Electronic Supplementary Material (ESI) for Lab on a Chip

PDMS-Glass bonding using grafted polymeric adhesive - Alternative process flow for compatibility with patterned biological molecules

Cyrus Weijie Beh,[a,b] Weizhuang Zhou[a,b] and Tza-Huei Wang[a,c,d]

[a] *Department of Biomedical Engineering, Johns Hopkins University, Baltimore, Maryland, USA. E-mail: thwang@jhu.edu; Tel: +1 4105167086*

[b] *Agency for Science, Technology and Research (A*STAR), 1 Fusionopolis Way, Connexis Singapore 138632 E-mail: wbeh1@jhmi.edu*

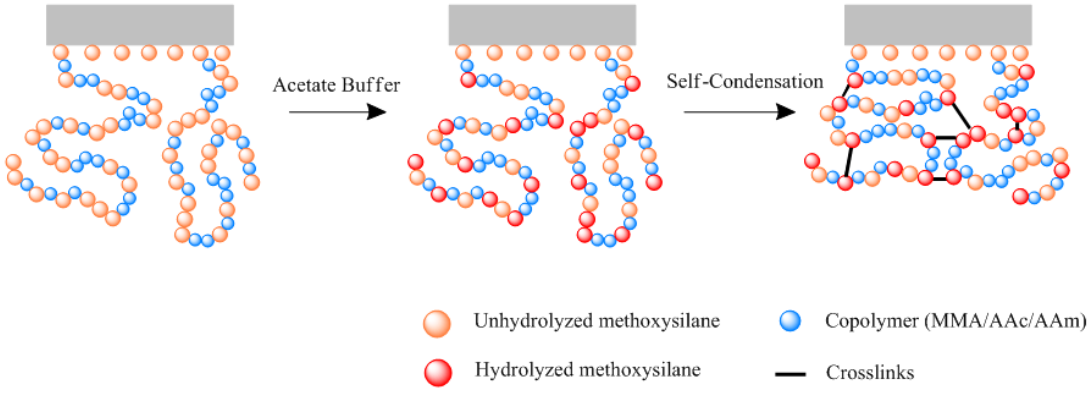
[c] *Sidney Kimmel Comprehensive Cancer Centre, Johns Hopkins University, Baltimore, Maryland, USA*

[d] *Department of Mechanical Engineering, Johns Hopkins University, Baltimore, Maryland, USA*

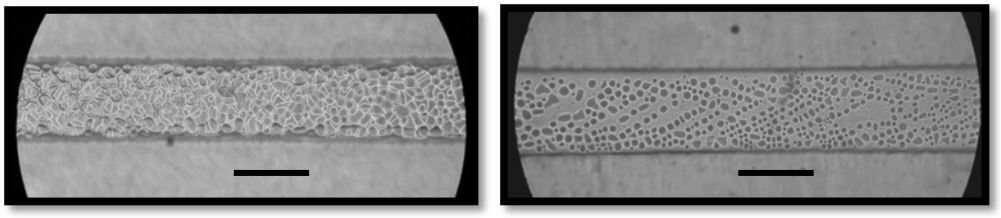
Supplementary Data

1. Alkoxysilane Self-Condensation

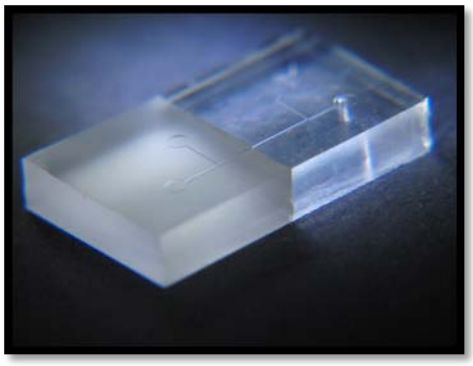
Alkoxysilanes form silanols (Si-OH) after hydrolysis of the Si-O-Me functional group. This can either be achieved under acidic conditions (which minimize self-condensation), or can happen in the presence of moisture in the air. The silanols can self-condense to form siloxane groups if not bonded to a substrate (Supplementary Figure 1). These crosslinked polymer molecules appear as bumps on the surface of the PDMS (Supplementary Figure 2), that can be removed using buffered hydrofluoric acid etch (Supplementary Figure 3).



