Supporting Information

Mott transistor with giant switching ratio at room temperature and its emulation of artificial synapses

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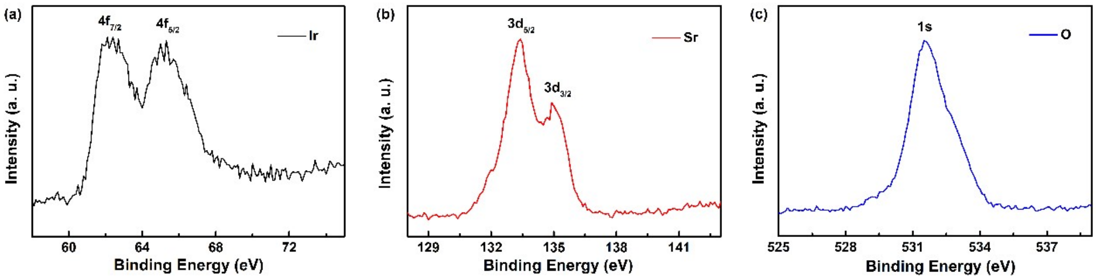


Figure S1. The XPS spectra of Sr_2IrO_4 films. (a) Ir 4f peaks; (b) Sr 3d peaks; (c) O 1s peaks. The binding energy of all valence elements are consistent with those reported previously.[1,2]

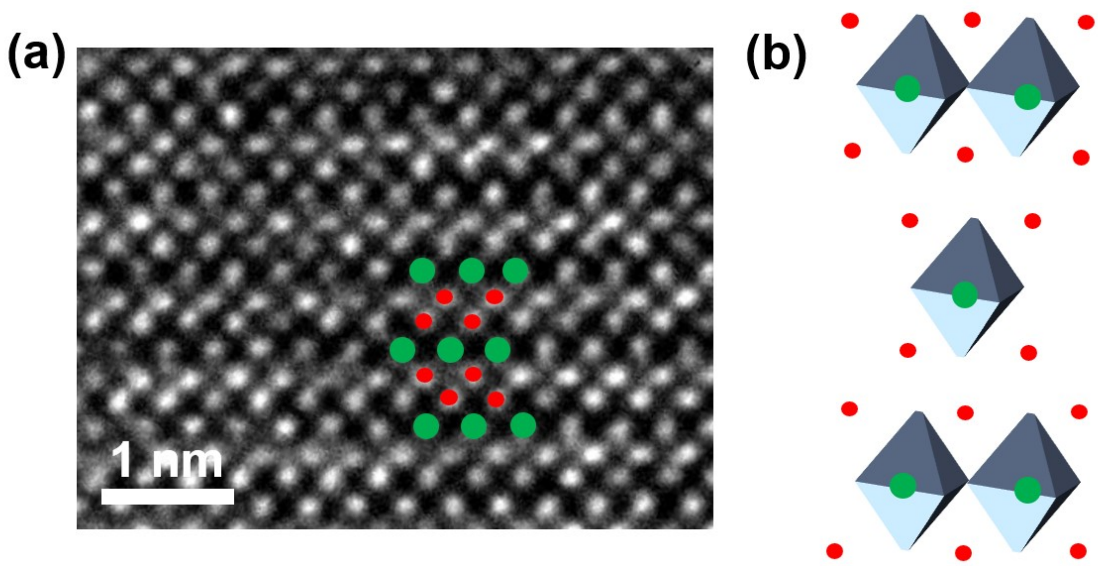


Figure S2. (a) A cross-sectional HRTEM images of the Sr_2IrO_4 films along the [100)] zone axis. (b) The schematic diagram of the Sr_2IrO_4 unit cell. Red dots represent Sr atoms and green dots represent Ir atoms.

