Electronic Supplementary Information

for

Elasticity and Failure of Liquid Marbles: Influence of Particle Coating and Marble Volume

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Supplemental Discussion

The volume *V* of a doubly truncated oblate spheroid with in plane radius *R*, out of plane radius *r* and total height *H* is given by[1]

$$V = \frac{4}{3}\pi R^2 r - 2\left[\frac{\pi R^2}{3}\left(2r - \frac{3H}{2} + \frac{H^3}{8r^2}\right)\right]. \tag{1}$$

Which can be simplified to

$$V = \frac{\pi R^2}{3}\left[3H - \frac{H^3}{4r^2}\right]. \tag{2}$$

In the case of $H = 2r$ (no caps), Eq. (2) reduces to

$$V = \frac{\pi 4 R^2 r}{3}, \tag{3}$$

as expected. Using Eq. (2), we derive an expression for *r* as a function of *H*, *R*, and *V*,

$$r = R\sqrt{\frac{\pi}{12}\frac{H^3}{\pi H R^2 - V}}. \tag{4}$$

Using Eq. (4), it is possible to compute *r* using experimentally determined values of *H*, *V*, and *R*.

Supplemental Figures

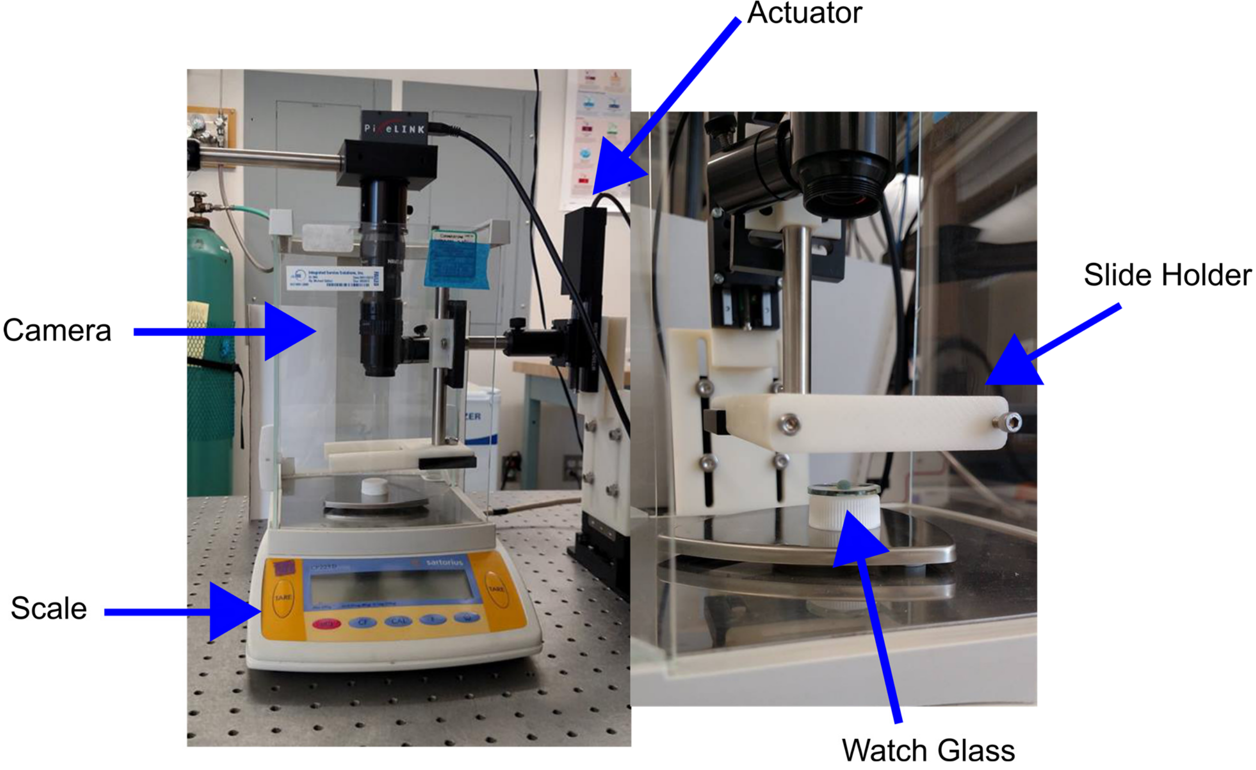

Fig. S1 Labeled photographs of the apparatus used to compress liquid marbles.

