2023「中技社科技獎學金」

2023 CTCI Foundation Science and Technology Scholarship

境外生生活助學金

Bursary Award for Overseas Students

CMOS-Compatible Memristor for Optoelectronic Neuromorphic Computing

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Abstract Optoelectronic memristor is a promising candidate for future light-controllable high-density storage and neuromorphic computing.[1] In this work, light-tunable resistive switching (RS) characteristics are demonstrated in the CMOS process-compatible ITO/HfO_2/TiO_2/ITO optoelectronic memristor. High transmittance under visible light was realized to ensure photosensitization. Stable bipolar analog switching, beyond 10^4s data retention, and endurance of 10^6 cycles were achieved as basic storage function. Synaptic functions including LTP, LTD, and photonic potentiation were established. Tis memristor shows great potential in the next generation of intelligent optoelectronic neuromorphic computing systems.

Device Fabrication and Characterization

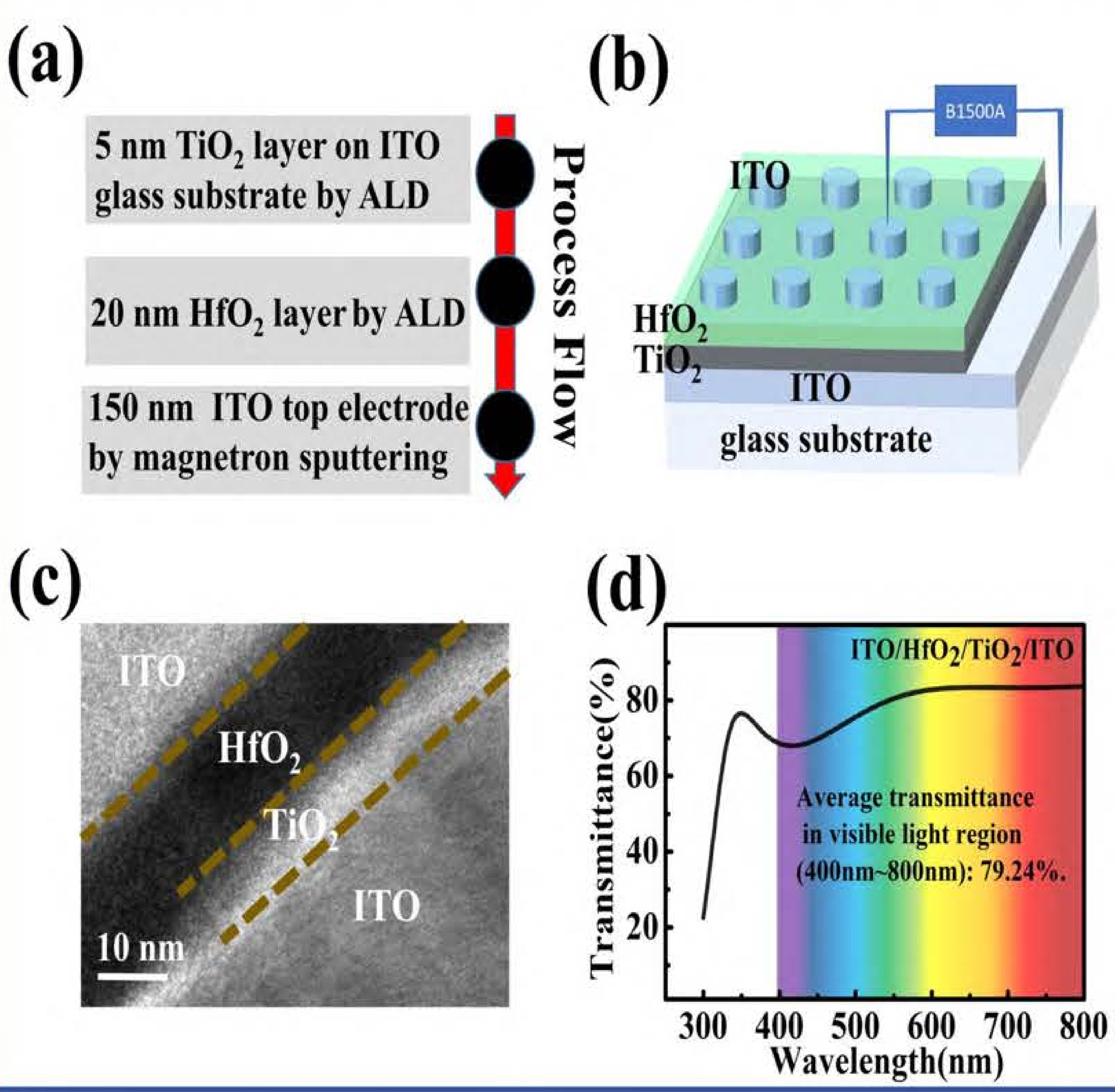

Fig. 1 (a) Device fabrication process. (b) Schematic description of the ITO/HfO_2/TiO_2/ITO memristors. (c) Typical cross-sectional TEM image of the device. (d) UV−visible spectrum of the device.

