ADVANCED MEASUREMENT TECHNIQUES FOR THE CHARACTERIZATION OF ReRAM DEVICES

M. Nafria, Universitat Autonoma Barcelona, Spain
montse.nafria@uab.es
R. Rodriguez, M. Porti, J. Martin-Martinez, A.Crespo-Yepes, S.Claramunt, X. Aymerich
Universitat Autonoma Barcelona, Spain

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In some Resistive Random Access Memories (ReRAM), which could become the next generation of non-volatile memories [1], the voltage-controlled high and low resistance states (HRS and LRS, respectively) are associated to the creation (Set) and disruption (Reset) of a conductive filament (CF) that locally connects (LRS) or disconnects (HRS) the electrodes [2]. Usually, a current limit (CL) must be fixed during the Set process. Typically, these devices are characterized using source measurement units (SMU) to measure the current through the device. However, most of the SMU have a low sampling rate (around 1sample/1ms) and the current limitation mechanism used by the equipment is not well understood. To overcome these limitations, in this work, a low-cost setup with large sampling rate (larger than 1sample/10µs) is presented which, in addition, includes a well-controlled wide-range current limiting unit, CLCU (Fig. 1). The system is suitable to capture fast transients during the Set/Reset processes (Fig. 2) and to detect HRS Random Telegraph Noise (RTN) unresolvable by SMUs (Fig. 3) [3]. These device-level measurements can be combined with a Conductive Atomic Force Microscope, to get information on CF properties that cannot be directly measured at device level, as, for example, the spatial distribution of current in the CF at LRS and HRS (Fig. 4) [4].

[1] F. Yoshihisa, Jap. J. Appl. Phys. 52, 2013; [2] W. Rainer et al., Adv. Mat., 21, 2009; [3] J. Diaz-Fortuny et al., Rev. Sci. Inst., 87, 2016; [4] S. Claramunt et al., Mic. Eng., 147. 2015

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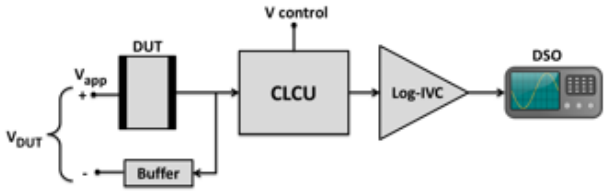

Figure 1 – Block diagram of the developed setup.

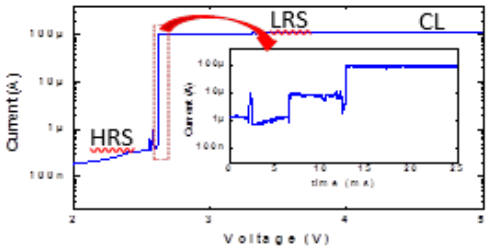

Figure 2 – Set process (CL=100µA) in a ReRAM measured with a conventional SMU. Inset: The same event measured with our fast sampling system.

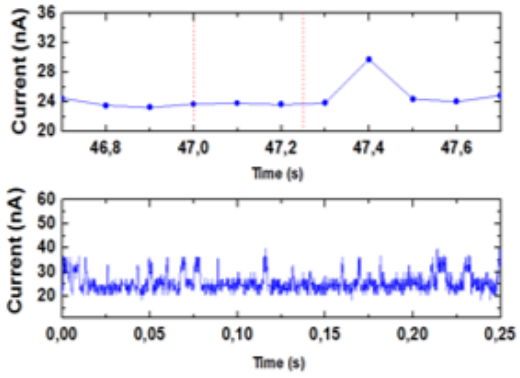

Figure 3 – Top: Current measured with a SMU in a ReRAM. Bottom: RTN signal of 0.25s duration measured with our system in the time interval between dashed lines in the top figure.

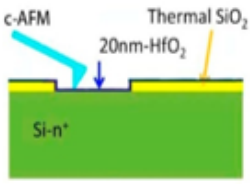

Figure 4 – Top: After top electrode removal, the device can be scanned at constant voltage with the CAFM tip. Right: Current images of (a) LRS and (b) HRS CFs on different samples. The CF area is enclosed by the line.