Protecting, Patterning, and Scaffolding Supported Lipid Membranes Using Carbohydrate Glasses

Ann E. Oliver,*[a] Eric L. Kendall,[b] and Michael C. Howland,[b] Babak Sanii,[a] Andrew P. Shreve,[c] Atul N. Parikh*[a,b,d]

[a] *Department of Applied Science, University of California-Davis, 1 Shields Ave., Davis, CA, 95616, USA. Fax: 530-752-2444; Tel: 530-754-9571; E-mail: aeoliver@ucdavis.edu*

[b] *Chemical Engineering and Materials Science, University of California-Davis, 1 Shields Ave. Davis, CA 95616, USA*

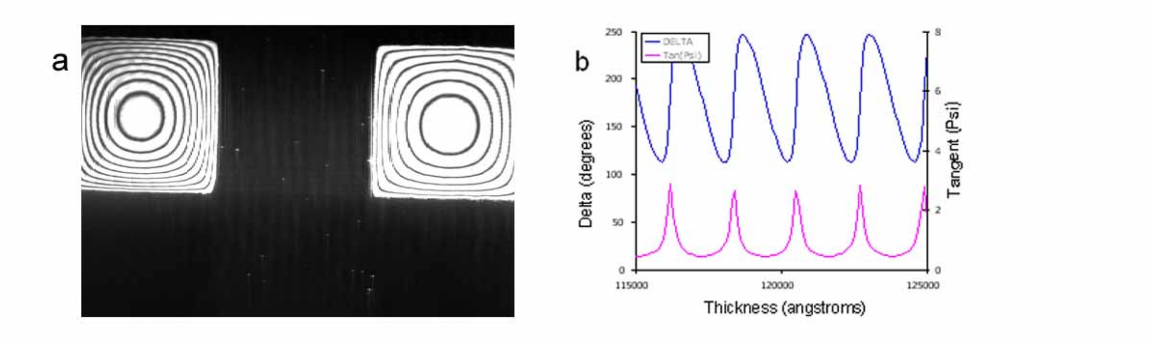
[c] *Center for Integrated Nanotechnologies, Materials Physics and Applications Division, Los Alamos National Laboratory, Los Alamos, NM 87545 USA*

[d] *Biophysics Graduate Group, University of California-Davis, 1 Shields Ave., Davis, CA, 95616, USA. Fax: 530-752-2444; Tel: 530-754-7055; E-mail: anparikh@ucdavis.edu*

Supplemental Information

Imaging ellipsometry

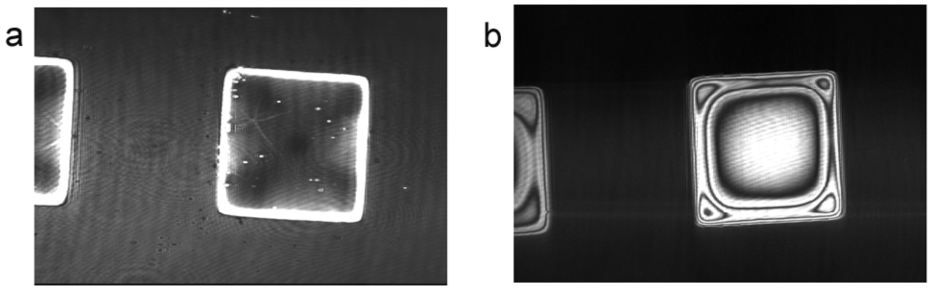
The alternating light and dark rings seen in the ellipsometry images (Suppl. Fig. 1a & main text, Fig. 3a) correspond to the periodicity on the plot showing the thickness dependence of ellipsometric angles, Delta and psi, (Suppl. Fig. 1b)[1]. Each dark ring corresponds to a change in thickness by approximately 220 nm, using a refractive index for dry trehalose of 1.5[2]. The number of rings ranged from 2 – 9, indicating some variability between spots. However, the rings were always more closely spaced toward the edges of the trehalose domains. The increasingly closer spacing of the rings near the edges appears to exceed the lateral resolution of our ellipsometer, supporting the presence of a sharp domain edge as was observed by profilometery, and confirmed by scanning electron microscopy (see main text, Fig. 3b).



Suppl. Fig. 1

Alternate Configurations for Patterned Trehalose Glasses

Besides the various domain configurations mentioned in the main text, thickness and topology of carbohydrate domains can be controlled by the trehalose deposition technique. Using higher concentrations, larger volumes and/or smaller ratios of hydrophilic to hydrophobic regions, all resulted in thicker trehalose films. Furthermore, very thin trehalose films (1-100 nm) could be formed by forcibly removing (either through spinning or decanting) the bulk of the trehalose solution, leaving only small, adhered droplets in the hydrophilic regions before drying. An example of this alternate method was allowing a trehalose solution (100 μL of 10 or 100 mM trehalose) to flow over the surface of an OTS patterned coverslip maintained at approximately a 90^{o} angle. The coverslip was then incubated flat at 100 ^{o}C overnight. Domains of trehalose glass formed by this method (Suppl. Fig. 2) were thicker on the edges than in the center, as shown by the ring patterns in the second contrast image (Suppl. Fig. 2b). These results show the plasticity in the trehalose deposition, indicating that the method is tunable for many different types of constructs or applications.



Suppl. Fig. 2

References

1 Azzam, R.M.A. & Bashara, N.M. Ellipsometry and Polarized Light. North-Holland Pub. Co., Amsterdam (1977).

2 CRC Handbook of Chemistry and Physics, 64th edition, 1984 (ed. Weast, RC). CRC Press, Inc. Boca Raton, FL. l estimated from value for 85% sucrose, 1.5033.

Figure Legends

Supplemental Information Figure 1. a) Imaging ellipsometry contrast image of patterned trehalose glasses deposited using the solution evaporation method. b) Thickness dependence of ellipsometric angles delta (upper trace) and tangent of psi (lower trace). Note that periodicity corresponds to the light and dark rings visible in panel a.

Supplemental Information Figure 2. Imaging ellipsometry contrast images of trehalose glasses patterned using the directed flow technique with 100 μL of (a) 10 mM trehalose, or (b) 100 mM trehalose, as described in the text. The rings apparent in b show these trehalose domains to be thicker than those in a, as expected due to the higher concentration of sugar. The pattern of contrast rings also indicates that the domains are thicker on the edges than in the center.