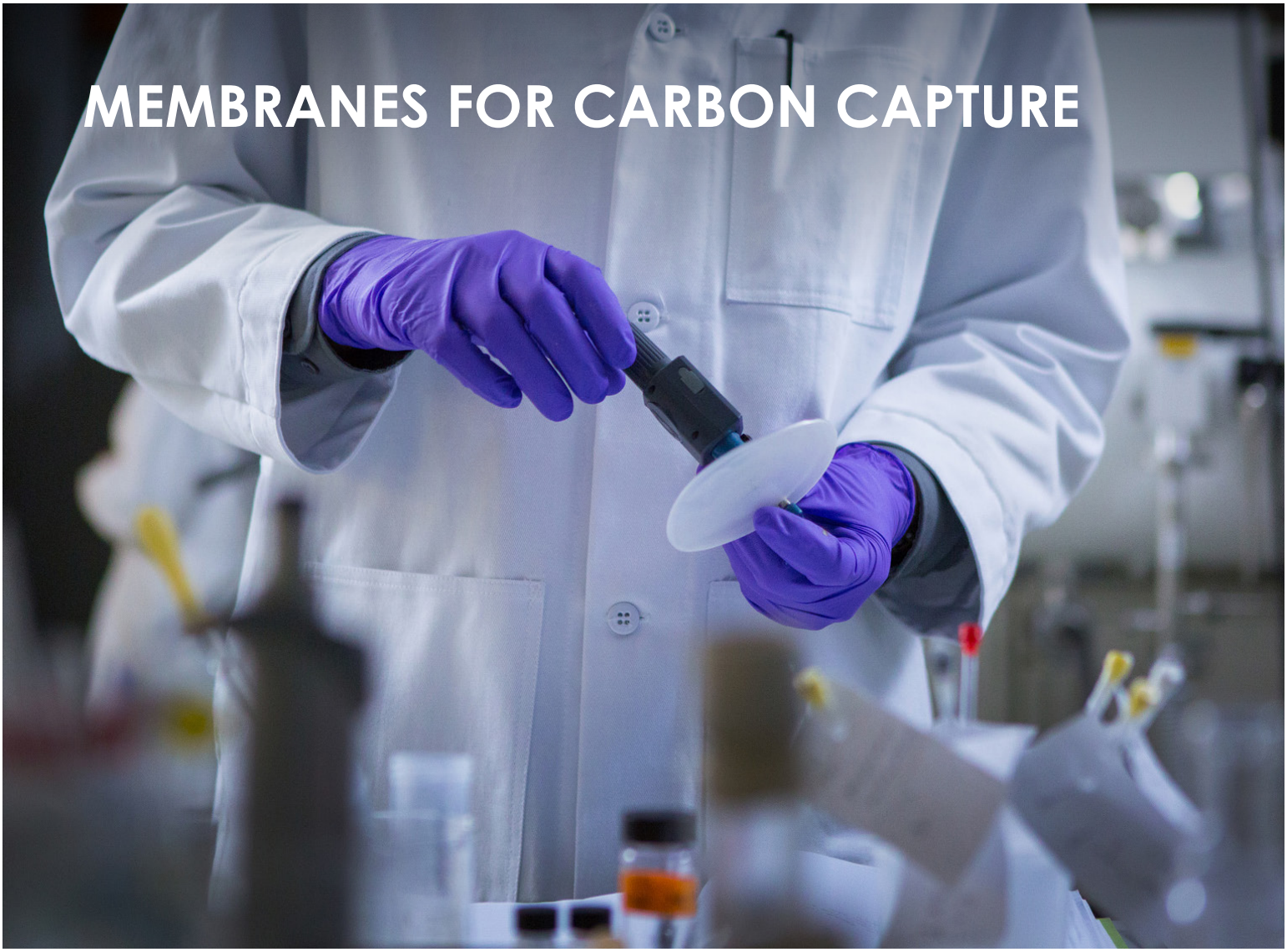
MEMBRANES FOR CARBON CAPTURE



NETL

NATIONAL ENERGY TECHNOLOGY LABORATORY

The National Energy Technology Laboratory's (NETL) Point Source Carbon Capture (PSCC) Program is developing the next generation of advanced carbon dioxide (CO_2) capture concepts to support the United States in achieving ambitious goals for a greenhouse gas (GHG)-neutral economy by 2050, a carbon-pollution-free power sector by 2035, and a 50% reduction from 2005 levels in economy-wide net GHG pollution by 2030. The PSCC Program is accelerating commercially deployable solutions that can be applied to a wide spectrum of CO_2 emissions sources with varying characteristics, including facilities that produce power, hydrogen, chemicals, cement, or steel.

