

TABLE OF CONTENTS

KEYNOTE - PAUL GERRISH, MEDTRONIC MICROELECTRONICS CENTER

SESSION 2A: GATE DIELECTRICS

2A-1 Post-Breakdown Statistics and Acceleration Characteristics in High-k Dielectric Stacks, E. Wu, J. Suñe*, B. Linder**, R. Achanta, B. Li, and S. Mittl, IBM System & Technology Group, *Universitat Autònoma de Barcelona, **IBM Research Division	1
2A-2 Methodologies for Sub-1 nm EOT TDDB Evaluation, T. Kauerauj, R. Degraeve, L.-A. Ragnarsson, P. Roussel, R. O'Connor*, S. Sahhaf and G. Groeseneken**, imec, *Tyndall National Institute, ** also at KU Leuven	7
2A-3 Frequency Dependent TDDB Behaviors and its Reliability Qualification in 32nm High-k/Metal Gate CMOSFETs, K.T. Lee, J. Nam, M. Jin, K. Bae, J. Park, L. Hwang, J. Kim, H. Kim and J. Park, Samsung Electronics	17
2A-4 Re-investigation of Gate Oxide Breakdown on Logic Circuit Reliability, Y.C. Huang, T.Y. Yew, W. Wang, Y.-H. Lee, R. Ranjan, N.K. Jha, P.J. Liao, J.R. Shih and K. Wu, Taiwan Semiconductor Manufacturing Group	22

SESSION 2B: CIRCUIT RELIABILITY

2B-1 In Situ Screening Techniques for Defective Oxides in Devices for Automotive Applications (ESREF Paper), V. Malandrucolo, M. Ciappa, W. Fichtner, H. Rothleitner*, Institute of Technology (ETH), *Infineon Technologies	28
2B-2 A TDC-based Test Platform for Dynamic Circuit Aging Characterization, M. Chen, V. Reddy, J. Carulli, S. Krishnan, V. Rentala, V. Srinivasan and Y. Cao *, Texas Instruments, *Arizona State University	36
2B-3 Fast Characterization of the Static Noise Margin Degradation of Cross-Coupled Inverters and Correlation to BTI Instabilities in MG/HK Devices, A. Kerber, N. Pimparkar, S. Balasubramanian, T. Nigam, W. McMahon and E. Cartier*, GLOBALFOUNDRIES Inc., *T.J. W	41
2B-4 Reliability Monitoring Ring Oscillator Structures for Isolated/Combined NBTI and PBTI Measurement in High-K Metal Gate Technologies, J.-J. Kim, B. Linder, R. Rao, T.-H. Kim, P.-F. Lu, K. Jenkins, C. Kim*, A. Bansal, S. Mukhopadhyay and C.-T. Chuang, IBM	47
2B-5 Negative Bias Temperature Instability “Multi-Mode” Compact Model Based on Threshold Voltage and Mobility Degradation, D. Varghese, R. Higgins, S. Dunn, A. Krishnan, V. Reddy and S. Krishnan, Texas Instruments	51
2B-6 A New Smart Device Array Structure for Statistical Investigations of BTI Degradation and Recovery, C Schlünder, J.M. Berthold, M. Hoffmann, J.-M. Weigmann, W. Gustin and H. Reisinger, Infineon Technologies AG	56

SESSION 2C: FABLESS AND PRODUCT RELIABILITY

2C-1 Characterization and Challenge of TDDB Reliability in Cu/Low K Dielectric Interconnects, F. Xia, J. He, P. Prabhumirashi, A. Schmitz, A. Lowrie, J. Hicks, Y. Shusterman and R. Brain, Intel Corporation	61
2C-2 Backend Low-k TDDB Chip Reliability Simulator, M. Bashir, D.H. Kim, K. Athikulwongse, S.K. Lim and L. Milor, Georgia Institute of Technology	65
2C-3 Determination of CPU Use Conditions, R. Kwasnick, A. Papathanasiou, M. Reilly, A. Rashid, B. Zaknoon and J. Falk, Intel Corporation	75
2C-4 Si3N4 Extrinsic Defects and Capacitor Reliability, J. Scarpulla, E. King and J. Osborn, The Aerospace Corporation	81

SESSION 2D: MEMORY

2D-1 AC-DC Factor Sensitivity for DRAM Components Lifetime under Hot-Carrier Injection, S. Baeg, H. Nam, P. Chia*, S. Wen* and R. Wong*, Hanyang University at ERICA Campus, *Cisco Systems Inc.	91
2D-2 STI Stress-induced Degradation of Data Retention Time in DRAM and a New Characterizing Method for Mechanical Stress, T.-S. Jang, K.-D. Kim, M.-S. Yoo, Y.-T. Kim, S.-Y. Cha, J.-G. Jeong and S.-J. Hong, Hynix Semiconductor Inc. .	95
2D-3 Hot Hole Induced Damage in 1T-FBRAM on Bulk FinFET, M. Aoulaiche, N. Collaert, A. Mercha, M. Rakowski, B. De Wachter, G. Groeseneken, L. Altissime, M. Jurczak and Z. Lu*, imec, *University of Florida	99
2D-4 Effects of BTI during AHTOL on SRAM VMIN, S.-M. Lim, H. Hong, S. Yul, M. Zhang, J. Park, Y. Kim, Samsung Electronics	105

SESSION 2E: THIN FILM TRANSISTOR

2E-1 (Invited) Flexible Biomedical Devices for Mapping Cardiac and Neural Electrophysiology, D.-H. Kim, J. Rogers, J. Viventi*, B. Litt*, University of Illinois at Urbana-Champaign, *University of Pennsylvania	111
2E-2 Low-Energy UV Effects on Organic Thin-Film-Transistors, N. Wrachien, A. Cester, D. Bari, G. Meneghesso, J. Kovac*, J. Jakabovic*, M. Sokolsky*, D. Donoval* and J. Cirak*, University of Padova, *Slovak University of Technology .	113
2E-3 A New Method for Predicting the Lifetime of Highly Stable Amorphous-Silicon Thin-Film Transistors From Accelerated Tests, T. Liu, S. Wagner and J. Sturm, Princeton University	121
2E-4 Investigation of Ultra Thin Polycrystalline Silicon Channel for Vertical NAND Flash, B. Kim, S.-H. Lim, D. W. Kim, T. Nakanishi, S. Yang, J.-Y. Ahn, H.M. Choi, K. Hwang, Y. Ko and C.-J. Kang, Samsung Electronics Co., Ltd.	126

