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HfO_2 and Ta_2O_5 for Resistive Random Access Memory (ReRAM) applications and more

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Recent progresses in memory requirements have conducted to an increase of interest in the investigation of novel technologies to improve data storage, as the current on-going downscaling of Si-based Flash memory has reached a physical limit, difficult to overcome. Resistive Random Access Memories (ReRAM) based on resistive switching phenomena in dielectrics, are considered as promising candidates for next generation of non-volatile memory (NVM). Compared with other NVM, ReRAM devices potentially offer high performances: high density integration, high speed, low power consumption, low fabrication costs and Back-End-Of-Line (BEOL) compatibility with CMOS technologies, ensured by a basic Metal/Insulator/Metal (MIM) structure.

Depending on the nature of the insulator (oxide) and the metallic electrodes, the resistance switching is based on a bipolar valence change mechanism (VCM) or a bipolar electrochemical metallization mechanism (ECM). However, the exact mechanisms at the origin of the resistive switching are not fully understood yet. For all these devices, the choice of the oxide (nature, crystallization, density, doping, presence of vacancies…), the metal (inert electrode, its free energy formation of corresponding oxide) as well as the presence of interfacial layers (role of the electrode, role of the process) are impacting the operation sets and reliability of the devices.

In this work, I propose to give an overview of the recent developments in the understanding of the resistive switching of HfO_2 (LTM) and Ta_2O_5 (NIMS) based ReRAM, and to present the broader field of applications opened by the study of resistive switching phenomena.