Easy and Inexpensive fabrication of PDMS films

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Why is this useful?

The following tip describes an easy and inexpensive way to fabricate PDMS films of different thicknesses. The main advantage is that no infrastructure (e.g. spin coater) is needed for fabrication and that the materials needed are readily available. The idea here is to use a film of a specific thickness as spacer between two plates. PDMS is first deposited on one plate and squeezed in between plates to get a PDMS film with thickness similar to that of the film used as spacer. A similar methodology could be used to make films of other materials as well.

This methodology allows for very quick fabrication of a wide range of PDMS films using off the shelf components which are common in a traditional laboratory and office or can be easily purchased. The final goal is to fabricate films which feature different thickness, according to the original film used as spacer, and different hardness, by changing the ratio of PDMS to cross linker. The film can be stored and used as needed to cut off parts such as gaskets, spacers, etc. Here in the lab we use them to make microfluidic chambers (by cutting a gasket) of specific thickness.

What do I need?

- 2 rigid plates with at least one flat surface per plate. They can be glass, PMMA (>3-4 mm thickness) or other material as long as they are rigid, preferably a fair thermal conductor and do not soften at temperatures as hot as 100 °C. The use of transparent plates is not necessary but recommended to monitor the squeezing process of the PDMS and minimize the presence of bubbles in the final PDMS film.
- Pieces of a film, which can be tape, pieces of a plastic bag or any film that does not compress or absorbs PDMS, with similar thickness to that being targeted for the PDMS film
- Paper clamps, binder clips
- Soap

And of course PDMS and the equipment recommended to process it: balance, degasser and oven. Although this equipment is recommended it is not necessary as already suggested by Francesca Burgoyne in a previous tip
http://blogs.rsc.org/chipsandtips/2011/05/26/degassing-a-pdms-mixture-without-a-vacuum-desiccator-or-a-laboratory-centrifuge-and-curing-the-pdms-chip-in-an-ordinary-kitchen-oven/

Where do I get it and how much it will cost me?

In principle all the materials required are already available in the lab. The two plates can be two pieces of glass, as simple as two glass slides. In this work I used PMMA plates. The cost of the plates can be minimal and should not be more than $10. For example, you could go and buy a couple of very cheap picture frames with a glass piece of the size you want and use those. The pieces of film you use depend on the final thickness of the PDMS film and they can be obtained from a variety of sources, use your imagination! The paper clamps or binder clips are usually available in the office, if not you can buy them for cents apiece.

What do I do?

1. Wear gloves before starting, PDMS can be messy! The materials needed are detailed above and shown in figure 1.
2. Dip your rigid plates in soapy water for a couple of minutes to deposit a layer that prevents PDMS from adhering to the plates. Remove the plates and blow them dry or let them dry naturally, do not wipe dry!
3. Prepare your PDMS. Different ratios between the polymer and the cross-linker give different hardness. A 20:1 mix results in a gluey, soft film that easily sticks to a variety of materials. A traditional 10:1 results in a harder film. 5 grams of mix should be enough for films featuring an area of 8 by 8 cm and thickness of up to 200 µm.
4. After the plates are dry (but still with the dried soap layer on them), you can position your film close to the edges of the plate as shown in figure 2. Do it on only two edges to allow plenty of space for the PDMS to flow out from between the plates during step 7.
5. After the PDMS is well mixed manually deposit the PDMS mix on one plate as shown in figure 3.
6. Degas the PDMS deposited on the plate until the mix looks homogeneous.
7. Remove this plate from the degasser, place it on a flat surface and use the other plate to squeeze the PDMS in between the plates. It is recommended to start applying pressure in one side and work your way towards the other side to avoid introducing bubble in the PDMS.
8. Use the paper clamps to clamp the plates together at the location of the film used as spacer as shown in figure 4.
9. Bake for 1 hour at 80 °C
10. Remove from oven and let cool for 5 min.
11. Use a knife to remove the PDMS accumulated on the edges of the plates. This is important because it will facilitate the release of the PDMS film in the next step.
12. Slowly but firmly separate the two plates, the PDMS film is likely to remain on one plate from where you can peel it off as shown in figure 5. Make sure you do it slowly to avoid rupturing the film. You may use fine tweezers to aid you during the release.
13. Done! you can store your film and later use a hole puncher, knife, etc. to cut off any feature you want.
14. Clean your plates from PDMS and store them clean for the next time. Avoid scratching the surface of your plates!

