Electronic Supplementary Material (ESI) for Lab on a Chip

Supplementary Information

Low-voltage electroosmotic pumps fabricated from track-etched polymer membranes

Ceming Wang[a], Lin Wang[a] ,Xiaorui Zhu[a], Yugang Wang[a b] and Jianming Xue[a b *]

[a] *State Key Laboratory of Nuclear Physics and Technology, Peking University, Beijing 100871, People's Republic of China*

[b] *Center for Applied Physics and Technology, Peking University, Beijing 100871, People's Republic of China*

* *Corresponding author*：*jmxue@pku.edu.cn; Tel: 86-10-62758494; FAX: 86-10-62751875.*

Table of Contents

Conductometric measurements on single pores

In order to fabricate samples with specific pore diameters, we first performed conductometric measurements on single pores to obtain the average etching rate, which can be used as a reference for etching porous track-etched polymer membranes.

Take PC samples for example; we first etched different single-pore track-etched PC membranes for a series of etching time respectively in beaker placed in a constant temperature bath. These single-pore membranes irradiated under the same conditions contain only one latent track. The etching recipe was 6 M NaOH aqueous solution at 50 □. The diameters of single pores can be determined based on their ionic conductance. The diameter, d_S, of a cylindrical pore with resistance R=U/I and specific conductivity κ is given by

$$d_S = \sqrt{\frac{4LI}{\pi \kappa U}}$$

where L is the length of the pore, corresponding to the membrane thickness. U is the applied voltage and I is the measured current. In our experiments, we used 1 M KCl aqueous solution (κ=11.6 S/m) to perform the conductance measurements. Two Ag/AgCl electrodes connected with Keithley 6487 picoammeter were used to record ion current. Fig. S1 is the schematic diagram of ion current recording system. Conductometric measurements of single-pore diameters in track-etched PC membranes showed that their diameters scaled with etching time yielding an average etching rate of ~10 nm/min.

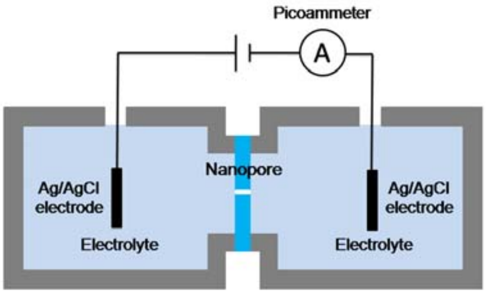

Fig. S1 The schematic diagram of ion current recording system for conductometric measurements.

The measurements of pore diameters with SEM

The etching rate obtained with conductometric measurements was used as a reference to etch porous track-etched PC membranes with specific pore diameters. We etched the PC foils for 10, 15 and 20 minutes so that the diameters of the nanopores are approximately 100, 150 and 200 nm, respectively. Actually, the referential etching rate (this method) is not efficient to all track-etched membranes due to experimental uncertainties. We checked these as-prepared samples and made detailed measurements of the pore diameters through their SEM images. The following SEM images (Fig. S2) are shown as an example. These as-prepared samples with undesired pore diameters were discarded in our experiments. The same method was used to fabricate the track-etched PET membranes with pore diameter of around 250 nm. We also analyzed the pore diameters of about 100 pores in each sample and the results show that the relative standard deviations of pore size are typically less than 10%.

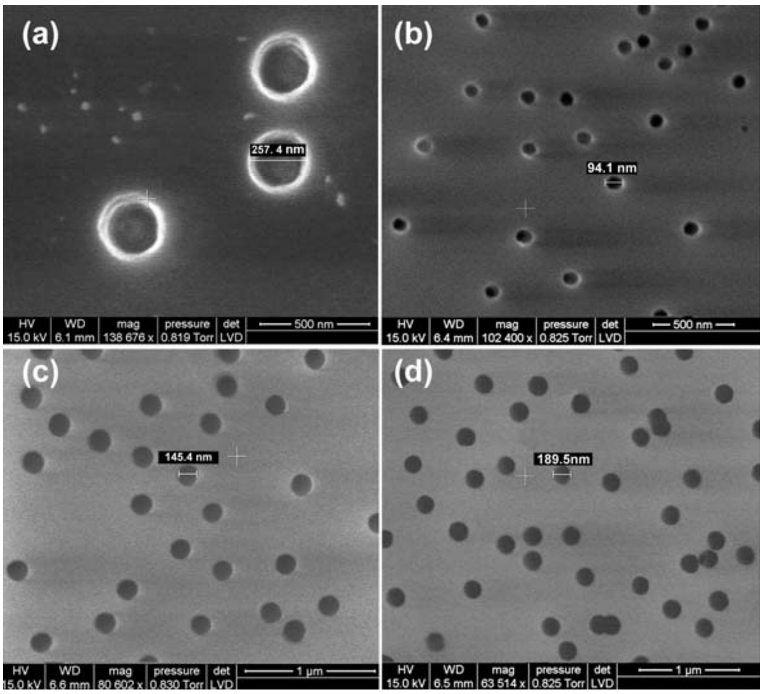

Fig. S2 SEM micrographs of (a) track-etched PET membrane with 10^8 pores cm^{-2} and pore diameter of approximately 250 nm, and track-etched PC membranes with $5{\times}10^8$ pores cm^{-2} and pore diameter of approximately (b) 100 nm, (c) 150 nm and (d) 200 nm, respectively.

Preparation of cleavages of track-etched polymer membranes

Comprehensive information on the shapes of track-etched pores can be obtained by analyzing the SEM images of cross sections of these track-etched polymer membranes, which is realized by exploring the cleavages.

We have prepared cleavages of our samples to investigate their structures by SEM. It is well known that the absence of sample strains in the preparing cleavages is an important requirement. Otherwise, a cleavage fails to represent the primary structure. To avoid residual strains, we used a method proposed by O. L. Orelovich and P. Yu. Apel *et al.* [1] to prepare cleavages. These cleavages were prepared by γ-radiation destruction of the samples in ambient air. The absorbed dose was about 2.5 MGy (at ~ 8 Gy/s dose rate). The cross-sectional SEM images show that the resulting track-etched PC and PET membranes consist of an array of straight, cylindrical pores with a tortuosity approaching unity.

Reference

[1] O. L. Orelovich and P. Yu. Apel, Instruments and Experimental Techniques, Vol. 44, No. 1, 2001, pp. 111–114.