TW-P048

Large-area imaging evolution of micro-scale configuration of conducting filaments in resistive switching materials using a light-emitting diode

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Resistive random access memory devices have been widely studied due to their high performance characteristics, such as high scalability, fast switching, and low power consumption. However, fluctuation in operational parameters remains a critical weakness that leads to device failures. Although the random formation and rupture of conducting filaments (CFs) in an oxide matrix during resistive switching processes have been proposed as the origin of such fluctuations, direct observations of the formation and rupture of CFs at the device scale during resistive switching processes have been limited by the lack of real-time large-area imaging methods. Here, a novel imaging method is proposed for monitoring CF formation and rupture across the whole area of a memory cell during resistive switching. A hybrid structure consisting of a resistive random access memory and a light-emitting diode enables real-time monitoring of CF configuration during various resistive switching processes including forming, semi-forming, stable/unstable set/reset switching, and repetitive set switching over 50 cycles.

Keywords: ReRAM, Conducting Filament, Real time observation, Hybrid device