

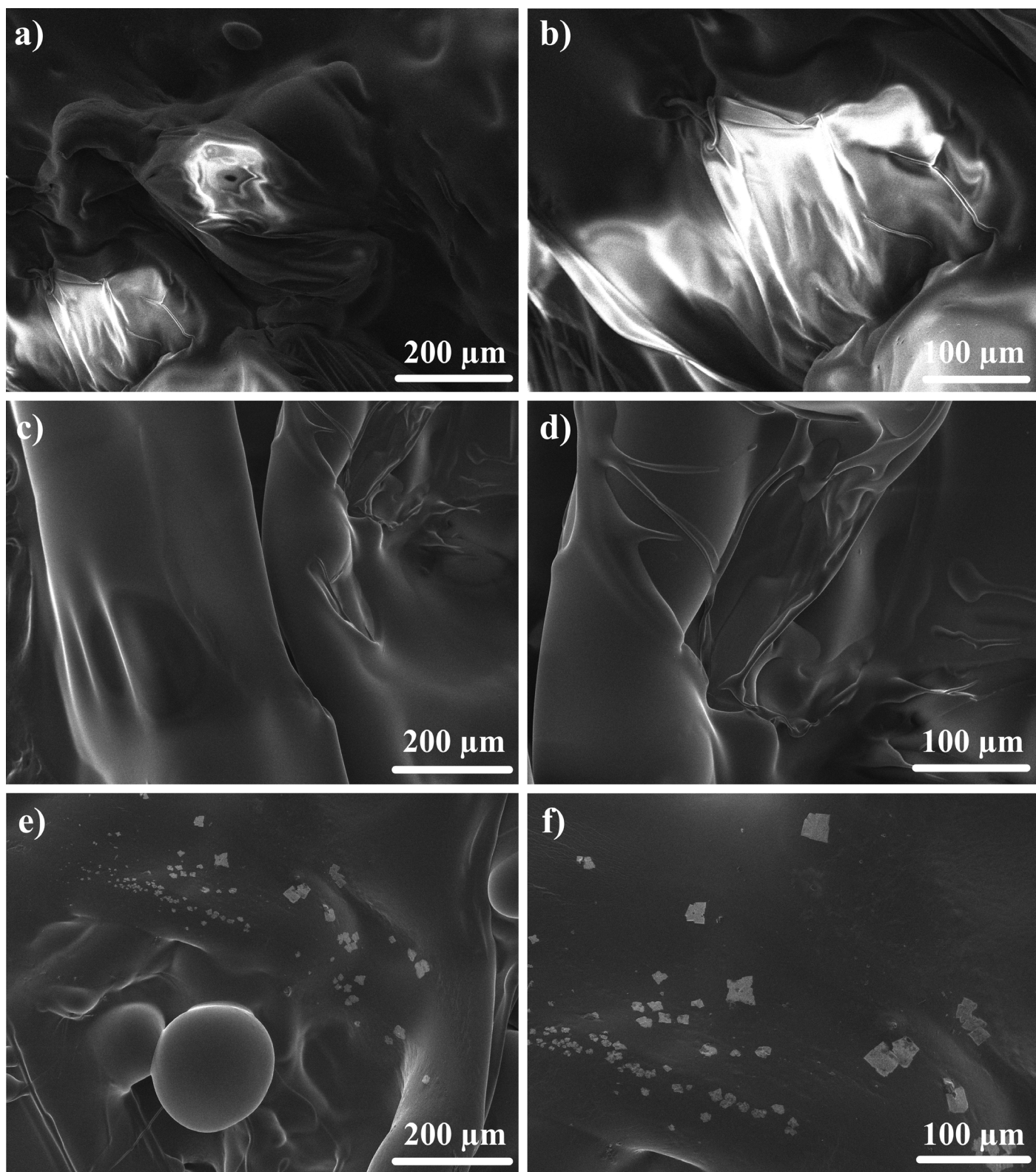


Figure S1. SEM images of the internal structure of PVA/LiCl hydrogels: (a, b) PVA, (c, d) PLi1, (d, f) PLi4.

