

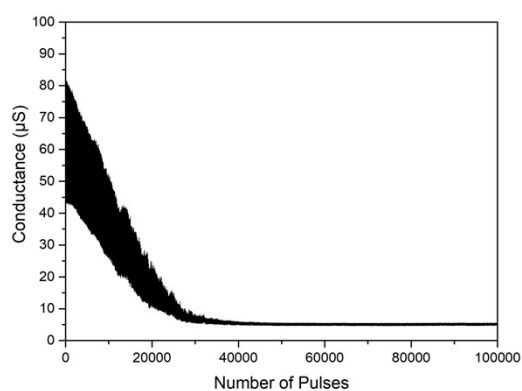
## Supplementary Information

### Polymer Wire Wetware Synapse with Improved Endurance for Physical Neuromorphic Implementation

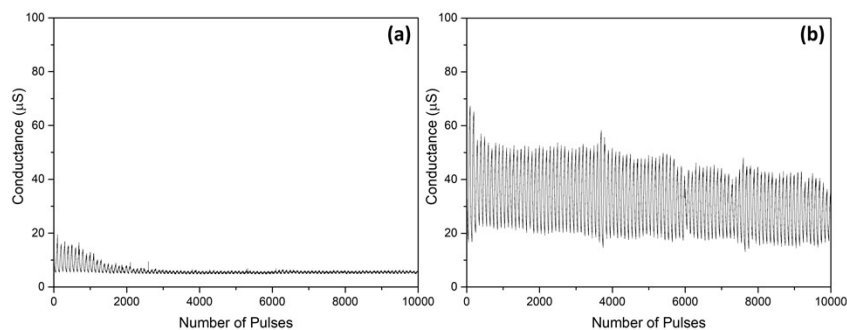
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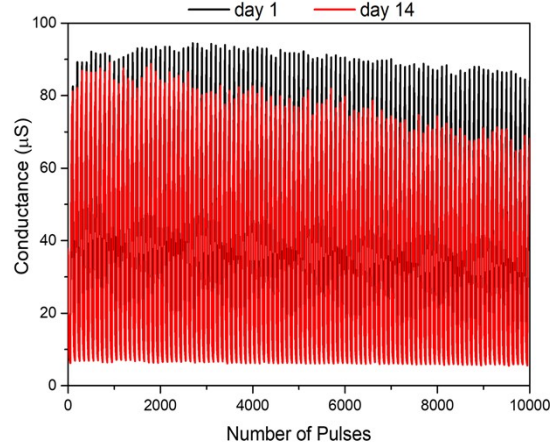
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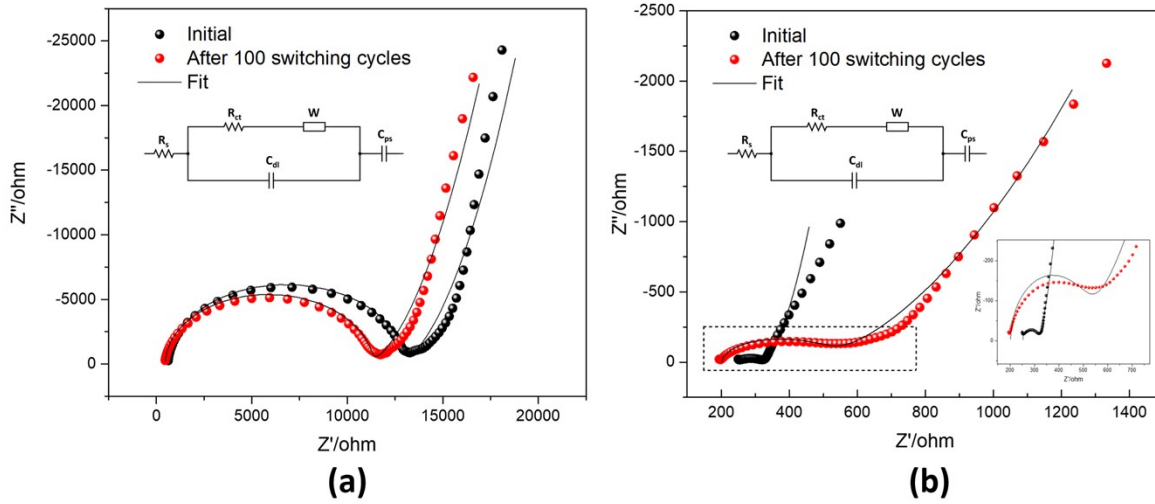
**Fig. S1** Operation of polymer wire device in water at reduced voltage ( $\pm 0.8$  V and 25 ms pulse width). The reduced voltage condition resulted in slower degradation and produced a lower conductance switching range.



**Fig. S2** Operation of polymer wire device in other solvent systems at  $\pm 1.1$  V and 25 ms pulse width (a) in DMSO (b) in 1,2-propanediol. To further assess whether the improved endurance is specific to EG, the additional solvent systems were examined. Operation in DMSO and 1,2-propanediol resulted in lower  $G_{\max}/G_{\min}$  and poorer stability than in EG. Additionally, low-protic solvents such as propylene carbonate were not suitable to be tested because of insufficient SDBS solubility.



**Fig. S3** Switching behavior of the device measured on Day 1 and Day 14 after storage at room temperature. The initial switching window was maintained after 14 days of storage, while a decrease in  $G_{\max}$  was observed at later cycles relative to Day 1. The measurement was conducted over 100 cycles.



