Supplemental Material

Imaging viscoelastic properties of live cells by AFM: Power-law rheology on the nanoscale

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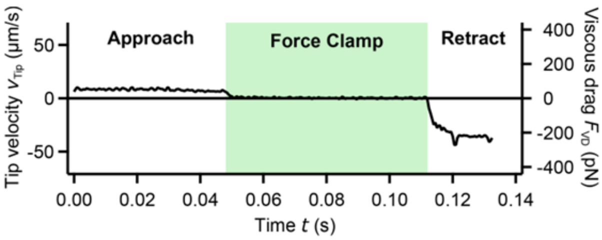

Fig. S1 Estimation of the viscous drag force acting on the cantilever, generated by the cantilever's motion through the surrounding liquid, for the data shown in Figure 1. The tip velocity $v_{Tip}(t)$ was calculated as the time derivative of the tip position, $z(t) - d(t)$. The viscous drag force F_{VD} was estimated from the tip velocity using $F_{VD} = \mu\, v_{Tip}$, where μ is the viscous drag coefficient of the cantilever. For the cantilevers used here, the drag coefficient was determined as $\mu = 6.2$ pN (µm/s)$^{-1}$ in a separate measurement (data not shown). We found that for the conditions used here, the influence of the tip-sample distance on the drag coefficient was negligible.

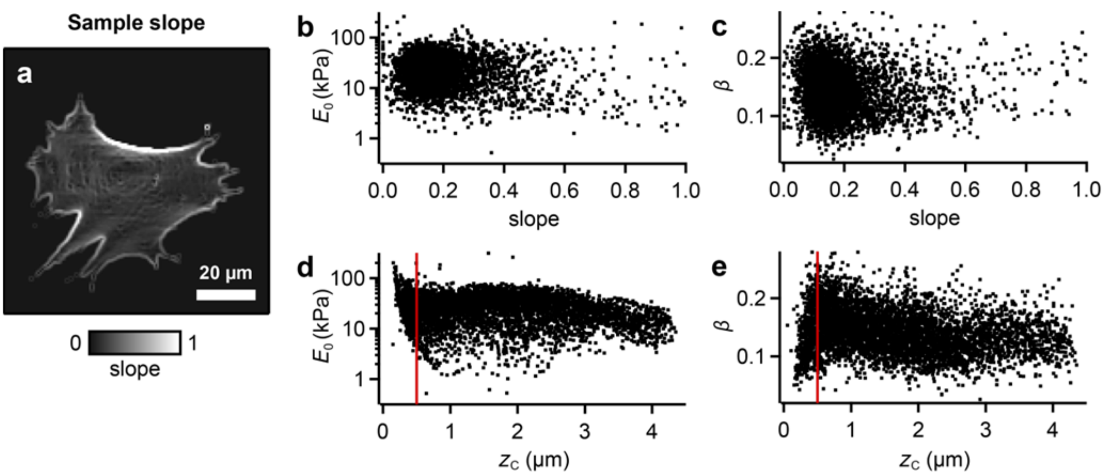

Fig. S2 Correlation of modulus scaling parameter E_0 and power-law exponent β vs sample slope and height for the cell shown in Figure 2. (**a**) Image of the sample slope, $[(dz_C/dx)^2 + (dz_C/dy)^2]^{1/2}$. (**b**) E_0 and (**c**) β as a function of sample slope. Neither the modulus scaling parameter E_0 nor the power-law exponent β show a significant correlation with sample slope. (**d**) E_0 and (**e**) β as a function of sample height. E_0 and β show a visible correlation only for heights smaller than about 500 nm (red line).

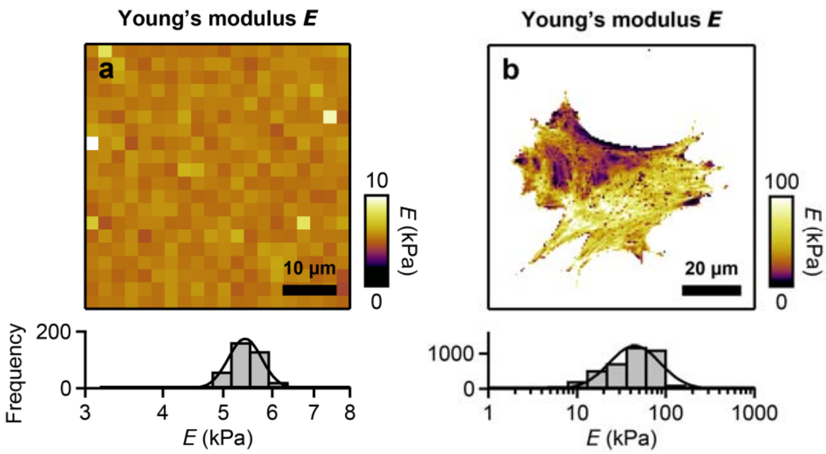

Fig. S3 Maps of the apparent Young's modulus E of (**a**) the polyacrylamide (PAA) gel from Figure 2 and (**b**) the MEF vin-/- cell from Figure 3, obtained when applying a purely elastic contact model to the approach part of the force-distance curves. The Young's moduli are slightly larger than the respective modulus scaling parameters (Figure 2 and Figure 3, respectively).

