# Supported Lipid Membranes Corralled by Nanoscale HSQ and PDMS Barriers

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Supported lipid bilayers have become an important platform for a variety of biological experiments. By mimicking the cell membrane, supported lipid bilayers offer a method to control placement of membrane proteins.[1] Also, DNA molecules tethered to lipid bilayers can be organized in arrays by barriers which interrupt lipid bilayer motion in buffer flow, as in Figure 1. In most work to date, lipid bilayer barriers have been made from metal, photoresist, and scratches on glass.[2,3] In this work, we demonstrate the use of nanoscale barriers made from hydrogen silsesquioxane (HSQ) and polydimethyl siloxane (PDMS) in organizing biological molecules within supported lipid bilayers.

HSQ and PDMS offer certain advantages over metallic barriers. HSQ is a negative tone electron beam resist with sub-10 nm resolution.[4] Finely patterned barriers can provide molecular-scale separations between bilayer regions. In addition, because it is a spin-on glass, HSQ has similar optical properties to silicon dioxide. This can alleviate optical scattering effects that can impede measurement of biomolecule activity within the supported bilayers. PDMS, on the other hand, is an elastomeric polymer frequently used for stamps in microcontact-printing. It is also of interest because of its biocompatibility. In addition, the mechanical properties of PDMS can be useful for studies of cellular and DNA motion on surfaces. Furthermore, we have found that the base solution of PDMS can be crosslinked by exposure to electron beam irradiation. Thus, both HSQ and PDMS barriers can be lithographically patterned directly without further pattern transfer.

We have created patterned lipid bilayers using HSQ and PDMS corrals. Micrographs of grid patterns are shown in Figure 2. To prove that these materials can stop lipid bilayers, we use FRAP (fluorescence recovery after photobleaching) to monitor the flow of proteins within the lipid bilayer. In FRAP, a small spot on the lipid bilayer is exposed to laser light for a fixed amount of time. Recovery is defined by replenishment of fluorophores in the bleached spot by lateral diffusion.[5] The photobleached lipids, confined to the corral, do not recover, as no fresh fluorescent lipids diffuse into them. However, the lipids are mobile within the corrals, as is evident from Figure 3.

By using HSQ and PDMS barriers to organize lipid bilayers, we expand the catalog of materials for engineering organized arrays of cytoplasmic proteins and DNA. These materials offer advantages over metal patterns in that they do not require metal deposition. Combined with their fine resolution and biocompatibility, these "rinse-and-go" methods offer improvements in substrate fabrication for high-throughput single-molecule and cell biology experiments.

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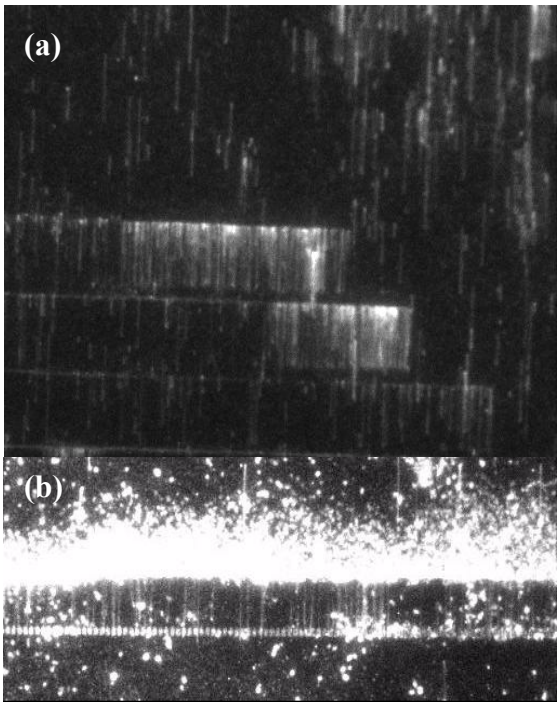


**Fig 1:** (a) DNA tethered to a set of barriers made from PDMS. (b) DNA double-tethered to an HSQ barrier set.

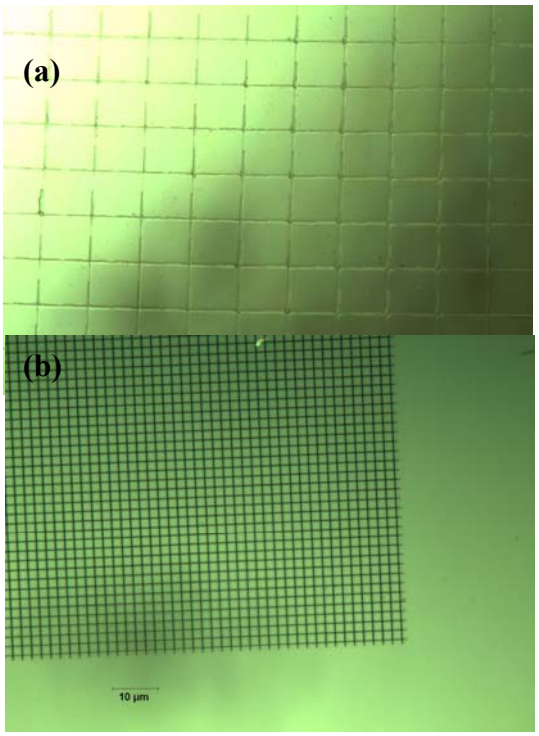


**Fig 2:** Optical micrograph of grid patterns written in (a) PDMS and (b) HSQ.

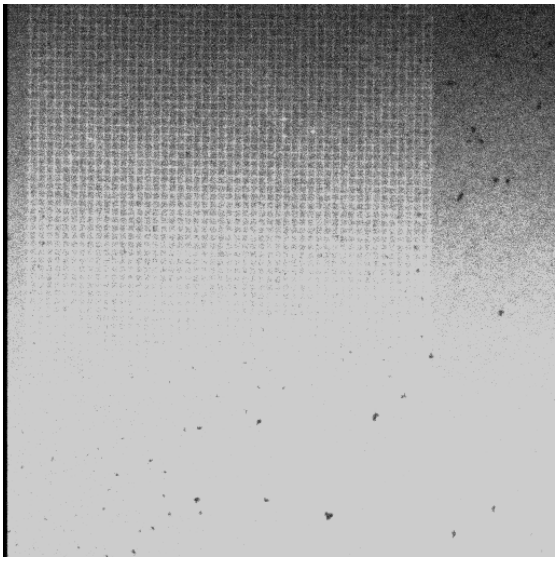

**Fig 3:** Photobleached fluorescent lipids (top half). No diffusion occurs between adjacent HSQ corrals. Grid squares are 2µm wide.