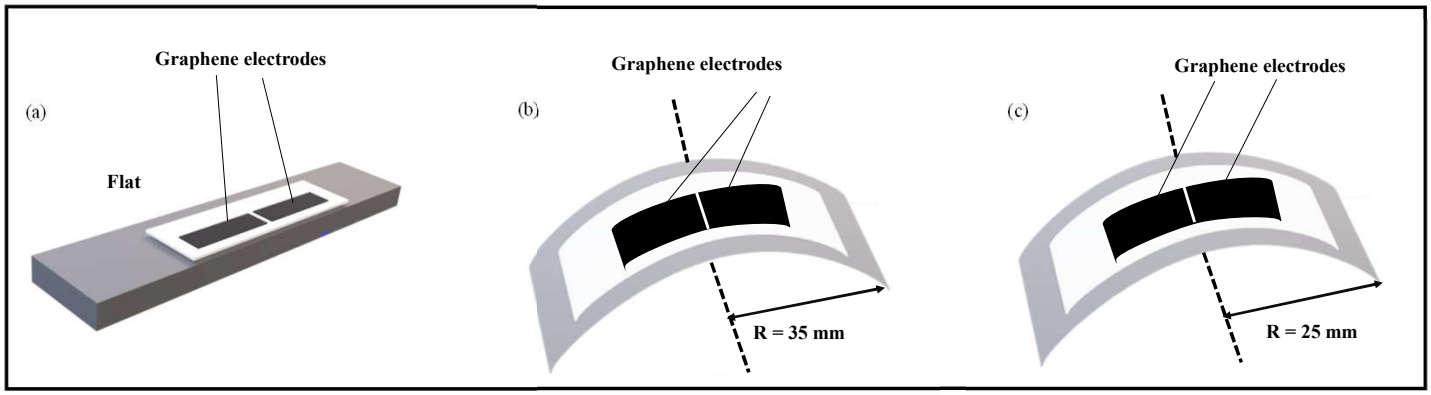
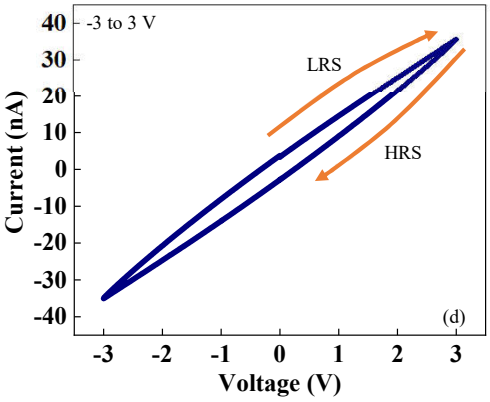
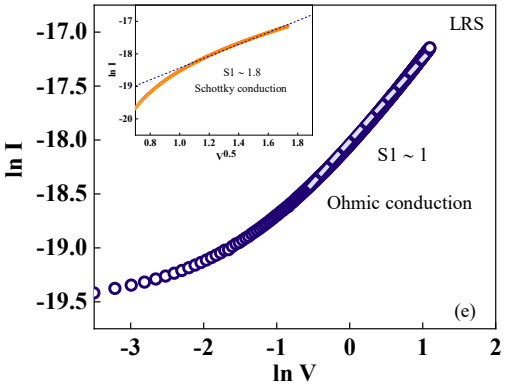
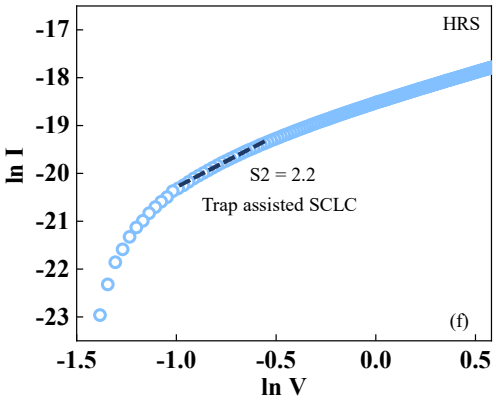
Strain dependent MoO_3-Aloevera

