Supplementary material

1 Travelling wave solution and numerical analysis

The travelling wave solution $h = h_F f[\xi \equiv r - R_F(t)]$ satisfies the governing equation such that

$$-\dot{R}_F h_F f' = \frac{Bh_F^4}{12\mu}(f^3 f^V)' \quad \Rightarrow -\dot{R}_F = \frac{Bh_F^3}{12\mu} f^2 f^V, \tag{1}$$

using mass conservation at the fluid front, $\dot{R}_F = \lim_{r\to R_F} -h^2 p_r/12\mu$, where $f' = \partial f/\partial\xi$, $f^V = \partial^5 f/\partial\xi^5$ and $p_r = \partial p/\partial r$. This balance at the fluid front may be used to define a viscous peeling lengthscale $l_p = (Bh_F^3/12\mu\dot{R}_F)^{1/5}$ [1]. By writing $X \equiv \xi/l_p$ and choosing curvature scaling in the viscosity controlled regime, $2h_F/l_p^2 = \sigma l_p^2/8B$, we derive a fifth order ODE for f, $-1 = f^2 f^V$, along with unknown lag length, $L = \lambda l_p$, subject to four matching conditions for the deflection of the elastic plate at the fluid-vapour interface, $X = 0$,

$$f' = \frac{2\lambda^3}{3} - \frac{3f}{\lambda} + \frac{\lambda\kappa l_p^2}{2h_F}, \qquad f'' = -4\lambda^2 + \frac{6f}{\lambda^2} - \frac{2\kappa l_p^2}{h_F},$$
$$f''' = 12\lambda - \frac{6f}{\lambda^3} + \frac{3\kappa l_p^2}{\lambda h_F} \qquad \text{and} \quad f^{IV} = -16. \tag{2}$$

To close the system we require the curvature to tend to a constant to match the interior solution, $f'' \to \gamma$, as well as f''', $f^{IV} \to 0$ as $X \to -\infty$. To solve numerically we use the MATLAB function BVP4c and find

$$\gamma = \begin{cases} 1.77(2^{-3/7}) \\ \frac{\kappa l_p^2}{h_F} \end{cases}, \quad \lambda = \begin{cases} 1.33(2^{-12/7}) & L \gg L_C \\ 1.10(2^{-4/3})\left(\frac{\kappa l_p^2}{h_F}\right)^{-2/3} & L \ll L_C \end{cases}, \tag{3}$$

(powers of 2 are due to the peeling lengthscale l_p being defined differently to [2]). The scalings in the adhesion dominant regime when $L \ll L_C$ are recovered by considering mass conservation at the fluid front, $\dot{R}_F \simeq h_F^2\sigma/12\mu L$, and the curvature due to adhesion, $2h_F/L^2 \simeq \kappa$. Hence, this gives a moving boundary condition at $r = R_F$ [3],

$$\kappa_F = \begin{cases} 1.77((12\mu)^2\sigma/B^3)^{1/7}\dot{R}_F^{2/7} & L \gg L_C \\ \kappa & L \ll L_C \end{cases}. \tag{4}$$

Matching onto the interior curvature $\kappa_{int} = 24Qt/\pi R_F^4$, we have an asymptotic model for the radial extent, central deflection and lag length,

$$R_F = \begin{cases} 1.52\,(Q^7B^3/(12\mu)^2\sigma)^{1/30}t^{3/10} & L \gg L_C \\ (24Q/\pi\kappa)^{1/4}t^{1/4} & L \ll L_C \end{cases}, \tag{5}$$

$$h_0 = \begin{cases} 0.41\,((12\mu)^2\sigma Q^8/B^3)^{1/15}t^{2/5} & L \gg L_C \\ (3\kappa Q/8\pi)^{1/2}t^{1/2} & L \ll L_C \end{cases}, \tag{6}$$

$$L = \begin{cases} 1.19\,((12\mu)^4B^9Q/\sigma^{13})^{1/30}t^{-1/10} & L \gg L_C \\ 0.82\,((12\mu)^4Q/\sigma^4\kappa^9)^{1/12}t^{-1/4} & L \ll L_C \end{cases}. \tag{7}$$

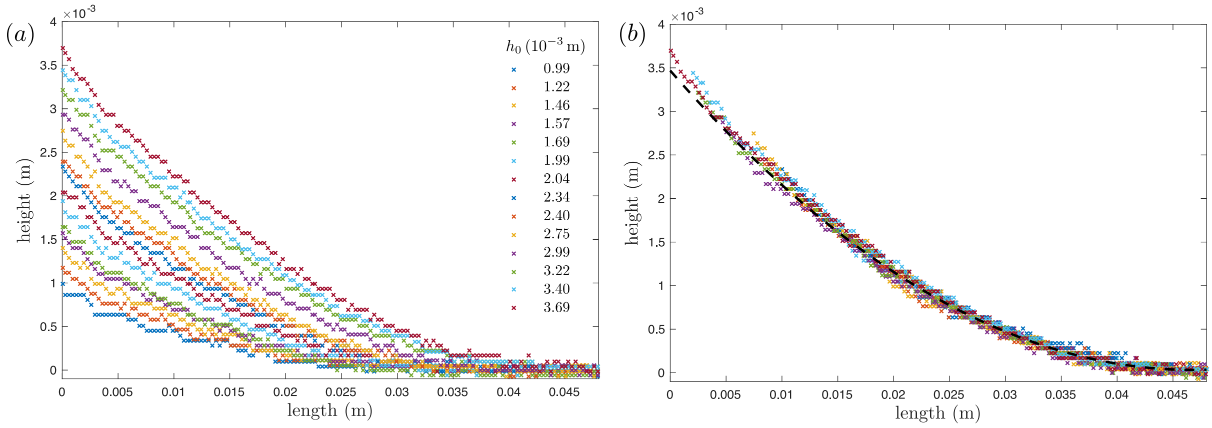

Figure 1: (a) Plot of profiles for two-dimensional lift-off experiment for increasing heights h_0. (b) Translated profiles such that the fracture positions coincide. Fitted quadratic curve given by black-dashed line.

