Supplementary Material (ESI) for Lab on a Chip


# Triggering vacuum capillaries for pneumatic pumping and metering liquids in point-of-care immunoassays

Kuo-Yao Weng[1,2*], Nien-Jen Chou[2], and Jya-Wei Cheng[1*]

[1] Institute of Biotechnology and Department of Life Science, National Tsing Hua University, Hsinchu 300, Taiwan ; [2] Medical Electronics and Device Technology Center, Industrial Technology Research Institute, Hsinchu 300, Taiwan

# Electronic Supplementary Information

**Materials**. Luteinizing Hormone from human pituitary was obtained from the Sigma-Aldrich Co. Luteinizing hormone immunochromatographic strips were obtained from Genmedika Biotechnology Corp. (Taipie,Taiwan). UV adhesives (Loctite 3211) were purchased from Henkel Loctite (Düsseldorf, Germany). Borosilicate glass capillaries were purchased from Asahi Techno Glass (Chiba, Japan). Polyethylene capillary tubing (O.D. 1.8mm, I.D. 1.0mm) was supplied by GE Healthcare. 0.25mm

thickness of polytetrafluoroethylene film (Teflon$^{TM}$), FP301350, was obtained from Goodfellow Corporation. Laminating pouch films and the laminating machine were obtained from local office stationery suppliers.

**Fabrication of vacuum capillaries and metering volume test**. A vacuum glass capillary could be made by heating one end of a borosilicate glass capillary (O.D. 0.78mm, I.D. 0.63mm) by the hand-held butane refillable micro torch supplied by Blazer Products (NY, USA) to melt the glass to form a first closed end. This can be seen schematically illustrated in Figure S1a. The vacuum pump (model DOA-P104-AA) purchased from Gast Manufacturing (Benton Harbor, MI, USA) was used to pump air out of the glass capillary through the open end (Figure S1b). After evacuating air for 1 min. the glass capillary was heated at different locations from the first closed end (e.g. 20, 30, 40 and 50mm), as shown in Figure S1c. The heat softened glass could be pinched or twisted to form a second closed end (Figure S1d). The vacuum glass capillaries of different lengths were inserted and fixed in the polyethylene capillary tubing sealing one end by dipping UV adhesives and exposing to UV light. Another end of the packed tubing was inserted in the beaker filled with deionized water. The glass capillaries was broken resulting in a set volume of water being drawn into the polyethylene capillary

tubing. The increasing weights of the packed tubing were measured and the total volumes of water taken in were calculated by water assuming the water density to be 1.0 g/cm$^3$.

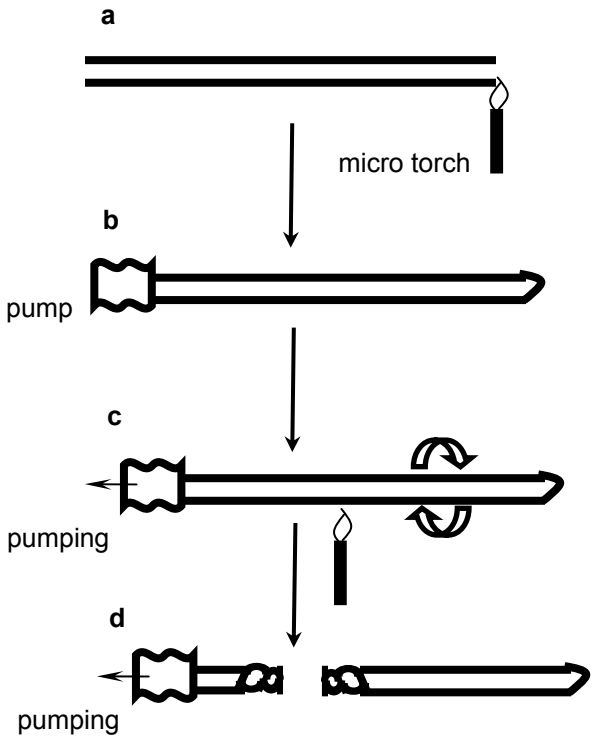


Figure S1. Schematic diagram depicting the fabrication of vacuum capillaries. (a) The glass capillary is melted by micro torch to seal one end. (b) The other end of capillary is connected to pump for

evacuating air. (c) Twist and pull the capillary during the pumping period. (d) The vacuum capillary has been constructed completely.

