

## **Publications**

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### **Recent Refereed Journal Publications**

- P.D. Kirsch, C. S. Kang, J. Lozano, J. C. Lee, J. G. Eckerdt, "Electrical and spectroscopic comparison of HfO<sub>2</sub>/Si interfaces on nitrided and un-nitrided Si (100)," *Journal of Applied Physics*, Volume 91, Number 7, pp. 1 – 11, 1 April 2002.
- H. Cho, C. Kang, K. Onishi, S. Gopalan, R. Nieh, R. Choi, S. Krishnan and Jack Lee, "Structural and Electrical Properties of HfO<sub>2</sub> with Top Nitrogen Incorporated Layer," *IEEE Electron Device Letters*, vol. 23, no. 5, p. 249, May 2002.
- S. Gopalan, K. Onishi, R. Nieh, C. Kang, R. Choi, J. Cho, S. Krishnan, and J. Lee, "Electrical and Physical Characteristics of Ultrathin Hafnium Silicate Films with Polycrystalline Silicon and TaN Gates," *Applied Physics Letters*, vol. 80, no. 23, p. 4416, June 10, 2002.
- R. Nieh, R. Choi, S. Gopalan, K. Onishi, C. Kang, H. Cho, S. Krishnan and J. Lee, "Evaluation of Silicon Surface Nitridation Effects on Ultra-thin ZrO<sub>2</sub> Gate Dielectrics," *Applied Physics Letters*, vol. 81, no. 9, p. 1663, August 26, 2002.
- Chang Seok Kang, Hag-Ju Cho, Katsunori Onishi, Renee Nieh, Rino Choi, Sundar Gopalan, Sid Krishnan, Jeong H. Han, and Jack C. Lee, "Bonding states and electrical properties of ultrathin HfO<sub>x</sub>N<sub>y</sub> gate dielectrics", *Appl. Phys. Lett.* 81, p2593, September 30, 2002.
- Chang Seok Kang, Katsunori Onishi, Laegu Kang, and Jack C. Lee, "Effects of Hf contamination on the properties of silicon oxide metal--oxide--semiconductor devices", *Appl. Phys. Lett.* 81, p5018, December 23, 2002.
- Y. Kim, K. Onishi, C. Kang, H. Cho, R. Nieh, S. Gopalan, R. Choi, J. Han, S. Krishnan, and J. Lee, "Area Dependence of TDDB Characteristics for HfO<sub>2</sub> Gate Dielectrics," *IEEE Electron Devices Letters*, vol. 23, no. 10, p. 594, October 2002.
- Y. Fan, R. Nieh, J. Lee, G. Lucovsky, G. Brown, F. Register and S. Banerjee, "Voltage and Temperature Dependent Gate Capacitance and Current Model: Application to ZrO<sub>2</sub> n-channel MOS Capacitor," *IEEE Tran. Electron Devices*, vol. 49, no. 11, p. 1969, November 2002.
- S. Mudanai, F. Li, S. Samavedam, R. Tobin, C. Kang, R. Nieh, L. Register, J. Lee, and S. Banerjee, "Interfacial Defect States in HfO<sub>2</sub> and ZrO<sub>2</sub> nMOS Capacitor," *IEEE Electron Devices Letters*, vol. 23, no. 12, p. 728, December 2002.
- Y.H. Kim, K. Onishi, C. Kang, H. Cho, R. Choi, S. Krishnan, M. Akbar and J. Lee, "Thickness Dependence of Weibull Slopes of HfO<sub>2</sub> Gate Dielectrics," *IEEE Electron Devices Letters*, vol. 24, no. 1, p. 40, January 2003.
- Z. Shi, D. Onsongo, K. Onishi, J. Lee, and S. Banerjee, "Mobility Enhancement in Surface Channel SiGe PMOSFETs With HfO<sub>2</sub> Gate Dielectrics," *IEEE Electron Device Letter*, vol. 24, no. 1, p. 34, January 2003.
- K. Onishi, C. Kang, R. Choi, H. Cho, S. Gopalan, R. Nieh, S. Krishnan and J. Lee, "Improvement of Surface Carrier Mobility of HfO<sub>2</sub> MOSFET's by High-

Temperature Forming Gas Annealing,” IEEE Trans. On Electron Devices, vol. 50, no. 2, p. 384 – 390, February 2003.

