PDMS Microfluidic Chip Post-Processing

Manuel Robert Handta
Microfluidics Lab / Hochschule RheinMain

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Abstract

This report covers the post-processing steps necessary for the fabrication of PDMS microfluidic chips, specifically the extraction and hole punching procedures. Additionally, preliminary results from experiments using resin-printed molds are presented, evaluating their usability for creating microstructures.

1 Introduction

Microfluidic chips fabricated from PDMS (Polydimethylsiloxane) require post-processing steps after molding. This report describes the careful chip extraction and hole punching. Furthermore, initial experiments using resin-based molds are described and alternative mold fabrication methods discussed. [1]

2 Materials and Methods

2.1 Molding of Two Additional PDMS Ratios

Two additional mixtures of PDMS (Sylgard 184) were prepared in volume ratios of 5:1 and 20:1 (base to curing agent), with respectively 10 ml base. These mixtures were mixed, degassed, and molded following the procedures detailed in the prior report. The PDMS thickness is chosen to 0.4–0.6 cm for improved hole punching. The mixtures were allowed to cure for at least 1.5 hours at 75 °C on a hot plate. [2]

2.2 Post-processing

2.2.1 Chip Extraction

The PDMS chips were extracted from the molds using a scalpel and tweezers. Special care should be taken to prevent damage to the mold structure. The scapel was used to cut around the outline of the mold. Then using tweezers the chips were extracted while taking care not to touch the channels. Excess PDMS around the mold was removed, and the chips were carefully transferred into clean petri dishes with the microstructures facing downward to avoid contamination.

2.2.2 Hole Punching

Punching holes was practiced on the excess material using a 1 mm Miltex biopsy punch. The procedure involved precise alignment of the punch (making sure it is not tilted), controlled application of pressure, punching, and careful removal of the punched material.

3 Preliminary Results with Resin-Printed Molds

Resin molds produced by 3D printing were evaluated for PDMS chip fabrication. Despite proper cleaning and post-curing of the molds (and 1 year aging), PDMS surfaces exhibited stickiness indicative of incomplete curing. However, successful replication of fine microstructures, including intricate channels, was achieved, demonstrating promising potential for resin mold usage. Picture are not included due to bad camera quality.

4 Future Work and Optimization

The next lab course will focus on finalizing chip functionality, by punching holes for the inlets and outlets. Then adding tubing, testing fluid flow and conducting microscopic analyses.

Future optimization steps for 3D-printed resin molds include:

- Surface treatments of resin molds to enhance PDMS curing: "application of epoxy coating, particularly at a 0.50 acetone ratio, significantly decreases surface imperfections and increases optical clarity of PDMS replicas from SLA printed molds" [3].
- Additional thermal post-curing to improve PDMS hardness, and maybe reduce stickiness.
- Experimentation with silicone negatives casted in a 3D-printed resin mold, to then create a PDMS compatible Epoxy-mold.
- Creating Epoxy molds from already available PDMS chips, like demonstrated by Burgoyne in her Chips and Tips issue [4].
- Testing fully 3D-printed PDMS chips for demonstrative fluid behavior applications.

References

[1] Prof. X. Li, "Lecture on Microfluidics and Lab-on-Chip," *Fraunhofer IMM & HSRM*, 2025

[2] Dow Inc. *SYLGARD™ 184 Silicone Elastomer Kit*. Available at: `https://www.dow.com/en-us/pdp.sylgard-184-silicone-elastomer-kit.01064291z.html#overview`. Accessed: 29 June 2025.

[3] Rana J. Abbed, Edwin I. Quiñones Cruz, Susan E. Leggett. *3D Printed Molds for Organ-on-a-Chip and Fluidics: PDMS-Based Rapid and Accessible Prototyping*. Available at: `https://doi.org/10.1101/2025.03.29.645830`. Accessed: 05 July 2025.

[4] Francesca Burgoyne. *Chips and Tips: An inexpensive and durable epoxy mould for PDMS*. Available at: `https://blogs.rsc.org/chipsandtips/2009/04/22/an-inexpensive-and-durable-epoxy-mould-for-pdms/?doing_wp_cron=1751720681.7554070949554443359375`. Accessed: 05 July 2025.