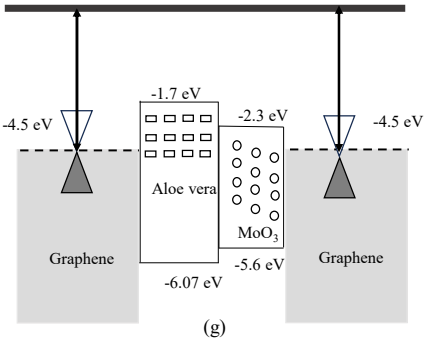
Figure 1

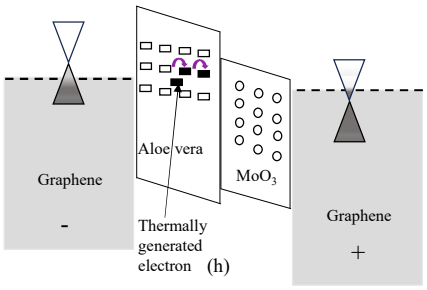


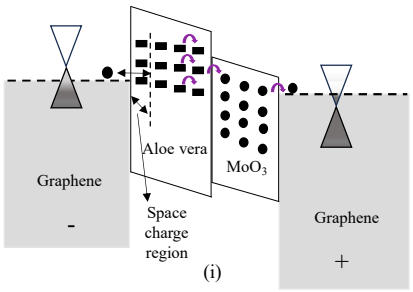




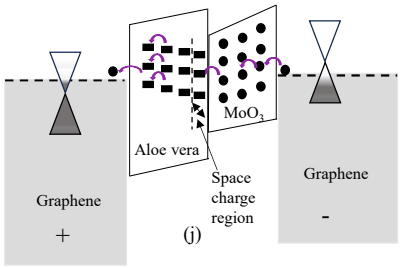


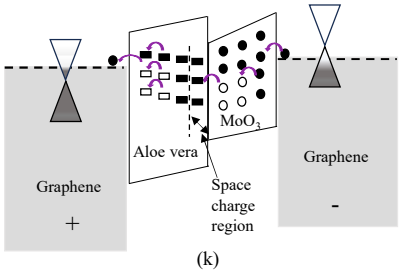






Charge Trap Vacancy or Electron





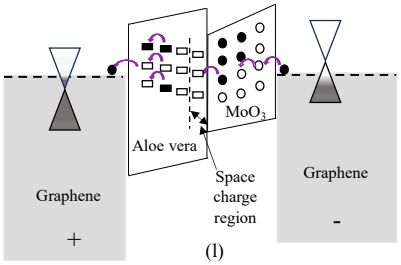


Figure 1: (a) Schematic representation of multilayer graphene electrodes developed using pencil-on-paper in (a) Flat surface (b) Strained device to a radius of 35 mm (0.3 % strain) (c) Strained device to a radius of 25 mm (0.42 % strain). (d) current-voltage characteristics curve for device in flat surface. (e) Linear relationship between ln I vs ln V shows ohmic conduction in low resistance state. Inset shows the Schottky/thermal emission in low resistance state. (f) Linear relationship between ln I vs ln V, with slope of $\sim$2 shows Trap-controlled SCLC in High resistance state. (g-l) Schematic illustration of band diagram at different stages: (g) pristine state, (h) trap-filled limited conduction, (i) conduction state in LRS when all traps are completely filled from the left electrode to the right electrode (j) trap-free conduction during when positive voltage is applied to left electrode, and (k,l) electron extraction toward left electrode leading to HRS state.