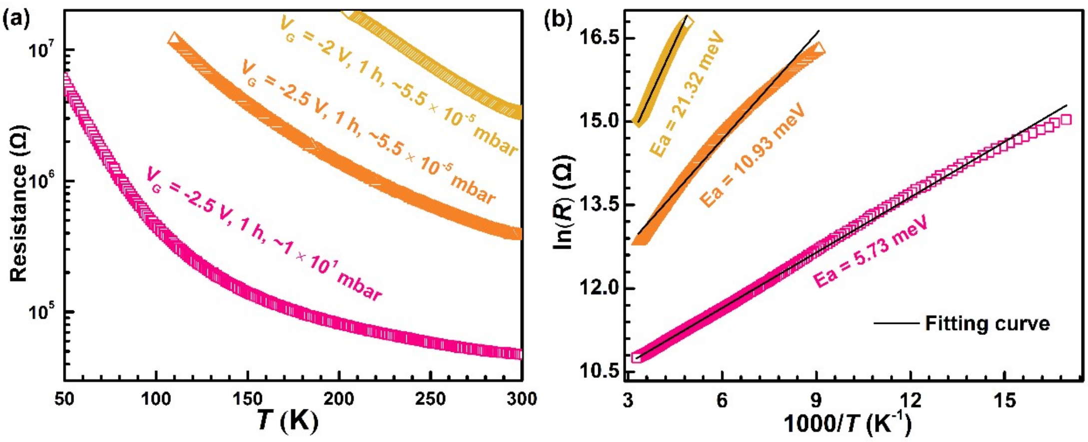


Figure S3. (a) Temperature (*T*) dependence of resistance (*R*) of the Sr_2IrO_4 channel under the different gate voltage and vacuum conditions. (b) ln(*R*) as a function of 1/*T* according to the thermal activation model. With the increase of gating bias (V_G) and the decrease of vacuum, both the values of *R* and activation energy (Ea) of the Sr_2IrO_4 channel decrease, indicating that the metallicity tends to increase.[3]

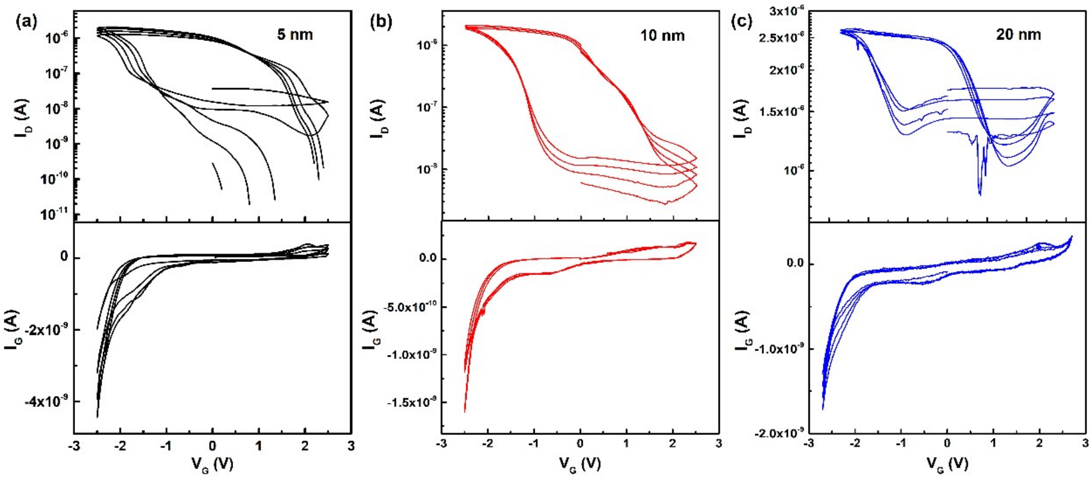


Figure S4. Transfer characteristics (I_D–V_G and I_G–V_G curves) of SIO-EDLTs with various channel thickness measured under 10 mbar. The thickness of channel Sr_2IrO_4 film is (a) 5 nm, (b)10 nm and (c) 20 nm, respectively.

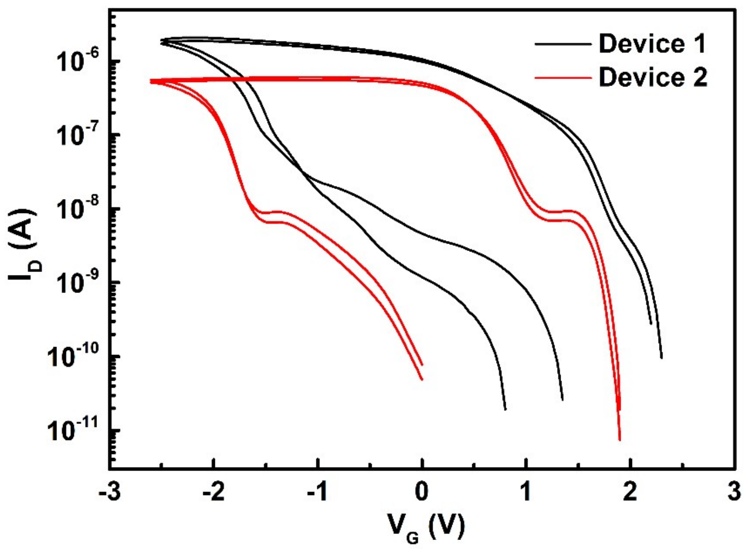


Figure S5. Transfer curves (I_D–V_G) of various SIO-EDLTs with ~5nm-thick SIO films measured under 10 mbar. The transfer characteristics of the SIO-EDLTs are sensitive to thickness of SIO channel layer. The observed difference between these two devices probably originates from small thickness difference of their SIO channel because a relatively large error is generally present when estimating the thickness of ultrathin films from XRD patterns.

