

2D materials in memory device applications

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Modern-day computation systems are facing failure in doing complex tasks and calculations. This is due to the fact that modern computer memory and processors are located in two different locations, leading to von Neumann's bottleneck. On the other hand, our brain can efficiently do such complex tasks in a research-efficient way. The enormous learning ability of the brain comes from its plastic nature. The synapses present in the brain can undergo plasticity during the learning process. Hence scientists have been studying the design of artificial brain-memory that mimics synapses in the brain. They have been successful in inventing the artificially built neurons called memristors. Memristors are used in building artificial brain memory. They change their weightage (resistance) with changes in other parameters, such as voltage. Among them, SiO₂ based memristors are of great importance due to the abundance of SiO₂ on the earth's crust and process compatibility with the available "complementary metal-oxide semiconductor" (CMOS) technology. Previously, SiO₂ filament formation-disruption type memristors have been tried but the filament formation in the case of SiO₂ memristors is not stable and tends to break quickly. As a solution, a 2D material is being inserted in between cathode and anode in SiO₂ memristors. MXenes are a new class of transition metal carbides and nitrides with high conductivity, super hydrophilicity and increased surface area. When MXene is inserted in between the cathode and anode of SiO₂ memristors there is a formation of stable filaments which gradually lead to resistance variation. The variation of resistance with respect to input bias in SiO₂/MXene memristors can be used to store information efficiently. Hence, SiO₂/MXene memristors could potentially be used in neuromorphic engineering.

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