

## Advanced Membrane Technologies

### Executive Overview:

The multibillion-dollar market for membranes continues to grow at an annual rate of nearly 10%. Membrane technology breakthroughs are opening new high-margin markets and applications for which membranes provide dramatic cost reductions compared with entrenched technologies. For example, Los Alamos National Laboratory (LANL) membrane technologies promise to deliver energy cost savings of up to 50% compared with cryogenic distillation in olefin/paraffin separations that currently consume more than a billion dollars worth of energy per year. Similarly, fuel cells based on advanced membrane technologies are entering markets now dominated by internal combustion engines and batteries.

LANL is now offering its extensive portfolio of advanced membrane technologies for licensing and collaboration. The LANL membrane portfolio includes enabling technologies for products in hydrogen separation, CO<sub>2</sub> separation, olefin/paraffin separation, zeolite membranes, and fuel cells.

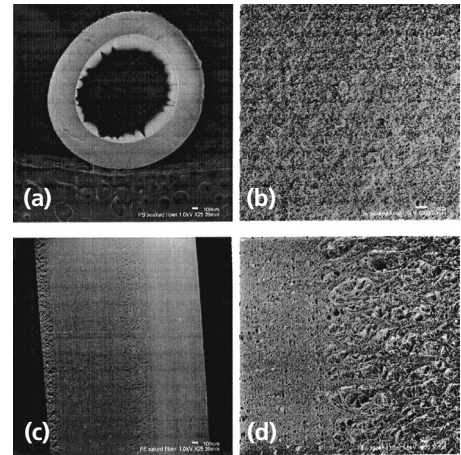
By working with LANL, companies gain access to highly innovative membrane technology while minimizing R&D risks and expenditures. Our partners gain access to leading membrane research teams, as well as to LANL's extensive intellectual property (IP) portfolio of advanced membrane technologies. We invite you to explore membrane business opportunities available with LANL today.

### Select LANL Membrane IP:

- Meniscus Membranes for Separation (US patents 6,681,648 & 6,946,019)
- Thermally Tolerant Multilayer Metal Membrane (US patent 6,214,090)
- Fuel Cell Membrane Humidification (US patent 5,952,119)
- Membrane Catalyst Layer for Fuel Cells (US patents 5,234,777 & 5,211,984)
- Porous Membrane Materials as Structured Packing for Distillation (patent pending)
- Synthesis of Zeolites in Reverse Microemulsions (US patent 6,949,238)
- Tubular Hydrogen Permeable Metal Membrane and Method of Fabrication (US patent 7,022,165)
- Porous Support for Hydrogen Permeable Membrane (US patent 7,611,565)

### Partnership Mechanisms:

- Licensing Agreements
- Non-Federal Work-for-Others Agreements (WFO)
- Cooperative Research and Development Agreements (CRADA)



*LANL's advanced membrane technology portfolio includes a high-efficiency olefin/paraffin membrane material. The figure shows SEM images of the cross section (a), porous structure in the wall (b), surface (c) and morphology of the skin (d) of the fibers.*

### Partner Benefits:

- Access to new high-margin membrane markets
- Reduced cost of R&D
- Reduced risk of R&D
- Reduced development cycle
- Design freedom (IP)

### Advanced Technologies:

- Hydrogen separation membranes-
- CO<sub>2</sub> separation membranes
- High-aspect ratio crystals for zeolite membranes
- Non-cryogenic separation of olefins and paraffins
- Fuel cell membranes and membrane electrode assemblies (MEAs)

### Markets:

- Petroleum refining
- Hydrogen production
- Fuel cells
- Chemicals

### Business Development Contacts:

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