FDM-based 3D Printing of Microfluidic Discs with Multilayered Microchannels

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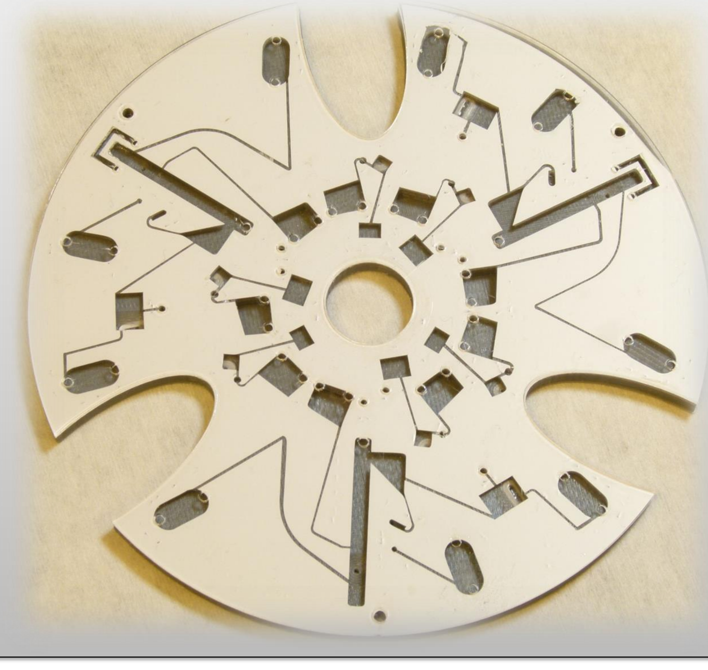
We present a novel method of fused deposition modelling (FDM)-based 3D printing of microfluidic discs with multilayered microchannels. This method:

- Enhances automation of fabrication
- Is much cost-efficient
- Increases the three-dimensional design freedom
- Enhances the Point of Care (POC) potential of lab-on-disc approach



Fabrication Method

In this method, firstly, the entire microfluidic disc was 3D printed using white-colored opaque polylactic acid (PLA) filament except for the very top layer. To facilitate transparency from the top of the disc, only one PMMA layer with vent holes needed to be manually bonded on the top of the 3D printed disc through an additional PSA layer (Fig. 1) resulting in a 3-layered disc (Fig. 2a). While using the traditional approach, a total of 7 layers of PMMA and PSA are needed to fabricate the same microfluidic disc.