SESSION 2F: BEOL DIELECTRICS

2F -1 (Invited) Electrical Reliabilities of Porous Silica Low-k Films, T. Kikkawa, Y. Kayaba, K. Kohmura*, S. Chikaki**, Hiroshima University, *Mitsui Chemicals Inc., **Renesas Electronics Corp	130
2F-2 Invasion Percolation Model for Abnormal TDDDB Characteristics of ULK Dielectrics with Cu Interconnects at Advanced Technology Nodes, F. Chen, M. Shinosky, B. Li, J. Aitken, S. Cohen*, G. Bonilla*, A. Simon, P. McLaughlin, R. Achanta, F. Baumann, C. Parks, M. Angyal, IBM Microelectronics, *IBM TJ. Watson Research Center	134
2F-3 Comparison Between Intrinsic and Integrated Reliability Properties of Low-k Materials, K. Croes, M. Pantouvaki, L. Carbonell, L. Zhao, G. Beyer and Z. Tökei, imec	142
2F-4 Statistics of Breakdown Field and Time-Dependent Dielectric Breakdown in Contact-to-Poly Modules, S. Yokogawa, S. Uno, I. Kato, H. Tsuchiya, T. Shimizu and M. Sakamoto, Renesas Electronics Corporation	149
2F-5 Reliability Limitations to the Scaling of Porous Low-k Dielectrics, S.-C. Lee, A.S. Oates, TSMC	155
2F-7 A Comprehensive Process Engineering on TDDDB for Direct Polishing Ultra-Low-k Dielectric Cu Interconnects at 40nm Technology Node and Beyond, W.C. Lin, T.C. Tsai, H.K. Hsu, J. Lin, W.C. Tsao, W. Chen, C.M. Cheng, C.I. Hsu, C.C. Liu, C.M. Hsu, J.F. Lin, C.C. Huang and J. Y. Wu, United Microelectronics Corp.	160

SESSION 2G: EXTREME ENVIRONMENTS

2G-1 Space Radiation Effects and Reliability Considerations for the Proposed Jupiter Europa Orbiter, A. Johnston, California Institute of Technology	165
2G-2 (Invited) Reliability and Performance Characterization of a MEMS-Based Non-Volatile Switch , R. Gaddi, C. Schepens, C. Smith, C. Zambelli*, A. Chimenton* and P. Olivo*, Cavendish Kinetics, *Universia di Ferrara	171
2G-3 Microanalysis for Tin Whisker Risk Assessment, M. Mason, G. Eng, M. Leung, G. Stupian and T. Yeoh, The Aerospace Corporation	177

SESSION 3A: GATE DIELECTRICS

3A-1 Random Telegraph Noise Reduction in Metal Gate High-k Stacks by Bipolar Switching and the Performance Boosting Technique, W. Liu, K.-L. Pey, N. Raghavan, X. Wu, M. Bosman [^] , T. Kauerauf ^{^^} , Nanyang Technological Univ., [^] A*STAR Institute of Materials Research & Engineering, ^{^^} imec	182
3A-2 Correlation of Id- and Ig-Random Telegraph Noise to Positive Bias Temperature Instability in Scaled High-k/Metal Gate n-type MOSFETs, C.-Y. Chen, Q. Ran, H.-J. Cho*, A. Kerber*, Y. Liu, M.-R. Lin* and R. Dutton, Stanford University, *GLOBALFOUNDRIES	190
3A-3 SILC-Based Reassignment of Trapping and Trap Generation Regimes of Positive Bias Temperature Instability, J. Yang, M. Masuduzzaman, J. Kang* and M. Alam, Purdue University, *Peking University	196
3A-4 A New Interface Defect Spectroscopy Method, J. Ryan, L.C. Yu, J. Han, J. Kopanski, K. Cheung, F. Zhang**, C. Wang***, J. Campbell, J. Suehle, V. Tilak* and J. Fronheiser*, National Institute of Standards and Technology, *GE Global Research, **Michigan State University, ***Purdue University	202
3A-5 Experimental Identification of Unique Oxide Defect Regions by Characteristic Response of Charge Pumping, M. Masuduzzaman, A. Islam, R. Degraeve*, M. Cho*, M. Zahid* and M. Alam, Purdue University, *imec	207

SESSION 3B: MEDICAL ELECTRONICS

3B-1 The Implications of RoHS on Active Implantable Medical Devices (Invited), T.S. Savage, Medtronic Tempe Campus	213
3B-2 Implantable Microelectronics for the Brain: Challenges and Strategies for Reliable Operation (Invited), J. Muthuswamy, S. Anand, J. Sutanto, M. Baker*, M. Okandan*, Arizona State University, *Sandia National Laboratories	220
3B-3 A Swallowable Diagnostic Capsule with a Direct Access Sensor Using Anisotropic Conductive Adhesive, P. Jesudoss, A. Mathewson, K. Twomey, F. Stam and W.M.D. Wright*, Tyndall National Institute, *University College Cork	224
3B-4 Application Based Reliability Assessment and Qualification Methodology for Medical ICs (Invited), X. Zhu, K. Vasanth, X. Xu, C. Smyth, B. Rhoton, Texas Instruments	231

SESSION 3C: SOFT ERRORS

3C-2 Quantification and Mitigation Strategies of Neutron Induced Soft-Errors in CMOS Devices and Components (Invited), E. Ibe, K. Shimbo, H. Taniguchi, T. Toba, K. Nishii, Y. Taniguchi, Hitachi, Ltd.	239
3C-3 Effects of Scaling on Muon-Induced Soft Errors, B. Sierawski, R. Reed, M. Mendenhall, R. Weller, R. Schrimpf, S.-J. Wen*, R. Wong*, N. Tam** and R. Baumann***, Vanderbilt University, *Cisco Systems, Inc., **Marvell Semiconductor, Inc., ***Texas Instruments	247
3C-4 Neutron Induced Single Event Multiple Transients With Voltage Scaling and Body Biasing, R. Harada, Y. Mitsuyama, M. Hashimoto, T. Onoye, Osaka University	253
3C-5 Double-Pulse-Single-Event Transients in Combinational Logic, J. Ahlbin, T.D. Loveless, D. Ball, B. Bhuvu, A. Witulski, L. Massengill, M. Gadlage*, Vanderbilt University, *NSWC Crane	251