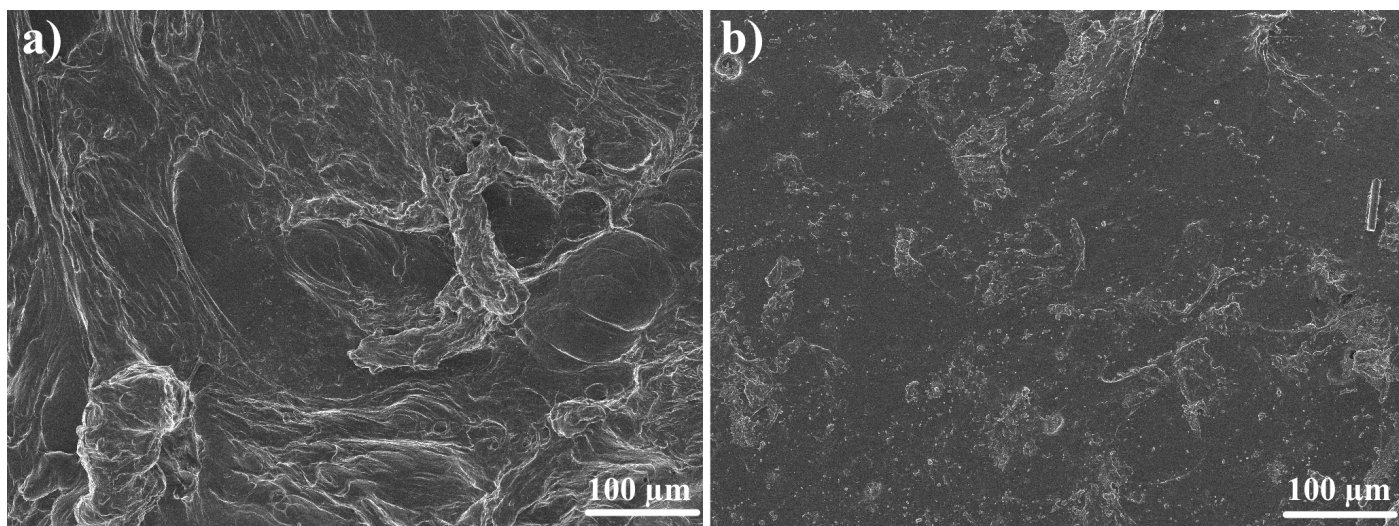


Figure S2. SEM images of the internal structure of PVA/NaCl hydrogels: (a) PNa1, (b) PNa4.