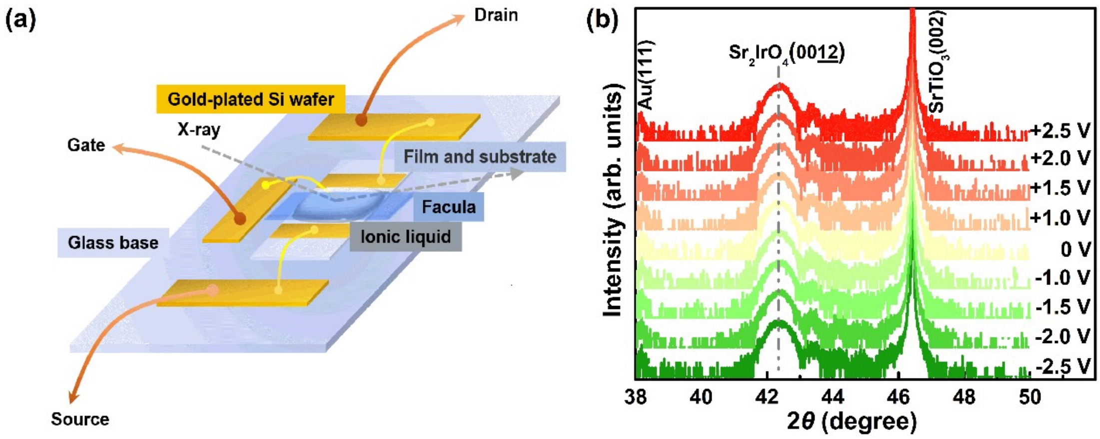


Figure S6. (a) Schematics of in situ XRD test device. (b) In situ XRD tests of Sr_2IrO_4 films at different gate voltages. Applying different gate voltages, the position, intensity and half-height width of the Sr_2IrO_4 film peak (00$\underline{12}$) did not show any significant change.

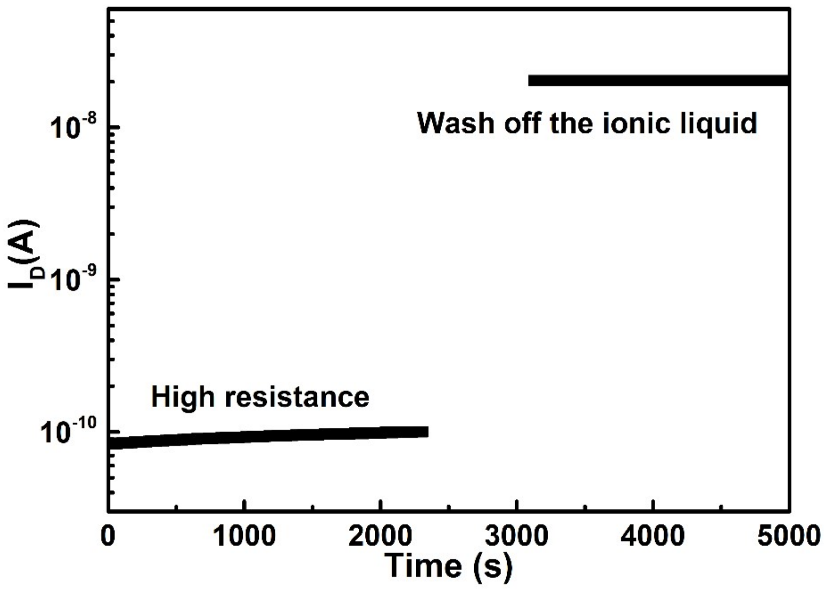


Figure S7. Channel current changes before and after ionic liquid exists. In the case of high resistance, the resistance decreases rapidly when the ionic liquid is washed off.

