I am especially passionate about supporting students and young membrane scientists and engineers, where NAMS has an exceptional track record. If I am elected to the Board of Directors, I would like to work with meeting organizers to expand activities targeted at them. I am particularly interested in organizing a career fair event to connect them with industrial participants. I am an avid advocate for building a diverse and inclusive community. In addition, informed by my involvement in two membrane technology start-ups, I would like to broaden the participation of start-ups and small businesses at NAMS. I believe that this would enrich the meeting content, expand the NAMS community, and offer additional role models and career paths for students.

I would be grateful for a chance to contribute to NAMS as a board member, and hope that you give me the opportunity to do so.

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NAMS has been my entry into the broader world of membranes. I have a 30 year career in industrial membrane manufacture and research centered on gas separations, where I have worked from basic material science of membranes in dense films through lab and production scale asymmetric fiber spinning to the design and operation of commercial membrane systems. This includes collaboration with the SRP, the University of Texas Austin, Georgia Tech, NETL, and the EPA among others. Attending NAMS in Boulder an unspecified but large number of years ago, I received an education in the other vibrant fields of membrane research, such as water purification, fuel cells, pervaporation and more. NAMS is a society of many facets. successfully combining academia and industry from a wide variety of separations, applications and techniques. However, it has maintained a primary focus on the continuation of membrane science by the education and mentoring of the next generation of membrane scientists. Mentoring is both an avocation and occupation. I train and mentor young engineers as part of my job, but I am also engaged locally in numerous STEM programs in the middle and high schools. As a member of the board, my primary function would be to support and mentor the next generation of membrane scientists and engineers For our next generation, NAMS is a forum to display research findings, but it also serves as the primary avenue for the community to show the breadth of the membrane society. The society passes down insights from experts in the field in future jobs, research topics and life. I would be honored to have an opportunity to serve on the Board of Directors.

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NAMS has played a vital and supportive role in my education, training, and professional career. Since attending my first NAMS meeting as a graduate student in 2001, I quickly realized that this society cares deeply about supporting young scientists and engineers. For many students, NAMS is an open forum to share exciting research findings. Unlike many other organizations, however, NAMS has always maintained an extraordinary balance in representation from academia, industry, and national labs. This close community enables students to interact with a strong contingent of members from industry and national labs, providing invaluable advice and perspective on career opportunities. After brief adventures at a national lab (Sandia National Laboratory at Livermore) during my postdoc project and in industry (Intel Corporation), I have grown to appreciate this diversity even more. I would be grateful for an opportunity to give back to this organization through service on the Board of Directors. In the past year and half, I have had the privilege to serve as Associate Director for Center for Advanced Energy Studies (CAES) representing University of Wyoming. As a 5-entity consortium, CAES consists of 4 universities and Idaho National Laboratory (INL). I have also served as an ad hoc board member for a Department of Energy (DOE) Energy Frontier Research Center (EFRC). Serving with fellow ADs and board members, I have gained first-hand experience developing programs to support students and young professionals. Particularly important to me is maintaining a focus on inclusion and diversity, in addition to providing opportunities to further strengthen the NAMS community by providing professional skill training to the next generation of membrane scientists and engineers through career coaching and networking. In particular, I would actively seek to further promote interactions between students and professionals from industry and national labs. By leveraging the core features and strengths of NAMS, my goal will be to provide our young talent with internship and job opportunities for their professional growth so that the society continues to flourish in strength and influence. Finally, if elected, I would be honored to have the opportunity to serve on the Board of Directors for NAMS twenty years after attending my first NAMS conference.

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NAMS is my home community! I have been involved with and benefited from being a part of the NAMS community in various roles over the last decade. I was first a tentative attendee, then worked on student programming (poster sessions and workshops) and organized sessions, and most recently contributed as a conference co-chair. What I enjoy most, and what I would like to amplify most as a Board Member, is the true interactiveness and small nurturing community feel that we have during NAMS events. We have a welcoming and inclusive culture that has led to the expansion of our community to involve scientists and engineers from widely different backgrounds and training. I have been told many times at our meetings by new attendees that they feel welcome and comfortable and by the next meeting they seem to be already embedded in our community! I have also valued the openness to new ideas. This was exemplified by the latest and most unusual version of our annual conference. We were one of the first communities to go all in on an online conference and the support that we (Prof. Mary Laura Lind and I) received as organizers was truly heartwarming. I hope to keep this spirit alive and thriving as a future board member. Finally, our community has a true balance between academic and industrial research which always drives towards benefitting society through applications while also appreciating the value of basic science research. This spirit makes us innovative and relevant. Maintaining this balance through careful programming at our conferences and in our programs would be key to healthy and sustainable growth of our community. I hope to reinforce this perspective in our board. I am truly honored to be considered and look forward to seeing you in person very soon.