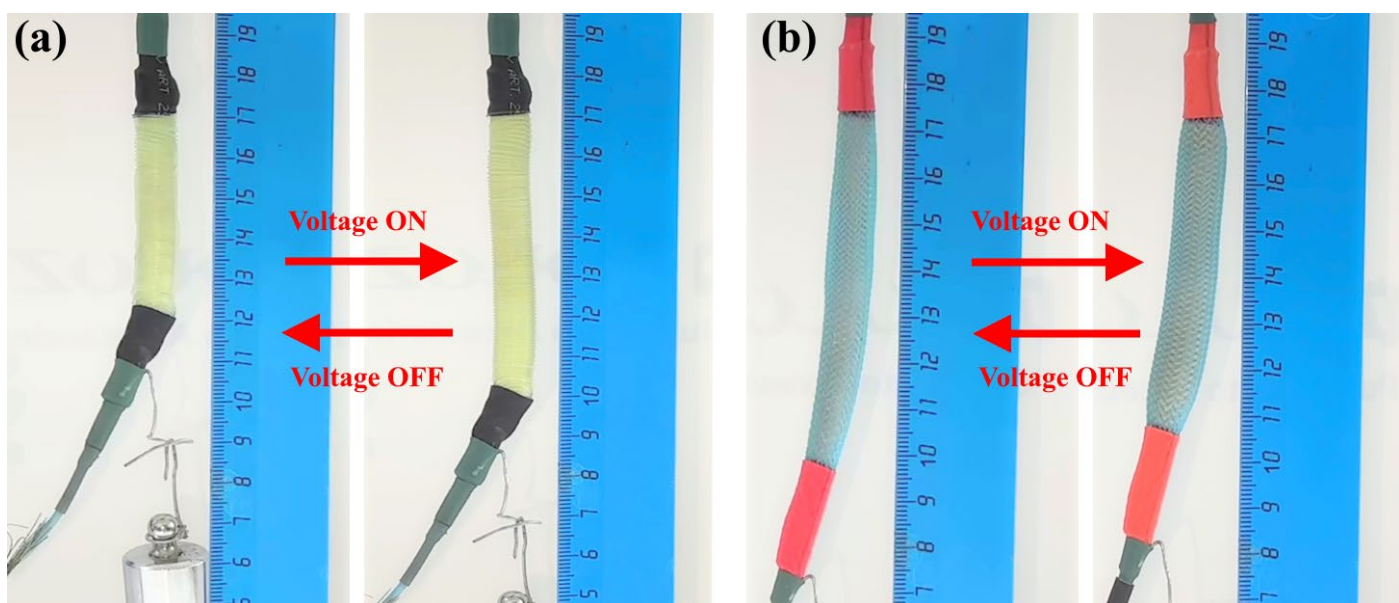


Figure S3. Working mechanism of linear actuators based on PVA/salt hydrogel reinforced by (a) spiral weave and (b) woven mesh braided.

Table S1. Extension, activation and relaxation values for hydrogel actuators of PNa1.

Voltage, V	20		30		60		90		110	
Frequency, Hz	50	500	50	500	50	500	50	500	50	500
Deformation, %	Low voltage	Low voltage	Low voltage	Low voltage	33.01 ±1.10	38.17 ±0.10	44.20 ±1.20	57.32 ±0.73	44.40 ±2.20	63.73 ±0.60
Activation time, sec	-	-	-	-	11.03 ±0.65	8.42 ±0.29	4.99 ±0.57	6.30 ±0.20	3.86 ±0.80	4.54 ±0.16
Relaxation time, sec	-	-	-	-	6.06 ±0.41	8.57 ±0.07	5.01 ±0.52	7.54 ±0.49	4.43 ±0.37	6.81 ±0.22

Table S2. Extension, activation and relaxation values for hydrogel actuators of PNa2.

Voltage, V	20		30		60		90		110	
Frequency, Hz	50	500	50	500	50	500	50	500	50	500
Deformation, %	Low voltage	Low voltage	Low voltage	22.52 ±0.23	34.51 ±0.52	47.63 ±1.08	54.59 ±0.75	56.93 ±0.44	54.62 ±0.78	65.32 ±0.62
Activation time, sec	-	-	-	9.32 ±0.13	8.22 ±0.15	6.75 ±0.03	4.77 ±0.48	4.29 ±0.12	2.86 ±0.12	3.67 ±0.13
Relaxation time, sec	-	-	-	2.78 ±0.07	3.65 ±0.20	7.82 ±0.10	5.40 ±0.45	6.87 ±0.08	3.01 ±0.29	5.12 ±0.13

Table S3. Extension, activation and relaxation values for hydrogel actuators of PNa3.

Voltage, V	20		30		60		90		110	
Frequency, Hz	50	500	50	500	50	500	50	500	50	500
Deformation, %	Low voltage	Low voltage	31.07 ±1.60	32.9 ±0.40	40.98 ±0.38	50.85 ±0.45	67.24 ±2.67	73.51 ±0.21	57.4 ±2.23	68.21 ±1.11
Activation time, sec	-	-	9.81 ±0.11	15.52 ±0.13	3.78 ±0.11	7.93 ±0.11	4.17 ±0.13	5.19 ±0.34	2.86 ±0.33	4.30 ±0.52
Relaxation time, sec	-	-	7.47 ±0.34	7.61 ±0.49	5.16 ±0.59	4.45 ±0.49	7.18 ±0.35	9.14 ±0.92	5.63 ±0.15	8.82 ±0.82

Table S4. Extension, activation and relaxation values for hydrogel actuators of PNa4.

