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# A finger-powered microfluidic device for agglutination study

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**Abstract**
**A portable and cost-effective microfluidic diagnostic device is proposed. The double-layered microfluidic device is fabricated using soft lithography technique. The proposed device can reduce required sample volume thus reducing sample cost with the antibody for multiple agglutination assays in parallel without cross contamination. The microfluidic platform can also be used to detect the bacteria and viruses. The embedded finger pump makes the reaction faster and makes it a device, which solves the complex sample loading issue. The device is preloaded with the antibody of choice making it useful for variety of diagnostic applications.**

**Keywords:** ***agglutination, lab-on-a-chip, micro pump, micro valves, microfluidics***

## 1. Introduction

Agglutination is the process in which the blood mix with corresponded antibody, which then undergoes condensation reaction. The most commonly used application is at the ABO/Rh blood typing and it can be used at enzyme testing, patient/donor cross matching, detect the bacteria and viruses. The conventional agglutination blood tests are categorized into two, namely, slide method and the tube method. However, these two methods need well-trained person to operate and load the blood separately. Commercially available automatic machines are bulky and expensive which not all hospitals can afford. Microfluidic device solves above problem. It reduces the sample cost. In addition, the device is quite small and the finger powered pump is internal, it is easy to operate.

Lin et. al. replaced need of external pump by designing hand powered pump[1], Sun et. al. used microfluidic droplet array for volume control in every chamber[2], Chen et. al. device uses a very small amount of blood nearly 1μl to operate all the steps[3], Gökçe et. al research discusses use of dried reagent dissolution.[4]

All of above designs have some drawbacks such as difficulty in operation, and complex fabrication process. The proposed microfluidic chip is easy to fabricate and easy for operation too. The chip uses finger-powered pump, which eliminates the need of syringe pump, which can be operated by anyone without prior training. The advantage of this research is simple fabrication, less sample requirement and ease of operation. Since the device required very less amount of blood, it can be collected by simply pricking with virtually no pain.

## 2. Experimental procedure

The experimental process starts with preloading the antibody in the chamber and then loading the blood from inlet. Finger pump is used to push the liquid to second layer to let it mix through the mixer. The first layer design is to control the volume of blood. The design consists of reservoirs with bypass channels from which the blood reaches to the next reservoir after the previous is filled. This helps to reduce the sample volume and eventually the cost of testing.

The two-layer structure is to avoid cross contamination of different antibody and blood (Figure 2)

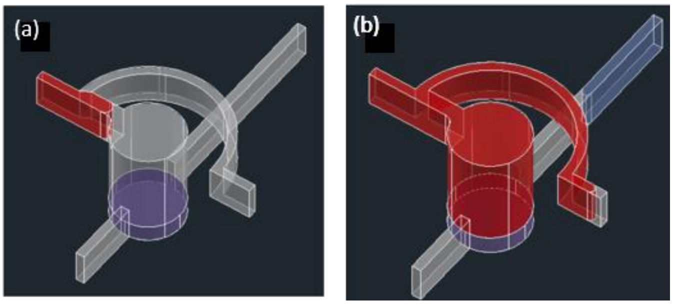


**Figure 1: (a) preloading of antibody (b) loading of blood in reservoir**

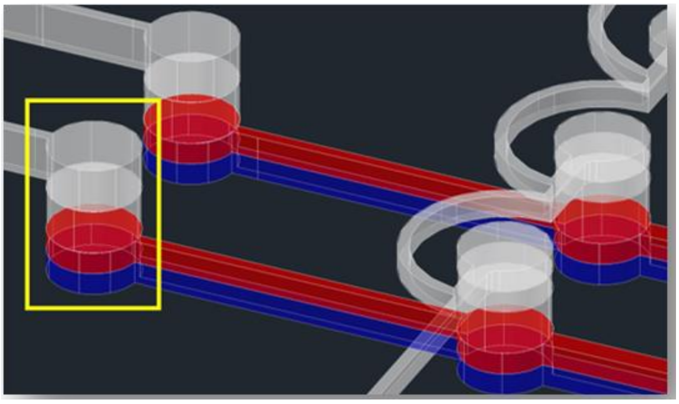

**Figure 2: the two-layer design is to avoid liquid cross contamination**

## 3. Device Description:

The proposed microfluidic device is a three-layered structure (Figure 1) fabricated using soft lithography technique. The bottom layer is glass, which is bonded to PDMS using oxygen plasma. The second layer is a mixer integrated with antibody reservoir structure. The top layer is a finger powered PDMS micro-pump structures similar to the diode, which allows flow of fluid only in one direction

