1P3-12

Proceedings of Symposium on Ultrasonic Electronics, Vol. 34 (2013) pp. 153-154
20-22 November, 2013

Digital microfluidic system using a surface acoustic wave device
弾性表面波素子を用いたデジタル式マイクロ流体システム

Kazuya Aoki[1†], Jun Kondoh[2] ([1]Shizuoka Univ.; [2]Shizuoka Univ.)
青木 一矢 [1†], 近藤 淳 [2] ([1]静岡大学, [2]静岡大学)

1. Introduction

Development of a integrated system of manipulation and measurement of droplet is reguired. Droplet manipulation is possible with a surface accoustic wave (SAW) device [1]. In 2009, Yasuda et al. proposed the digital microfluidic system (DMFS) using the SAW device [2]. The DMFS consists of cover glass/ liquid layer/ piezoelectric substrate [3]. As a droplet on a SAW propagating pass is manipulated, precise dropping is needed. In this paper, we discusse stable droplet manipulation method. First, development of an automatic dropping system is described. Then, a part of the cover glass surface was treated using a hydrophchilic material.

2.DMFS

The DMFS and experimental set up are shown in Fig. 1. A SAW device was fabricated on a 128°YX-$LiNbO_3$ single crystal. RF signal was fed to an interdigital transducer (IDT). Fabrication process are follows a distilled water droplet was placed on 128°YX-$LiNbO_3$. Then a cover glass was placed onto it. A droplet spontaneously spreads and three layer structure is formed. When a radio frequency (RF) signal is applied to the IDT, the SAW is generated. At the matching layer and 128 YX-$LiNbO_3$ interface, the SAW becomes a leaky-SAW and the longitudinal wave is generated into the matching layer. When the longitudinal wave is reflected at the glass interface, a bulk acoustic wave (BAW) is generated [3]. A droplet on the cover glass is moved due to a longitudinal wave radiation from the BAW.

3.Automatic dropping system

Automatic dropping system is also shown in Fig. 1. A piezoelectric pump (TAKASAGO ELECTRIC, INC) was used to flow air. Sample liquid was holded in a small tank. Flow volume of air was controlled and optimum volume of liquid was ejected. The flow volume was decided by applied frequency and voltage. For a droplet of 1 μℓ, frequency and droplet were set at 40 Hz and 250 V, respectively. Also, a droplet of 2 μℓ, frequency and droplet were set at 60Hz and 250V, respectively.

f0230235@ipc.shizuoka.ac.jp

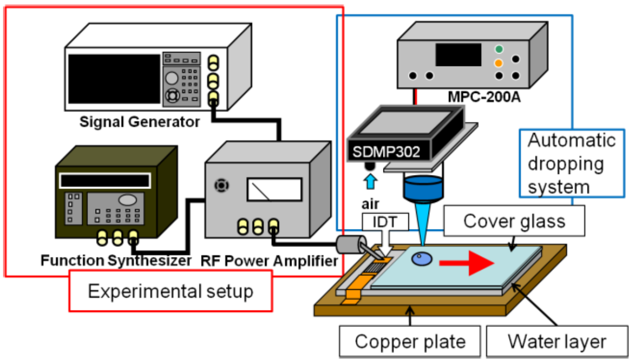


Fig. 1 Schematic of experimental setup (left), and automatic dropping system (right)

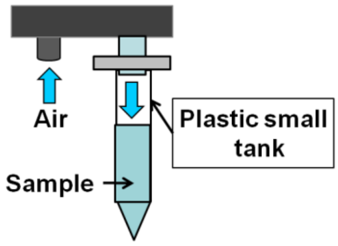
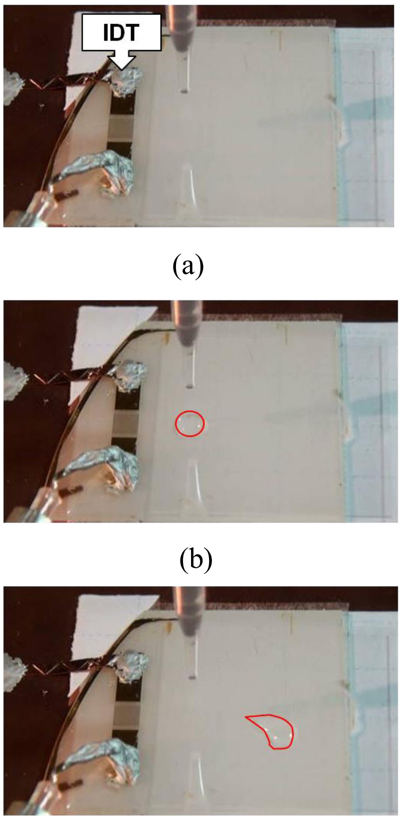


