

Composite Block Polymer-Microfabricated Silicon Nanoporous Membrane

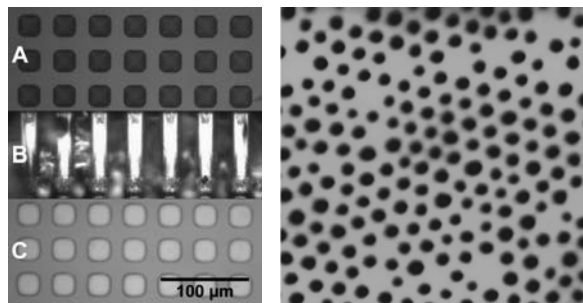
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NNIN Facilities utilized: Characterization Facility & Nanofabrication Center

DESCRIPTION OF WORK

- ◆ Thin self assembled nanoporous membrane formed from polystyrene-*block*-poly(lactic acid), with cylindrical poly(lactic acid) domains removed by treatment with NaOH
- ◆ Method was developed to cast nanoporous membrane on a silicon-based microporous support
- ◆ Result is strong, size-selective membrane with precise pore geometry, providing rapid transport selective for small molecules



Left: Microporous silicon support as viewed from the top (A), cross-section (B) and bottom (C).

Right: Tapping mode AFM height image of nanoporous block polymer film on Si₃N₄. Image is 1 μm square. Pore diameters are 43 nm ± 11% RSD.

Research Support:

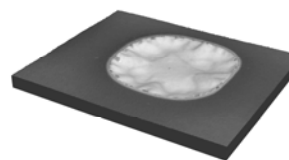
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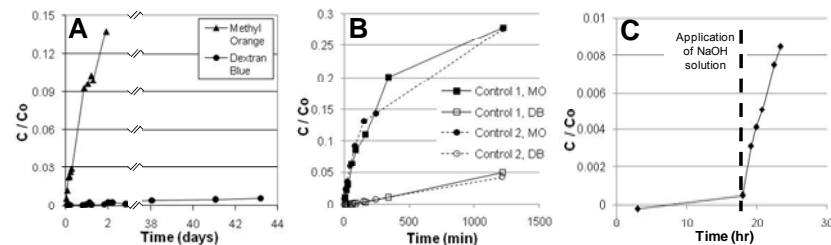
NSF MRSEC (DMR-0212302 and DMR-0819885)

MAJOR OBSERVATIONS

- ◆ Nanoporous membrane covers micropores, but forms wavy texture
- ◆ When mounted into diffusion cell, membrane exhibits transport strong selectivity based on molecular size



Confocal microscope topograph of polymer film spanning a 20 μm pore in the silicon support. The z-axis is magnified by a factor of 5 to better view the curvature in these pore coverings.



Membrane breakthrough curves. A) Methyl orange (MO: MW=327) and dextran (DEX: MW=2x10⁶) across nanoporous composite membrane, indicating 1500-fold permeability difference between MO and DEX. B) MO and DEX across Anodisc control membrane, indicating 30-fold permeability difference between MO and DEX. C) MO across composite membrane without prior removal of polylactic acid block. NaOH was added after 18 hours, dissolving that block and prompting dramatic increase in permeability.

Publications

- ◆ Nuxoll, E.E., Hillmyer, M.A., Wang, R., Leighton, C., and Siegel, R.A., *ACS Appl. Mater. Interf.*, DOI: 10.1021/am900013v (2009).