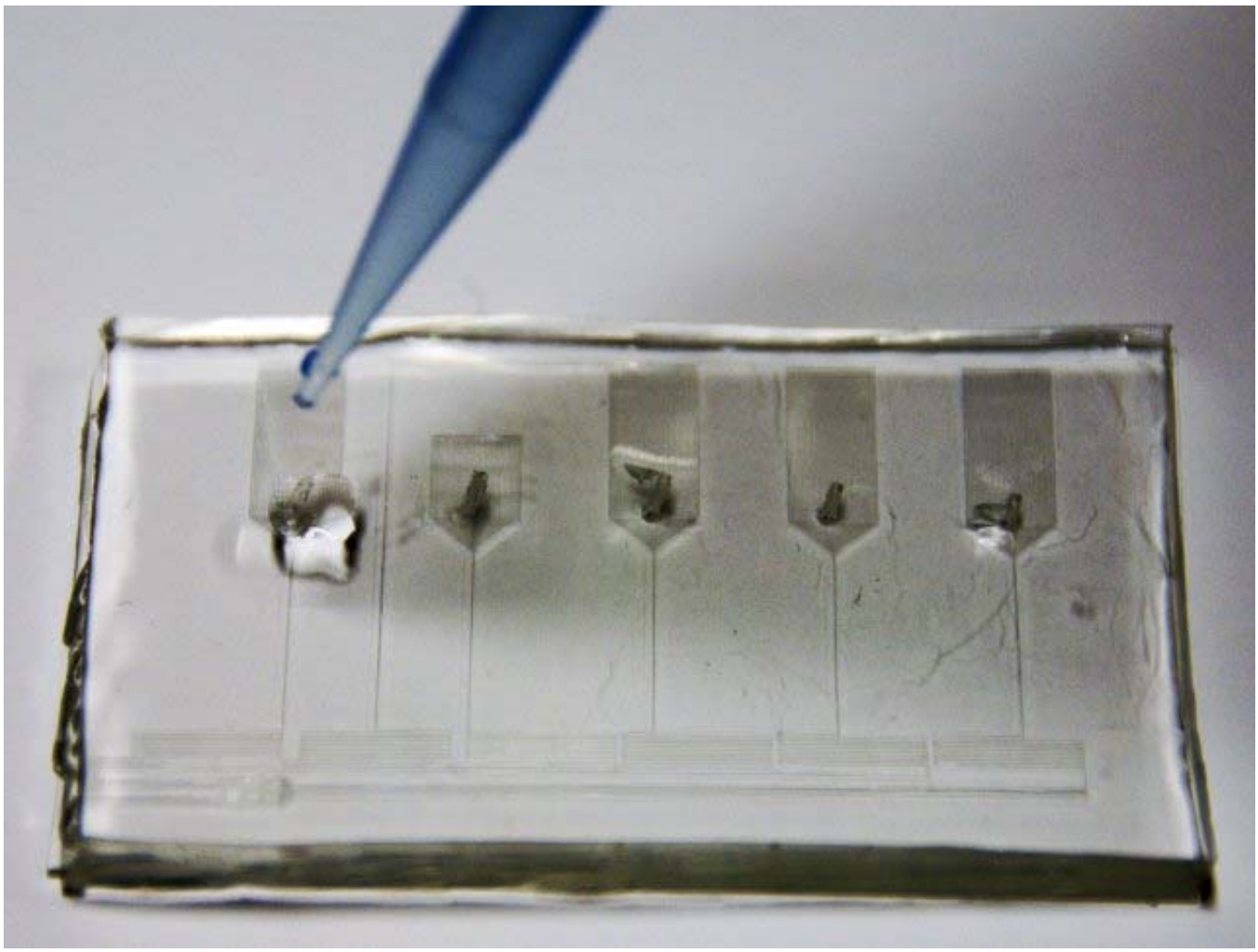
Fluid Reservoirs

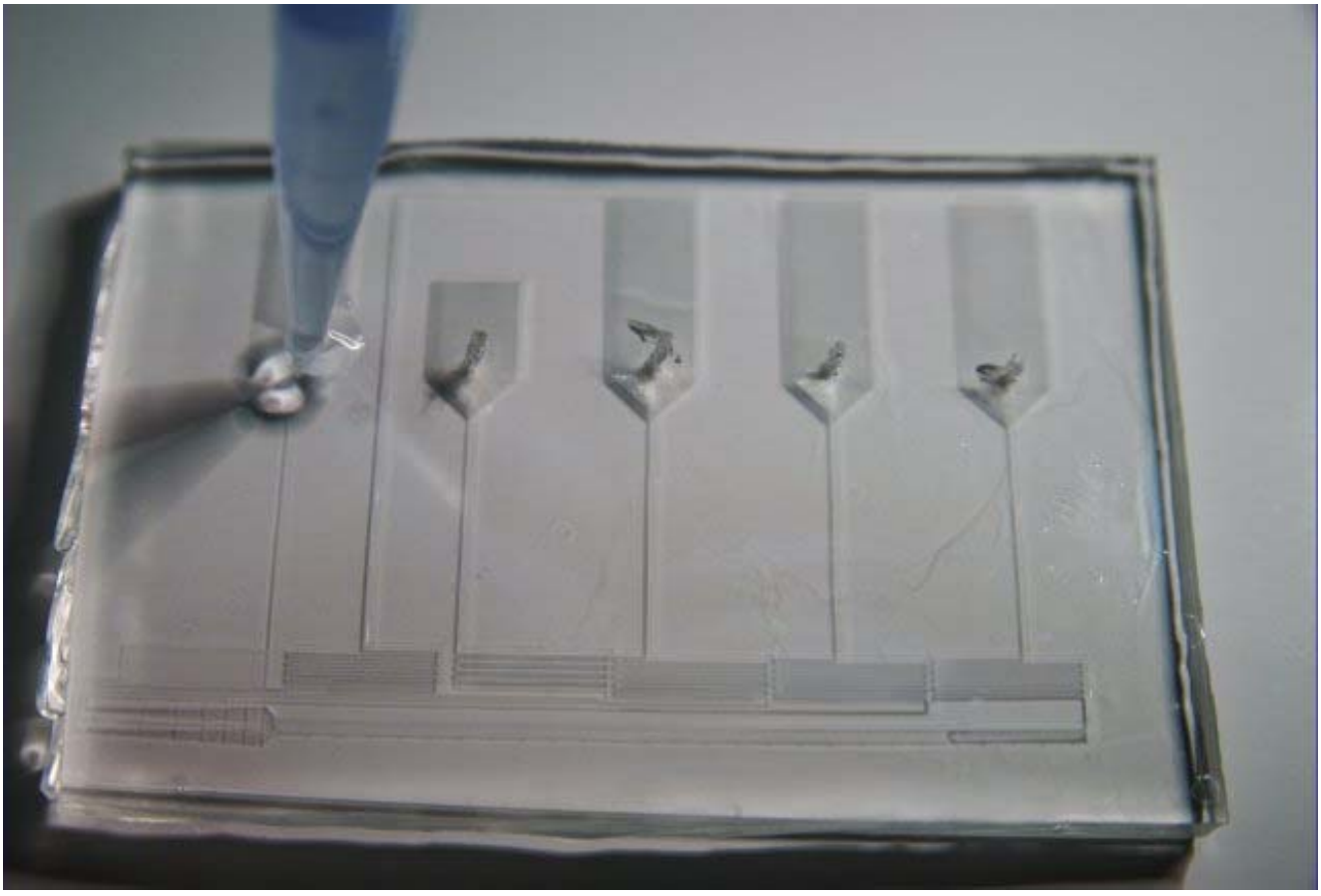
One of the key challenges with using microfluidic devices is getting fluids into and out of them. Several techniques have been developed. One common method is to insert plastic tubing that is connected to a motorized pump, but this approach is expensive and can be challenging to master. Here we will show several simple techniques.

The first technique is to punch small holes into the device before bonding, and insert pipette tips filled with fluid into these holes. The image below shows a device with five holes punched into it to act as inlets and outlets. To insert a pipette, first a droplet of water is placed over the hole to guarantee that no air bubbles are introduced into the device.

