Supporting Information

Voltage dependent properties of DNA origami nanopores

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1. Agarose gel analysis of purified DNA origami structure

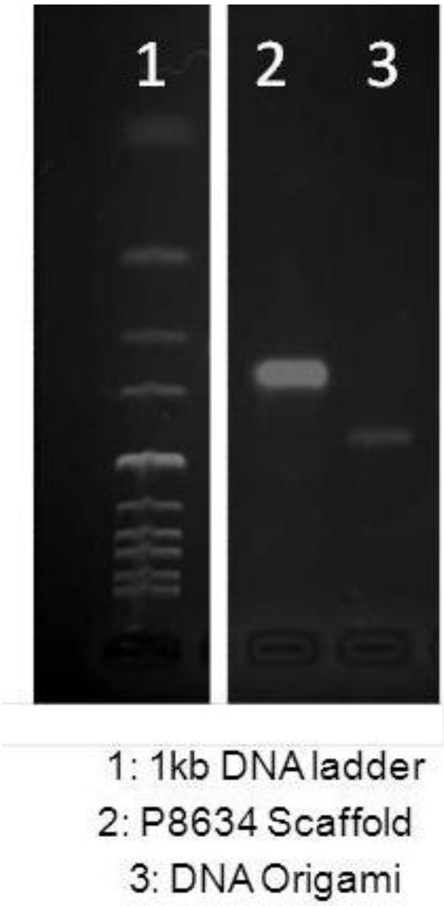


Figure S1. Agarose gel analysis of purified DNA origami structures. Structures were electrophoresed in 11 mM $MgCl_2$ solution buffered with 0.5 × TBE.

2. SEM image of a representative bare nanocapillary and histogram of the outer diameter

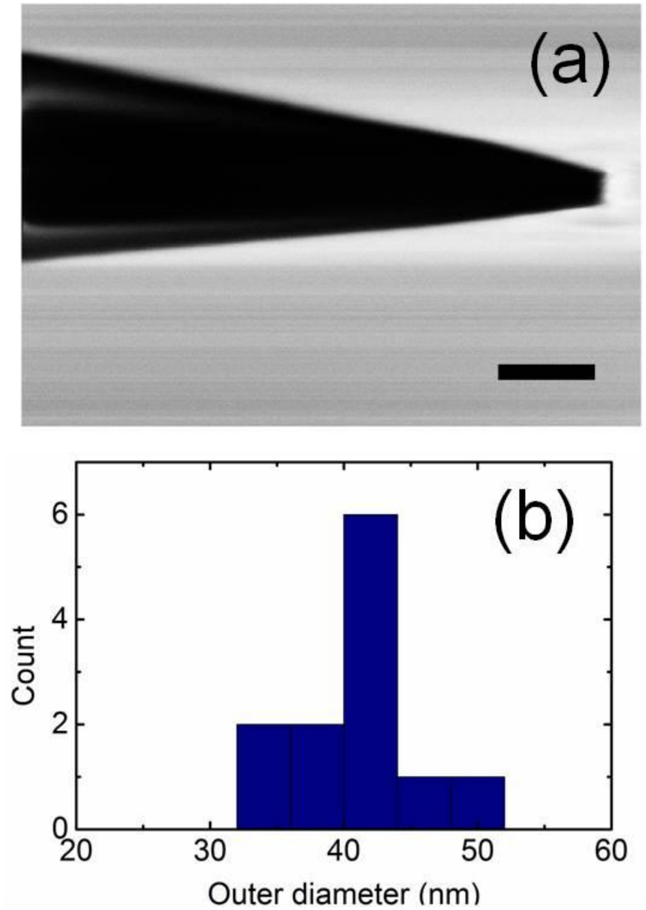


Figure S2. (a) Scanning electron microscopy image of a representative glass nanocapillary. Scale bar = 100 nm. (b) Histogram of the outer diameter of 12 nanocapillaries observed by SEM images. An outer diameter of mean 41 nm and standard deviation 5 nm was measured.

3. Examples of histograms of the percentage drop in ionic current produced by the DNA origami nanopore trapping at different voltages: leash design

