Electronic Supplementary Material (ESI) for Soft Matter.

Supplementary Information (ESI)

Coupling between surface structure and loading conditions in the viscous contribution of peeling

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Peeling Apparatus.

The bath is made of acrylic with one optically clear viewing wall (Edmund Optics), and the fluid volume in the bath is approximately 45 mL. Prior to testing, samples are spin coated at 7000 rpm for one minute with the same fluid used in the bath to ensure that fluid is present in the structures and to avoid trapped bubbles in the structures.

Loading phase

An aluminum foil boat, visible in Fig. S1, is placed between the weight and the upper surface to be able to remove the weight without pulling the surfaces apart at the end of the loading phase. There is no fluid in the boat, therefore no viscous forces are present when removing the weight. In the absence of the boat the viscous forces between the coverslip and the weight would pull the coverslip away from the bottom surface and increase the fluid film thickness. The aluminum boat also does not prevent the coverslip from bending during peeling phase.

Peeling phase.

The rigid contactor pulling on the edge of the coverslip is mounted onto a bending beam load cell (Model LCL-454, Omega Engineering with a DP7600 strain meter, Omega Engineering, 0.4 mN resolution, ~20 readings per second). The bending beam load cell is attached to a vertically translating motorized stage (NSL4 Precision Linear Stage with custom 10:1 planetary gear, Newmark Systems, 0.13 μm resolution). During the peeling phase, a CCD camera (AVT Stingray F-125, binned to 644x300, 70 FPS) was used to take images of the sample as shown in Figure 2. The motor, camera, and data acquisition are all controlled through LabVIEW (National Instruments).

A representative force curve obtained during the peeling phase is shown in Figure S1 along with snapshots of the surfaces taken at different times during the peeling process. The force is plotted as a function of the motor displacement. Based on the pictures, we see that initially the separation between the surfaces appears constant, and the section of the coverslip in the bulk of the fluid up to the contactor begins to bend (Figure S1a) until the force reaches a peak (Figure S1b). Right after the peak, as the contactor continues to move upward, a crack becomes clearly visible and propagates laterally (Figure S1c) as the force decreases abruptly and the contactor tilts upward.

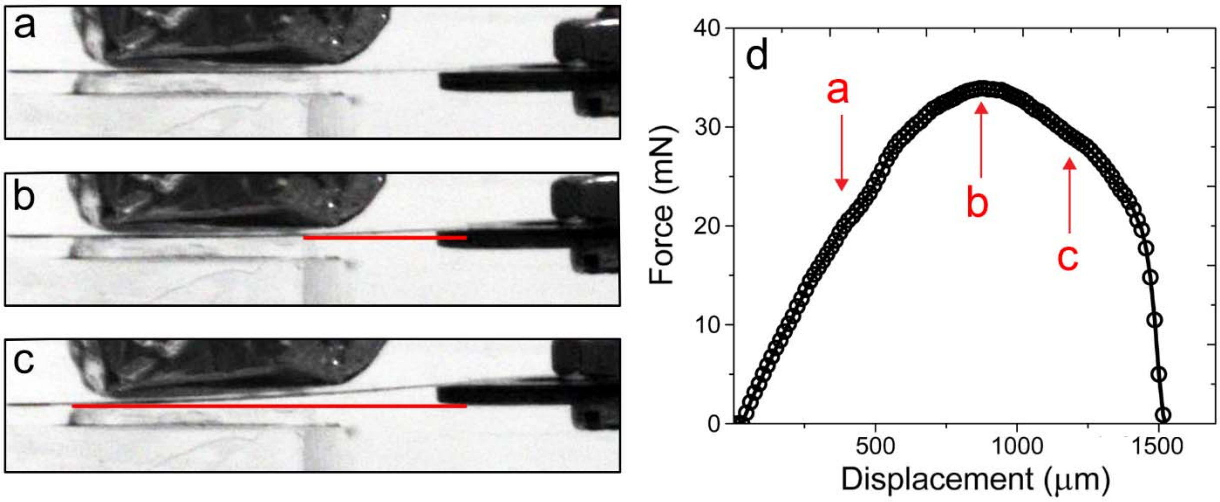

Figure S1. (a,b,c) Side view images taken during peeling. The sample is a smooth surface in 1000 cSt silicone oil brought near the lower surface with a 0.05 kg load during 180 seconds. The arrows on the force curve in (d) correspond to the images of (a-c). The red lines in (b,c) are a visual guide outlining the bottom substrate to show bending in the sample, which is slightly visible in (b) and more prominent in (c). The normal force applied by the aluminum foil is negligible during the peeling phase.

Calculation of the van der Waals interaction between two semi-infinite media

The non-retarded Hamaker constant[1] was calculated below, assuming a constant value for the dielectric constant.

$$A_{123} \approx \frac{3}{4}kT\left(\frac{\varepsilon_1-\varepsilon_3}{\varepsilon_1+\varepsilon_3}\right)\left(\frac{\varepsilon_2-\varepsilon_3}{\varepsilon_2+\varepsilon_3}\right)+\frac{3h\nu_e}{8\sqrt{2}}\frac{(n_1^2-n_3^2)(n_2^2-n_3^2)}{(n_1^2+n_3^2)^{\frac{1}{2}}(n_2^2+n_3^2)^{\frac{1}{2}}((n_1^2+n_3^2)^{\frac{1}{2}}+(n_2^2+n_3^2)^{\frac{1}{2}})}$$

Where 1 = CyTop, 2 = Silicone Oil (intervening medium) and 3 = SU-8, k is the Boltzmann constant, T is the temperature (298 K), h is the Planck constant and ν_e is the main electronic absorption frequency in the UV spectrum. The parameters are listed in Table S1. Based on these value we obtain a Hamaker constant of $A_{CyTop-Silicone\ Oil-SU-8} = -8.0 \times 10^{-23}\ J$.

Table S1: Material properties.

Material	Dielectric Constant	Index of Refraction
CyTop	2[2]	1.34[2]
Silicone Oil	2.74[3]	1.4[4]
SU-8	3.2[5]	1.39[5]
ν_e=3E15 s^{-1}		

The van der Waal interaction energy (per unit area) of two flat surfaces[1] was calculated using:

$$W = -\frac{A_{CyTop-Silicone\ Oil-SU-8}}{12\pi D^2}$$

At a separation D=2 nm,

$$W = 5.31\,\mathrm{E} - 7\,\frac{J}{m^2}$$

Considering the interacting area between the surface and substrate is a square with a 14 mm length, the van der Waals interaction energy between the two substrates would be 1.04 10^{-10} J, far below the typical work of separation measured in our system.

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