TF-P004

Investigating InSnZnO as an Active Layer for Non-volatile Memory Devices and Increasing Memory Window by Utilizing Silicon-rich SiOx for Charge Storage Layer

Heejun Park[1], Cam Phu Thi Nguyen[1], Jayapal Raja[1], Kyungsoo Jang[1], Junhee Jung[2], Junsin Yi*[1]

[1]College of Information and Communication Engineering, Sungkyunkwan University, Suwon, 440-746, Korea
[2]Department of Energy Science, Sungkyunkwan University, Suwon, 440-746, Korea

In this study, we have investigated indium tin zinc oxide (ITZO) as an active channel for non-volatile memory (NVM) devices. The electrical and memory characteristics of NVM devices using multi-stack gate insulator SiO2/SiOx/SiOxNy (OOxOy) with Si-rich SiOx for charge storage layer were also reported. The transmittance of ITZO films reached over 85%. Besides, ITZO-based NVM devices showed good electrical properties such as high field effect mobility of 25.8 cm2/ V.s, low threshold voltage of 0.75 V, low subthreshold slope of 0.23 V/dec and high on-off current ratio of 1.25 × 107. The transmission Fourier Transform Infrared spectroscopy of SiOx charge storage layer with the richest silicon content showed an assignment at peaks around 2000-2300 cm-1. It indicates that many silicon phases and defect sources exist in the matrix of the SiOx films. In addition, the characteristics of NVM device showed a retention exceeding 97% of threshold voltage shift after 104 s and greater than 94% after 10 years with low operating voltage of +11 V at only 1 ms programming duration time. Therefore, the NVM fabricated by high transparent ITZO active layer and OOxOy memory stack has been applied for the flexible memory system.

Keywords: memory, NVM, ITZO

Retention Time	ΔV_{TH} (V)	
	T2	T3
1s	2.22	2.23
10s	2.15	2.21
100s	2.02	2.20
1000s	1.94	2.18
10000s	1.90 (85.58%)	2.17 (97.31%)
10 years	1.49 (67.12%)	2.11 (94.62%)

Table 1. Memory window of NVM devices after durating of retention (10000 s) and

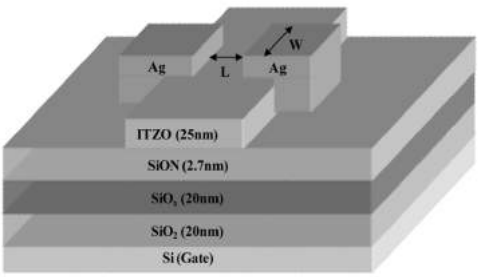

Figure 1. Schematic cross section of the ITZO NVM bottom-gate structure with SiO2/SiOx/SiOxNy memory stack on silicon substrates.

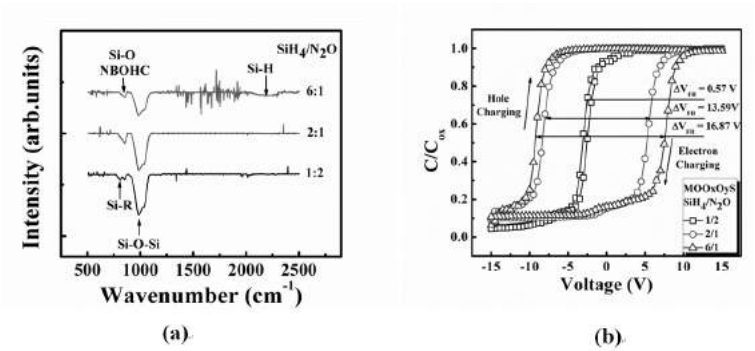

Figure 2. (a) Transmission FTIR and optical bandgap of Si-rich SiO_x charge storage layer. (b) Capacitance-voltage measured at retrace mode of OOxOy MIS structure.

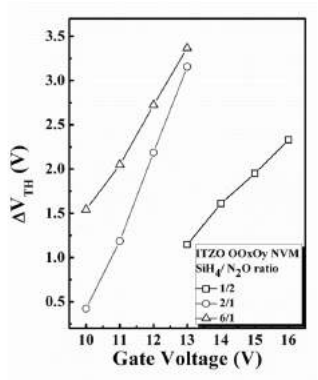

Figure 3. Threshold voltage shift of OOO NVM devices at different operating voltage.

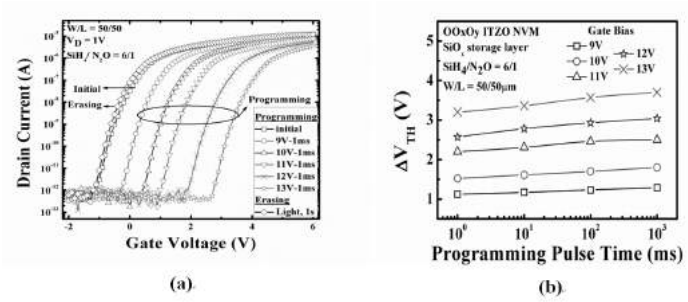

Figure 4. (a) Transfer hysteresis characteristics of OOxOy/ITZO NVM device at different operating voltages. (b) Programming characteristics of NVM device for various programming pulse widths at difference operating voltages.

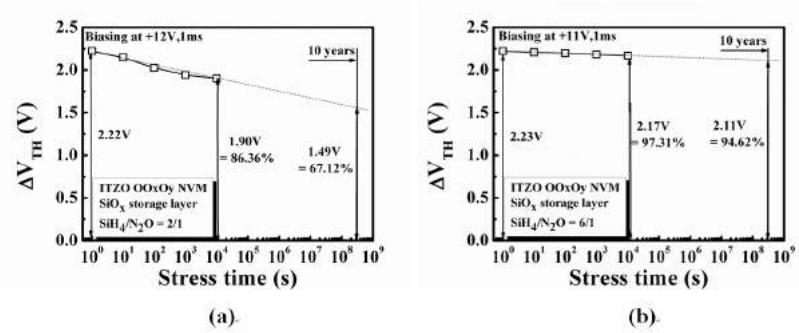

Figure 5. Retention properties extrapolation up to 10 years of OOxOy/ITZO NVM devices with the gas ratio SiH_4/N_2O of (a) 2/1 and (b) 6/1 for charge storage layer.