- R. Nieh, C. Kang, H. Cho, K. Onishi, R. Choi, S. Krishnan, J. Han, Y. Kim, A. Shahriar and J. Lee, “Electrical Characterization and Material Evaluation of Nitrogen Incorporated  $ZrO_2$  ( $ZrO_xN_y$ ) Gate Dielectric in TaN-gated NMOSFET’s with High Temperature Forming Gas Annealing,” IEEE Trans. On Electron Devices, vol. 50, no. 2, p. 333 – 340, February 2003.
- Rino Choi, Katsunori Onishi, Chang Seok Kang, Hag-Ju Cho, Y.H. Kim, Siddharth Krishnan, M. S. Akbar and Jack C. Lee, " Effects of Deuterium Anneal on MOSFETs with  $HfO_2$  Gate Dielectrics,” IEEE Electron Device Letter, vol. 24, no. 3, p. 144, March 2003.
- Katsunori Onishi, Chang Seok Kang, Rino Choi, Hag-Ju Cho, Young Hee Kim, Siddharth Krishnan, Mohammad Akbar, and Jack C. Lee, “Performance of polysilicon gate  $HfO_2$  MOSFET’s on (100) and (111) silicon substrates,” IEEE Electron Device Letter, vol. 24, no. 4, p. 254, April 2003.
- M.S. Akbar, S. Gopalan, H.-J. Cho, K. Onishi, R. Choi, C.S. Kang, Y.H. Kim, J. Han, S. Krishnan, and J. C. Lee, “High Performance TaN/HfSiON/Si MOSCAP and MOSFET Prepared by Low Thermal Budget  $NH_3$  Post-Deposition Anneal,” Applied Physics Letters, vol. 82, no.11, pp.1757, March 17 2003
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- Chang Seok Kang, H.-J. Cho, R. Choi, K. Onishi, Y.H. Kim, M. S. Akbar, and J. C. Lee, “Characterization of resistivity and work function of sputtered-TaN film for gate electrode applications”, accepted to be published in the Journal of Vacuum Science and Technology, September/October 2003.
- Y. H. Kim, and J. C. Lee, “Reliability Characteristics of high-k dielectrics” invited paper in the Microelectronics Reliability Journal, Volume 44, Issue 2, Pages 183-193, February 2004.
- C.Y. Kang, Hag-Ju Cho, Rino Choi, Chang Seok Kang, Young Hee Kim, Se Jong Rhee, Chang Hwan Choi, Shahriar M. Akbar, and Jack C. Lee, "Effects of dielectric structure of  $HfO_2$  on carrier generation rate in Si substrate and channel mobility", App Phy. Lett., vol 84, 12, pp. 2148-2150, 2004.

### **Recent Refereed Conference Publications**

- J. Lee, “High-K Gate Dielectrics ( $HfO_2$  and  $ZrO_2$ ), Semicon Korea Technical Program Digest, p. 155, February 2002.
- C. Kang, H. Cho, K. Onishi, R. Choi, R. Nieh, S. Gopalan, S. Krishnan, and J. Lee, “Improved Thermal Stability and Device Performance of Ultra-thin ( $EOT < 10 \text{ \AA}$ ) Gate Dielectric MOSFET’s by Using Hafnium Oxynitride ( $HfO_xN_y$ ),” 2002 Symposium on VLSI Technology, p. 146, June 2002.
- R. Nieh, S. Krishnan, H. Cho, C. Kang, S. Gopalan, K. Onishi, R. Choi, and J. Lee, “Comparison between ultra-thin  $ZrO_2$  and  $ZrO_xN_y$  gate dielectrics in TaN or poly-gated

NMOSCAP and NMOSFET devices,” 2002 Symposium on VLSI Technology, p. 186, June 2002.

