

WoDiM 2016

**19th Workshop on Dielectrics in
Microelectronics
June 27-30, 2016 – Hotel Baia Verde,
Aci Castello (Catania), ITALY**

Conference Program

Monday, June 27, 2016

8:30. Welcome and Introduction

8:45. First Session: Advanced CMOS FETs

Session Chair: Salvatore Lombardo, CNR-IMM

8:45. INVITED: Hiroshi Iwai, Tokyo IoT, Japan: "High-k/metal gate technology"

9:15. INVITED: Jim Stathis, IBM, USA: "Advanced CMOS dielectrics reliability in FINFETs, 7nm node and beyond"

9:45. Coffee Break

10:15. Second Session: GaN FETs

Session Chair: Karol Frolich, Univ. Bratislava

10:15. INVITED: Gaudenzio Meneghesso, Padua University, Italy: "Dielectric-Related Bias-Induced Threshold Voltage Instability in GaN based power HEMTs"

10:45. "High temperature investigation of electron transport properties in 2DEG AlGaIn/AlIn/GaN MIS-HEMT", I. Nifa¹, C. Leroux¹, A. Torres¹, M. Charles¹, J. Cluzel¹, E. Bano², G. Ghibaudo², G. Reimbold¹, ¹ LETI, France

11:05. "Fixed Charge Engineering using N₂ Plasma Enhanced Atomic Layer Deposition of Aluminum Oxynitride Gate Dielectric to Produce Enhancement-Mode AlGaIn/GaN Device Operation", M.A. Negara, R.D. Long and P.C. McIntyre, Stanford University, USA

11:25. "Interface states and border traps in SiC and GaN transistors using SiO₂ as gate insulator", P. Fiorenza¹, G. Greco¹, M. Vivona¹, F. Giannazzo¹, S. Di Franco¹, A. Frazzetto², A. Guarnera², M. Saggio², F. Lucolano², A. Patti², F. Roccaforte¹, ¹ CNR-IMM, ² ST-Italy

11:45. "Low-temperature ALD grown Al₂O₃ gate dielectric for GaN/AlGaIn/GaN MOS-HEMTs: Impact of deposition conditions on interface state density" L. Válik, M. Ťapajna, F. Guemann, D. Gregušová, K. Fröhlich, and J. Kuzmík, Univ. Bratislava, Slovakia

12:05. "High-k/GaN interface engineering towards AlGaIn/GaN MISHEMTs with improved V_{th} stability", Nadine Szabo¹, Andre Wachowiak¹, Johannes Ocker¹, Annett Winzer¹, Rico Hentschel¹, Thomas Mikolajick^{1,2}, NamLab, ¹ Dresden, Germany

12:25. "Impact of the ohmic contact anneal on AlGaIn/GaN MISHFETs with Al₂O₃ and GdScO₃ gate dielectric", Alexander Schmid¹, Sarah Seidel¹, Ronald Otto¹, Annett Winzer², Andre Wachowiak², Thomas Tromm³, Jürgen Schubert³, Johannes Heitmann¹, ¹ TU Freiberg, Germany

12:45. Lunch Break

15:00. Third Session: RRAMs I

Session Chair: Gabriella Ghidini, ST-Italy

15:00. INVITED: Barbara De Salvo, LETI, France: "NVM cells for future nodes"

15:30. "Different Al incorporation methods in HfO₂ based RRAM and their effects on forming and thermal stability", M. Alayan¹, E. Vianello¹, A. Padovani², P. Blaise¹, B. Sklénard¹, C. Charpin¹, S. Bernasconi¹, A. Roule¹, C. Cagli¹, E. Jalaguier¹, B. De Salvo¹, L. Larcher², L. Perniola¹, ¹ LETI, France

15:50. "Double layer vertical HfO₂-based resistive switching structures with low forming voltage", B. Hudec¹, I-T. Wang¹, W-L. Lai¹, C-C. Chang, T-H. Hou, P. Jancovic², K. Frohlich², ¹ National Chiao-Tung University, ² Univ. Bratislava, Slovakia

