Hydrophobically Modified Porous Anodic Alumina Membranes

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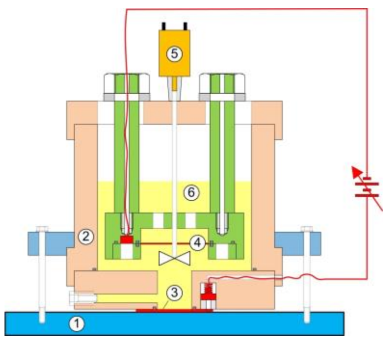
Brief Historical Review

Protection of Aluminum and its alloys, over 100 years

Masuda & Fukuda, Closely Packed Hexagonal Array, 1995

Versatile Template for Nanopatterning, Today

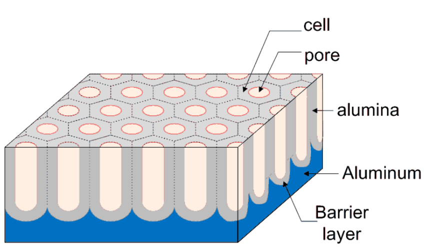
Experimental Set up

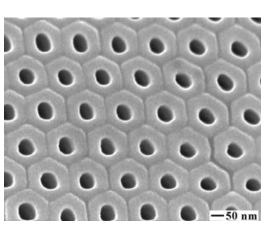


1. Cooling Stage (Peltier)
2. Teflon Cell
3. Aluminum Foil (Anode)
4. Platinum mesh (Cathode)
5. Stirrer
6. Electrolyte

Photograph of experimental set up in the Solid State Lab of U. of Patras

Ordered Structure



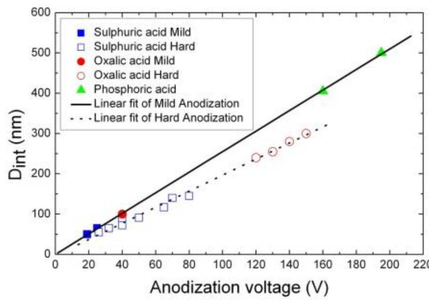


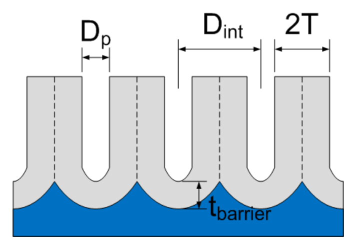
Masuda, H. & Fukuda, K. *Science* **268,** 1466 (1995)

Lee et al, Nature Materials, **5**, 741 (2006)

Nanoporous Anodic Alumina

Interpore Distance, D_{int}, and Pore Diameter, D_p





$D_{int} = k_1V$ $K_1 = 2.5$ nm/V

$D_p = k_2V$ $K_2 = 1.0$ nm/V

Nanoporous Anodic Alumina

Experiment

University of Patras

JOURNAL OF APPLIED PHYSICS **103**, 094521 (2008)

Nanoporous alumina enhanced surface plasmon resonance sensors

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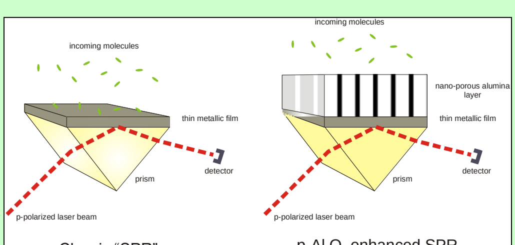
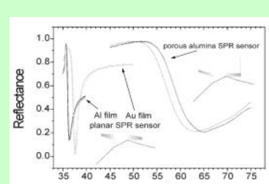
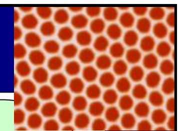