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Since beginning my career as a membrane scientist with MilliporeSigma in 2005, I have relied on opportunities provided by the North American Membrane Society for engagement with the membrane scientific community. I appreciate that NAMS helps this community keep up to date on research trends in our field, facilitates collaboration across industries and institutions, and fosters interactions between the next generation of membrane scientists and more experienced members. One highlight of my involvement with NAMS has been serving on the awards committee since 2014, through which I have learned first-hand about the exciting work being done by students and young membrane scientists. I have also greatly enjoyed interacting one-on-one with several students through the NAMS mentoring program. I began serving on the NAMS Board of Directors in 2018. Since then, I have learned more about how NAMS operates and the expectations for the Board, and I feel that I am now in a better position to make contributions. This is why I am seeking a second term. I am particularly looking forward to continuing to work with the Membership, Diversity and Inclusion Committee to find ways to provide more value to our members outside of the annual meeting, such as through the recently launched webinar series. As an industrial membrane scientist, I will also continue to provide suggestions on how to engage our industrial members and to increase collaboration between the industrial and academic communities, as we have much to learn from each other.

NAMS has a two-fold mission around development and dissemination of knowledge and fostering collaboration. Throughout my career, I have greatly benefited from both the educational content and the opportunities for collaboration provide by NAMS. If I can serve another term on the Board, I will strive to ensure that we fulfill our mission to both our current membership and future generations of membrane scientists. I am honored by this nomination and hope to have this opportunity to serve the membrane community.

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Many of the most enjoyable and rewarding experiences of my career thus far have emerged from my involvement in the North American Membrane Society (NAMS); I am therefore thrilled to offer my name for consideration for the Board of Directors. I was particularly honoured to co-chair the highly successful 2019 NAMS Annual Meeting in Pittsburgh with Meagan Mauter and Andrew Zydney (my PhD advisor at Penn State University) and I look forward to many more opportunities to contribute to the society. If elected to the NAMS Board of Directors, my goals are threefold:

- First, I would strengthen the Canadian presence in NAMS by acting as a liaison between the Board and the growing number of leading Canadian membrane scientists. As a former research engineer in the membrane manufacturing division of ZENON Environmental (now SUEZ Water Technologies & Solutions) in Burlington, Ontario and in my current role as an associate professor at McMaster University in Hamilton, Ontario, I am well positioned to draw on a broad network of industrial and academic collaborations to achieve this goal.
- Second, I will enhance the profile of NAMS in Canada by spearheading connections between the society and relevant major Canadian research initiatives (e.g., BioCanRx, Global Water Futures, Human Health & Therapeutics Research Centre at the National Research Council). Membrane processes play a critical role in these initiatives yet to date their scientific and management committees have had essentially zero engagement with NAMS, indicating a missed opportunity for productive collaboration.
- Third, I will work with my fellow board numbers to rejuvenate the separations community in line with the National Academies' Committee 2019 report entitled 'A Research Agenda for Transforming Separation Science'. To this end, I would help develop and distribute new educational tools (e.g., laboratory procedures) that highlight the critical role of membrane

processes in achieving the United Nations Sustainable Development Goals. I will also build on the remarkably well received NSF funded pilot at the 2019 NAMS Annual Meeting to promote increased involvement of undergraduate students in NAMS, particularly focused on extending access to such initiatives to all North American students.

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Since my first NAMS meeting in 2016, this organization and its membership have been extremely supportive of my research and professional development. I would be honored to serve on the Board of Directors and look forward to contributing to the continued development of the organization and its offerings. As a member of the NAMS Board of Directors, I would focus on two main activities: (1) organizing new opportunities for student engagement with professionals between national meetings and (2) continuing to expand the content in the members only section of the NAMS website.