16:10. "Exploring the Multilevel Capability of TiN/Ti/HfO₂/W RRAM Devices by Pulse Programming", M.B. Gonzalez, M.C. Acero, J. Calvo, M. Zabala, and F. Campabadal, IMB-CNM, Barcelona, Spain

16:30. "MBE-grown oxides-based resistive switching memristive devices", M. Minvielle¹, N. Najjari², G. Sassine², C. Botella¹, G. Ghibaudo³, F. Alibart³, C. Dubourdieu¹, ¹ CNRS Lyon, France

16:50. "Enhanced Switching in Ta₂O₅ RRAM by Fluorine Doping" N. Sedghi¹, I. Brunell², R. Potter², S. Hall¹, K. Dawson², and P. R. Chalker², ¹ Univ. Liverpool, UK

17:10. Coffee Break

17:25. 4th Session: III-V FETs (Joint Session with the Compose³ Project)

Session Chair: Jean Fompeyrine, IBM Switzerland

17:30. Session Introduction, Jean Fompeyrine, IBM Switzerland: the Compose³ Project

17:35. INVITED: Vladimir Djara, IBM Switzerland: "Hybrid 3D Monolithic CMOS Technology With InGaAs n-FETs on SiGe-OI p-FETs"

18:00. "Capacitance-Voltage based characterisation of InGaAs on Insulator Structures", K. Cherkaoui¹, Y. Y. Gomeniuk^{1, 2}, J. Lin¹, B. Sheehan¹, M. Schmidt¹, J. O'Brien¹, A. Blake¹, K. K. Thomas¹, E. Pelucchi¹, D. O'Connell¹, S. Monaghan¹, and P. K. Hurley¹, ¹ Tyndall, Ireland

18:20. INVITED: Thierry Baron, CNRS, France: "InGaAs thin film directly grown on 300 mm Si(100) standard microelectronic wafers for InGaAs-OI wafer fabrication"

18:50. "The effect of forming gas annealing on capacitance-voltage hysteresis in the high-k/In_{0.53}Ga_{0.47}As metal-oxide-semiconductor system", Jun Lin¹, Scott Monaghan¹, Karim Cherkaoui¹, Ian M. Povey¹, Brendan Sheehan¹, Jacopo Franco² and Paul K. Hurley¹, ¹ Tyndall, Ireland

19:10. "Initial investigation on the impact of in situ hydrogen plasma exposure to the interface between molecular beam epitaxially grown p-Ga_{0.7}In_{0.3}Sb (100) and thermal atomic layer deposited (ALD) Al₂O₃", David Millar, Uthayasankaran Peralagu, Yen-Chun Fu, Xu Li, Mathew Steer and Iain Thayne, Univ. Glasgow, UK

19:30. End of Sessions of the First Day

Tuesday, June 28, 2016

8:30. 5th Session: 2D Semiconductors

Session Chair: Paul Hurley, Tyndall

8.30. INVITED: Christopher Hinkle, UTDallas, USA, "Transition Metal Dichalcogenide (TMD) growth by MBE and its interfaces with other materials"

9:00. "Atomic layer deposition of Al₂O₃ on graphene with in-situ seed-layer for field effect transistors", G. Fisichella*, E. Schilirò, S. Di Franco, P. Fiorenza, F. Roccaforte, R. Lo Nigro, F. Giannazzo, CNR-IMM, Italy

9:20. "Effect of Annealing And MoS₂ Thickness on Top-Gated MoS₂ Transistors With HfO₂ Dielectric", P. Zhao¹, A. Azcatl¹, P. Bolshakov-Barrett¹, J. Moon¹, P.K. Hurley², C.L. Hinkle¹, R.M. Wallace¹, and C.D. Young¹, ¹UTDallas, USA

9:40. "Influence of oxide traps and channel transport in graphene field effect transistors: Effect of oxide traps on channel transport in graphene field effect transistors", Marlene Bonmann¹, Andrei Vorobiev¹, Samina Bidmeshkipour², Jan Stake¹ and Olof Engström¹, ¹Univ. Chalmers, Sweden

