Membrane Applied Science and Technology Center (MAST)

University of Colorado at Boulder (lead) and University of Cincinnati

Membranes offer new separation techniques that will save money and energy for industry. Moreover, membranes are the only separations technique that will work on the Micro-Electro-Mechanical Systems (MEMS) scale. Hence, they offer exceptional potential for separations and controlled release on the microscale.

A National Science Foundation Industry/University Cooperative Research Center since 1990

Center Mission and Rationale

Separation processes constitute a large segment of materials processing in the chemical, petrochemical, and gas separation industries. The cost of separation can represent as much as 80% of total processing costs, especially for commodity chemicals. A wide range of separation issues is of increasing concern to the pharmaceutical, biomedical, semiconductor, and food and beverage industries. In addition, there are exciting new applications for membranes in biosensors and MEMS devices. Utilization of polymeric, ceramic, and metallic membranes offers new possibilities for efficient separations with a resulting positive impact on the user-industry's capital, operating costs, and energy-consumption costs.

The MAST Center was established to advance the technology of membrane separations. The Center mission is to:

- Conduct basic research and related developmental activities for the use of membrane technology in separation processes
- Provide timely and effective technology transfer between the Center and its sponsors
- Promote education in membrane science and technology.

Research Program

The MAST Center is a multi-university Center with sites at the University of Colorado and the University of Cincinnati. In addition, faculty from the Colorado School of Mines, Colorado State University, and the University of Toledo participate in the Center research program. Faculty and students from the biological, chemical, and physical sciences; health sciences; pharmacy; and aeronautical, chemical, civil and environmental, electrical and computing, materials, and mechanical engineering departments conduct research for the MAST Center in chemically enhanced separations, membrane structure and performance, membrane fouling, catalytic membrane reactors, water treatment and reclamation, and applications in food and beverage, barrier layer and container, pharmaceutical and biomedical, smart sensors and MEMS areas. The Center has exceptional facil-

Center Co-Director Dr. Alan R. Greenberg and graduate student Diana J. Hellman discuss the results of a new membrane fabrication process that has been developed in a Center research project.

ities and equipment to characterize membranes and evaluate the performance of membrane separation devices.

In the area of technology transfer, the Center's milestone achievements include:

- Three patents allowed for sulfur-tolerant complexing agents for olefin separations
- Patent allowed for modified ion-exchange membranes
- Patent allowed for convective liquid crystal membranes
- Patent allowed for production of novel molybdenum-sulfide dimers
- Patent allowed for membrane fouling and cleaning meter
- Patent application for photografting on membrane surfaces
- Patent application for modification of zeolite membranes
- Patent application for new types of zeolite membranes.

Special Center Activities

The MAST Center sponsors an NSF *Summer Research Experiences for Undergraduates Program in Membrane Science,* with a special focus on providing research opportunities for women and minorities.

Highlights of other MAST Center activities include:

- Stimulating 43 research projects, many of them multi-P.I. and interdisciplinary
- Enlisting 28 faculty spanning 10 departments at 5 universities
- Facilitating a graduate research program in which approximately 15 doctoral and postdoctoral students participate annually
- Providing research opportunities leading to 22 Ph.D. and 20 M.S. degrees
- Providing research opportunities for more than 130 undergraduates
- Developing new courses on *Chemically Specific Separations and Introduction to Membrane Science*
- Sponsoring the 1994 Annual Meeting of the North American Membrane Society and the 2004 International Conference on Inorganic Membranes
- Sponsoring research resulting in two North American Membrane Society Graduate Fellowships, five North American Membrane Society Graduate Paper Awards, and other major student awards.
- Hosting visiting postdoctoral fellows, international professors, and industry scientists
- Interacting with two other I/UCRCs via TIE projects
- Establishing an international exchange program with the Center for Membrane Science and Technology at the University of Twente, Netherlands
- Interacting with MAST Center industry sponsors via NSF's GOALI program.
- Making available to MAST Center sponsors a Membrane Science short course developed by the Center co-directors.

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