3D functional microfluidic 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.