Supplementary Material (ESI) for Lab on a Chip

Supplementary Information

PMMA/PDMS Valves and Pumps for Disposable Microfluidics

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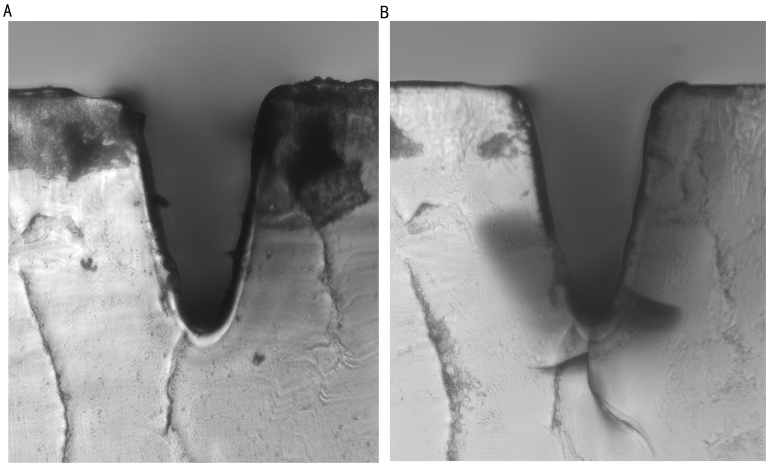

Fig S1. Microscope pictures of PMMA channel surface before (A) and after (B) LAH treatment. The surface of LAH treated PMMA channel and trench rim became smoother.

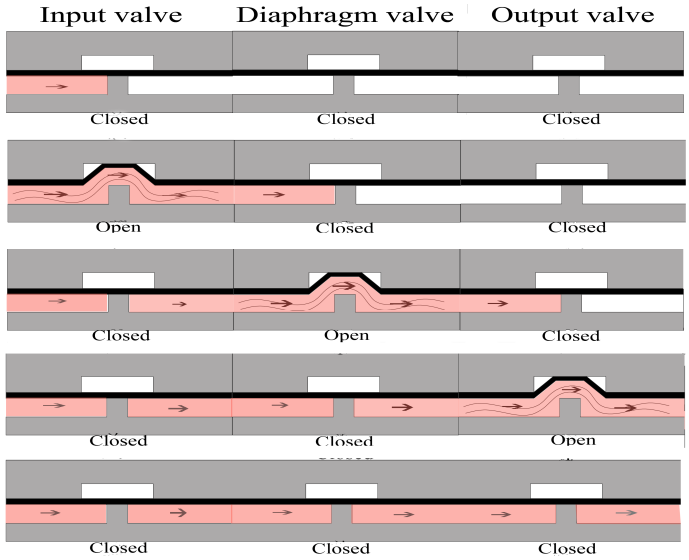

Fig S2. Schematic diagram of micropump pumping scheme. The pumping scheme involves cycles of three steps: (1) open input valve and close diaphragm and output valve; (2) open diaphragm valve and close input and output valve; (3) open output valve and close input and diaphragm valve.

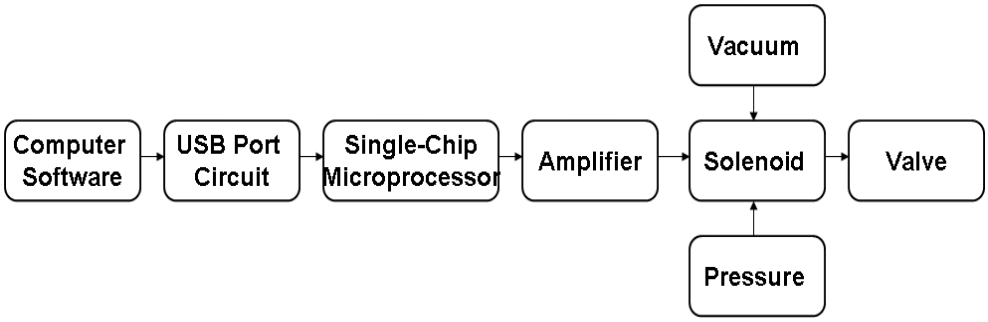

Fig S3. Schematic of microfluidic valve control device. Running parameters are typed in the program and transferred to the Single-Chip Microprocessor via a USB port, TTL signal from the Single-Chip Microprocessor is then amplified by a ULN2803 chip to activate solenoid which regulates pressure in the displacement chamber.