Figure 2

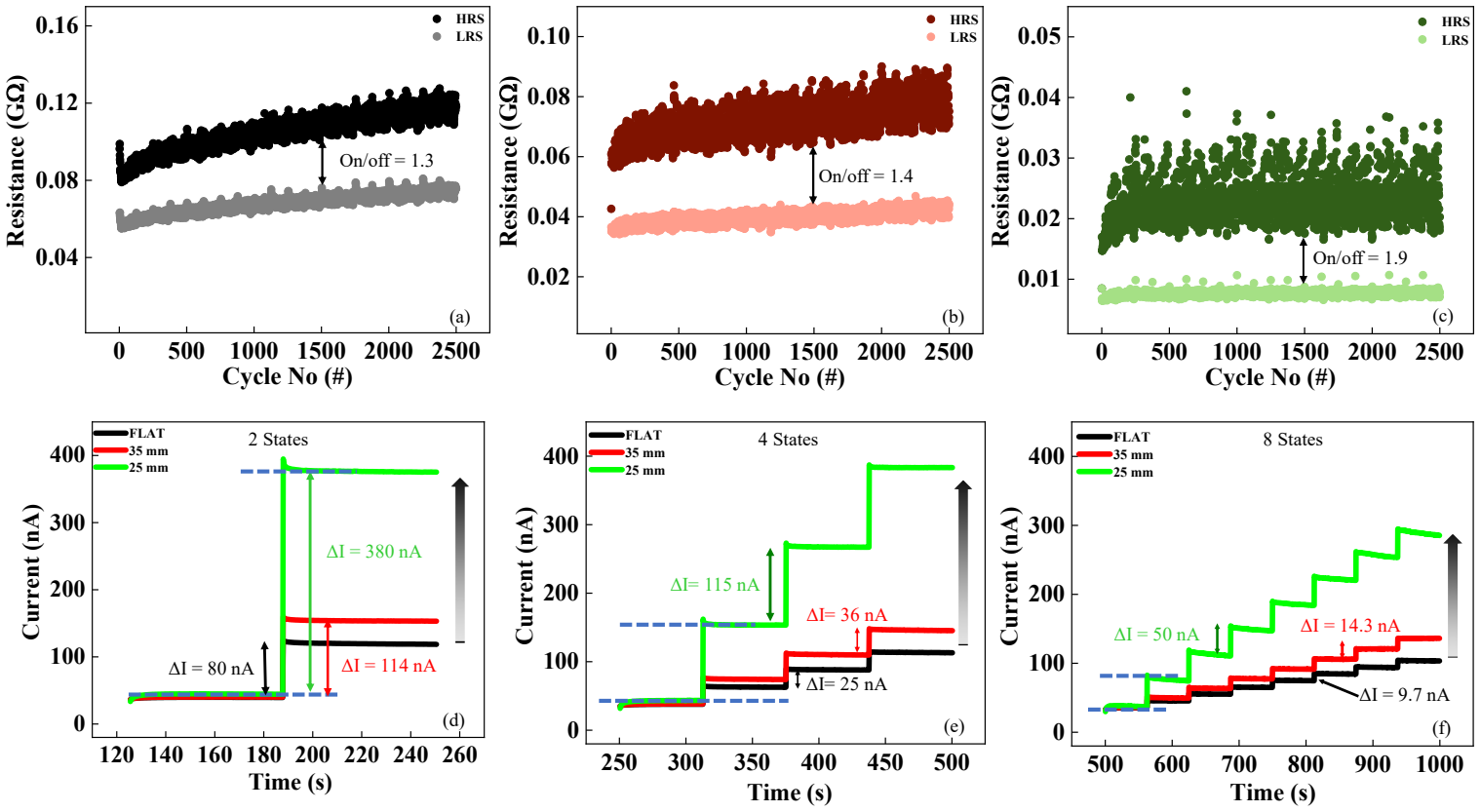


Figure 2: (a-c) Endurance measurement performed with a write voltage of +3 V and 0.5 V as the read pulse at 100 ms pulse width. (a) Flat surface (b) Strained device to a radius of 35 mm (0.3 % strain) (c) Strained device to a radius of 25 mm (0.42 % strain) (d-f) Memory level comparison of MLG/MoO_3-Aloevera/MLG device for device in a flat surface (no strain) and at 0.3 \% and 0.42 \% strain. The write voltage is from 2.5 V to 5.5 V. (d) 2 (e) 4 (f) 8 memory levels using different write pulse of 60 s duration.