Voltage, V	20		30		60		90		110	
Fre- quency, Hz	50	500	50	500	50	500	50	500	50	500
Deformation, %	17.10 ±8.60	22.30 ±1.01	38.27 ±0.45	38.70 ±2.60	43.74 ±0.33	47.43± 2.38	62.70±0. 67	75.46±1. 96	55.34±1. 45	63.72±1. 98
Activation time, sec	6.62± 3.37	9.93± 0.43	6.54± 0.18	7.38± 0.92	1.93± 0.01	3.65±0 .75	1.78±0.0 3	1.61±0.2 9	1.29±0.0 2	1.37±0.3 6
Relaxation time, sec	2.76± 1.13	3.86± 0.28	2.77± 0.44	4.67± 0.57	2.56± 0.19	5.53±0 .47	3.13±0.0 5	3.59±0.8 1	4.81±0.4 9	4.10±0.1 8

Table S5. Contraction, activation and relaxation values for hydrogel actuators of PNa1.

Voltage, V	20		30		60		90		110	
Fre- quency, Hz	50	500	50	500	50	500	50	500	50	500
Deformation, %	Low volt- age	Low volt- age	Low volt- age	Low volt- age	7.21± 1.54	12.48± 1.32	8.72±0.7 9	13.76±2. 61	10.38±0. 87	15.94±1. 76
Activation time, sec	-	-	-	-	9.80± 0.65	9.50±4 .447	5.30±1.1 0	4.60±1.9 4	4.80±0.5 4	3.02±0.3 8
Relaxation time, sec	-	-	-	-	17.90 ±3.75	7.79±1 .73	12.40±2. 50	8.03±4.5 5	13.40±1. 45	5.52±1.1 7

Table S6. Contraction, activation and relaxation values for hydrogel actuators of PNa2.

Voltage, V	20		30		60		90		110	
Fre- quency, Hz	50	500	50	500	50	500	50	500	50	500
Deformation, %	Low volt- age	Low volt- age	1.41± 1.32	9.24± 1.61	9.14± 0.48	13.77± 2.13	11.72±0. 95	15.31±2. 37	12.98±1. 73	16.87±1. 17
Activation time, sec	-	-	8.50± 2.98	27.88 ±4.88	9.10± 1.32	7.84±1 .69	4.90±0.7 6	4.28±0.0 5	2.50±0.2 3	2.77±0.6 0
Relaxation time, sec	-	-	6.2±5 .65	15.03 ±8.61	23.8± 1.69	16.12± 6.62	16.3±1.8 4	13.86±0. 46	12.9±3.4 7	15.03±4. 77

Table S7. Contraction, activation and relaxation values for hydrogel actuators of PNa3.

Voltage, V	20		30		60		90		110	
Fre- quency, Hz	50	500	50	500	50	500	50	500	50	500
Deformation, %	Low voltage	Low voltage	5.60± 2.76	5.34± 4.29	11.86 ±1.16	13.17± 1.07	14.75±4. 25	12.70±0. 60	16.50±2. 90	13.63±1. 60
Activation time, sec	-	-	15.60 ±5.30	11.90 ±6.9	6.75± 1.15	5.34±2 .04	2.75±0.9 5	3.66±0.8 4	2.04±0.6 2	3.03±1.8 7
Relaxation time, sec	-	-	1.54± 3.98	5.21± 6.84	7.55± 2.70	15.21± 7.79	10.20±2. 60	11.79±8. 04	10.62±4. 08	11.40±2. 60

Table S8. Contraction, activation and relaxation values for hydrogel actuators of PNa4.

Voltage, V	20		30		60		90		110	
Fre- quency, Hz	50	500	50	500	50	500	50	500	50	500
Deformation, %	Low voltage	1.90± 3.80	7.62± 4.60	9.71± 1.71	11.30 ±0.10	11.71± 1.71	11.65±1. 25	14.03±2. 37	15.15±0. 17	12.02±0. 50
Activation time, sec	-	5.20± 0.70	13.78 ±4.38	6.85± 3.57	1.90± 0.29	3.24±0 .16	1.70±0.5 8	1.86±1.3 2	1.32±0.4 1	0.98±1.3 2
Relaxation time, sec	-	1.24± 0.49	7.32± 3.2	5.31± 2.71	2.92± 1.93	3.54±1 .49	4.18±2.4 2	5.07±0.9 0	4.46±0.1 2	4.04±1.3 4

Table S9. Extension, activation and relaxation values for hydrogel actuators of PLi1.