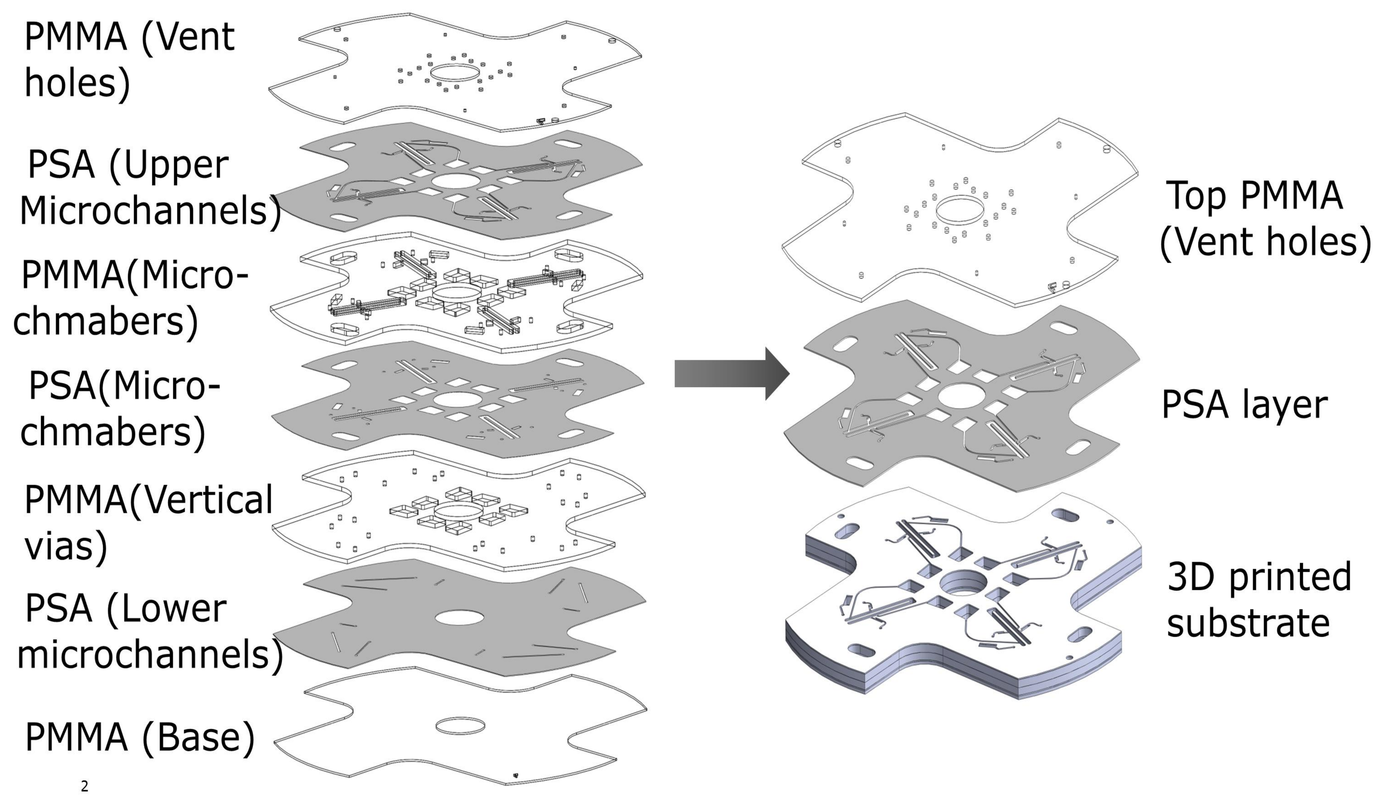


Figure 1. The left panel is the exploded view of the disc fabricated by traditional approach. The right panel represents the exploded view of the disc fabricated by 3D printing approach.

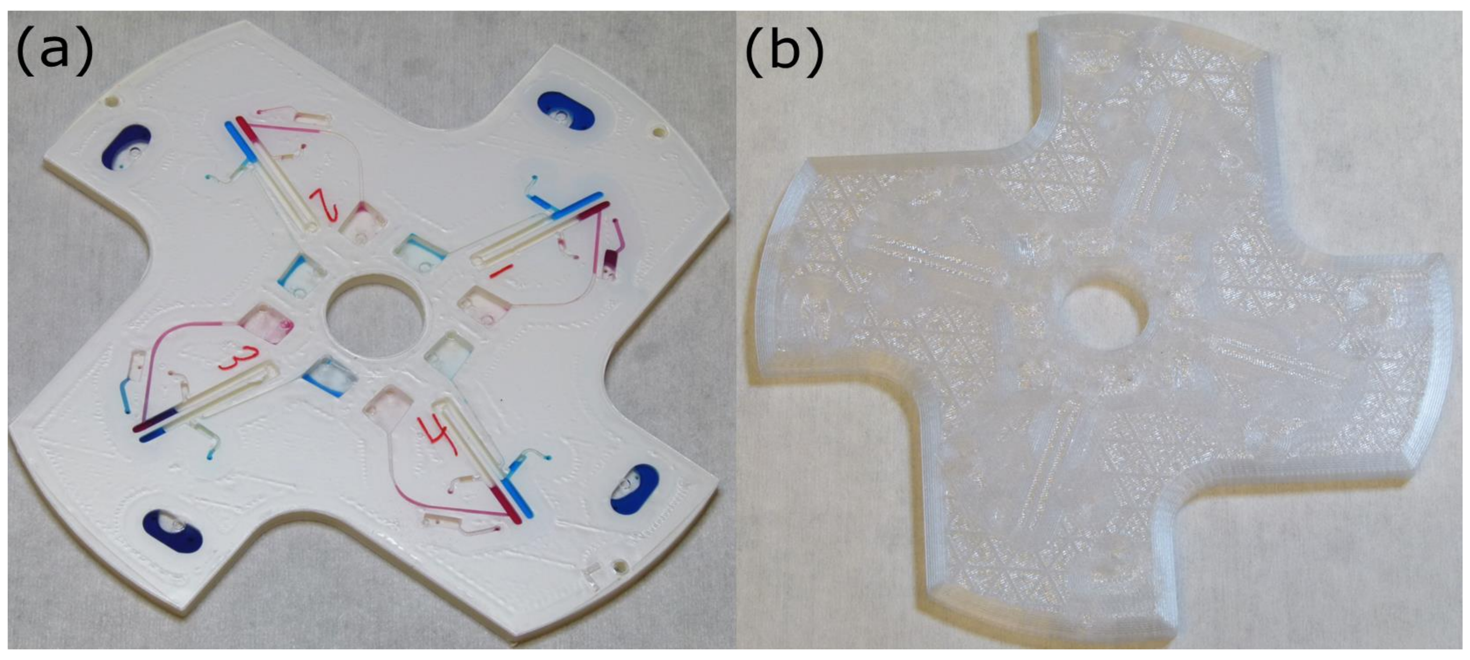


Figure 2. Photographs of the star-shaped (a) PLA-based opaque disc and (b) PET-G-based transparent disc. They were made star-shaped for reducing the required printing material and the printing time.

Microfluidic Operation

Here, we demonstrate a microfluidic operation through microchannels positioned at different depths of the FDM-based 3D printed disc.

Figure 3: Photograph of the experimental setup. The test instrument is an optical spin-stand consisting of a spindle motor for inducing rotation of the disc, a short-exposure-time camera to record image sequence and a strobe light for illumination.