XPS Analysis of PMMA and PDMS Surface:

X-ray photoelectron spectroscopy (XPS) is a quantitative spectroscopic technique that can be used to analyze the surface elemental composition of a material. It provides abundant information about the chemical composition and chemical environment of elements at the surface of solids. Therefore, it is extremely useful for the investigation of chemical changes on the surface of polymers (PMMA and PDMS) after UV-ozone treatment. A Quantum 2000 (Physical Electronics Inc. USA) XPS was used for the analysis of PDMS and PMMA. XPS spectra showed in Fig S4 reveals the changes in the chemical composition of the irradiated PDMS and PMMA after treating with UV ozone for 10min. For example, the C1s signal (See Fig. S4A) of PDMS didn't change much after the treatment while the O1s signal (Fig. S4B) increased after the irradiation. The change of O1s was likely due to the generation of hydroxyl groups on PDMS surface upon UV ozone treatment. Similarly, the O1s XPS spectra of PMMA changed remarkably after UV ozone treatment while the C1s remained unchanged (Fig. S4C-D). Oxygen in C=O groups (ketone, lactone, carbonyl) has a lower binding energy (531.9-532.3) while has a higher energy (533.3–533.7 eV) in C–OH and/or C–O–C groups. The increase of O1s XPS intensity at higher binding energy from treated PMMA clearly indicates the generation of OH groups as a result of UV ozone treatment. Our XPS results were consistent with FT-IR results, suggesting the generation of hydroxyl groups on PMMA and PDMS upon UV ozone treatment.

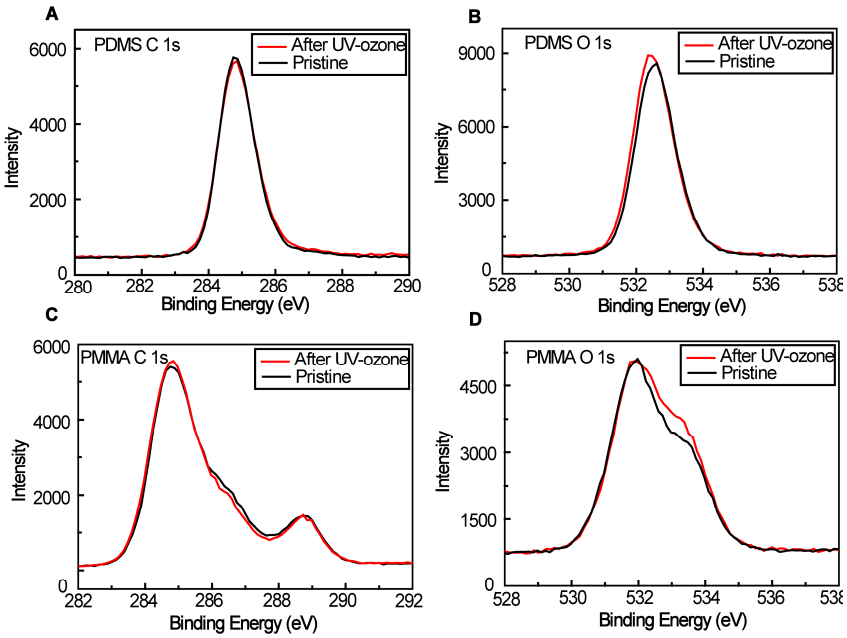

Fig S4. C1s and O1S XPS of PDMS and PMMA before and after 10 minutes UV ozone treatment.

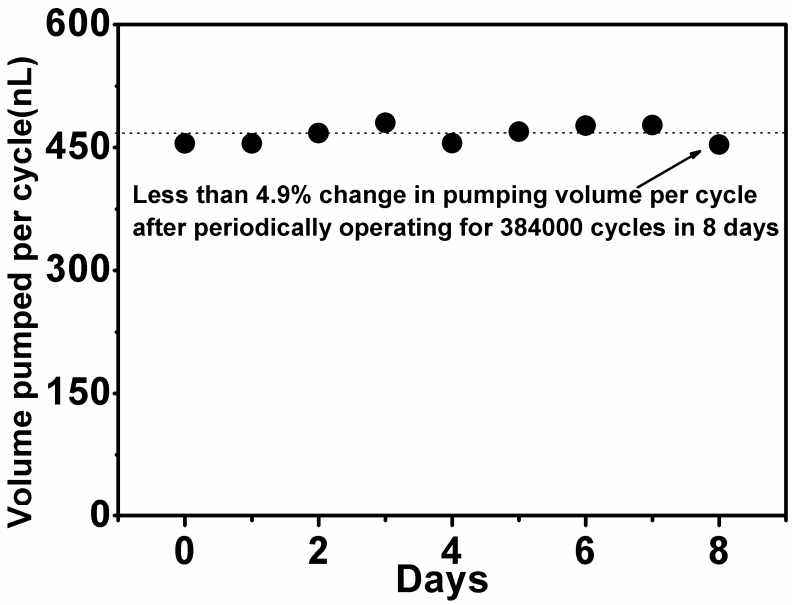

Fig S5. Volume pumped per cycle by a 1712nL PDMS diaphragm pump after 0, 1, 2, 3, 4, 5, 6, 7 and 8 days of periodically pumping.

