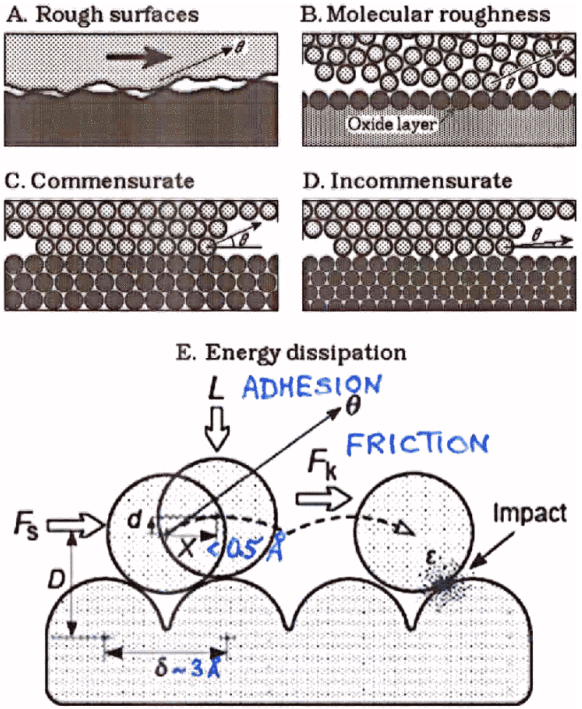


Figure 1.

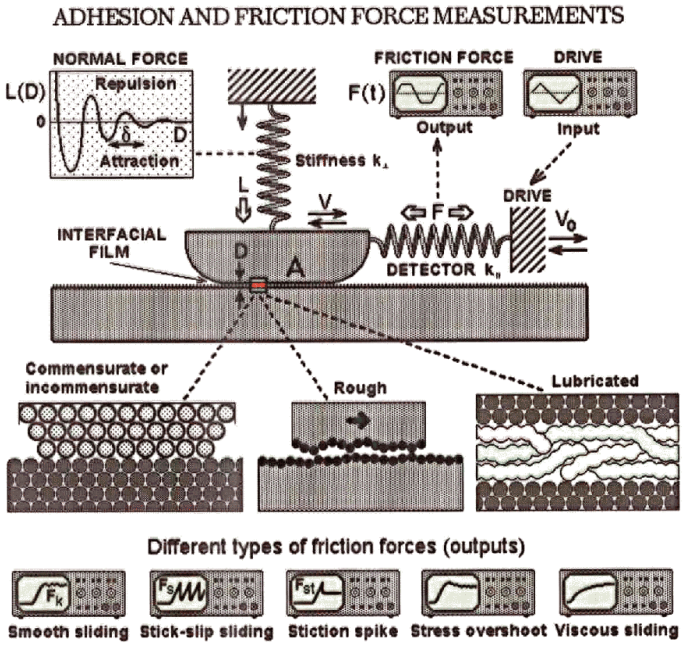
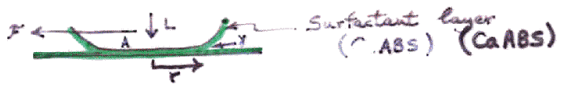
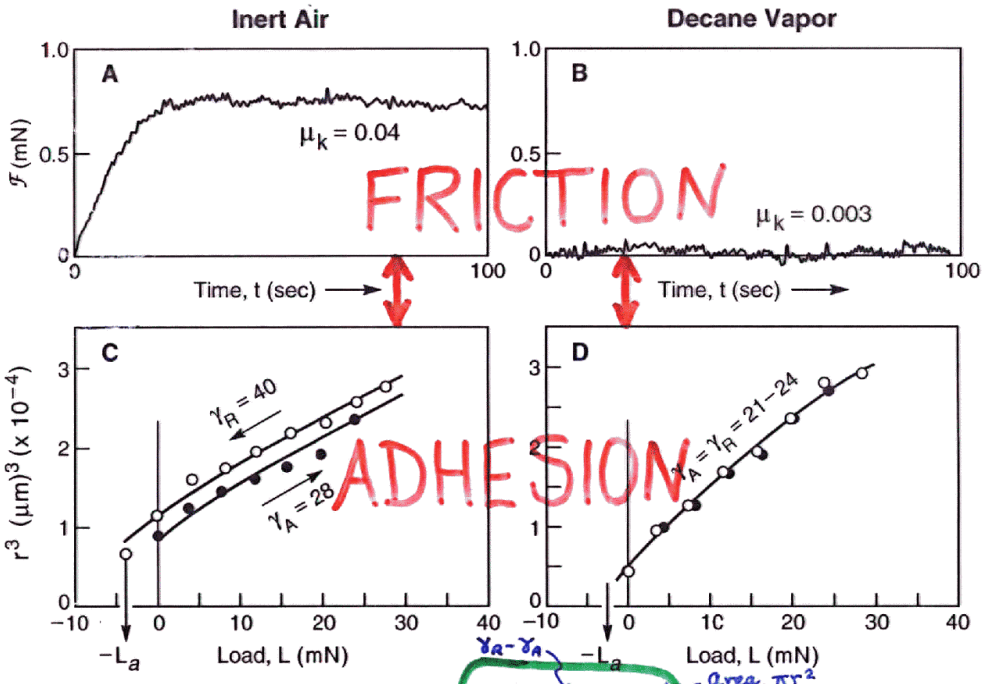


