

NAMS 2022: **Membranes for Sustainability**

Workshop descriptions

CONFERENCE CHAIRS

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Measurement Methods for Membranes

Saturday May 14th 8AM – 5PM

Lecturers:

Uwe Beuscher, ubeusche@wlgore.com, W.L. Gore & Associates, Inc.

Ryan Lively, ryan.lively@chbe.gatech.edu, Georgia Institute of Technology

John Pellegrino, john.pellegrino@colorado.edu, University of Colorado at Boulder

Abstract:

This workshop provides an overview of the entire field of membrane science, technology, and applications through measurements, and is therefore an excellent resource for novices with a technical background, as well as, seasoned veterans interested in broadening their scope (or having a refresher.) The workshop will provide a survey of the various physical and chemical properties of membranes (and membrane process characteristics) that are measured, and the equipment (instruments) and techniques used, along with their underlying principles. A mixture of classical, novel, and resource-intensive techniques are included.

Syllabus topics include: materials and structures; gas and liquid phase transport; mechanical and physical metrology techniques; porometry; surface and chemical measurements; visualization and scattering techniques; and special topics illustrating emerging characterization approaches. The workshop will finish with an industrial perspective segment that features a few invited panelists who will comment on how their organizations use membrane characterization to advance (or maintain) their business objectives.

Two weeks prior to the workshop a set of journal articles will be made available to the registrants. These articles will be used in class discussions. Also, all registrants will be asked to fill out a survey with questions and topics of particular interest to them.

The co-instructors combine many decades of membrane science and technology experience in industry, academia, and government. Their expertises include both polymeric and inorganic membranes as applied to gases, organic liquids, and water over a broad range of separations and filtration applications requiring both dense and porous materials. They have all actively applied advanced and classical characterization methods throughout their careers.

Uwe Beuscher is a Technical Leader at W.L. Gore & Associates, Inc., the world leader in fluoropolymer materials for a wide variety of applications. Dr. Beuscher received his Diplom-Engineer degree in Mechanical Engineering from RWTH Aachen (Germany) and his Ph.D in Chemical Engineering from Clemson University (U.S.A.). After joining W.L. Gore & Associates, Dr. Beuscher contributed for over 20 years to developments in a wide variety of separation applications including adsorption, catalysis, chromatography, polymer fuel cells, gas-liquid contactors, barrier materials, gas separation, liquid purification, and advanced microfiltration. Currently, Dr. Beuscher is leading the Gore Mercury Control System Team, which explores novel ways to remove Mercury and SO₂ from flue gases and waste gas streams. Dr. Beuscher has authored or co-authored more than thirty technical papers, book chapters, and presentations. He has served on various advisory boards and as the president of the North American Membrane Society (NAMS).

Ryan Lively is an Associate Professor at the School of Chemical and Biomolecular Engineering at the Georgia Institute of Technology. His research is in the area of separations science and technology and focuses on creating improved materials and processes that enable low energy chemical separations. He has received a variety of awards for his research efforts including the 2020 Allan P. Colburn Award from the AIChE. He is currently the John H. Woody Faculty Fellow and serves as an Editor for the Journal of Membrane Science and on the North American Membrane Society's Board of Directors. In 2020, he was appointed as Director of the Center for Understanding and Control of Acid Gas-Induced Evolution of Materials for Energy (UNCAGE-ME), an Energy Frontier Research Center of the US Department of Energy. He has over 110 publications in the field of separations including articles in Science, Nature, and Nature Materials.

John Pellegrino founded this workshop in 1995 and has helped evolve it since then. He has held research and development positions at Rohm & Haas Co., duPont Inc., the National Institute of Standards and Technology (NIST), and Santa Fe Science and Technology Inc., and is currently a Research Professor in the Mechanical Engineering Department at CU-Boulder.

