Analysis of the Behavior of a Memristive Device within a One-Transistor-One-Resistor Structure

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SUMMARY

This paper investigates a one-transistor-one-resistor structure consisting of an NMOS and a memristive device (MD). MDs contain a conductive filament inside and depending on their geometric configuration, it is either in the so-called high-resistive state (and thus off, during the RESET cycle) or in the so-called low-resistive state (and thus on, during the SET cycle) [1]. To prevent damage to the MD, the current must be limited [2], which can be achieved using a compliance current or a transistor. This paper focuses on the influence of the transistor on the MD. Figure 1 (a) illustrates the difference between the two cases and clearly shows that the transistor can influence the current flow in the MD. The 1R curve was fitted to measurement data using the Stanford Model (SM). Different circuits must be set up for SET and RESET, as shown in figure 1 (b). By examining the points where the MD operating lines intersect with the NMOS output curve, we can demonstrate how the current is limited. Because of the different structures during the SET cycle, we discovered that the VGS always remains constant, whereas during the RESET cycle, the VGS value changes over the course of the cycle, which is researched further in the span of this paper. Figure 2 shows the IV-characteristic as a function of the voltage VR, which is plotted in figure 1(b). It is notable that during the SET cycle, the voltage VR initially rises, as does the current. However, the voltage VR then decreases while the current continues to rise. This behavior is interesting and could be useful for various applications. The observations in the simulation were also noticed in measurement data from a 1T1R structure. In addition, the influence of parasitic resistance on this curve shown in figure 2 was investigated.

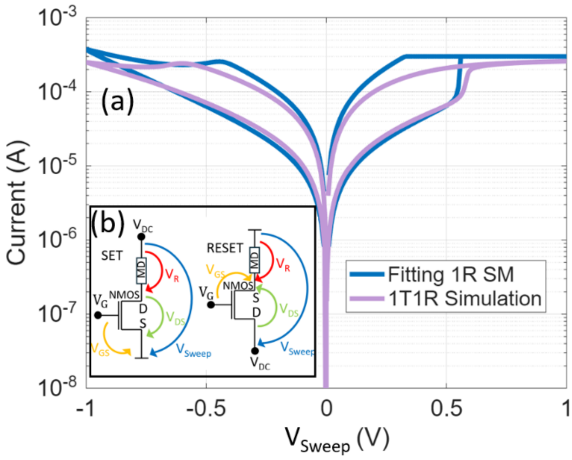

Figure 1. (a) 1R Simulation with compliance current (fitting result for a measurement) and 1T1R Simulation. (b) 1T1R structure.

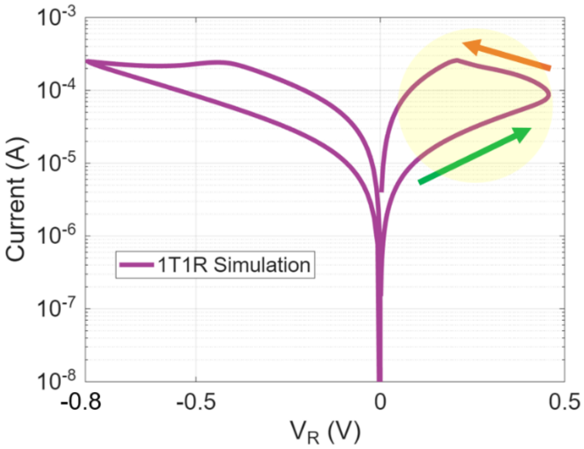

Figure 2. V_R curve: The voltage decreases while the current continues to rise (orange arrow).

REFERENCES

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