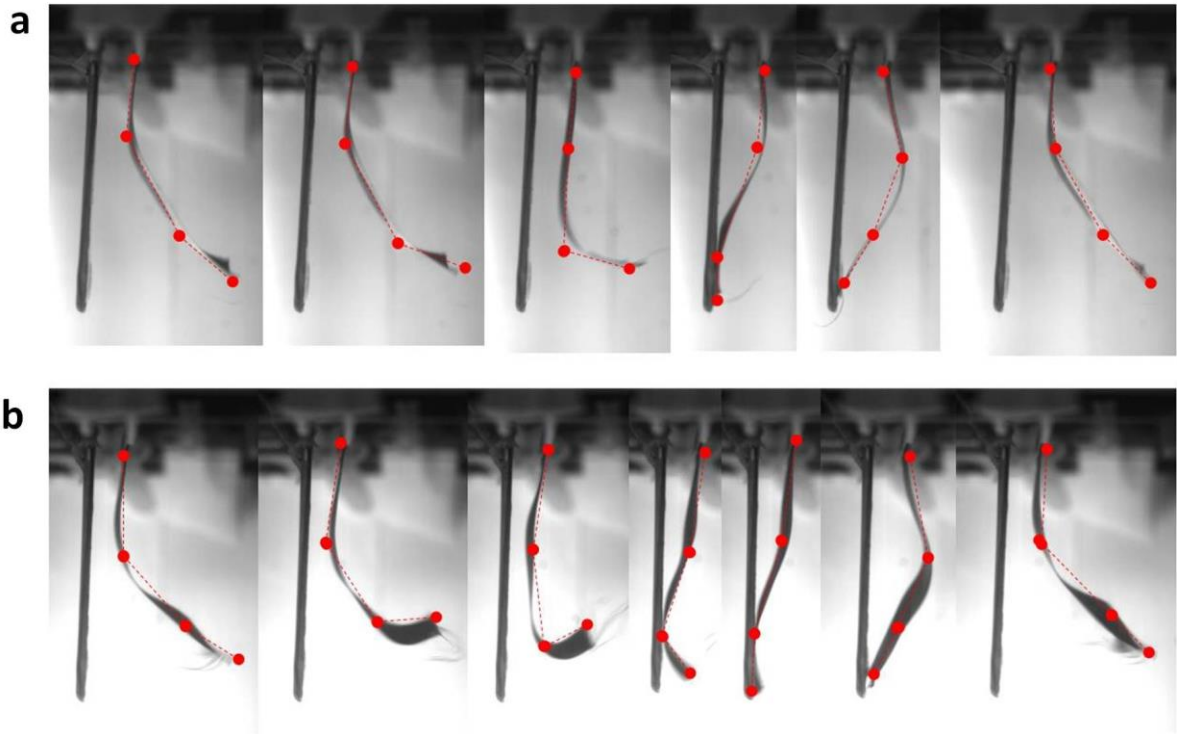
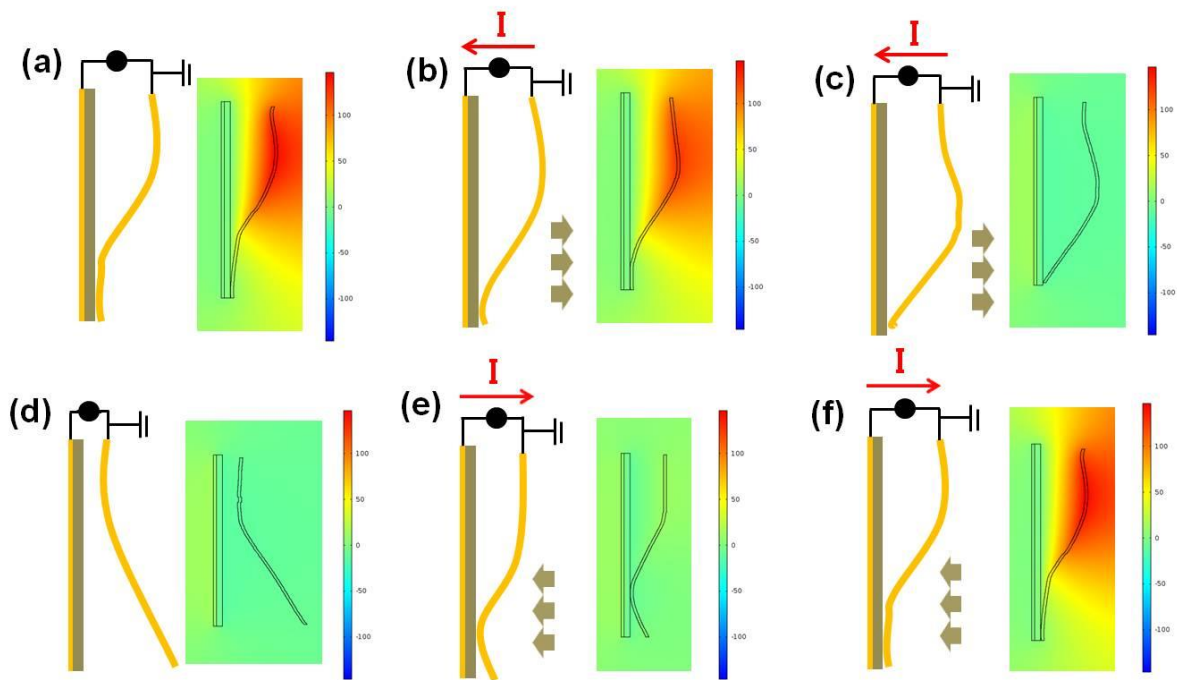