Figure 3.



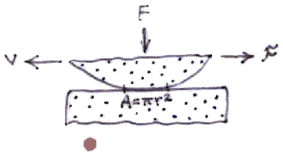


If done at similar rates: $F \approx \frac{\Delta\gamma \cdot A\epsilon}{\delta}$ ($\gamma_R - \gamma_A$; area, πr^2; Const. ≈1; characteristic molecular dimension (5-10 Å))

J. Phys. Chem. 97 (1993) 4128.

cf. at L=0: $\Delta\gamma \sim 12$, $A \sim \pi r^2 \sim 3\times10^{-6}$, $\delta \sim 10$ Å

→ $\Delta\gamma \cdot A/\delta \approx 400$ dynes = 4 mN. cf. $F = 0.8$ mN. ($\therefore \epsilon \approx 0.2$).



SILICA SURFACES

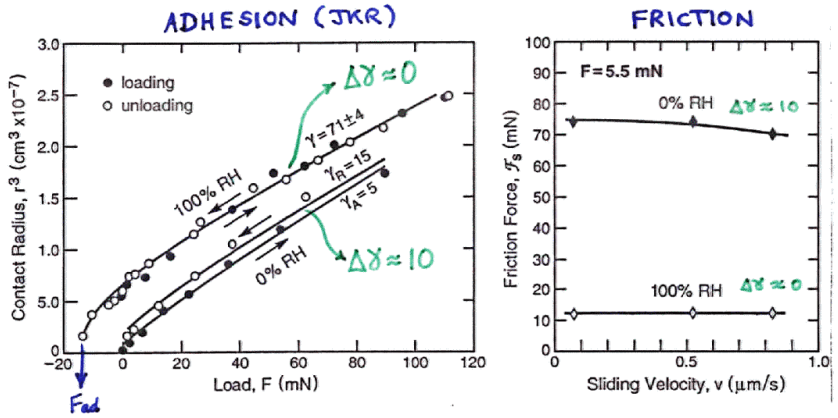


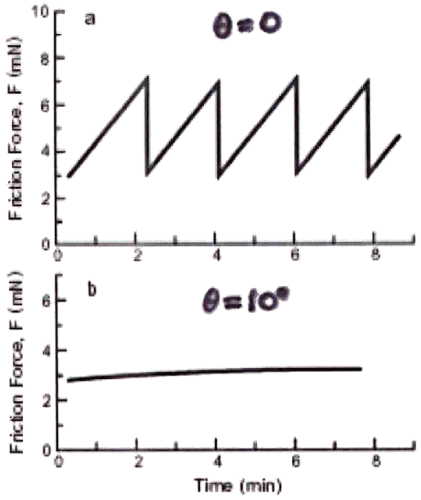
Figure 4. Measurements of adhesion loading-unloading curves (left) and friction forces (right) for two silica surfaces at different humidities (0% and 100%). Data taken from [5].

