# RAPID FABRICATION AND MODIFICATION OF 2.5D MICROCHIP THROUGH TAPE, AND ITS APPLICATION FOR CHANNEL-HEIGHT INFLUENCED PROGRAMMABLE AUTONOMOUS FLOW

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## ABSTRACT

This paper reports an improved lithography technique which can fabricate 2D and 2.5D microchip more easily, rapidly and cheaply than traditional techniques. For example, a 2.5D microstructure with more than five different channel height may require tens of hours to fabricate by traditional techniques like “stacking method”. In our case, only several minutes is enough to fabricate such complicated 2.5D system. Furthermore, we find that a new type of programmable autonomous flow can be easily realized and controlled inside a 2.5D chip containing a series of micro-channels with different height, which are easily fabricated by our technique.

**KEYWORDS:** 2.5D microchip, modifiable channel height, programmable autonomous flowing

## INTRODUCTION

Photolithography is the mostly widely used technique in microchip fabrication today. [1] Nevertheless, it’s a costly technique because various machines (spin coater, UV transmitter, oven and hot plate, etc), various reagents (photoresist, developer, and washing reagent, etc) and clean room are required. J.K. Kim *et al.* presented a technique in fabricating PDMS chips by getting rid of the use of photolithography. [2] According to this technique, a channel structure must be carved manually for every single microfluidic device. This is no doubt quite laborious if large amounts of micro-devices are fabricated. Furthermore, 2.5D microfluidic systems are impossible to fabricate using this method. In comparison, not only our lithography technique can fabricate large amount of structure-adjustable 2D microsystem rapidly, but also it possesses greater advantages than traditional 2.5D fabrication techniques, i.e., “stacking method”. [3-5] Furthermore, One very attractive phenomenon we find from this technique, is that “automatic timed fluidic sequence” can be easily realized inside a PDMS chip simply by changing channel height, without the use of any reagent treatment for surface modification. reagent-caused programmable flow technique has been introduced recent years. [6-7]

## EXPERIMENTAL

A schematic fabrication process of this lithography is shown in Figure 1. The channel height is determined by the number of tape layers attached to glass slide, and can be conveniently adapted by tape layers. After the channel structure is cut in the multi-layer-tapes depending on the paper mask, the paper mask and double size tape can be easily removed, leaving a tape-glass hybrid master for structure replicating into PDMS.

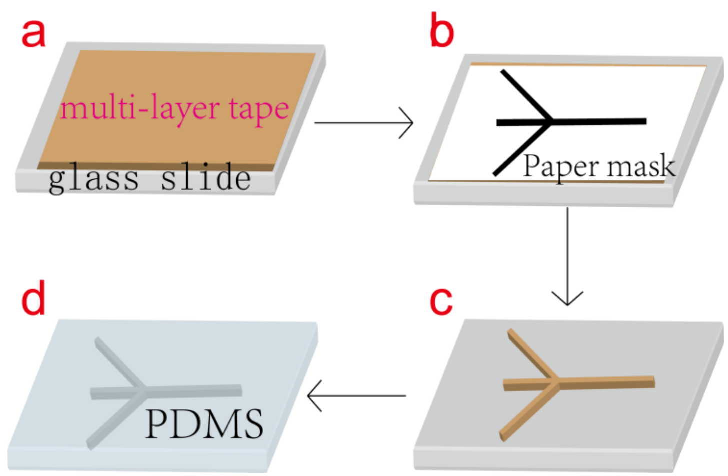


*Figure 1: Schematic fabrication steps of the multi-tape- lithography. a) multi-layer tape adheres on a glass slide. b) paper mask is attached to the tape through double size tape. c) the tape master d) structure is replicated into PDMS.*

Based on this new lithography, we first fabricate a 3 layer-tape master, which is used to replicate a Y-structure in a PDMS chip (Figure 2 a, b), with a channel width of 500µm and channel height of 150µm. As shown in Figure 2, micro droplets or multiphase flow can stably form in this chip, demonstrating the application of our lithography technique for microchip fabrication.

