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Microfluidics 5: PDMS Microchannel Bonding on Glass/PDMS V.4

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Microfluidic chips, made of PDMS, are one-side open when fabricated. Another layer of glass, PDMS, or etc is needed. Liquid seal is provided by complete covalent bonding between layers or by external forces like threads, magnets or similar factors. This protocol describes the covalent bonding of PDMS on glass by air plasma technique.

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microfluidics, PDMS, oxygen plasma

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Glass slide; Standard sizes microscope glass preferably Marienfeld Microscope Slides 1000000
PDMS material; Dow Corning, Sylgard 184

* All the related steps must be done in a clean room classD (minimum) with appropriate clothing.

* All oxygen plasma generation procedures must be performed carefully and not alone.

* Please learn well about the hazards of plasma generators and PDMS material.

This protocol is derived from "soft lithography" literature and can be modified by user freely.

Oxygen Plasma Exposure

18m

1 **1.0.1.** Cured PDMS manufactured at previous steps using lithography or 3D printed molds^{3m} are cut or removed from the mold and put inside a clean petri dish. Since PDMS is vulnerable to surface adsorption of dust, each must be clean and performed inside cleanroom facilities.

1.0.2. NehirBT's air plasma generator is a homemade setup of microwave instrument in which there is a glass vacuum desiccator.



There are standard oxygen plasma devices commercially available. We are using a homemade air plasma generator modified from a microwave oven which is modified by including a desiccator inside and opening appropriate holes for vacuum tubing. Also in order to form a vacuum inside the desiccator, appropriate tubing is connected with the vacuum pump.

Please, do not try to make a similar modification yourself if you are not an expert on electronic devices.



Do not use any kind of metal inside the microwave oven when it is on or off.

The purple plasma waves inside the instrument must not touch PDMS otherwise PDMS burns and bonding is not possible.



The duration of plasma exposure depends on the power of plasma, the volume of the desiccator, the size of the PDMS film, and some others. So an optimization step is required for all different setups. If the duration of plasma exposure is too low the surfaces of PDMS and glass will not be cleaned enough to be bonded. On the other hand, if the plasma exposure time is long, the surface of PDMS will be scorched and

will not bond on the glass again.

Oxygen/Air Plasma

custom-made microwave incl. glass vacuum chamber

1.1 1.1.1. PDMS material is cleaned inside a fume hood by isopropanol and dried^{5m} by nitrogen gas spraying.

1.1.2. Glass slide is cleaned inside a fume hood by isopropanol and dried by nitrogen gas spraying.

1.2 1.2.1. PDMS microchannels can be bonded on a glass microscope slide,^{10m} glass petri dish, or another PDMS layer according to the necessities of the application.

1.2.2. The glass and PDMS materials are placed inside the desiccator inside the plasma generator system without touching each other. Glass petri dishes and/or glass cell flasks can also be used for PDMS bonding when their sizes fit inside the desiccator.

1.2.3. The lid of the desiccator is closed. The door of the instrument is closed well.

1.2.4. The vacuum pump is run for 5-6 minutes to remove the air inside the desiccator and to secure a low vacuum level.

1.2.5. Then the microwave is kept turned on till purple oxygen plasma waves are generated and observed. It is kept on for 5-6 seconds more with plasma generated inside the desiccator.

Bonding After Exposure

2m

2 2.0.1. After exposure bonding and alignment is critical and a few minutes is present to keep plasma effect on materials.

2.1 2.1.1. When the alignment is important between layers, a special jig may be^{1m} used. In this case, place the jig between layers perform the further steps.

2.2 2.2.1. The plasma exposed PDMS layer is put on the other plasma exposed^{1m} layer which may be glass or PDMS layer and both will bond permanently with covalent bonding.

2.2.2. The exposed PDMS and bottom layer may not be enforced for bonding, this behavior may cause over bonding of microchannels inside.

2.2.3. After bonding if there is any air present between layers, a plastic tip may be used to remove air by manual smooth pressure.

2.2.4. The duration of bonding may take a few minutes at room temperature.

Final Heating and Ready

10m

3 3.0.1. The final PDMS on Glass/PDMS chip is heated at 85°C for 5-10 minutes on a heating plate or for 10 minutes in a heater oven.^{10m}



Do not forget to cool down the final chip product before touching and using it. This step is performed inside the cleanroom.

Hot Plate

Electromag LB.EM.M4060

Stock of PDMS chips

3m

4 4.0.1. The prepared chips can be stored at room temperature inside a closed clean box or^{3m} petri dish after sealing the top and down of channels with scotch tape and they can be used anytime.



If the PDMS chips are left uncovered, dust on air will stick on the chip very soon.

Visual Quality Check

1m

5 5.0.1. Visual check of bonding PDMS on glass layer is performed under a digital microscope,^{1m} and these parameters are checked mainly;

5.0.2. Poor adhesion or poor bonding, Debris (Trace), air bubbles (active areas), Stains-Voids, Scratch marks, Broken PDMS, Uneven PDMS, Wrong Orientation (PDMS), Crooked trace, Chipped or Broken Glass, and Wrong Alignment of PDMS on Glass.