Abstract

Resistive Random Access Memories (ReRAMs), belonging to the wide family of memristive devices, have recently gained great attention for their logic-in-memory capability and the ability to mimic the biological synapses behavior, becoming a good candidate for the realization of new technologies able to overcome the bottleneck of Von Neumann architectures. In this study, metal-insulator-metal (MIM) devices are considered, where the active layer consists in a binary metal-oxide thin film deposited via atomic layer deposition (ALD). The first part of the dissertation is devoted to the inspection of the correspondences between the internal dynamics responsible of the switching and the engineering of active layer and electrodes. The influence of several factors is inspected, such as the device geometry, the active layer composition and the electrode materials. The choice for the active layer in this material-based study falls on oxides that are not conventionally used in microelectronic components. In particular, an extensive study on ZnO is reported, including DC and AC characterizations. Moreover the ALD doping process is defined and the impact of the insertion of partial Al_2O_3 single-layers in ZnO and TiO_2 thin films is inspected, dealing with the differences in the material properties (such as structure, morphology, stoichiometry...) and in the memristive response. In the second part of the dissertation, HfO_2-based devices are introduced. These devices, with their low temporal and spatial variability, allow systematic electrical tests. The main purpose in this part is the study of multi-bit information storage and resistance multi-state control. The multi-state retention, the behavior reliability over consecutive programming operations and the impact of different programming stimuli are the main explored elements. Finally, the multi-resistance control is achieved by pulse rise time modulation, thanking advantage from the multi-oxidation states of the W top electrode and the proper engineering of oxide/electrode interfaces.