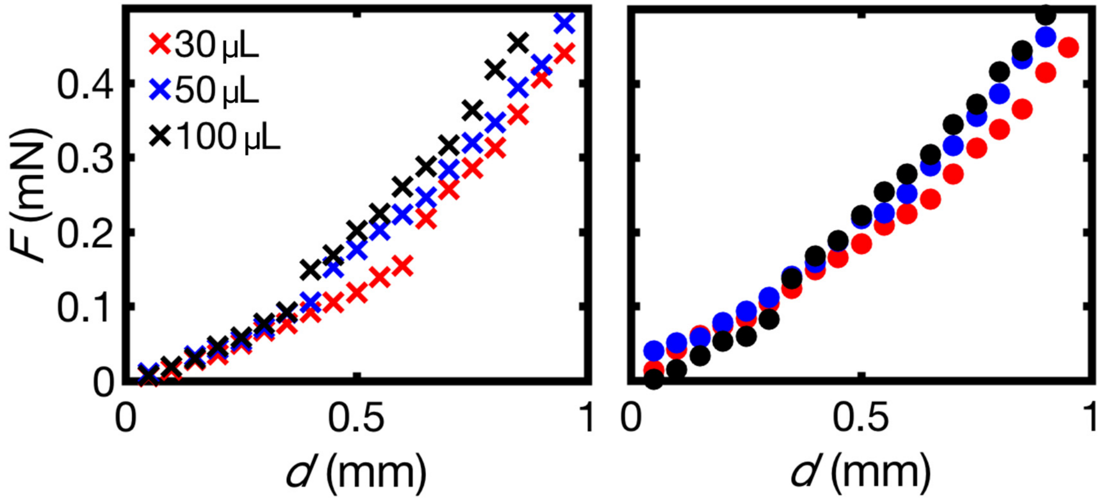

Fig. S2 Force F measured by scale *vs.* compression d for aqueous liquid marbles coated with (left) lycopodium and (right) polytetrafluoroethylene (PTFE) powders. Here, the curves are plotted to highlight variability between measurements with different marble volumes, as defined by the colors of the markers. This is the same data as shown in Figure 2.

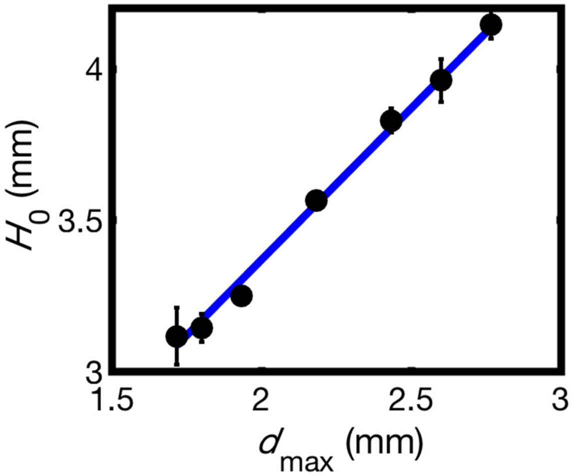

Fig. S3 Determination of the height of marbles during mechanical testing. For a given marble, the initial height H_0 was found by photographing the marble from the side. Subsequently, the marble was compressed until the scale registered solid-on-solid contact which occurred at a maximum deformation d_{max}. By linear fitting (blue line), we find that $H_0 = d_{max} + 1.368 \pm 0.027$ mm, which allows us to estimate the depth of the watch glass on which the marbles rest**.**

