Dynamics of Memristor-based Memory Cells

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Construction of memristive memories requires usage of stable and reliable individual memory devices. So far several technologies were tested to implement the memristive RRAM elements. Many of these use the metal-oxide/metal junctions. In all the experiments reported in this presentation we used the memristors realised in the cleanroom of Swiss Federal Institute of Technology in Lausanne. Several laboratory tests have been carried out using the above-mentioned devices. The dynamic phenomena encountered in real memristors realised as solid state devices in the $Pt/HfO_2/Ti/Pt$ technology. The forming behaviour and repeatability of the process has been tested. The switching behaviour is studied in detail. Further, the investigation of the phenomena associated with switching behaviour induced by voltage pulsing techniques has been carried out. The pulsing technique allows for fast transition between the stable states characterised by different device resistances. In this presentation we describe and analyse simple situations of formation of the memristive states, switching between the high-low resistve states. The first partial results of voltage pulse stimulation/switching behaviour has been also given.

Alternative ways of programming the state an memristive elements have been proposed. The underlying idea is to apply to the element read-out and write-in voltages in form of pulses. The shape of such pulses has to be optimised — the amplitude and duration have to be adjusted depending on the technology used in the element implementation. Some solutions of this problems have been patented [1, 2, 3]. The write-in operation equivalent to setting the memristor into one of stable resistance states can be performed by applying a voltage impulse of sufficient amplitude and duration. The area of the impulse is proportional to the charge applied to the element or equivalently to the energy needed for changing the state of the element.

In presentation, we show changes of the resistance of the element observed when the series of impulses of growing amplitudes is applied. It can be seen how the application of a negative impulse resets the element. Programming of this type can be effective if the pulse width and amplitude are properly selected — this means that we have to be careful to select sufficient width-amplitude ratio to ensure proper energy of the pulses.

References

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