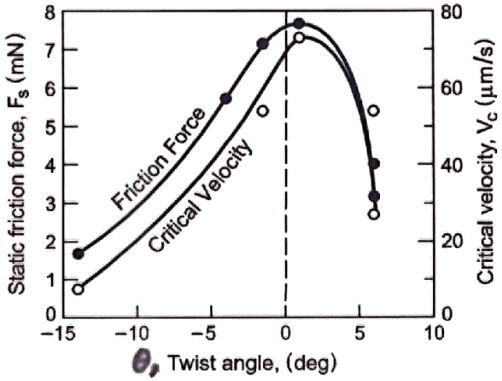
At 0% RH: $A = 10^{-8}$ m^2, $\Delta\gamma = 10$ mJ/m^2

Expect $F_k \approx \frac{\Delta\gamma \cdot A}{\delta} \approx 100$ mN. for $\epsilon \sim 1$. ($\delta \sim 1$ nm)

— J. Colloid Interface Sci. Vigil et. al. 165 (1994) 367.

OMCTS





H. Yoshizawa, thesis, 93
A. Berman, thesis, 96

VISCOELASTIC (POLYMER) SURFACES

↓F near T_g

INITIAL CONTACT (ELASTIC) at t = 0

area A_o

— G. Luengo
— M. Heuberger
Langmuir (1998) 14, 3873.
N. Maeda, M. Tirrell
Nianhuan Chen
Hongbo Zeng

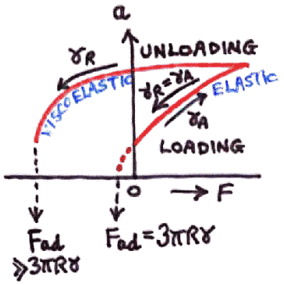
↓F

AFTER SOME TIME

Flow Flow

$A > A_o$

JKR PLOTS



↓F

EVEN LATER Molecular-scale Reptation Bulk Flow

$A \gg A_o$

↑-F

ON SEPARATION

Fingering

Cavitation

Fast

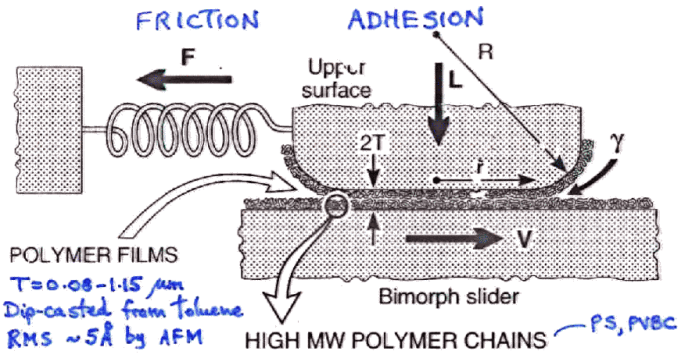
PULL-OFF

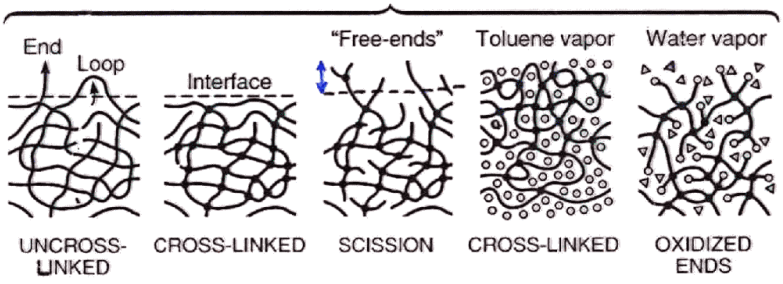
$\uparrow F_{ad}$

Craters

LATER

Smooth





Maeda, Chen, Tirrell, Israelachvili - Science 297 (2002) 379.

