nature COMMUNICATIONS

ARTICLE

DOI: 10.1038/s41467-017-00636-y OPEN

Direct measurement of strain-dependent solid surface stress

Qin Xu[1,2], Katharine E. Jensen[1,2], Rostislav Boltyanskiy[2], Raphaël Sarfati[2], Robert W. Style[1,3] & Eric R. Dufresne[1,2]

Surface stress, also known as surface tension, is a fundamental material property of any interface. However, measurements of solid surface stress in traditional engineering materials, such as metals and oxides, have proven to be very challenging. Consequently, our understanding relies heavily on untested theories, especially regarding the strain dependence of this property. Here, we take advantage of the high compliance and large elastic deformability of a soft polymer gel to directly measure solid surface stress as a function of strain. As anticipated by theoretical work for metals, we find that the surface stress depends on the strain via a surface modulus. Remarkably, the surface modulus of our soft gels is many times larger than the zero-strain surface tension. This suggests that surface stresses can play a dominant role in solid mechanics at larger length scales than previously anticipated.

[1] Department of Materials, ETH Zürich, 8093 Zürich, Switzerland. [2] Department of Mechanical Engineering and Materials Science, Yale University, New Haven, CT 06511, USA. [3] Mathematical Institute, University of Oxford, Oxford OX1 3LB, UK. Qin Xu and Katharine E. Jensen contributed equally to this work. Correspondence and requests for materials should be addressed to R.W.S. (email: robert.style@mat.ethz.ch) or to E.R.D. (email: eric.dufresne@mat.ethz.ch)