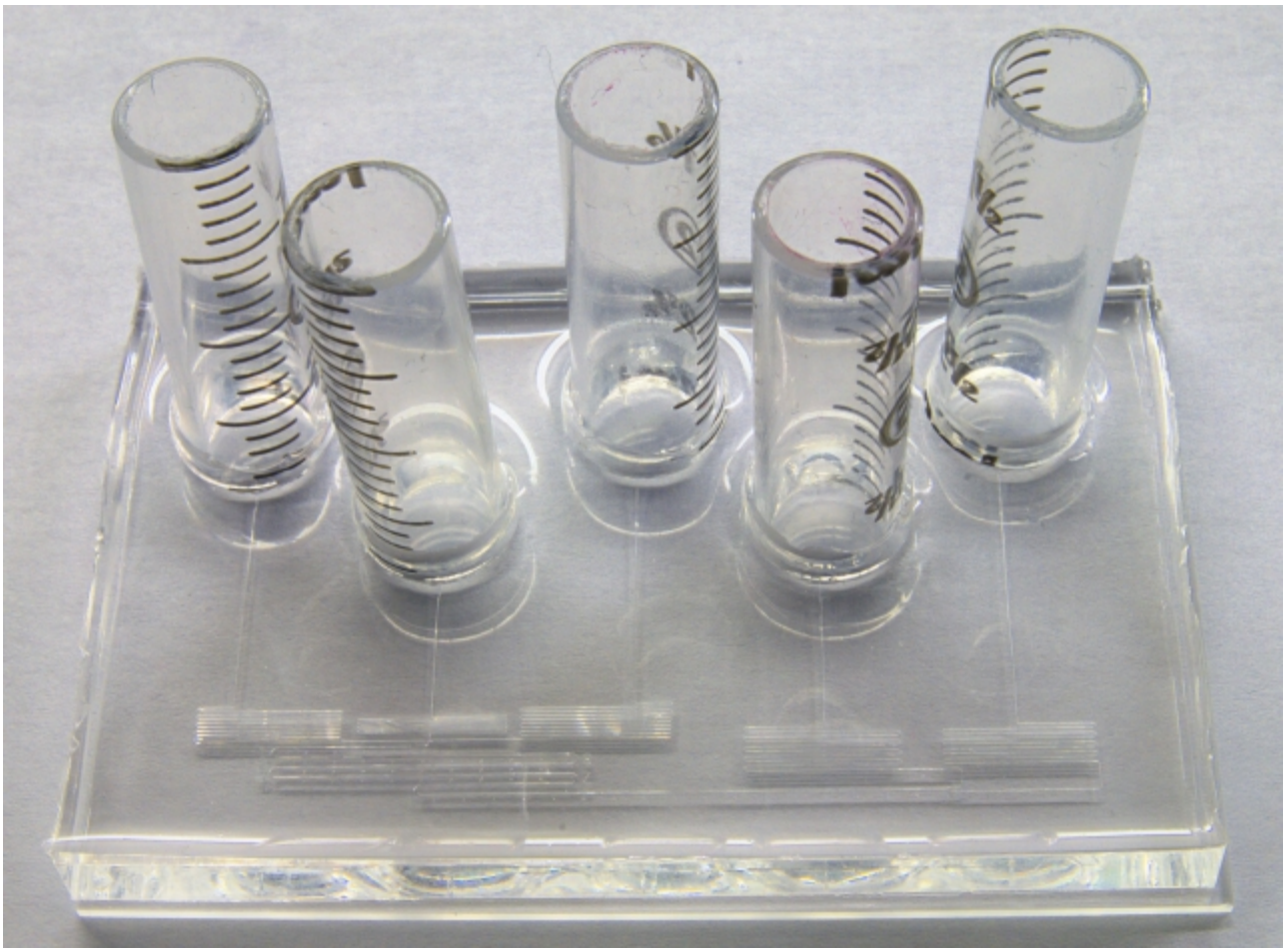


Next, a pipette tip filled with fluid is inserted into the hole. The pipette tip must not contain any air bubbles. One advantage of this technique is simplicity; it is relatively easy