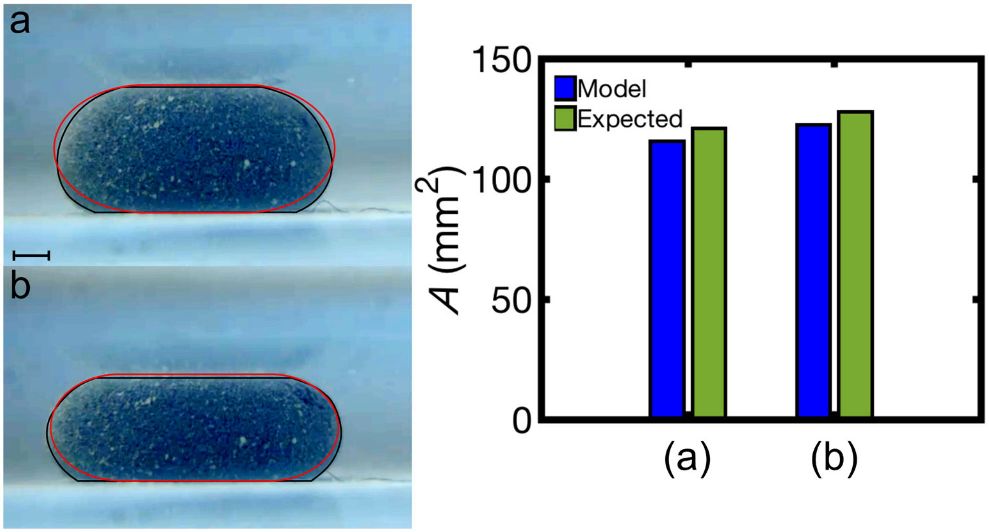

Fig. S4 Validation of the doubly truncated oblate spheroid model. Side view optical microscopy of a 100 μL lycopodium-coated marble being compressed to a height H of (a) 3.48 mm and (b) 2.87 mm. Black outlines denote the actual perimeter of the marble while the red outlines denote the profile computed by the doubly truncated oblate spheroid model. (c) Importantly, the area A predicted by these methods only differs by 4.5% in case (a) and 3.5% in case (b).

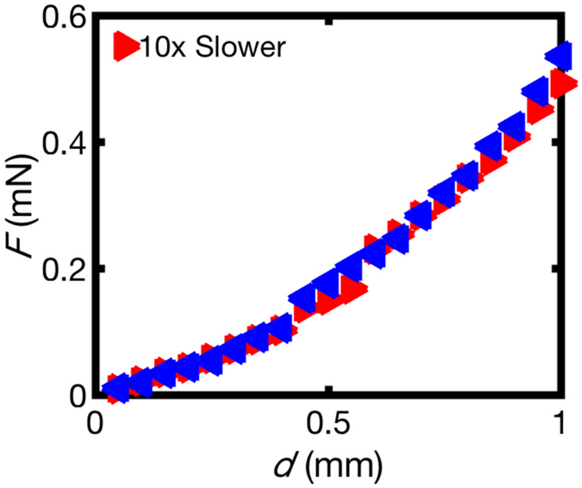

Fig. S5 *F* vs *d* measured for a 50 µL lycopodium-coated marble while compressing it at 50 µm/s (blue) and 5 µm/s (red).

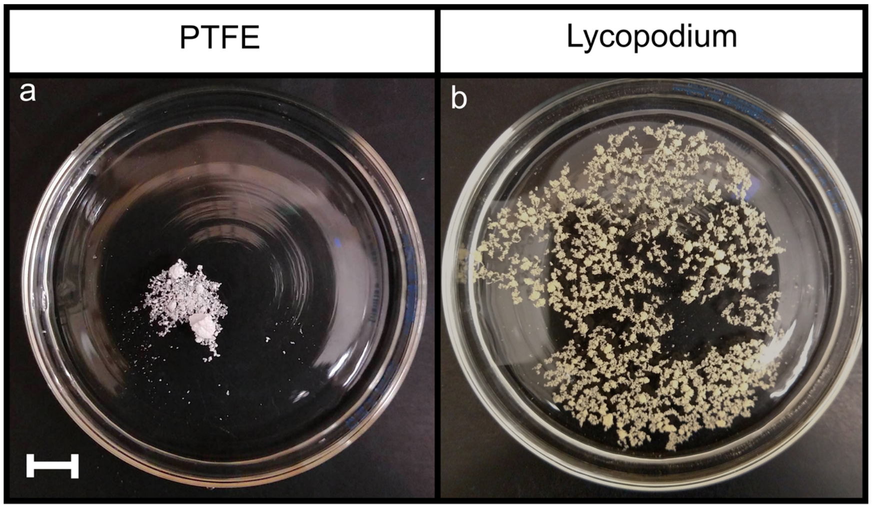

Fig. S6 Photographs of ~0.5 mg of (a) PTFE particles with a 1 cm scale bar and (b) lycopodium spores placed on the surface of deionized water in a petri dish.

