Fundamental properties of cross-bar non-volatile RRAM elements and their integration for low energy system-on-chip applications

Sergei Koveshnikov

Institute of Microelectronics Technology
Russian Academy of Sciences

The main goal of this project is research and development of non-volatile resistive memory elements with metal oxides and their integration with selector diodes based on multilayer dielectric structures. This report will provide a brief overview of the experimental data obtained on 1T / 1R HfOx-RRAM structures during my work at Intel Corporation. I will try to answer the simple questions such as:

-*What is RRAM, and what are the main characteristics?*
-*Why, despite demonstrated advantages, the elements of resistive memory have not found wide practical application?*
-*Why should Russian Academy od Sciences be seriously engaged in resistive memory research and development?*

The main practical application of tightly integrated memory elements are energy-efficient single-chip systems (System-on-Chip) with a control voltage of less than 1V. Despite the progress in development of RRAM structures based on high-k metal oxides, their practical application is limited by a number of problems:

1. First of all, it is necessary to develop forminless memory cells in which the first switching from the initial high-resistance state to the low-resistance state occurs at small electric fields. Currently, development of forminless memory elements is based mainly on empirical efforts while the operative switching mechanism has not yet been established.
2. The second major factor is the need for selector devices in the high density RRAM matrixes. to eliminate leakage current
3. The third important factor is the need to optimize (reduce) the operating voltage for single-chip systems
4. To achieve high performance of RRAM elements, it is necessary to solve intrinsic and extrinsic variability issues in order to improve reproducibility of switching characteristics
5. Finally, additional efforts are needed to fully understand operative switching mechanism

I will discuss the above issues along with proposed solutions.