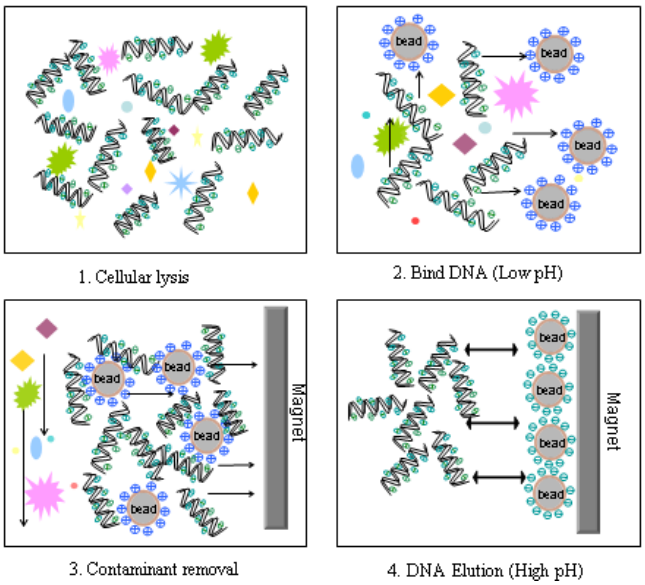

Fig S6. Schematic diagram of DNA extraction using charge-switching micromagnetic beads. At low pH conditions, the beads have positive charges that bind the negatively charged DNA backbone. Proteins and other contaminants are not bound and are simply washed away in an aqueous wash buffer (pH 5.0). To elute DNA, the bead surface charge is switched to negative by raising the pH to 8.5 using a low salt elution buffer.

Cost Analysis

To suit for disposable applications, a device should be as inexpensive as possible. Using PMMA as the substrate for valves and pumps has its advantages of fast fabrication and low cost. We compared the in-house production cost and time for fabricating glass and PMMA pumps in house. The total cost for making a glass pump was about $20, which was much higher than the cost of a PMMA pump ($0.47) (see Fig S7). Moreover, it takes 80 hours to manufacture a glass pump, while a PMMA pump takes only 2 hours (Supplementary Table S1). In comparison, the cost and time of machining a PMMA chip were negligible and thus made PMMA pump attractive for disposable microfluidic devices.

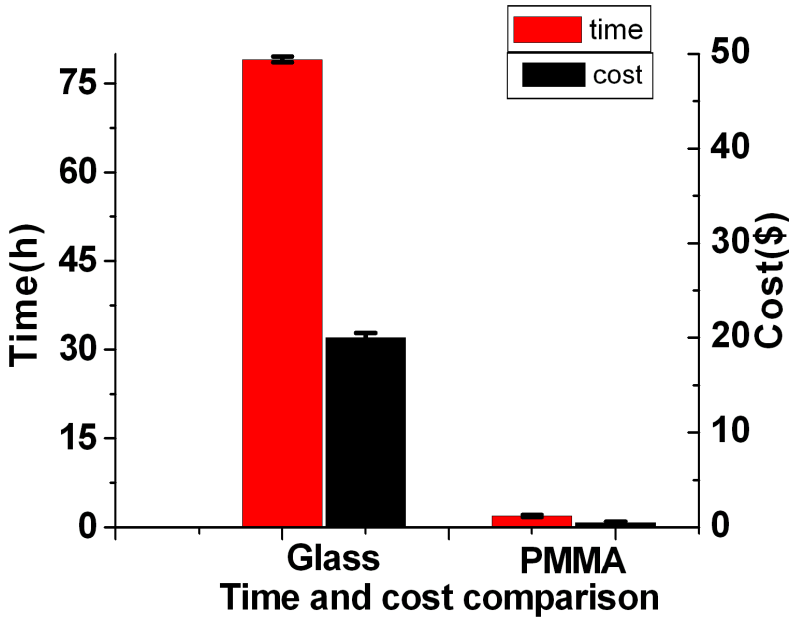

Fig S7. The cost of a glass chip was 22 times more expensive than PMMA and the consuming time was 40 times more as well.

	Glass	PMMA
Material cost ($)	11	0.40
Fabrication cost($)	9	0.07
Total cost ($)	**20**	**0.47**
Mask fabrication (h)	72	0
Chip machining (h)	8	2
Total time (h)	**80**	**2**

Supplementary Table S1 Cost analysis for making a Glass pump and PMMA pump in house