The study of 2D van der Waals material based synaptic device

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The development of reliable memristor devices capable of storing multiple states of information has opened up new applications as neuromorphic computing.[1,2] Recently, Reported ion migration based synaptic memristor devices using two-dimensional (2D) layered transition metal dichalcogenides (TMDs) materials such as MoS_2 and WS_2. Native oxidized layer of sub nanometer thickness exhibits excellent synaptic plasticity and learning capacity close to the ~100mV level of neuron spike by electrically induced oxygen vacancy conductive bridge.[3] However, these devices has dimension limit as reducibility total thickness due to Native oxidized $MoOx/MoS_2$ and WOx/WS_2 heterostructure. Meanwhile, two-dimensional (2D) van der Waals (vdW) materials have recently attracted considerable attention due to their excellent electrical and mechanical properties. TmPSx (where Tm = a transition metal), which is a new class of 2D vdW materials, is expected to show various physical phenomena depending on the Tm used. In this paper, the unprecedented synaptic behavior of a vertical $Ag/CrPS_4/Au$ capacitor structure, where $CrPS_4$ is a single-crystalline 2D vdW layer, is reported. Multi-stable resistive states were obtained using an external voltage of less than 0.3 V. Both short-term plasticity and long-term potentiation were observed by controlling the interval of the external voltage pulse. Simple mechanical exfoliation was used to develop a synaptic device based on a very thin $CrPS_4$ layer with a thickness of ~17 nm. Therefore, it was demonstrated that vertical $Ag/CrPS_4/Au$ capacitors could be promising inorganic synaptic devices compatible with next-generation, flexible neuromorphic technologies.

References

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Figures

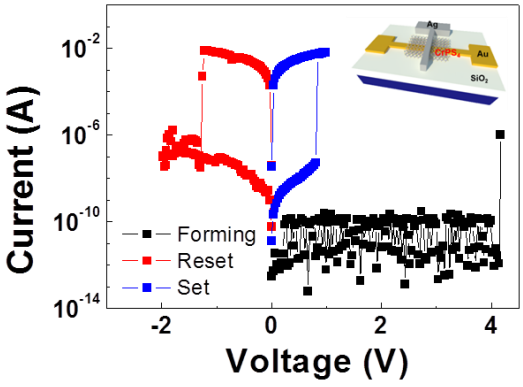

Figure 1. The current-voltage (*I-V*) curves show the bias-polarity-dependent bipolar resistive switching (RS) behaviors of the $Ag/CrPS_4/Au$ device.