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Supplementary Information

Preparation of Nanoporous Silica Microspheres.

Monodisperse droplets of a precursor solution were generated by means of a vibrating-orifice aerosol generator (TSI Model 3450). In the VOAG, the precursor solution was forced through a small orifice (22μm diameter) by a syringe pump at a rate of 6×10^{-4} cm/s and was broken up into uniform droplets by the vibrating orifice. The orifice vibration frequency was 75.95 kHz. The droplets were dispersed in nitrogen of a flow rate of 2L/min, which was then further diluted by nitrogen at a flow rate of 20L/min. The droplet-laden gas stream flowed through a 2m long 2.5 cm diameter pyrex tube placed in a vertical Lindberg/Blue M tube furnace maintained at 300 ºC. This provided a residence time in the heated zone was approximately 1.5 seconds. The particles were collected on a filter maintained at approximately 80 ºC by a heating tape. Collected particles were calcined in air at 550ºC for 5 hours with a temperature increase rate of 1 ºC /min to remove the surfactant template.

The precursor solution was prepared from a pre-hydrolyzed acid-catalyzed silica sol (A2**) and CTAB ($CH_3(CH_2)_{15}N^+(CH_3)_3Br^-$). In a typical preparation, tetraethylorthosilicate (TEOS) (Aldrich), ethanol, nanopure water and dilute HCl (mole ratios 1:3.8:1:0.0005) were refluxed at 60ºC for 90 minutes and stored as stock solution. Then 20mL of stock sol was diluted with ethanol, followed by addition of water, dilute HCl, and CTAB to provide overall TEOS:ethanol:H_2O:HCl:surfactant molar ratios of 1:19.6:15.85:0.0031:0.158.

References:

- Y. Lu, H. Fan, A. Stump, T.L.Ward, T. Reiker, C.J. Brinker, *Nature* **398**, 223 (1999).
- G.V. Rama Rao, G.P. Lopez, J. Bravo, H. Pham, A.K. Datye, H.F. Xu, and T.L. Ward, *Adv. Mater.* **14** (18), 1301 (2002).
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Preparation of Lipid Vesicles (copied from Adrian's 2005 JACS)

Small unilamellar vesicles were prepared by following a now well-established extrusion method (1). Briefly, desired lipids (which were in chloroform) were first mixed together in pre-determined mole-ratios in a glass vial. The solvent was subsequently evaporated using a stream of nitrogen until dry and the vial is kept under house vacuum for approximately 60 min in order to remove residual solvent which leaves behind a film of lipid at the bottom of the vial. The lipid film is then hydrated using filtered DI water (18.2MΩ) and kept overnight at 4°C. The total lipid concentration was 2 mg/ml and the lipid solutions were used within 2 weeks. The hydrated lipids were sonicated for 4min and were extruded by a mini-extruder (Avanti polar lipids, AL) with 0.1 μm polycarbonate membrane filters (Whatman, Inc., Newton, MA.) both were done at a temperature at least10ºC above the transition temperature of the lipid or the lipid-mixtures used. The lipid solution was passed through the extruder for at least 19 times. Typically, POPC (AvantiPolar Lipids, Al) mixed with Texas Red DHPE in 99:1 mol ratio was used to prepare SUVs.

SUVs so formed display a relatively uniform, single population comprising small unilamelllar vesicles of 110 (±20) nm as determined by simple light scattering measurements.

(1) Mayer, L. D.; Hope, M. J.; Cullis, P. R. *BiochimicaEt BiophysicaActa* **1986**, *858*, 161-168

Substrate Preparation.

The substrates (Corning glass coverslips) were cleaned by oxidizing in a freshly prepared 4:1 (v/v) mixture of sulfuric acid and hydrogen peroxide (*Piranha-etch*) for a period of 4-5 min at 100 °C. The substrates were then withdrawn using Teflon tweezers, rinsed immediately with a copious amount of DI water (18.2MΩ), and dried in a stream of nitrogen.

Details of Supplemental Video

20 micron diameter porous silica microspheres are coated in a lipid bilayer composed of 99%POPC and 1%NBD-PE. These spheres are then dropped onto a planar silica-supported bilayer of 99%POPC and 1%Texas Red-DHPE in pure De-Ionized water where they move freely in two dimensions without any measurable fluorophore mixing.

