OPTOFLUIDICS 2017 CONFERENCE ABSTRACT

Fabrication of 3D microfluidic channels using 3D-printed, water soluble sacrificial mold

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We describe a process to fabricate simple (2D, planar) and complex (3D, non-planar) microfluidic devices using molds consisting of polyvinyl alcohol (PVA) fabricated with fused deposition modeling (FDM) 3D printer. Our approach successfully created leak-free, closed microfluidic devices in various commercial polymers, which are both photo and heat curable. The fabrication process requires only water to remove the sacrificial mold, and fabrication of microfluidic hydrogels are easily demonstrated. The approach we describe here offers a rapid and simple route to create channels with complex three-dimensional architecture.

Figure. 1 describes the schematics of the steps required in the sacrificial molding. Figure. 2 shows that sacrificial molding of FDM 3D printed microfluidic mold is suitable for use with hard polymers such as rigid polyurethane, epoxy, and thiolene-based polymers. It is also compatible for use with soft polymers like flexible polyurethane and PDMS. Water-soluble FDM 3D printed PVA mold was stable in hydrogels like TG gelatin and PEGDA. To demonstrate the versatility of the technique, we fabricated and demonstrated application of 3D staggered herringbone based chaotic mixers (Figure. 3) and modular perfusion grid of interconnected microchannels (Figure. 4).

At present, the capability to directly fabricate closed microfluidic channel, 3D microfluidic design or 3D design with undercut structures may be achieved by stereolithography[1] and a combination of laminated object manufacturing and soft lithography[2]. Although recently, FDM was also used to produce entire reaction-wares incorporating fluidic circuit by printing polypropylene[3]. Alternatively, other methods may be employed albeit with additional assembly steps to achieve such feat. Even so, 3D microfluidic geometry is still difficult to achieve with these printing techniques.
The versatility of fabrication of FDM printed microchannels by sacrificial molding can be useful in fabricating microchannels in soft, biomimetic matrixes (e.g. hydrogels). In addition, the wide selection of the various polymers for the materials of the channels encourages opportunities to build chemically resistant microchannels to support relevant applications.

REFERENCES:

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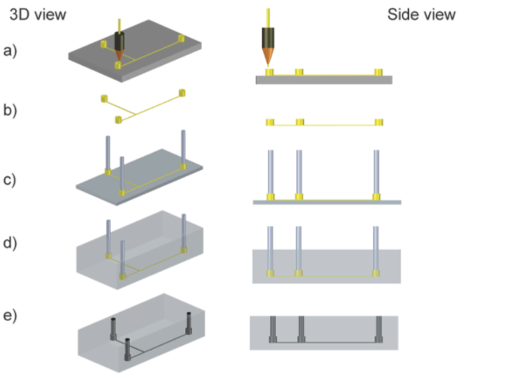

Fig. 1 Schematics of sacrificial molding steps to fabricate 3D microfluidic channels in castable materials.

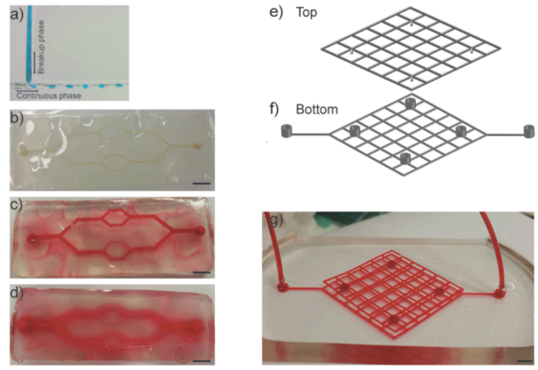

Fig. 4 Optical images of 2D/3D microfluidic devices produced by sacrifical molding.

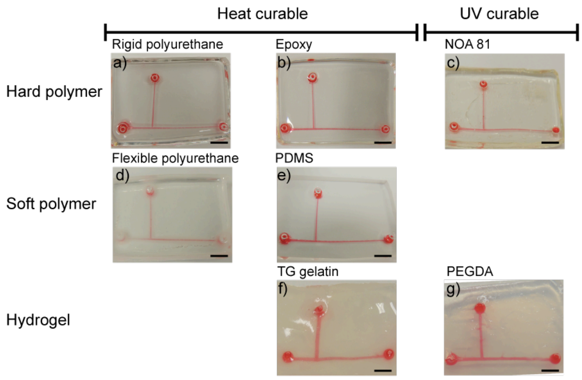

Fig. 2 Optical images of microchannels fabricated in various castable materials, solution of red dye was perfused to illuminate geometry of microchannels.

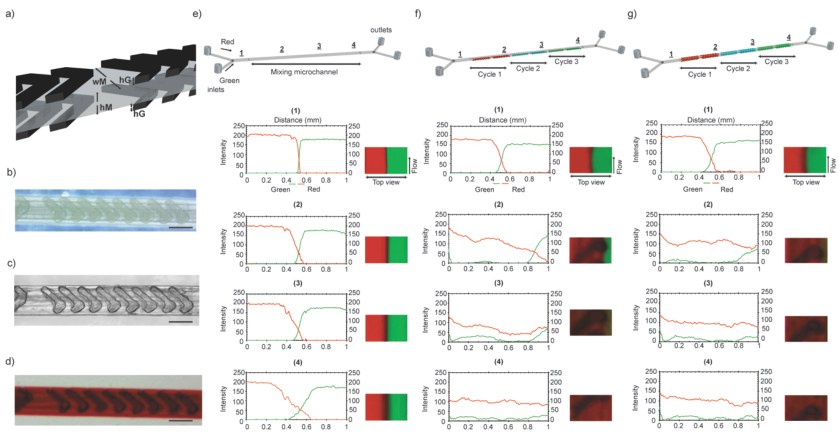

Fig. 3 Schematics showing application of 3D chaotic mixer produced by sacrificial molding