Supporting Information

for

Stick-Slip Mechanisms at the Nanoscale

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1. Statistics of plateau desorption curves in single molecule desorption experiments

Polymer	Substrate	Desorption force F_{des} (pN)	Detachment length z_{des} (nm)
PS	PTFE	96 (± 2)	3662 (± 123)
PI	HD	71 (± 2)	195 (± 174)
PI	SiO	68 (± 3)	165 (± 8)
PSPI	OHD	61 (± 2)	1074 (± 25)
PGA	OHD	54 (± 3)	376 (± 128)
PGA	SAM	65 (± 2)	443 (± 13)
ssDNA	HD	76 (± 3)	330 (± 37)

Table S1 Desorption force F_{des} and detachment length z_{des} distribution of measured polymer-substrate combinations. All data sets were measured in H₂O with a retraction velocity of 1 $\mu\text{m}\cdot\text{s}^{-1}$ and a dwell time of 1s. The measured velocity-independent plateaus represent an equilibrium desorption process on the timescale of the experiments (1). The height of the final plateau is called the desorption force F_{des} , while the length is denoted as desorption (detachment) length z_{des} . Absolute plateau force values are subject to uncertainty in cantilever force constant calibration and therefore the absolute force error is around 10 %, while the relative uncertainties when one and the same cantilever is used are around 2 % (2). The errors for z_{des} correspond to the standard deviation.

Fig. S1. Distribution of desorption force and length of ssDNA on HD. (a) Example of F_z vs. z curve with a desorption plateau belonging to an individual polymer segment detaching from the substrate. (b) Desorption force distribution F_{des} and (c) detachment length distribution z_{des} . The data set was measured in H_2O with a retraction velocity of $1 \mu m \cdot s^{-1}$. The mean values and standard deviations of the distributions can be found in Table S1. The traces were taken at least at three different positions on the interface and the distributions contain at least 100 F_z vs. z curves.

2. Lateral force constant

The lateral force constant $k_{lateral}$ for beam shaped cantilevers is given by [217]:

$$k_{lateral} = k_z \frac{2L^2}{3(1+\nu)h^2} \quad (S1)$$

with the cantilever length L , the cantilever tip height h , the Poisson ratio ν (0.25 for Si_3N_4) and the normal force constant k_z . For the B cantilever of MLCT (Bruker AXS, USA) with $L=210 \mu m$; $h=2.5$ - $8.0 \mu m$ and $k_z=30$ - $40 pN \cdot nm^{-1}$ the lateral force constant ranges to about $k_{lateral}=30 nN \cdot nm^{-1}$. Thus, single polymer friction with forces of up to 100 pN cannot induce detectable lateral cantilever deflection. Triangular cantilevers tend to be even stiffer. The respective geometrical description can be found in refs. (3, 4). Hence, the normal cantilever deflection is used for single polymer desorption and friction measurements.

3. Examples of solvent effect on stick-slip

Fig. S2. Solvent effect on stick-slip. (a) F_z vs. x plot for PS on PTFE in H_2O with $v_x = 1.05 \mu m \cdot s^{-1}$ showing DS (dashed white line) during lateral pulling followed by slip (plateau of constant F_z). (b) For PI on HD in H_2O with $v_x = 2.70 \mu m \cdot s^{-1}$ DS is followed by slip. (c) ssDNA on HD in H_2O with $v_x = 1.40 \mu m \cdot s^{-1}$ exhibit mostly DS (lower curve) and partly DS followed by a slip event (upper curve). The upper curve is vertically offset by 100 pN. (d) PSPI on PTFE in $CHCl_3$ with $v_x = 0.20 \mu m \cdot s^{-1}$ resulting in slip (undetectable friction force).

3. Examples of stick-slip on hydrophilic surfaces

Fig. S3. Stick-slip on hydrophilic surfaces. (a) PI on Si in H_2O with $v_x = 2.5 \mu m \cdot s^{-1}$ showing DS-slip events and (b) CS-slip events. (c,d) ssDNA on mica in H_2O with $v_x = 1.4 \mu m \cdot s^{-1}$ leads to DS-CS as well as consecutive CS and slip events.

Supplementary references

- (1) Horinek, D., Serr, A., Geisler, M., Pirzer, T., Slotta, U., Lud, S. Q., Garrido, J. A., Scheibel, T., Hugel, T., Netz, R. R. (2008), *Proc. Natl. Acad. Sci. U. S. A.*, 105, 2842-2847.
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