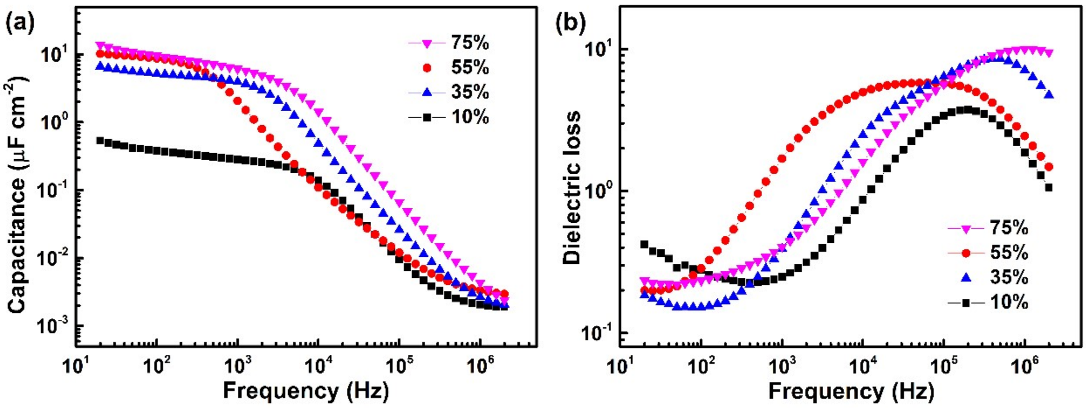


Figure S8. The capacitance (a) and loss (b) of ionic liquid vary with frequency at different humidity (10%, 35%, 55% and 75%). Different saturated salt solutions were selected to achieve humidity control. The saturated salt solutions of potassium hydroxide, magnesium chloride, magnesium nitrate and sodium chloride were respectively placed in a closed test chamber with a hygrometer to achieve humidity states of 10%, 35%, 55% and 75% at room temperature.[4] Each humidity level was kept at room temperature for 12 hours prior to each test.

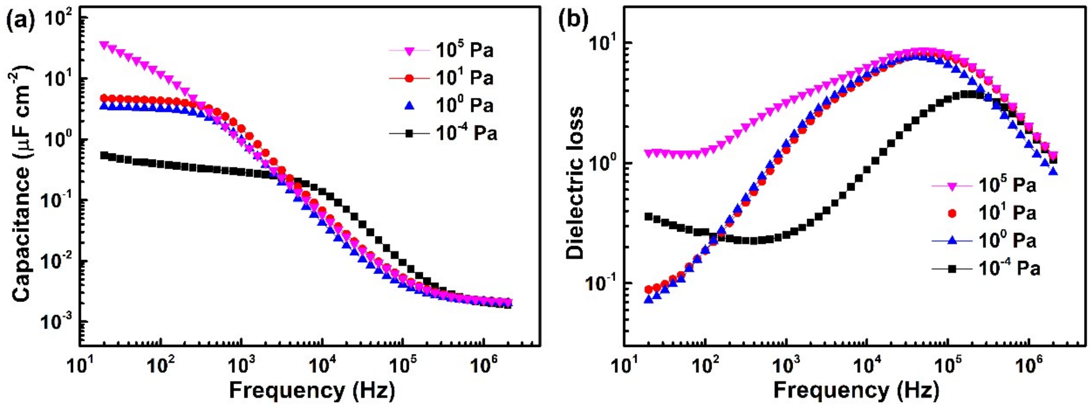


Figure S9. The capacitance (a) and loss (b) of ionic liquid vary with frequency at different vacuum degrees (10^{-4}, 10^{0}, 10^{1} and 10^{5} Pa).

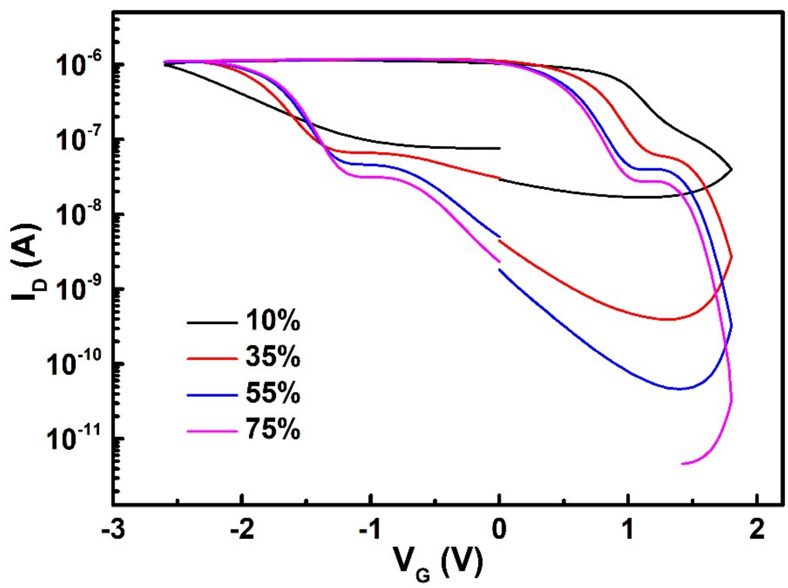


Figure S10. Transfer characteristics (I_D–V_G curves) of ~5nm-thick SIO-EDLT under various humidity. The relative humidity increases from 10% to 75% and each relative humidity level needs to be stabilized for 12 hours in the chamber before the electrical measurement.

