Nanoscale memory devices for chemical sensing applications

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The advancements in neuromorphic computing have unveiled novel memory effects inherent to nanoscale materials, encompassing resistive switching and ion migration, among others. Over the past decade, these materials have demonstrated remarkable potential beyond computing, particularly in the realm of highly sensitive chemical sensing. Three-terminal devices, i.e. field-effect transistors (FETs), have emerged as pivotal components in this domain, serving as memristive biosensors and neurotransistors. In this work, we highlight the utilization of one-dimensional materials-based FETs for the ultrasensitive detection of biomarkers. We also illustrate how convenient surface engineering of these FETs with polarizable gate materials endows them with neuron-like learning capabilities. Additionally, by replacing the unipolar semiconductor channel with an ambipolar counterpart, we unveil devices with enhanced learning potential. The convergence of sensing and learning functionalities holds promise for the development of multifunctional devices capable of storing and processing data together with responding more efficiently to analyte exposure following a learning process.