Rotation of a submerged finite cylinder moving down a soft incline
Electronic supplementary information

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1 Materials properties

Polyacrylamide (PAA) gels are obtained by mixing a solution containing both acrylamide monomers and bis-acrylamide crosslinkers (40% solution of 37.5 : 1 acrylamide and bis-acrylamide from Bio-Rad, solution MIX) with a solution of potassium persulfate (0.2 mol/L, solution C) and a solution of tetramethylethylenediamin (TMEDA) (0.3 mol/L, solution D). By changing the proportion of MIX and water, we were able to tune a purely elastic response within a modulus range: $G \in [0.1 - 37]$ kPa. Fig. 1a shows rheology curves obtained for the extrema of this modulus range. Right after mixing the components together we wait typically two hours, the time to reach a steady modulus value (see supplementary information in[1]), before either doing an incline or a rheology experiment. For the incline experiments, the films are made by filling a gap created between the glass plate and a – non sticky – acrylic plate, that we control by using calibrated spacers.

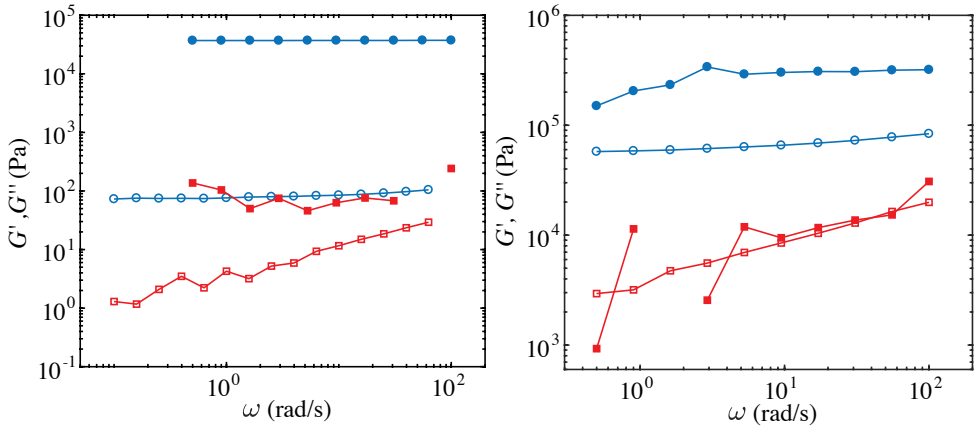

Fig. 1 Rheology curves from oscillatory tests. Storage modulus G' (blue circles) and loss modulus G'' (red squares), plotted as a function of the angular frequency. (a) Polyacrylamide with acrylamide concentration 4.5% and bis-acrylamide/acrylamide ratio 0.5% (hollow markers) and 10% with ratio 2.7% (filled markers). The amplitude of the strain oscillation is 0.1%. (b) PDMS with mixing ratio 30:1 (hollow markers) and 5:1 (filled markers). The amplitude of the strain oscillation is 0.5%.

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Polydimethylsiloxane (PDMS) samples are obtained by mixing a monomer base (part A) and a crosslinker (part B) from Dow Corning (Sylgar 184). By changing the ratio of A and B, we can tune the elastic properties with shear moduli in the range $G \in 35-400$ kPa. Both parts are mixed thoroughly during five minutes. The samples are then either introduced in a rheometer or applied on the incline with a 90 minutes curing step between 70 and 150°C, depending on the modulus value targeted, to reach a stable shear modulus (see supplementary information in[1]). When used on the incline, the film is made by filling the gap between the glass plate and an acrylic plate, as with the PAA. Fig. 1b shows rheological curves for both extreme values of the modulus range used in the experiments with PDMS.

2 Master plot for different values of the Poison ratio

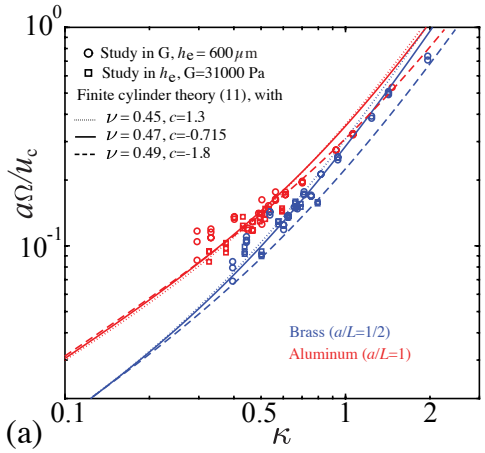

Fig. 2 Experimental dimensionless angular velocity $a\Omega/u_c$ as a function of the modified scaled compliance $\kappa = \left(\frac{\rho^* g h_e \cos\alpha}{2G\tan^3\alpha}\right)^{1/5}$, as plotted in Fig. 4a. in the article, with $\nu = 0.45$ (dotted line), $\nu = 0.47$ (plain line), $\nu = 0.49$ (dashed line). The red symbols correspond to the aluminum cylinder with $a/L = 1$, while the blue symbols correspond to the brass cylinder with $a/L = 1/2$. The circles and the squares correspond, respectively, to variations in G and h_e. The fit constants for every curves are respectively $c = 1.3$, $c = -0.715$ and $c = -1.8$.

Notes and references

1 B. Saintyves, T. Jules, T. Salez, and L. Mahadevan. *Proc. Nat. Acad. Sci.*, 113(21):5847, 2016.