Lab on a Chip

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TECHNICAL INNOVATION

Electronic Supplementary Information (ESI) for

"Overpass" at the junction of a crossed microchannel: An enabler for 3D microfluidic chips†

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Experimental method

1. Fabrication of microchannels

The bi- and tri- crossed microfluidic channel was prepared by classical wet etching method. In typical procedure, a glass slide was cleaned by acetone, alcohol and deionized water, and dried by nitrogen flow. Then, an adhesive chrome layer (30 nm) and a sacrificial layer of gold (100 nm) were deposited orderly on the glass slide. After that photoresist was spin coated on the sacrificial layer for the patterning of required microchannel by UV lithography and subsequent development. After removal of exposed region of the sacrificial layer, the glass slide was etched by hydrofluoric acid. Finally, the glass chip with crossed channels was obtained. In our work, the channel was ~60 μm in width and 20 μm in depth.

The SU-8 microchannel was fabricated by photolithography with a shadow mask.

2. Fabrication of the “overpass” structure

Before the laser fabrication, the 3D “overpass” structures were designed by 3D MAX, and converted to operable computer data for subsequent processing control. The crossed microfluidic channel was firstly coated with negative resin SU-8 2075 (Microchem, US) on the junction region and then scratched by straight-edged cover glass. Then a prebake process was performed at 95 °C for 40 min for solidification. After cooled down to room temperature, the microchanenl containning SU-8 photopolymer is ready for the following fabrication. In the laser processing experiments, the laser beam from a femtosecond laser with 80 MHz repetition rate, 120 fs pulse width and 800 nm central wavelength was focused by a 60× oil immersion objective lens (numerical aperture NA= 1.35) to directly write the preprogrammed microstructures. After the writing of the whole structure, the chips were post-baked at 95 °C for 15 min. After developing, the final microfluidic channel with “overpass” microstructure was obtained. For the test of microfluids flow, the chip was covered with a cured PDMS slice, and pressed for adhesion.

3. Characterization

Scanning electron microscope (SEM) images were measured on a JEOL JSM-6700F field emission (FE-SEM) operating at 3.0 keV. Optical micrographs were obtained from a Motic BA400 microscope.

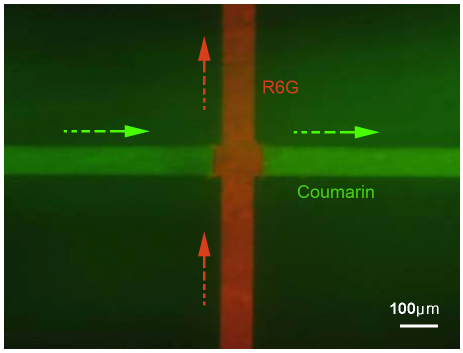

Fig. S1 Fluorescence microscopic image of the flow test of R6G and coumarin solutions.

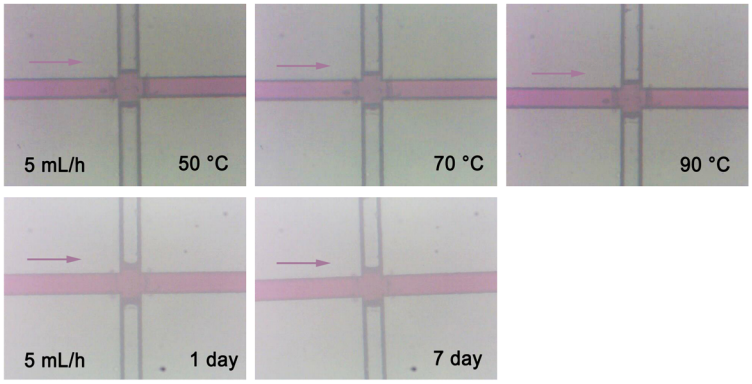

Fig. S2 Stability of the micro-overpass structure used at different temperatures, and for 1d, 7d, respectively. The flow rate was fixed at 5 mL/h, R6G aqueous solution is used as the test microfluids.

