Electronic Supplementary Information

Modulating DNA Adsorption on Silica Beads Using an Electrical Switch

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Experimental

Buffer preparation

The buffers of pH 4.0, 5.0, 6.0 and 7.0 were prepared by mixing acetic acid (HAc), sodium acetate (NaAc) and sodium chloride (NaCl) (Table S1). The buffer of pH 10.0 was prepared by mixing 25 mL of 0.1 M Na_2HPO_4 solution and 0.87 mL of 0.1 M NaOH and then diluting to 100 mL.

Table S1 Preparation of 25 mM acetate buffer of different pHs

pH	1.0 M HAc (μL)	1.0 M NaAc (μL)	1.0 M NaCl (μL)	H_2O (mL)
4.0	2120	400	2120	95.4
5.0	900	1600	900	96.6
6.0	133	2400	133	97.4
7.0	14	2500	14	97.5

DNA labeling

λ-DNA (Sigma, St. Louis, MO) with 48,502 base pairs was stocked in 10 mM Tris-HCl buffer (pH 7.0). DNA samples were fluorescently labeled with YOYO-1 (Invitrogen, Carlsbad, CA) at a ratio of one dye molecule per five base pairs with a concentration of 1 nM in acetate and phosphate buffer solutions. After incubating the mixture at room temperature for at least 1 hr in the dark, these samples were further diluted to have a DNA concentration of 100 pM with proper buffer solutions immediately prior to the experiment.

Device operation

The inlet of the device was first connected to a syringe pump (PHD infusion pump, Harvard Apparatus, Hollistion, MA) through plastic tubing. A suspension of silica microbeads (4.8 μm diameter, Bangs laboratories, Fishers, IN, or 10 μm diameter, Corpuscular, Cold Spring, NY) with a concentration of 0.05% was subsequently loaded into the channel at 3 μL/min. After the beads packed to a length of ~400 μm in the microfluidic channel, DNA sample flowed into the channel at different flow rates (0.3 μL/min, 1 μL/min, 2 μL/min and 3 μL/min) for the study of electrical actuation of DNA adsorption. To apply electricity, microelectrodes were connected to a direct

current power supply with a constant voltage of 22 V. The packed bed was stable during the experimental runs. All experiments were conducted at 25 ± 1 ºC in the dark.

Fluorescence imaging

For fluorescence intensity measurements, the microfluidic device was mounted on an inverted fluorescence microscope (IX-71, Olympus, Melville, NY) equipped with a 20× dry objective and a CCD camera (ORCA-285, Hamamatsu, Bridgewater, NJ). The epifluorescence excitation was provided by a 100 W mercury lamp. The excitation and emission from λ-DNA labeled with YOYO-1 were filtered by a fluorescence filter cube (Exciter HQ480/40, emitter HQ535/50, and beamsplitter Q505lp, Chroma Technology, Rockingham, VT). One image was taken every two min. To avoid photobleaching, the shutter was normally closed, and opened for less than two seconds during image capturing. Images were processed using ImageJ (NIH, http://rsb.info.nih.gov/ij) software to acquire the fluorescence intensity data.

Supplementary Data

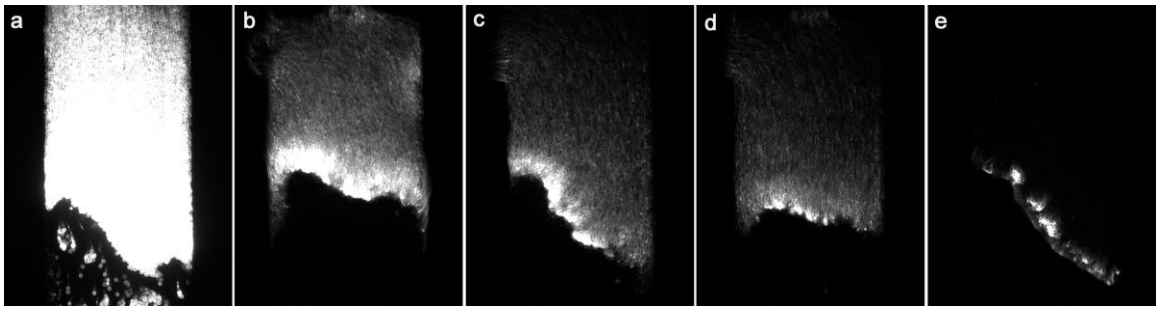

Fig. S1 Fluorescent images of DNA molecules adsorbed on silica beads (4.8 μm diameter) in (a) pH = 4.0, (b) pH = 5.0, (c) pH = 6.0, (d) pH = 7.0, and (e) pH = 10.0 buffers at a flow rate of 1 μL/min. Images were captured after the DNA solution flowed for 20 mins in the channel with a exposure time of 100 ms.