SESSION 3D: THERMO-MECHANICAL AND MEMS

3D-1 Thermomechanical Reliability of Through-Silicon-Vias Structures in 3D Interconnects (Invited), K.-H. Lu, S-K Ryu, J. Im, R. Huang, P. Ho, University of Texas	264
3D-2 Characterization of Steady and Transient Heating of Interconnects - A Review (Invited), B. Barabadi, Y. Joshi, S. Kumar, Georgia Institute of Technology	271
3D-3 Impact of Scaling on the Performance and Reliability Degradation of Metal-Contacts in NEMS Devices, H.Dadgour, M. Hussain*, A. Cassell**, N. Singh^, K. Banerjee, University of California, *King Abdullah University of Science and Technology, **NASA Ames Research Center, ^A*STAR	280
3D-4 The Effect of Temperature on Dielectric Charging of Capacitive MEMS, M. Koutsourelis, L. Michalakis, G. Papaioannou, University of Athens	290

SESSION 3E: ELECTROMIGRATION/VOIDING

3E-1 Electromigration Induced Void Kinetics in Cu Interconnects for Advanced CMOS Nodes, L. Arnaud, P. Lamontagne*, R. Galand*, E. Petitprez*, D. Ney*, P. Waltz*, CEA LETI-MINATEC, *STMicroelectronics	297
3E-2 Formation of Highly Reliable Cu/Low-k Interconnects by Using CVD Co Barrier in Dual Damascene Structures, H. K. Jung, H.-B. Lee, M. Tsukasa, E. Jung, J.-H. Yun, J. M. Lee, G.-H. Choi, S. Choi, C. Chung, Samsung Electronics	307
3E-3 Electromigration-resistance Enhancement with CoWP or CuMn for Advanced Cu Interconnects, C. Christiansen, B. Li, M. Angyal, T. Kane, V. McGahay, Y. Y. Wang, S. Yao, IBM Systems and Technology Group	312
3E-4 A Study of Via Depletion Electromigration with Very Long Failure Times, B. Li, C. Christiansen, K. Chanda, M. Angyal, J. Oakley, IBM Systems and Technology Group	317
3E-5 Study of Void Formation Kinetics in Cu Interconnects using Local Sense Structures, K. Croes, M. Lofrano, C.J. Wilson, L. Carbonell, Y.K. Siew, G. Beyer, Zs. Tökei, imec	321

SESSION 3F: PROCESS INTEGRATION AND 3D/TSV

3F-1 (Invited) 3D Integration Technology and Reliability, M. Koyanagi, Tohoku University	328
3F-2 Impact of Air-Induced Poly Si/Oxynitride Interface Layer Degradation on Gate-Edge Leakage, Z. Liu, S. Ito, T. Saito, S. Chang*, A. Ogawa**, S. Horii**, T. Horikawa***, M Wilde^, K. Fukutani^, T. Chikyow^^, Renesas Electronics Corp., *Renesas Electronics America, Inc., **Hitachi Kokusai Electric Inc., ***AIST, ^University of Tokyo and CREST-JST, ^^NIMS	335

3F-3 On the Thermal Failure in Nanoscale Devices: Insight Towards Heat Transport Including Critical BEOL and Design Guidelines for Robust Thermal Management & EOS/ESD Reliability, M. Shrivastava, M. Agrawal*, J. Aghassi, H. Gossner, W. Molzer, T. Schulz, V. Ramgopal Rao*, Intel Mobile Communications, *Indian Institute of Technology-Bombay	342
3F-4 Resistance Increase Due to Electromigration Induced Depletion Under TSV, T. Frank, C. Chappaz, P. Leduc*, L. Arnaud, S. Moreau*, A. Thuair*, R. El Farhane*, L. Anghel**, STMICROELECTRONICS, *CEA-Leti, Minatec, **TIMA	347

SESSION 4A: TRANSISTORS/ORGANICS TFTS

4A-1 Reliability- and Process-Variation Aware Design of Integrated Circuits - A Broader Perspective (Invited), M.A. Alam, K. Roy, C. Augustine, Purdue University	353
4A-2 Response of a Single Trap to AC Negative Bias Temperature Stress, M. Toledano-Luque, B. Kaczer*, Ph.J. Roussel*, T. Grasser**, G.I. Wirth^, J. Franco*, C. Vrancken*, N. Horiguchi*, G. Groeseneken*, Universidad Complutense de Madrid, *imec, **Technische Universitat, ^Universidade Federal do Rio Grande do Sul	364
4A-3 PBTI Under Dynamic Stress: From a Single Defect Point of View, K. Zhao, J. Stathis, B. Linder, E. Cartier, A. Kerber*, T.J. Watson Research Center, IBM, *GLOBALFOUNDRIES Inc.	372
4A-4 Understanding of Traps Causing Random Telegraph Noise Based on Experimentally Extracted Time Constants And Amplitude, K. Abe, A. Teramoto, S. Sugawa, T. Ohmi, Tohoku University	381
4A-5 Mechanistic Understanding of Breakdown and Bias Temperature Instability in High-k Metal Devices Using Inline Fast Ramped Bias Test, S. Krishnan, E. Cartier, J. Stathis, M. Chudzik, A. Kerber*, IBM, *GLOBALFOUNDRIES	387