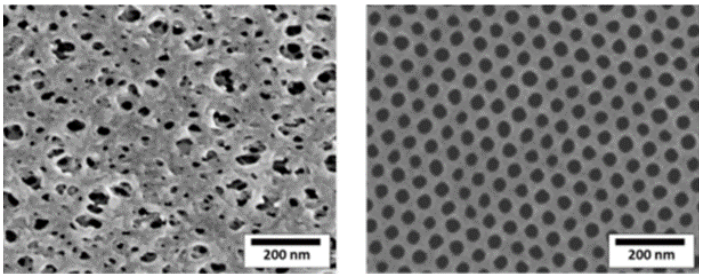
R&D efforts to date have led to reductions in both capital and operating costs through implementation of energy and process efficiencies and development of advanced CO_2 capture media (e.g., solvents, sorbents, and membranes). To achieve deep decarbonization of emissions sources, the program is focused on developing highly efficient, scalable carbon capture technologies with even further cost reductions that are capable of operation under a flexible duty cycle and that can achieve greater than 95% carbon capture.

MEMBRANES FOR CARBON CAPTURE

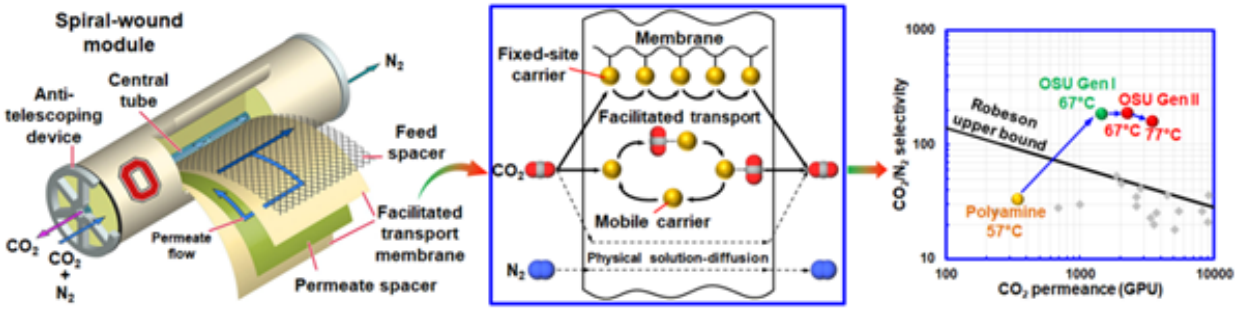
MEMBRANE-BASED CAPTURE TECHNOLOGY

Membrane-based CO_2 capture uses permeable or semi-permeable materials that allow for the selective transport and separation of CO_2 from a gas stream, taking advantage of differences in the relative transfer rates or permeation of the various gases present and is affected by both relative diffusivity and surface adsorption. Membrane processes offer potential advantages when compared to other CO_2 separation technologies, including no hazardous chemical storage, handling, disposal, or emissions issues; tolerance to high sulfur oxide and nitrogen oxide content; simple operation with no moving parts; a reduced plant footprint with lower capital cost; and the ability to incorporate modular unit design, which reduces scale-up complications.

Advancements in membrane-based technology development are being pursued along three main innovation pathways: materials, processes, and equipment. R&D objectives include development of low-cost, durable membranes (e.g., polymeric membranes, facilitated transport membranes, mixed matrix membranes, sub-ambient temperature membranes) with improved permeability and selectivity for CO_2, thermal and physical stability, tolerance to gas contaminants, and improved system configurations such as solvent/membrane hybrid systems, and subambient operation integrated with CO_2 liquefaction. Process enhancements for membrane-based capture systems include low-pressure drop membrane modules, hybrid systems, novel process conditions (e.g., systems that operate at subambient temperatures), dual-phase membranes, and nanomaterials with highly tuned functionality.



Surface of conventional versus enhanced membrane support material that improves permeance and selectivity, driving down capture cost



Facilitated transport membrane currently being tested at small pilot scale – membrane module (left), transport mechanism (center), and performance (right)

NETL is a U.S. Department of Energy national laboratory that drives innovation and delivers technological solutions for an environmentally sustainable and prosperous energy future. Through its world-class scientists, engineers and research facilities, NETL is ensuring affordable, abundant and reliable energy that drives a robust economy and national security, while developing technologies to manage carbon across the full life cycle, enabling environmental sustainability for all Americans, advancing environmental justice and revitalizing the economies of disadvantaged communities.

Leveraging the power of workforce inclusivity and diversity, highly skilled innovators at NETL's research laboratories in Albany, Oregon; Morgantown, West Virginia; and Pittsburgh, Pennsylvania conduct a broad range of research activities that support DOE's mission to ensure America's security and prosperity by addressing its energy and environmental challenges through transformative science and technology solutions.

NETL lends its expertise toward achieving a carbon-free power sector by 2035 and a net-zero economy by 2050 while catalyzing economic revitalization, creating good-paying jobs and supporting workers in energy communities, especially hard-hit coal, oil and gas, and power plant communities, across the country. One of the most rewarding aspects of NETL's research is that our innovations and our technologies have the potential to improve people's lives in meaningful ways.

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