10:00. "Top-gated MoS₂ field effect transistors with chemical engineered gate stacks", HyunJeong Kim,^{1,2} WungYeon Kim,^{1,2} Maria O'Brien,^{2,3} SinZad Winters,^{2,3} Toby Hallam,^{2,4} Gyu-Tae Kim,¹ Georg S. Duesberg^{2,3}, ¹Korea University, ^{2,3,4}Trinity College, Dublin, Ireland

10:20. "Atomic scale study of the interface graphene/C-face SiC", G.Nicotra¹, I. Deretsis¹, M. Scuderi¹, F. Giannazzo¹, P. Longo², R. Yakimova³, A. La Magna¹ and C. Spinella¹, ¹CNR-IMM, Italy

10:40. "Field effect transistors of thermal assisted conversion of metals (TAC) derived WSe₂ film with various growth conditions", WungYeon Kim,^{1,2} HyunJeong Kim,^{1,2} Riley Gatensby,^{2,3} Toby Hallam,⁴ Gyu-Tae Kim,¹ Georg S. Duesberg^{2,3}, ¹Korea University, ^{2,3,4}Trinity College, Dublin, Ireland

11:00. Coffee Break

11:30. 6th Session: Photovoltaics and Water Splitting

Session Chair: Catherine Dubourdieu, HZB

11:30. "MIS Photoelectrodes for Solar Fuel Synthesis: Dielectric Design for Optimized Performance", A.G. Scheuermann,^a K.W. Kemp,^a K. Tang, J.P. Lawrence,^a D.Q. Lu,^a P.F. Satterthwaite,^a T. Ito,^a A. Walsh,^b C.E.D. Chidsey,^a P.K. Hurley,^b and P.C. McIntyre^a, ^aStanford Univ., USA

11:50. "Industrial scale optimization of Hydrogenated Silicon sub-oxide as bottom n-layer in tandem silicon solar cell", Condorelli G.⁽¹⁾, Canino A.⁽¹⁾, Battaglia A.⁽¹⁾, and Gerardi C.⁽²⁾, ⁽¹⁾3SUN, ⁽²⁾Enel Green Power, Italy

12:10. "Investigating the effect of TiO₂ thickness on the electrical conductivity and photoelectrochemical response of metal/TiO₂/SiO_x/Si photoanodes", Adrian Walsh¹, Karim Cherkaoui¹, Michael Schmidt¹, Andrew G. Scheuermann², Robert S. Tang-Kong², Martyn E. Pemble¹, Paul C. McIntyre², Ian M. Povey¹ and Paul K. Hurley¹, Tyndall, Ireland

12:30. "Metal-oxide-semiconductor (MOS) photoanodes for photoelectrochemical water splitting devices", Yuanyuan Shi¹, Tingting Han^{1,2}, Xiaoxue Song¹, Antonio Mio², Luca Valenti², Stefania Privitera², Salvatore Lombardo², Mario Lanza¹, ¹Soochow University, China

12:50. "Effect of illumination and electric field intensity on the efficiency improvement of amorphous silicon single junction and tandem solar cells", Andrea Scuto,¹ Marina Foti,² Cosimo Gerardi,³ Anna Battaglia,⁴ and Salvatore Lombardo¹, ¹CNR-IMM, Italy

13:10. Lunch Break

15:00. 7th Session: Reliability

Session Chair: Karim Cherkaoui, Tyndall

15:00. INVITED: Jacopo Franco, IMEC, Belgium: "SiGe, Ge, and III-V devices BTI"

15:30. "Applications of Clustering Model to Bimodal Distributions for BEOL/MOL/MIMCAP Dielectrics", Ernest Y. Wu, Ronald Bolam*, Ronald Filippi⁺, James H. Stathis, Baozhen Li*, and Andrew Kim*, IBM, USA

15:50. INVITED: Alain Bravaix, IM2NP, France: "BTI and HCI in FDSOI CMOS"