Figure 3

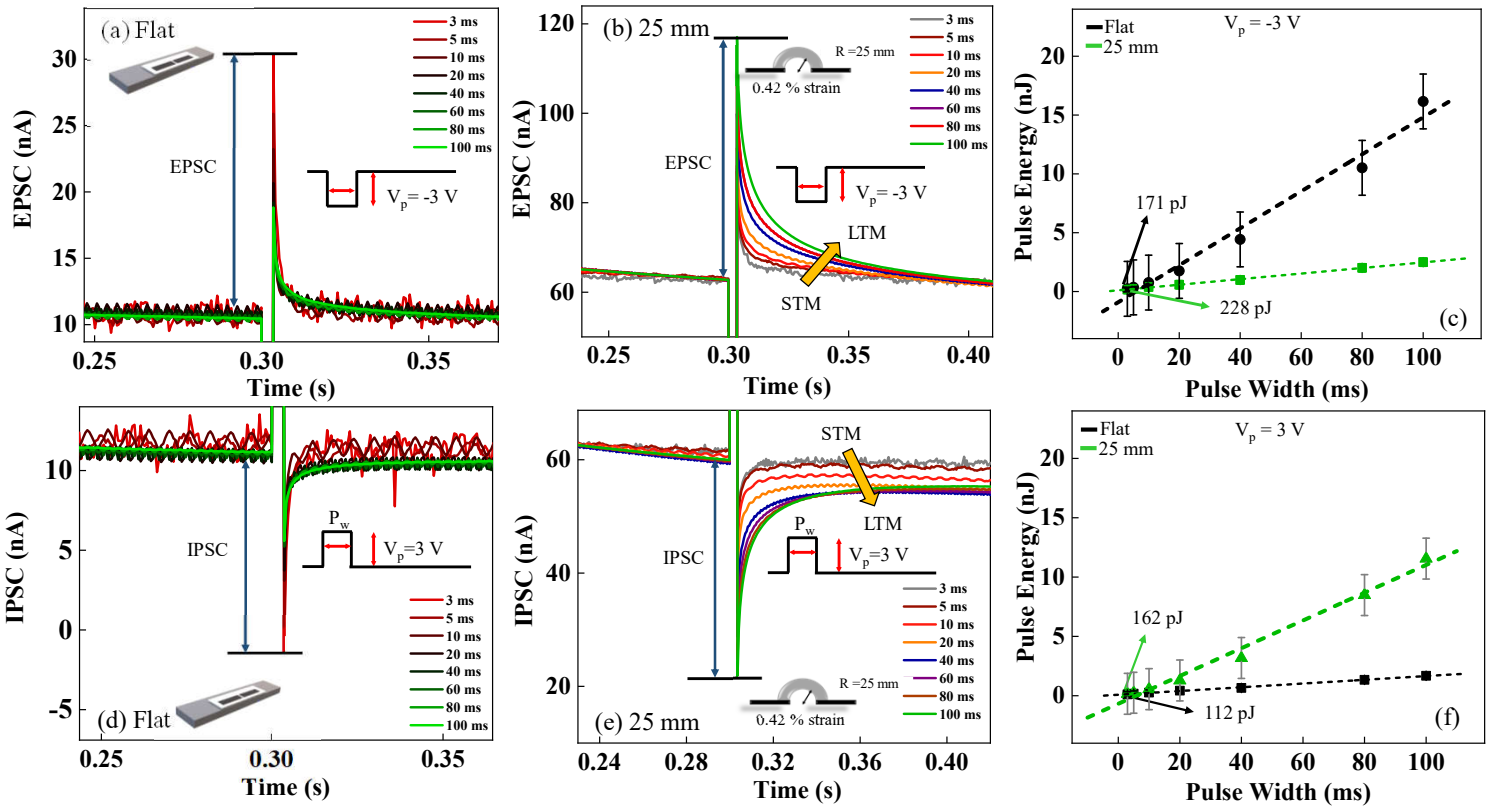


Figure 3: Inhibitory and Excitatory post synaptic current. (a) Electrical pulse (EPSC) applied to device in a flat surface with an amplitude of -3 V with pulse width varying from 3 ms to 100 ms. (b) Electrical pulse (EPSC) applied to device undergoing 0.42 \% strain with an amplitude of -3 V with pulse width varying from 3 ms to 100 ms. (c) Comparison of pulse energy calculated for EPSC with -3 V pulse by varying pulse width (P$_w$) for the device in a flat surface and undergoing strain at 0.42 \% (d) Electrical pulse (IPSC) applied to device in a flat surface with an amplitude of +3 V with pulse width varying from 3 ms to 100 ms. (e) Electrical pulse (IPSC) applied to device undergoing 0.42 \% strain with an amplitude of +3 V with pulse width varying from 3 ms to 100 ms. (f) Comparison of pulse energy calculated for IPSC with -3 V pulse by varying pulse width (P$_w$) for the device in a flat surface and undergoing strain at 0.42 \%

