

Tuesday, June 13, 1:30 p.m.

Chairpersons: A. Lacaíta, Politecnico di Milano
Y. Omura, Kansai University

4.1 – 1:30 p.m.

A Comparative Study of NBTI and PBTI (Charge Trapping) in SiO₂/HfO₂ Stacks with FUSI, TiN, Re Gates, S. Zafar, Y.H. Kim, V. Narayanan, C. Cabral Jr., V. Paruchuri, B. Doris, J. Stathis, A. Callegari, M. Chudzik, IBM Semiconductor Research & Development Center, Yorktown Heights, NY

A comparative study of NBTI and PBTI (charge trapping) in SiO₂/HfO₂ FETs with different gate materials (FUSI NiSi, TiN, Re) is performed. The main results are as follows. NBTI is independent of gate material and is comparable to conventional SiON/poly-Si FETs. PBTI is worse for HfO₂/NiSi nFETs in comparison to HfO₂/TiN and HfO₂/Re devices. Consequently, HfO₂ FETs with TiN and Re gates exhibit superior transistor reliability characteristics in comparison to those with FUSI gates.

4.2 – 1:55 p.m.

Impact of Crystalline Phase of Ni-FUSI Gate Electrode on BTI and TDDB Reliability of HfSiON MOSFETs, M. Terai, T. Onizawa, S. Kotsuji, A. Toda, S. Fujieda, H. Watanabe, NEC Corp., Sagamihara, Japan

We investigated the impact of crystalline phase of Ni-FUSI gate on NBTI/PBTI and TDDB reliability of HfSiON MOSFETs. While NFET-TDDB degraded with a higher Ni-content electrode, PFET-TDDB was improved by using NiSi and Ni₃Si instead of p⁺ poly-Si. We attribute this improvement to a reduction in electron energy at the anode. The NFET: NiSi and PFET: Ni₃Si is judged to be a superior combination for both of NBTI/PBTI and TDDB reliability and initial characteristics.

4.3 – 2:20 p.m.

Impact of Polarity and Hf Concentration on Breakdown of HfSiON/SiO₂ Gate Dielectrics, M. Sato, I. Hirano, T. Aoyama, K. Sekine, T. Kobayashi, T. Yamaguchi, K. Eguchi, Y. Tsunashima, Toshiba Corporation, Yokohama, Japan

We have investigated the impact of polarity and Hf concentration on HfSiON/SiO₂ gate dielectrics breakdown with TZDB and TDDB. Breakdown mechanisms are strongly dependent on the polarity of the gate bias. In TZDB, gate leakage currents at breakdown were determined by the polarity without regard to accumulation or inversion states. In TDDB, though thermochemical breakdown of HfSiON itself was adequate for nMOS in inversion, breakdown of pMOS in inversion was affected by the carrier currents.

4.4 – 2:45 p.m.

Newly Found Anomalous Gate Leakage Current (AGLC) for 65 nm Node and Beyond, and Its Countermeasure Using Nitrogen Implanted Poly-Si, M. Togo, T. Suzuki, E. Hasegawa, S. Koyama, T. Fukai, A. Sakakidani, S. Miyake, T. Watanabe, I. Yamamoto, M. Tanaka*, Y. Kawashima, Y. Kunimune, M. Ikeda, K. Imai, NEC Electronics Corp., Kanagawa, Japan, *NEC Corp., Kanagawa, Japan

We found a new anomalous gate leakage current (AGLC) of ultra-thin gate-SiON, which may directly impact standby leakage and yield for 65 nm node and beyond. We have identified the AGLC mechanism and also developed gate-stack fabrication process as effective countermeasures. Reducing gate-SiON to less than 1.3 nm induces AGLC leading to reliability degradation in nFET. Nitrogen implantation into poly-Si suppresses AGLC and effectively prevents the reliability degradation while boosting drivability, as the poly-Si grain size is reduced. For suppression of AGLC for even thinner gate-SiON of 1.1nm, additional poly-Si/SiON fabrication process optimization has been implemented.