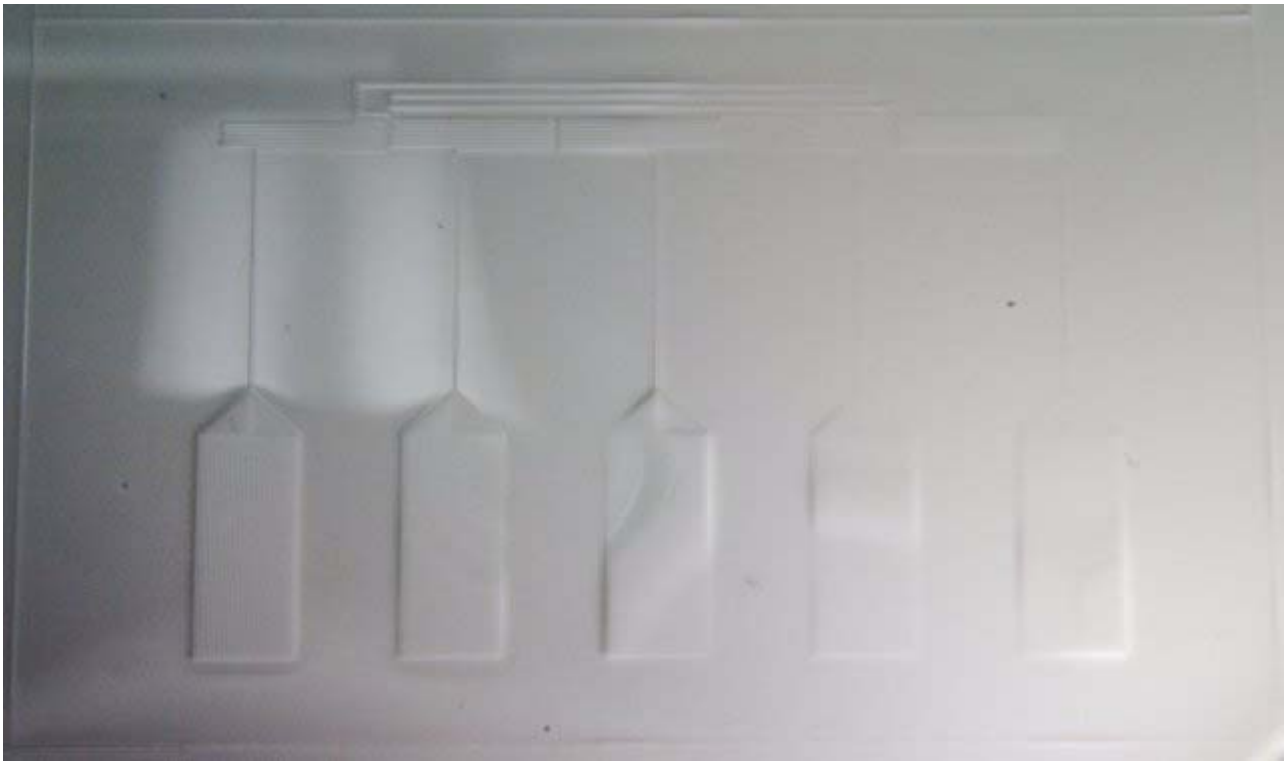
to punch holes into PDMS, and pipette tips are plentiful. Another advantage is that it is easy to switch solutions. Simply place a drop of fluid around the base of the pipette tip, place your thumb over the back of it to keep the fluid in, and pull it out of the device. Then simply insert a pipette tip containing the new fluid to be perfused through the device. One disadvantage is that it can be tricky to control the fluid height, which determines how fast fluid flows through the device. Another disadvantage is that the PDMS can tear when punching holes, causing fluid to leak out of the tear rather than flow into the device.



A second approach is to use cylinders from syringes as the reservoir, as shown in the image below. This technique has the advantage of being mechanically stable, and the reservoirs can be cut to any height necessary. In addition fluids can easily be exchanged by pipetting them into and out of the reservoirs. Also, this approach has a built-in o-ring to prevent leaks (described below). It has the disadvantage of being more difficult to fabricate. In addition, cells and debris tend to collect at the bottom of the reservoir, clogging the device.