**Variation source of the vacuum glass capillaries.** To analyze the I.D. variation of the original glass capillaries, the increasing weight of the different nominal O.D. capillaries was measured after the capillaries were loaded with the deionized water. The length of the vacuum capillaries fabricated by the processes in Figure S1 was measured using the digital caliper. The detailed results are shown in the Table S1. The original I.D. variations were 2~3% and the length variations of the vacuum by the manual handling processes were also 2~3%. The length variation control will be improved if the processes are implemented for mass production. Based on the current fabrication processes, the smaller variations are in the longer vacuum capillary. The 50mm nominal vacuum capillaries are implemented in the fluidic card.

Table S1 The measured size of the different capillaries and the fabricated vacuum capillaries.

| | Measured I.D. of the different O.D. capillaries[a] | | | Measured length of the vacuum capillaries[b,c] | | | |
|---|---|---|---|---|---|---|---|
| Nominal size (mm) | 1.0 | 0.8 | 0.5 | 20 | 30 | 40 | 50 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Mean (mm) | 0.896 | 0.646 | 0.380 | 18.98 | 29.77 | 39.21 | 47.87 |
| St. Dev. | 0.018 | 0.015 | 0.010 | 0.451 | 0.785 | 0.483 | 0.242 |
| C.V. (%) | 2.06 | 2.35 | 2.58 | 2.37 | 2.64 | 1.23 | 0.50 |

[a] Ten independent experiments. [b] The nominal O.D. of capillaries is 0.8mm. [C] Three independent experiments.

**The concept of portable lab-on-a-chip fluidic cards** is illustrated in Figure S2.

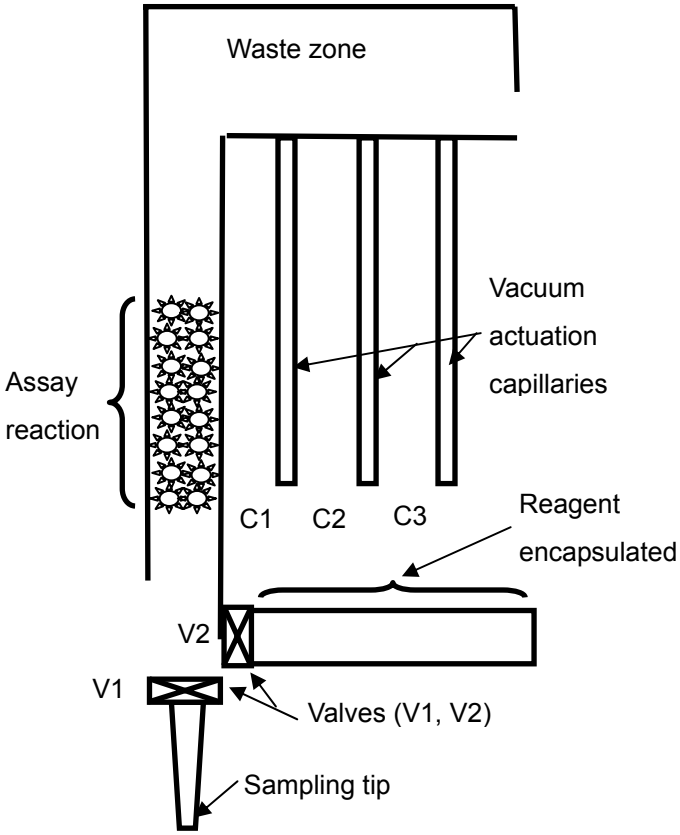


Figure S2. Schematic diagram depicting the concept of portable lab-on-a-chip fluidic cards incorporated with vacuum actuation capillaries. Assay performance in the following procedures: (i) to draw patient sample into the reaction zone for assay reaction from the sampling tip by breaking C1 capillary and opening V1 valve, (ii) then to introduce encapsulated reagents into the reaction zone (e.g. washing purpose) by breaking C2 capillary after closing V1 valve and opening V2 valve, (iii) finally to remove reagent by breaking C3 capillary for further signal detection.