Voltage, V	20		30		60		90		110	
Fre- quency, Hz	50	500	50	500	50	500	50	500	50	500
Deformation, %	Low voltage	Low voltage	Low voltage	Low voltage	31.87 ±1.56	31.95± 1.85	44.20±1. 30	46.28±4. 42	42.40±3. 92	50.43±4. 67
Activation time, sec	-	-	-	-	8.30± 1.82	14.45± 0.98	6.83±2.3 0	6.80±0.5 5	5.24±0.1 8	5.38±0.8 8
Relaxation time, sec	-	-	-	-	5.79± 0.31	6.77±0 .23	6.5±01.3 0	6.40±2.1 5	3.83±1.4 8	6.40±2.1 5

Table S10. Extension, activation and relaxation values for hydrogel actuators of PLi2.

Voltage, V	20		30		60		90		110	
Fre- quency, Hz	50	500	50	500	50	500	50	500	50	500
Deformation, %	Low voltage	Low voltage	25.21 ±1.49	27.48 ±2.98	48.8± 4.90	51.33± 2.33	63.97±5. 40	67.03±9. 22	57.10±1. 80	70.14±6. 30
Activation time, sec	-	-	23.06 ±4.73	16.76 ±0.64	11.31 ±1.01	13.80± 1.40	7.21±0.3 6	7.42±0.8 8	4.89±1.4 9	6.31±0.6 9
Relaxation time, sec	-	-	9.50± 1.18	7.14± 0.56	8.88± 0.95	8.16±1 .14	8.57±1.0 9	8.11±0.7 1	5.92±0.5 8	7.82±0.4 8

Table S11. Extension, activation and relaxation values for hydrogel actuators of PLi3.

Voltage, V	20		30		60		90		110	
Fre- quency, Hz	50	500	50	500	50	500	50	500	50	500
Deformation, %	Low voltage	Low voltage	25.20 ±1.10	25.18 ±0.58	43.88 ±2.62	43.80± 5.41	47.02±1. 72	47.79±3. 01	52.53±2. 42	53.36±5. 76
Activation time, sec	-	-	17.68 ±1.62	18.02 ±0.2	6.45± 1.22	7.29±1 .19	3.04±1.2 9	4.45±1.0 5	2.54±0.6 6	2.14±0.7 2
Relaxation time, sec	-	-	5.38± 1.42	5.72± 0.57	6.75± 1.05	6.41±1 .66	6.57±1.2 4	5.96±0.8 2	5.74±0.5 4	5.21±1.1 9

Table S12. Extension, activation and relaxation values for hydrogel actuators of PLi4.

Voltage, V	20		30		60		90		110	
Fre- quency, Hz	50	500	50	500	50	500	50	500	50	500
Deformation, %	25.2± 4.50	21.34 ±1.09	39.2± 3.60	33.73 ±1.47	56.14 ±3.20	52.30± 0.93	79.09±4. 81	76.17±6. 13	87.04±2. 30	84.20±4. 90
Activation time, sec	19.2± 0.8	14±1. 01	14.81 ±3.85	12.46 ±1.14	4.25± 0.55	6.62±0 .12	2.86±0.6 4	2.94±0.1 9	2.10±0.7 5	2.71±0.3 1
Relaxation time, sec	7.42± 2.18	3.52± 0.93	8.25± 1.45	7.34± 0.73	3.85± 1.05	4.60±0 .10	6.20±1.7 3	5.21±0.1 9	5.50±1.3 1	6.56±1.0 8

Table S13. Contraction, activation and relaxation values for hydrogel actuators of PLi1.