Figure S3: Capillary resistance: 74 MΩ

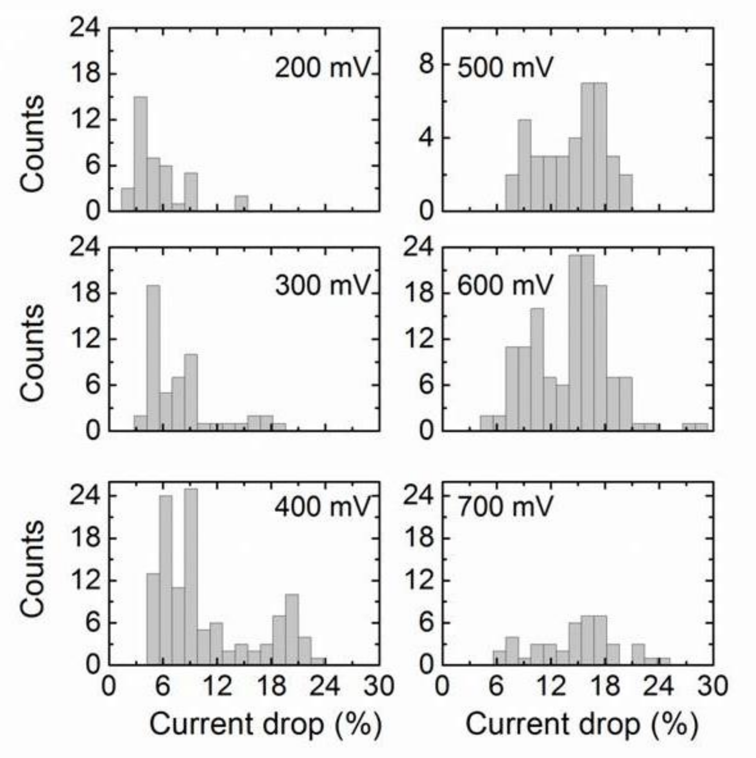


Figure S4: Capillary resistance: 64 MΩ

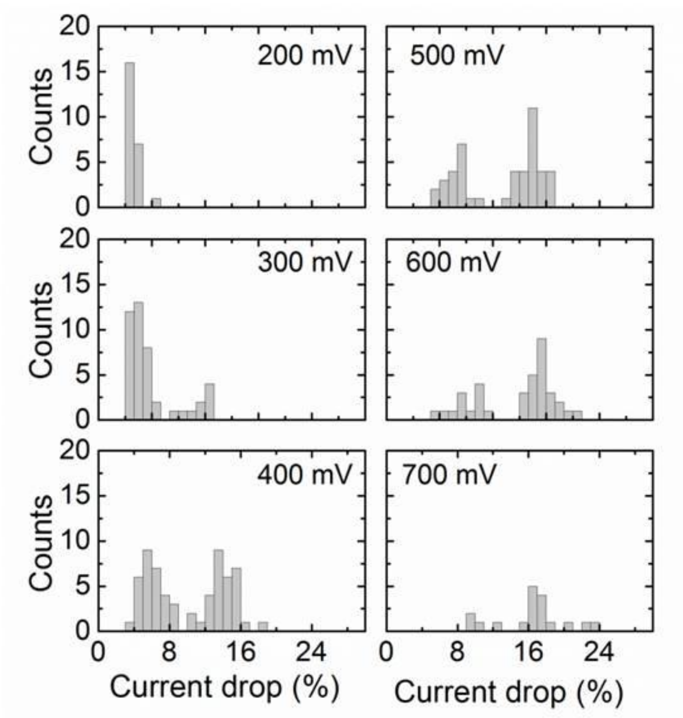


Figure S5: Capillary resistance: 61 MΩ

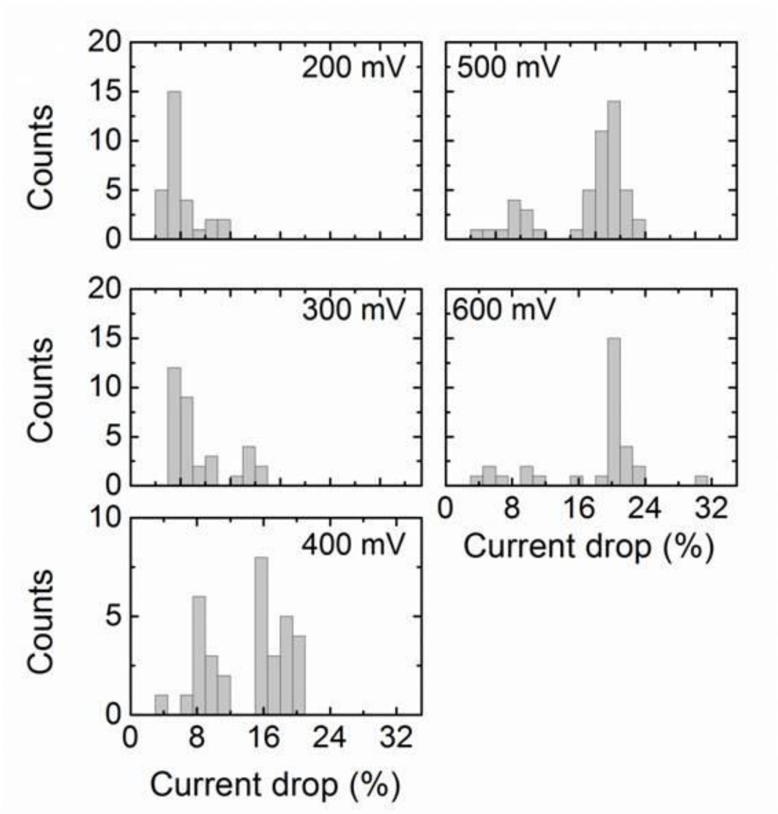
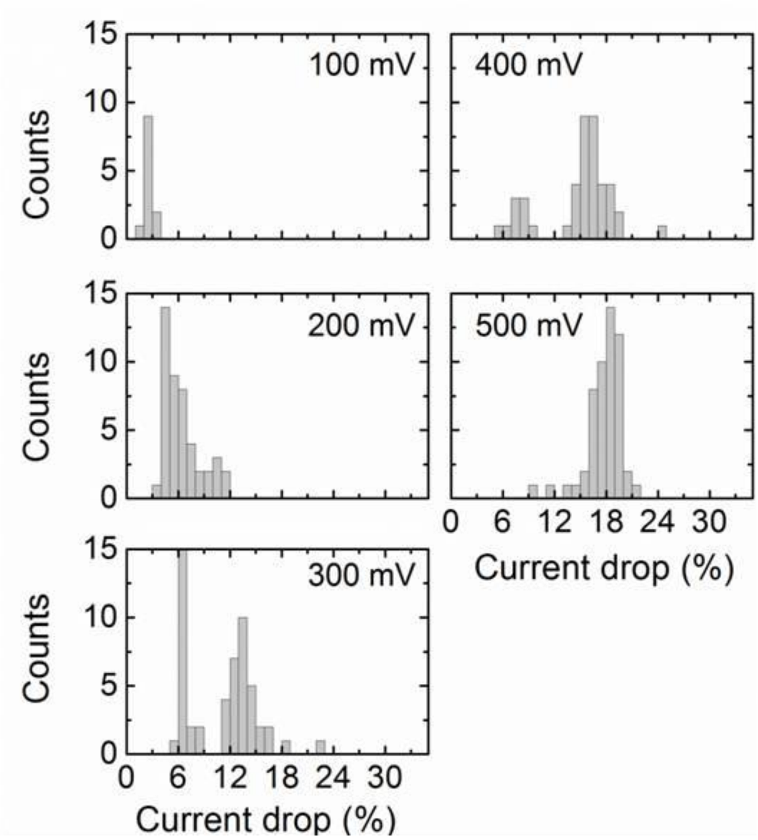


Figure S6: Capillary resistance: 43 MΩ



4. Attempt of trapping and translocation of DNA origami observed at low or high voltages

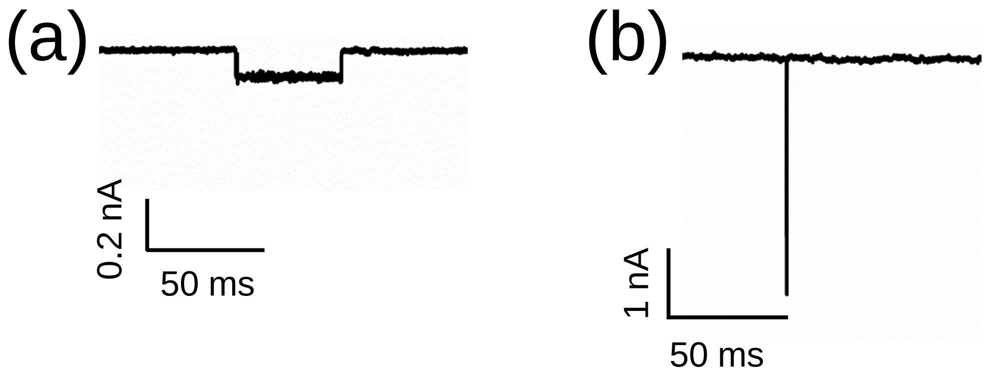


Figure S7. (a) Ionic current event showing the attempt of DNA origami trapping detected at 200 mV. (b) Ionic current event showing the translocation of DNA origami detected at 1000 mV.

5. Schematic representation of the analogous DNA origami structure without leash

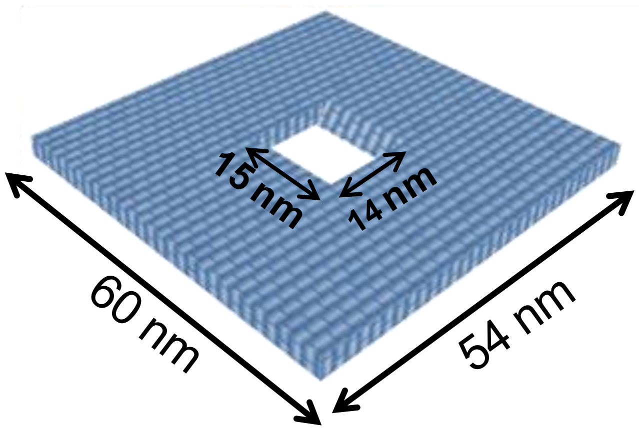


Figure S8. Schematic representation of the DNA origami structure without a leash.[1]

6. Examples of histograms of the percentage drop in ionic current produced by the DNA origami nanopore trapping at different voltages: no leash design

