Electronic Supplementary Material (ESI) for Soft Matter.

Supplementary Information for: Surface Elastic Constants of a Soft Solid

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I. Wetting Profiles

Figure S1 shows all the wetting profiles that were measured in experiments. The red and green curves correspond to the profiles measured at points A and B, respectively.

II. Measurement of $(\epsilon_{\infty\parallel}, \epsilon_{\infty\perp})$

When we apply a stretch with a strain of $\epsilon_{\infty\parallel}$, the membrane will be compressed in the perpendicular direction. To measure this compressive strain $\epsilon_{\infty\perp}$, we track displacements of the fluorescent beads under stretch without droplets. For instance, the red and blue dots in Fig. S2b represent the beads positions before and after applying a uniaxial strain $\epsilon_{\infty\parallel} = 13\%$. As a result, the black arrow attached to each red dot in Fig. S2c points to the moving direction. The length of the black arrow is proportional to corresponding bead displacement.

For every single bead, we plot the horizontal displacement u_x against x (blue), and vertical displacement u_y against y (red) in Fig. S2d. The slopes of $u_x(x)$ and $u_y(y)$ give $\epsilon_{\infty\parallel} = 12.8\%$ and $\epsilon_{\infty\perp} = -2.1\%$, respectively. Since the strains are calculated by the slopes, it is worth noting that a global shift of the image does not affect the results. We also vary the applied strain $\epsilon_{\infty\parallel}$ and measure the corresponding $\epsilon_{\infty\perp}$. Figure S2e shows the relation between $\epsilon_{\infty\perp}$ and $\epsilon_{\infty\parallel}$. Within range of strain we applied, they are proportional to each other.

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III. Local Strain ϵ_{local} Measurements

We implemented the same method as discussed in Ref. [1] to measure the local strain ϵ_{local} induced by droplet deposition. In order to measure the local strain near the contact point, we measure the local in-plane and out-of-plane displacements of the substrate, (u_x, u_z), near the contact line by tracking the displacements of individual fluorescent beads upon removing a glycerol droplet (see e.g. [1, 2] for details).

We then convert these displacements into the extra strain due to the presence of the wetting ridge, $\Delta\epsilon$, using the relation:

$$\epsilon_{local} = \sqrt{\left(1 + \frac{\partial u_x}{\partial x}\right)^2 + \left(\frac{\partial u_z}{\partial x}\right)^2} - 1 \tag{1}$$

The local strain at the wetting ridge is then $\epsilon = \epsilon_\infty + \epsilon_{local}$.

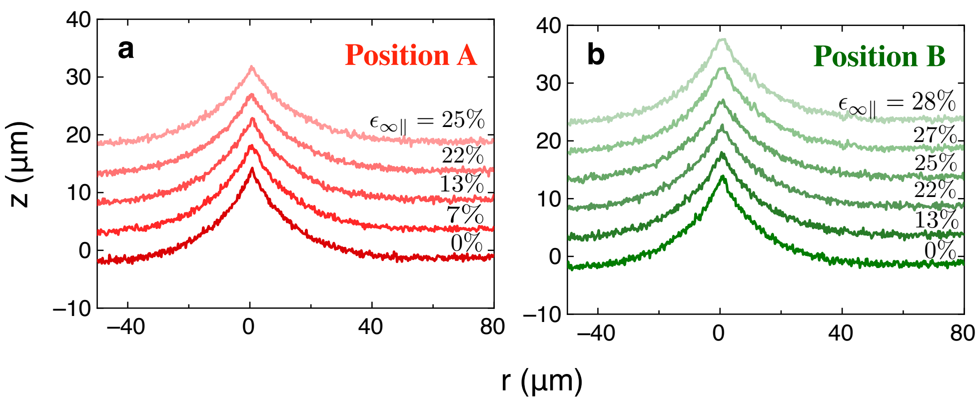

FIG. S1: Wetting profiles at A (red) and B (green) under different applied strains $\epsilon_{\infty\parallel}$.

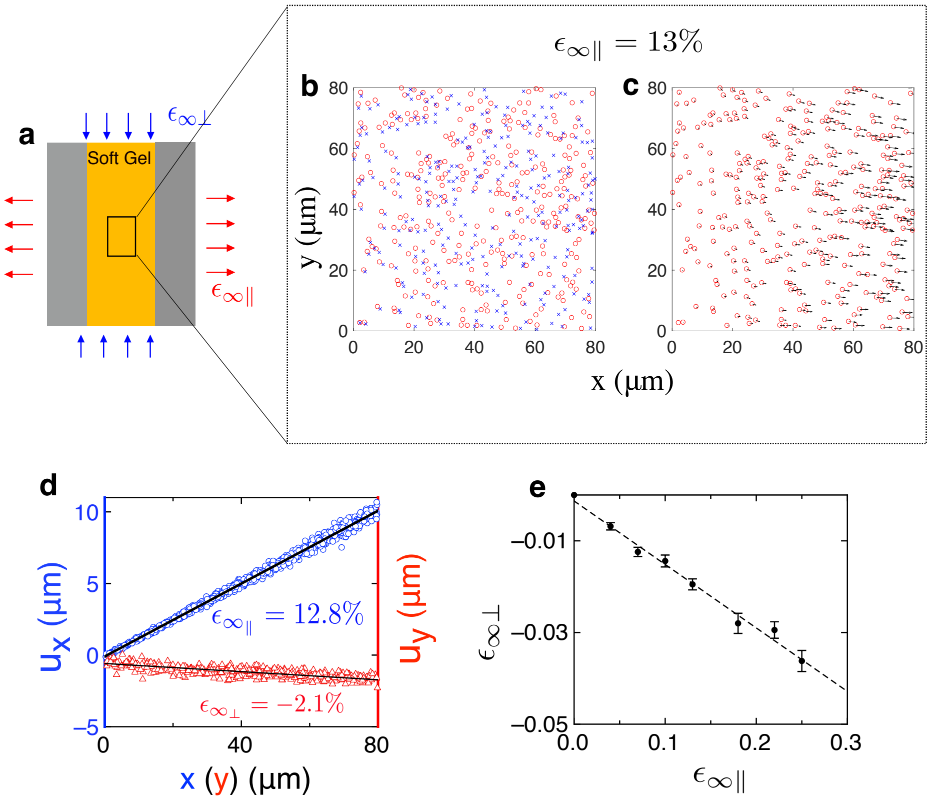

FIG. S2: **Measurement of applied strain fields**. **a.** The schematics of the experimental setup. **b.** The locations of the fluorescent beads before and after stretching $\epsilon_{\infty\parallel} = 13\%$ of strain. **c.** The tracking result. The arrow attached to each dot points to its moving direction. The length is proportional to the magnitude of displacement. **d.** For each point with a coordinate of (x, y), the horizontal displacement u_x is plotted against x (blue), and the vertical displacement u_y is plotted against y (red). The slopes give $\epsilon_{\infty\parallel}$ and $\epsilon_{\infty\perp}$, respectively. **e.** The plot of $\epsilon_{\infty\perp}$ against $\epsilon_{\infty\parallel}$.

[1] Q. Xu, K. E. Jensen, R. Boltyanskiy, R. Sarfati, R. W. Style, and E. R. Dufresne, Nature Communications **8**, 555 (2017).
[2] E. R. Jerison, Y. Xu, L. A. Wilen, and E. R. Dufresne, Phys. Rev. Lett. **106**, 186103 (2011).