PS — Non-polar

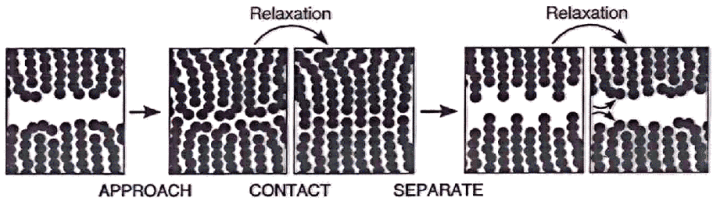
PVBC — Polar

MW 500 → 3,000,000

T_g −70°C → +107°C

ADHESION

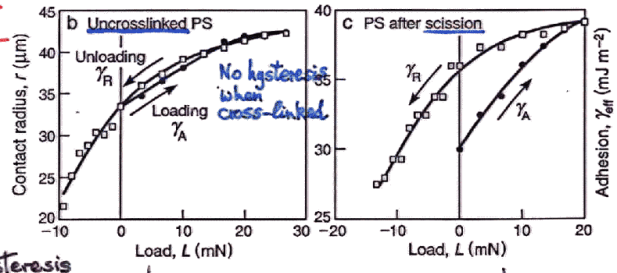
Surfactant[a] Monolayer Surfaces

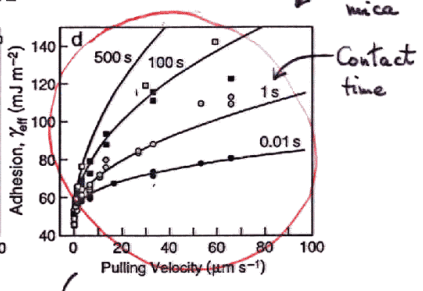


Yoshizawa et al. (1993)

CTAB on mica

Polymer surfaces





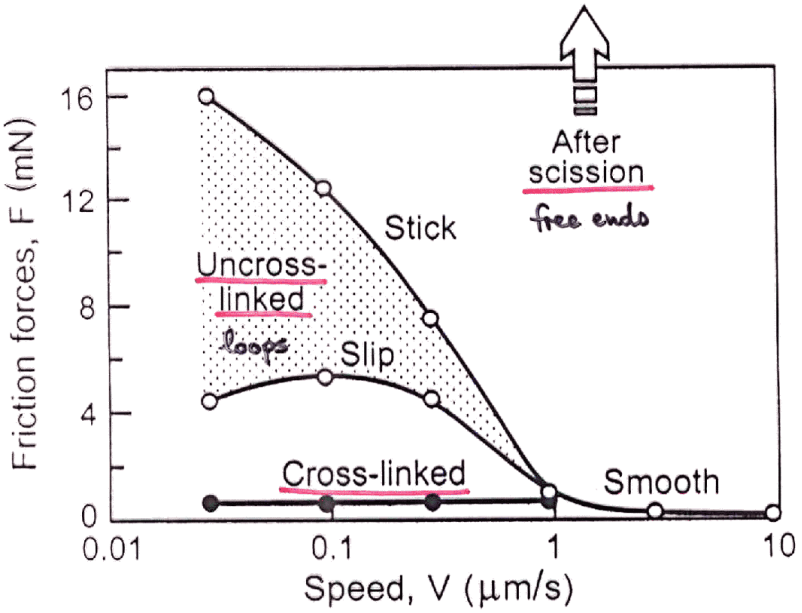
No hysteresis at all with cross-linked

Also polarity of minor importance.

