Long-term reliable filament formation in 2D material-based synaptic memristor by inserting active metal reservoir

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Abstract

This low diffusion energy barrier through multi-vacancies in 2D materials leads to the advantages of low switching voltage and excellent synaptic characteristics but also leads to the disadvantages of short retention characteristics. Herein, we suggest the new approach to form a robust copper filament that has excellent retention characteristics by inserting the copper reservoir. MoS_2 and Al_2O_3 are used as the switching layer and the copper reservoir, respectively. The fabricated Cu/Ti/MoS_2/Al_2O_3/Au device exhibits low switching voltage (<0.5 V), wide dynamic range (>12), and great switching uniformity (σ/μ ~ 0.07). Additionally, the linear potentiation/depression curve (a_P=0.31 and a_D=-1.01) is achieved. Most importantly, this device has excellent multistate retention characteristics over 10^4 s in the switching conductance range. The recognition rate of deep neural network (DNN) simulation is over 93% and the same recognition rate is maintained for 10 years.

References

[1] Xu R, et al., Nano letters, 19 (2019) 2411.

Figures

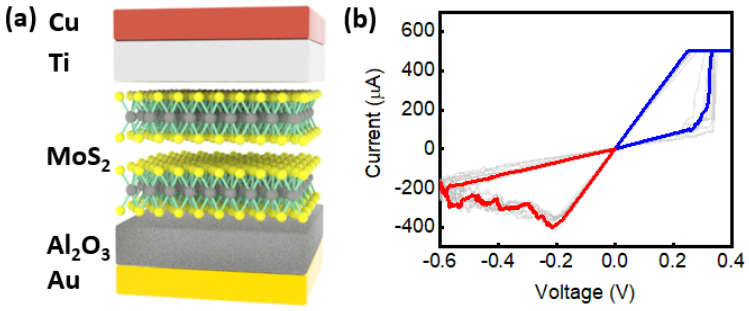

Figure 1: a) Schematic illustration of the Cu/Ti/MoS_2/Al_2O_3/Au device. b) I-V curves of 10 DC sweep

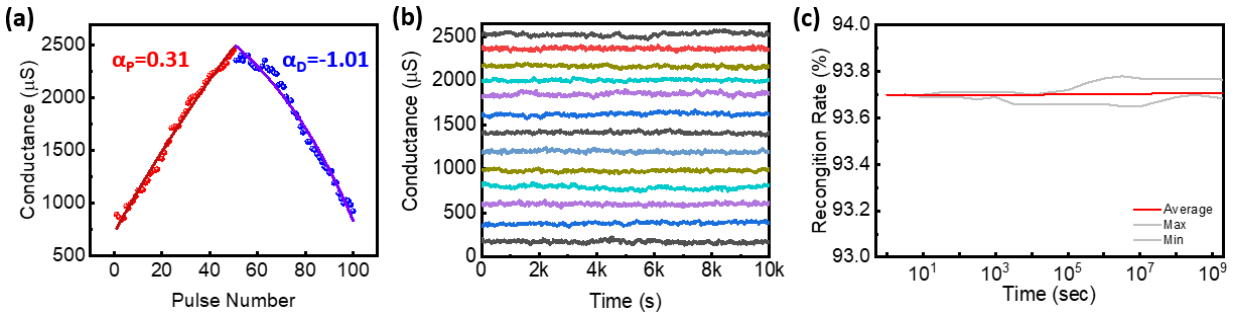

Figure 2: a) Potentiation/depression curve of the device. b) Retention characteristics of the device in the switching range. c) MNIST data recognition rate of DNN simulation for the 10 years.