SESSION 4C: ESD AND LATCH-UP

4C-1 Design of Modified ESD Protection Structure with Low-Trigger and High-Holding Voltage in Embedded High Voltage CMOS Process, T.-H. Lai, L.-A. Chen, T.-H. Tang, K.-C. Su, United Microelectronics Corp.	392
4C-2 An EOS-Free PNP-Enhanced Cascoded NMOSFET Structure for High Voltage Application, S.-Y. Wang, Y.-W. Chang, Y.-Y. Chen, C.-W. He, G.-W. Wu, T.-C. Lu, K.-C. Chen, C.-Y. Lu, Macronix International Co., Ltd	396
4C-3 Latch-up Free ESD Protection Design With SCR Structure in Advanced CMOS Technology, C.-T. Wang, T.-H. Tang, K.-C. Su, United Microelectronics Corporation	401
4C-4 Transient Latchup in Power Analog Circuits, V. Vashchenko, D. LaFonteese, A. Concannon, National Semiconductor Corp.	405
4C-5 WCDM2 -Wafer-Level Charged Device Model Testing with High Repeatability, N. Jack, T. Maloney*, B. Chou*, E. Rosenbaum, University of Illinois at Urbana-Champaign, *Intel Corporation	409

SESSION 4E: COMPOUND OPTO-ELECTRONICS

4E-1 Reliability of GaN-HEMTs for High-Voltage Switching Applications (Invited), W. Saito, Toshiba Corporation	417
4E-2 An overview of wide Band Gap Semiconductor physics of failure and reliability, Jose Jimenez, TriQuint Semiconductor .	
4E-3 Time Evolution of Electrical Degradation under High-Voltage Stress in GaN Electron Mobility Transistors, J. Joh, J. del Alamo, Massachusetts Institute of Technology	422
4E-4 Reliability-limiting Defects in AlGaIn/GaN HEMTs, T. Roy, E. X. Zhang, D. Fleetwood, R. Schrimpf, Y. Puzyrev, S. Pantelides, Vanderbilt University	426
4E-5 250 GHz Heterojunction Bipolar Transistors: From DC to AC Reliability, M. Diop, S. Ighilahriz, F. Cacho, V. Huard, STMICROELECTRONICS	430

SESSION 5A: HIGH VOLTAGE/RF

5A-2 (Invited) Intrinsic Reliability of RF Power LDMOS FETs, D. Burdeaux, W. Burger, Freescale Semiconductor	435
5A-3 Investigation of Multistage Linear Region Drain Current Degradation and Gate-Oxide Breakdown Under Hot-Carrier Stress in BCD HV PMOS, Y.-H. Huang, J.-R. Shih, C.-C. Liu, Y.-H. Lee, R. Ranjan, P.-Y. Chiang, D.-C. Ho, K. Wu, Taiwan Semiconductor Manufacturing Company	444
5A-4 New Investigation of Hot Carrier Degradation of RF Small-Signal Parameters in High-k/Metal Gate nMOSFETs, H.C. Sagong, C.Y. Kang*, C.W. Sohn, M.S. Park, D.Y. Choi, E.Y. Jeong, J.C. Lee**, Y.H. Jeong, POSTECH. *SEMATECH, **Univ. of Texas at Austin	449

5A-5 Design-in Reliability Approach For Hot Carrier Injection Modeling in the Context of Ams/RF Applications, V. Huard, T. Quemerais, F. Cacho, L. Moquillon, S. Haendle, X. Federspiel, STMicroelectronics	454
5A-6 Impact of Source/Drain Contact and Gate Finger Spacing on the Rf Reliability of 45-nm RF nMOSFETs, R. Arora, S. Seth, J. Poh, J. Cressler, A. Sutton*, H. Nayfeh*, G. Rosa*, G. Freeman*, Georgia Institute of Technology, *IBM Semiconductor Research and Development Center	461

SESSION 5B: SOFT ERRORS

5B-1 Soft-Error Testing at Advanced Technology Nodes (Invited), B. Bhuya, B. Narasimham*, A. Oates**, K. Patterson***, N. Taml^, M. Vilchis^^, S.-J. Wen^^^, R. Wong^^^, Y. Xu‡, Vanderbilt University, *Broadcom Corporation, **TSMC, ***Avago Technologies, ^Marvell Semiconductor, ^^LSI Corporation, ^^Cisco Systems, Inc., ‡Altera Corporation	467
5B-2 Measurement of Neutron-induced SET Pulse Width Using Propagation-induced Pulse Shrinking, J. Furuta, C. Hamanaka*, K. Kobayashi*, H. Onodera, Kyoto University, *Kyoto Institute of Technology	471
5B-3 Multicenter Comparison of Alpha Particle Measurements and Methods Typical of Semiconductor Processing, J. Wilkinson, B. Clark, R. Wong, Medtronic, C. Slayman, Ops A La Carte, B. Carroll, Freescale, M. Gordon, IBM, Y. He, Intel, O. Lauzeral, iRoC Technologies, K. Lepla, Teck Metals Ltd., J. Marckmann, Medtronic, B. McNally, XIA LLC, P. Roche, STMicroelectronics, M. Tucker, Alpha Sciences, Inc., T. Wu, SGS Taiwan	476
5B-4 The Impact of New Technology on Soft Error Rates, A. Dixit, A. Wood, Oracle Corporation	486

SESSION 5C: FAILURE ANALYSIS

5C-1 Quantitative, Nanoscale Free Carrier Concentration Mapping Using Terahertz Near-field Nanoscopy (Invited), J. Wittborn, R. Weiland, A.J. Huber*, F. Keilmann**, R. Hillenbrand^, Infineon Technologies AG, *Neaspec GmbH, **Max Planck Institut of Quantum Optics and Center for NanoScience, ^CIC nanoGUNE Consolider	493
5C-2 Rapid and Automated Grain Orientation and Grain Boundary Analysis in Nanoscale Copper Interconnects, K.J. Ganesh, S. Rajasekhara, D. Bultreys*, P. J. Ferreira, The University of Texas-Austin, *Nano MEGAS Inc.	500
5C-3 High Reliable Strain Measurement for Power Devices Using Stem-CBED Method, N. Nakanishi, H. Arie, H. Maeda, Y. Hirose, N. Hattori, T. Koyama, E. Murakami, Renesas Electronics Corp.	503
5C-4 Electron Beam Induced Current Characterization of Dark Line Defects in Failed and Degraded High Power Quantum Well Laser Diodes, M. Mason, N. Presser, Y. Sin, B. Foran and S. Moss, The Aerospace Corporation	509
5C-5 Spectral Resolution of Photon Emission from SiGe:C Heterojunction Bipolar Transistors (HBTs), U. Kindereit, O.-M. Mutihac*, C. Boit*, B. Tillack**, IBM T.J. Watson Research Center, *TUB-Berlin Institute of Technology, **IHP GmbH – Innovations for High Performance Microelectronics	514
5C-6 Isolating Light-Sensitive Defects Using C-AFM, H.S. Lin, M.S. Wu, United Microelectronics Corporation, Ltd.	520

