High-throughput Fabrication of Memristive Devices via Electrophoretic Deposition of Solution-Processed h-BN

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Abstract

Hexagonal boron nitride (hBN) is a highly attractive two-dimensional (2D) material for memristor fabrication owing to its wide bandgap, which ensures excellent insulation and enables devices with stable OFF states, which is an aspect that has remained challenging in transition metal dichalcogenide (TMD)–based memristors. To date, most hBN devices have been realized through elaborate techniques such as chemical vapor deposition (CVD), which offer limited potential for industrial scalability [1]. Liquid-phase exfoliation of hBN provides an alternative route, but devices fabricated by inkjet printing often suffer from high variability due to poor control over film quality [2]. Here, we demonstrate memristive switching in hBN devices fabricated using inks prepared by liquid-phase exfoliation and deposited via a scalable electrophoretic deposition (EPD) process. The resulting devices have been fabricated in two different architectures; a conventional crossbar geometry exhibiting stable threshold as well as bipolar resistive switching with an ON/OFF ratio of ~10^5 (Fig. 2); and a non-conventional geometry employing eutectic GaIn electrodes compatible with flexible electronics (Fig. 1). In combination with the thermally stability and moisture resistant nature of hBN, our approach yields devices that are not only robust but also compatible with large scale producibility.

References

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[2] Zhu K, Vescio G, González-Torres S, López-Vidrier J, Frieiro JL, Pazos SM, Jing X, Gao X, Wang S-D, Ascorbe-Muruzábal J, Ruiz-Fuentes JA, Cirera A, Garrido B, Lanza M. Inkjet-printed h-BN memristors for hardware security. Nanoscale. 2023;15:9985-9992.

Figures

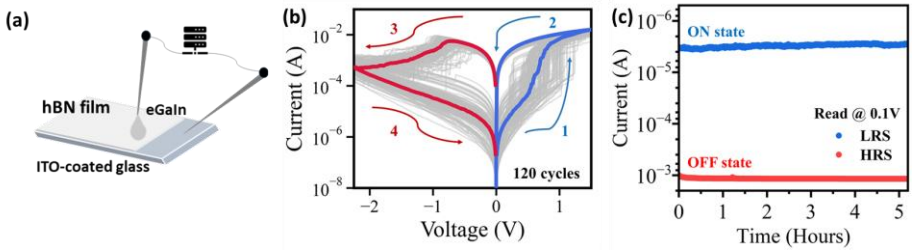

Figure 1: (a) Schematic of the eGaIn/hBN/ITO device structure. (b) Bipolar resistive switching behavior over 120 I–V cycles. (c) Retention performance at 0.1 V showing stable ON (LRS) and OFF (HRS) states over 5 hours.

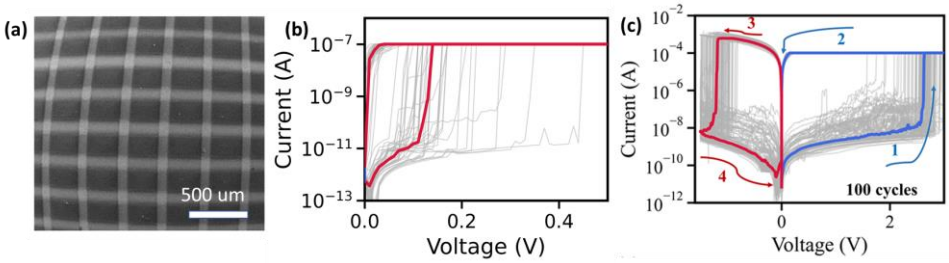

Figure 2: (a) SEM image of the device array (scale bar: 500 µm). (b) Threshold and (c) Bipolar resistive switching behaviour for the same device at different compliance.