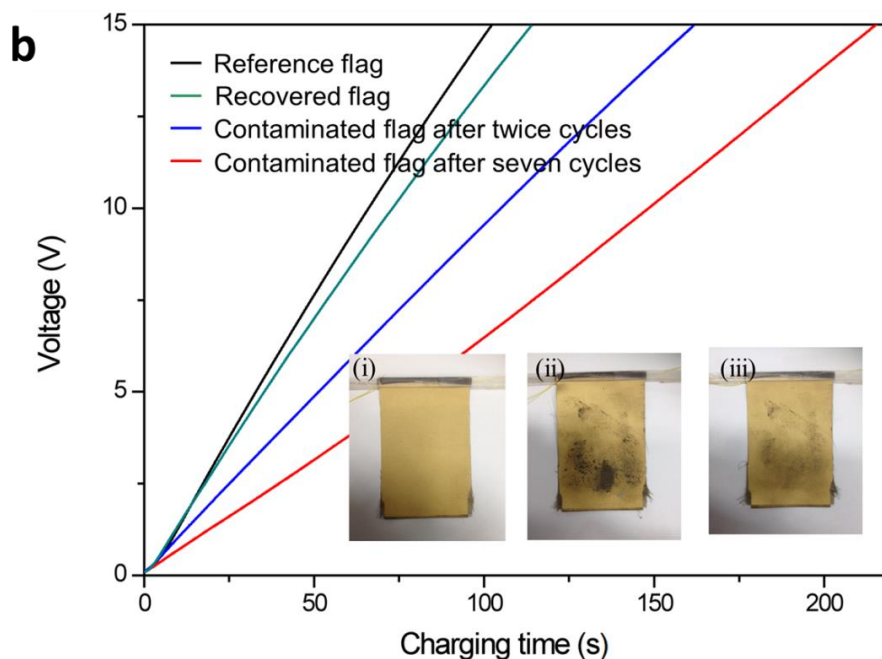
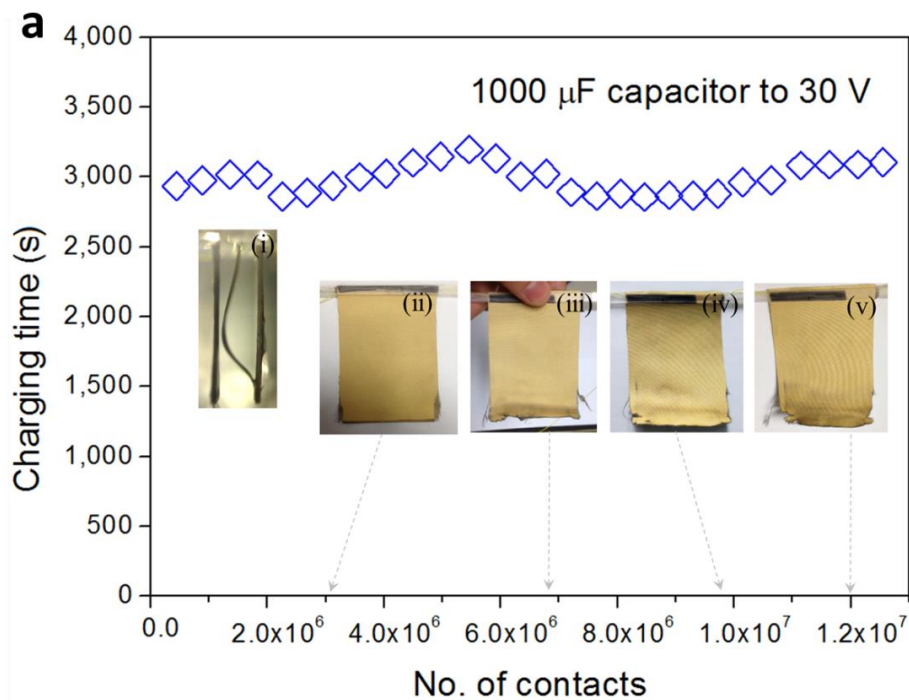
Supplementary Figure 1 Sequential images of contact-propagation-separation behaviour. (a) Single contact mode. (b) Double contact mode. Images were captured using a high speed camera under a flow velocity of 9.2 ms^{-1} at a time interval of 0.002 s .