SESSION 5D: PROCESS INTEGRATION AND 3D/TSV

5D-1 A Holistic Approach to Process Co-optimization for Through-Silicon Via (Invited), S. Ramaswami, Applied Materials Inc.	524
5D-2 Thermal and Spatial Profiling of TSV-induced Stress in 3DICs (Invited), C. McDonough, B. Backes, W. Wang, and R. Geer, University at Albany, SUNY	527
5D-3 Reliability Studies of a 32 nm System-on-Chip (SoC) Platform Technology with 2nd Generation High-k/Metal Gate Transistors, A. Rahman, M. Agostinelli, P. Bai, G. Curello, H. Deshpande, W. Hafez, C.-H. Jan, K. Komeyli, J. Park, K. Phoa, C. Tsai*, J.-Y. Yeh*, J. Xu, Intel Corporation	533
5D-4 VTH Shift Mechanism in Dysprosium (Dy) Incorporated HfO2 Gate nMOS Devices, T. Lee and S.K. Banerjee, The University of Texas at Austin	539

SESSION 5E: PHOTOVOLTAIC DEVICES

5E-2 Physics of Instability of Thin Film Si and (Si,Ge) Alloy Solar Cells, V. Dalal, Z. Li, Iowa State University	546
5E-3 Reliability Testing beyond Qualification as a Key Component in Photovoltaic's Progress Toward Grid Parity, J. Wohlgemuth, S. Kurtz, NREL	551
5E-4 Identification, Characterization and Implications of Shadow Degradation in Thin Film Solar Cells, S. Dongaonkar, M.A. Alam, Y. Karthik, S. Mahapatra*, D. Wang**, M. Frei**, Purdue University, *Indian Institute of Technology, **Applied Materials	557

5E-5	Metastability of Hydrogenated Amorphous Silicon Passivation on Crystalline Silicon and Implication to Photovoltaic Devices, B. Hekmatshoar, D. Shahrjerdi, M. Hopstaken, D. Sadana, IBM T.J. Watson Research Center	562
5E-6	Optical Stress and Reliability Study of Ruthenium-Based Dye-Sensitized Solar Cells (DSSC), D. Bari, N. Wrachien, A. Cester, G. Meneghesso, R. Tagliaferro*, S. Penna*, T.M. Brown*, A. Reale*, A. Di Carlo*, University of Padova, *University of Rome	566

SESSION 5F: CPI / ELECTROMIGRATION / VOIDING

5F-1	(Invited) The Role of Elastic and Plastic Anisotropy of Sn on Microstructure and Damage Evolution in Lead-Free Solder Joints, T. R. Bieler, B. Zhou, L. Blair, A. Zamiri, P. Darbandi, F. Pourboghra, T.-K. Lee*, K.-C. Liu*, Michigan State University, *Cisco Systems, Inc.	573
5F-2	Robust Pad Layout to Improve Wire Bonding Reliability, K.-H. Kim, H.K. Min, S.Y. Park, S.R. Park, S.J. Yang, B.S. Shim, Y.T. Kim, and J.-U. Han, Samsung Electronics	582
5F-3	Electromigration Characterization of Lead-Free Flip-Chip Bumps for 45 nm Technology Node, C. Hau-Riege, Y.-W. Yau, N. Yu, Qualcomm	588
5F-4	Electromigration Failure Mechanisms for Different Flip Chip Bump Configurations, R. Labie, T. Webers, C. Winters, V. Cherman, K. Croes, B. Vandeveld, F. Dosseul, Imec, *STMicroelectronics	592

SESSION 6A: TRANSISTORS/ORGANICS TFTS

6A-1	Understanding and Modeling AC BTI, H. Reisinger, T. Grasser*, K. Ermisch, H. Nielen, W. Gustin, and C. Schlünder, Infineon Technologies, *Technical University of Vienna	597
6A-2	The ‘Permanent’ Component of NBTI: Composition and Annealing, T. Grasser, T. Aichinger*, G. Pobegen*, Hans Reisinger**, P. Wagner**, J. Franco***, M. Nelhiebel and B. Kaczer*, Technical University of Vienna, *KAI, **Infineon, ***IMEC	605
6A-3	A Critical Re-evaluation of the Usefulness of R-D Framework in Predicting NBTI Stress and Recovery, S. Mahapatra, A.E. Islam*, ^, S. Deora, V. Maheta, K. Joshi, A. Jain^, M.A. Alam^, Indian Institute of Technology Bombay, *Purdue University, ^University of Illinois	614
6A-4	On the Recoverable and Permanent Components of Hot Carrier Degradation and NBTI in Si pMOSFETs and Their Implications in Si0.45 Ge0.55 pMOSFETs, J. Franco, B. Kaczer, G. Eneman, P.J. Roussel, M. Cho, J. Mitard, L. Witters, T.Y. Hoffmann G. Groeseneken, F. Crupi*, T. Grasser**, Imec, *University of Calabria, **Technical University of Vienna	624
6A-5	Impact on HK / MG Stacks and Future Device Scaling on RTN (Invited), N. Tega, H. Miki*, Z. Ren**, C.P. D’Emic**, Y. Zhu**, D.J. Frank**, M. A. Guillorn**, D.-G. Park**, W. Haensch**, K. Torii, Hitachi Ltd., *Hitachi America, **IBM T.J. Watson Research	630

