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3D functional microfludic chips with both mixing and filtering functions by hybrid femtosecond laser microfabrication

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In the past few years, three dimensional (3D) functional microfluidic chips realized by Femtosecond (fs) laser-induced two photon polymerization (TPP) have attracted great attentions because of their potential applications in filtering, mixing and so on. For example, Wang *et al.* firstly employed TPP microfabrication to integrate 3D polymer microfilter into 2D glass microchannels [1]. The shape of the microfilter could be precisely controlled and its functions were demonstrated. Lim *et al.* fabricated three-dimensionally crossing manifold micro-mixer in microfluidic channels by TPP method and demonstrated fast mixing in a short length [2]. However, these works[1-3] only focused on single function. There is no report about multifunctional devices on single microchip. In this work, we designed and realized a kind of true 3D, multifunctional microchips by combining TPP microfabrication and femtosecond laser-assisted wet etching (FLAE). Simultaneously filtering and mixing functions were demonstrated.

The second harmonic (522 nm) from commercial fs laser (FCPA μJewel D-400, IMRA America; wavelength: 1045 nm; pulse width: 360 fs; repetition rate: 200 kHz) is used for both TPP and FLAE microfabrication in this study. The 3D multifunctional microdevices were design as a filter-mixer model, as shown in Figs. 1(a)-1(c). It was integrated into 3D embedded glass microchannel by TPP. Shown in Figs. 1(d)-1(e) are top-view and 30° tilted SEM images of the corresponding microstructures on flat surface. It showed excellent functions in the microfluidic channel.

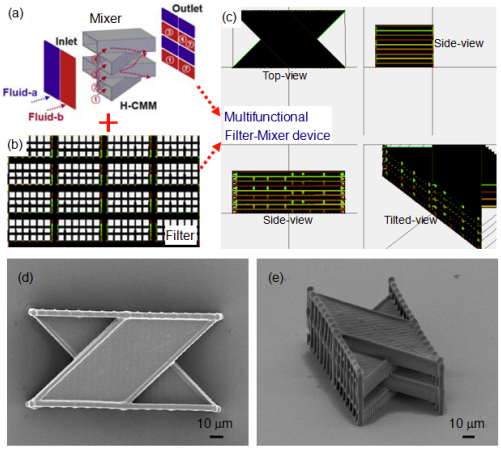

Figure 1. (a)-(c) The schematic image of the design model. (d)-(e) Top-view and 30° tilted SEM images of the corresponding microstructures on flat surface.

[1] J. Wang, *et al.*, *Lab Chip*, **11**, 1993 (2010). [2] T. W. Lim, *et al.*, *Lab Chip*, **11**, 100 (2011). [3] L. Amato, *et al.*, *Lab Chip*, **12**, 1135 (2012).