Figure 4

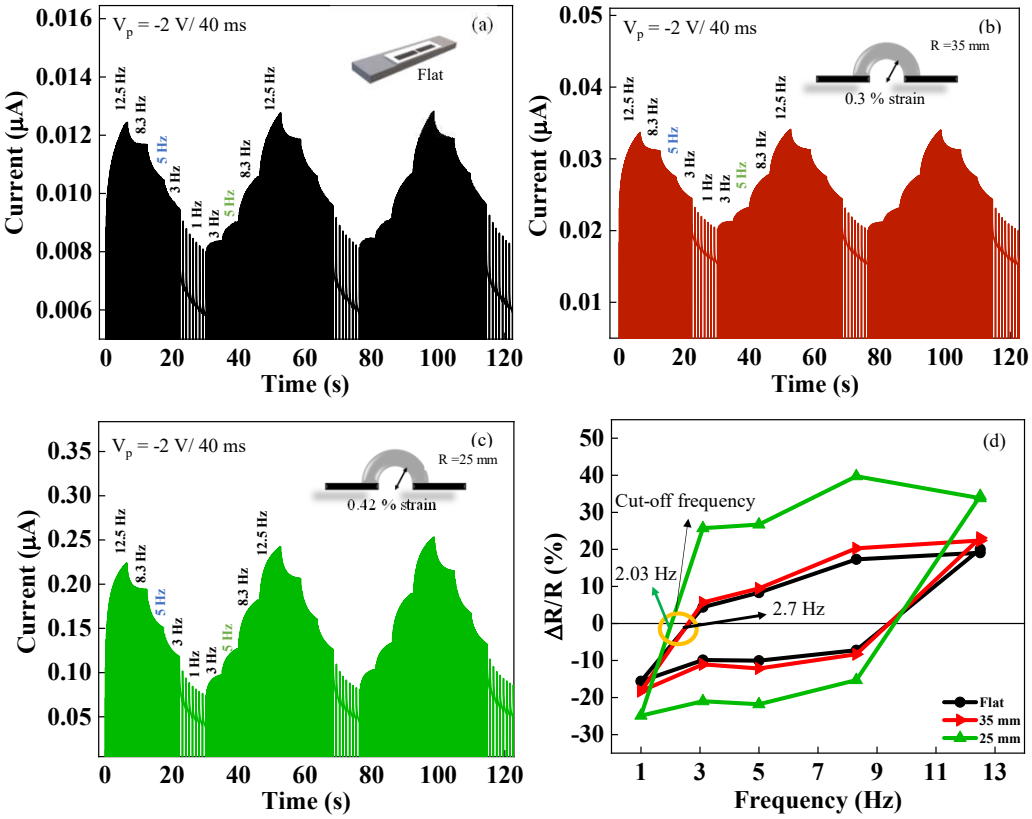


Figure 5: Synaptic plasticity based on Activity dependence induced by successive pulses of various frequency. (a) SRDP measured at five different frequencies (12.5 Hz, 8.3 Hz, 5Hz, 3 Hz and 1 Hz) for device in a flat surface. 5 Hz frequency exhibiting depression is shown in green letter and that showing potentiation is depicted using blue colour. (b) SRDP measured at five different frequencies for device under 0.3 \% strain (c) SRDP measured at five different frequencies for device under 0.42 \% strain (d) Extracted relative I change during each pulse train at various frequency for device .

Figure 5

20 pulses

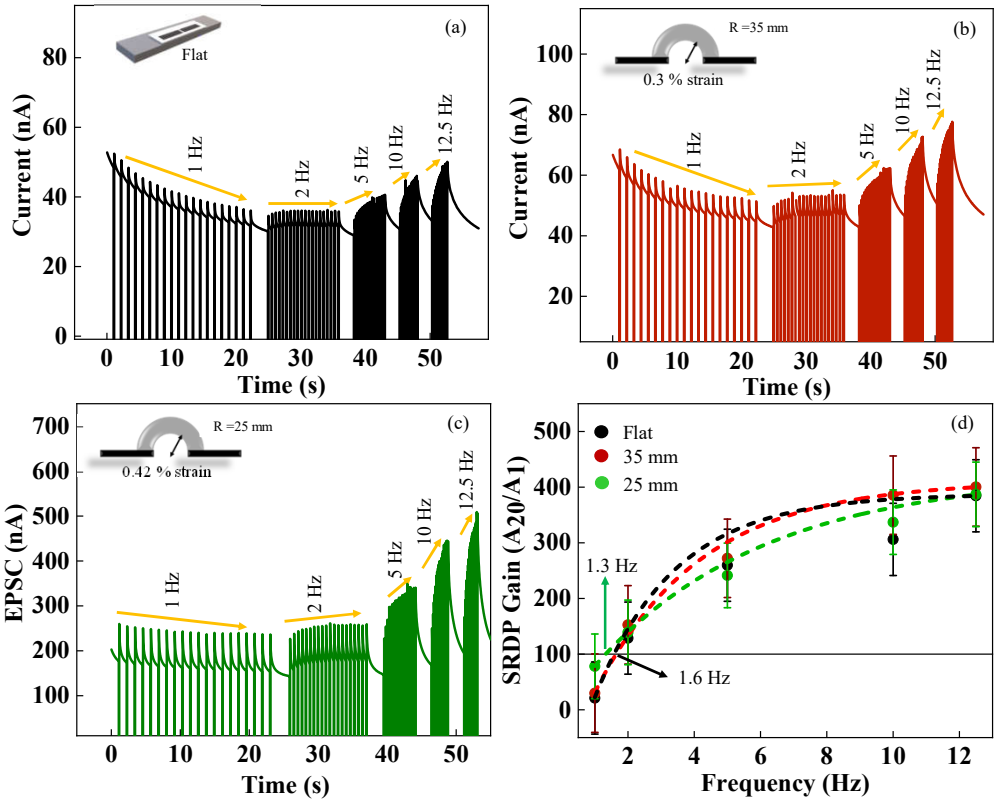


Figure 5: Spike rate dependant plasticity in FLG/MoO_3-Aloevera/FLG device. (a)-(c) Frequency dependant EPSC measurement for -3 V with 20 pulses (a) Device in flat surface (0 \% strain) (b) Device under 0.3 \% strain. (c) Device under 0.42 \% strain (d) Comparison ratio of PSC for 20^{th} pulse to 1^{st} pulse A_{20}/A_1 for the device under no strain and under strain of 0.3 \% and 0.42\% respectively.