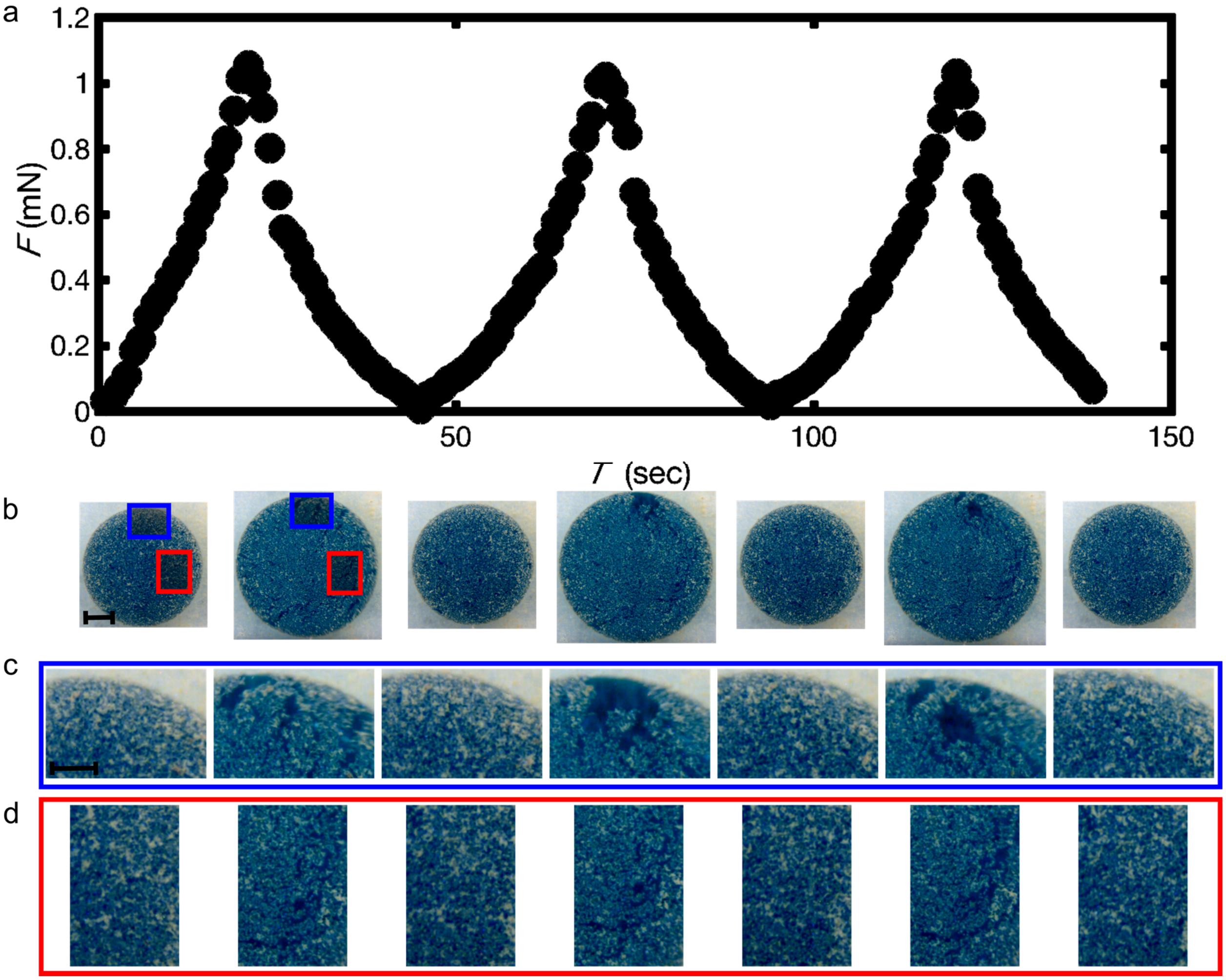

Fig. S7 (a) Force F vs time T profile recorded during a cyclical loading experiment wherein a 50 µL lycopodium-coated marble was compressed and released three times to the same maximum d. These experiments show the reversibility of liquid marble mechanics, even beyond the onset of fracture. (b) Photographs that depict the state of the marble at each minimum and maximum loading point. (c,d) Magnifications of two regions on the marble surface showing that fracture occurs in a similar, but not precisely the same, location upon subsequent compressions. Scale bar in (b) is 1 mm, while the scale bars in (c) and (d) are 500 µm.

Supplemental References

1. H. Y. Erbil and R. A. Meric, *J. Phys. Chem. B*, 1997, **101**, 6867–6873.