Influence of vacuum conditions on the resistive switching of h-BN-based memristors

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Hexagonal boron nitride (h-BN), a two-dimensional (2D) insulator with a wide band gap (~6 eV), has emerged as a promising resistive switching (RS) medium in memristive devices [1,2]. Its atomically thin structure enables low off-state currents and a broad switching window. The RS mechanism in h-BN is typically attributed to metallic filament formation under electrical stress [3], possibly like the electrochemical metallization (ECM) process known from metal oxide-based memristors [4]. Since environmental factors like water and oxygen molecules can significantly influence RS behavior in oxide-based ECM cells [4], we investigated whether similar dependencies exist in h-BN-based devices. We examined the forming behavior of Pd/h-BN/Ni memristors (schematic in Figure 1) under ambient air and vacuum conditions.

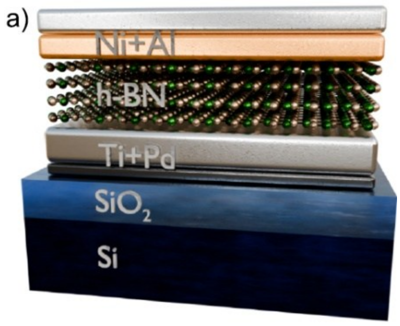

Figure 1: Schematic of the fabricated device stack. [5]

Voltage sweeps were applied to multiple devices. In ambient, devices successfully formed within a specific voltage and current range. However, under vacuum, no switching was observed even after repeated attempts with identical voltage stress. We further support these findings through simulations using an established metal oxide memristor model [6] to compare SET kinetics in both conditions. Our work extends the use of this model to 2D materials and highlights the crucial role of environmental species in h-BN device operation, an important consideration for applications in encapsulated or vacuum-sealed electronic systems [5].

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