Figure S9: Capillary resistance: 80 MΩ

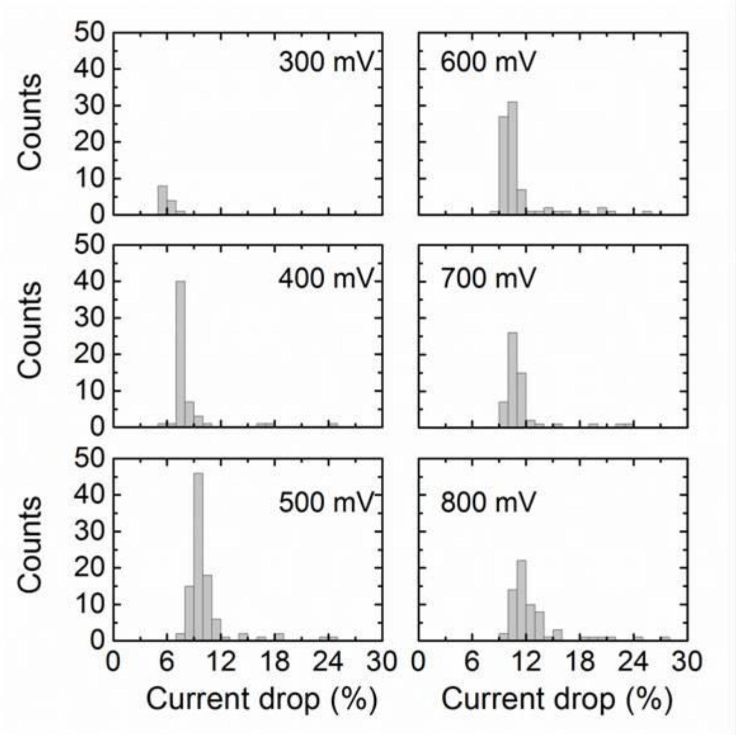


Figure S10: Capillary resistance: 65 MΩ

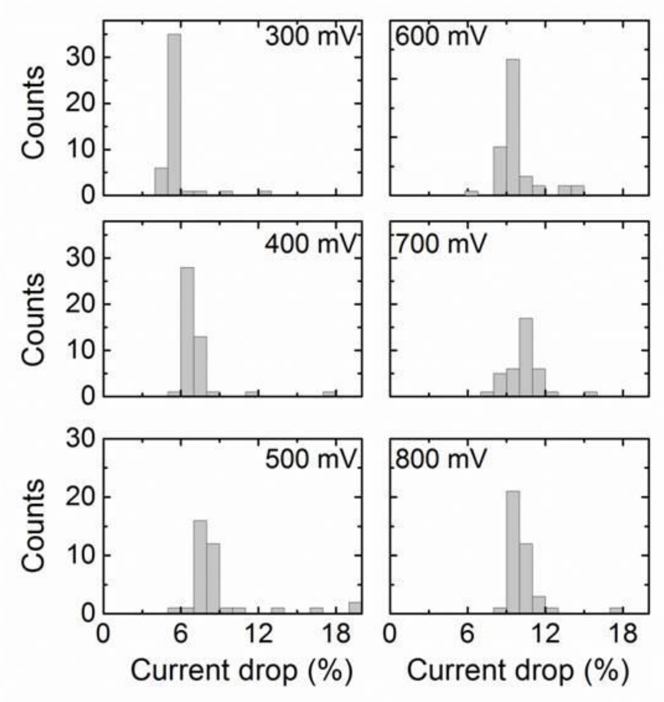


Figure S11: Capillary resistance: 56 MΩ

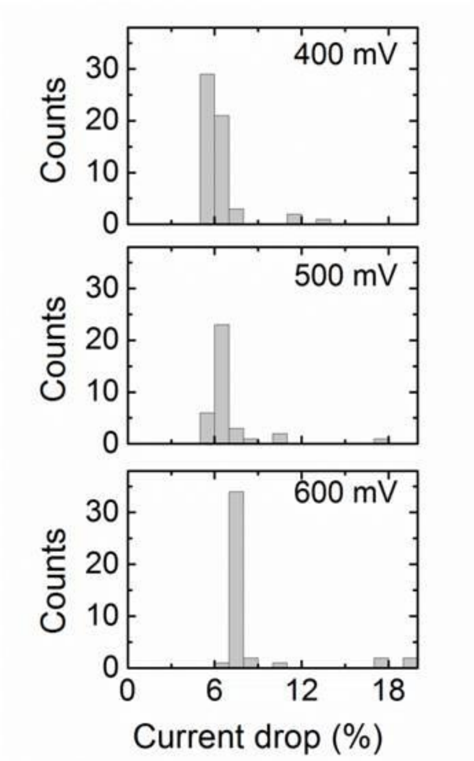
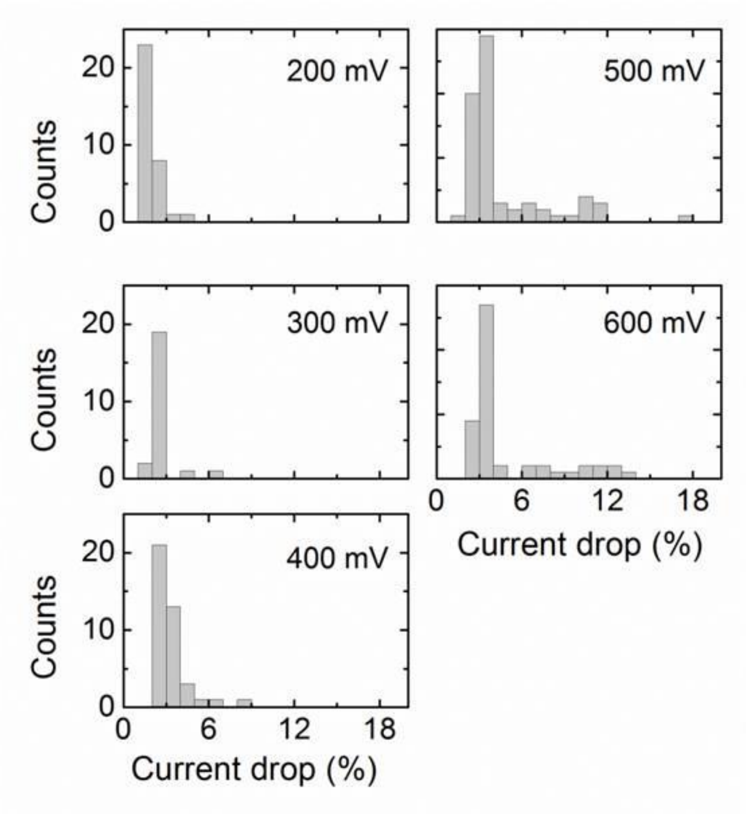


Figure S12: Capillary resistance: 51 MΩ



7. Ionic current traces and histograms of the λ-DNA translocations

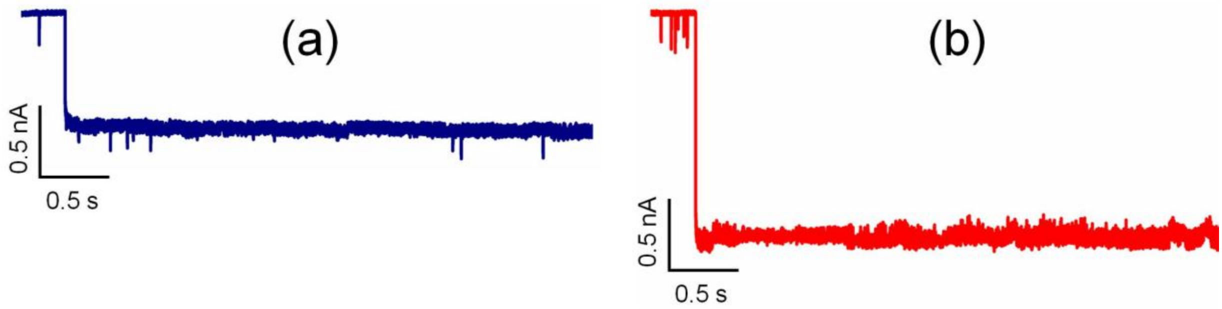


Figure S13. Example of an ionic current trace as a function of time upon applying 400 mV for an experiment with λ-DNA added. Initially some λ-DNA translocations through the bare nanocapillary are detected (see left part of the traces). The drop in ionic current indicates the formation of the hybrid DNA origami nanopore: (a) initial state (blue trace); (b) buckled state (red trace). Some λ-DNA translocations through the hybrid nanopore are observed in the case of the DNA origami nanopore with the initial state (blue trace, a). Capillary characteristics: resistance 59 MΩ.