2 Measuring adhesion energy

The adhesion energy $\Delta\gamma$ of the adhesive film was measured using a two-dimensional lift-off experiment. A $30\,\mathrm{cm} \times 8\,\mathrm{cm}$ strip of PDMS adhered to a glass table was uplifted at one end using a micrometer in $0.2\,\mathrm{mm}$ increments. The resulting profiles for one series of experiments are shown in Fig. 1(a) for increasing heights h_0. In Fig. 1(b) the profiles have been translated such that the fracture positions coincide and collapses the data onto one curve with the same tip structure. To calculate the curvature, and hence adhesion energy, a quadratic is fit to the tip of the profiles (black-dashed line). From four independent experiments (including the one shown in Fig. 1), the curvature is measured to be $\kappa = 2.94 \pm 0.15\,\mathrm{m}^{-1}$, and hence adhesion energy $\Delta\gamma = 0.78 \pm 0.17\,\mathrm{Jm}^{-2}$. This adhesion energy is comparable to values previously obtained for similar tapes [4].

3 Adhesion dominant spreading

In the adhesion dominant regime, we measure the curvature κ_{adh} for each experiment by fitting a quadratic to the tip region of the detected deflection profiles. Fig. 2(a) shows the measured curvature for the six experiments for the period $t = 40 - 60\,\mathrm{s}$. The coloured dashed lines indicate the average curvature. We find that the curvature at the front is constant in each experiment but varies with the fluid viscosity; and hence is a function of the glycerol-water content. In Fig. 2(b) (Fig. 6(c) in the main text), we plot the measured curvature values against prefactor c, where $R_F = c(Qt)^{1/4}$; the error bars are given by one standard deviation above and below the mean. We find $c = c(\kappa_{adh})$ where $c = 1.45\,\kappa_{adh}^{-1/4}$, black-dashed line, where the exponent of κ_{adh} is consistent with the static scaling given by Eqn. 16 in the main text.

References

[1] J. R. Lister, G. G. Peng, and J. A. Neufeld, "Viscous Control of Peeling an Elastic Sheet by Bending and Pulling," Phys. Rev. Lett. **111**, 1–5 (2013).

[2] I. J. Hewitt, N. J. Balmforth, and J. R. De Bruyn, "Elastic-plated gravity currents," Eur. J. Appl. Math. **26**, 1–31 (2015).

[3] J. C. Flitton and J. R. King, "Moving-boundary and fixed-domain problems for a sixth-order thin-film equation," Eur. J. Appl. Math. **15**, 713–754 (2004).

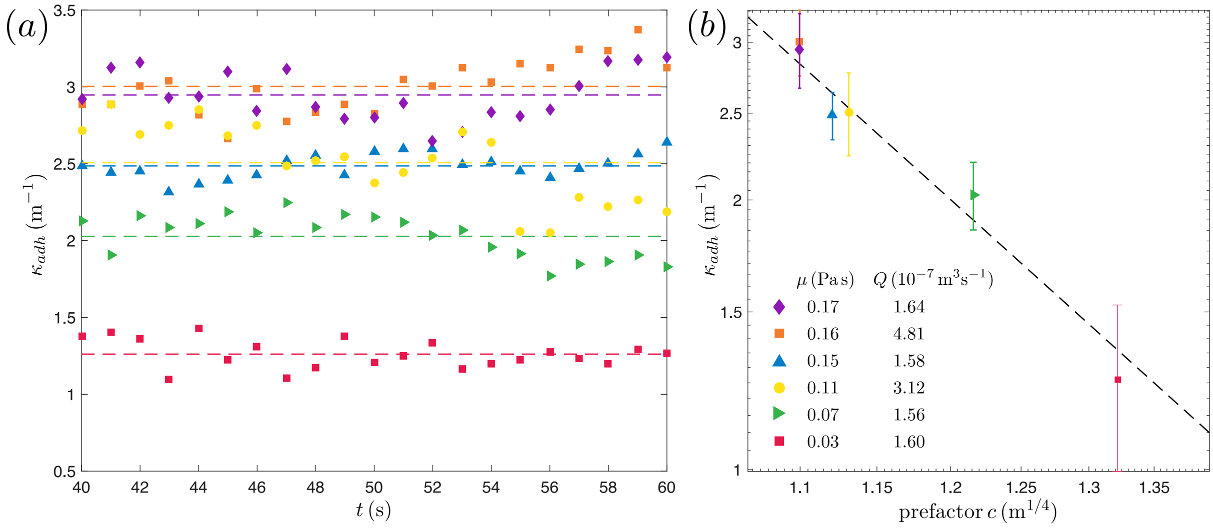

Figure 2: (a) Plot of measured curvature with time for six experiments in the adhesion dominant regime, and (b) plot of measured curvature against prefactor c, where $c = R_F/(Qt)^{1/4}$.

[4] T. J. W. Wagner and D. Vella, "The 'Sticky Elastica': delamination blisters beyond small deformations," Soft Matter **9**, 1025–1030 (2013)