## Supporting Information

## On-Chip Hydrodynamic Chromatography of DNA through Centimeters-Long Glass Nanocapillaries

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## EXPERIMENTAL SECTION

Device Fabrication. The devices were fabricated on p-type <100>-oriented double-side polished 100-mm-diameter silicon wafer substrates in a four-mask process. Fig. S-1 describes the device layout in a cartoon view as well as major fabrication steps in cutaway views. A set of trenches, each 3 µm wide and deep and 5 cm long, were patterned on silicon substrates in a serpentine layout through a contact mask aligner (MA6, Karl Suss, GmbH, Germany) and then engraved into the substrates through a deep reactive ion etch (DRIE) system (STS, Newport, UK). After stripping off the photoresist film, low pressure CVD (LPCVD; 180 mTorr; 420 °C) was applied on the substrates to deposit a phosphosilicate glass (PSG) layer 5.5 µm thick. As a result of non-conformal step coverage, the trench openings became gradually closed with the continuous deposition of PSG, leading to self-enclosed tunnels in triangular cross-sectional profile buried inside the trenches (Step 1). Subsequently, the wafers underwent thermal annealing (60 min at 1000°C) transforming the self-enclosed tunnels into cylindrical nanocapillaries (radius  $\sim 600$  nm), as a result of glass reflow which minimized the surface energy. Chemical mechanical polishing (CMP) was applied on the wafers to smoothen the PSG surface (Step 2). Amorphous silicon (a-Si) was deposited 100 nm thick through plasma-enhanced CVD (PECVD; Step 3) as an interfacial layer. Subsequently, an observation window was made into the relatively opaque a-Si film through a dry etch applied over the nanocapillaries. The sample injection junctions and U-shape delivery microchannels were lithographically patterned and etched to a depth of  $\sim 5 \,\mu m$  by applying advanced oxide etch (AOE) and DRIE (Step 4). These microchannels were then enclosed by sodium-rich borosilicate glass wafers placed over the silicon wafers and secured in place through anodic bonding (800 V, 400 °C, Step 5). Finally, fluidic access ports were created from backside with the removal of the PSG layer and bulk silicon through AOE and DRIE (Step 6).

**Pneumatic System.** Fig. S-2 illustrates a conceptual layout of the custom-built pneumatic system utilized during the microchip experiments. The pressure from a compressed gas cylinder was fed into four identical gas lines; the pressure of each gas line was independently controlled to a preset value through a dedicated regulator and switched on/off through a computer-controlled solenoid valve with a minimum switching time 10 ms (SMC, Tokyo, Japan). The microchip was sandwich-clamped inside a stainless-steel holder (not illustrated) with a set of fluidic access ports, each connected to a PTFE tube via Nanoport fitting (Upchurch Scientific, Oak Harbor, WA). The free ends of the tubes were immersed into liquid tanks (Elveflow, Pairs, France). The system was able to sustain pressure levels in excess of 140 psi. When a solenoid valve was switched on, the corresponding liquid tank was pressurized to the preset level, supplying the liquid content at a constant flow rate to a downstream port. However, when the solenoid valve was switched off, the tank pressure was released to atmosphere. As illustrated, screw plugs were placed to seal respective ports after venting gas bubbles during the initial filling stage.

## FIGURES AND TABLES



**Fig. S-1.** Schematics: (A) overall device layout and (B) critical fabrication steps illustrated for a single nanocapillary through transverse and axial cutaway views.



**Fig. S-2.** Conceptual layout of the pneumatic system utilized to perform sample injection and separation steps on the microchip.



**Fig. S-3.** (A) Plot of the migration velocity of fluorescein (FL) bands measured against the elution pressure. The solid line represents the best linear fitting ( $R^2 = 0.9976$ ); (B) Plot of the plate height against the measured migration velocity of FL bands. The solid curve describes the theoretically predicted values. The minimum achievable plate height: ~3.7 µm. Error bars:  $\pm 1$  s.d. (n = 5).