Voltage, V	20		30		60		90		110	
Frequency, Hz	50	500	50	500	50	500	50	500	50	500
Deformation, %	Low voltage	Low voltage	Low voltage	Low voltage	6.49±0.88	10.74±0.44	7.74±0.93	13.47±0.9	6.72±1.2	12.96±0.26
Activation time, sec	-	-	-	-	8.10±1.82	16.98±3.98	3.74±1.41	12.75±3.15	2.22±0.74	7.48±2.72
Relaxation time, sec	-	-	-	-	11.75±3.20	13.42±1.08	6.44±1.27	8.50±0.13	3.94±0.89	6.49±2.46

Table S14. Contraction, activation and relaxation values for hydrogel actuators of PLi2.

Voltage, V	20		30		60		90		110	
Frequency, Hz	50	500	50	500	50	500	50	500	50	500
Deformation, %	Low voltage	Low voltage	Low voltage	3.17±2.70	9.17±1.04	13.91±1.98	11.18±0.04	14.66±2.11	10.48±1.75	15.14±2.47
Activation time, sec	-	-	-	6.95±2.30	8.58±0.28	9.79±1.41	4.99±0.91	4.13±0.37	2.68±0.45	3.29±1.36
Relaxation time, sec	-	-	-	2.23±0.44	12.59±0.45	16.93±5.41	11.87±0.63	8.10±3.25	7.28±1.73	7.13±3.39

Table S15. Contraction, activation and relaxation values for hydrogel actuators of PLi3.

Voltage, V	20		30		60		90		110	
Frequency, Hz	50	500	50	500	50	500	50	500	50	500
Deformation, %	Low voltage	Low voltage	7.63±0.96	Low voltage	11.14±1.10	16.3±0.77	14.90±3.60	19.43±1.43	14.28±3.29	21.74±0.95
Activation time, sec	-	-	17.22±4.84	-	5.40±3.05	5.88±0.55	2.47±0.71	2.74±0.51	1.83±0.40	2.17±0.45
Relaxation time, sec	-	-	18.20±1.02	-	13.17±3.61	11.71±0.92	11.76±3.45	13.55±4.95	8.65±1.65	12.57±3.16

Table S16. Contraction, activation and relaxation values for hydrogel actuators of PLi4.

Voltage, V	20		30		60		90		110	
Fre- quency, Hz	50	500	50	500	50	500	50	500	50	500
Deform- ation, %	Low volt- age	5.87± 1.45	10.82 ±0.52	11.59 ±1.48	17.39 ±0.92	12.30± 1.10	21.41±0. 91	14.75±1. 63	21.27±0. 88	16.43±1. 47
Activation time, sec	-	26.30 ±7.51	16.70 ±6.26	23.04 ±1.03	4.99± 0.34	6.44±0 .90	2.67±0.4 3	2.41±0.4 9	1.75±0.6 5	2.26±0.1 9
Relaxation time, sec	-	5.19± 1.91	11.29 ±0.82	14.61 ±1.19	11.16 ±0.54	13.60± 2.50	16.22±4. 91	13.60±3. 10	19.15±1. 85	15.87±1. 57