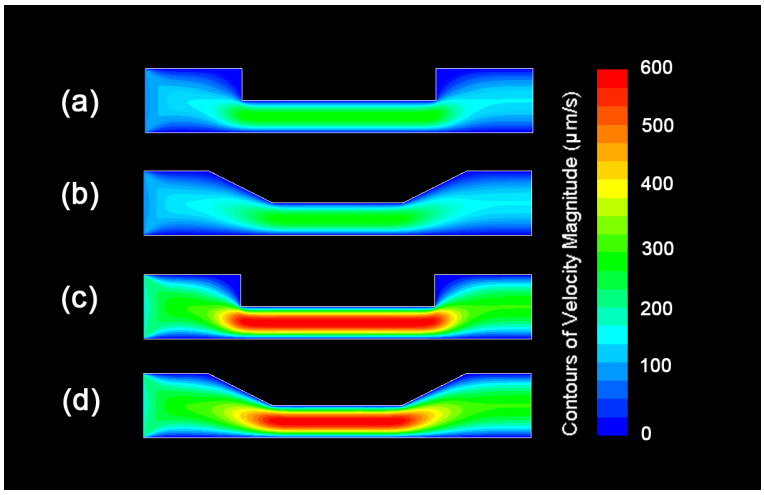

Fig. S3 Contours of velocity of microfluid inside a microchannel with different overpass profiles. (a) square, (b) trapezoid, (c) square, (d) trapezoid. For (a) and (b), the starting flow rate is 100 µm/s; For (c) and (d), the starting flow rate is 200 µm/s.

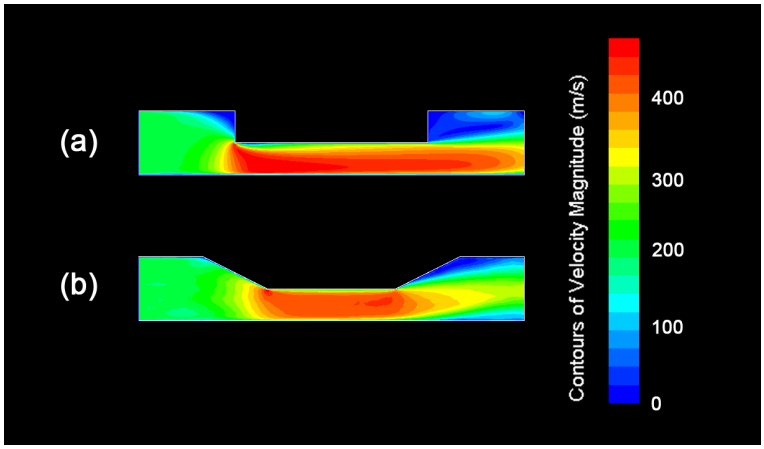

Fig. S4 Contours of velocity of microfluid inside a microchannel with different overpass profiles. (a) square, (b) trapezoid. The starting flow rate is 200 m/s.

The simulation was carried out by using water as microfluid, the viscosity is 0.001003 Pa·s , the density is 998.2 kg/m3, and the temperature is 20 °C. The size of the microchannel is 120 × 20 µm, and the overpass profile is 60 × 10 µm for the square, and for the trapezoid, the upper bottom and the lower bottom are 80 and 40 µm, respectively.

Software: Fluent (ANSYS Inc.)

Obviously, the overpass structure shows certain resistance to the microfluid. As shown in the Fig. S3, the trapezoid profile shows relative smaller resistance than that of the square one. Especially, at a very high flow rate (Fig. S4, 200 m/s), the difference becomes obvious. These results indicate that the design of a trapezoid shaped profile of the overpass structure is necessary.

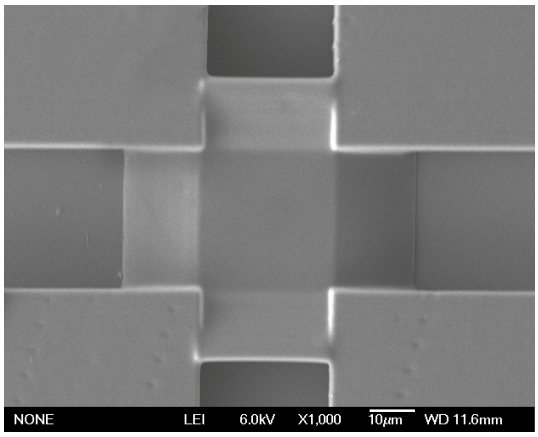

Fig. S4 SEM image of a SU-8 microchannel with a SU-8 overpass structure.