Novell EEPROM device, based on silicon quantum dots embedded in high-k dielectric

V.A. Gritsenko [a], K.A. Nasyrov [b], D.V. Gritsenko [a,*], Yu.N. Novikov [a], J.-W. Lee [c], C.W. Kim [c]

[a] *Institute of Semiconductor Physics, 630090, Novosibirsk, Russia.*

[b] *Institute of Automation and Electrometry, 630090, Novosibirsk, Russia.*

[c] *Samsung Advanced Institute of Technology, P. O. Box 111, Suwon 440-600, Korea.*

The new memory structure based on silicon dots, embedded in high-k dielectric is proposed for electrically erasable programmable read-only memory (EEPROM) devices. The comparison of simulated write/erase and retention characteristics of silicon/oxide/Si-quantum dots/oxide/poly-Si nonvolatile memory with SiO_2 and ZrO_2 as top blocking dielectrics was made. We demonstrate, that it is impossible to achieve 10 years retention of memory window in Si/Si-dot/SiO_2/poly-Si structures. The problem is that for 10 years information retention it is necessary to increase the bottom tunnel oxide thickness. However the thick tunnel oxide blocks the hole injection at negative potential on poly-Si and memory window becomes asymmetric and narrow. The application of high-k dielectric (ZrO_2) as a top oxide effectively amplifies the electric field in bottom oxide. This opens possibility to increase the tunnel bottom oxide thickness, and, consequently, achieve 10 years of retention in EEPROM. Simulated write/erase characteristics of Si/SiO_2 (5 nm)/Si quantum dot (5 nm)/ZrO_2 (8 nm)/poly-Si at voltage ± 11 V shows the memory window of 3 V with 10 years retention.

---

* Corresponding author. Tel. +7 3832 333864. FAX +7 3832 332771.
Email address: gritsenkodv@ngs.ru (D.V. Gritsenko).