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Physics of ON-OFF Switching Mechanism of ReRAM via Oxygen Vacancy Based Conducting Channels KATSUMASA KAMIYA, MOONYOUNG YANG, University of Tsukuba, BLANKA MAGYARI-KOPE, Stanford University, MASAAKI NIWA, University of Tsukuba, YOSHIO NISHI, Stanford University, KENJI SHIRAISHI, University of Tsukuba — Resistive–Random–Access–Memories (ReRAMs) have attracted increased attention as a promising candidate for the next generation of non-volatile memories. It has been pointed out that the ON-OFF switching in ReRAMs is governed by the formation and disruption of oxygen vacancy conducting filaments. However, the origin of this formation-isolation transition is still unclear. We thus studied the ON-OFF switching mechanism of ReRAM using first-principles calculations. We found that electron-captured oxygen vacancies tend to form a cohesive conductive filament ("ON"-state), while the filament is disrupted when electrons are removed from the oxygen vacancies ("OFF"-state). We concluded that this cohesion and isolation transition of the oxygen vacancies upon carrier injection and removal is the physical origin of the ON-OFF switching in ReRAMs. This concept is also applicable for other binary-oxide-based ReRAMs, since the physics is inherently related to the properties of the oxygen vacancies. Based on this physics, we proposed a guiding principle for stack-structures of ReRAMs, which has been very recently shown to improve ReRAM properties drastically.

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