Pacific Northwest NATIONAL LABORATORY

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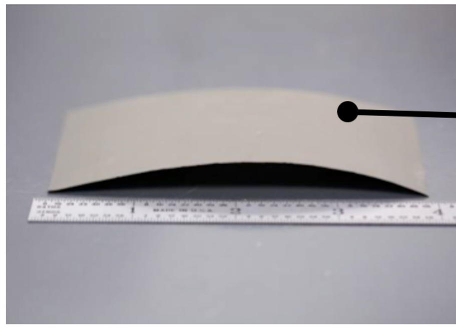
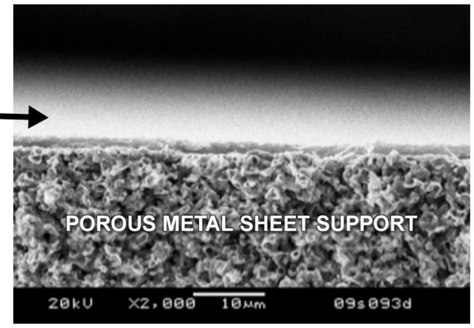
# Micro-porous Zeolite Membrane made into Metal Foil-like Thin Sheet



50μm-thick porous metal sheet of about 1μm mean pore sizes




<2μm-thick membrane layer made of inter-grown zeolite crystals

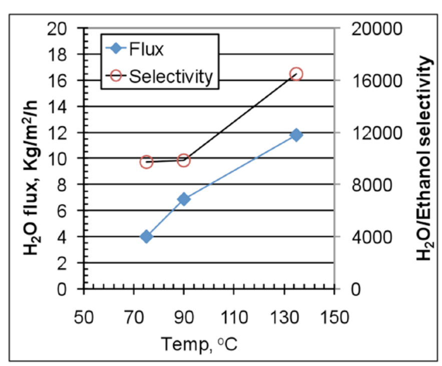
## TECHNOLOGY SUMMARY

Zeolite crystals with well-defined pore structures from 0.3 to 0.8nm and molecule-specific surface chemistry have been widely used in today's industries as catalysts and adsorbents. Making the zeolite into a membrane form enables realization of molecular-sieving functions in macro-scale (as compared to individual crystal scale) and can potentially revolutionize a number of important industrial reaction and/or separation processes. However, zeolite crystals are primarily ordered Si and Al metal oxides, and are too fragile to form a self-supported, thin membrane. In our work, an ultra thin (<2μm) zeolite membrane has been successfully deposited on a special porous metal sheet support that has uniform pore structures at about 1μm levels. The thin (~50μm), robust metal sheet provides mechanical strength and thermal stability for practical applications. More importantly, the metal foil-like thin membrane sheet makes it possible to pack a large membrane surface area into a small module volume, such as 1000 to 2000 $m^2$ per $m^3$.

Our innovations of material processing technologies enable deposition of tailored zeolite crystal lattice structures and surface chemistry according to specific application requirements. The simple planar membrane sheet structure may be manufactured at low costs in industrial scales.

### Application Example I: Dehydration of Ethanol Fuel and Alcohols

Dehydration of a water-miscible alcohol or organic solvent mixture has been a common problem for existing industrial processes and bio-fuel productions.

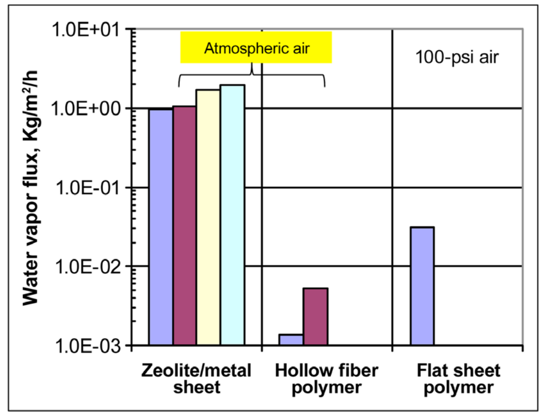



U.S. DEPARTMENT OF ENERGY

The $H_2O$-selective zeolite membrane deposited on the porous metal sheet shows exceptionally high water flux and high $H_2O$/ethanol selectivity. The energy consumption and capital cost may be dramatically reduced by using this novel membrane technology in lieu of conventional separation technologies.

## Application Example II:
## Hot Air Dehumidification

The $H_2O$-selective zeolite membrane allows vapor-phase separation of water molecule from a humid gas stream. Dehumidification and cooling of hot, humid air is known very energy-intensive with conventional technologies. The vapor-phase membrane separation is conducted at constant temperature without any environmental emissions, which is an efficient and completely green technology. The zeolite membrane shows exceptionally high water vapor permeation flux. The technology has large potential in building efficiency industry.




## ABOUT PNNL

Pacific Northwest National Laboratory, a U.S. Department of Energy Office of Science laboratory, solves complex problems in energy, the environment, and national security by advancing the understanding of science. PNNL employs more than 4,900 staff, has a business volume exceeding $1.1 billion, and has been managed by Ohio-based Battelle since the Lab's inception in 1965.

*For more information, please contact:*


**Dr. Wei Liu**, Chief Engineer
Pacific Northwest National Laboratory
P.O. Box 999, MSIN K2-12
Richland, WA 99352
(509) 375-2524
wei.liu@pnl.gov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