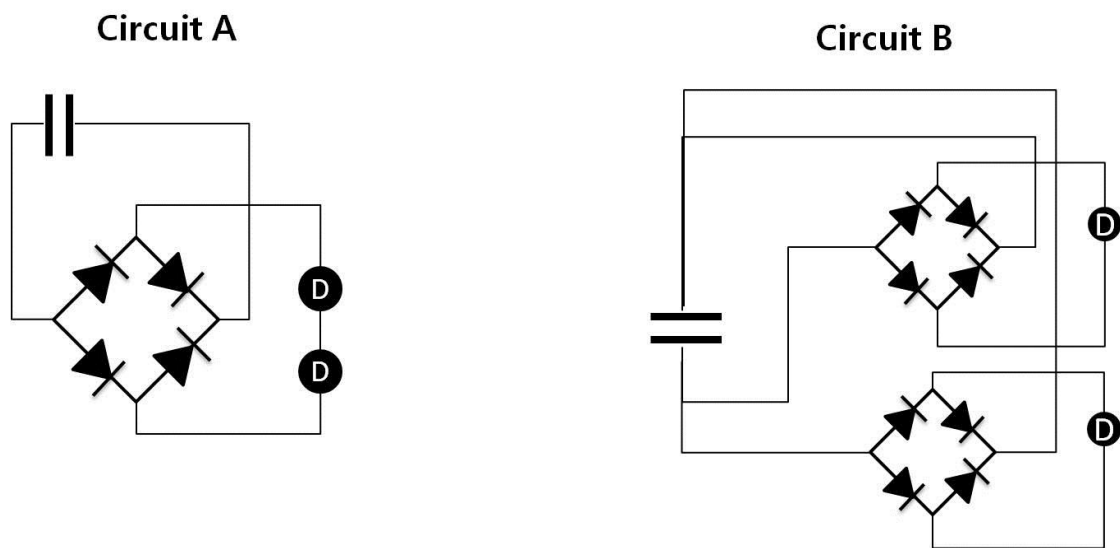
Supplementary Figure 2 The fluttering motions and the impact moment. Fluttering images of the impact motion between flag flutter and counter plate, outlined by double pendulum motion at a flow velocity of (a) 7.5 ms^{-1} and (b) 11.4 ms^{-1} .



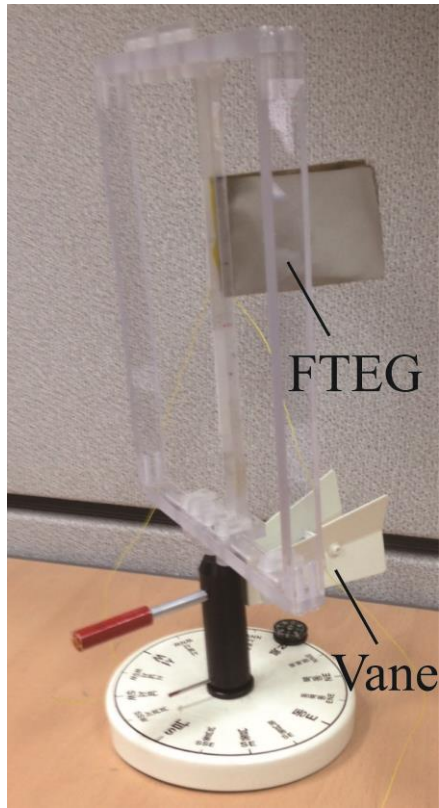
Supplementary Figure 3 Working principle of a FTTEG. Two dimensional schematic flow of the contact-propagation-separation motion with charge distribution simulations. (a) Initial contact between the flag and plate (charge generation) without external flow. (b and c) Decreasing contact area via external flow (in-plane charge separation). (d) Maximum amplitude of fluttering motion. (e) Flag approaching and then contacting the plate. (f) Increase in contact area.



