Supplementary information

1. Laser plotter setup

Fig I shows the main frame of the computer-driven laser plotter employed in our experiment (Fig I (a)). It comprises of laser source, stage controller, optical elements manipulated by stage controller, computer-based driver, and air exhausting system (which is not shown in the figure below). The inset is an illustration of the laser plotter employed in this paper. The optical images of representative microstructures plotted on PDMS by DLP is presented as Fig I (b).

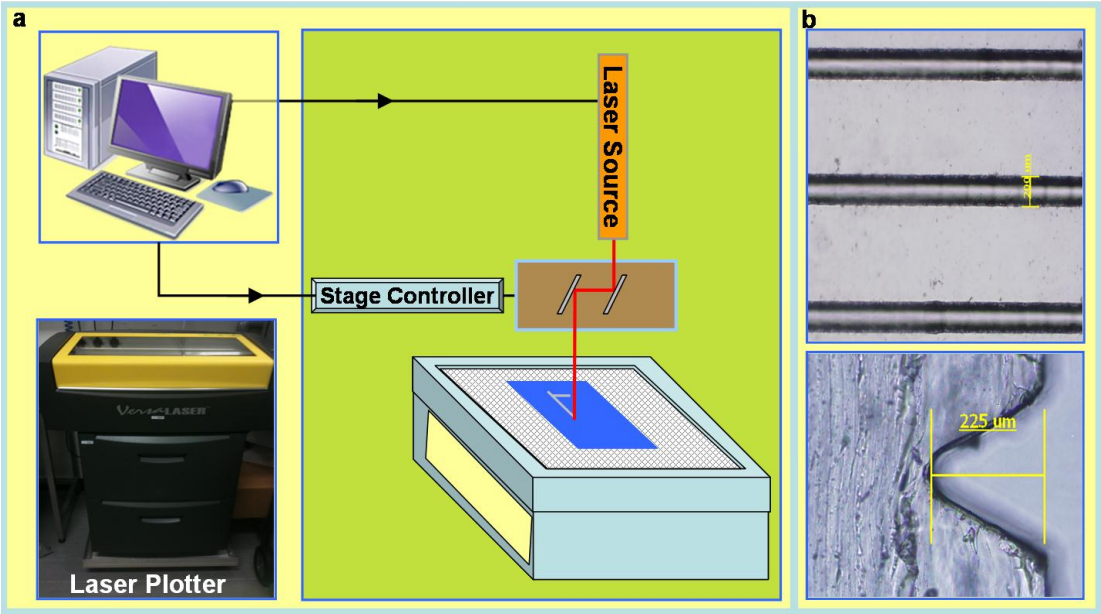

Fig I. Laser plotter setup and laser plotted PDMS channel. (a) computer-driven laser plotter, inset is the photo of real machine. (b) top view of laser plotted PDMS channel (upper) and its side view (lower).

2. Design of mixer with ribcage structure (similar to fishbone structure) using CAD software

Here, we take the mixer with ribcage structure and the integrated concentration separator to illustrate how the DLP can be used to realize functional 3D micro-patterns from a single AutoCAD design file (Fig.III). Fig.III (a): A sketch of the 3D microstructure for a mixer with integrated concentration separator using AutoCAD software.

Two colors are employed to distinguish different operation parameters which will be fed to the Laser plotter system: black lines refer to cutting parameters [1%-0.75-1000], and the red lines refer to the cutting parameters [2%-0.75-120]. The resultant structure will be a dot array forming the backbone of the ribcage structure. Fig. III (b) shows the fabricated result which has been explained in the main text. Fig. III(c) shows the design of a large sheet of PDMS substrate of size of 10 cm×10 cm, with multiple microstructures which can be fabricated simultaneously, and Fig. III (d) is the actual sheet of PDMS substrate with fabricated microstructures based on a single design file described in Fig. III(c) which took about 10 minutes for the plotting process.