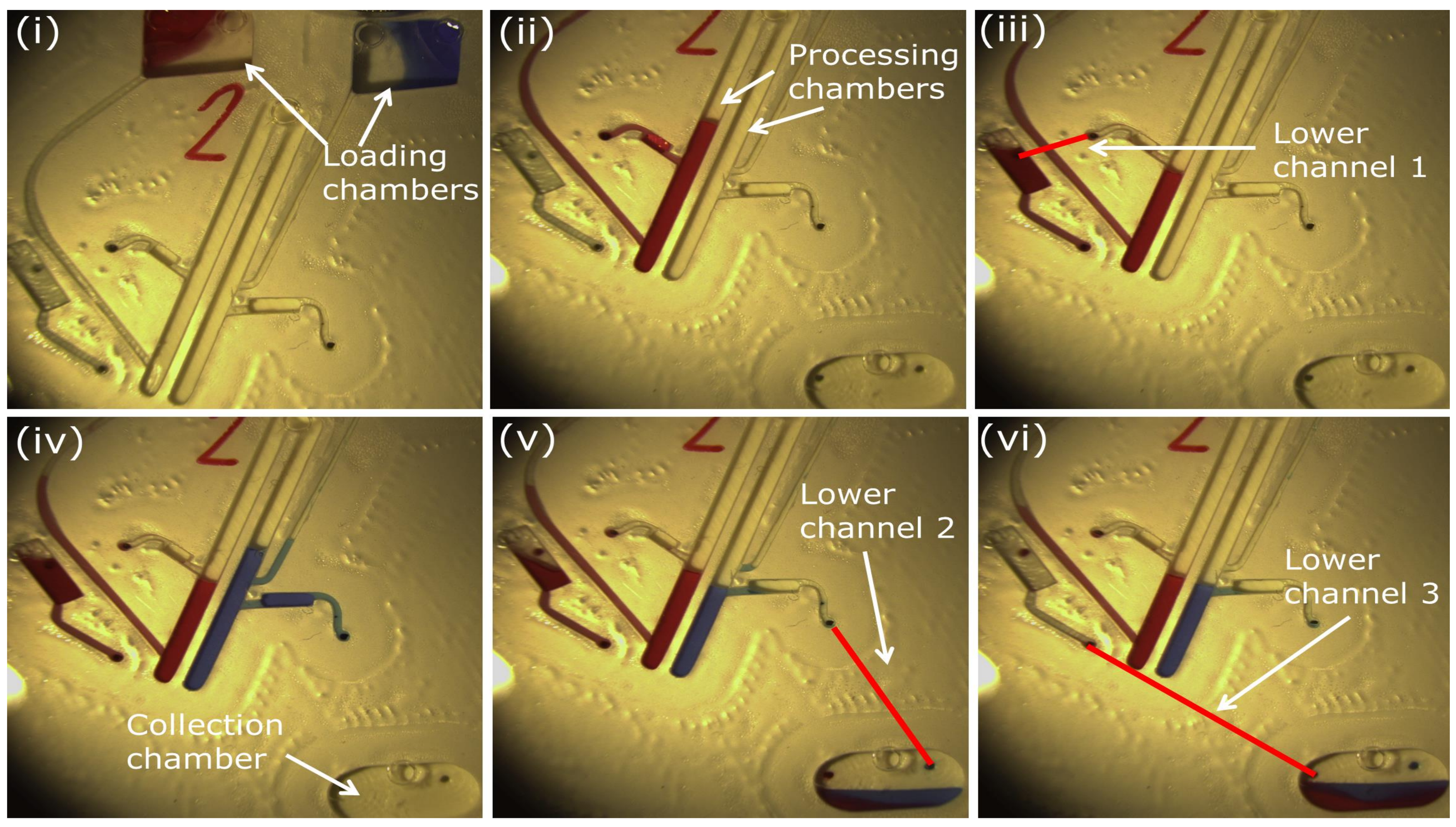


Figure 4. Sequential images of the flow and subsequent mixing of blue and red dye through microchannels at different depths of the PLA-based 3D printed disc. (i) Blue and red dye loaded into the loading chambers (ii) Red dye enters the processing chamber at 12 Hz spin rate. (iii) At same spin rate, red dye enters a 2nd chamber through lower channel-1 (microchannel positioned at a lower depth of the 3D printed disc) (iv) At 20 Hz spin rate, blue dye enters the processing chamber (v) At 30 Hz spin rate, blue dye enters the collection chamber through lower channel-2. (vi) At 45 Hz spin rate red dye enters the collection chamber through lower channel-3 and mixes with the blue dye.

Conclusion

The fabrication technique holds great potential towards **significantly reducing manual intervention** in microfabrication as well as **increasing fabrication reproducibility**. This method requires less materials thus **reducing the fabrication cost** resulting in enhancement of POC potential of microfluidic discs.

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