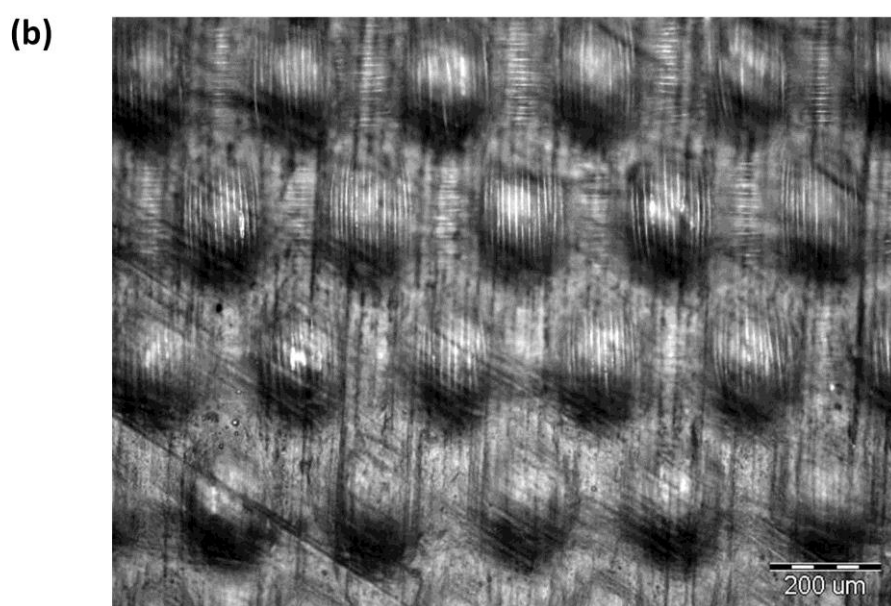
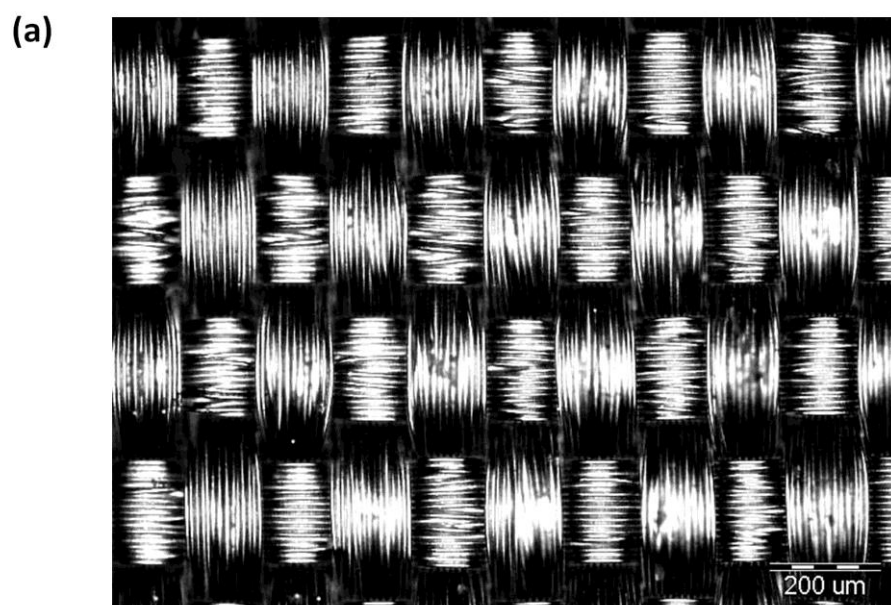
Supplementary Figure 4 Electrical output performance after durability test. (a) Durability test result of the charging time for 1000 μF capacitor to 30 V with a dual plate FTEG; the insets include (i) the pictures of the tested device and (ii)~(v) the damaged flags. (b) A 100 μF capacitor charging time to 15 V with an initial flag (i), a contaminated flag (ii), and the contaminated flag after several cycles of operations (iii).