Participation in the 2020 NAMS conference was at an all-time high due to the virtual format. As a result, members from around the globe were able to log-in to enjoy technical content and networking opportunities. While virtual conferences will never fully replace in-person meetings, I believe we can leverage virtual events in between annual meetings to engage more of our student membership. One example would be organizing online student workshops (similar to the live version) that would allow for greater participation of student members—not just those who were able to travel to the conference. I imagine a 3-workshop series (spread throughout the calendar year) that will have separate sessions focused on academia, industry and national laboratories. The online format will provide more opportunities to engage with a diverse group of professionals. These member benefits will be free to implement and may encourage more students to become members. This fall, I have been volunteering with the NAMS mentoring to organize a virtual panel of membraneologists in industry to kick-off the NAMS Mentoring Program. I believe NAMS can expand on this framework to offer academia- and national laboratory-focused workshops.

Second, I would encourage and facilitate the use of the NAMS members only section of the website as a platform to share educational materials. This new area is already being populated with excellent technical presentations from the NAMS 2020 conference. I would like to take this progress a step further and dedicate a section to sharing membrane-focused demonstrations, experiments for unit operations courses, tutorials developed by members, membrane-focused YouTube videos and showcasing the educational modules developed through the NAMS Education Innovation Fellowship. Developing an online database of educational resources would further solidify NAMS as the central hub for membrane education and innovation.

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I have been a member of NAMS since the 1980's and had the privilege to serve NAMS as Chair/Co-Chair of the annual NAMS meetings (2002 and 2016) and the 2008 ICOM meeting. Throughout the years, NAMS has been a home for me and my students to learn and share ideas on fundamental science and recent advances in membrane fabrication and applications in water technology, energy and pollution prevention. I have had the pleasure of interacting with generations of enthusiastic young membranologists, exceptional researchers and professionals. I can categorically state that the North American Membrane Society (NAMS) is the premiere association society with a focus on the science and technology of membranes and their applications in a wide variety of fields. This makes NAMS a unique association that reaches a diverse audience engaged in multidisciplinary research and professional activities involving the development and application of membrane technology. While NAMS has developed beneficial interactions with other professional societies, I believe that there is a great potential for even more cooperation with various professional societies and industries which are also engaged in various membrane science and technology areas which are important in the water, energy, food, biomedical, and chemical industries. As a NAMS Board member, I pledge to continue and expand NAMS's course of building bridges with other societies and industries that have interests in membrane science and technology. NAMS has provided students with opportunities to interact with professionals in the field of membrane research. I would work to encourage an even greater level of participation of students (as well as seasoned membranologists) in NAMS, through activities that can be fostered through online workshops, tutorials, and meetings which will benefit our student community and contribute to the development of the new generation of membranologists. In closure, it will be an honor and a privilege to serve NAMS and to contribute to its continued success and excellence.

Ranil Wickramasinghe
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Thank you for considering me for the NAMS Board of Directors. NAMS has been central to my professional life for more than 25 years and I am passionate about serving NAMS, especially elevating the visibility of NAMS both in North America and globally. I have been an active participant as a session chair, poster judge and been part of Lunch with Legends at numerous NAMS Annual Meetings. I have attended almost every NAMS and ICOM meeting during my professional career. I co-chaired the 2009 NAMS Annual Meeting with Scott Husson in Charleston. Recently I co-chaired ICOM 2017 with Glenn Lipscomb. Currently I am the NAMS representative on the education task force of the World Association of Membrane Societies (WAMS) as well as a NAMS representative to WAMS. As a founding society of WAMS, NAMS has a major role to play in elevating membrane science and technology both in North America and around the world. I have helped establish a series of short courses to be delivered by WAMS to researchers around the world. Through WAMS, NAMS can play a significant role in education and outreach in membrane science and technology. If elected to the NAMS Board will continue to work on these efforts.

NAMS serves as vital link between researchers at universities, in industry and government laboratories. Our annual meetings connect students with researchers in membrane science and technology. If elected to the NAMS Board, I will work to further strengthen these links. Annual meetings should provide a forum for exchange of research ideas and results. Our annual meetings must be well organized with a high-quality technical program, ample opportunities for networking and showcase the newest products from industry. Our students represent the future of NAMS. I will ensure that we maximize opportunities for students by providing travel support to attend meetings as well as further developing student oriented programming. As Center Director for the Membrane Science Engineering and Technology (MAST) Center, a partnership between universities, industry and the National Science Foundation, I have a unique perspective of the important link NAMS can provide for membrane scientists in academia, industry and government. As a professor at the University of Arkansas, I am aware of the need to engage students in NAMS. I look forward to working on the NAMS Board to serve our members and humbly request your support.