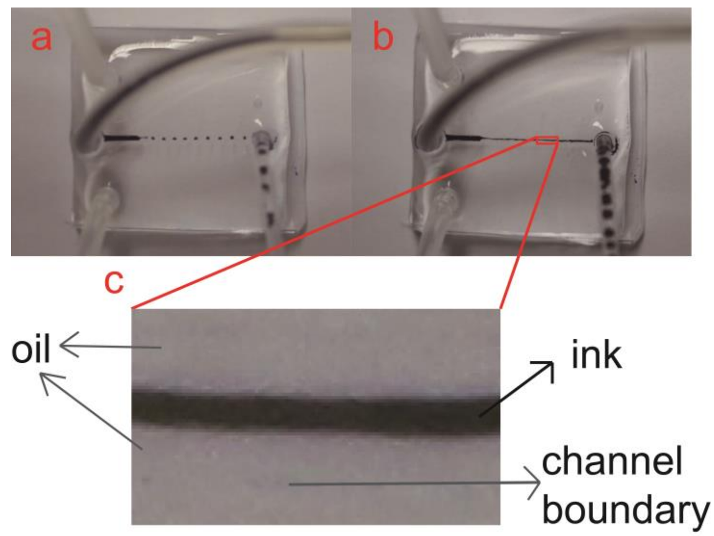


*Figure 2. a) micro-droplets flow inside the chip. b) multi-phase (oil-ink-oil) flow inside the chip. c) magnification of the multi-phase flow chip.*

In most fabrication technique, micro-structure is impossible to be modified once it's fabricated. On the contrary, in our technique, modification of the micro-structure can be easily made after the master is fabricated, which can heighten fabrication efficiency. A 2.5D master with different channel height of 200µm, 300µm and 400µm is firstly fabricated using this lithography. Then we detach two, one and one layer of tape from these three channels respectively, making the channel height change to 100µm, 250µm and 350µm, correspondingly. A new kind of velocity-based programmable autonomous flow can be easily realized and controlled by differentiate the height of a series of micro-channels (Figure 3).

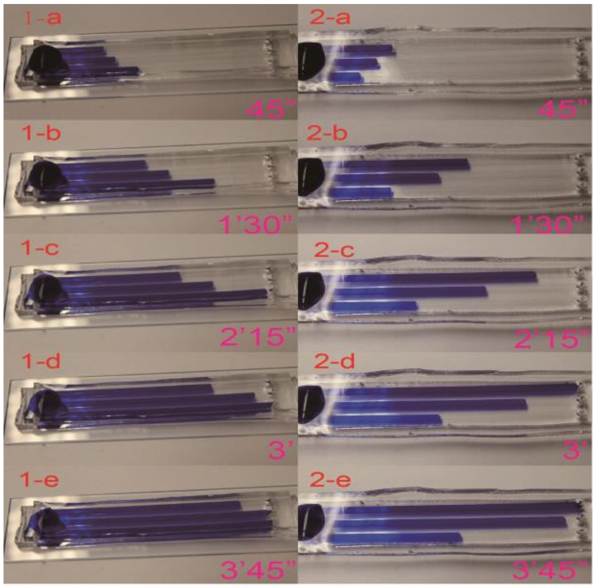


*Figure 3. Programmable autonomous flow controlled by channel height. The height of three channels in chip 1 are 200µm, 300µm and 400µm from top down. In chip 2: 350µm, 250µm and 100µm from top down.*

## CONCLUSION

This lithography technique provides one easy approach for quickly (minutes) fabricating 2D and 2.5D micro-structure without the use of any photolithography devices, photoresist, optical masks or clean room. We believe that this technique will lower the barrier to the widespread use of microfluidic chips in non-engineering labs or POC (point of care) clinic labs.

## ACKNOWLEDGEMENTS

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