Non-Volatile Memory Based on Solid Electrolytes

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Abstract

Programmable Metallization Cell (PMC) memory is based on the electrochemical control of nanoscale quantities of metal in thin films of solid electrolyte. A silver or copper layer and an inert electrode formed in contact with a Ag^+ or Cu^{2+} containing electrolyte film creates a device in which information is stored via reduction of the metal ions. Key attributes are low voltage (with thresholds as low as a few hundred mV), low power consumption (μW range), and the ability for the storage cells to be physically scaled to a few tens of nm. Electrolyte formation is a relatively simple process, typically involving the introduction of metal into a chalcogenide or oxide base glass. Standard processing equipment may be utilized and no high temperature steps are necessary. The ion reduction effect results in a resistance change of several orders of magnitude even for currents in the μA range. A reverse bias of a few hundred mV will reverse the process until the excess electrodeposited metal has been removed, thereby erasing the device. Since information is retained via metal atom electrodeposition rather than charge storage, PMC memory is truly non-volatile, with extrapolated retention of greater than 10 years. Write and erase can be achieved rapidly – both occur in the sub-25 nsec regime (and single-digit nsec programming is thought possible). Endurance appears to be excellent with projected operation beyond 10^{16} cycles. A wide operational temperature range is achievable - devices will function above 125°C and well below 0°C. The experimental results from our research program will be discussed in this talk and will illustrate the attributes described above.