PDMS Microfluidic Chip Inspection

Manuel Robert Handta
Microfluidics Lab / Hochschule RheinMain

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Abstract

Before plasma bonding, an exemplary PDMS replica was examined under a Zeiss compound microscope to demonstrate the process of Chip Inspection. Things to consider are the verification of channel integrity, surface cleanliness and defect detection. This report summarizes methods, observations, and pass/fail criteria to ensure reliable bonding and flow performance.

1 Introduction

Visual quality control of PDMS chips is critical: contaminants or structural defects could lead to leaks, blockage and poor adhesion. This report describes brightfield microscopic inspection of the chips channels. To demonstrate on what cues to focus the inspection a already defect Chip with a lot of fine details was used.

2 Materials & Methods

Images were acquired on a Zeiss compound microscope with an attached camera in brightfield mode. The PDMS side faced upward on a glass slide. An immersion was not used. The glass slide was clean with a isopropyl alcohol solution before the chip was placed.

Then the chip could be inspected. Interesting features were adjusted till in focus and a picture was saved on the attached computer for further evaluation. Due to the sparse time, only a visual inspection was performed. Analysis of the found contaminants size didn't happen. The magnification also wasn't noted.

3 Results

Each defect is shown with its figure, a brief description, and the corresponding risk for bonding or flow. Furthermore interesting features were also documented and described.

Particulate Contamination is shown in figure 1. A small particle is trapped in the channel, potentially causing partial blockage and disturbed laminar flow.
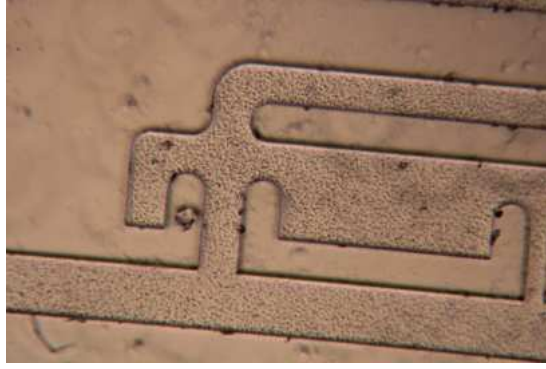
Figure 1: Particle trapped in channel.

Figure 2 shows smearing on the microfluidic chip. Visible smear on the PDMS indicates a residue that might lead to uneven plasma bonding.
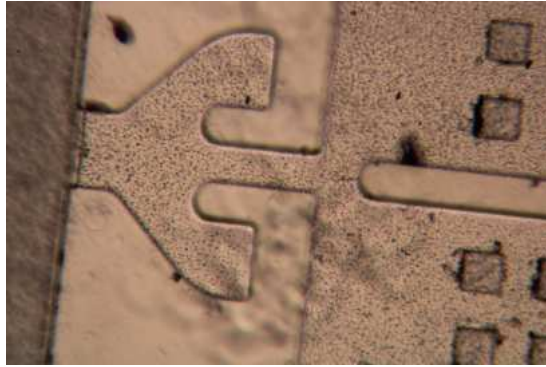

Figure 2: Smeared PDMS surface along channel wall.

A Crack is show in figure 3. The images portrait the end of the crack that was caused by uncarefull extraction of the PDMS chip from the SU-8 mold. This would definitely cause leakage of the chip therefore making it unusable, except for inspection purposes. The figure also features a channel with elevated cubed structures: (left) focus at the channel floor and (right) with the cubes surface in focus.
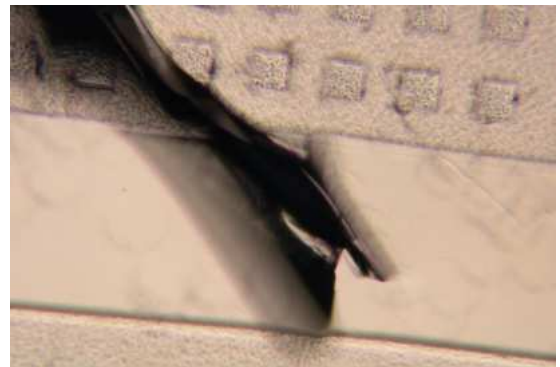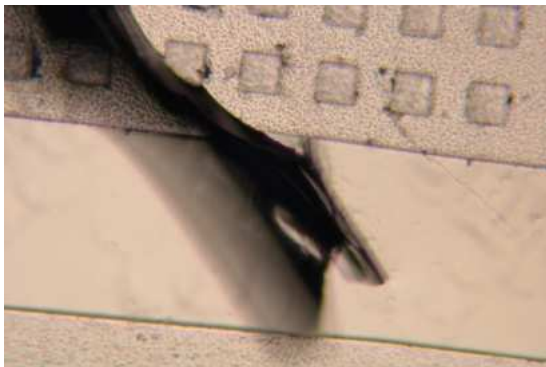

Figure 3: Longitudinal crack imaged at the floor (left) and top of cubes (right) of the channel.

The last figures (Fig. 3) show a channel with a depth step. A region where channel depth abruptly changes. Left: focus on shallow section; right: focus on deep section. This abrupt change in height might create dead volumes.
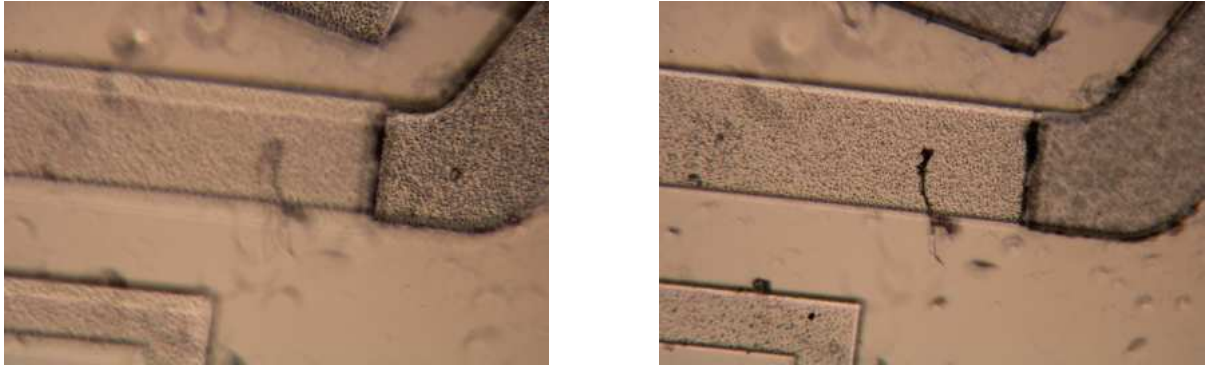
Figure 4: Channel depth transition, shallow (left) versus deep (right) focus.

4 Discussion & Future Work

The third lab appointment introduced the students into the process of visual inspection for quality control of microfluidic chips. Key takeaway are:

- Contaminants may block flow

- Smears reduce effective bonding area and risk detachment

- Cracks cause leakage (small cracks possibly only under pressure)

Only PDMS replicas meeting all visual criteria should proceed to oxygen-plasma bonding. This ensures consistent chip performance and leak-free operation. The last lab course will document the process of plasma bonding and how to glue the tubing to then test the chip.