Results and Discussion

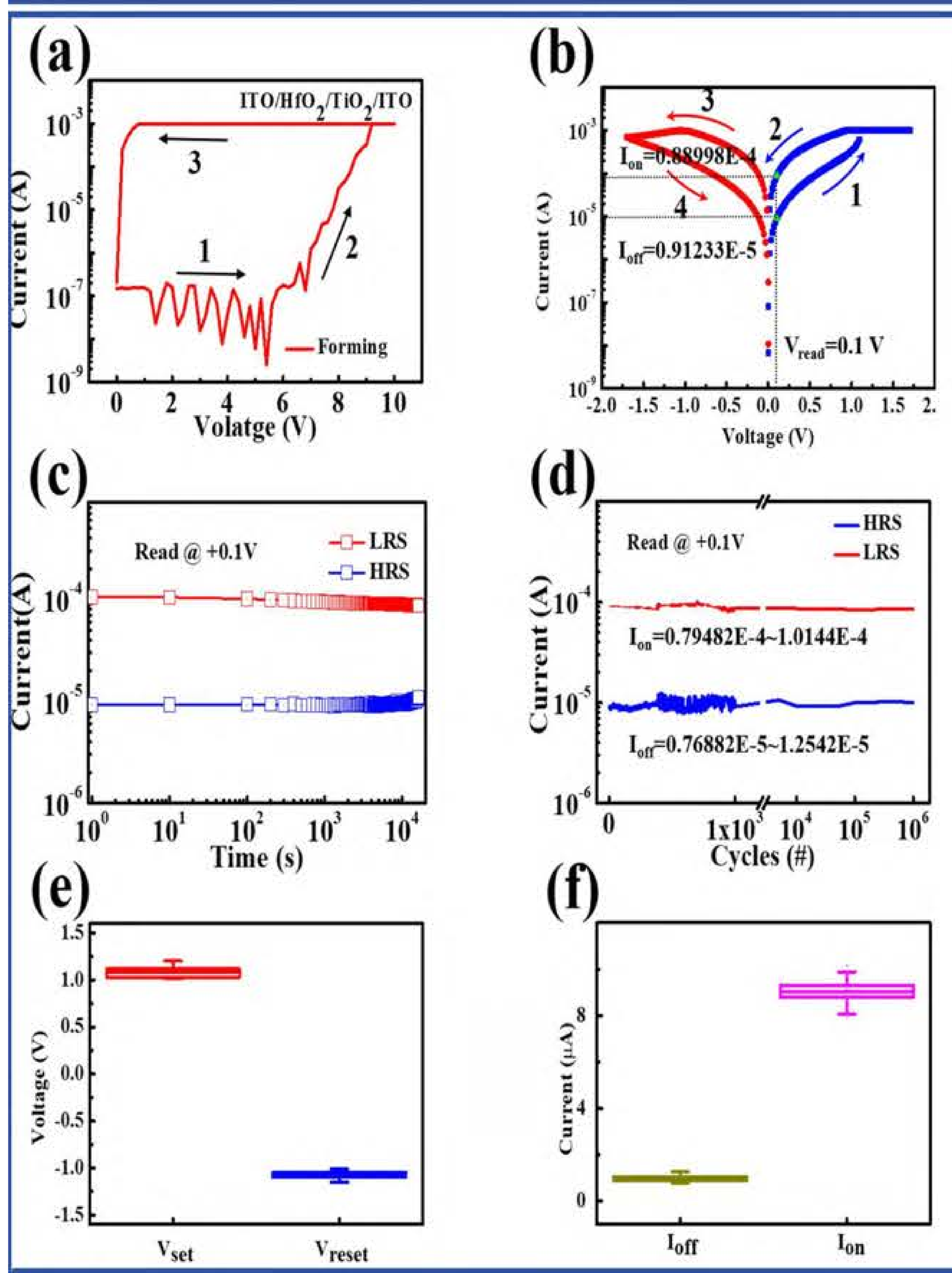

Fig. 2 (a) Electroforming process of the device. (b) I–V curve. (c) Retention of the device at room temperature. (d) Endurance plot. (e) Set and reset voltage distributions. (f) On and of current distributions

