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A physically based model for resistive memories including a detailed temperature and variability description

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Abstract

A new model to account for variability in resistive memories is presented. It is included in a previous general current model that considers the main physical mechanisms involved in the conductive filament formation and disruption processes that lead to different resistive states. The validity of the model has been proved for different technologies of metal-insulator-metal bipolar resistive memories. The model can be implemented in Verilog-A for circuit simulation purposes.

Keywords: Resistive RAM; ReRAM; physical model; stochastic variability

1. Introduction[*]

Resistive Random Access Memories (RRAMs) are known to be one of the most promising alternatives to substitute flash technology in the non-volatile memory market [1, 2]. In addition to fabrication developments, simulation and compact modeling are essential facets to make a new technology pass into the maturity state. In this context, the variability of resistive switching (RS) based on the formation and disruption of Conductive Filaments (CF) in Metal-Insulator-Metal (MIM) structures has been modeled in this manuscript. The model works well for MIM structures fabricated with different technologies, once the corresponding model parameters are fitted. The resistance of the electrodes and that of the CFs in different stages of formation is considered, as well as the hopping current in the gap (g) between the CF tip and the electrode. The thermal description of the CF is included by solving the heat equation where Joule heating and lateral dissipation from the CF to the surrounding dielectric are taken into account [3-5]. Variability [6] has also been introduced by employing a sigmoid function that allows reproducing the stochastic nature of the device physics. The model is suitable for implementation in circuit simulators to analyze circuits based on RRAMs under different operation regimes.

2. Fabricated devices

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