16:20. "Mapping of CMOS FET Degradation in Bias Space-Application to DRAM Peripheral Devices", B. Kaczer¹, J. Franco¹, S. Tyaginov^{2,3}, M. Jech², B. O'Sullivan¹, R. Ritzenthaler¹, T. Schram¹, D. Linten¹, N. Horiguchi¹, T. Grasser², ¹IMEC, Belgium

16:40. "High-k Bilayer Gate Stack Degradation Mechanisms Studied by Pulsed Stress at Nanometric Scale", Martin Kogelschatz^{1,2}, Romain Foissac^{1,2,3}, Serge Blonkowski³, ¹Univ. Grenoble Alpes, France

17:00. "Comparison of gate oxide damage in rad-hard Power MOSFET's induced by 10 keV X-rays and constant current stress", F. Pintacuda, V. Cantarella, R. Nicolosi, V. Cinnera, L. Abbene, A. Grimaldi and F. Principato, ST-Italy

17:20. Coffee Break

17:30. 8th Session: POSTERS

P1. "Function-Fit Model for the Generation of Conductive Filaments in Constant Voltage Stressed Multilayer Oxide Stacks", A. Rodriguez-Fernandez^a, M.B. Gonzalez^b, J. Suñé^a, F. Campabadal^b, E. Miranda^a, ^aUniv. Autònoma Barcelona, Spain

P2. "Impedance characterisation of conduction processes in HfO₂ based resistive switching memory", M. Mikolasek¹, P. Benko¹, P. Jancovic², L. Harmatha¹, K. Frohlich², ¹Univ. Bratislava, Slovakia

P3. "SPICE simulation of thermal reset transitions in Ni/HfO₂/Si-n+ RRAMs including quantum effects", G. Gonzalez, F. Jimenez-Molinos, M.A.Villena, J.B. Roldan, Univ. Granada, Spain

P4. "Effects of the extension of conductive filaments within the electrodes in RRAMs, a simulation approach", M. A. Villena, J. B. Roldán, P. García-Fernández, F. Jiménez-Molinos, Univ. Granada, Spain

P5. "Ta₂O₅ dielectric layers in capacitive RF MEMS switches on GaAs substrate", A. Persano, F. Quaranta, A. Cola, A. Taurino, P. Creti, and P. Siciliano, CNR-IMM, Italy

P6. "Low off-state Leakage Currents in AlGaIn/GaN High Electron Mobility Transistors By Employing A Highly Stressed SiN_x Surface Passivation Layer", S. J. Cho^a, X. Li^a, I. Guiney^b, K. Floros^a, D. Hemakumara^a, O. Ignatova^a, D. Moran^a, C. J. Humphreys^b, & I. G. Thayne^a, ^aUniv. Glasgow, UK

P7. "Effects of Titanium Layer Oxygen Scavenging on the High-k/InGaAs Interface", R. Winter¹, P. Shekhter¹, K. Tang², L. Floreano³, A. Verdini³, P.C. McIntyre² and M. Eizenberg¹, ¹Technion, Israel

P8. "Trapping and de-trapping effects of border traps in MG/HK/InGaAs stacks", F. Palumbo^{1,2,3}, S. Pazos^{1,2,3}, F. Aguirre², R. Winter⁴, I. Krylov⁴, and Eizenberg⁴, ¹CONICET, Argentina

P9. "Optimisation of UV-assisted wet oxidation of GaAs for double-layer gate insulators", F. Gucmann¹, R. Kudela¹, A. Rosov¹, E. Dobrocka¹, M. Micusik², K. Frohlich¹, and D. Gregusova¹, ¹Univ. Bratislava, Slovakia

P10. "Barrier tuning of atomic layer deposited Ta₂O₅ and Al₂O₃ in resonant tunneling diodes for terahertz electronics", I. Nemr Nouredine, N. Sedghi, I. Z. Mitrovic, and S. Hall, Univ. Liverpool, UK