Notes:

- Tape (175 µm and 70 µm-thick) and plastified paper (50 µm-thick) have been used as spacers.
- This methodology has been used to fabricate films as thin as 50-70 um. The exact thickness of the PDMS film is difficult to measure due to the soft nature of the film.
- You may want to use a Mylar® film in between the rigid plate and PDMS. This way you don't need to worry about scratching your plates or about cleaning the plates each time you use them. Furthermore, storing your PDMS film between Mylar® film can help protect it against scratches.

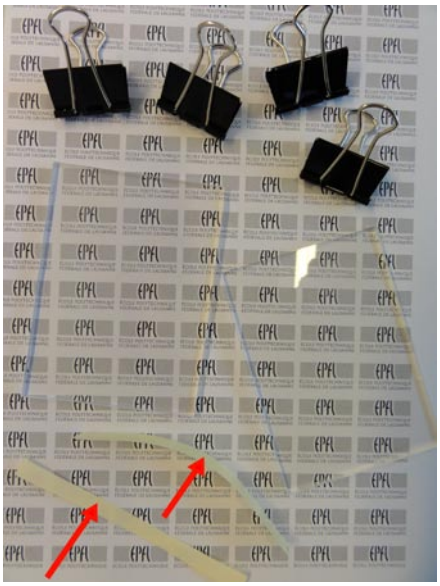

Figure 1. Materials needed: paper clamps, rigid plates and pieces of film (red arrows)

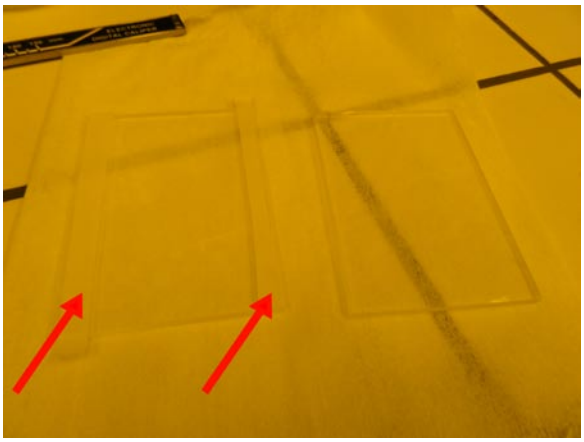

Figure 2. Pieces of film (red arrows) positioned close to the edges of the rigid plate shown on the left.

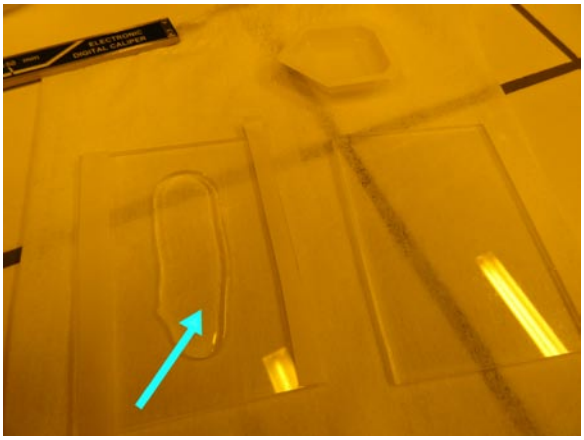

Figure 3. Manually deposited PDMS (blue arrow) on one of the plates

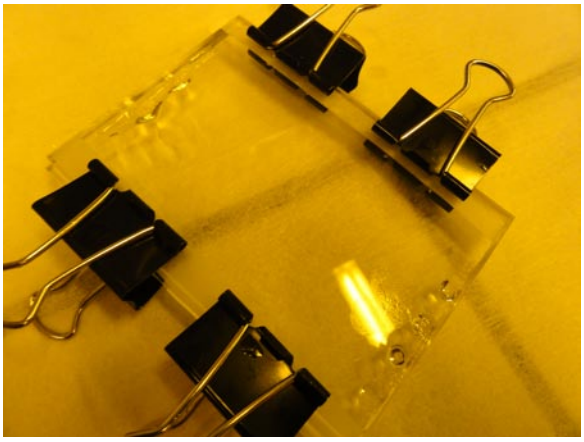
Figure 4. Squeezed PDMS between rigid plates using paper clamps


Figure 5. Release of the PDMS film from one of the plates after it has been cross-linked by heating