Electronic Supplementary Material (ESI) for Nanoscale. This journal is © The Royal Society of Chemistry 2018

# **Supporting information**

## 1. Set up of MLD equipment



**Figure S1.** Schematics diagram of homemade MLD set up, equipped with in situ FTIR spectroscopy and hot wall viscous flow vacuum chamber.



2. Thickness characterization of transferred polyurea film using AFM

**Figure S2.** Two-dimensional AFM image and the height profiles (along with red line in AFM image) of the (PDI/PDA)<sub>25</sub> polyurea MLD film transferred to a-Si layer on pyrex substrate. The blue arrow indicates the polyurea film and the right is the a-Si layer. The scan area is 10  $\mu$ m × 10  $\mu$ m.



3. Surface charge density characterization from ionic conductance of nanopore

**Figure S3.** I-V plots for (a) polyurea nanopore ( $h_{eff}$ =8nm) and (b) SiN nanopore ( $h_{eff}$ =9nm) at 1 M KCl electrolyte with TE buffer (pH=8). The experimental conductance value were fitted with the conductance equation. The conductance of five polyurea nanopores (c) and SiN nanopores (d) were used to characterize the surface charge density at 1 M KCl. The solid line indicates the surface charge density value with 10 mC/m<sup>2</sup>s intervals. The surface charge of polyurea nanopore is in  $-51 \pm 8$  mC/m<sup>2</sup> and SiN nanopore is in  $-14 \pm 5$  mC/m<sup>2</sup>.

4. 1/f noise characterization with variable mechanical stability of membrane



**Figure S4.** (a) TEM images of 7 nm polyurea nanopores with 25 nm thick 2µm opening membrane (Top) and 10 nm thick 0.15 µm opening membrane (Bottom) (b) Power spectral densities (PSD) for 3 kinds of 7 nm pores under 100 mV voltages in 1 M KCl electrolyte solution with TE buffer (pH 8.0), filtered at 100kHz. Each line results from fitting of the data to  $S = Af^{-\beta} + B + Cf + Df^2$ .

# 5. Lower DNA translocation frequency for polyurea nanopore compared to SiN nanopore in 1 M KCl electrolyte.



**Figure S5.** Ionic current traces with 2nM 1kbp dsDNA in cis-chamber for polyurea nanopore and SiN nanopore at 300 mV applied voltage, filtered at 100 kHz in 1 M KCl with TE buffer (pH 8.0).

#### 6. Salt dependence of ionic conductance



**Figure S6.** I-V plots on a. polyurea nanopore (a, d=8nm, h=9nm) and b. SiN nanopore (d=8nm, h=10nm) at 0.1, 1, 10, 100, 1000, 2000 and 2500 mM KCl electrolyte with TE buffer (pH=8). The experimental conductance value were fitted with the conductance equation. (c, d) The point is experimental conductance and blue line is calculated total conductance, which is a sum of geometry term and surface charge density term. The surface charge of polyurea nanopore (c) is in  $-50 \pm 5$  mC/m<sup>2</sup> and SiN nanopore (d) is ranging from -5.2 to -13 mC/m<sup>2</sup> at 0.1mM ~ 2.5 M KCl electrolyte.

### 7. In-pore diffusion coefficients and drift velocities for MDM2



**Figure S7.** Diffusion coefficients (*D*) and drift velocities (*v*) for MDM2 transport through polyurea and SiN nanopore used in Fig. 5, obtained from fitting dwell times to 1D diffusion-drift model treating *D* and *v* as free parameters.