**Fig. S4** Equivalent circuit fitting of the EIS. (a) operation in ethylene glycol (b) operation in water media

**Table S1.** Values for the Circuit Elements

Circuit elements	$R_s$ ( $\Omega$ )	$R_{ct}$ ( $\Omega$ )	$W$ ( $\Omega s^{1/2}$ )	$C_{dl}$ (F)	$C_{ps}$ (F)	Error
In EG (initial)	628.4	12240	$1.385 \times 10^{-4}$	$7.756 \times 10^{-9}$	$7.599 \times 10^{-5}$	0.04641
In EG (after 100 switching cycles)	470.4	10730	$1.439 \times 10^{-4}$	$7.442 \times 10^{-9}$	$8.424 \times 10^{-5}$	0.05506
In water (initial)	252.3	57.7	$1.746 \times 10^{-4}$	$5.700 \times 10^{-7}$	$1.652 \times 10^{-4}$	0.03469
In water (after 100 switching cycles)	202.7	300.8	$3.851 \times 10^{-4}$	$4.557 \times 10^{-7}$	$1.321 \times 10^{-4}$	0.05548

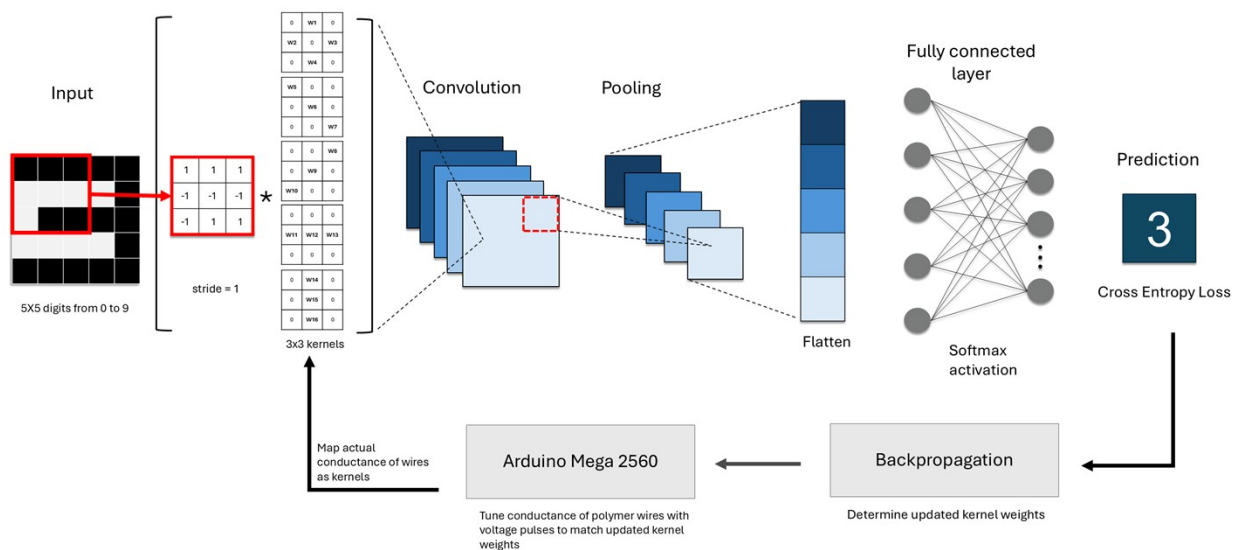


Fig. S5 CNN architecture workflow using the polymer wire based synaptic device as kernels.

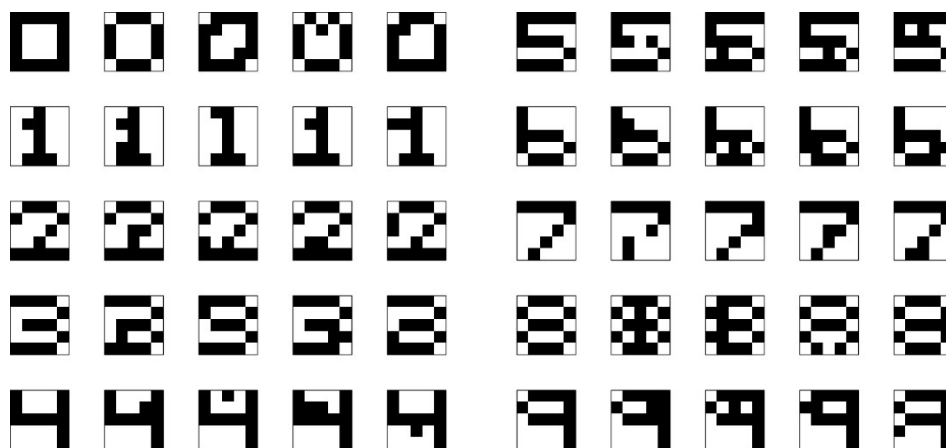


Fig. S6 Digit input toy dataset with additive noise for sample variation.

0	W1	0	W5	0	0	0	0	W8	0	0	0	0	W14	0
W2	0	W3	0	W6	0	0	W9	0	W11	W12	W13	0	W15	0
0	W4	0	0	0	W7	W10	0	0	0	0	0	0	W16	0

Fig. S7 Kernel matrix used for training. Each W1-W16 represents the conductance state of the synaptic polymer wire. The maximum and minimum conductance [ $G_{\max}$  ( $\times 0.90$ ) and  $G_{\min}$ ] of each wire was initially obtained and was used to normalize all the values to [0, 1].