Membranes for Water Treatment & Reuse

Saturday May 14th 8AM – 5PM

Lecturers:

Dibakar Bhattacharyya, University of Kentucky, DB@uky.edu

Isabel C. Escobar, University of Kentucky, Isabel.Escobar@uky.edu

Ben Weaver, Solecta, ben.weaver@solectamembranes.com

Abstract:

Membrane processes are finding wide applications ranging from water treatment to reactors to advanced bio-separations. Membranes are particularly useful for material recovery and for permeate reuse (such as, water recycle). The workshop is configured as a one day program of about 6 hours of lectures. Both desalination and toxic pollutant removal/destruction techniques will be discussed. The workshop topics include membrane selection criteria, practical information regarding configuration, performance and operating conditions of membrane technology applied to desalination of brackish and seawater, and wastewater reclamation systems, mixed-matrix membranes, and advanced functionalized/responsive membranes from metal capture to emerging pollutants (PFAS) detoxification. Membrane surface and pore functionalization approaches, reactive nanostructured for water detoxification will be part of the advanced membrane topics. The effects of feed water quality, pretreatment options, operating parameters and performance of membrane units and hybrid options will also be discussed. The workshop material will also include information on economics of membrane systems including drivers for membrane selection for various applications.

OUTLINE

Session 1 (Instructor: I.C. Escobar)

Introduction to membrane theory

Materials, configuration and performance

□ Session 2 (Instructor: I.C. Escobar)

Scaling and fouling phenomena

Membrane Integrity and degradation

□ Session 3 (Instructor: I.C. Escobar)

Membrane water applications and pretreatment

Membrane markets

□ Session 4 (Instructor: D. Bhattacharyya)

RO, NF, etc. for pollutants removal

Graphene-based membranes and hybrid systems

Valuable materials recovery and water reuse

□ Session 5 (Instructor: D. Bhattacharyya)

Functionalized and responsive membranes for water area

Toxic metal capture, and emerging pollutant (PFAS) separations

□ Session 6 ((Instructor: D. Bhattacharyya)

Membranes with nanostructured catalytic materials

Advanced membrane-based oxidation/reduction for organic pollutant detoxification

□ Session 7 (Instructor: Ben Weaver)

Module design and elements

Drivers for membrane selection

Isabel Escobar is a Professor in the Department of Chemical and Materials Engineering at the University of Kentucky. In the field of membrane separations, she has been the PI of numerous membrane research projects, has one recently licensed patent on a breakthrough anti-biofouling feed spacer material. Isabel Escobar and her research group have published over 75 articles in peer-reviewed journals, and have made over 200 presentations at national/international conferences. She has edited two books, Sustainable Water for the Future—Water Recycling versus Desalination (ISBN: 9780444531155) and Modern Applications in Membrane Science and

Technology (ISBN: 9780841226180). Escobar Chaired the 2006 American Water Works Association (AWWA) Desalination Symposium Chair, Honolulu, Hawaii, 21-22 May 2006; the NAMS 2007 Annual Meeting Chair, Orlando, FL, 11-16 May 2007; and the NAMS 2012 Annual Meeting Chair, New Orleans, LA, 9-13 June 2012. With Dr. Jamie Hestekin of the University of Arkansas, Escobar co-Chaired the Engineering Conferences International: Advanced Membrane Technology VII in Cork, Ireland, 11-16 September 2016; and with Dr. Dibakar Bhattacharyya, she co-Chaired the NAMS 2018 Conference in Lexington, KY. In 2020, she Chaired the Second Pan American Nanotechnology (Pannano II) in Brazil, and she was the Co-Meeting Program Chair of the AIChE Fall Annual Meeting. In 2022, she will co-Chair the Gordon Research Conference: Membranes: Materials and Processes. In September of 2015, Escobar gave a TEDx talk on Worldwide Water Issues: <https://www.youtube.com/watch?v=-wbHD77kMWE&app=desktop>.

