Physical Reservoirs Capable of Multi Time-scale Processing Implemented Using Direct-grown Bi_2O_2Se-based Memristors

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Abstract

The implementation of an analog physical reservoir for sequence data processing reduces the complexity of neural networks [1]. However, the differences in data interval and decay time of the memristor make it difficult to universally use reservoir computing for various types of data. Therefore, it is necessary to develop a physical reservoir with a tunable decay time scale within a single device. Herein, we report memristors with programmable decay times using Bi_2O_2Se grown directly on Al electrodes. The SET and HOLD voltages of memristors show small standard deviations of 0.031 and 0.030 respectively. Interestingly, our volatile memristors exhibited an order-of-magnitude difference decay time when input pulses of 5 μs, 50 μs, and 500 μs width were applied. Also, the linear increase of lnτ (τ: decay time) with temperature increasing shows that metallic filament lifetime is strongly affected by diffusion of Ag ions [2]. Finally, we analyzed output responses to four types of sequence inputs for each pulse width, and distinct conductance levels were obtained in the array level.

References

[1] Zhong Y, et al., Nat. Electron., 5 (2022) 672
[2] Ahn W, et al., Small, 19 (2023) 2300223

Figures

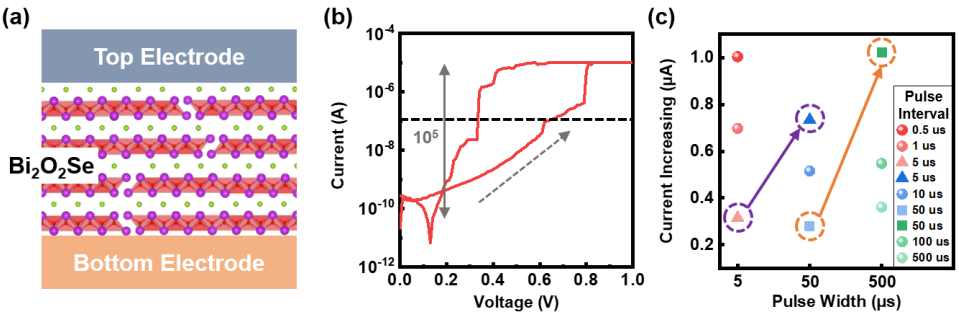

Figure 1: a) Schematic illustration of the device. b) I-V curves of the device c) Current increase for different pulse widths and intervals

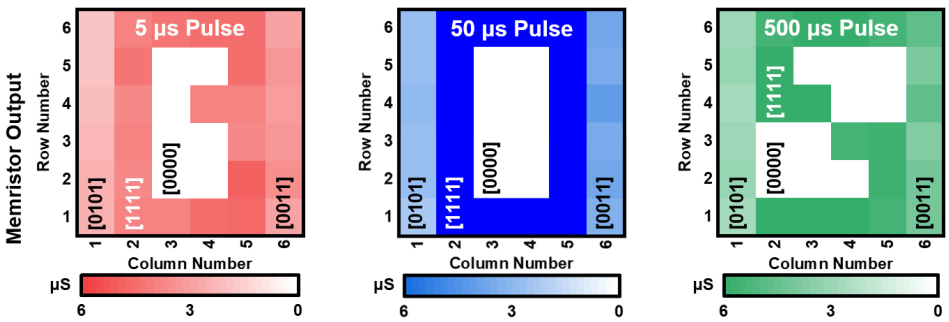

Figure 2: Output responses of 36 devices to four types of sequence inputs with different pulse widths