Electronic Supplementary Material (ESI) for Nanoscale.

Ultra-sensitive flow measurement in individual nanopores through pressure-driven particle translocation

Supplementary information

Materials and methods

Nanopores were fabricated by FIB milling in 50 nm commercial SiN membranes, with diameters between 150 and 200 nm. Various FIB scan protocols were tested in order to obtain straight cylinders. Electrical measurements were carried out in the same home-made electrochemical cell previously described by our group[1]. The reservoirs consist in 2 cm^3 PEEK chambers. The squeezing is ensured via a third part pushing the top chamber by a screw to the bottom one ensuring a parallel contact during sealing. The sealing is performed via two O-rings directly on the membrane. Before each set-up insertion, a careful cleaning of the chambers and of the O- ring is performed using soap (MicroSon, Fischer Scientific) and 15 minutes of ultrasound at 60^{o}C, followed by rinsing with deionized water (Millipore). Careful use of Teflon nip is performed to avoid scratch and potential leak on the chamber. Two Ag/AgCl electrodes were embeddded in the PEEK reservoir on each side, as represented in figure 1.

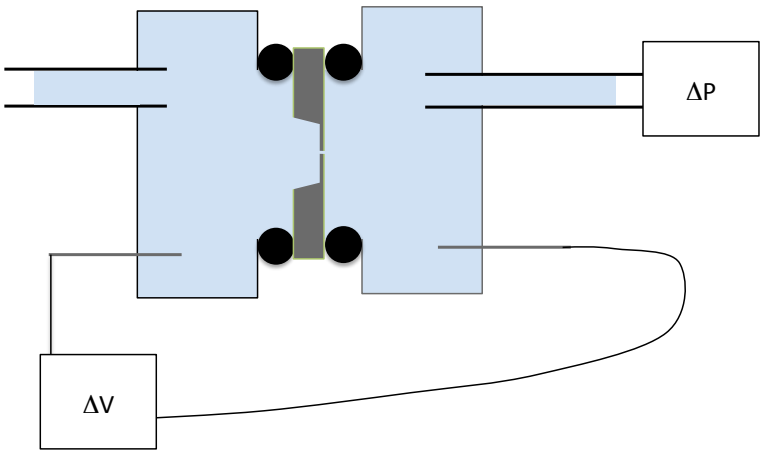

Figure 1 Sketch of the experimental set-up.

[1]Siria, A.; Poncharal, P.; Biance, A.-L.; Fulcrand, R.; Blase, X.; Purcell, S. T.; Bocquet, L. *Nature* **2013**, *494*, 455–458.

Each membrane was delicately blown and plasma cleaned for 1 minute, just before mounting in the cell. The cell was filled only on the SiN side of the membrane with pure water, degassed and filtered through a 220 nm syringe filter. 100 mbar pressure was applied for 30 minutes before filling the other half of the cell. The solution was then swapped with a 1 M KCl solution, buffered with Tris at pH 8.3, filtered and degassed. The colloidal solution was prepared just before measuring, using COOH-functionalized latex nanoparticles produced by Bangs Laboratories. Colloids were diluted in 1 M pH 8 solution, adding 0.01% v/v Triton X-100 as as surfactant, obtaining a final concentration of about 10^{11} particles/ml. Solution was agitated and then sonicated for 4 minutes. Then the solution in the *cis* was swapped with the colloidal solution. All electrical measurements were carried out inside a copper Faraday cage, on a stabilized optical table (Thorlabs), using an Axopatch 200B patch-clamp amplifier (Molecular Devices) in resistive feedback mode with an 8 pole, 100 kHz low-pass filter in output, then operating at the internal bandwidth of 70 kHz. The output signal from the amplifier was collected by a USB 6216 DAQ board (National Instruments) and digitized at 200 kHz. Current noise was about 58 pA RMS at 10 kHz filter bandwidth and 125 pA at 100 kHz. Pressure was applied using a 1.6 bar Elveflow AF1 compact pressure source (Elvesys). Each current recording was usually about 10-15 minutes long. Experiments on each nanopore usually concluded after a few hours at most, due to partial but irreversible clogging of the pore.

To ensure good analysis of the data, scatter plots showing the depth intensity versus dwell time are reported in figure 2 for the different experiments. Even a small tendency showing that the conductance blockade is smaller when dwell time decreases can be observed, this effect though very small can be attributed to our particular geometry. Indeed, a V-shape is expected, the bottom of the peak being reduced due to filtering. Similar scatter plots have been reported for different complex geometries [2].

[2] L.J. Steinbock, G. Stober, U.F. Keyser, *Journal of Applied Physics*, **2009**, 105(8):084702

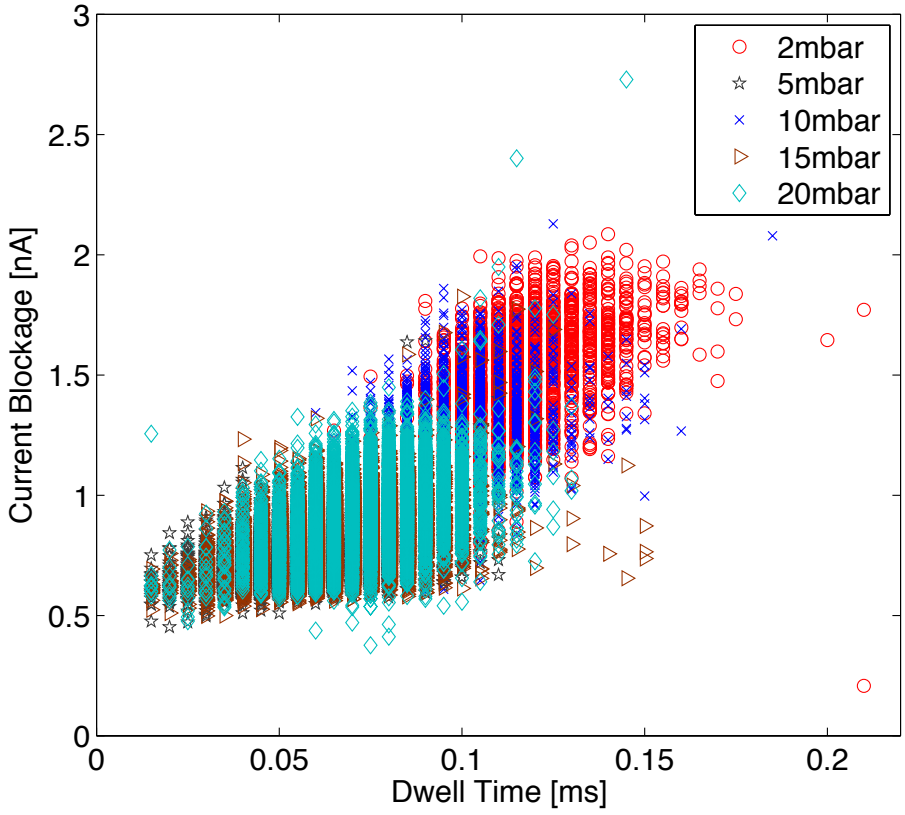

Figure 2 Scatter plots of dwell time versus current blockade for the five different applied pressures.