Microfluidics Report on Soft Lithography and PDMS Design

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Introduction:

Photolithography is a process used in the manufacture of semiconductor devices, such as microprocessors, LEDs, and memory chips. It involves using UV light to transfer a pattern onto a light-sensitive material, which is then used to etch the pattern onto a substrate, such as silicon. This allows for the precise control of the dimensions of the features on the semiconductor device, which is crucial for the device's performance.

Materials and Methods:

Design your wafer:

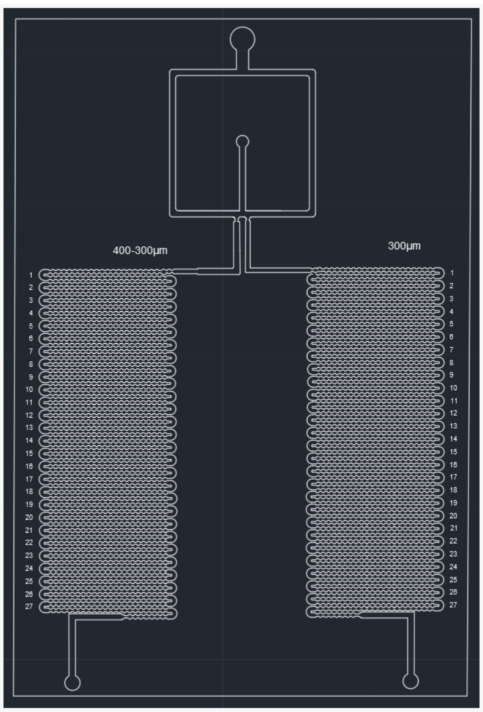

Figure 1. Two channel design

Thoroughly clean your 4in wafer - dip in ethanol, then water. Blow dry with nitrogen.

Coat the wafer with epoxy - using a vacuum sealed spinner, pour a generous amount of SU-8 epoxy evenly on the wafer. Spin the wafer at your desired rate and length for a thin even coating.

Prebake - Set wafer on a 60 degrees Celsius hotplate for 5 minutes, transfer to 90 degrees hotplate Celsius for 30 minutes.

Etch prints onto wafer - place a photomask on-top the wafer with your designs and use UV light at a specific wavelength and duration.

Post-bake - Set wafer on a 60 degrees Celsius hotplate for 5 minutes, transfer to 90 degrees hotplate Celsius for 30 minutes.

Development - From here you can develop the photoresist in a developer. We used a machine that creates a chemical reaction and develops the substrate. From here you clean with isopropanol and an air jet.

Mix and degas PDMS - Mix the elastomer mixture and degas it under a vacuum for a specific amount of time. From there you can transfer the mixture to the master mold.

Bake - Heat the entire system at 80 Celsius, then let it completely cool. From this point you can cut and separate each individual structure if needed.

Plasma Treatment - Remove all debris. Then treat the surface and glass slide using oxygen plasma. From there you can bond both pieces together and have a sealed microfluidic device.

Results and Discussion:

The device worked as intended, fluid flowed at a fast rate through the smaller diameter channel and a slower rate through the larger diameter channel. Even though this is good, I wished for the device to work better.

For whatever reason there was a preference for it to flow to one side of the channel at the beginning instead of equally to both sides (even before different diameter channels were introduced). Therefore, the fluid did not reach the two different diameter openings at the same time and had a preference of flow to the smaller channel. My theory is that this along with other factors caused pressure to build up in the larger channel now making it even less likely for the larger channel to be reached as well as the rate to be even slower than intended. Although, with enough effort and fiddling around we were able to get it working as shown in figure 2.

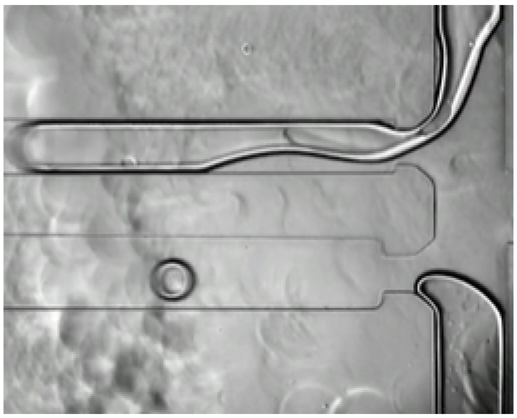

Figure 2. Screenshot of faster rate occurring in smaller channel and slower rate occurring in bigger channel.

Conclusion:

I am satisfied with the process and results for the time-frame available. I came out with a design that has been tested and works as intended. Important lessons were learned in fluidics and how fluids behave, so future endeavors can be more successful. In the future I would be interested in developing a scaling factor/equation that could tell you the exact rate that each channel would flow at depending on their diameter, and rate of fluid insertion for my design.