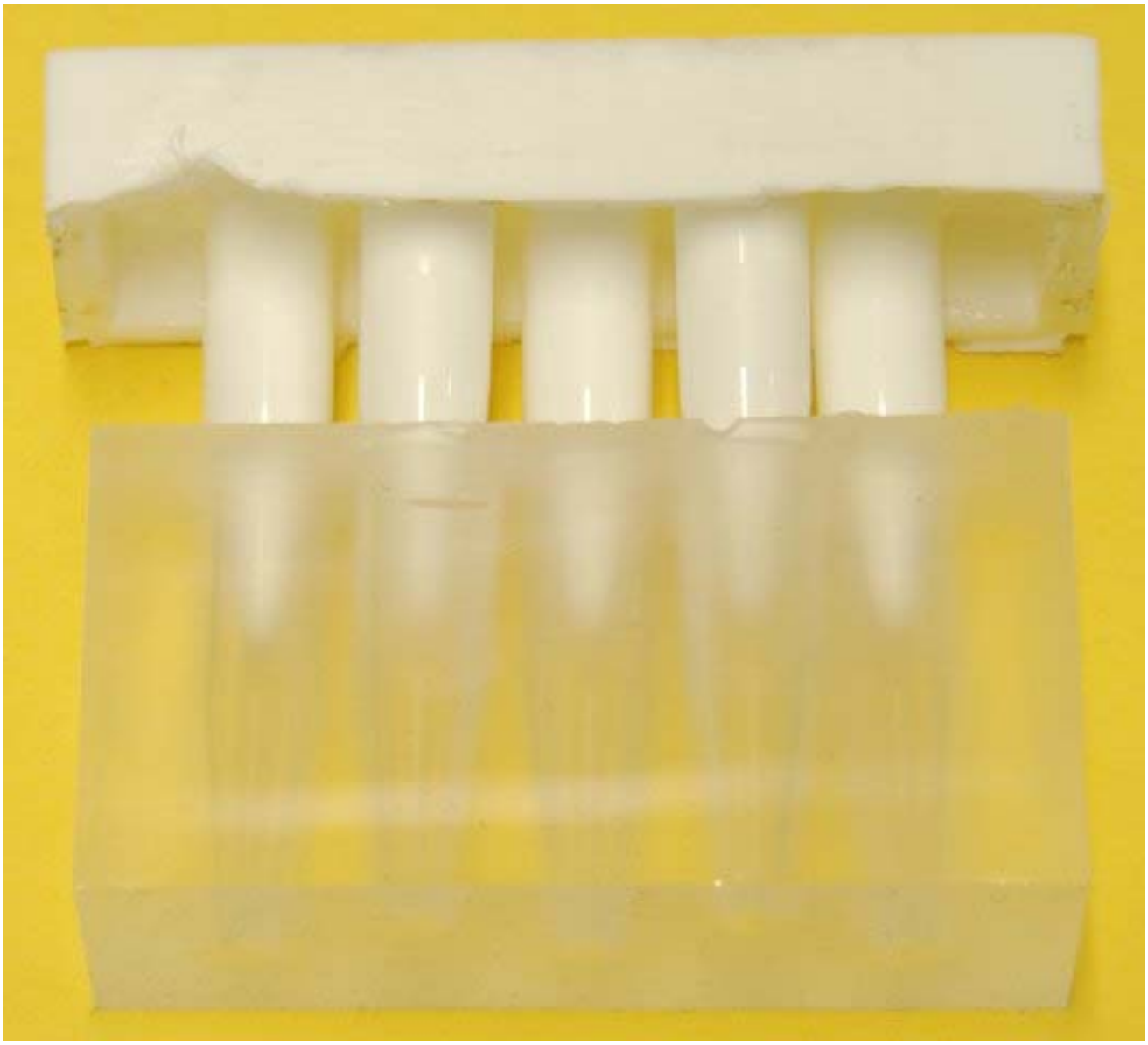
To fabricate devices using this technique, we first start with a device containing no inlets our outlets, as shown here.



We then place cylindrical plastic devices at each location where we would like to insert a syringe cylinder. These plastic devices were cast from capacitors that have an indented ring near the bottom. In the final device, this ring is filled with PDMS; since it is smaller than the syringe cylinder, it acts as an o-ring to hold the cylinder in place.

A third technique is to cast reservoirs out of PDMS. This technique has all of the advantages of the cylinder method, and can be tapered at the bottom to prevent clogging. It has the disadvantage of requiring another casting and bonding step. First, tapered cylinders like the one shown below are cast to form a mold.

This mold is then used to create a plastic negative. The plastic negative is used to cast the reservoirs in PDMS.



Since the bottom surface will be bonded to a PDMS device, it must be smooth. To ensure smoothness, a glass chamber is built out of microscope slides to surround the plastic mold. PDMS is then poured into this chamber to cast the reservoirs. The resulting reservoirs have smooth, optically clear surfaces.