SESSION 20 – TAPA I
High k Transistor Reliability

Thursday, June 17, 1:30 p.m.
Chairpersons: P. Zeitzoff, International Sematech
H. Tanaka, Oki Electric

20.1 — 1:30 p.m.
A Model for Negative Bias Temperature Instability (NBTI) in Oxide and High κ pFETs, S. Zafar, B. Lee, J. Stathis, A. Callegar and T. Ning, IBM Research Division, Yorktown Heights, NY

A model for the negative bias temperature instability (NBTI) is proposed. Unlike previous empirical models, this model is derived from physics principles. The model attributes NBTI to de-passivation of SiO2/Si interface and its two distinguishing features are: application of statistical physics to calculate de-passivated site density increase and the assumption that the hydrogen diffusion is dispersive. The model is verified using new and published NBTI data for SiO2/poly, SiON/W and HfO2/W pFETs.

20.2 — 1:55 p.m.
SiN-capped HfSiON Gate Stacks with Improved Bias Temperature Instabilities for 65 nm-node Low-Standby-Power Transistors, Y. Tamura, T. Sasaki, N. Izumi, F. Ootsuka, M. Yasuhira, T. Hoshi, S. Kume, H. Amai, T. Ida, T. Aoyama, S. Kamiyama, K. Torii, H. Kitajima and T. Arikado, Semiconductor Leading Edge Technologies, Inc., Ibaraki, Japan

This paper describes SiN-capped HfSiON gate stacks for 65 nm-nodelow-standby-power transistors with improved bias temperature instabilities (BTI). By employing SiN-cap and counter-implant for pFET, symmetrical threshold voltages for nFETs and pFETs have been obtained. The nitrogen incorporation in the interfacial layer prevents positive BTI. Negative BTI can be improved by reducing the thickness of SiN-cap. 10-year lifetimes for both positive and negative BTI have been achieved.

20.3 — 2:20 p.m.
Detrimental Impact of Hydrogen on Negative Bias Temperature Instabilities in HfO_2-Based pMOSFETs, M. Houssa, S. De Gendt, J.L. Autran*, G. Groeseneken and M.M. Heyns, IMEC, Leuven, Belgium, *L2MP, UMR CNRS, Marseille, France

The impact of hydrogen on NBTI in atomic layer deposited HfO2-based pMOSFETs is reported for the first time. It is shown that Vth instability is reduced by a factor 2 in devices exposed to forming gas anneal at 520 C, as compared to transistors annealed at 580 C. NBTI is almost suppressed after subjecting the transistors to higher dopant activation thermal budget, which allows to drive most of hydrogen out of the high-k gate stack.

20.4 — 2:45 p.m.
The Effects of Nitrogen and Silicon Profile on High-K MOSFET Performance and Bias Temperature Instability, C. Choi, C.S Kang, C.Y Kang, R.Choi, H.J Cho, Y.H Kim, S.J Rhee, M.Akbar, and J.C. Lee, The University of Texas at Austin, Austin, TX

Nitrogen profile has been modulated by inserting Si layer into HfOxNy. In this paper, the effects of nitrogen and silicon on MOSFET performance and BTI (Bias Temperature Instability) characteristics have been investigated. Nitrogen incorporation enhanced threshold voltage shift for both PBTI (Positive Bias Temperature Instability) and NBTI (Negative Bias Temperature Instability). However, BTI degradation is significantly suppressed by the Si insertion. This improvement can be attributed to the reduction of oxide bulk trapped as well as interface trapped charge generation resulting from the insertion of Si layer.