Nanoporous Anodic Alumina



Experiment

University of Patras

Adsorption of Block Copolymers in Nanoporous Alumina

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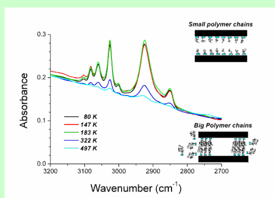

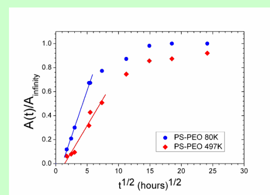

Nanoporous Anodic Alumina

Simulation

University of Patras

THE JOURNAL OF CHEMICAL PHYSICS **131**, 044901 (2009)

Formation of polymer brushes inside cylindrical pores: A computer simulation study

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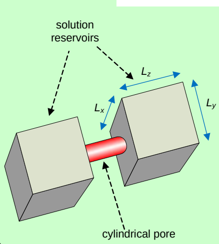
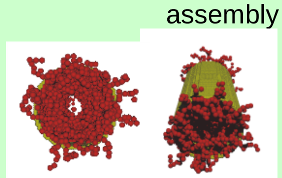
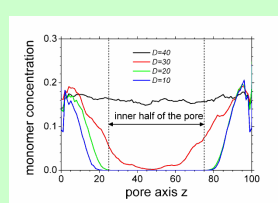
BFMC Simulation of brush self assembly