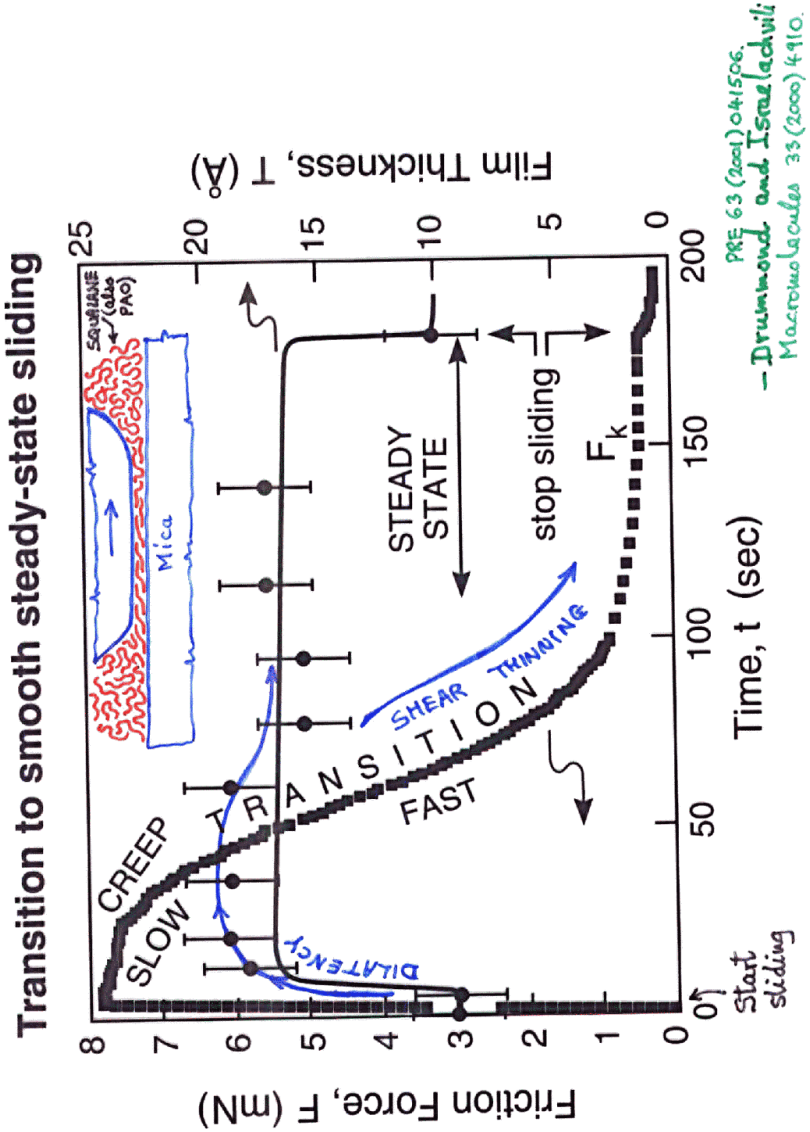
Maeda et al. Science 297 (2002) 379.

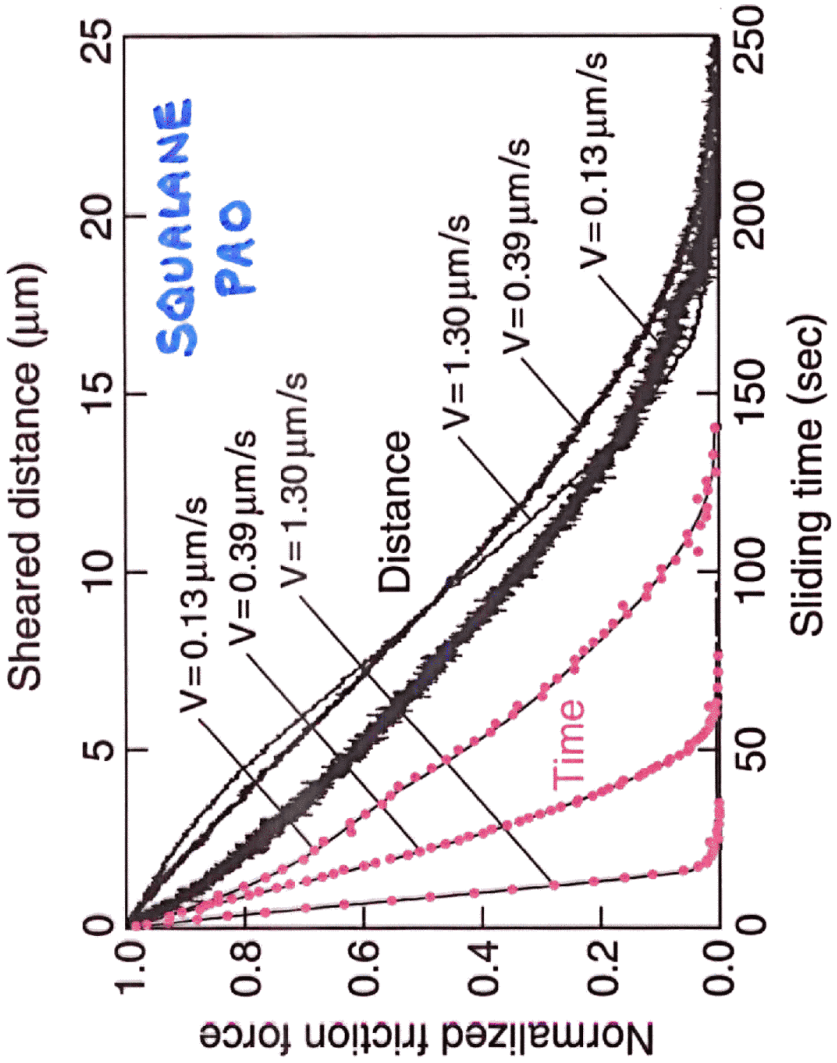
– Barthel & Roux Langmuir 16 (2000) 8134.