Supplementary Figure 1 Grafted polymer on the PDMS surface undergo acidic hydrolysis in the acetate buffer, which generate silanol groups along the polymer chain. Without a surface to bond to, the activated functional groups self-condense to yield microscopic bumps of polymeric material.



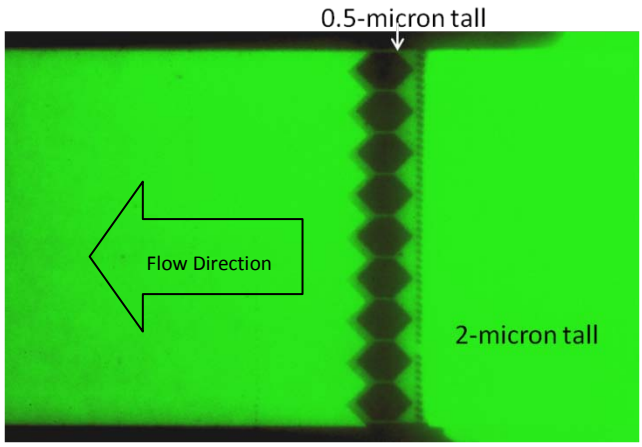
Supplementary Figure 2 'Grafting-from' (left) and 'grafting-to' (right) reactions result in significantly different grafting densities. When similarly aged (exposed to humid environment unprotected for 10 days) the silica-like structures are much denser in the 'grafting-from' device (bar = 100 µm). These structures result from polymer intra- and inter-chain crosslinking, resulting in non-productive cyclic structures. The higher number of these structures therefore correspond to a higher grafting density.



Supplementary Figure 3 A polymer-modified PDMS was left in a humidified environment and formed cloudy structures on the surface due to self-condensation. The resulting Si-O-Si bonds can be removed using buffered hydrofluoric acid (BHF). The fPDMS was cut in two and one part was placed in BHF for 30 minutes and it became clear.

2. Device Patency Test

To verify that our modification does not significantly change the geometry of microchannels, the modification was performed on a device with 2- and 0.5-micron channels. Alexafluor 488™ (100 nM) dye is injected into the device with 8 psi driving pressure. The channels are then imaged on Olympus Axiovert fluorescence microscope with a Retiga intensifier CCD camera (Qimaging). Since most microchannels are larger than the 0.5-micron channels tested here, device patency in this shallow channel indicates that the channel geometry of normal microfluidic devices will not be significantly altered. This is a significant advantage over applied adhesives which are cured after application, since these approaches tend to result in channel clogging.



Supplementary Figure 4 Device patency was tested by grafting our polymer onto a PDMS with 0.5- and 2-μm channels. The PDMS is then bonded onto a glass slide, and a 100 nM Alexafluor 488™ solution is introduced from the inlet (right side of image). The regions with stronger green color are those with higher channels, and hence more fluorescent dye in the cross-section. It is clear that the 2-by-0.5 micron channels (10 thin horizontal lines in the image) remain fully patent after bonding, proving that our modification layer is significantly thinner than 0.5 microns, and hence will not affect the channel geometry of most microfluidic devices when applied.

3. Oxygen Plasma-Treated PDMS Poorly Bonded to Glass

Supplementary Figure 5 The oxygen-plasma treatment generates silanol groups on the surface of the PDMS. Without corresponding plasma treatment to the glass, insufficient silanols are present on the glass to form sufficient SI-O-Si bonds with the PDMS, resulting in poor bond. Oxygen plasma treatment of the glass will presumably increase the density of Si-OH on the glass surface, resulting in much more productive interactions.