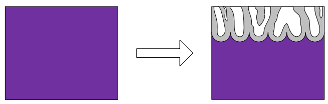


Snapshot at equilibrium



Nanoporous Anodic Alumina

Free Standing Membrane Fabrication



1^{st} Anodization

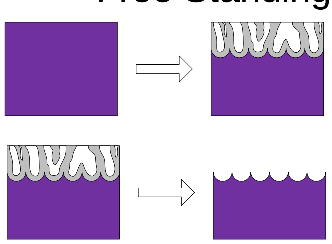
Al

Al_2O_3

air

Nanoporous Anodic Alumina

Free Standing Membrane Fabrication



1^{st} Anodization

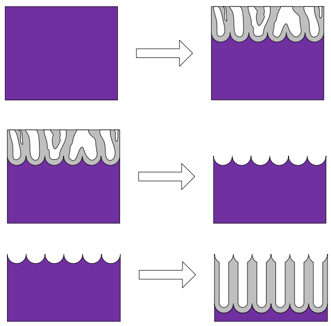
Oxide Removal

Al

Al_2O_3

air

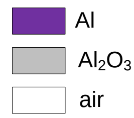
Free Standing Membrane Fabrication



1^{st} Anodization

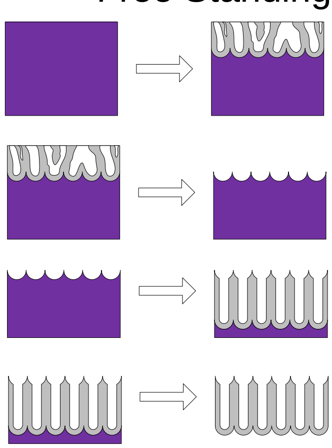
Oxide Removal

2^{nd} Anodization



Nanoporous Anodic Alumina

Free Standing Membrane Fabrication

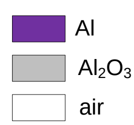


1^{st} Anodization

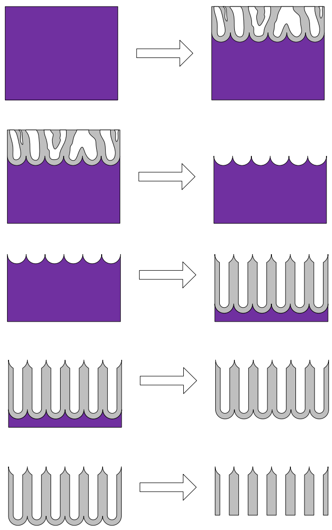
Oxide Removal

2^{nd} Anodization

Al Removal



Free Standing Membrane Fabrication



1^{st} Anodization

Oxide Removal

2^{nd} Anodization

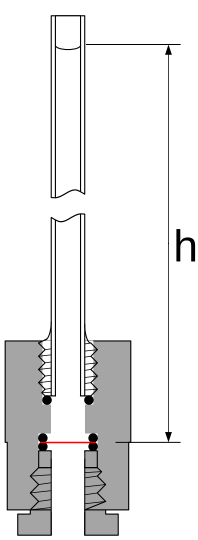
Al Removal

Barrier Layer Removal

Al

Al_2O_3

air



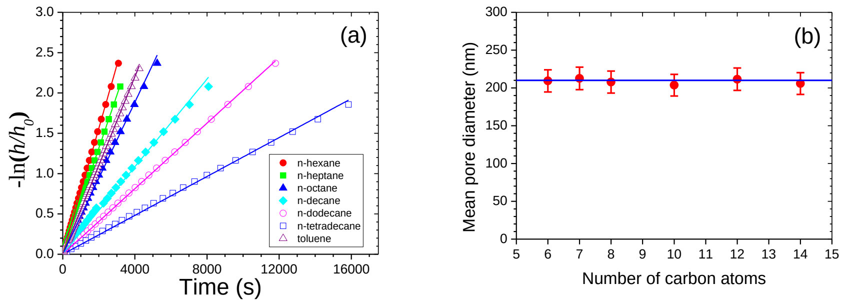
Poiseuille's law $$Q = \frac{\pi R^4}{8\eta l}\Delta P$$

$$Q = \frac{N\pi R^4}{8\eta l}\Delta P = \frac{N\pi R^4}{8\eta l}\rho g h \qquad Q = \frac{dV}{dt} = \frac{S_t dh}{dt}$$

$$\frac{dh}{h} = \frac{nNR^4\rho g}{2\eta l D_t^2}dt \qquad -\ln\frac{h}{h_0} = \frac{NR^4\rho g}{2\eta l D_t^2}t = Bt$$

Schematic view of the experimental set-up consisting of a Teflon cell and a scaled glass tube, for the determination of the flow rate through nanoporous alumina membrane.

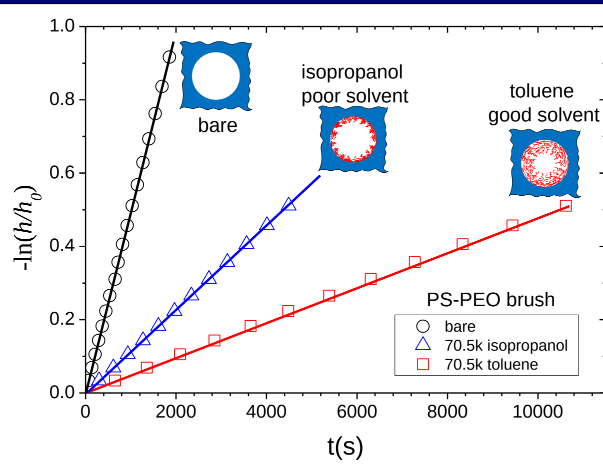
Nanoporous Anodic Alumina



$$-\ln\frac{h}{h_0} = \frac{NR^4\rho g}{2\eta l D_t^2}t = Bt$$

(a) Plot of -ln(h/h_0) vs. time diagram for various solvents through bare porous alumina membrane.
(b) Pore diameter determination for the various slopes, B of diagram (a)

Nanoporous Anodic Alumina



Plot of -ln(h/h_0) vs. time diagram for the flow of toluene through bare porous alumina membrane (black,) and for flow of isopropanol (blue) and toluene (red) through porous alumina membrane in which the polymer brush of PS-PEO with molecular weight 70.5k has been formed.

Conclusions

- Porous Anodic Alumina: A versatile template for nanofabrication.
- Controlled porous diameter and interpore distance
- Can be Functionalized or Modified

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