Supplementary Figure 5 Circuit design for dual plate configuration. Circuit design for converting AC to DC current. (a) Two parallel FTEGs are connected to a rectifier. (b) For the design using a dual plate configuration, an FTEG is connected to a rectifier and then each plate is connected in parallel to the circuit.



Supplementary Figure 6 Rotatable FTEG system incorporated into a weathercock.



Supplementary Figure 7 micrographs of the surface Optical of the woven flag. Magnified surface image of (a) the woven flexible structure and (b) the PTFE film. Dimensions are indicated in each micrograph.

(a)

L (cm)	w (cm)	U (ms ⁻¹)	E (Pa)	B (Pa m ⁴)	M _L (kgm ⁻¹)	Mass ratio	Nondimensional velocity
7.5	5	5.4195	611920000	1.305E-06	0.0039515	0.878103704	23.86437459
7.5	5	7.226	611920000	1.305E-06	0.0039515	0.878103704	31.81916612
7.5	5	9.0325	611920000	1.305E-06	0.0039515	0.878103704	39.77395765
7.5	5	10.839	611920000	1.305E-06	0.0039515	0.878103704	47.72874917
10	5	7.226	611920000	1.305E-06	0.0039515	0.658577778	48.98881099
10	5	9.0325	611920000	1.305E-06	0.0039515	0.658577778	61.23601374
5	7.5	7.226	2.394E+09	7.66E-06	0.0059272	1.317155556	8.757181873
5	7.5	10.839	2.394E+09	7.66E-06	0.0059272	1.317155556	13.13577281
5	7.5	14.452	2.394E+09	7.66E-06	0.0059272	1.317155556	17.51436375
5	7.5	18.065	2.394E+09	7.66E-06	0.0059272	1.317155556	21.89295468
5	7.5	21.678	2.394E+09	7.66E-06	0.0059272	1.317155556	26.27154562
6	12	9.0325	2.394E+09	1.226E-05	0.0094835	1.09762963	14.38951816
6	12	12.6455	2.394E+09	1.226E-05	0.0094835	1.09762963	20.14532542
6	12	16.2585	2.394E+09	1.226E-05	0.0094835	1.09762963	25.90113268
6	12	19.8715	2.394E+09	1.226E-05	0.0094835	1.09762963	31.65693994
6	12	21.678	2.394E+09	1.226E-05	0.0094835	1.09762963	34.53484357

(b)

L (cm)	w (cm)	U (ms ⁻¹)	E (Pa)	B (Pa m ⁴)	M _L (kgm ⁻¹)	Mass ratio	Nondimensional velocity
12	3	5.4195	611920000	7.833E-07	0.0023709	0.548814815	48.29809832
12	3	7.226	611920000	7.833E-07	0.0023709	0.548814815	64.39746443
12	3	9.0325	611920000	7.833E-07	0.0023709	0.548814815	80.49683054
16	8	5.4195	611920000	2.089E-06	0.0063223	0.411611111	74.35978685
16	8	7.226	611920000	2.089E-06	0.0063223	0.411611111	99.14638247
16	8	9.0325	611920000	2.089E-06	0.0063223	0.411611111	123.9329781

(c)

L (cm)	w (cm)	U (ms ⁻¹)	E (Pa)	B (Pa m ⁴)	M _L (kgm ⁻¹)	Mass ratio	Nondimensional velocity
12	3	10.839	611920000	7.833E-07	0.0023709	0.548814815	96.59619665
12	3	12.6455	611920000	7.833E-07	0.0023709	0.548814815	112.6955628
12	3	16.2585	611920000	7.833E-07	0.0023709	0.548814815	144.894295
12	3	21.678	611920000	7.833E-07	0.0023709	0.548814815	193.1923933
16	8	10.839	611920000	2.089E-06	0.0063223	0.411611111	148.7195737
16	8	12.6455	611920000	2.089E-06	0.0063223	0.411611111	173.5061693
16	8	14.452	611920000	2.089E-06	0.0063223	0.411611111	198.2927649
16	8	21.678	611920000	2.089E-06	0.0063223	0.411611111	297.4391474
10	5	10.839	611920000	1.305E-06	0.0039515	0.658577778	73.48321649
10	5	14.452	611920000	1.305E-06	0.0039515	0.658577778	97.97762199
10	5	18.065	611920000	1.305E-06	0.0039515	0.658577778	122.4720275
10	5	21.678	611920000	1.305E-06	0.0039515	0.658577778	146.966433
7.5	5	12.6455	611920000	1.305E-06	0.0039515	0.878103704	55.6835407
7.5	5	14.452	611920000	1.305E-06	0.0039515	0.878103704	63.63833223
7.5	5	18.065	611920000	1.305E-06	0.0039515	0.878103704	79.54791529
7.5	5	21.678	611920000	1.305E-06	0.0039515	0.878103704	95.45749835