Fig. 2 Schematic of The dropping method

4. Droplet manipulation on cover glass surface

Frequency and power of the signal was 56.48MHz and 1.5 W, respectively. A droplet of 1 μℓ was placed onto the cover glass using the automatic dropping system. Manipulation results are shown in Fig. 3. The droplet center and IDT center were on straight line. However, manipulated direction did not agree with SAW propagating direction. For the DMFS, a sensor will be fabricated onto the cover glass. Droplet must be manipulated onto a sensor. For this purpose, a cover glass surface as patterned using a water repellent agent. Droplet manipulation pass was hydrophilic surface and other area was converted to a hydrophobic surface by using the water repellent agent. When a droplet was placed onto the hydrophilic area, the droplet does not squeeze out. It is restricted in the hydrophilic area. Manipulator results are show in Fig. 4. In Fig. 4(a), surface condition is illustrated. From Fig. 4(b), it is found that the droplet is manipulated to desired direction. Using this technique, multi-droplets manipulation was carried out. Surface pattern is shown in Fig. 5(a). Two droplets were placed onto the surface. From Fig. 5(b), it is found that the droplets were manipulated in accordance with path and mixed.

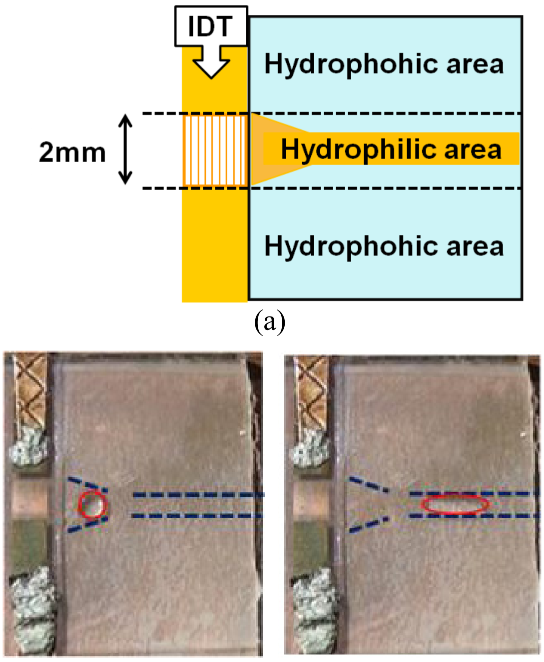


(a)

(b)

(c)

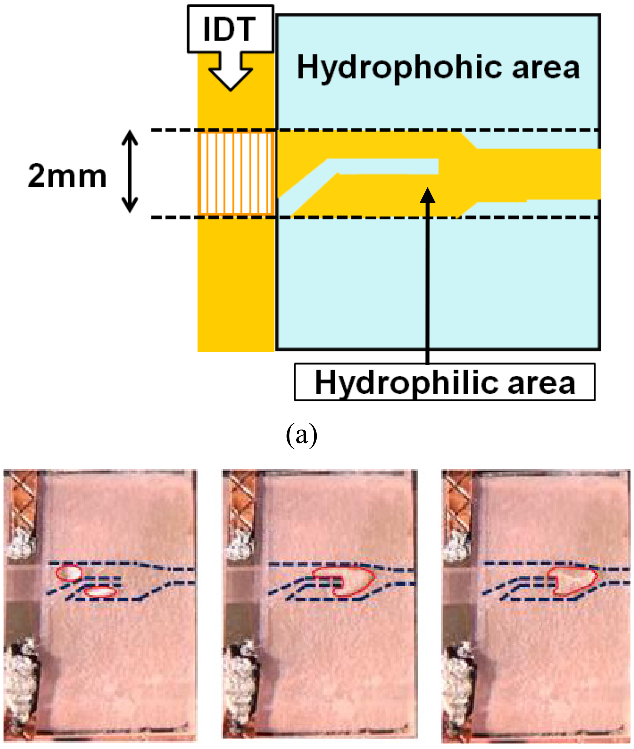
Fig. 3 Droplet manipulation using automatic dropping equipment. (a) Before SAW generation, (b) and (c) 0.5s and 1.0s after SAW generation.



(a)

(b)

Fig. 4 A droplet manipulation. (a) schematic illustration and (b) manipulated results.



(a)

(b)

Fig. 5 Two droplets manipulation. (a) schematic illustration and (b) manipulated results.

4. Conclusion

In this paper, two problems of the DMFS were solved. Using the developed automatic dropping system, a fixed quantity of liquid was placed onto the cover glass surface. Also, reproducibility of dropped position is improved using the system. Secondly, the manipulation surface was divided into two parts. As the hydrophilic manipulation pass was encircled by the hydrophobic area, the droplets were manipulated to desired position. Integration of a sensor onto the modified manipulation surface is future work.

References

[1] S. Shiokawa et al. Jpn. J. Appl. Phys. 28 (1989) Suppl.28-1, p.126.

[2] N. Yasuda,et al.,Jpn. J. Appl. Phys., vol. 48, O7GG14(2009)

[3] J. Kondoh and Y. Nakayama , "Acoustic streaming on "micro-laboratory" using sensor plate /matching layer/ piezoelectric substrate structure, " Proc. of the 20th ICA, 2010 (in press).