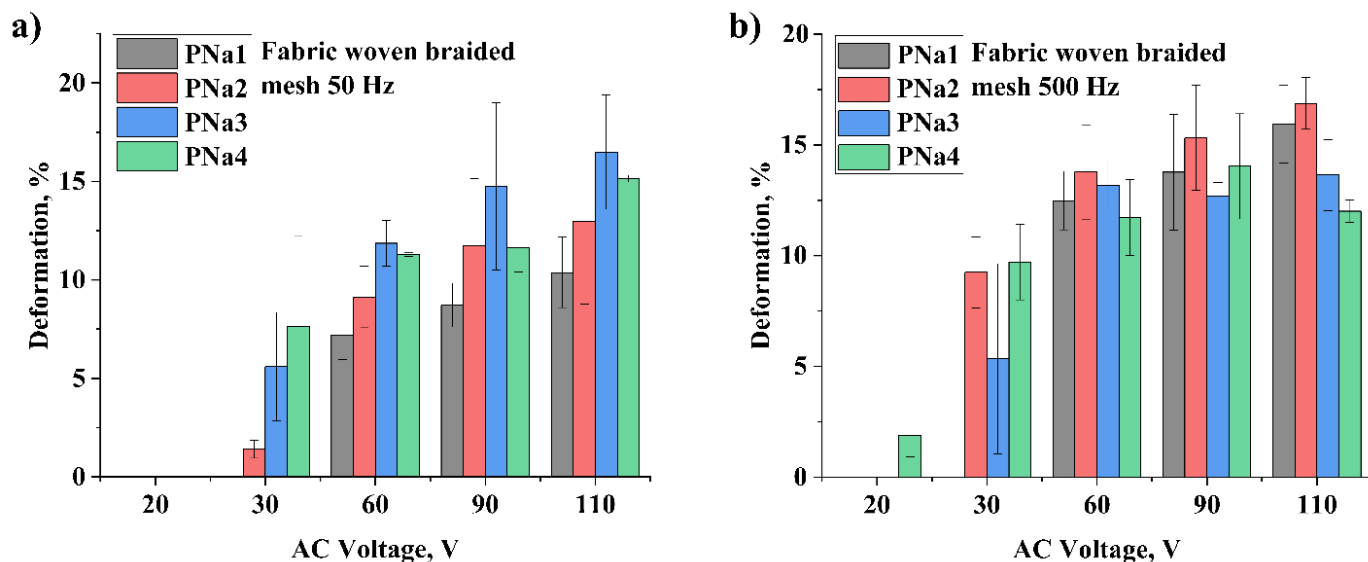


Figure S4. Contraction values of activated actuators based on PVA/NaCl under (a) 50 Hz and (b) 500 Hz.

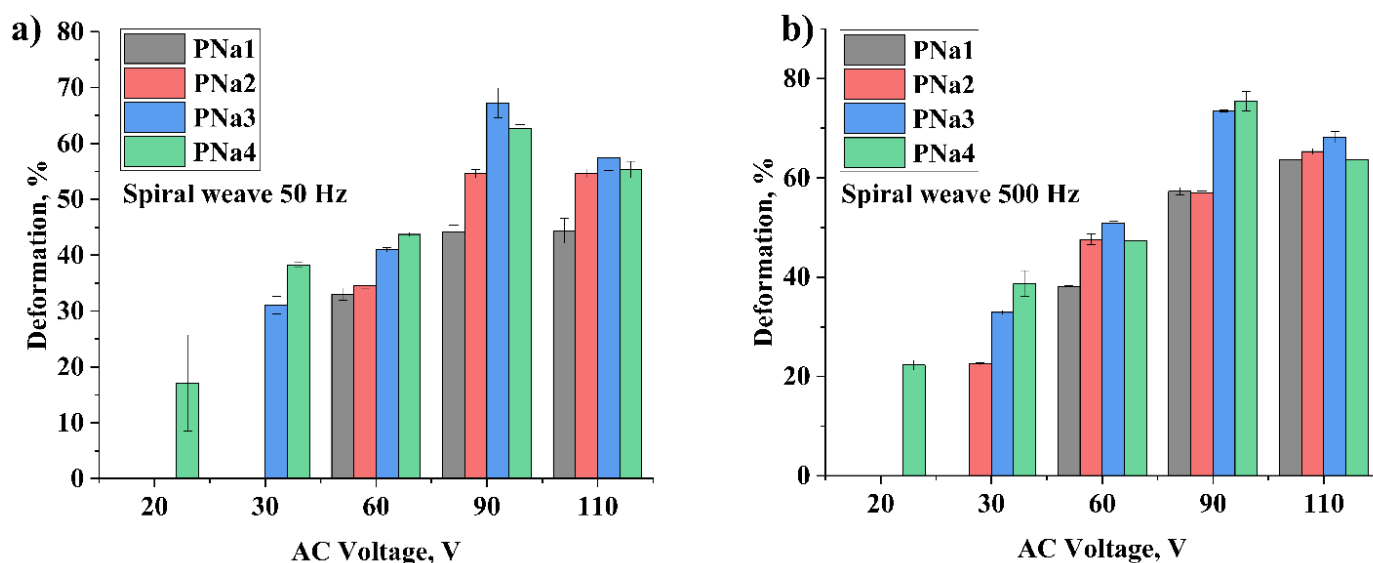


Figure S5. Extension values of activated actuators based on PVA/NaCl under (a) 50 Hz and (b) 500 Hz.