## **Supplemental Information**

## Methods:

Lipids deposited over large polystyrene particles were assessed for fluidity by FRAP techniques. Red-fluorescent, 1 µm fluospheres (Invitrogen) or 16 µm, carboxylate-modified polystyrene particles (Invitrogen) were deposited on a clean cover glass surface and coated with lipids as described in the main text. The 1 µm particles were coated with 2% Marina Blue-DHPE (MB-DHPE) in a SoyPC background. FRAP was measured as described in the main text. The 16 µm particles were coated with 2% NBD-DHPE (Avanti Lipids, Alabaster, AL) in a POPC background. On a confocal microscope, fluorescent bilayer coated particles were located and FRAP was measured using a 2 µm diameter bleach spot. Both the top of the particles and a segment of the circumference were investigated. Images were taken for 40 s, continuously, and at 5 m and 10 m, after photobleaching to monitor fluorescence recovery. Fluidity of the bilayer on the glass coverslip below was measured and only samples that have fluid bilayers on the glass coverslip were used to assess lipid fluidity on the large polystyrene particles.

## **Results:**

The mobility of lipids depends greatly on the interaction between the material, typically glass or polystyrene, and the lipids. To further test lipid fluidity, we measured the FRAP recovery of MB-DHPE (2%) within a SoyPC bilayer (98%) on a variety of glass/polystyrene surfaces. Fluorescent lipids are completely immobile on larger (16  $\mu$ m diameter) polystyrene particles (Figure S1). However, lipids recover slowly when they are deposited on 1  $\mu$ m diameter polystyrene particles on a glass surface, where the lipid bilayer on the nanoparticle is in continuum with the flat surface (Figure S1). This suggests that the interaction between lipids and

the nanoparticle depends on size and may be due to how tight the lipid bilayer wraps around the nanoparticles when transitioning from regions of curvature to flat regions.



**Supplemental Figure 1:** Fluorescence recovery after photobleaching does not occur on large polystyrene particles. A series of confocal images taken from the middle of an NBD-DHPE (2%, in a background of POPC) bilayer coated 16  $\mu$ m diameter particle show a lack of lipid mobility after a 2  $\mu$ m diameter bleach event at time 0.0 seconds. Scale bar is 10  $\mu$ m.



**Supplemental Figure 2**: Lipids surrounding larger particles recover. (A) Confocal images of three  $1\mu m$  particles, (B) blue fluorescent lipids (MB-DHPE) are imaged and observed coating the particles. Lipids are bleached at 0s and recover after 8 seconds. Images are  $4.1x4.1 \mu m$ .



**Supplemental Figure 3**: A single tailed lipid (Fluorescein-HDA) accumulates at regions of membrane curvature in asymmetrically formed bilayers. Confocal images of (A) 200 nm nanoparticles (left) and Fl-HDA (middle) that has been added to POPC bilayers using Fl-HDA loaded BSA, and an overlay (right). Scale bar = 5  $\mu$ m. (B) Averages of cropped images of Fl-HDA at regions containing varying degrees of membrane curvature (d= 40, 100, and 200 nm). Both the Fl-HDA and nanoparticle images are shown for each size and autoscaled. (C) The cross section of each Fl-HDA image in D for 200 nm (white circles), 100 nm (black circles) and 40 nm (gray circles) nanoparticles.