# Temperature Dependent Studies to Understand the Mechanism of Switching in Resistive Random Access Memory Devices

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Resistive Random Access Memory (ReRAM) devices have gathered significant attention recently for high-density non-volatile data storage applications. However, there are several hurdles that need to be overcome to take the complete benefit of this enabling technology [1-5]. In this paper, we address the challenges concerning the electroforming and reset of ReRAM devices.

Electroforming is one of the key processes that governs the performance of the devices and yield. There are several techniques of electroforming that have been studied so far. These include DC voltage sweeps, constant voltage stressing, constant current stressing, and constant voltage stressing at elevated temperatures. However, it is known that parasitic capacitances can come into the picture and lead to a current overshoot that can destabilize the filament [6-8]. In this work we will first present data on a novel technique of electroforming using multi-step voltage sweeps. We will also present statistical analysis of data comparing the conventional electroforming and novel multi-step electroforming to show the benefit of this proposed technique. Thereafter, schemes to implement the proposed electroforming in crossbar arrays of ReRAM devices will be discussed.

Next, we will focus on understanding the mechanism of switching in ReRAM devices, more specifically, the mechanism of Reset in ReRAM devices will be discussed in details. To understand the mechanism of reset, we have performed temperature dependent studies on ReRAM devices using a cryogenic probestation. Our studies show that the final resistance state obtained during the reset depends on the ambient temperature. Devices are found achieving higher resistive states at elevated reset temperatures. This observation will be explained using a series of temperature based measurements. Based on these observations, the mechanism of reset in ReRAM devices will be discussed and correlated with the material parameters.

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