Supplementary Material (ESI) for Lab on a Chip

Supplementary Information for:

Three-Dimensional Fabrication of Heterogeneous Microstructures using Soft Membrane Deformation and Optofluidic Maskless Lithography

Seung Ah Lee, Su Eun Chung, Wook Park, Sung Hoon Lee and Sunghoon Kwon

Seoul National University, Department of Electrical Engineering and Computer Sciences,

Fig. S1. Schematic diagram of two-layered microfluidic channel fabrications.

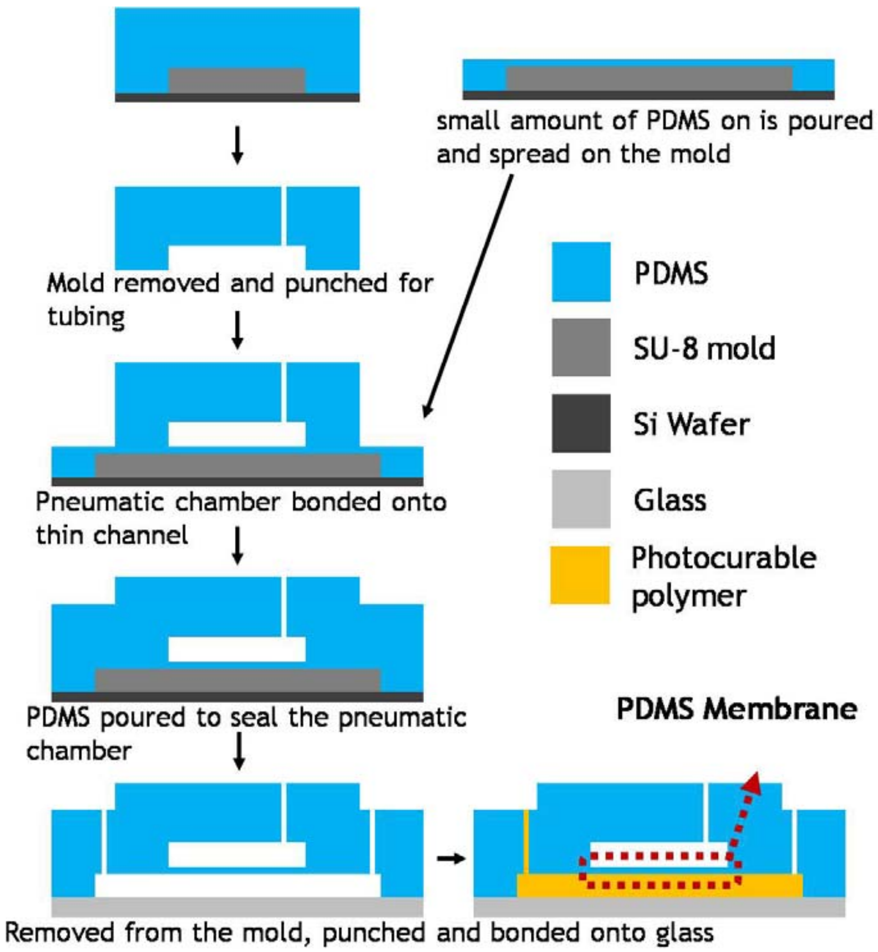
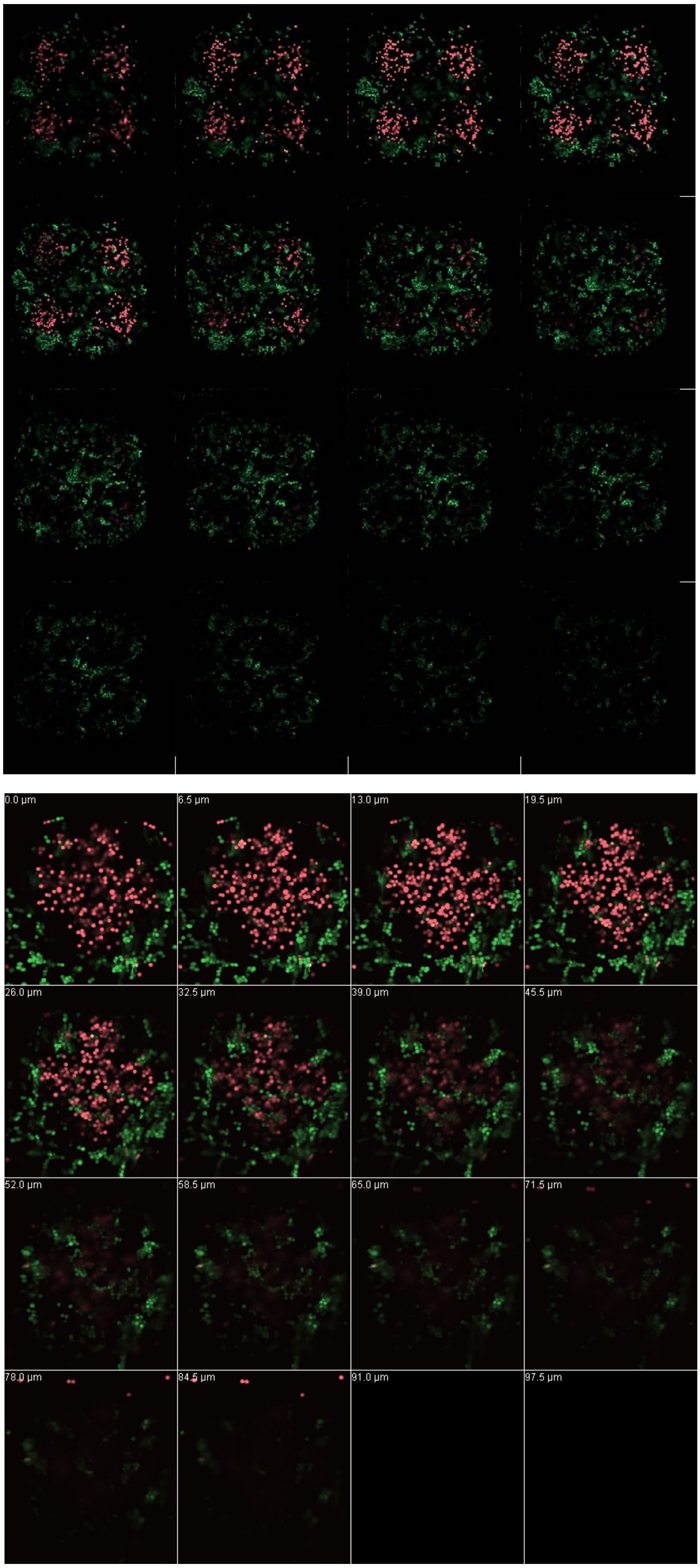