Dibakar Bhattacharyya (DB) is the University of Kentucky Alumni Chair Professor of Chemical Engineering, Director of the Center of Membrane Sciences, and a Fellow of the American Institute of Chemical Engineers. He was the past President of NAMS, and he was the past Chair of the Separations Division of AIChE. He is the Co-Founder of the Center for Membrane Sciences at the University of Kentucky. He has published over 230 refereed journal articles and 21 book chapters, 2 books and Kirk-Othmar Encyclopedia chapter on Reverse Osmosis, and has 9 (one utility patent pending, 2021) U.S. Patents (Functionalized Membranes, green Synthesis, and thermo responsive membranes). He has worked with several industries in projects dealing with wastewater, material recovery, water reuse, and membrane separations. Dr. Bhattacharyya has received a number of awards for his research and educational accomplishments, including the 2009 Gerhold Award from the AIChE Separations Division for his outstanding contributions in Membrane Separations Technology Development, 2004 Kirwan Prize for Outstanding Research accomplishments, Larry K. Cecil AIChE Environmental Division Award for outstanding membrane technology developments in the water related field, and the University of Kentucky Great Teacher (1984,1996, 2008) Awards three times. At the 2007 NAMS Annual Meeting, he was honored for his contributions in the area of functionalized membranes. He has edited a book on Responsive Membranes and Materials, published by John Wiley.

Ben Weaver graduated from University of California, Berkeley with a BS degree in Chemical Engineering. He has spent his 8+ year career in various roles supporting membrane technology. Ben began his membrane career at Hydranautics where he worked on applications and development of hollow fiber and spiral wound MF and UF products used for treatment of seawater, wastewater, surface and ground waters primarily for pretreatment to NF/RO and drinking water. He spent 2+ years working on the Encina Seawater Pilot in Carlsbad, CA, future home of a 50 MGD desalination plant. He worked on applications for ethanol production as well as produced and seawater treatment for the oil and gas industry. He then started working for Solecta (previously Nanostone Water, Ultura, and Sepro Membranes) in an applications and sales role primarily focusing on process applications in food and beverage, industrial waste waters and specialty applications in energy and oil markets.

Membrane Gas Separations

Sunday May 15th, 2021 8AM – 5PM

Lecturers:

Benny Freeman, University of Texas at Austin, freeman@che.utexas.edu

Glenn Lipscomb, The University of Toledo, glenn.lipscomb@utoledo.edu

Tim Merkel, MTR Inc., tim.merkel@mtrinc.com

ABSTRACT

This workshop will cover the entire spectrum of membrane-based gas and vapor separations: from the materials science of gas separation membranes and the fundamentals of membrane transport to the design and economics of industrial gas separation applications. This workshop should be of interest to membrane researchers as well as membrane practitioners.

Outline:

1. Materials: Freeman, 8-10:30 AM
 - Material science of gas separation membranes and transport mechanisms
2. Break: 10:30-10:45 AM
3. Modules: Lipscomb, 10:45-12 and 1-2:15 PM
 - Module Manufacture (patent review)
 - Scroll/spiral wound module formation
 - Fiber bundle/tubesheet formation and types
 - Header and case design
 - Module Performance
 - Basic design equations for gas separations
 - Hollow fiber versus spiral wound
 - Module inefficiencies: fiber size/property variation & poor shell flow distribution
5. Break: 2:15-2:30 PM
6. Applications: Merkel, 2:30-5 PM
 - Basics of Gas Separation System Design
 - Pressure ratio
 - Multi-step and multi-stage configurations
 - Gas Separation Industry: History and Overview
 - Air Separation
 - Nitrogen - enriched Air
 - Oxygen - enriched Air
 - Hydrogen Separation
 - Natural Gas Separation
 - Acid Gas Removal
 - Nitrogen Removal
 - NGL Recovery/Fuel Conditioning
 - VOC Removal/Recovery
 - Emerging Applications