Argonne NATIONAL LABORATORY

Office of Technology Transfer

NANOSTRUCTURED CATALYTIC MEMBRANES

Nanoporous Catalytic Membranes Offer New Potential for Transportation, Chemical, and Petroleum Industries

BENEFITS OF NCMS

- High uniformity of catalytic sites
- Ability to limit reactant-catalyst contact time
- Capability to tune both pore diameter and pore wall composition to optimize the NCM for each particular catalytic process
- Allow sequential catalytic reactions to occur with a single pass through the membrane.
- Offer molecular size-specific separation to the NCMs
- Can be applied to critical new nanotechnologies that require materials and structures with constrained sizes.
- NCM technology is easily scaled up for industrial applications.

COLLABORATORS

Argonne National Laboratory
Northwestern University
BP Aromatics and Acetyls

Scientists at Argonne National Laboratory are fabricating novel nanostructured catalytic membranes (NCM) that overcome the limitations of conventional powder catalysts. By converting feedstocks into chemicals, diesel fuel, or gasoline using the NCMs, they can enable the efficient and cost-effective synthesis of hydrocarbons for transportation fuels. One chemical process under study converts a mixture of hydrogen and carbon monoxide into high-purity hydrocarbon fuels with no sulfur content and little or no aromatic contamination. The feed gas for this reaction can be derived from many different sources, including coal, natural gas, or biomass such as corn.

Scientists at Argonne have started work that could provide clean, renewable fuels for transportation using a variety of feedstocks. Here, chemist Jeffrey Elam holds a prototype membrane that is ready to be evaluated in a catalytic testing reactor operated by chemical engineer Donald Cronauer.

NCMs also can be used for selective oxidation in the chemical and petroleum industries. Another NCM application: For oxidative dehydrogenation, which provides a useful starting point for chemical synthesis.

The new membranes offer unique catalyst environments that:

- Provide a wide range of pore sizes, including larger pores than conventional mesoporous materials;
- Permit tailoring of channel size and pore wall composition in an atomic layer by atomic layer fashion;
- Constrain catalyst mobility, thus hindering agglomeration;
- Control flow of reagents in and out of the catalyst.

Argonne's ultra-uniform NCMs are based on anodic aluminum oxide (AAO). AAO membranes are formed by the electrochemical etching of aluminum metal, and Argonne is pioneering the use of AAO membranes as templates for

LINKS TO ONLINE INFORMATION

http://chemistry.anl.gov/MSDReview/MicroInstr/ALD.pdf

http://www.es.anl.gov/Energy_systems/Atomic_Layer_Deposition/index.html

http://www.msd.anl.gov/highlights/docs/wang_catalysis_highlight.pdf

http://www.cmt.anl.gov/Science_and_Technology/Basic_Science/Nanoporous_Catalytic_Membranes.shtml

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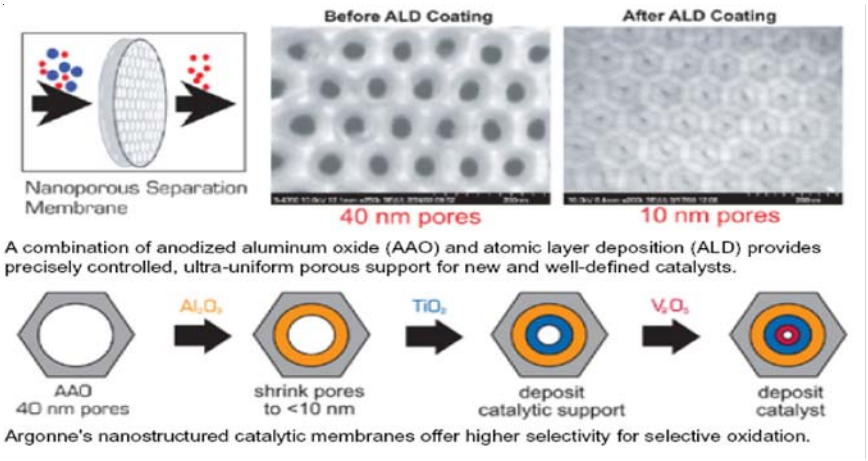
ABOUT ARGONNE TECHNOLOGY TRANSFER

Argonne National Laboratory is committed to developing and transferring new technologies that meet industry's goals of improving energy efficiency, reducing wastes and pollution, lowering production costs, and improving productivity. Argonne's industrial research program, comprised of leading-edge materials research, cost-saving modeling, and unique testing and analysis facilities, is providing solutions to the challenges that face U.S. manufacturing and processing industries.

nanofabrication. Using atomic layer deposition (ALD) thin-film growth techniques Argonne scientists precisely tune the AAO pore size within ± 0.1 nm to control the reactant/catalyst contact time as well as to provide filtration capability. Next, catalyst support and active catalyst layers are deposited using ALD to form the NCMs.



Status:

Fabrication of the NCMs has been accomplished successfully in the laboratory. Researchers are now focusing their attention on measuring the properties of the catalyst and preparing other catalytically relevant materials inside the NCMs.

A patent has been filed: Nanoporous Catalytic Membranes (ANL-IN-03-055).

Partnering:

Argonne has partnered in separate projects with Northwestern University and BP Aromatics and Acetyls in further development of NCMs.

Licensing:

Additional partnering and licensing opportunities are available.

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