Wafer-scale integration of two-dimensional materials in high-density memristive crossbar arrays for artificial neural networks

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During the last decade, memristors have attracted enormous interest due to their excellent capability to store digital information, and they are being considered to be a key element to build future artificial neural networks for bio-inspired neuromorphic computing systems [1-5]. Recent works have shown that memristors made of layered two-dimensional (2D) materials can exhibit performances that traditional memristors (made of transition metal oxides) do not show, such as excellent transparency and flexibility, high-temperature stability, and unique controllability of the conductance potentiation, depression and relaxation [6-10]. However, all studies on 2D materials based memristors focused on single devices, and system level performances like yield and device-to-device variability have never been analyzed in depth. Furthermore, several basic properties of 2D materials based memristors (such as switching time, write energy, I-V non-linearity, and scalability) have never been investigated. In this talk, I will present the first wafer-scale statistical analysis of high-density memristive crossbar arrays made of 2D layered materials. By using chemical vapor deposited multilayer hexagonal boron nitride (h-BN) sheets, we have fabricated metal/h-BN/metal memristive crossbar arrays not only exhibit outstanding performance, but also high yield ~98%, and low device-to-device variability. These findings may accelerate the use of 2D materials for building wafer-scale and high-density electronic memories and artificial neural networks.

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