P11. "A novel low voltage field-effect emitter suitable to vacuum microelectronics", Davide Patti¹, Delfo Sanfilippo¹, Salvatore Pennisi², Giuseppe Nicotra³, and Salvatore Lombardo³, ¹ST-Italy

P12. "High energy x-ray photoelectron spectroscopy characterisation of Fermi level alignment at metal-MoS₂ interfaces", Conor McGeough¹, Tony Cafolla¹, Paul Hurley² and Greg Hughes¹, ¹Dublin Univ., Ireland

P13. "CAFM analysis of the Temperature Dependence of Random Telegraph Noise in SiON gate dielectrics", Q. Wu, J. Martin-Martinez, M. Porti, R. Rodriguez, M. Nafria, X. Aymerich, ¹Univ. Autònoma Barcelona, Spain

19:30. End of Sessions of the Second Day

Wednesday, June 29, 2016

8:30. 9th Session: RRAMs II. Session Chair: Fernanda Irrera, Univ. Roma I

8:30. INVITED: Christian Wenger, IHP, Germany: "Impact of HfO₂ deposition techniques on the switching parameters in embedded 1T-1R cells and arrays"

9:00. "HfO_x-RRAM based Neuromorphic Architecture for handwritten digits recognition ", G. Romano, P. Lorenzi, R. Rao and F. Irrera, Univ. Roma I, Italy

9:20. "Changing the SET current limit to control the Bipolar Resistive Switching conductivity", J. Martin-Martinez¹, M. Pedro¹, M. B. Gonzalez², R. Rodriguez¹, F. Campabadal² and M. Nafria¹, ¹ Univ. Autonoma Barcelona, Spain

9:40. "A new experimental setup for the ultrafast characterization of the resistive switching phenomenon", J. Diaz-Fortuny, M. Maestro, J. Martin-Martinez, A. Crespo-Yepes, R. Rodriguez, M. Nafria and X. Aymerich, Univ. Autonoma Barcelona, Spain

10:00. "An in-depth study of the physics behind resistive switching in TiN/Ti/HfO₂/W structures", G. González-Cordero, M.B. González, F. Jiménez-Molinos, F. Campabadal, Univ. Granada, Spain

10:20. "3-bit Multilevel Cell switching in Nitrogen Doped Ta₂O₅ RRAM", N. Sedghi¹, I. Brunell², R. Potter², S. Hall¹, and P. R. Chalker², ¹ Univ. Liverpool, UK

10:45. Coffee Break

11:15. 10th Session: Advanced Dielectrics for FETs and MIMs

Session Chair: Thomas Schröder, IHP

11:15. INVITED: Moshe Eizenberg, Technion, Israel: "The Role of Interfaces and Defects in Controlling the Electrical Properties of Metal/high-k Stacks on Various Semiconductors"

11:45. "Rare Earth Element Doping of GeO₂ for Improved Stability and Densified Network: a DFT View", Hongfei Li, Yuzheng Guo, John Robertson, Univ. Cambridge, UK

12:05. "Impact of low thermal processes on reliability of HK/MG stacks", A.Tsiara^{1,2}, X.Garros¹, C.-M.V.Lu¹, C.Fenouillet-Boranger¹ and G.Ghibaud³, ¹ LETI, France

12:25. " Investigation of physical and electrical scaling limits of strontium titanate in metal-insulator –metal capacitors for DRAM technology", Mihaela Popovici, Augusto Redolfi, Ben Kaczer, Hubert Hody, Malgorzata Jurczak, Sven Van Elshocht, IMEC, Belgium

12:45. "Reliability improvements of TiN/Al₂O₃/TiN for linear high voltage MIM capacitors using an optimized thermal treatment", A. Lefevre¹, M. Czernohorsky², F. Lallemand³, D. Ferreira¹, M.Veillerot¹, J.P.Barnes¹, G. Parat¹, ¹ LETI, France

13:05. "Structure of the interface in sub-nm EOT TmSiO/HfO₂ gate stack", I.Z. Mitrovic¹, S.N. Supardan¹, D. Hesp², V.R. Dhanak², S. Hall¹, S. Schamm-Chardon³, E. Dentoni Litta⁴, P.-E. Hellstrom⁴, and M. Ostling⁴, ¹ Univ. Liverpool, UK

13:30. End of Sessions of the Third Day

13:30. Lunch Break

14:30. Tourist Excursion and Social Dinner

Thursday, June 30, 2016

8:30. 11th Session: Synthesis and Characterization of Novel Dielectrics.