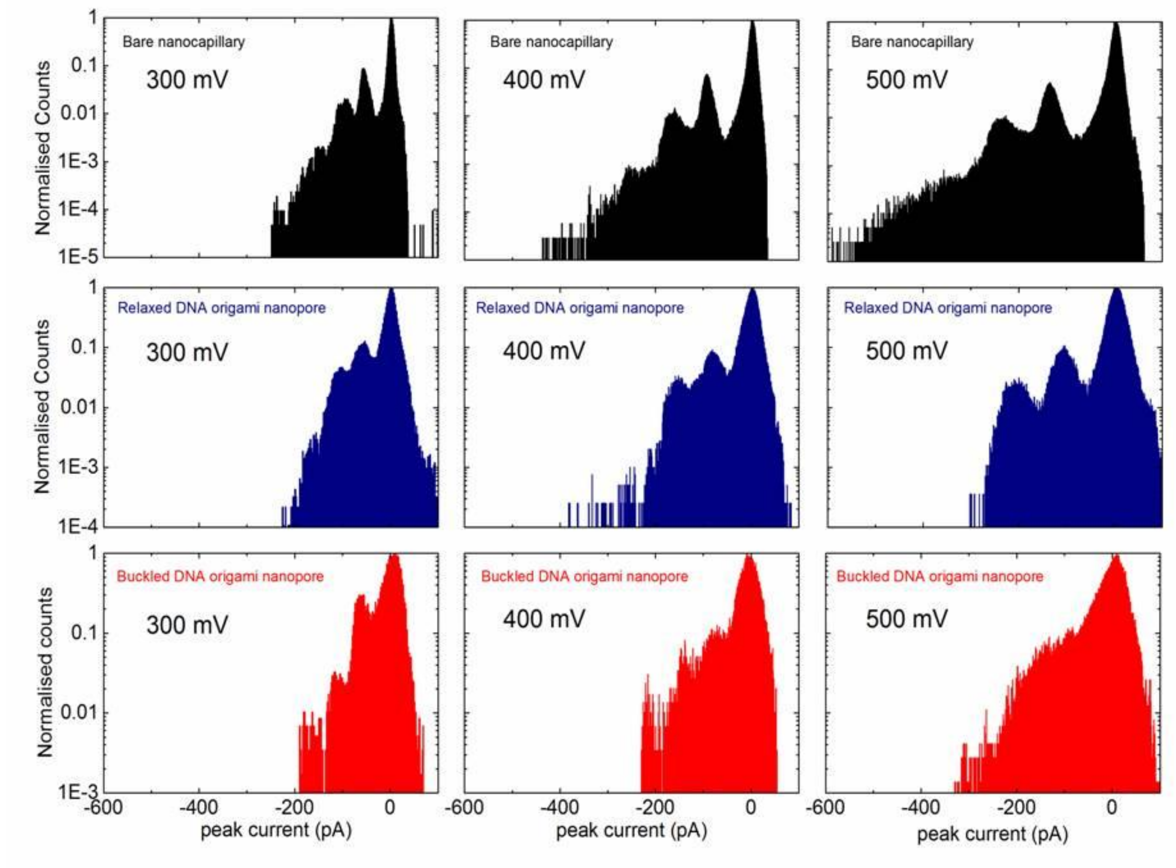


Figure S14. Histograms of the whole ionic current trace during λ-DNA translocations in the bare (black), the hybrid DNA origami nanopore in the initial state (blue) and the hybrid DNA origami nanopore in the buckled state (red) at different voltages. The existence of more than two peaks reveals λ-DNA folding.[2] Capillary characteristics: resistance 59 MΩ

8. Model for the DNA origami deformation

We model the DNA origami structure as an elastic sheet that is supported by circular boundary that represents the glass nanopore. The hole inside the nanopore is approximated as a perfect circle and thus the elastic sheet is an annular disk. The applied external electric field exerts a force on the DNA leash directed into the nanopore, and therefore, we assume that the leash is inside the nanopore. The leash is attached at the inner edge of annular disk where it exerts a force that deforms the elastic sheet. See figure S15.

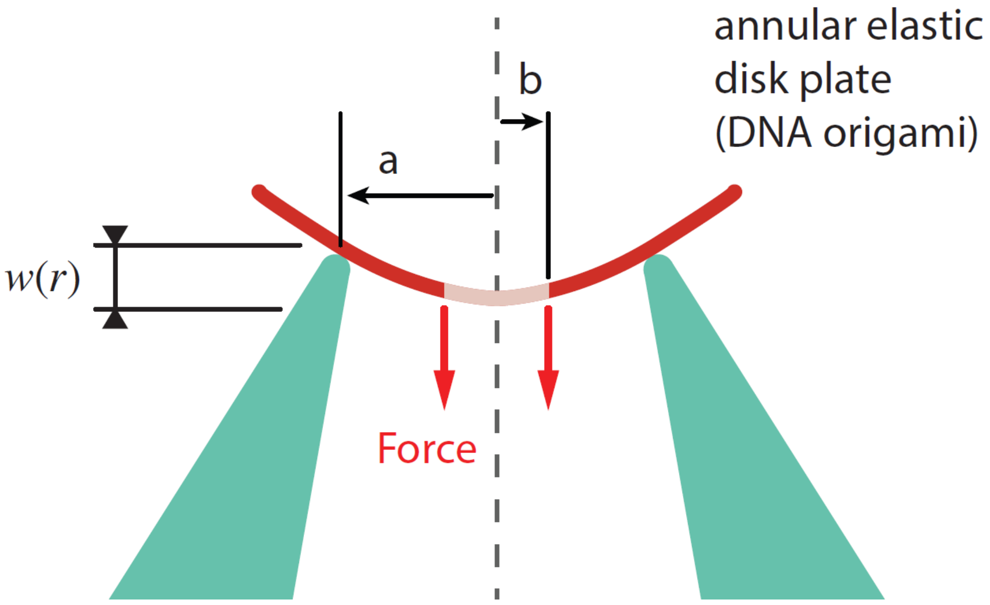


Figure S15. Model diagram. *w(r)* is the deformation of the sheet, a is the radius of the bare nanocapillary and b is the radius of the hole in the origami sheet.

The deformation *w(r)* of a thin isotropic elastic annular sheet that is supported at an outer edge is described by equation S1.[3]

Equation S1:

$$w(r) = \frac{F}{2\pi b}\frac{a^2 b}{4D}\left\{\left(1-\frac{r^2}{a^2}\right)\left[\frac{3+\nu}{2(1+\nu)} - \frac{b^2}{a^2-b^2}\log\left(\frac{b}{a}\right)\right] + \frac{r^2}{a^2}\log\left(\frac{r}{a}\right) + \frac{2b^2}{a^2-b^2}\frac{1+\nu}{1-\nu}\log\left(\frac{b}{a}\right)\log\left(\frac{r}{a}\right)\right\}$$

where F is the force on the leash, a is the radius of the bare nanocapillary, b is the radius of the hole in the origami sheet, D is flexural rigidity of the sheet, and ν is the Poisson's ratio.