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Since the early stages of my career, NAMS has played an important role in my professional and personal journey. When I attended my first NAMS meeting as a graduate student, over ten years ago, I had the opportunity to build up a solid network with academic and industrial colleagues from all over the world. In that moment I realized that this society is a great asset to help scientists and engineers in their career development. I believe this is crucially important to ensure that the membrane science of tomorrow is as great and healthy as it is today.

I would be honored to serve this organization on the Board of Directors, to pay off the wonderful opportunities I was given, to ensure that these opportunities continue to be given to the next generation of membranologists, and to contribute, at the best of my ability, to the growth of our community.
As a member of the NAMS Board of Directors, I commit to support initiatives to involve students, post-docs, industrial researchers and junior Faculty members within the society and promote their career development, through networking sessions and forums. These initiatives will help the membrane community continue to be vibrant, brilliant and influential.

So, continuing a long standing NAMS tradition, my ultimate goal as a member of the Board would be to support young talent, so that NAMS can grow and expand its influence. For this reason, I would be deeply honored to have the opportunity to serve on the Board of Directors.

Journal of Membrane Science Content

Porosimetric membrane characterization techniques: A review Melike Begum Tanis-Kanbur, René I. Peinador, José I. Calvo, Antonio Hernández, Jia Wei Chew

A perspective on the application of operando characterization to probe the structure, performance, and dynamics of membranes under realistic operating conditions Casey P. O'Brien

How physicochemical properties of filtration membranes impact peptide migration and selectivity during electrodialysis with filtration membranes: Development of predictive statistical models and understanding of mechanisms involved Sabita Kadel, Gaétan Daigle, Jacinthe Thibodeau, Veronique Perreault, ... Laurent Bazinet

Copper surface-alloying of H2-permeable Pd-based membrane for integration in Fischer–Tropsch synthesis reactors Sara Escorihuela, Fidel Toldra-Reig, Sonia Escolástico, Raúl Murciano, ... Jose Manuel Serra

Fabrication of antifouling thin-film composite nanofiltration membrane via surface grafting of polyethyleneimine followed by zwitterionic modification Luyao Deng, Shaolu Li, Yiwen Qin, Longjiang Zhang, ... Yunxia Hu

Continuous single pass diafiltration with alternating permeate flow direction for high efficiency buffer exchange Ruijie Tan, Fabian Hezel, Matthias Franzreb

A pervaporation-crystallization (PC) process for simultaneous recovery of ethanol and sodium pyruvate from waste centrifugal mother liquid Wenhao Zeng, Beibei Li, Hui Li, Hua Jin, ... Yanshuo Li

Optimized ion-conductive pathway in UV-cured solid polymer electrolytes for all-solid lithium/sodium ion batteries Jin Il Kim, Young Gyun Choi, Yeonho Ahn, Dukjoon Kim, Jong Hyeok Park

High-permeability graphene oxide and poly(vinyl pyrrolidone) blended poly(vinylidene fluoride) membranes: Roles of additives and their cumulative effects Thi Tuong Van Tran, Selvaraj Rajesh Kumar, Chi Hieu Nguyen, Jing Wen Lee, ... Shingjiang Jessie Lue

Crosslinked PPO-based anion exchange membranes: The effect of crystallinity versus hydrophilicity by oxygen-containing crosslinker chain length Seounghwa Sung, T.S. Mayadevi, Kyungwhan Min, Junghwa Lee, ... Tae-Hyun Kim

Thin-film composite membranes fabricated directly on a large-porous ceramic support using poly (4-styrenesulfonic acid) as a scaffold for ethanol dehydration Xin Zhang, Ze-Peng Liu, Zhen-Liang Xu, Feng-Yi Cheng, ... Xin-Ru Xu

Effect of sludge characteristics on optimal required dosage of flux enhancer in anaerobic membrane bioreactors Magela Odriozola, Maria Lousada-Ferreira, Henri Spanjers, Jules B. van Lier

Constructing tunable bimodal porous structure in ultrahigh molecular weight polyethylene membranes with enhanced water permeance and retained rejection performance Yuhang Guo, Tianci Zhang, Menghao Chen, Chunhai Li, ... Shaoyun Guo

Phase-field modeling of non-solvent induced phase separation (NIPS) for PES/NMP/Water with comparison to experiments M. Rosario Cervellere, Xianghong Qian, David M. Ford, Christina Carbrello, ... Paul C. Millett

CeO2 decorated graphene as separator modification material for capture and boost conversion of polysulfide in lithium-sulfur batteries Pu Cheng, Pengqian Guo, Kai Sun, Yonggang Zhao, ... Deyan He