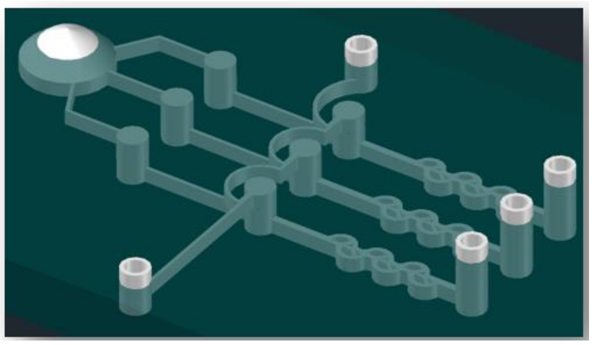

**Figure 3: 3D schematic view of microfluidic chip**

**4. Result**

Here for the demonstration of chip, we preloaded the blue dye-representing antibody and red dye representing blood. After pressing the finger-powered pump, we tried to see if the diode design helps to prevent liquid from the backflow. The next step was to see if the designed micromixer can mix the two liquids completely and we observe this from the purple color we observe from the end of micromixer. The purple color represents completing mixing of liquids.

**Figure 4: Closer look at micromixer chamber**

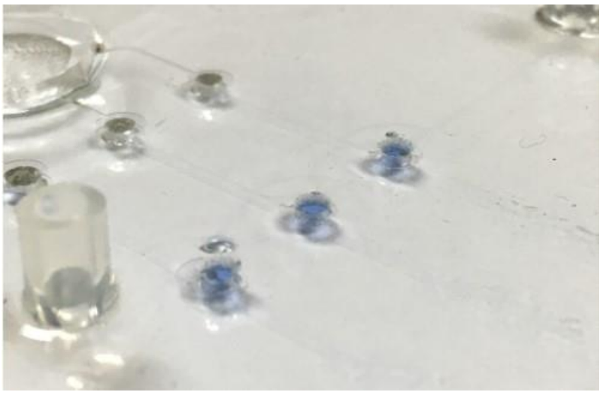

**Figure 5: Antibody loading chamber. Here we have used blue dye for the demonstration**

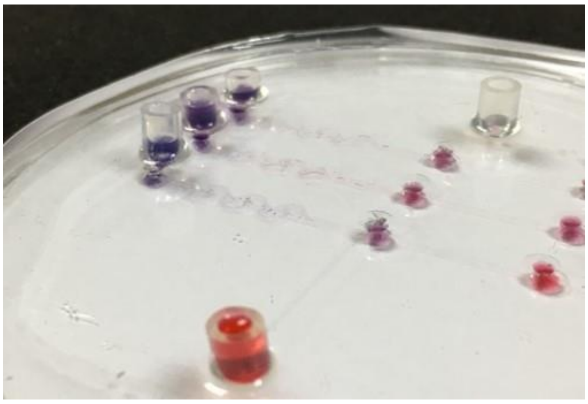

**Figure 6: Outlets showing mixed liquid showing purple color**

**5. Conclusion**

The two-layered design solves the problem of complex fabrication of making a diode by separating chamber for preloading of antibody. In addition, we used a specialized microfluidic structure to maintain lower sample volume thus reducing the cost.

**Reference:**


[1] K. Iwai, K. C. Shih, X. Lin, T. A. Brubaker, R. D. Sochol, and L. Lin, "Finger-powered microfluidic systems using multilayer soft lithography and injection molding processes," *Lab Chip,* vol. 14, pp. 3790-9, Oct 07 2014.

[2] M. Sun, S. S. Bithi, and S. A. Vanapalli, "Microfluidic static droplet arrays with tuneable gradients in material composition," *Lab Chip,* vol. 11, pp. 3949-52, Dec 07 2011.

[3] J. Y. Chen, Y. T. Huang, H. H. Chou, C. P. Wang, and C. F. Chen, "Rapid and inexpensive blood typing on thermoplastic chips," *Lab Chip,* vol. 15, pp. 4533-41, Dec 21 2015.

[4] Onur Gökçe, Samuel Castonguay, Yuksel Temiz, and T. Gervais, "Passive orthogonal flow mixers" for homogeneous dissolution of reagents in microfluidics," MicroTAS, 2016.