Fundamentals of Oxide Resistive Random Access Memories (RRAM)

David C. Gilmer

NANTERO, 2706 Montopolis Dr. Austin TX 78741

Among the technology options for non-volatile memory devices, Metal-Oxide based Resistive Random Access Memories (RRAM) is currently under consideration because of its superior scaling opportunities and structural simplicity. This technology offers the possibility of reversible changes in the conductivity of a dielectric film between high (HRS) and low (LRS) resistance states by consecutively applying voltage pulses of opposite or similar polarities across the metal-‘resistor’-metal “MIM” memory cell.

While the key factors driving the resistive switching in metal oxides have been identified, microscopic description of the conductive filament features that enable memory operations is only recently evolving. This talk will cover some fundamentals of Metal-Oxide based RRAM with an emphasis toward Hafnia-¬Oxide, including materials/vacancy engineering profile and ramifications. The entire set of reported experimental data and material structure modeling and transport simulation results are consistent with the physical picture of the RRAM operations as caused by oxidation/reduction processes of a conducting filament formed in the dielectric. The materials/vacancy engineering profile and the outcome of the filament formation process establishes initial structural conditions for the subsequent reset and set operations. A microscopic description of these processes, the framework of which is presented here, directly links the device electrical and material characteristics thus enabling improving device performance through optimization of the materials compositional profile and operation conditions.