Pulse Width Programming based on GeTe/Sb_2Te_3 Superlattice Structure for Artificial Synapse

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As Artificial Intelligence (AI) technology advances, the development of information technology is imperative. Among them, neuromorphic computing, which realizes hardware of adaptive parallel processing, has been proposed as one of the most promising technologies [1]. Among them, emerging non-volatile memory (eNVM) has advantages for energy efficiency and fast operation speed. Synapses used to operate the biological brain are implemented through synaptic weights for information transmission and storage [1]. To implement this as a hardware-based eNVM, it should have excellent analog conductance regulation. Among the 2-terminal eNVMs, phase change memory (PCM) is considered the most promising artificial synapse and neuron device. However, a rapid and high reset pulse destroys the inherent state and consumes high energy during high amorphization. To solve this problem, an interfacial phase change memory (iPCM), a superlattice structure having a vdW gap by alternately depositing GeTe/Sb_2Te_3, has been proposed [2]. As shown in Figure 1, the iPCM reconfigure the atomic structure by changing the atomic arrangement of Ge atoms by charge injection. It appears that the superlattice structure restricts the movement of atoms. This mechanism suggests that the iPCM has the possibility of finely controlling conductance with electrical pulse programming. Therefore, as shown in Figure 2, the conductance characteristics of the GeTe/Sb_2Te_3 superlattice according to the pulse width can be confirmed. As the pulse width becomes shorter, it can be seen that the increase in conductance also increases gradually. This has a great advantage in implementing analog conductance regulation. It is expected that iPCM pulse programming scheme can be widely employed in neuromorphic computing.

[1] Banerjee, Writam. "Challenges and applications of emerging nonvolatile memory devices." *Electronics* 9.6 (2020): 1029.

[2] Simpson, R. E., et al. "Interfacial phase-change memory." *Nature nanotechnology* 6.8 (2011): 501-505.

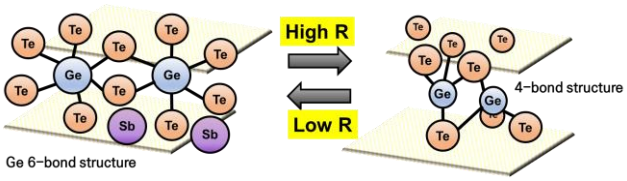

Fig.1 Schematic of the iPCM mechanism

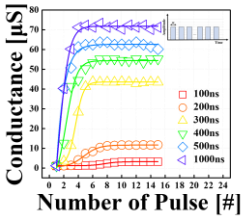

Fig. 2 Conductance characteristics of the iPCM by pulse width

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