Fig. S2. Confocal microscope images of fluorescent bead-embedded hydrogel structures (Fig. 4B)



S1. Calculation model for the membrane curvature

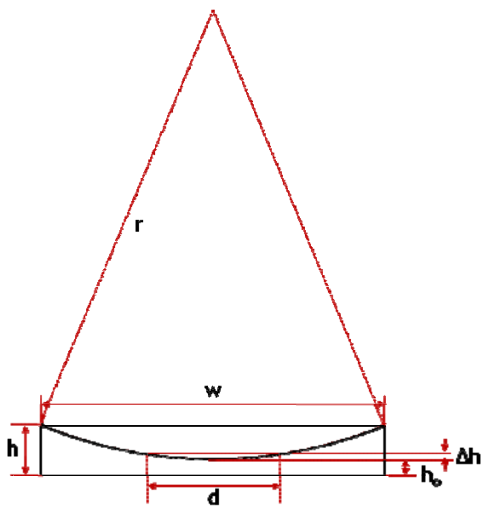


Fig. S3. Simple geometrical model for calculation of membrane curvature in the fabrication area.

To determine the width of the channel, *w*, to ensure flat membrane in the fabrication area *d*, we used simple model as given in Fig.S3. Since the aspect ratio (*w*/*h*) of the underlying channel is very large, we assumed that the cross-section of the deformed membrane forms an arc with a curvature radius *r*. The median vertical position of the membrane, h_0, corresponds to the desired thickness of the fabricated layer. We defined Δh as the maximum height variation within the fabrication area *d* at h_0. Considering the size of the structure, we defined $\Delta h < 2\mu m$ as the tolerable flatness of the membrane surface at the desired value of *d* and h_0.

From fig. S3, the curvature radius of the membrane can be determined as

$$r = \frac{\left(\frac{w}{2}\right)^2 + (h - h_0)^2}{2(h - h_0)}$$

Using the obtained radius value, Δh can be calculated with the following equation.

$$\Delta h = r\left(1 - \sqrt{1 - \left(\frac{d}{2r}\right)^2}\right)$$

The value of *d* that is tolerable to certain Δh can be obtained as below.

$$d = 2r\sqrt{1 - \left(1 - \frac{\Delta h}{r}\right)^2}$$

Fixing the channel height, $h = 100\mu m$, Δh of the membrane according to *w*, *d* and h_0 can be obtained (Figure S4).

The maximum value of *d* is determined by the field of view of the optical systems, which was approximately 1*mm* to ensure uniform UV intensity and no image distortion. Toughest condition in all experiments was to have $\Delta h < 2\mu m$ at $h_0=10\mu m$ and $d=800\mu m$, which required a large channel with $w=5.5mm$. In normal conditions, we used $w=2mm$ channel, which provides 2μm Δh tolerance at $h_0=20\mu m$ within $d=300\mu m$ area.

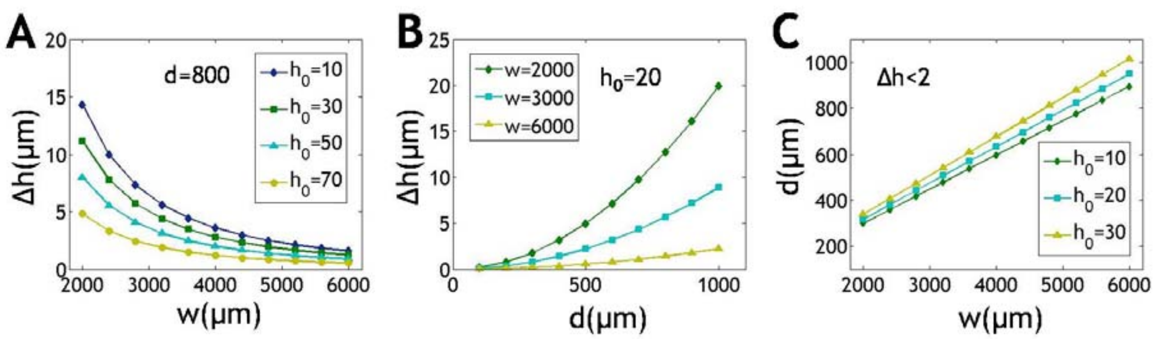


Fig. S4. (a) Δh variation within the 800μm fabrication area with the channel width *w* and membrane height h_0. (b) Δh variation along the fabrication area when the membrane height is 20μm. (c) Width of flat fabrication area according to the channel width while fixing Δh to $2\mu m$.