The addition of a moderate concentration of salt, in this case an increase to 100 mMolar NaCl, causes the spheres to settle and the bilayers on the majority of spheres to fuse with the underlying planar bilayer, allowing the fluorophores in each bilayer to mix.

The magnification used was 10x. The frame rate of the video is one image per 15 seconds. The contrast has been adjusted for ease of viewing.

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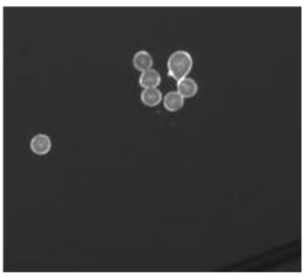
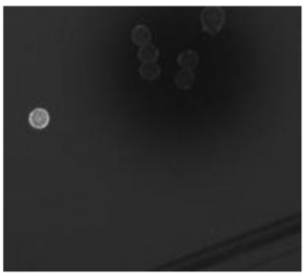
An example of non-communicative supported bilayers (no component exchange)

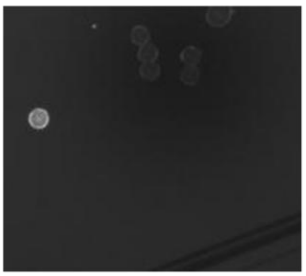
1% TexasRed DHPE/99%POPC bilayers on beads and planar silica in 15mM NaCl, Beads are mostly immobile but the bilayers do not fuse.



Pre-bleach frame

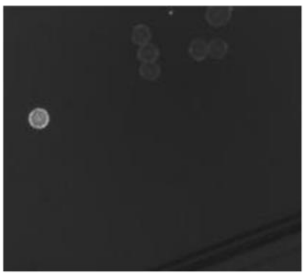


Time = 0 min

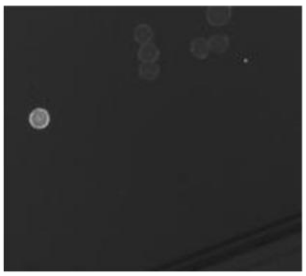


Time = 10 min

Here we see the fluid planar bilayer recover fluorescence in the bleached area, but these unbleached fluorophores cannont transfer to the bilayers on the beads.



Time = 30 min



Time = 60 min

Supplemental Figure 1

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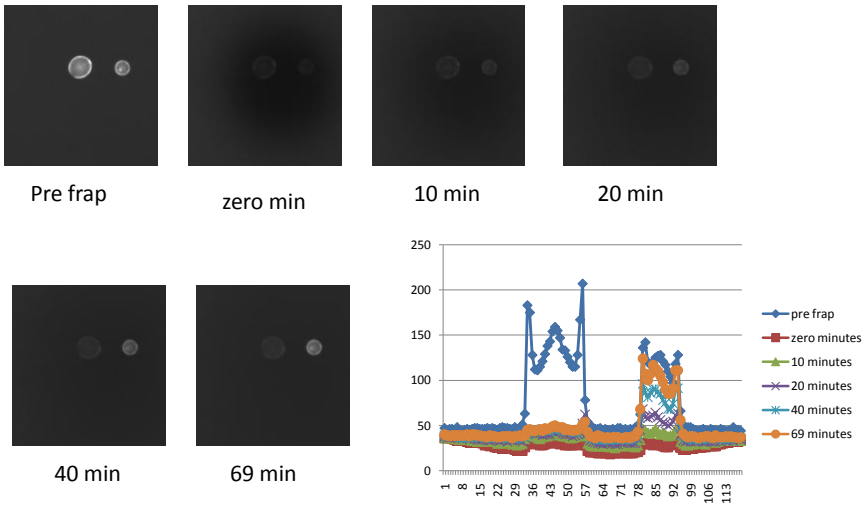
Borderline conditions for fusion



In this series we see two spheres side by side. The bilayer on one fuses with the underlying bilayer while the bilayer on the other does not. The graph shows a series of fluorescence intesity line-scans across both beads clearly indicating the lack of fluorophore transfer between the non-fusing sphere and the planar bilayer.

Supplemental Figure 2