Fabrication of Extremely Shallow "Nano-Sieve" Device with Positive Photoresist Sacrificial Layer

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Recently, rapid fabrication of extremely shallow micro-and nanochannels with Polydimethylsiloxane (PDMS) has generated great interests for single-cell genomic analysis[1] and individual bacteria trapping[2]. However, creating nanostructures on PDMS is very challenging due to the structural flexibility of PDMS and the stiction problem due to the surface activation. Here, we demonstrate a novel and simple approach for building a stable PDMS "nano-sieve" device with an aspect ratio of 4,000:1 (width/height) without roof collapsing. The fabrication process is shown in **Fig. 1a**. We first deposit a thin layer of silicon oxide (SiO_2) on a glass wafer via plasma-enhanced chemical vapor deposition. Then, we pattern a shallow channel on SiO_2 with the desired dimensions (width: 2 mm; length: 8 mm; height: 500 nm), via standard photolithography and wet etching. A thin layer of AZ701 positive photoresist (PR) is subsequently coated onto the surface of silicon oxide layer, followed by the PR patterning in the defined microchannel. A flat PDMS layer with punched holes (1 mm) is bonded onto the glass substrate via plasma-treatment. The second PR layer in the channel is easily dissolved with acetone, leaving a clean "nano-sieve" channel. To validate the stability of this channel, green food dye solution is used to fill the channel showing uniform color (**Fig. 1b**). This "nano-sieve" device is used for high throughput particle trapping and isolation as shown in **Fig. 1c**. Using this strategy, stiction between plasma activated PDMS and glass can be avoided, enabling reliable fabrication of extremely shallow microchannel for the applications including filtration, optical waveguide, and imaging.

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[1]Yu, Miao, Youmin Hou, Ruyuan Song, Xiaonan Xu, and Shuhuai Yao. "Tunable Confinement for Bridging Single‐Cell Manipulation and Single‐Molecule DNA Linearization." Small 14, no. 17 (2018): 1800229.

[2] MBaker, Joshua D., David T. Kysela, Jinsheng Zhou, Seth M. Madren, Andrew S. Wilkens, Yves V. Brun, and Stephen C. Jacobson. "Programmable, pneumatically actuated microfluidic device with an integrated nanochannel array to track development of individual bacteria." *Analytical chemistry*88, no. 17 (2016): 8476-8483.

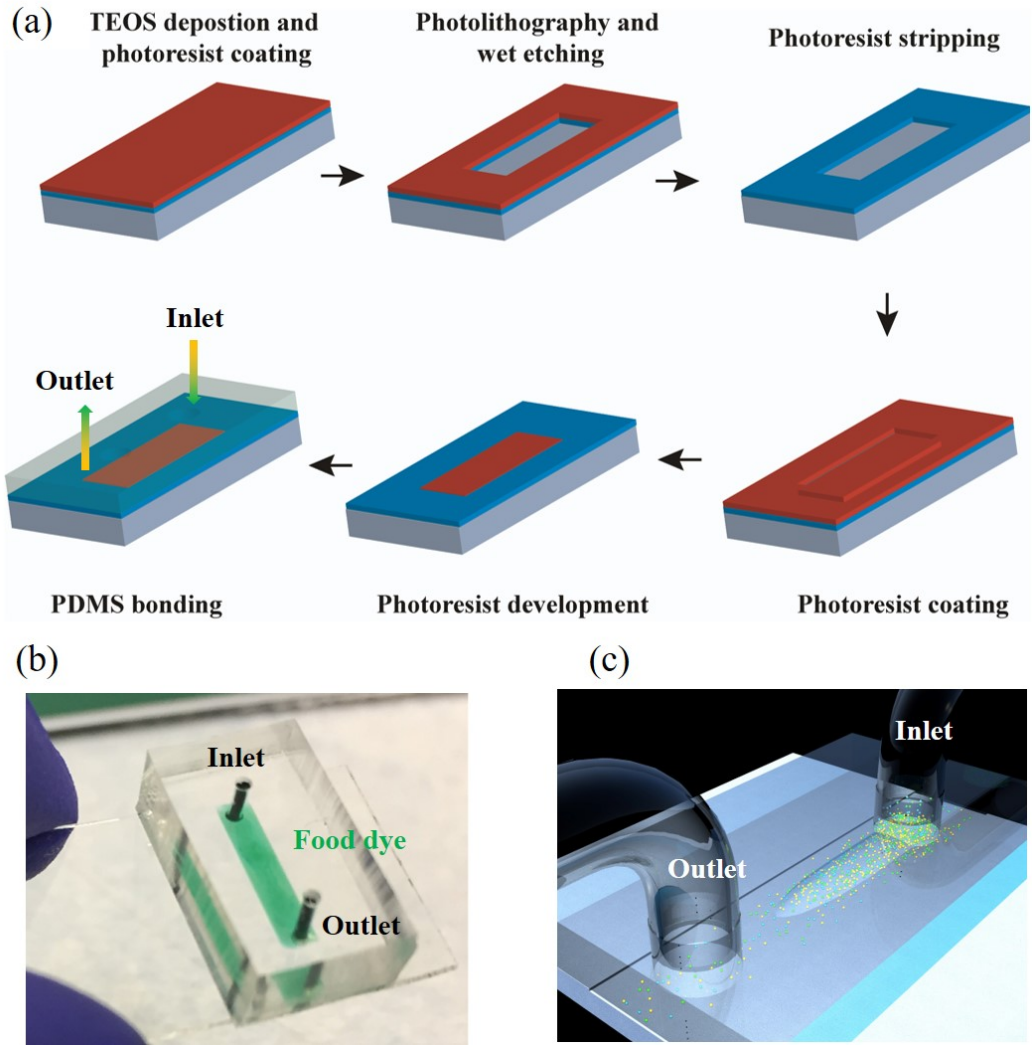

***Figure 1**: (a) Schematic of the process flow for fabricating the "nano-sieve" channel on a glass substrate. (b) The optical image of the "nano-sieve" channel filling with the food dye solution without roof collapsing. (c) Schematic of the "nano-sieve" device for on-chip particle separation and concentration.*