

Measurement Methods for Membranes

Saturday

8:00 AM

Lecturers:

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

MaryLaura Lind, mllind@asu.edu, Arizona State University

Ryan Lively, ryan.lively@chbe.gatech.edu, Georgia Tech

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

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.

Dr. Uwe Beuscher is a senior filtration technologist for W.L. Gore & Associates, Inc. He has more than 20 years of experience exploring separations and mass transport problems for a variety of high performance applications using unique experimental approaches and numerical simulation. He has served on SEMI standard committees and as the president of the North American Membrane Society (NAMS).

Dr. Mary Laura Lind is an Associate Professor in the School for Engineering of Matter, Transport and Energy (SEMTE) at Arizona State University, as well as, the Graduate Program Chair for the Chemical Engineering Program. She is a member of the Board of Directors of NAMS and the co-chair of the 2018 Membranes: Materials and Processes Gordon Research Conference.

Dr. Ryan Lively spent three years as a research engineer at Algenol Biofuels before joining the School of Chemical & Biomolecular Engineering at Georgia Tech. as an Assistant Professor. He is a recipient of the 2013 NSF BRIGE Award and has over 60 publications in the field of separations including articles in *Science*, *Nature*, *Nature Nanotechnology*, and *Advanced Functional Materials*, covering advances in critical fluid separation processes using chemistry-inspired materials design.

Dr. 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. He is a former board member and president of NAMS.

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.

- Two weeks prior to the workshop a set of journal articles will be made available to registrants through a Google (or other) Cloud drive. These articles will be used in active learning segments of the class utilizing concept questions.
- One week prior to the workshop all registrants will be asked to fill out a survey with questions and topics of particular interest to them. We will strive to make sure that these items are discussed.

Syllabus topics include:

- Introduction to membranes: review of membrane types and structures; goals of measurements; broad perspective on trade-offs and opportunities in characterization
- Overview of transport processes and figures-of-merit: flux, selectivity, rejection, sieving coefficient; simple geometric membrane models
- Membrane materials and polymers; density and fractional free volume; thermal and mechanical analysis - differential scanning calorimetry, dynamic mechanical analysis, thermal relaxation, nanoindentation; dielectric relaxation
- Metrology basics: metrology basics and uncertainty; measuring density-pycnometry; solubility-sorption pycnometry, gravimetric, SAW, QCM, TGA, calorimetry
- Gas and vapor systems: measuring time lag for permeation; mass spectrometry-transient permeation
- Liquid systems testing: calibrations; permeation; species fractionation; integrity
- Porometry
- Surface and chemical measurements: surface energy and charge; FTIR; surface chemical analysis - XPS, Auger, SIMS, RAMAN, NMR, MRI, MALDI-TOF
- Visualization and scattering: SEM, TEM, optical, NSOM, CLSM, AFM; WAXD; SAXS; SANS; PALS
- Other topics and motivations: (for example, ultrasonics, electrochemical, TIRF, etc.)
- 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.