Electronic Supplementary Material (ESI) for Analytical Methods.

Electronic Supplementary Material

Fabrication of Paper-based Analytical Devices by Laminating Method with Thermal Ink Ribbon, Sticky Notes, and Office Appliances

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Table S1. Average areas of dye on the paper substrate after loading to the sample pools under various conditions

Ink Deposition time	**Heating time/min**	S/mm²	S_0/mm²	S_{MASK}/mm²
Single	0	153.8	89.30	78.50
	5	127.6	100.0	78.50
	10	113.3	88.98	78.50
	30	96.02	95.73	78.50
	60	90.00	93.57	78.50
Double	0	154.8	93.00	78.50
	5	91.69	91.63	78.50
	10	87.79	91.56	78.50
	30	82.85	94.82	78.50
	60	77.40	93.49	78.50
Triple	0	139.7	91.58	78.50
	5	87.60	88.81	78.50
	10	84.72	90.09	78.50
	30	79.53	90.71	78.50
	60	72.51	88.43	78.50

Table S2. Tolerance of hydrophobic barrier to various chemical solvent

	Single printing	Double printing	Triple printing
Ultrapure Water			
Aqueous ethanol (20 vol%)			
Aqueous ethanol (40 vol%)			
Aqueous ethanol (60 vol%)	△	△	×
Aqueous ethanol (80 vol%)	×	×	×
Ethanol	×	×	×
DMSO			
DMF			
Ethylene glycol			

: Solvent was not leaked (Tolerable).

×: Solvent was leaked (Not tolerable).

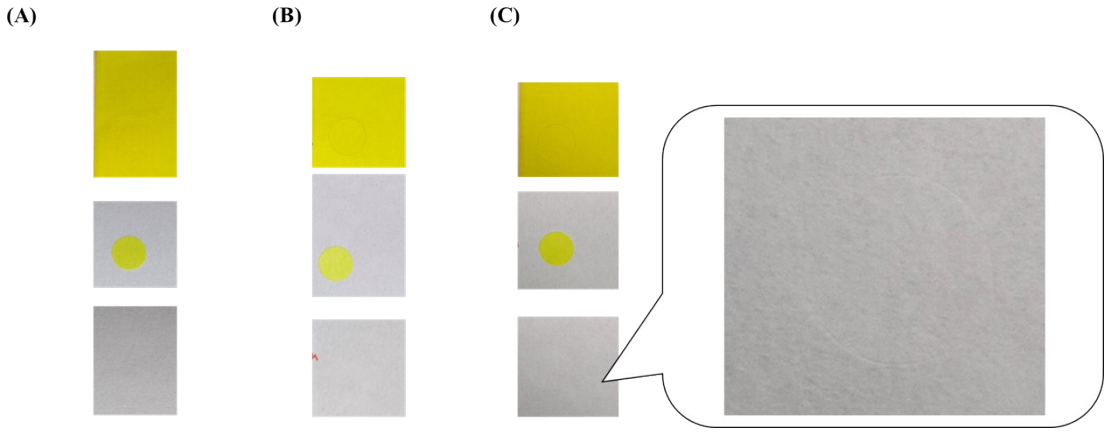


Figure S1 Optimization of cutting depth (A)0.1 mm (B) 0.2 mm (C)0.3 mm
(from top to bottom) surface right after cutting, after removing excessive sticky notes only to remain masks and paper substrate after removing masks