Under this force, the stress σ_t on the sheet can be estimated using equation S2.

Equation S2:

$$\sigma_t(r) = -\frac{12z}{h^3}\, D\left(\frac{1}{r}\frac{\partial}{\partial r}w(r) + \nu\frac{\partial^2}{\partial r^2}w(r)\right)$$

where h is the sheet thickness and z is a vertical coordinate in cylindrical coordinate system.

We assume that this elastic deformation occurs until the sheet reaches a certain stress and undergoes a plastic deformation into the buckled state. This stress is maximum at $r = b$, as this is where the deforming force is applied (see equation S3).[Note 1]

Equation S3:

$$\sigma_t(b) = -\frac{12z}{h^3}\frac{F}{4\pi}\left((\nu-1) + (\nu+1)\frac{2a^2}{a^2-b^2}\log\left(\frac{b}{a}\right)\right)$$

Experiments have shown that the force needed for transition to the buckled state is proportional to the bare nanocapillary resistance. The resistance of the nanocapillary can be directly related to the radius of nanocapillary as given in equation S4.[2]

Equation S4:

$$a(R) = \frac{2l}{d_i \pi g}\frac{1}{R}$$

where l is the length of conical part of capillary, d_i is the size of the capillary at widest, g is specific conductance of buffer, and R is the resistance of the bare nanocapillary.

The force on the tethered DNA leash F is linearly proportional to the applied electric potential V_0.[4] The relation is $F = 2\kappa\ V_0$, where $\kappa = (F_0/V_0)$ is force per molecule normalized by the applied voltage. The factor 2 is because the leash is attached to the origami sheet from its two "ends".

Taking this into account, we rearrange equation S3 to get equation S5.

Equation S5:

$$V_0 = -\sigma_t(b)\ \frac{2\pi h^3}{12 z\kappa}\ \left((\nu-1) + (\nu+1)\frac{2a(R)^2}{a(R)^2 - b^2}\log\left(\frac{b}{a(R)}\right)\right)^{-1}$$
$$\equiv -\sigma_t(b)\ \frac{2\pi h^3}{12 z\kappa} f(R).$$

Equation S5 can be expressed in a simple manner as $V_0 = C_1\ f(R) + C_0$. Performing least squares fit for $V_0 = C_1\ f(R) + C_0$ to the experimental data gives a slope $C_1 = 1692 \pm 123$ (mV) and an offset $C_0 = -347 \pm 50$ (mV). The fitted model and the experimental data are shown in figure S16.

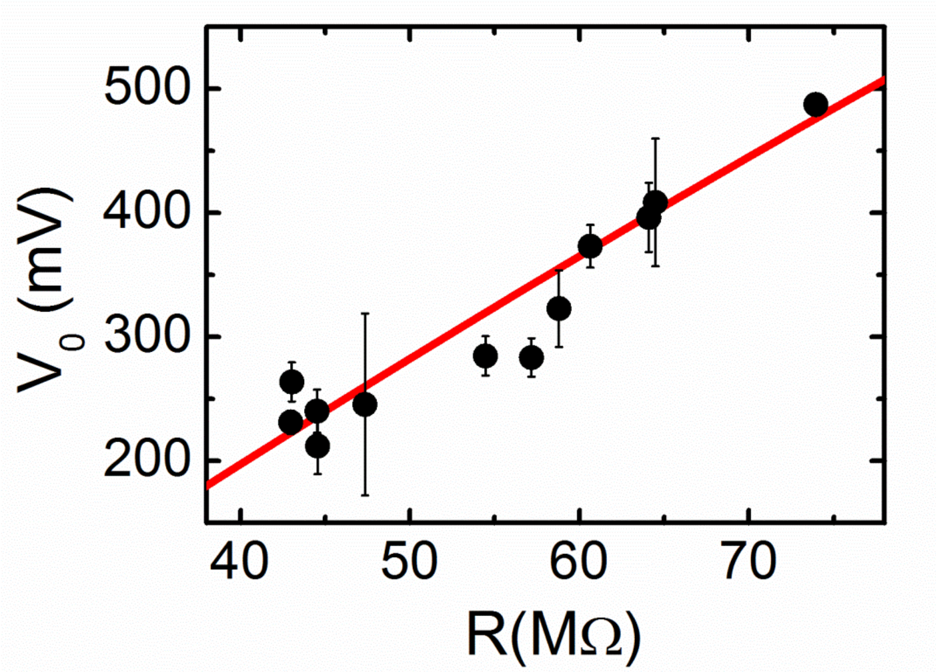


Figure S16. Model fit and experimental data. Black circles show experimental data. Red line shows model from equation S5. V_0 is the voltage required for obtaining an equal proportion of both conformations based on the experimental data and R is the resistance of the bare nanocapillary.

As observed in figure S16, equation S5 is almost linear in the range of interest (R) for a given b. From the fitted value we can estimate the maximum stress σ_t (b) using equation S6.

Equation S6:

$$\sigma_t(b) = -\frac{12\, z\, \kappa}{2\pi h^3} \times C_1$$

All the variables can be assessed from literature. Namely, the force on tethered DNA leash was estimated about $\kappa = 2 \pm 1$ pN/mV per DNA.[4, 5] As there are two strands, $F = 2\,\kappa\,V_0 = 4 \pm 2$ pN. The Poisson's ratio was chosen to be close to polymer/rubber type materials ($\nu = 0.4$).[6] It is worth to note that the model is not sensitive to small variations of Poisson's ratio. The height of the elastic sheet is estimated as h = 5 ± 1 nm, because it is composed of two DNA layers.[7] The effective inner diameter of the hole in the sheet is calculated from the area of the hole in the structure, $b = \sqrt{14 \times 15/\pi}$ = 8.2 ±1.6 nm.

The height at which the stress is measured must be somewhere around centre of one DNA molecule, thus z = 1.5 ± 0.3 nm.

Substituting all these values into the equation S6, we can roughly estimate the breaking stress σ_t (b) for our DNA origami structure, σ_t =77±64 MPa. This value is in the range of the flexural strength values exhibited by other well characterised polymers[8] such as poly-ethylene terephthalate (110 MPa), polycarbonate (93 MPa), Nylon 6 (97 MPa) or isotactic polypropylene (50 MPa).

