Solid-supported thin elastomer films deformed by microdrops

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Supplementary Information

In the work of Long *et al.* [1], the existance of a microtrough close to the ridge at the TPCL is explained by the combination of two limiting cases. Analytic approximations can be given for distortions of the surface with a wave number *q* much smaller than the film thickness *t* ($q \cdot t << 1$) and with very high wave numbers ($q \cdot t >> 1$). To get a more intuitive impression for the mechanisms involved, it is useful to consider the Fourier tranformation of the deformation. Frederickson *et al.* [2] did calculate the energy density of a deformation *h*(*x*) of a thin layer of an elastic material to be

$$F[h] = \frac{1}{2}\int \frac{d^2 q}{(2\pi)^2} P(q) \cdot h(\vec{q}) \cdot h(-\vec{q}) \,, \qquad (4)$$

where $h(\vec{q})$ is the Fourier transform of the surface deformation *h*(*x*) and *P*(*q*) is the energy contribution in the wave vector interval from *q* to *q*+*dq*. In simplified form, *P*(*q*) is given by

$$P(q) = \frac{1}{t^2}\left\{ \frac{\gamma}{(q \cdot t)^2} + E \cdot t \cdot \left[\frac{3}{(q \cdot t)^2} + 2 \cdot q \cdot t \right] \right\}. \qquad (5)$$

As depicted in the main part of Fig. S1, this function shows a pronounced minimum for *q* in the order unity. Both short and long wave length deformations cost more energy than deformations with wavelength of the order of the layer thickness. As already stated by Frederickson *et al.*, the actual surface profile must minimize the free energy functional (4). Starting close to the TPCL with a monotonic profile of the ridge (e.g. the logarithmic decay predicted by Rusanov), the system can reduce its energy by reducing the amplitude of the Fourier modes where *P*(*q*) takes large values and by increasing the amplitude of energetically less expensive modes, i.e., modes close to the minimum of *P*(*q*). To illustrate this, we use a test function that combines both the logarymic decay (close to the TPCL) and an exponentially decreasing modulation at higher distances. The parameter b scales the amplitude of the oscillatory part of the profile.

$$h(x) \sim \frac{1 + b \cdot \cos(\frac{x}{\xi_1})}{1+b} \left[\ln(|x| \cdot \exp(-\frac{|x|}{\xi_2}) \right]. \qquad (6)$$

The inset to Fig. S1 gives the Fourier transform of (6) in two cases. The dashed line shows the Fourier transform of a monotonically decaying profile ($b = 0$) and the solid line gives the Fourier transform of a profile with a microtrough at approximately the layer thickness ($b >> 1$). The free energy as calculated by (4) is smaller for the profile with the microtrough. Since the mechanism of this energy reduction is actually not dependent on the details of $h(q)$ but a rather general feature of $P(q)$, similar results could be reproduced with various test functions.

To summarize, the formation of the microtrough reduces the contribution of the low wave vector (long wavelength) part in $h(q)$ on the expense of intermediate wave vectors and globally reduces the energy stored in the surface deformation.

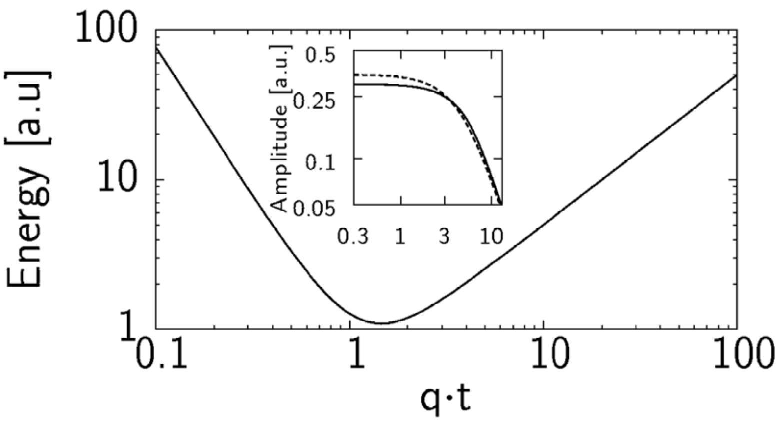

Figure S1: Qualitative behavior of the energy density in the interval from *q* to *q+dq* as deduced by Frederickson et al. [2]. The inset shows the Fourier transform of a profile with (solid line, as observed in our experiments) and without (dashed line) microtrough close to the TPCL.

1. D. Long, A. Ajdari and L. Leibler, *Langmuir*, 1996, **12**, 5221-5230.

2. G. H. Fredrickson, A. Ajdari, L. Leibler and J. P. Carton, *Macromolecules*, 1992, **25**, 2882-2889.