(d)

L (cm)	w (cm)	Distance (cm)	U (ms ⁻¹)	E (Pa)	B (Pa m ⁴)	M _L (kgm ⁻¹)	Mass ratio	Nondimensional velocity
7.5	5	∞	3.14331	611920000	1.305E-06	0.0039515	8.78104E-05	13.84133726
12	3	∞	3.46848	611920000	7.833E-07	0.0023709	5.48815E-05	30.91078293
5	7.5	∞	5.20272	2.394E+09	7.66E-06	0.0059272	0.000131716	6.305170948
6	12	∞	5.81693	2.394E+09	1.226E-05	0.0094835	0.000109763	9.266849692
10	4	∞	3.17944	611920000	1.044E-06	0.0031612	6.58578E-05	21.55507684
10	5	1	3.68526	611920000	1.305E-06	0.0039515	6.58578E-05	24.98429361
16	8	1	3.79365	611920000	2.089E-06	0.0063223	4.11611E-05	52.0518508
12	3	∞	5.67241	2.394E+09	3.064E-06	0.0023709	5.48815E-05	25.55941377
7.5	5	0.5	3.93817	611920000	1.305E-06	0.0039515	8.78104E-05	17.34144553
7.5	5	1	3.39622	611920000	1.305E-06	0.0039515	8.78104E-05	14.95500807
7.5	5	1.5	2.99879	611920000	1.305E-06	0.0039515	8.78104E-05	13.20495394
7.5	5	2	2.81814	611920000	1.305E-06	0.0039515	8.78104E-05	12.40947479
12	3	∞	3.46848	611920000	7.833E-07	0.0023709	5.48815E-05	30.91078293
12	3	0.8	3.50461	611920000	7.833E-07	0.0023709	5.48815E-05	31.23277025
12	3	1.6	3.46848	611920000	7.833E-07	0.0023709	5.48815E-05	30.91078293

(e)

L (cm)	w (cm)	Distance (cm)	U (ms ⁻¹)	E (Pa)	B (Pa m ⁴)	M _L (kgm ⁻¹)	Mass ratio	Nondimensional velocity
7.5	5	∞	4.58851	611920000	1.305E-06	0.0039515	8.78104E-05	20.20517048
12	3	∞	3.72139	611920000	7.833E-07	0.0023709	5.48815E-05	33.16469418
5	7.5	∞	5.96145	2.394E+09	7.66E-06	0.0059272	0.000131716	7.224675045
6	12	∞	6.39501	2.394E+09	1.226E-05	0.0094835	0.000109763	10.18777885
10	4	∞	3.79365	611920000	1.044E-06	0.0031612	6.58578E-05	25.71912577
10	5	1	5.09433	611920000	1.305E-06	0.0039515	6.58578E-05	34.53711175
16	8	1	4.94981	611920000	2.089E-06	0.0063223	4.11611E-05	67.91527199
12	3	∞	7.226	2.394E+09	3.064E-06	0.0023709	5.48815E-05	32.55976277
7.5	5	0.5	5.34724	611920000	1.305E-06	0.0039515	8.78104E-05	23.54618293
7.5	5	1	4.87755	611920000	1.305E-06	0.0039515	8.78104E-05	21.47793713
7.5	5	1.5	3.17944	611920000	1.305E-06	0.0039515	8.78104E-05	14.00043309
7.5	5	2	3.07105	611920000	1.305E-06	0.0039515	8.78104E-05	13.5231456
12	3	0	3.72139	611920000	7.833E-07	0.0023709	5.48815E-05	33.16469418
12	3	0.8	3.79365	611920000	7.833E-07	0.0023709	5.48815E-05	33.80866883
12	3	1.6	3.75752	611920000	7.833E-07	0.0023709	5.48815E-05	33.4866815

Supplementary Table 1 Experimental data for fluttering behaviour (a) Single contact mode. (b) Double contact mode. (c) Chaotic mode. (d) Measurements with increased incoming velocity. (e) Measurements with decreasing incoming velocity.