Electronic Supplementary Material (ESI) for Lab on a Chip.

Supporting information

A One-Step Strategy for Ultra-Fast and Low Cost Mass Production of Plastic Membrane Microfluidic Chips

Chong Hu,[a] Sheng Lin,[a] Wanbo Li,[a] Han Sun,[a] Yanfan Chen,[b] Chiu-Wing Chan,[a] Chung-Hang Leung,[c] Dik-Lung Ma,*[ade] Hongkai Wu*[b] and Kangning Ren*[ade]

---

[a] *Department of Chemistry, Hong Kong Baptist University. Waterloo Rd, Kowloon, Hong Kong, China. kangningren@hkbu.edu.hk, edmondma@hkbu.edu.hk*

[b] *Department of Chemistry, The Hong Kong University of Science and Technology, Clear Water Bay, Kowloon, Hong Kong, China. chhkwu@ust.hk*

[c] *State Key Laboratory of Quality Research in Chinese Medicine, Institute of Chinese Medical Sciences, University of Macau, Macao, China.*

[d] *HKBU Institute of Research and Continuing Education, Shenzhen, China.*

[e] *State Key Laboratory of Environmental and Biological Analysis, The Hong Kong Baptist University, Waterloo Rd, Kowloon, Hong Kong, China.*

Cost in Device Production

Three factors are frequently considered in the production of commercial devices: (1) the cost of material and energy; (2) the cost of time; and (3) the generation of waste and pollution. In the production of microfluidic devices, even the broadly used, relatively cost-efficient materials are still more costly than normal plastics, e.g., PDMS is supplied at around 180£ per 1.1 kg Kit[1]. In terms of time consumption, the fabrication of semiconductor chips normally takes a couple of days, while that for PDMS chips takes about 2 days including template preparation, and a few hours solely for reproduction from an existing template. Finally, the production of microchips often involves considerable amount of toxic chemicals and wastes. For instance, the fabrication of semiconductor chips consumes approximately 45 g of chemicals (e.g., solvents, photolithographic chemicals) per cm^2 chip area.[2,3]

In sharp contrast, our process involves no solvent or waste, and completes a product within 12 s. The plastic membranes used are available at very low price (less than \$0.0002 per cm^2). Therefore, our method could be taken as an ultra-low cost, super-fast, and green process.

References

1. http://www.mgchemicals.com/products/rtv-silicones/potting-compounds/rtv615
2. E. D. Williams, R. U. Ayres, and M. Heller. *Environ. Sci. Technol.* 2002, **36**, 5504–5510.
3. M. Schmidt, H. Hottenroth, M. Schottler, G. Fetzer, and B. Schlüter. *Int. J. Life Cycle Assess*, 2012, **17**, 126–144.
4. http://www.bpf.co.uk/plastipedia/polymers/LDPE.aspx

Choosing of Materials for the Stamp

Table S1. Tested materials as the mold for fabricating microfluidic chip by single-step hot pressing.

Materials	Performances			Suitable for forming microchannel
	Melting temperature (°C)	Thermal conductivity	Nonstick to LDPE film	
Teflon PFA	240-260	Good	Good	Yes
PS/PMMA	130-140	Fair	Poor	No
PDMS	N/A	Poor	Poor	No
Glass	N/A	Good	Poor	No
Metal (Al)	660	Good	Poor	No

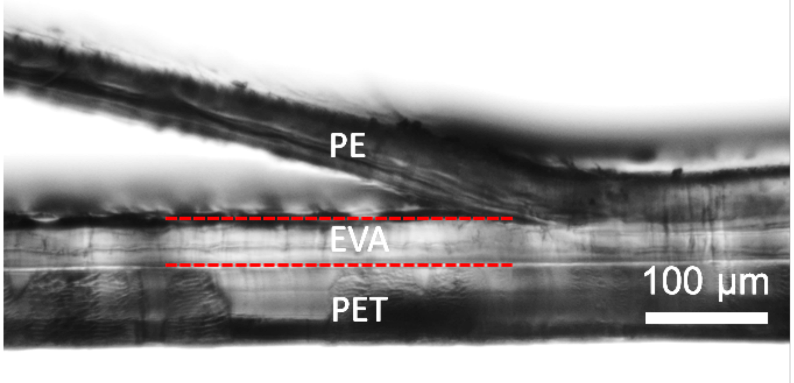

Figure S1. Bright-field microscopic image of the cross section of a bonded plastic membrane chip. The bottom layer of the plastic membrane is a hybrid of EVA and PET, and the top layer is PE. The dash lines indicate the boundary of the three layers.

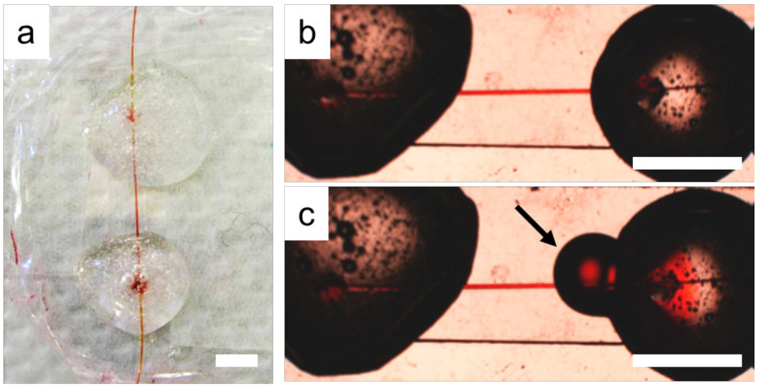

Figure S2. Test of the bonding strength of our method. The connection interfaces at channel inlet and outlet were fixed by epoxy glue (**a**). The 100-µm wide microchannel and the connection interfaces were well sealed when the air pressure was up to 290 kPa (**b**). The connecting interface broke (arrow) when the air pressure was 300 kPa, but the microchannel still did not leak (**c**). Scale bars are 2 mm.