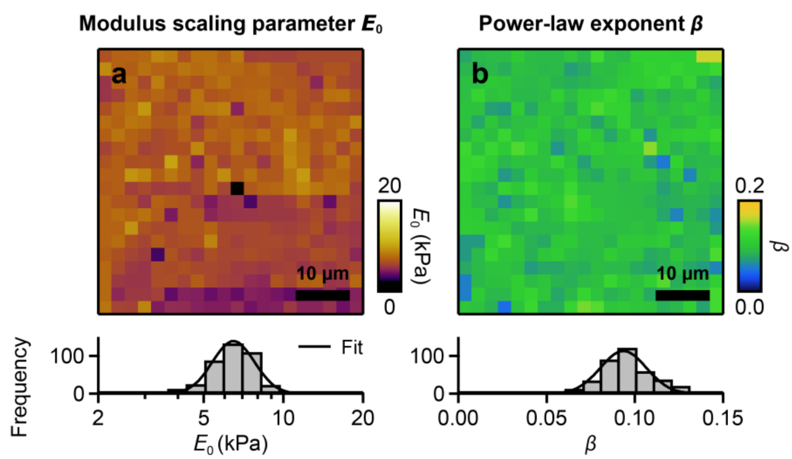

Fig. S4 Force clamp force mapping (FCFM) on the same polyacrylamide (PAA) gel as in Figure 2, but recorded with a DNP type cantilever. (**a**) Map and histogram of the modulus scaling parameter E_0. (**b**) Map and histogram of the power-law exponent β. Pixel resolution is 20 × 20 pixels. The mean values (E_0 = 6.4 kPa and β = 0.092) are in well agreement with the values obtained with the MLCT type cantilever from Figure 2 (E_0 = 5.3 kPa and β = 0.091), demonstrating the reliability of the FCFM method. The small difference in E_0 could be explained by the inaccuracy in the determination of the cantilevers' spring constants (typically 10 – 20%).[1]

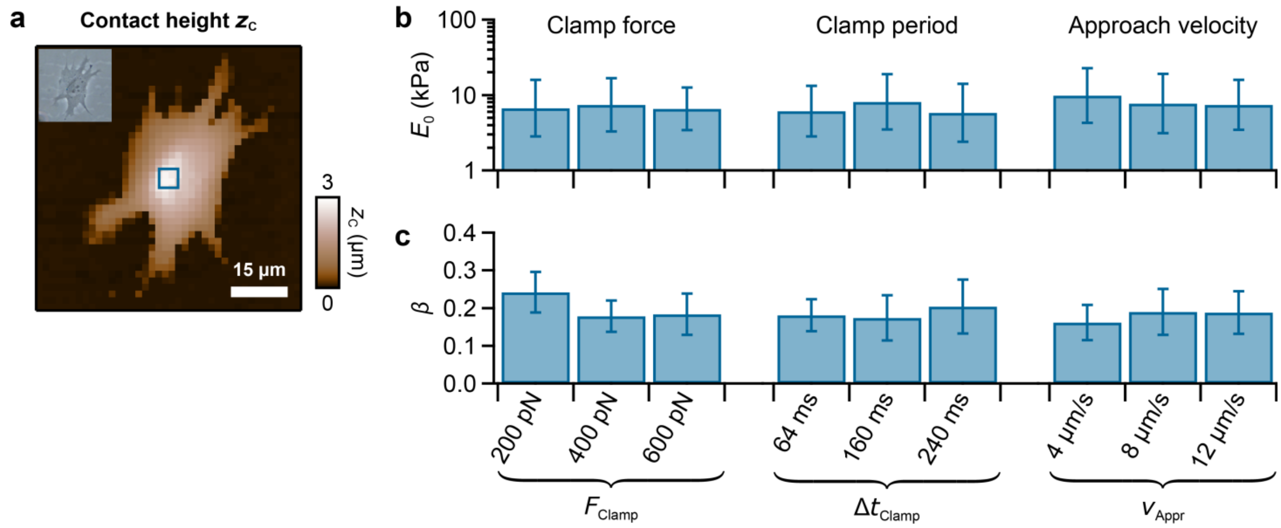

Fig. S5 Power-law parameters E_0 and β for different experimental parameters. (**a**) Map of contact height z_C of a MEF WT cell. (**b**) Modulus scaling parameter E_0 and (**c**) power-law exponent β for different experimental parameters F_{Clamp}, Δt_{Clamp}, and v_{Appr}, recorded within a small region on the cell (5 µm × 5 µm, 10 × 10 pixels, marked by the box in panel a). Median ± standard deviation is shown. Neither the mean values nor the standard deviations depend considerably on the different experimental parameters.

References

1 C. T. Gibson, D. J. Johnson, C. Anderson, C. Abell and T. Rayment, *Rev. Sci. Instrum.*, 2004, 75, 565-567.