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Dynamic Behavior of Resistive Random Access Memories (RRAMS) Based on Plastic Semiconductor

Abstract

Resistive Random Access Memories based on metal-oxide polymer diodes are characterized. The dynamic behavior is studied by recording current-voltage characteristics with varying voltage ramp speed. It is demonstrated that these organic memory devices have an internal capacitive double-layer structure, which inhibits the switching at high ramp rates (1000 V/s). This behavior is modeled and explained in terms of an equivalent circuit.

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Dynamic Behavior of Resistive Random Access Memories (RRAMS) Based on Plastic Semiconductor

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Abstract. Resistive Random Access Memories based on metal-oxide polymer diodes are characterized. The dynamic behavior is studied by recording current-voltage characteristics with varying voltage ramp speed. It is demonstrated that these organic memory devices have an internal capacitive double-layer structure, which inhibits the switching at high ramp rates (1000 V/s). This behavior is modeled and explained in terms of an equivalent circuit.

Keywords: Resistive Random Access Memory (RRAM), Switching, Electrical Bistability, Non-Volatile Memory, Negative Differential Resistance (NDR).

1 Introduction

Organic memory devices are becoming interesting candidates for electronic applications in information technologies [1]. One emerging candidate is the resistance random access memory (RRAM) based on metal oxides [2,3] and organic semiconductors [4-6]. These RRAMs have shown electrically induced resistive switching effects and have been proposed as the basis for future non-volatile memories. They associate the advantages of Flash and DRAM (dynamic random access memories) such as higher packing density, faster switching speed and longer storage life.

Although, several metal-oxides structures exhibited resistive switching properties, the measured switching parameters vary in a wide range, which calls for a more consistent and uniform characterization methodologies. Furthermore, reported switching speeds vary by orders of magnitude [7-14]. The values range from nanoseconds to milliseconds. The inconsistencies might be due to different semiconductors, device geometries, or measurement procedures. In order to clarify these discrepancies, we characterize the switching speed of a metal-oxide memory device using dynamic measurements and equivalent circuit modeling.

The dynamic characterization of the metal-oxide polymer structure through a double RC circuit provides insight on the switching phenomenon. It is demonstrated the relevance of the oxide layer and its role on limiting the switching speed.

2 Contribution to Value Creation

Organic based memory devices provide a simplified manufacturing process yielding low-cost, flexible, and light-weight area approaching the nano-scale dimensions.

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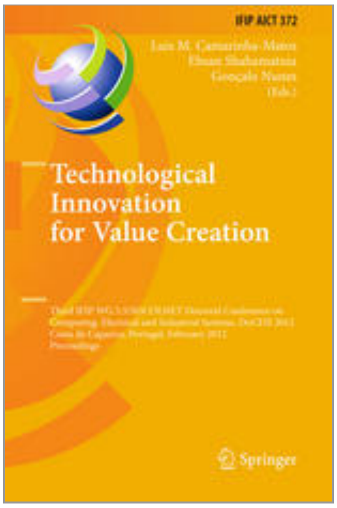
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