Precise surface modification of porous membranes with well-defined zwitterionic polymer for

antifouling applications Yuhei Oshiba, Yusuke Harada, Takeo Yamaguchi

Unravelling intercalation-regulated nanoconfinement for durably ultrafast sieving graphene oxide membranes Jing Guo, Hongfei Bao, Yanqiu Zhang, Xi Shen, ... Lu Shao

Enhancing selectivity of ZIF-8 membranes by short-duration postsynthetic ligand-exchange modification Lin Lang, Fateme Banihashemi, Joshua B. James, Jiansong Miao, Jerry Y.S. Lin

Artificial intelligence for performance prediction of organic solvent nanofiltration membranes Jiahui Hu, Changsu Kim, Peter Halasz, Jeong F. Kim, ... Gyorgy Szekely

Coordinate covalent grafted ILs-modified MIL-101/PEBA membrane for pervaporation: Adsorption simulation and separation characteristics Ao-Shuai Zhang, Shen-Hui Li, Ali Ahmad, Heng Mao, ... Zhi-Ping Zhao

Inkjet printing of dopamine followed by UV light irradiation to modify mussel-inspired PVDF membrane for efficient oil-water separation Renjie Li, Jinyan Li, Linhua Rao, Hongjun Lin, ... Bao-Qiang Liao

In situ formation of ultrathin polyampholyte layer on porous polyketone membrane via a one-step dopamine co-deposition strategy for oil/water separation with ultralow fouling Lei Zhang, Ryosuke Takagi, Shengyao Wang, Yuqing Lin, ... Hideto Matsuyama

Hydrocarbon permeation properties through microporous fluorine-doped organosilica membranes with controlled pore sizes Mari Takenaka, Hiroki Nagasawa, Toshinori Tsuru, Masakoto Kanezashi

In situ growth of two-dimensional ZIF-L nanoflakes on ceramic membrane for efficient removal of iodine Huan Xiao, Huixian Zhou, Shasha Feng, Damian B. Gore, ... Weihong Xing

Sterilization of polypropylene membranes of facepiece respirators by ionizing radiation Luka Pirker, Anja Pogačnik Krajnc, Jan Malec, Vladimir Radulović, ... Luka Snoj

Prepared poly(aryl piperidinium) anion exchange membranes for acid recovery to improve dialysis coefficients and selectivity Xinming Du, Zhe Wang, Hongyu Zhang, Yongjiang Yuan, ... Zhenguo Zhang

Novel sulfonated polyimide membrane blended with flexible poly[bis(4-methylphenoxy) phosphazene] chains for all vanadium redox flow battery Miaomiao Zhang, Gang Wang, Anfeng Li, Xiaoyan Wei, ... Ruilin Wang

Organic fouling in forward osmosis: Governing factors and a direct comparison with membrane filtration driven by hydraulic pressure Francesco Ricceri, Mattia Giagnorio, Katherine R. Zodrow, Alberto Tiraferri

Effect of porous organic polymers in gas separation properties of polycarbonate based mixed matrix membranes Laura Rodríguez-Jardón, Mar López-González, Marta Iglesias, Eva M. Maya

Plasticizer-assisted interfacial polymerization for fabricating advanced reverse osmosis membranes Yitian Qin, Zhihao Zhu, Guodong Kang, Haijun Yu, Yiming Cao

Effect of membrane pore structure on fouling behavior of glycoconjugate vaccines Fatemeh Fallahianbijan, Parinaz Emami, Jordan M. Hillsley, Seyed Pouria Motevalian, ... Andrew L. Zydney

Under-brine superaerophobic perfluorinated ion exchange membrane with re-entrant superficial microstructures for high energy efficiency of NaCl aqueous solution electrolysis Jianlong Lei, Xiaohong Chen, Xundao Liu, Wei Feng, ... Yongming Zhang

In situ ATR-FTIR spectroscopic imaging of PVC, plasticizer and water in solvent-polymeric ion-selective membrane containing Cd2+-selective neutral ionophore Elena V. Solovyeva, Huiqiang Lu, Galina A. Khripoun, Konstantin N. Mikhelson, Sergei G. Kazarian

Dynamic hydrophobicity of superhydrophobic PTFE-SiO2 electrospun fibrous membranes Fangdong Zou, Gen Li, Xinhou Wang, Alexander L. Yarin