Results and Discussion

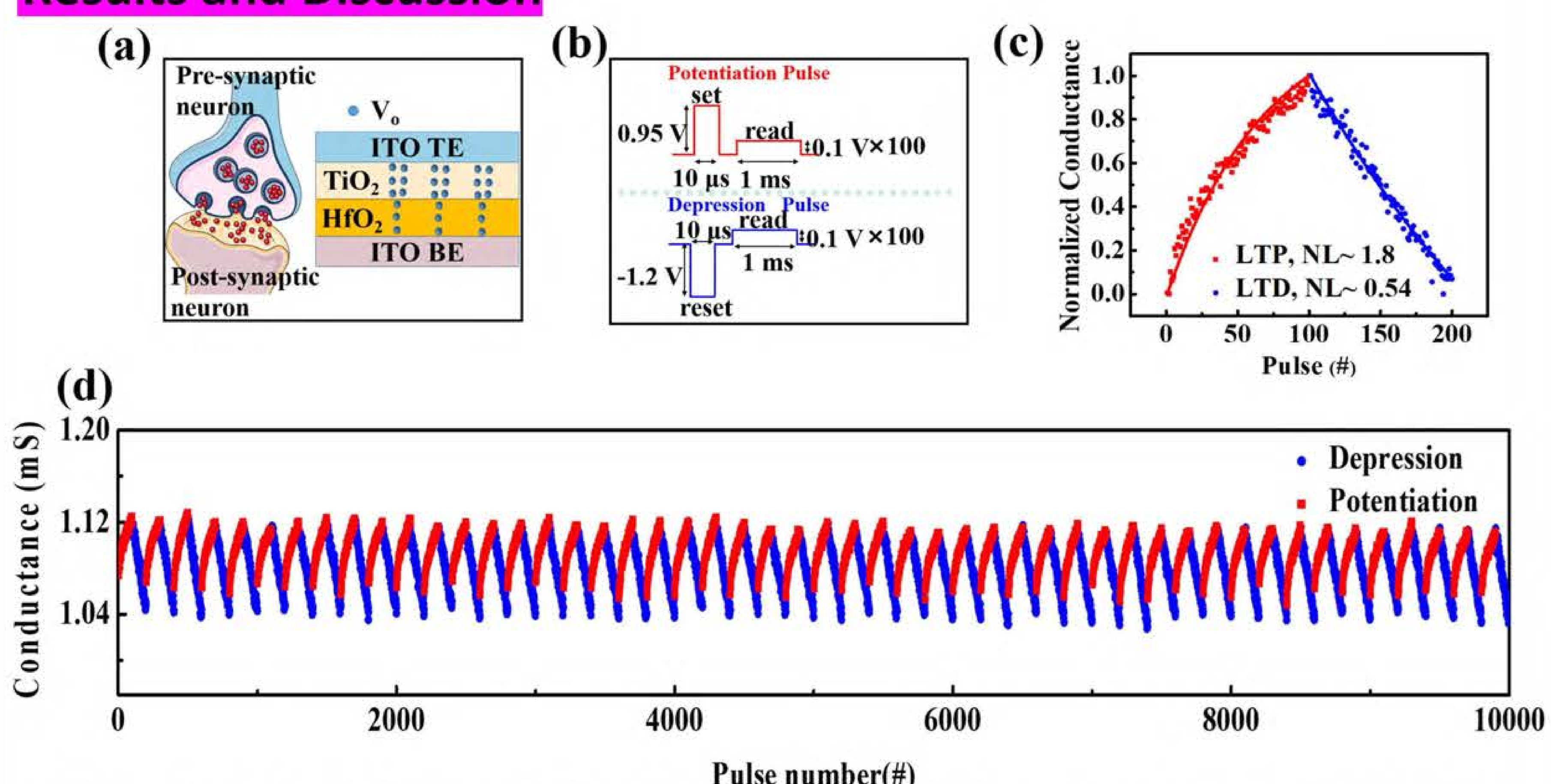

Fig. 3 (a) Schematic diagram of the synapse and the structure of the ITO/HfO_2/TiO_2/ITO synaptic device. (b) Pulsing schemes for potentiation and depression, respectively. (c) Gradual conductance modulation of potentiation and depression under successive pulse stimulation. (d) Stable 50 epoch potentiation and depression trainings