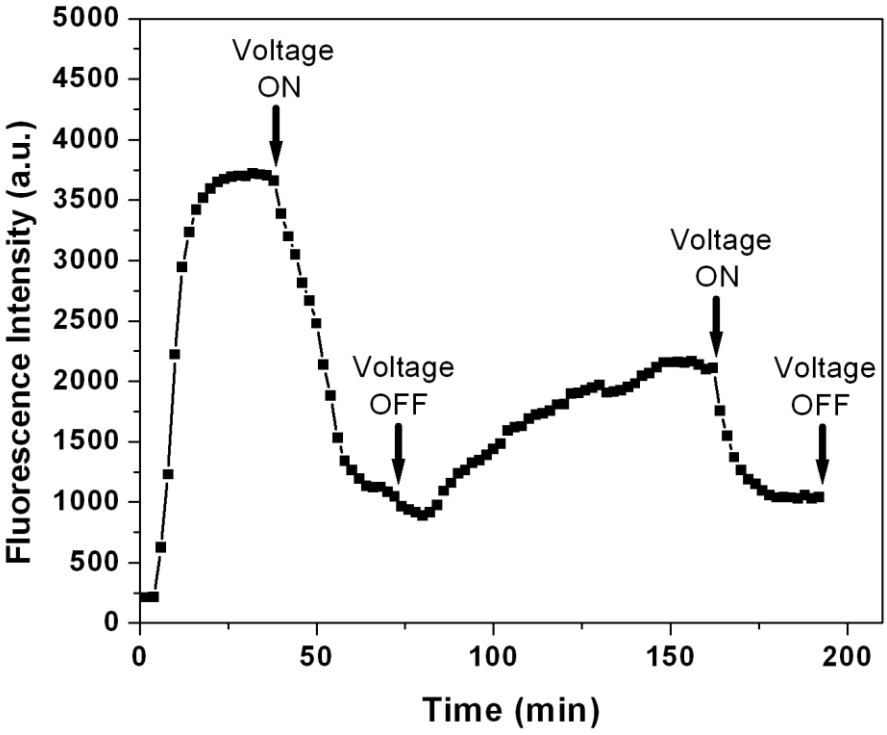

Fig. S2 The modulation of DNA adsorption on silica beads (10 μm diameter) by electricity in 25 mM acetate buffer solution (pH 7.0) at a flow rate of 2 μL/min. The arrows show the onset and the removal of the constant voltage (22 V). Exposure time for each fluorescent image was 100 ms.

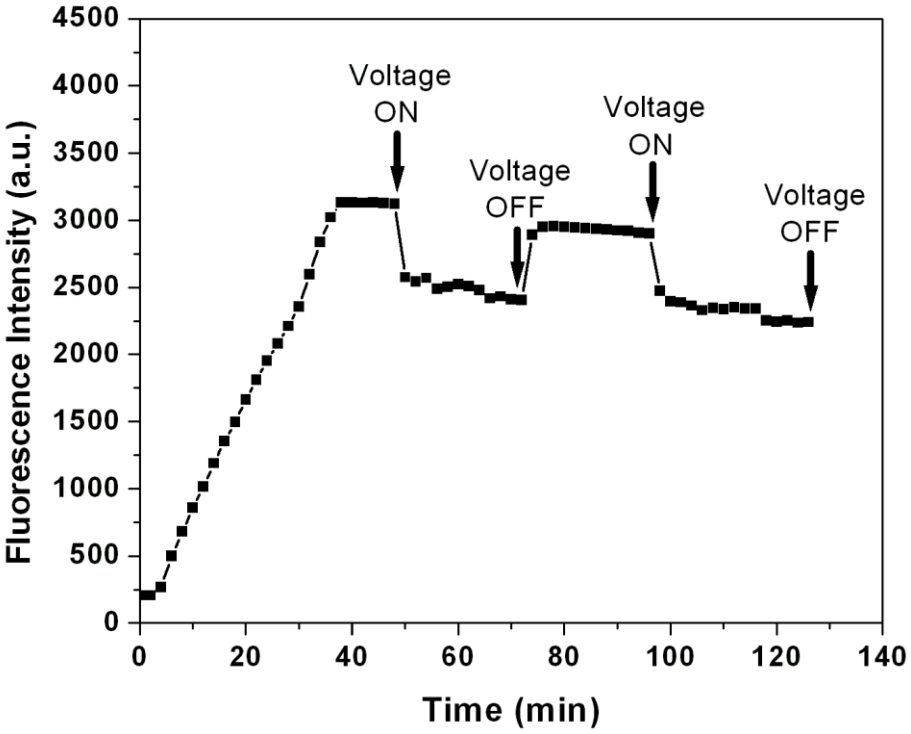

Fig. S3 The modulation of DNA adsorption on silica beads (10 μm diameter) by electricity in 25 mM acetate buffer solution (pH 4.0) at a flow rate of 1 μL/min. The arrows show the onset and the removal of the constant voltage (22 V). Exposure time for each fluorescent image was 100 ms.