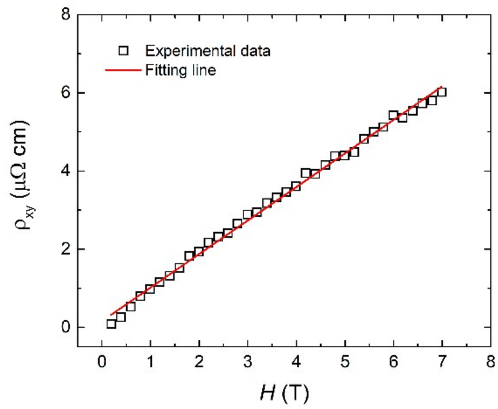
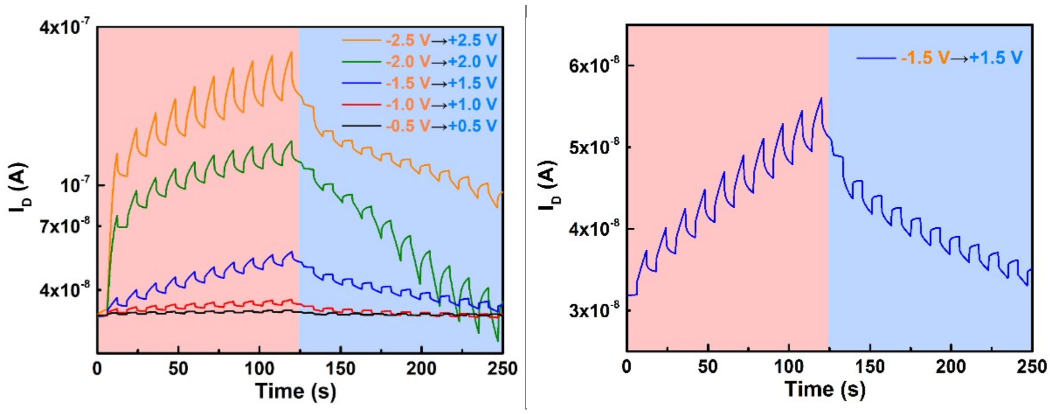


Figure S11. Magnetic field dependence of Hall resistivity ρ_{xy} at 300K of the SIO film with thickness of ~30 nm. The positive Hall coefficient indicates that the pristine SIO thin film is p-type conduction, which is consistent with typical p-channel field-effect-transistor operation of SIO-EDLT. A previous study[5] also reported p-type conduction in bulk SIO.



(a) (b)

Figure S12. (a) The response of ID triggered by a train of consecutive pulses with different pulse voltage. (b) ID response with consecutive pulses of -1.5V and +1.5V in linear coordinate. The orange area on the left is different negative voltage pulses, and the corresponding positive voltage pulses are on the right.

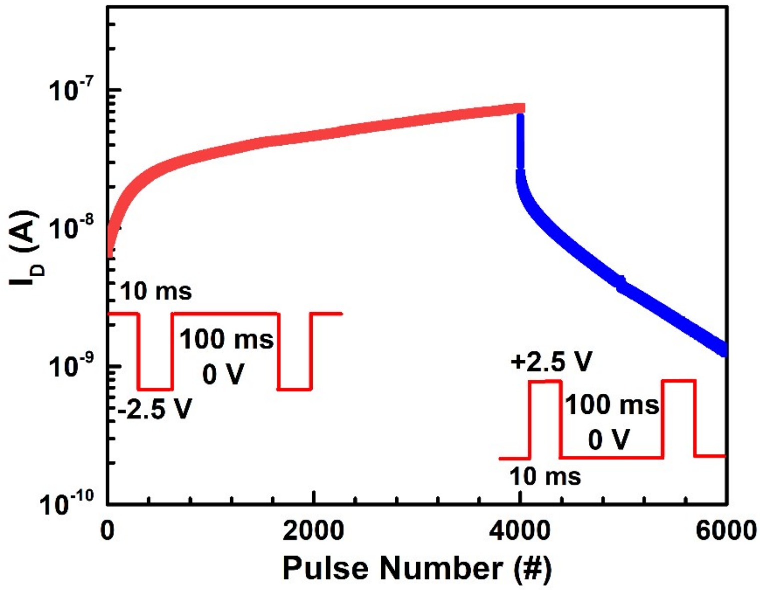


Figure S13. Simulation of synaptic potentiation and depression of SIO-EDLTs at short pulse width (10 ms).

References

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