Figure 6

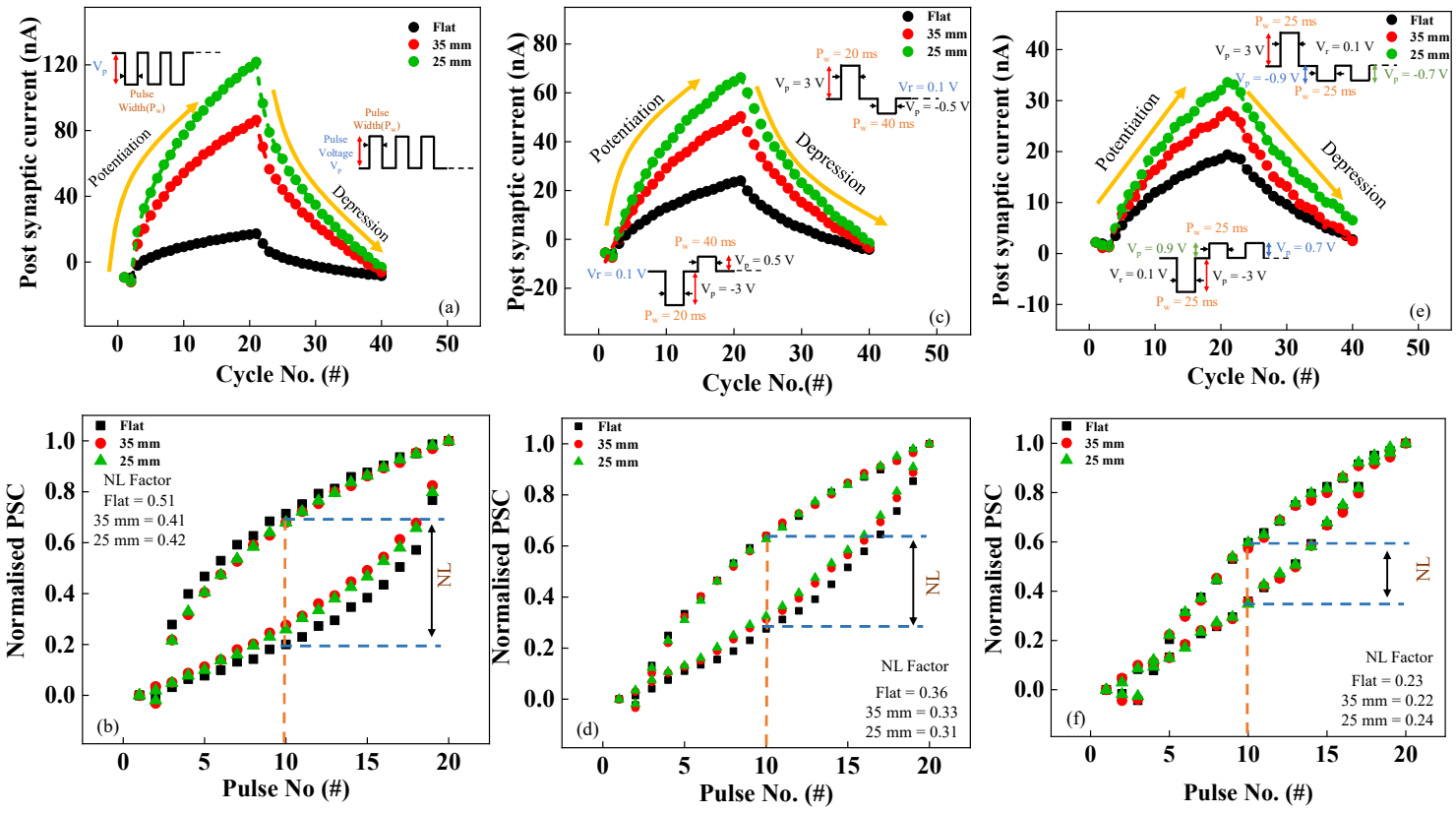


Figure 6: (a) Comparison of single cycle of potentiation and depression curve for FLG/Aloe vera/FLG device under flat surface and under 0.3 \% and 0.42 \% strain with pulse width of 200 ms and constant pulse voltage of 3 V P_w fitted using bi-exponential function. The read voltage used is 1.5 V. (b) The NL factor varies between 0.41and 0.52 for device under flat surface and device strained to 0.3 % and0.42 % respectively. We considered the 10^{th} pulse for calculation. (c) Comparison of Single cycle of potentiation and depression curve utilizing a control voltage of opposite polarity to both potentiation and depression cycle in case of MLG/Aloe vera/MLG device. Pulse sequence is depicted in the inset. (d) Non-linearity calculated for