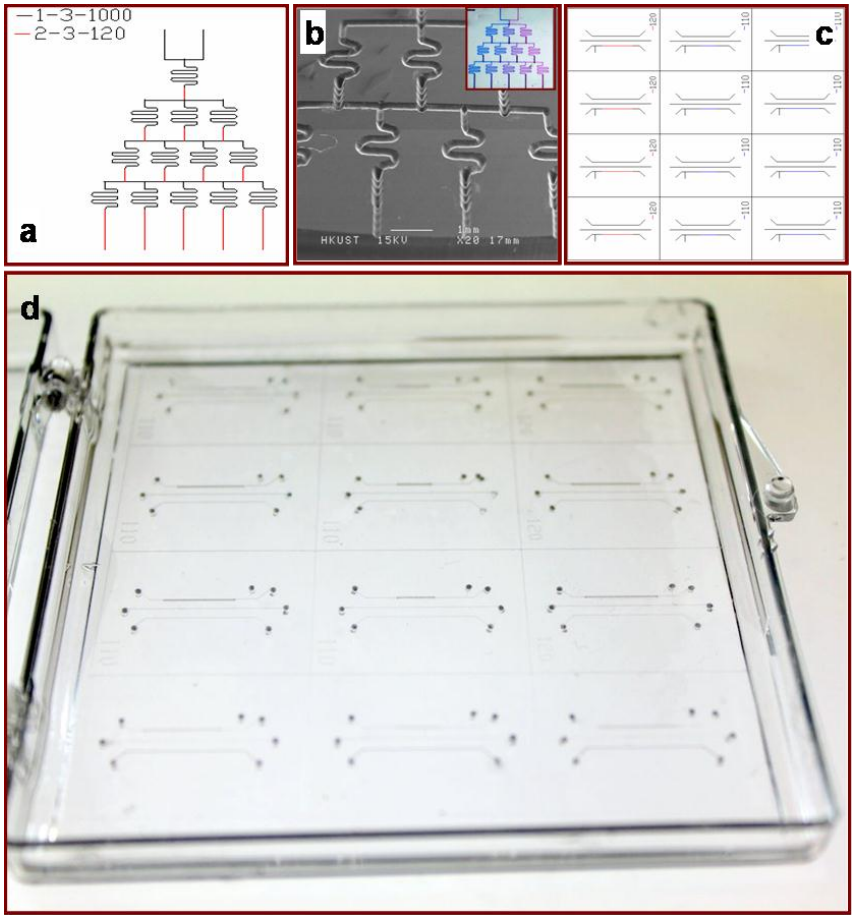

Fig. III Design pattern prepared using AutoCAD software and the fabricated results. (a) The inset illustrates the design of the ribcage structure for a micromixer with integrated concentration separator. Different line colors represent different operation parameter (plotting) using DLP system. (b) SEM image of the ribcage structure fabricated using DLP. Designs illustrated in insets(a) & (c) are applied to 10 cm x10 cm PDMS substrate, while insets (d) is the patterned PDMS sheet.

3. Comparison between DLP and soft lithography

DLP is a convenient, environmental friendly and time-saving method for fabricating microfluidic devices and functional microstructures. The amount of material consumption by DLP is much smaller than that of soft lithography which requires heavy machinery and toxic chemicals. Taking microfluidic chip with embedded electrodes as an example, we hereby compare the time required and the cost of fabrication by DLP and conventional soft lithography method (The hourly rate of equipment usage at the Hong Kong University of Science and Technology is used as the reference). Using conventional soft lithography method, the fabrication process of a microfluidic chip with embedding electrodes requires two fabrication masks, a chip master, two different layers of photoresist coating (one layer with SU8 and another with AZ4903). The entire process generally takes a week to complete. In contrary,

DLP is a mask-free protocol. It starts with a design pattern formulated by ordinary AutoCAD software. After the design stage, the pattern can be transferred directly to bulk PDMS substrate over a large area. Multiple microdevices can be fabricated on a single PDMS substrate which saves time and resources.

Table I: Comparison between traditional microfluidic chip fabrication method (by Soft Lithography) and DLP.

<table>
<tr><td></td><td></td><td colspan="2">Soft lithography</td><td colspan="2">DLP</td></tr>
<tr><td></td><td></td><td>Time</td><td>Price</td><td>Time</td><td>Price</td></tr>
<tr><td>Design</td><td>Mask design</td><td>1 day</td><td>0</td><td>1 day</td><td>0</td></tr>
<tr><td rowspan="10">Sample Prepare</td><td>Mask fabrication</td><td>3days ~2 weeks</td><td>30USD~100USD</td><td>0</td><td>0</td></tr>
<tr><td>SU8 channel layer</td><td>6 hrs</td><td rowspan="3">30~40 USD
(wafer included)</td><td rowspan="3">5mins~30mins</td><td rowspan="3">0</td></tr>
<tr><td>Mask alignment</td><td>0.5 hrs</td></tr>
<tr><td>AZ4903 Electrode layer</td><td>2 hrs</td></tr>
<tr><td>Mold surface smoothing</td><td>2hrs</td><td>5USD</td><td>0</td><td>N.A</td></tr>
<tr><td>AgPDMS patterning</td><td>2hrs</td><td>5USD</td><td>10mins</td><td>0</td></tr>
<tr><td>AZ4903 development</td><td>0.5hrs</td><td>N.A</td><td rowspan="2">0</td><td>N.A</td></tr>
<tr><td>Post-treatment of chip</td><td>0.5hrs ~2hrs</td><td>N.A</td><td>N.A</td></tr>
<tr><td>Total chip fabrication</td><td>13.5~15hrs
(2~3 days)</td><td>40~50 USD</td><td>15mins~40mins
(1 hour)</td><td>0</td></tr>
<tr><td></td><td>Total cost in sample preparing</td><td>1week ~3weeks</td><td>70~150USD</td><td>~1 hours</td><td>0</td></tr>
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