SUPPLEMENTAL MATERIALS

It has been shown that, for Thermomicroscopes (Sunnyvale, CA) cantilevers, the inclination and deflection at the cantilever tip are proportional to each other, i.e., $z(L) = \alpha L[dz/dx]_{x=L}$, which allows the definition of virtual deflection, i.e., $z^*(L,t) \equiv \alpha L[\partial z/\partial x]_{x=L}$ (Wu et al., 2005). In addition, mean square virtual deflections to the mean square real deflections are proportional to each other, and the proportionality constant is a linear function of the ratio of the molecular spring constant to the cantilever spring constant:

$$< z^{*2} > / < z^2 > = a(k/k_c) + b \quad \text{(S1)}$$

The constants α, a, and b are listed in Table 1 for Thermomicroscopes cantilevers.

Table 1

Cantilever	A	B	C	D	E	F	Theoretical
Shape	V-shaped	Rectangular	V-shaped	V-shaped	V-shaped	V-shaped	Rectangular
α	0.670137	0.665266	0.685908	0.661468	0.652268	0.584174	2/3
a	0.3943	0.3024	0.3879	0.4068	0.4188	0.4315	1/3
b	1.3072	1.2969	1.3831	1.3738	1.3834	1.3349	4/3

It has also shown that, due to the bandwidth limitations, errors will arise if one directly uses Eq. S1 in the equipartition theorem [i.e., $\frac{1}{2}(k_c + k) = \frac{1}{2}k_B T$] to evaluate the spring constants of the cantilever and the molecular linker according to the following (Wu et al., 2005).

$$k = k_c \frac{b k_B T - k_c < z^{*2} >}{k_c < z^{*2} > - a k_B T}. \quad \text{(S2)}$$

Depending the number (N) of vibration modes measurable from experiment, the following approximation will substantially reduce the errors.

$$k \approx c_N k_c \frac{b_N k_B T - k_c \sum_{n=1}^{N} < z_n^{*2} >}{k_c \sum_{n=1}^{N} < z_n^{*2} > + a_N k_B T}, \quad \text{(S3)}$$

The coefficients a_N, b_N, and c_N sing for N = 1, 2, and 3 are listed in Table 2 for the indicated Thermomicroscopes cantilevers.

Table 2

Cantilever B

	$N = 1$	$N = 2$	$N = 3$
a_N	0.1445	-0.0757	-0.1589
b_N	0.8170	1.0694	1.1556
c_N	0.9583	0.9813	0.9861

Cantilever C

	$N = 1$	$N = 2$	$N = 3$
a_N	0.1842	0.0045	-0.0991
b_N	0.6920	0.9727	1.0902
c_N	0.8697	0.9694	0.9838

Cantilever D

	$N = 1$	$N = 2$	$N = 3$
a_N	0.2067	0.0460	-0.0648
b_N	0.6946	0.9912	1.1226
c_N	0.8452	0.9655	0.9814

Cantilever E

	$N = 1$	$N = 2$	$N = 3$
a_N	0.2104	0.0626	-0.0487
b_N	0.6796	0.9915	1.1307
c_N	0.8098	0.9517	0.9750