- K. Onishi, C. Kang, R. Choi, H. Cho, S. Gopalan, R. Nieh, S. Krishnan, and J. Lee, “Effects of High-Temperature Forming Gas Anneal on HfO<sub>2</sub> MOSFET Performance,” The 2002 Symposium on VLSI Technology, p. 22, June 2002.
- Q. Lu, H. Takeuchi, X. Meng, T. King, C. Hu, K. Onishi, H. Cho, and J. Lee, “Improved Performance of Ultra-thin HfO<sub>2</sub> CMOSFETs Using Poly-SiGe Gate,” 2002 Symposium on VLSI Technology, p. 86, June 2002.
- K. Onishi, C. Kang, R. Choi, H. Cho, S. Gopalan, R. Nieh, S. Krishnan and J. Lee, “Charging Effects on Reliability of HfO<sub>2</sub> Devices with Polysilicon Gate Electrode,” Proceeding of International Reliability Physics Symposium, pp. 419-420, 2002.
- Q. Lu, H. Takeuchi, R. Lin, T. King, C. Hu, K. Onishi, R. Choi, C. Kang and J. Lee, “Hot Carrier Reliability of n-MOSFET with Ultra-thin HfO<sub>2</sub> Gate Dielectric and Poly-Si Gate,” 2002 International Reliability Physics Symposium Proceedings, p429 (2002).
- R. Choi, K. Onishi, C. S. Kang, R. Nieh, S. Gopalan, H.-J. Cho, S. Krishnan, and J. C. Lee, “High Quality MOSFETs Fabrication with HfO<sub>2</sub> Gate Dielectric and TaN Gate Electrode”, 60th Device Research Conference at the University of California, Santa Barbara, June 24-26, 2002, p. 193.
- S. Gopalan, R. Choi, K. Onishi, R. Nieh, C. Kang, H. Cho, S. Krishnan, and J. Lee, “Impact of NH<sub>3</sub> Pre-treatment on the Electrical and Reliability Characteristics of Ultra-thin Hafnium Silicate Films Prepared by Re-oxidation Method,” 60th Device Research Conference at the University of California, Santa Barbara, June 24-26, 2002, p. 195.
- K. Onishi, R. Choi, C. Kang, H. Cho, Y. Kim, R. Nieh, J. Han, S. Krishnan, A. Shahriar and J. Lee, “Charge Trapping and Interfacial Degradation of Polysilicon Gate HfO<sub>2</sub> NMOSFET’s,” Gate Stack Engineering Working Group Symposium, October 16-18, 2002.
- J. Lee, “Nitrogen Incorporation and High-Temperature Forming Gas Anneal for High-K Gate Dielectrics,” an Invited Paper in 202<sup>nd</sup> Meeting of The Electrochemical Society, October 20-25, 2002.
- J. Lee, “Effects of Interface States and Charge Trapping on Performance of High-K Dielectric Devices,” to be published as an Invited Paper in the 33<sup>rd</sup> IEEE Semiconductor Interface Specialists Conference, December 5-7, 2002.
- C. Kang, H. Cho, K. Onishi, R. Choi, Y. Kim, R. Nieh, J. Han, S. Krishnan and J. Lee, “Nitrogen Concentration Effects and Performance Improvement of MOSFETs Using Thermally Stable HfO<sub>x</sub>N<sub>y</sub> Gate Dielectrics,” International Electron Devices Meeting (IEDM), p. 865, December 2002.
- Y. Kim, K. Onishi, C. Kang, R. Choi, H. Cho, R. Nieh, J. Han, S. Krishnan and J. Lee, “Hard and Soft-Breakdown Characteristics of Ultra-Thin HfO<sub>2</sub> Under Dynamic and Constant Voltage Stress,” International Electron Devices Meeting (IEDM), p. 629, December 2002.
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- C.M. Osburn, S.K. Han, I. Kim, S. Campbell, E. Garfunkel, T. Gustafson, J. Hauser, T.-J. King, A. Kingon, D.-L. Kwong, S.J. Lee, C.H. Lee, J. Lee, C.S. Kang, K. Onishi, R. Choi, G. Lucovsky, J.G. Hong, T.P. Ma, W. Zhu, Z. Luo, J.P. Maria, D. Wicaksana, V. Misra, J.J. Lee, Y.S. Suh, G. Parsons, D. Niu, and S. Stemmer, “Integration Issues with High k Gate Stacks” an invited to VLSI Symposium of The Electrochemical Society Meeting, Spring 2002.
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- H. Cho, C. Kang, M. Akbar, K. Onishi, Y. Kim, R. Choi, and J. Lee, “Application of Top HfSiON Layer for Improved Poly-Gated HfO<sub>2</sub> PMOSFET Performance,” the 61st Device Research Conference (section II.B), p. 37, June 23-25, 2003.
- Y. H. Kim, K. Onishi, C. S. Kang, R. Choi, H. -J. Cho, M. S. Akbar, and J. C. Lee, “Polarity Dependence of the Reliability Characteristics of HfO<sub>2</sub> with Poly-Si Gate Electrode”, the 61st Device Research Conference proceeding (DRC), p.57, 2003.
- Y. H. Kim, K. Onishi, C. S. Kang, R. Choi, H. -J. Cho, and J. C. Lee, “The Effects of Forming Gas Anneal Temperature and Dielectrics Leakage Current on TDDB Properties of HfO<sub>2</sub> Devices” accepted for publication of Electrochemical Society Proceeding (ECS), October 2003.
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- C.S. Kang, H.-J. Cho, Y.H. Kim, R. Choi, A. Shahriar, C.Y. Kang, C.H. Choi, S.J. Rhee and J. C. Lee, “Characterization of resistivity and work function of sputtered-TaN film for gate electrode applications,” accepted for publication of Electrochemical Society Proceeding (ECS), October 2003.
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- J. Lee, “Hf-based High-K Dielectrics” Invited Paper presented at the International Workshop on Gate Insulator, Tokyo, Japan, Nov. 2003.
- Y. H. Kim, R. Choi, R. Jha, J.H. Lee, V. Misra and J. C. Lee, "Interface Tunneling Mechanism of HfO<sub>2</sub> /Dual Metal Gate Stack with Varying Interface Layer Thickness and Different Bias Polarities", presented and published at the 34<sup>th</sup> IEEE Semiconductor Interface Specialists Conference, December 2003.
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- C. Choi, C.S. Kang, C. Y. Kang, R. Choi, Y. Kim, S. J. Rhee, M. Akbar and J. Lee, "The Effects of Nitrogen and Silicon Profile on High-K MOSFET Performance and Bias Temperature Instability," accepted to 2004 Symposium on VLSI Technology, June 2004.
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