9. Staple strands sequences and scaffold-staple layout for the DNA origami structure

The staples complementary to the scaffold part that forms the leash are marked in red

Start	End	Sequence
0[79]	45[71]	AAATCAAGTTTTTTGGAGGGAAGAGAAGAAAATGAGATGG
0[103]	45[103]	GCCCACTAGCGCTGGCAACTGGCTTGAATTAC
0[143]	45[135]	TCCAACGTCAAAGGGCGCAGGCGTAGCGTCCATCCCCC
0[175]	45[167]	GAACAAGAGTCCACTAGAAATCGGGAGGGGGTAACGAGAA
1[56]	47[71]	AGAAAGGAGGTCGAGGTCAGTTGAGATTTAGG
1[88]	47[103]	CGCTAGGCGTGAACCAATGCAGATACATAA
1[112]	47[135]	CGGTCGGTTTGCCCCAGAAAAACCGAGGCATAGTAAGAG
1[152]	47[167]	GTGGTTCCTTAAAGAACTCGTTTACCAGACGA
2[71]	43[71]	ACAGGGCGGCCGATTATAACAAAGCGGTGTAC
2[103]	43[103]	CCACCACAACGCCAGAAAGAACCGACCTTCAT
2[135]	43[135]	GCAGCAAGCTGCATTGGAAGCCCCTTCAAA
2[167]	43[167]	TTGCCCTTGAGGCGGTAGCAAAGCCAACAGGT
3[56]	46[56]	AACAGGAGCGTACTATATTGGGCTATCTACGT
3[88]	46[88]	GAACGGTCCCGCCGCATCATTGCATTATAC
3[112]	46[120]	AAGTGTGTCGTGCCAGCGGTCCACTTCATTGAAATACTGC
3[152]	46[152]	CGCGGGGACACCGCCTGTTCAGAAAATAGTAA
4[71]	41[71]	ACGCAAATTTGCTGGTTAGCCGGAATACCAAG
4[103]	41[103]	TGAGGCCACAGCCATTTGTCGAAATTTGTATC
4[135]	41[135]	GCTTTCCATGTTTCCATAATGCTGTACGGT
4[167]	41[167]	ACTCACATAATTCCACTTGCGGATCAGTTGAT
5[56]	44[56]	TATCGGCCTAACCGTTCAGATGAACTGCTCAT
5[88]	44[88]	TTACCGCCCGAGTAACTGGCTGGATATTCA
5[112]	44[120]	AAAAAATGGTCATAGCGTCGGGAAAATTCGAGGAAAGACT
5[152]	44[152]	CCGCTCACTAATTGCGGCAAACTCGGATTGCA
6[71]	39[71]	GGATTATTGACCTGAAACGAAGGCGGTAGCAA
6[103]	39[111]	ACCTACATCAATATTTCCATTAAAAAAGACTTTTTCATGA
6[135]	39[135]	CGAGCTCGAACCCAATTTCATTTACTAATA
6[167]	39[167]	CCGAGTCAGCGGGGATCGCAAATGTCATACAG
7[56]	42[56]	ACCCTTCTTACATTGGCAGCGATTACGAGGCG
7[88]	42[88]	GCACAGATTTGACGCACGGAGATCCGCGAC
7[112]	42[120]	CTATTATAGATGATTAAATTCGTACAACTAAAGTAGCTCA
7[152]	42[152]	TCGCACTCCAGGAGAACCATATAAGGCTTAGA
8[71]	37[71]	AAATACCGAGAGCCAGGCTTGCAGGACAACAA
8[95]	40[88]	TAGCCCTAGAGGACTCGGGTAAA
8[135]	40[120]	CCCTCTCTGTACAAAATCAATTCTGGGGCGCG
8[167]	37[167]	ATTATCACATAAGTCTAGCTAAATTATTTCAA
9[56]	40[56]	CCACGCTGAACGAACCGGAACGAGACCAACCT
9[139]	40[152]	ACAAATATTCCATGAAGGTTTGAGTACGGCCAATAAAGTCAATAA
10[84]	35[71]	ATCTAAAGCATCACCTTGCTGTATCTAAATATCGGTTCCGAACAA
10[167]	35[167]	AGATGAAGGGCGTTATCTGAGTAACATCAATA

11[56]	38[56]	AGGAAGGTAACCTCAACGACAATGGAGTTA
11[139]	38[152]	AGAGTCTGAGCAAAAAGATTGGTATAGATAAGCCTTCGGTTGT
12[84]	33[71]	CACTAACAACTAATAGATTAGTCCTTTGCAAGAGCAATAATATCA
12[167]	33[167]	AGGAGTTTTATTATCTATTTTTGAGAATCGAT
13[56]	36[56]	GTATTAAAAGCCGTCACAGATAGTATCAGC
13[139]	36[152]	GTACTCAAACATCGGGTTGAGATAAATGAAAATCACTGTGTAG
14[84]	31[71]	ATTTTAAAAGTTTGAGTAACACAATTCATAAAACAGGTATTATTT
14[167]	31[167]	GCCAGAGTTGAGATCGTAATCAGACTCATTTT
15[56]	34[56]	GATGATGGTTATCATTTGAGCGCGAAACAA
15[96]	31[103]	TTATACTTAAATAGCATTTTTTGT
15[120]	31[135]	CATATGATGTCTGACGTATAAGCTAAAATT
15[152]	34[152]	AAGGAGAGCTGTAGTGAACAAGAGAGATCT
16[71]	29[71]	AATAAAGAACGGATTCTATCCTGAAGGCGTTT
16[103]	29[103]	CCATATCATTACAAAATTAGTTGCAGGTTTTG
16[135]	29[135]	TCAGGATGAAGACTCGAGTAACAGATTGAC
16[167]	29[167]	ATCGCTATACCTGGAATAGCCAGCGTAGATGG
17[56]	32[56]	AAACAATAAATTGCGTAACAGCCAGAAGCGCA
17[88]	32[88]	TACCAAGAAATTATTGAAACGAGCCTTTAC
17[112]	32[120]	AGGCGGCCATCCTGGGCAGGTGAGTATTTTGTAAATATTT
17[152]	32[152]	CACTGGTGTACGGGGTTAAATCAGAAAGCCCC
18[71]	27[71]	AACATCAATATGTGAGGTAGGAATGGCTGTCT
18[103]	27[103]	AATTACCTCGTCGCTACGAGAACATATTAAAC
18[135]	27[135]	AACCAGTTAACTGCGTTCCGGCACATTCGC
18[167]	27[167]	ACTGGAAAAAAACTCACGGCCTCAAAGGGCGA
19[56]	30[56]	AATCAATAGAAAACAAAGAACGCGATCTTACC
19[88]	30[88]	TGTAAATGAGCAAAATTGCGGGTATTTTGC
19[112]	30[120]	TTTTCAACAGTAGGGATCTTGTTGAAACGGCGACCCGTCG
19[152]	30[152]	GCAAAATCGCAACGAAACGTTGGTTTTCATCA
20[71]	25[71]	TGAGAAGAAACTATATATAGATAATACCGACA
20[103]	25[103]	GAAAACATCGCAAGACAGCTAATGACGACGAC
20[135]	25[135]	AGAACGAGGCAGGCAGGTTTTCCCAAGCTT
20[167]	25[167]	AACCAGCAGCAGACCTGCTGCAAGGTATTAAC
21[56]	28[56]	GGTTATATGTCAATAGCAATAATCCATTACCG
21[88]	28[88]	ATCCAATAGCGATAGGAACGGGAGCAAGCC
21[112]	28[120]	CGAGAGAAGCGGCAGAGATATTGCCAAAGCGCCCGCTTCT
21[152]	28[152]	GATTTGACATACATCACTGTTGGGGGAAGATC
22[71]	24[56]	AATTTAATAGCCTGTTCGCCATATTTAACAAC
22[103]	23[111]	TATATTTTTTCTTACCAGTATAGG
22[135]	24[128]	TAACTCTCTTGTTGTCAATAAAA
22[167]	24[160]	AGTAAACACGAAGACGTCAGAAAT
23[56]	26[56]	CTAGAAAAGGTTTGAAATATAAAGGTCCTGAA
23[88]	26[88]	ATACAAAAGTTAATTTGTCCAGCAGAACGC
23[112]	26[120]	CTATATCTGCCACTCAAGGCACTGGCCAGTGCCAGTCACG
23[144]	26[152]	CGATCCGATAGATGAAGAGAGGTTCCTCATGCGCGATTAA
24[55]	21[55]	GCCAACATATAAGAGAATACCGACTTAGGTTG