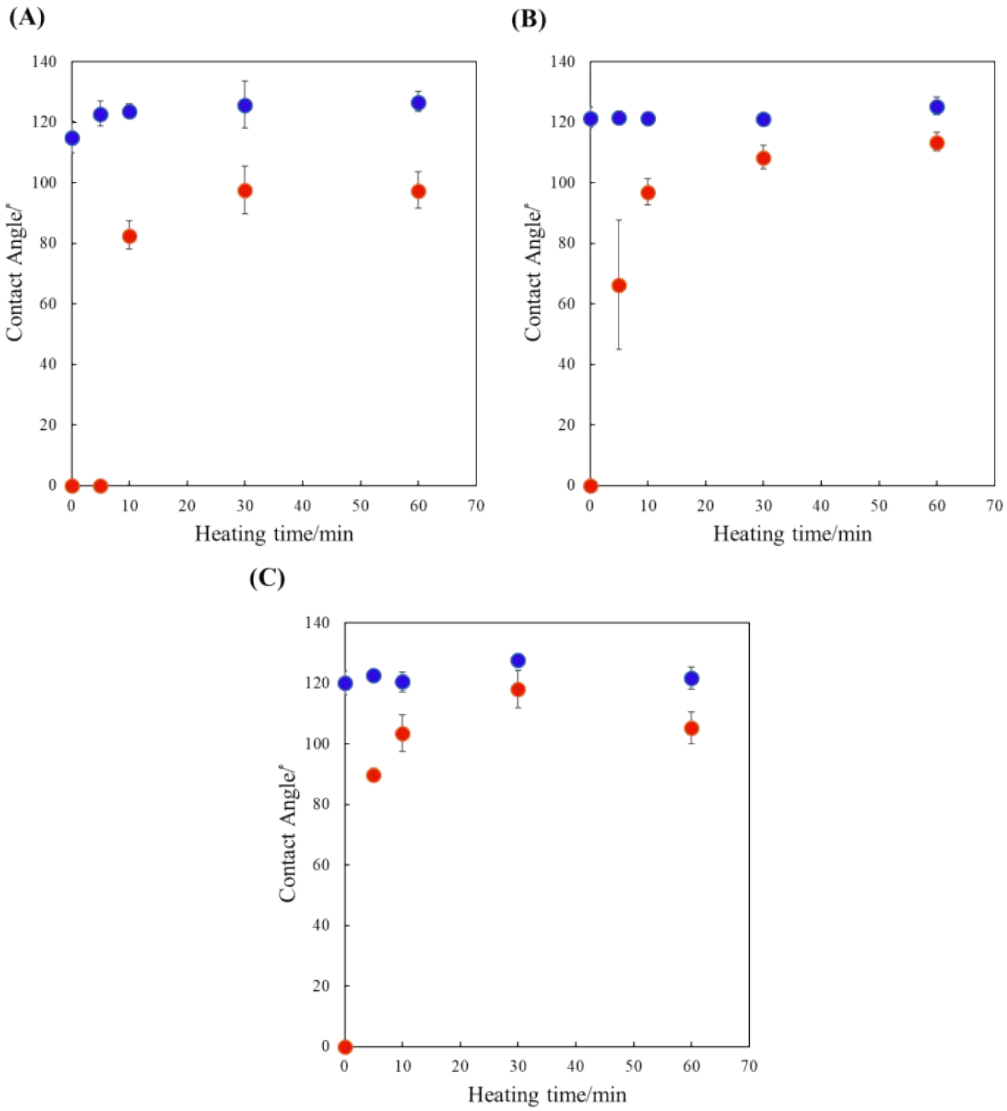
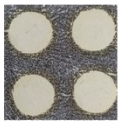
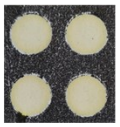


Figure S2 Contact angle measurement of the paper substrate after printing using (A) single process, (B) double processes, and (C) triple processes. The blue plots show the contact angle of the printed surface, whereas the red plots show those of the bottom surface.

(A)

Ink deposition time	Heating time		
	0 min	30 min	60 min
Single			
Double			
Triple			

(B)

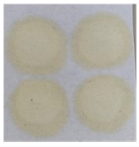
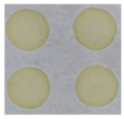
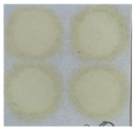
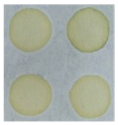
Ink deposition time	Heating time		
	0 min	30 min	60 min
Single			
Double			
Triple			

Figure S3 Representative images of sample leakage at reservoirs fabricated under various conditions: (A) printed surfaces and (B) bottom surfaces

