Multiplexed Synaptic Modulation and Memory in Ionic Film-coated Si Nanowire Transistors

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The brain has remarkable memory and learning ability using parallel information processing in multiple synapses.[1] By mimicking the brain functionality, artificial synapses have been established using memristors[2] and transistors[3] based on synaptic plasticity of ionic or memristive film. However, to realize the feasible learning and memory for neurocomputing is still in challenge because of the low compatibility of the memristive devices with conventional Si-based CMOS system and an unintuitive memory process using the timing between pre- and post-synaptic signals.[4] Here, we report synaptic Si nanowire transistors covered with ion-doped silicate film. A planar top gate can simultaneously modulate the conductivity of multiple post-synaptic nanowires through the film that would be able to realize multiplexed neurotransmission in the brain. The synaptic transistor acts as a random access memory (RAM) cell due to the ionic polarization of doped metal ions in the film depending on amplitude and frequency of pulses applied on the gate. Therefore, short term potentiation (STP) is configured by the transfer characteristics of a transistor. In addition, synaptic learning has been appeared after rehearsed training, so that the post synaptic current reaches the same current level faster than before training. This study has achieved a breakthrough in the convenient interconnection between neuromorphic devices and CMOS system with tunable memory mimicking the process of human brain.

References

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[2] D. S. Jeong *et al.*, RSC Adv., 3 (2013) 3169-3183
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Figures

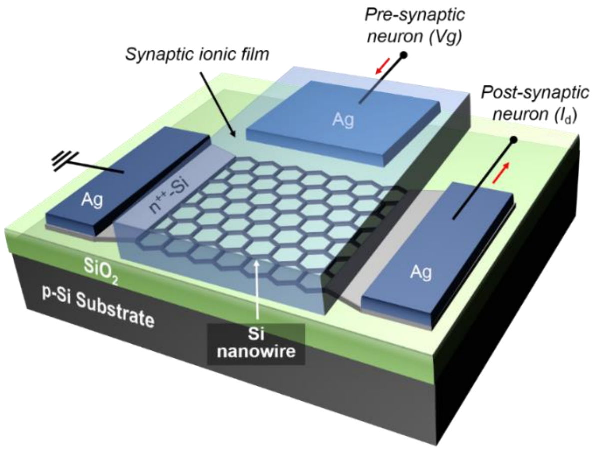

Figure 1. Schematic diagram of the synaptic Si nanowire field effect transistors (FETs)

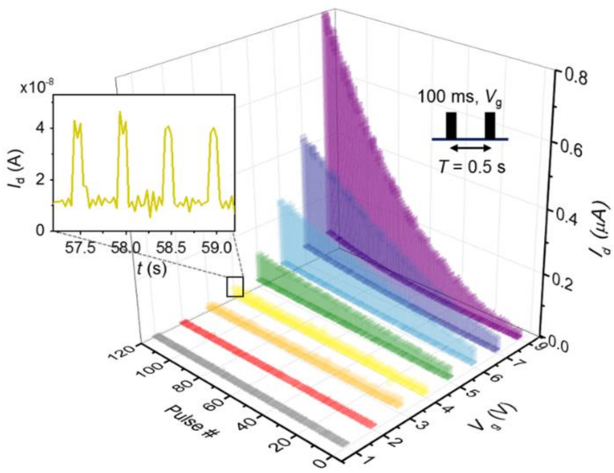

Figure 2. Synaptic plasticity depending on the gate bias