SESSION 6B: MEMORY

6B-1	Split-Gate Flash Memory for Automotive Embedded Applications, Y.S. Chu, Y.H. Wang, C.Y. Wang, Y.-H. Lee, A.C. Kang, R. Ranjan, W.T. Chu, T.C. Ong, H.W. Chin, K. Wu, TSMC	636
6B-2	Novel Negative Vt Shift Program Disturb Phenomena in 2X~3X nm NAND Flash Memory Cells, S. Seo, H. Kim, S. Park, S. Lee, S. Aritome, S. Hong, Hynix Semiconductor, Inc.	641
6B-3	Junction Optimization for Reliability Issues in Floating Gate NAND Flash Cells, C.H. Lee, I.C. Yang, C. Lee, C.H. Cheng, L.H. Chong, K.F. Chen, J.S. Huang, S.H. Ku, N.K. Zous, I.J. Huang, T.T. Han, M.S. Chen, W. P. Lu, K.C. Chen, T. Wang, and C.-Y. Lu, Macronix International Company, Ltd.	645
6B-4	Charge Diffusion in Silicon Nitrides: Scalability Assessment of Nitride Based Flash Memory, S.J. Baik, K.S. Lim, KAIST, W. Choi, H. Yoo, H. Shi, Kookmin University	650
6B-5	The Effect of Crystallinity of HfO2 on the Resistive Memory Switching Reliability, M.G. Sung, W.G. Kim*, J. H. Yoo, S.J. Kim, J.N. Kim, B.G. Gyun, J.Y. Byun, T.W. Kim, W. Kim, M.S. Joo, J.S. Roh, S.K. Park, Hynix Semiconductor, Inc.	656

BD — BEOL DIELECTRICS

BD-1	A Novel Pre-clean Process of BEOL Barrier-seed Process to Enhance Reliability Performance of Advanced 40nm Node, C.-M. Cheng, C.-M. Hsu, W.C. Lin, H.-F. Huang, Y.-C. Liu, K.-H. Lin, J.-F. Lin, C.C. Huang, J.Y. Wu, United Microelectronics Corp.	661
------	--	-----

BD-2 A Charge Transport Based Acceleration Model for Interlevel Dielectric Breakdown, Ravi Achanta, Paul McLaughlin, IBM Systems and Technology Group	665
BD-3 The Model for Post-CMP Cleaning Effect on TDDB, C.-L. Hsu, W.-C. Lin, T.-C. Tsai, C. Huang, and J.-Y. Wu, United Microelectronics Corp.	670

CD — COMPOUND OPTO-ELECTRONICS

CD-1 Performance and Structure Degradations of SiGe HBT After Electromagnetic Field Stress, A. Alaeddine, M Kadi* and K. Daoud, University of Rouen, *IRSEEM, ESIGELEC	674
CD-2 Reliability Testing of AlGaIn/GaN HEMTs under Multiple Stressors, B. Christiansen, R. Coutu, E. Heller*, B. Poling*, G. David Via*, R. Vetry** and J. Shealy**, Air Force Institute of Technology, *Air Force Research Laboratory, **RF Micro Devices, Inc.	680

CP — CPI/ELECTROMIGRATION/VOIDING

CP-1 Long Term Isothermal Reliability of Copper Wire Bonded to Thin 6.5 pm Aluminum, F. Classe and S. Gaddamraja, Spansion	685
CP-2 A New ESD Model Induced Yield Loss during Chip-On-Film Package Process and It's Failure Mechanism, J.-H. Lee, J.-R. Shih, Y.-H. Huang, C.P. Lin, D. Su, K. Wu, TSMC	690

CR — CIRCUIT RELIABILITY

CR-1 A Robust Reliability Methodology for Accurately Predicting Bias Temperature Instability Induced Circuit Performance Degradation in HKMG CMOS, D. Ioannou, K. Zhao, A. Bansal, B. Linder, R. Bolam, E. Cartier, J.-J. Kim, R. Rao, G. La Rosa, G. Massey, M. Hauser, K. Das, J. Stathis, J. Aitken, D. Badami, S. Mittl, IBM	696
CR-2 Bias Temperature Instability Model for Digital Circuits — Predicting Instantaneous FET Response, A. Bansal, K. Zhao, J.-J. Kim, R. Rao, IBM TJ Watson Research Center	700
CR-3 Soft Oxide Breakdown Impact on the Functionality of a 40 nm SRAM Memory, S. Cheffah, V. Huard, R. Chevallier, A. Bravaix*, STMicroelectronics, *JM2NP	704
CR-4 The Relationship Between Transistor-Based and Circuit-Based Reliability Assessment for Digital Circuits, B. Vaidyanathan, S. Bai, A. Oates, TSMC	706
CR-5 The Impact of RTN on Performance Fluctuation in CMOS Logic Circuits, K. Ito*, T. Matsumoto*, S. Nishizawa*, H. Sunagawa*, K. Kobayashi^, H. Onodera**, *Kyoto University, ^Kyoto Institute of Technology, **JST, CREST ...	710

EL — ESD AND LATCH-UP

EL-1 The Modified P+ Electrode Layout Schemes to Enhance ESD Robustness of SCR Structure for PMIC Applications, L.-A. Chen, C.-T. Wang, T.-H. Lai, T.-H. Tang, K.-C. Su, United Microelectronics Corp.	714
EL-2 Impact of Shielding Line on CDM ESD Robustness of Core Circuits in a 65-nm CMOS Process, Ming-Dou Ker*, Chun-Yu Lin and Tang-Long Chang, National Chiao-Tung University, *also with I-Shou University	717
EL-3 Test Chip Design for Study of CDM Related Failures in SoC Designs, N. Olson, V. Shukla and E. Rosenbaum, University of Illinois at Urbana-Champaign	719
EL-4 Nanosecond Transient Thermoreflectance Imaging of Snapback in Semiconductor Controlled Rectifiers, K. Maize, D. Kendig, A. Shakouri, V. Vashchenko *, University of California, Santa Cruz, *National SemiconductorCorp	725