potentiation-depression measurement using control voltage ranges from 0.31 to 0.36. (e) Comparison of Single cycle of potentiation and depression curve utilizing two control voltages of opposite polarity to both potentiation and depression cycle in case of MLG/Aloe vera/MLG device. The inset shows the pulse sequence applied for measurement. (f) Non-linearity calculated for potentiation-depression measurement using two control voltage ranges between 0.22 and 0.24.

Multi-level Measurement: MoO_3-Aloevera

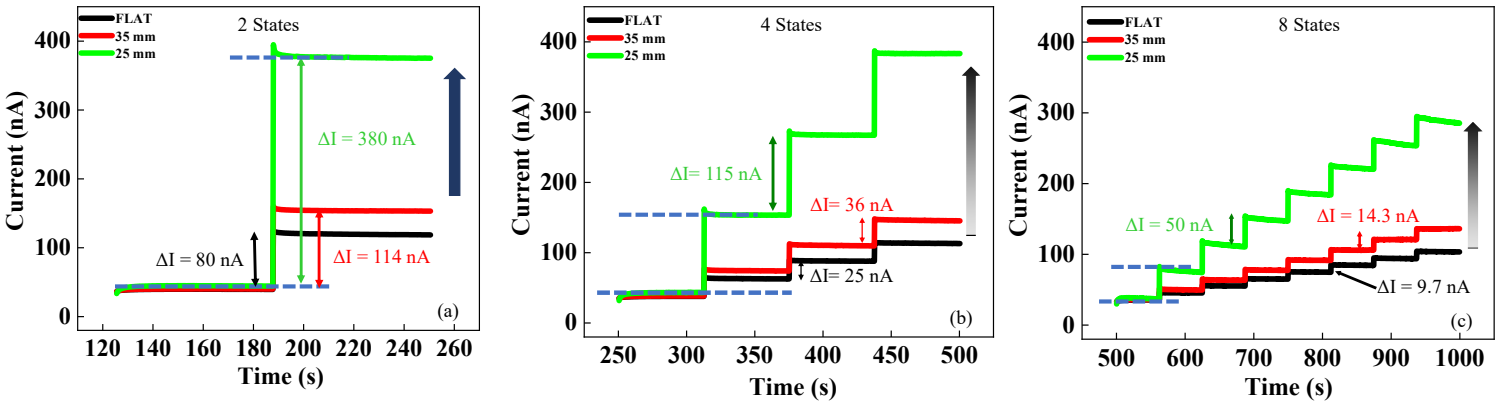


Figure 2. (a-c) Memory level comparison of MLG/MoO_3-Aloevera/MLG device for device in a flat surface (no strain) and at 0.3 \% and 0.42 \% strain. The write voltage is from 2.5 V to 5.5 V. (a) 2 (b) 4 (c) 8 memory levels using different write pulse of 60 s duration.