Session Chair: Sebania Liberto, CNR-IMM

8:30. INVITED: Nava Setter, EPFL, Switzerland, "Mobile Interfaces (domain walls for reconfigurable circuits)"

9:00. "Optimization of dielectric and ferroelectric properties in $\text{Hf}_{1-x}\text{Zr}_x\text{O}_2$ films for non-volatile ferroelectric memory applications", Min Hyuk Park,^{1,2} Han Joon Kim,¹ Yu Jin Kim,¹ Taehwan Moon,¹ Keum Do Kim,¹ Young Hwan Lee,¹ Seung Dam Hyun,¹ Franz Fengler,² Thomas Mikolajick,^{2,3} Uwe Schroeder,² and Cheol Seong Hwang¹, ¹ Seoul National University, ² NamLab, Dresden, Germany

9:20. INVITED: Erik Lind, Lund Univ., Sweden, "Characterisation techniques for dielectrics and interfaces"

9:50. "AlHfO for MIM applications", G.Ghidini, D.Brazzelli, R.Piagge, F.Toia, D.Erbetta, M.Caniatti, S.Bellini, ST-Italy

10:10. "Aerosol Deposition of Dielectrics from an Aqueous Fog", Nishit Murari,¹ Ryan Mansergh,² Yu Huang,² Doug Keszler,² John F. Conley, Jr.,¹ ¹ Oregon State Univ, USA

10:30. "Transmission Microwave Spectroscopy of Dielectric Materials", A. Lucibello, E. Proietti, G. M. Sardi, G. Capocchia, C. H. Joseph, R. Marcelli, CNR-IMM, Italy

10:50. "Oxidation of Germanium at Low-temperature by Plasma Enhanced Processing" W. Lerch^a, N. Sacher^a, W. Kegel^a, J. Niess^b, M. Czernohorsky^c, ^a Centrotherm, Germany

11:10. "High growth rate and low thermal budget DLI-ALD processes for HfO_2 using $\text{HfCp}(\text{NMe}_2)_3$ and H_2O ", C. Yeromonahos^{1,2}, A. Varghese^{1,3}, H. Guillon^{1,3}, C. Dubourdieu^{1,2}, J.M. Decams^{1,3}, ¹ CNRS, Lyon, France

11:30. Coffee Break

11:45. 12th Session: Dielectrics for Sensors and LEDs

Session Chair: Salvatore Lombardo, CNR-IMM

11:45. "Towards a High Performing UV-A Sensor based on Silicon Carbide and Silicon Nitride Absorbing Layers", Massimo Mazzillo^a, Antonella Sciuto^b, Nicola Costa^a, Giovanni Mannino^b, and Paolo Badalà^a, ^a ST-Italy

12:05. "Temperature and humidity dependence of ALD- Al_2O_3 degradation in (opto-) electronic devices", Andreas Ruckerl, Martin Mandl, Simeon Katz and Roland Zeisel, OSRAM, Germany

12:25. "DNA perfect match detection by electrical sensors", M. Favetta¹, T. Cosentino², M.E. Castagna³, F. Sinatra², A. Valletta⁴, G. Fortunato⁴, S. Conoci³, S.Libertino¹, ¹ CNR-IMM, Italy

12:45. "A miniaturized electrochemical system based on Nickel oxide species for sensing applications", Salvatore Petralia¹, Salvo Mirabella², Eloisa Castagna¹, and Sabrina Conoci¹, ¹ ST-Italy

13:05. End of Sessions, Wrap Up, Farewell

13:20. End of Conference