EM — ELECTROMIGRATION/VOIDING

EM-1 Degradation and Failure Analysis of Polysilicon Resistor Connecting with Tungsten Contact and Copper Line, C. Huang, M. Lin, J.W. Liang, A. Juan, K.C. Su, UMC, Inc	731
EM-2 A Practical Modeling for Transient Thermal Characteristics of Multilevel Interconnects, S.-M Choi, D.-C. Baek, T.-Y. Jeong, M.-S. Yeo, M. Lee, A.T. Kim, J. Park, Samsung Electronics Co., Ltd	734
EM-3 Electromigration of Cu Interconnects Under AC, Pulsed-DC and DC Test Conditions, R. Shaviv, G.J. Harm, S. Kumari, R.R. Keller*, D.T. Read*, Novellus Systems, Inc., *NIST	740
EM-4 Improving Lifetime of Cu Interconnects with Adding Compressive Stress at Cathode End, L. Arnaud, P. Lamontagne*, E. Petitprez*, R. Galand*, CEA LETI-MINATEC, *STMicroelectronics	746

EX - EXTREME ENVIRONMENTS

- EX-1 A Study on the Short- and Long-Term Effects of X-Ray Exposure on NAND Flash Memories, S. Gerardin, M. Bagatin, A. Paccagnella, A. Visconti*, S. Beltrami*, M. Bertuccio*, L. Czeppel*, University of Padova, *Numonyx R&D 751
- EX-2 Application of Reliability Test Standards to SIC Power MOSFETs, R. Green, A. Lelis and D. Habersat, U.S. Army Research Laboratory 756

FA — FAILURE ANALYSIS

- FA-1 A Novel and Low-cost Method to Detect Delay Variation by Dynamic Thermal Laser Stimulation, C. Wu, M. Motohiko, W. Wang, G. Song, J. Li, J. Yu, L. Tian, M. Wu, Freescale Semiconductor (China) Limited 765
- FA-2 A Study of the Influence of High Voltage Device Characteristics by Electron Beam Irradiation During Nanoprobing, H.S. Lin, United Microelectronics Corp., Ltd. 770
- FA-3 Detecting Laser Beam Reflectance Modulated by Electronic Device Operation with a Simple Setup, C. Pagano, C. Boit, Y. Yokoyama*, Berlin University of Technology, *Hamamatsu Photonics Deutschland GmbH 774
- FA-4 Backside Reflectance Modulation of Microscale Metal Interconnects, J.K.J. Teo, C.M. Chua*, L.S. Koh*, J.C.H. Phang, National University of Singapore, *SEMICAPS Pte Ltd 780

GD — GATE DIELECTRICS

- GD-1 Nanoscale Electrical and Physical Study of Polycrystalline High-k Gate Dielectrics and Proposed Reliability Enhancement Techniques, K. Shubhakar, K.L. Pey, S.S. Kushvaha*, M. Bosman*, S.J. O'Shea*, N. Raghavan, M. Kouda**, K. Kakushima**, Z.R. Wang, H.Y. Yu and H. Iwai**, Nanyang Technological Univ., *Inst. of Materials Research & Engineering, A *STAR, **Tokyo Institute of Technology 786
- GD-2 Investigation of Progressive Breakdown and Non-Weibull Failure Distribution of High-K Dielectric and SiO₂ Dielectric By Ramp Voltage Stress, N. Rahim, E. Wu, D. Misra*, IBM Microelectronics Division, *New Jersey Institute of Technology 792
- GD-3 Oxide Defects Generation Modeling and Impact on BD Understanding, Y. Mamy Randriamihaja, V. Huard, A. Zaka, S. Haendler, X. Federspiel, M. Rafik, D. Rideau, D. Roy, Alain Bravaix*, STMicroelectronics, *ISEN-IM2NP 798
- GD-4 Comprehensive Analysis of Charge Pumping Data for Trap Identification, D. Veksler, G. Bersuker, A. Koudymov*, C. Young, M. Liehr, B. Taylor, SEMATECH, *Rensselaer Polytechnic Institute 802
- GD-5 A Physics-Based Model of the Dielectric Breakdown in HfO₂ for Statistical Reliability Prediction, Luca Vandelli, Andrea Padovani, Luca Larcher, Gennadi Bersuker*, J. H. Yum*, P. Pavan, Universita di Modena e Reggio Emilia, *SEMATECH 807

HV — HIGH VOLTAGE/RF

- HV-1 Advanced 45nm MOSFET Small-Signal Equivalent Circuit Aging Under DC and RF Hot Carrier Stress, L. Negre, D. Roy, S. Boret, P. Scheer, D. Gloria, G. Ghibaudo, STMicroelectronics, *IMEP-LAHC 811

MY — MEMORY

- MY-1 Characterization of Hexagonal Rare-Earth Aluminates for Application in Flash Memories, M. Zahid, R. Degraeve, M. Toledano-Luque*, J. Van Houdt, IMEC, *Universidad Complutense 815
- MY-2 Charge Gain, NBTI Recovery and Random Telegraph Noise in Nitride-Trapping NVM Devices, M. Janai, I. Bloom, Y. Shur, Spansion Israel, Ltd. 819
- MY-3 A Highly Reliable Embedded P-Channel SONOS Memory using Dynamic Programming Method, Y.-J. Chen, C.-J. Liu, C.-Y. Lo, Y.-J. Ting, T.H. Hsu, W.-T. Sun, eMemory Technology Inc. 824
- MY-4 Analysis of Edge Wordline Disturb in Multimegabit Charge Trapping Flash NAND Arrays, C. Zambelli, A. Chimenton, P. Olivo, Universita degli Studi di Ferrara 828
- MY-5 Investigation of the Programming Accuracy of a Double-verify ISPP Algorithm for Nanoscale NAND Flash Memories, C. Miccoli, C. Monzio Compagnoni, A. Spinelli*, A.L. Lacaita*, Politecnico di Milano, *also with IFN-CNR 833
- MY-6 Precise Understanding of Data retention Mechanisms for MONOS Memories: Toward Simultaneous Improvement of Retention and Endurance Performances by SiN Engineering, S. Fujii, R. Fujitsuka, K. Sekine, N. Yasuda, Toshiba Corporation 839
- MY-7 Variability of Resistive Switching Memories and its Impact on Crossbar Arrays Performance, A. Chen, M.-R. Lin, GLOBALFOUNDRIES 843