24[95]	21[87]	AACAGTAGGGCTTAAAGTAATTCTCATCTTTGATGCAA
24[127]	22[104]	ATGCGCCGCCTGAACCAAACGACGCGTAAACTTTTTCAAA
24[159]	21[151]	AGAAGAATTACAGCGGCATTCACCGAAGTGCGACTGGG
24[186]	21[191]	AGACATCATTGCAGGGATTGGATCTGGAATTGGTAACACCATC
25[37]	23[55]	TCGAGCCAGTAGTAATTTAACCGGAATCATAATTA
25[72]	23[87]	AAAGGTAATTGAGAATTAGTATCATATGCGTT
25[104]	24[96]	AATAAACAACCAAAGCCAACGCTC
25[136]	23[143]	TATTATTCCAACACAGGAGTGTGG
25[168]	23[191]	CAACAGTTATTCAGCACCTGGTCGTTCAGGGTTGTCGGAC
26[55]	19[55]	CAAGAAAAAAACCAATTGAATTTAAGTACATA
26[87]	19[87]	GCCTGTTCATTCCAACTTAGATCTTGCTTC
26[119]	20[104]	ACGTTGTAAAACCAGGGCTCCTTAGAATCCTT
26[151]	19[151]	GTTGGGTCTGCGCAAAACGCCGTTGAAACA
26[186]	19[191]	GCTGGCGAAAGGGCCTCTTGGATGAACCGTGAGTATTACGAAG
27[37]	22[33]	CGAGCATGTAGATAATATCCCTCCGGCCGTGTGATAAATAAG
27[72]	22[72]	TTCCTTATTATCAACAGTAAATGCCTGACCTA
27[104]	21[111]	CAAGTACCACATGTTCAAAGAACG
27[136]	22[136]	CATTCAGGAACGCCAGATGCATGAAGCGAAAT
27[168]	22[168]	TCGGTGCGGGGGATGTTTTCCATGAACTTATC
28[55]	17[55]	CGCCCAATGTATTCTAAATTAATTATCGGGAG
28[87]	17[87]	GTTTTTACTCCCGACGAAGATGGCTTTGAA
28[119]	18[104]	GGTGCCGGGTGGGAACTTCAATTATTCATTTC
28[151]	17[151]	GCACTCCGATAGGTCGTCCGTGAAGCACTG
28[186]	17[191]	GAGGGGACGACTAACCGTGGTAAGCGTGCGGCAGTTAATCGAA
29[37]	20[33]	AGGCTTATCCGAGCAAGCAATGGAAACTCAAAATCATAGGTC
29[72]	20[72]	TAGCGAACTTTTCATCTGAATAACTAAGACGC
29[104]	19[111]	AAGCCTTAGCACTCATTTAATTAA
29[136]	20[136]	CGTAATGGAGCCAGCTTGTTGAGCCGACCAGG
29[168]	20[168]	GCGCATCGGACAGTATACGAGCAGGGGAAAGA
30[55]	15[55]	AACGCTAAACAAAATAAGATTTTCGATTATCA
30[87]	15[95]	ACCCAGCCCAAATAATGCACGTTCCTGATTGTTTGGA
30[119]	16[104]	GATTCTCCAACGTTAATATGGGTTAGAACCTA
30[151]	15[151]	ACATTAAATTTTTGTTGGAGGTTCGCATCA
30[186]	15[191]	TTCGCGTCTGGTAGGAACGATCGACATAAAGATAACGCTTGTG
31[37]	18[33]	ATTTGCCAGTTCGAGCGTCCCTTTTACACATTTAACAATTTC
31[72]	18[72]	ATCCCAATTACAATTTGCCTGATTATGAAACA
31[104]	17[111]	TTAACGTCAATCAAGATCGCGCAG
31[136]	18[136]	CGCATTAAATGTGAGCCTGTTATCAAGACGGA
31[168]	18[168]	TTAACCAACCTTCCTGGAGTTTCTATTGCTAA
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32[151]	14[139]	AAAAACACTGGAGCATCAGATGATGACC
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33[37]	16[33]	AACAAAGTCAGGAGAATTAATATTCCTAGGTTTAACGTCAGA

33[72]	16[72]	GAGAGATAATAACATACAATATAAAAAACAGA
33[133]	16[136]	TGCCTGAGAGTGGAAGATTGCTGGCATCAATGGGT
33[168]	16[168]	GAACGGTACCGGTTGAGTTTTGTACATTACGC
34[55]	11[55]	TGAAATAGAAAGTAAGATAGATAAAGGAATTG
34[90]	35[90]	TTGAGTTAAGCGAAGGAAACCG
34[151]	12[139]	ACAAAGGCAGACAGTCGTATCAATGAGTT
34[186]	11[191]	AATGCCGGAGAAACCGTTCAACGACATTGCAGATCCGGTGTCT
35[37]	14[33]	CCTTTTTAAGACAATAGCTAACAATTCCAAAGAAACCACCAG
35[72]	13[84]	AGTTACCACCAATAATCCGAACGTTATTA
35[133]	34[133]	AGAAAGGCCGGTATCAGGTCAT
35[168]	14[168]	TGATATTCGGGTAGCTTACTGTTTACAGCGAT
36[55]	9[55]	TTGCTTTCAGTTGCGCATATCAAACAACAGTG
36[88]	37[90]	AAAGGAGCCCACGCATAACC
36[151]	10[139]	GTAAAGATTGCGGGAGATAGAGTCGGCAT
36[186]	9[191]	TATATTTTAAATAAAAATTACGAAGGTCAAATCCCCATTCTGC
37[37]	12[33]	TTGATACCGATGAGGTGAACAGTTGAATACATTTGAGGATTT
37[72]	11[84]	CCATCGCCTTTAATTGATATCTTTAGGAG
37[133]	36[133]	TGTAATACTTTTCAAAAGGGTG
37[168]	12[168]	CGCAAGGATGCAATGCCAATGTTGACATTGCA
38[55]	7[55]	AAGGCCGCACAGCATCACCAGCAGGAGATAGA
38[90]	7[87]	GATATATTCGGGAGGCTTTAAACATCAATACGTG
38[151]	7[151]	ACCAAAAAATTAACATTGGAAACAACAATCC
38[186]	7[190]	ATAAAGCCTCAAAGAATTAGATACCGTTCTGAACTCGCTACG
39[37]	10[33]	AGCAGCGAAAGTTTTGCGGACCGCCTGCCCTCAATCAATATC
39[72]	9[84]	CGGCTACATCGCTGAGCAGCAAATGAAAA
39[112]	8[96]	AGGTGGCACATAGTCTTTAATGCGCGAACTGA
39[136]	38[133]	GTAGTAGCCATTATGACCC
39[168]	10[168]	GCAAGGCAGAGCATAAAATGAAGAGTTTATGT
40[55]	5[55]	AAAACGAATTGACCCCCAGATTCAACTCAAAC
40[87]	5[87]	ATACGTAAAAGTACATCAATCGGAACAATA
40[119]	6[104]	AGCTGAAATAAATATGATCCGCTCATGGAAAT
40[151]	5[151]	CCTGTTTGTTTCATTTGGATCCATTGTTAT
40[186]	5[190]	TTGACCATTAGCTGCGAACGATGATAACGAGCCGGAAGCATA
41[37]	8[33]	AACACTCATCTAGAGGCAAGGCCAACAAAGATAAAACAGAGG
41[72]	8[72]	CGCGAAACATGCCACTAGCGTAAGGCCATTAA
41[104]	7[111]	ATCGCCTGGGAAGTTTTTGAATGG
41[136]	8[136]	GTCTGGAAAGCTATATTATTACATGATACTTG
41[168]	8[168]	TCCCAATTATACATTTTTATTTTAGCAAAATT
42[55]	3[55]	CAGACGGTAAAGAGGAGTAGCAATGGGAGCTA
42[87]	3[87]	CTGCTCCCGCATAGGAAGAGTCTTAGACAG
42[119]	4[104]	ACATGTTTCGCGTTTTACCTTTTTATAATCAG
42[151]	3[151]	GCTTAATGACCGGAATTGCGCTGGCCAACG
42[186]	3[190]	TTTTGATAAGAGAGAGTACCCTAATGATGGGCGCCAGGGTGG
43[37]	6[33]	GACCAACTTTGCAATCATAGTAGAAGACCAGTCACACGACCA
43[72]	6[72]	AGACCAGGATGTTACTAATATCCATCTGAAAT