FRICTION



Dynamic effects: Contact times and sliding velocities central to determining adhesion and friction forces. i.e., static models not sufficient.




SQUALANE
PAO
V=0.13 μm/s
V=0.39 μm/s
V=1.30 μm/s
Distance
V=1.30 μm/s
V=0.39 μm/s
V=0.13 μm/s
Time
Sheared distance (μm)
Normalized friction force
Sliding time (sec)
0
5
10
15
20
25
1.0
0.8
0.6
0.4
0.2
0.0
0
50
100
150
200
250

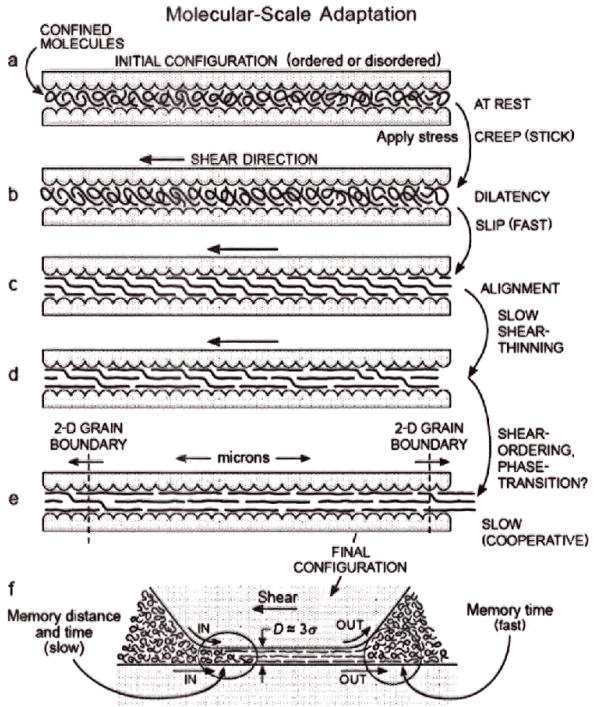

Molecular-Scale Adaptation
CONFINED MOLECULES
a
INITIAL CONFIGURATION (ordered or disordered)
AT REST
Apply stress
CREEP (STICK)
SHEAR DIRECTION
b
DILATENCY
SLIP (FAST)
c
ALIGNMENT
SLOW SHEAR-THINNING
d
2-D GRAIN BOUNDARY
microns
2-D GRAIN BOUNDARY
SHEAR-ORDERING, PHASE-TRANSITION?
e
SLOW (COOPERATIVE)
FINAL CONFIGURATION
f
Shear
Memory distance and time (slow)
IN
D ≈ 3σ
OUT
Memory time (fast)
IN
OUT

Figure 22.