MY-8	Statistical Analysis of Retention Behavior and Lifetime Prediction of HfOx-based RRAM, L. Zhang, R. Huang, Y.-Y. Hsu*, F.T. Chen*, H.-Y. Lee*, Y.-S. Chen*, W.-S. Chen*, P.-Y. Gu*, W.-H. Liu*, S.-M. Wang*, C.-H. Tsai*, M.-J. Tsai*, P.-S. Chen**, Peking University, *ITRI, **Ming Shin Univ. of Science & Technology	847
------	--	-----

PI—PROCESS INTEGRATION AND 3D/TSV

PI-1	Behaviors and Physical Degradation of HfSiON MOSFET Linked to Strained CESL Performance Booster, K. Bae, M. Jin, H. Lim, L. Hwang, D. Shin, J. Park, J. Heo, J. Lee, J. Do, I. Bae, C. Jeon, J. Park, Samsung Electronics.	852
PI-2	Experimental Study on Origin of Vth Variability under NBT Stress, Y. Mitani, A. Toriumi*, Toshiba Corporation, *The University of Tokyo	857

SE — SOFT ERRORS

SE-1	Multiple Cell Upsets Tolerant Content-Addressable Memory, S. Mohsin Abbas, S. Baeg, S. Park, Hanyang University	863
SE-2	An Automated Approach to Isolate Dominant SER Susceptibilities in Microcircuits, J. Castillo, D. Mavis, P. Eaton, M. Sibley, D. Elkins, R. Floyd, Microelectronics Research Development Corporation	868
SE-3	Bit Error and Soft Error Hardenable 7T/14T SRAM with 150-nm FD-SOI Process, S. Yoshimoto, T. Amashita, S. Okumura, K. Yamaguchi, M. Yoshimoto *, H. Kawaguchi, Kobe University, *JST, CREST	876
SE-4	Pulse Laser-Induced Transient Currents in Bulk and Silicon-On-Insulator FinFETs, F. El-Mamouni, E.X. Zhang, R. Schrimpf, R. Reed, K. Galloway, D. McMorro*, E. Simoen**, C. Claeys**, S. Cristoloveanu^, W. Xiong^^, Vanderbilt Univ., *Naval Research Laboratory, **Imec, ^IMEP-INP Grenoble MINA TEC, ^^Texas Instruments Inc.	882
SE-5	Neutron- and Alpha-Particle Induced Soft-Error Rates for Flip Flops at a 40 nm Technology Node, S. Jagannathan, D. Loveless, Z. Diggins, B. Bhuvu, S.-J. Wen *, R. Wong*, L. Massengill, Vanderbilt University, *Cisco Systems, Inc.	886
SE-7	Analysis of Multiple Cell Upsets Due to Neutrons in SRAMs for a Deep-N-Well Process, N. Mahatme, B. Bhuvu, Y.-P. Fang*, A. Oates*, Vanderbilt University, *Taiwan Semiconductor Manufacturing Company	891
SE-8	Impact of Ion-Induced Transients on High-Speed Dual-Complementary Flip-Flop Designs, D. Black, R. Reed, W. Robinson, J. Black, D. Limbrick, K. Dick, Vanderbilt University	897

TF—THIN FILMS

TF-1	Stability Improvement of a ZIO TFT Circuits using Low Temperature Anneal, A. Dey, D. Allee, Arizona State University	904
------	--	-----

XT — TRANSISTORS/ORGANICS TFTS

XT-1	Low-Frequency Noise Behavior of La-Doped HfSiON/Metal Gate nMOSFETs, D.-Y. Choi, M.S. Park, C.W. Sohn, H.C. Sagong, E.-Y. Jung, J.-S. Lee, Y.-H. Jeong, C.Y. Kang*, POSTECH, *SEMATECH	908
XT-2	Neutral Interface Traps for Negative Bias Temperature Instability, Z. Chen, X. Zhou, Y.Z. Hu, K.S. Machavolu, Nanyang Technological University	913
XT-3	Atomistic Approach to Variability of Bias-Temperature Instability in Circuit Simulations, B. Kaczer, S. Mahato, V. Valduga de Almeida Camargo, M. Toledano Luque, P. Roussel, T. Grasser**, F. Cathoor, P. Dobrovlny, P. Zuber, G. Wirth*, G. Groeseneken, imec, *UFRGS, **TU Wien.	915
XT-4	Probabilistic Defect Occupancy Model for NBTI, J. Martin-Martinez, B.Kaczer*, M. Toledano-Luque*, R. Rodriguez*, M. Nafria*, X. Aymerich*, G. Groeseneken*, Universitat Autònoma de Barcelona, *imec	920
XT-5	Mosfet's Hot Carrier Degradation Characterization and Modeling at A Microscopic Scale, Y. Mamy Randriamihaja, A. Zaka, V. Huard, M. Rafik, D. Rideau, D. Roy, A. Bravaix*, STMicroelectronics, *ISEN-IM2NP	926
XT-6	Simultaneous Extraction of Threshold Voltage and Mobility Degradation From on-the-fly NBTI Measurements, R.W. Herfst, J. Schmitz, A.J. Scholten*, University of Twente, *NXP-TSMC Research Centre	929
XT-7	Analysis of Recoverable and Non-recoverable NBTI and PBTI Using AC and DC Stresses, F. Monsieur, E. Cartier*, J. Stathis*, STMicroelectronics, *IBM Research Division.	933
XT-8	On the Evolution of the Recoverable Component in the SiON, HfSiON and HfO2 P-MOSFETs Under Dynamic NBTI, Y. Gao, A.A. Boo, Z. Teo, D.S. Ang, Nanyang Technological University	935
XT-9	New Observations on the Physical Mechanism of Vth-Variation in Nanoscale CMOS Devices After Long Term Stress, E.R. Hsieh, Steve Chung, C.H. Tsai*, R.M. Huang*, C.T. Tsai*, C.W. Liang*, National Chiao Tung University, *United Microelectronics Corporation	941
XT-10	On the Cyclic Threshold Voltage Shift of Dynamic Negative-Bias Temperature Instability, Z. Teo, A.A. Boo, D.S. Ang, K.C. Leong*, Nanyang Technological University, *GLOBALFOUNDRIES	943