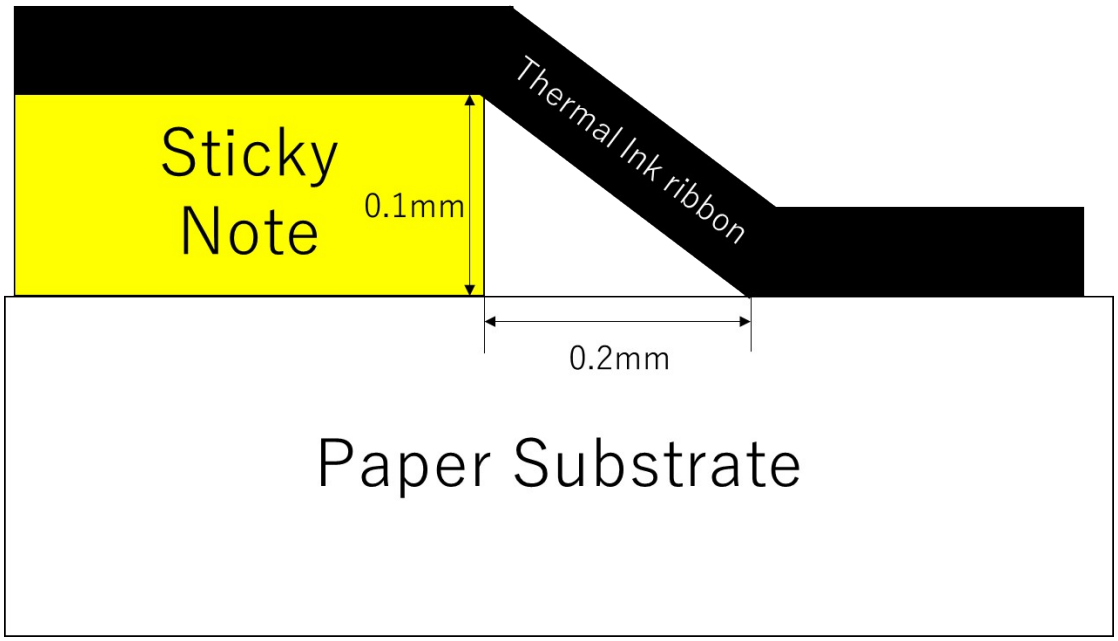


Figure S4. Schematic illustration of the contacting area of the ink ribbon to paper surface on printing.

An example of the application to sample measurement.

Finally, we fabricated a simple PAD for pH measurement. Herein, we employed two types of the devices. First, we fabricated simple microfluidic PADs for pH determination of the solutions. The devices structure and fabricated devices are shown in Figure S5(A). The solution is loaded to the sample reservoir and flows in the fluidic channel to reach the three reaction reservoirs. Methyl red, BTB and thymol blue were deposited on the reaction reservoirs in advance. Because the pK_a values for those three indicators are 5.0, 7.30 and 8.9[21,22], the patterns of color change at each reservoirs indicates the semi-quantitative values of the solution pH. Figure S5(B) shows the figures of the devices after loading buffer solutions having various pH values. All the solutions were prepared with acetate-ammonium buffer (0.1 M). The change in the color at each reservoir corresponds to the solution pH. Thus, the fabricated device works as semi-quantitative pH determination. The result above suggests that the present method is robust for fabricating microfluidic PAD without any expensive equipment, but only office appliances.

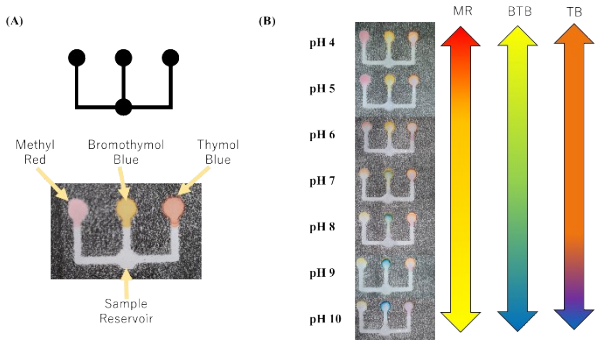


Figure S5. Fabrication of simple fluidic PAD for pH determination (A) mask pattern and device structure (B) Color change at each reaction reservoir on addition of aqueous buffers solution having different pH values.