Results and Discussion

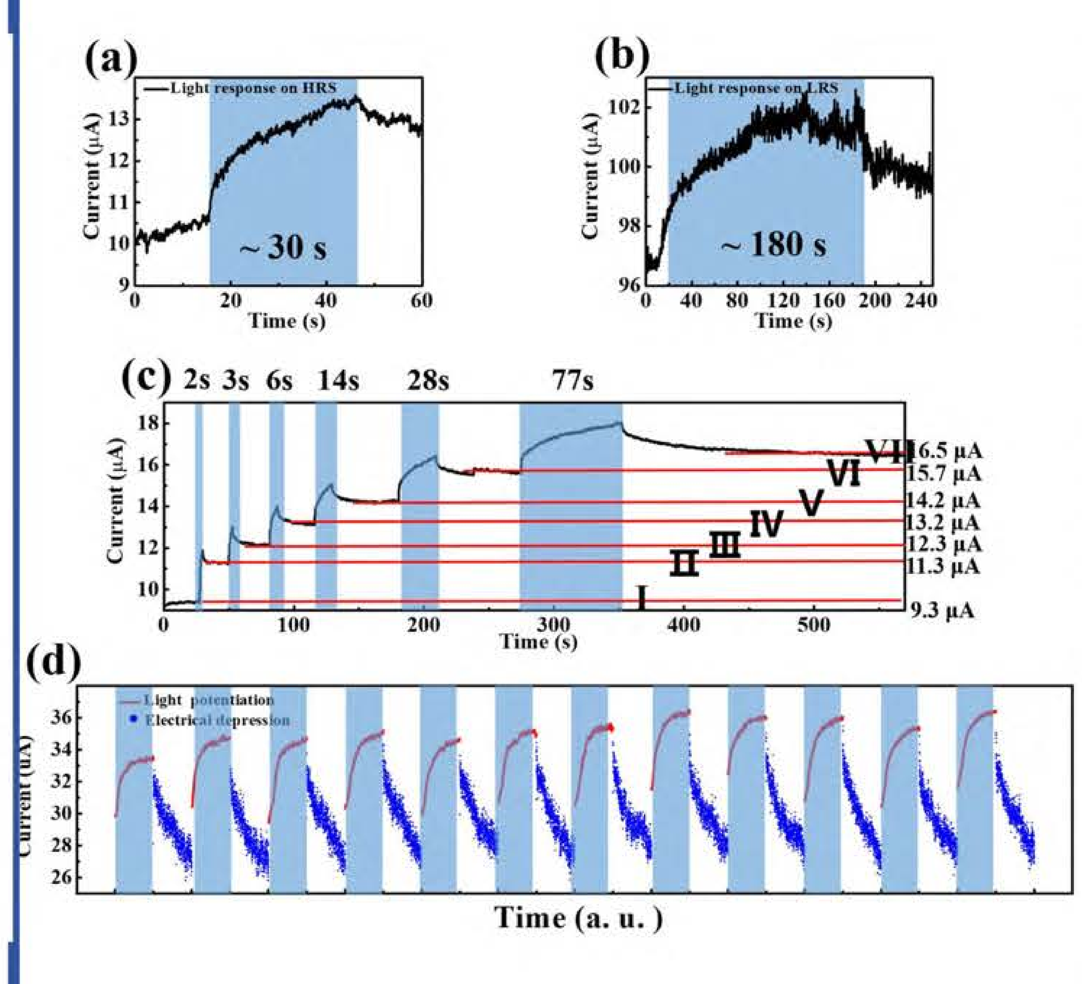

Fig. 4 Current response under the application of 405 nm wavelength light irradiation on (a) HRS and (b) LRS. (c) Multilevel storage realized by light irradiation. (d) Optical potentiation and electrical depression characteristics simulated by optoelectronic artifcial synapse

Conclusions In summary, the fully CMOS process-compatible ITO/HfO_2/TiO_2/ITO optoelectronic synaptic memristor was fabricated. These results suggest that this optoelectronic memristor has a high potential for neuromorphic application.

References [1] Song JF, Luo XS, Lim AEJ, Li C, Fang Q, Liow TY, Jia LX, Tu XG, Huang Y, Zhou HF, Lo GQ (2016) Sci Rep 6:22616