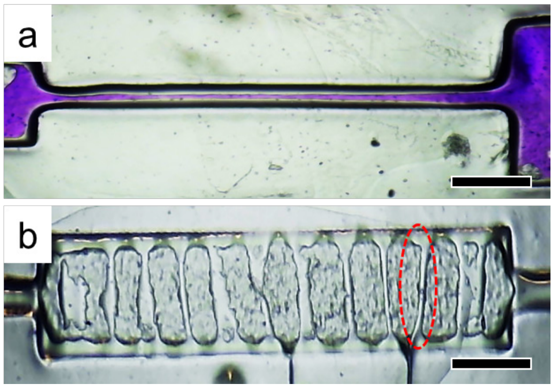

Figure S3. Test of the fabrication performance with PE membranes of different thicknesses. (**a**) The channel (filled with crystal violet dye) was fabricated using 20-µm thick LDPE membrane. (**b**) Channels were merged (oval) with bottom EVA coated PET layer using 10-µm thick cling wrap. Scale bars are 250 µm.

Table S2. Analysis of inter-chip reproducibility of fluid delivery

A thin-film chip containing a volume-determining chamber was used in the test of peristaltic pumping of 75% ethanol aqueous solution. The weight of delivered liquid was measured by an analytical balance. Three repeated measurements were performed for each chip and four chips were tested. The results of the test were analyzed using ANOVA, and the between-device deviation was found to be insignificant compared to the within-device deviation, suggesting that the devices made with the same design could be used as substitutes of each other with good analytical reproducibility.

Weight of delivered liquid (g) for three repeated measurements

chip1	chip2	chip3	chip4
0.0020	0.0019	0.0018	0.0018
0.0022	0.0022	0.0020	0.0021
0.0023	0.0019	0.0023	0.0018

Result of ANOVA analysis

ANOVA						
Source of Variation	**SS**	**df**	**MS**	**F**	**P-value**	**F crit**
Between Groups	1.33E-07	3	4.44E-08	0.9588	0.4576	4.066
Within Groups	3.71E-07	8	4.63E-08			
Total	5.04E-07	11				

Table S3. Blinded test of lead concentration in spiked water samples

Five samples were prepared and analyzed. The measured concentrations were compared with the initial concentrations of the sample, and the two-tailed P value of a paired T-test between these two groups was 0.5858, indicating that no significant difference between the two groups was observed at 95% confidence level.

	FI	MC (nM)	IC (nM)	Recovery (%)
sample1	38.905	487.4861	500	97.50
sample2	48.242	660.0739	650	101.55
sample3	64.243	955.841	1000	95.58
sample4	38.167	473.8447	450	105.30
sample5	22.732	188.5397	200	94.27

FI:	Fluorescence intensity
MC:	Measured Concentration
IC:	Initial Concentration

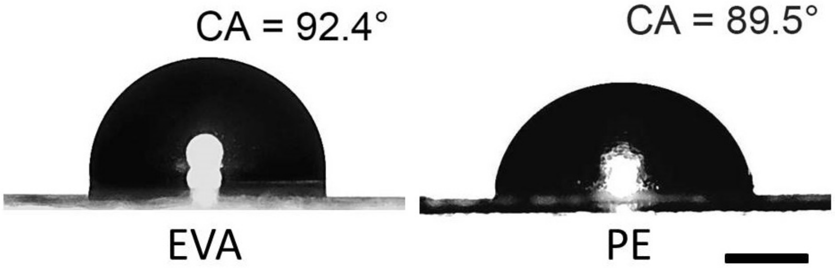

Figure S4. Advancing water contact angle on EVA and PE surfaces. Tests were conducted at 20° C using deionized water. Scale bar is 1 mm.

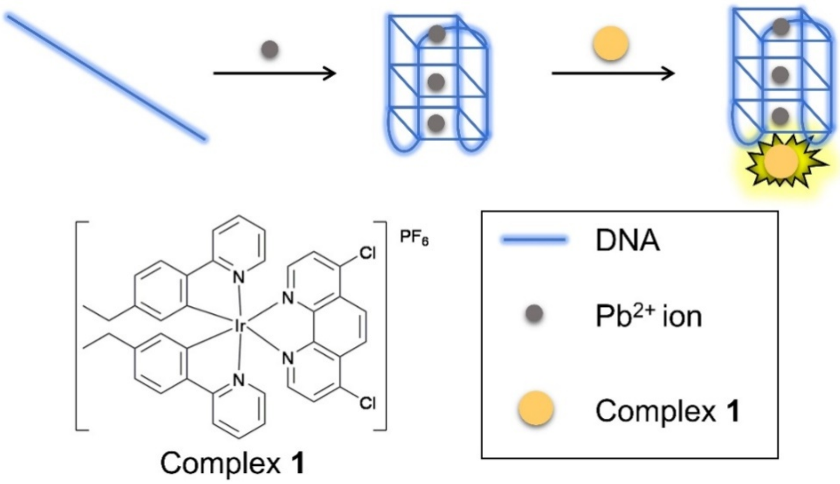

Figure S5. Schematic illustration of the formation of G-quadruplex in the presence of Pb^{2+} ions and the structure of luminescent switch-on probe complex **1**.