43[104]	5[111]	CAAGAGTAATAAATTGGCAACAGG
43[136]	6[136]	GCGAACCATGCTGAATTGTGTGAACCGGGTAC
43[168]	6[168]	CAGGATTAGGTCATTTACAACATAATGCACTT
44[55]	1[55]	TCAGTGAAAGTAGTAAGGTTGCTTACGTGGCG
44[87]	1[87]	TTACCCACAACTTTAGCTTAATGGAGCGGG
44[119]	2[104]	TCAAATATCATAAATAGCTACGCTGCGCGTAA
44[151]	1[151]	TCAAAAATTTAAACAGGCCCTGGTTTGATG
44[186]	1[190]	CCTGACTATTAAATCAAAAGACGGGCACTTATAAATCAAAAG
45[37]	4[33]	ACACCAGAACGTAAGGCTTATCAGAGCACTTCTTTGATTAGT
45[72]	4[72]	TTTAATTTAATCAACGAAGGGATTTGTCCATC
45[104]	3[111]	CTTATGCGATCTTGACATCCTGAG
45[136]	4[136]	TCAAATGCGATTAAGAAATGAATCCACTGCCC
45[168]	4[168]	TGACCATATAGTCAGATTGCGTATGTGAGCTA
46[55]	0[33]	TAATAAAAAAGATTCATGCCGTAAAGCACTAAATCGGAA
46[87]	0[80]	CAGTCAGATTCAACTATCACCC
46[119]	0[104]	GGAATCGTGGAATTACGTCTATCAGGGCGATG
46[151]	0[144]	AATGTTTTCATAACCCGTGGAC
46[186]	0[176]	TGCAAAAGAAGACCAAAATCCAGTTTG
47[37]	2[33]	TTACAGGTAGACGAACTAAGCCGGCGATGACGAGCACGTATA
47[72]	2[72]	AATACCACGACGTTGGAAGCGAAAGCGCCGCT
47[104]	1[111]	CGCCAAAAAATTTTAAGAAGTGTAG
47[136]	2[136]	CAACACTAAGACTGGAAAAATCCTAGAGAGTT
47[168]	2[168]	CGATAAAATTTTGCCACAAAATCCACAGCTGA
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		ACAAATAAATCCTCATTAAAGCCAGAATGGAAAGC
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		ACATGGCTTTTGATGATACAGGAGTGTACTGGTAA

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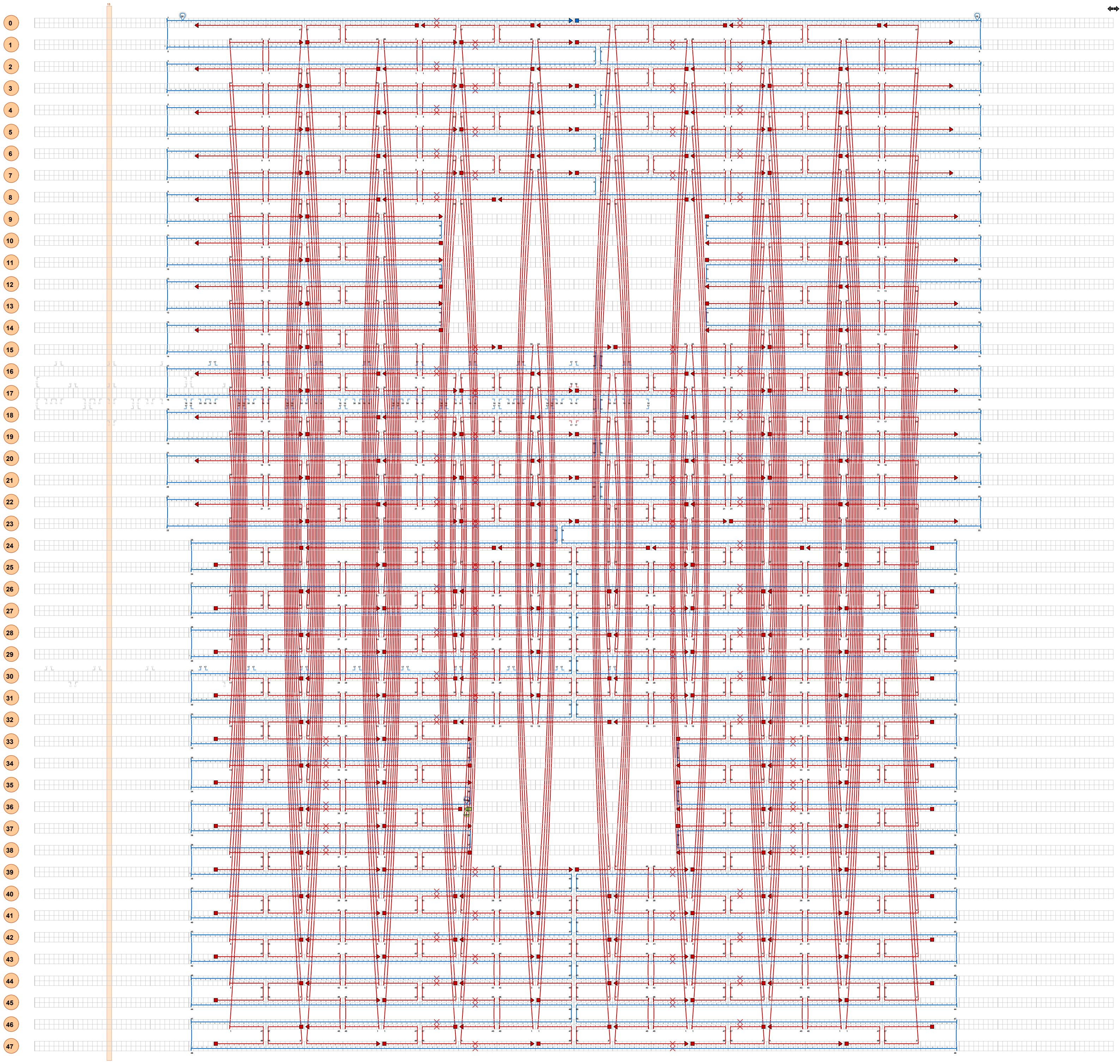
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Notes and references

(Note 1) The sheet has four stress tensor components: σ_r, σ_t are normal stresses in plane and tangential components, τ_{rt} = τ_{tr} = 0 shear stress components are zero due to assumed radial symmetry. The σ_r component was also investigated, but it did not produce observed behaviour

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