Rigid crosslinkers towards constructing highly-efficient ion transport channels in anion exchange membranes Chuan Hu, Xiuli Deng, Xuecheng Dong, Yanzhen Hong, ... Qinglin Liu

Renewable energy powered membrane technology: Impact of osmotic backwash on scaling during solar irradiance fluctuation Yang-Hui Cai, Claus J. Burkhardt, Andrea Iris Schäfer

Poly (vinyl alcohol) modification of poly(vinylidene fluoride) microfiltration membranes for oil/water emulsion separation via an unconventional

radiation method Yu Gu, Bowu Zhang, Zhiang Fu, Jihao Li, ... Jingye Li

Sugar-based membranes for nanofiltration Junfeng Zheng, Yanling Liu, Junyong Zhu, Pengrui Jin, ... Bart Van der Bruggen

High-performance and durable pressure retarded osmosis membranes fabricated using hydrophilized polyethylene separators Soon Jin Kwon, Kiho Park, Dal Yong Kim, Min Zhan, ... Jung-Hyun Lee

Crosslinked PVDF based hydrophilic-hydrophobic dual-layer hollow fiber membranes for direct contact membrane distillation desalination: from the seawater to oilfield produced water Lusi Zou, Xiangrui Zhang, Pri Gusnawan, Guoyin Zhang, Jianjia Yu

In-situ monitoring of polyelectrolytes adsorption kinetics by electrochemical impedance spectroscopy: Application in fabricating nanofiltration membranes via layer-by-layer deposition Yuanzhe Liang, Fei Gao, Li Wang, Shihong Lin

Corrigendum to 'A non-MPD-type reverse osmosis membrane with enhanced permselectivity for brackish water desalination' Junfeng Zheng, Yujian Yao, Meng Li, Lianjun Wang, Xuan Zhang

Meetings Calendar

December 2020

1-3 **Jordan International Chemical Engineering Conference**
Amman, Jordan
https://jeaconf.org/JICHEC

3-4 **Network Young Membrains Meeting 2020**
London, UK
http://www.icom2020.co.uk/nym.asp

6-11 **International Congress on Membranes & Membrane Processes 2020**
ExCel London, London, UK
http://www.icom2020.co.uk/

May 2021

22-27 **NAMS 2021**
Estes Park, Colorado, USA
https://membranes.org/nams-2021/

June 2021

6/20-7/02 **Nanofiltration 2021**
Achalm, Germany
http://nanofiltration2021.iamt.kit.edu/index.php

September 2021

20-24 **13th World Filtration Congress**
San Diego, California, USA
https://www.wfc13.com/v2/

30th Annual Meeting of the North American Membrane Society

NAMS21 CONVERGENCE

Connecting Membrane Science to Societal Challenges

May 22-27, 2021 **Ridgeline Hotel, Estes Park, CO**

3½ days of technical sessions including 2 poster sessions

Special Events	Plenary Speakers
Pre-meeting workshops	Distinguished Professor Kristi Anseth
Sunday afternoon student event	University of Colorado-Boulder
"*Lunch with Legends*"	Dr. Peter Green, Chief Research Officer
Welcome reception	National Renewable Energy Lab
Banquet at Estes Event Center	Dr. Roger Hart, Scientific Director
Alan Michaels Recipients Session	Amgen, Inc.

Meeting Organizers:

Uwe Beuscher, W.L. Gore & Assocs. (ubeusche@wlgore.com)

Yifu Ding, University of Colorado - Boulder (yifu.ding@colorado.edu)

John Pellegrino, University of Colorado - Boulder (john.pellegrino@colorado.edu)

NAMS 2021 Technical Program

Abstract submission opens: early December, 2020

Convergence sessions (by invitation)
- Pharmaceutical processing
- Energy & chemical processing
- Environmental applications
- Medicine & public health

Debate sessions (panel invitees)
- Funding the gap: TRL 1 & 2
- Materials research vs useful materials?
- Modeling, analysis, and characterization for membranes: too much?

Special topic sessions
- Industry
- Advanced metrology for membranes
- Water innovation using membranes
- Advanced module/process design
- Mathematics and machine learning
- Process intensification using membranes
- Membranes for food applications
- Membranes for energy efficient buildings
- Membranes for medical and pharmaceutical applications

NAMS standard sessions
- Award session
- Gas separations
- MF/UF/NF
- Osmotic processes (RO, FO, PRO)
- Organic separations (OSN)
- Fouling
- Contactors/MD/PV
- Inorganic membranes
- Electrochemical applications
- ...others as needed