# Influence of MOCVD $MoS_2$ Material Properties on Memristor Switching Voltage and Resistance State Variability

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Layered 2D $MoS_2$ has been extensively studied as an active material for memristors [1-5]. However, $MoS_2$-based memristors generally suffer from high variability and low yield [1,2]. This work addresses the influence of the surface properties of MOCVD-grown multilayer $MoS_2$ on the memristor variability. We fabricated vertical $MoS_2$ memristors with palladium (Pd) back electrodes (BE) and aluminum (Al) top electrodes (TE) using two different $MoS_2$ batches. Batch 1 has a smooth surface (roughness 1 nm) with large hexagonal and triangular crystallites and large grain boundaries. In contrast, batch 2 has a rougher surface (3.4 nm), smaller crystallites, and surface contaminations. Current-voltage (*I-V*) sweeps were performed on 63 devices with batch 1 and 59 devices with batch 2. The cumulative distributions of 1735 (batch 1) and 533 (batch 2) switching cycles show that batch 1 devices exhibit significantly lower variability in the switching voltages and resistance states. We show that our memristors switch via metallic filament formation of Al through $MoS_2$. Thus, we attribute the improved variabilities to more uniform filament formation through fewer grain boundaries [4,5] enabled by the large crystallites. Our work shows a pathway to reduce the variability of 2D memristors by tuning the grain boundary size and structure, achieving high device yields (95%) for MOCVD-grown $MoS_2$.

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