

# IEEE TRANSACTIONS ON ELECTRON DEVICES

A PUBLICATION OF THE IEEE ELECTRON DEVICES SOCIETY



NOVEMBER 2016

VOLUME 63

NUMBER 11

IETDAI

(ISSN 0018-9383)

---

## REGULAR PAPERS

### Silicon and Column IV Semiconductors Devices

- Compact Modeling of Surface Potential, Charge, and Current in Nanoscale Transistors Under Quasi-Ballistic Regime ..... *A. Dasgupta, A. Agarwal, S. Khandelwal, and Y. S. Chauhan* 4151
- Modeling of the Lateral Emitter-Current Crowding Effect in SiGe HBTs ..... *S. Yadav, A. Chakravorty, and M. Schroter* 4160
- Random Dopant Fluctuation-Induced Threshold Voltage Variation-Immune Ge FinFET With Metal-Interlayer-Semiconductor Source/Drain ..... *C. Shin, J.-K. Kim, G.-S. Kim, H. Lee, C. Shin, J.-K. Kim, B. J. Cho, and H.-Y. Yu* 4167
- Line Tunneling Dominating Charge Transport in SiGe/Si Heterostructure TFETs ..... *S. Blaesser, S. Glass, C. Schulte-Braucks, K. Narimani, N. von den Driesch, S. Wirths, A. T. Tiedemann, S. Trellenkamp, D. Buca, S. Mantl, and Q.-T. Zhao* 4173
- High-Performance Pi-Gate Poly-Si Junctionless and Inversion Mode FET ..... *D.-R. Hsieh, J.-Y. Lin, P.-Y. Kuo, and T.-S. Chao* 4179
- Raised Source/Drain Dopingless Junctionless Accumulation Mode FET: Design and Analysis ..... *S. Ramaswamy and M. J. Kumar* 4185
- Electron Mobility in Junctionless Ge Nanowire NFETs ..... *H.-Y. Ye, H.-S. Lan, and C. W. Liu* 4191
- Hybrid Open Drain Method and Fully Current-Based Characterization of Asymmetric Resistance Components in a Single MOSFET ..... *J. Kim, H. Lee, S. K. Kim, J. Kim, J. Park, S.-J. Choi, D. H. Kim, and D. M. Kim* 4196
- Charge-Based Compact Model for Bias-Dependent Variability of  $1/f$  Noise in MOSFETs ..... *N. Mavredakis, N. Makris, P. Habas, and M. Bucher* 4201
- A New Device-Physics-Based Noise Margin/Logic Swing Model of Surrounding-Gate MOSFET Working on Subthreshold Logic Gate ..... *T.-K. Chiang* 4209

### Compound Semiconductor Devices

- AlGaN/GaN HEMTs on Silicon With Hybrid Schottky-Ohmic Drain for RF Applications ..... *C.-W. Tsou, H.-C. Kang, Y.-W. Lian, and S. S. H. Hsu* 4218
- A Compact Model of Drain Current for GaN HEMTs Based on 2-DEG Charge Linearization ..... *N. Karumuri, G. Dutta, N. DasGupta, and A. DasGupta* 4226

(Contents Continued on Page 4149)

Lateral InAs/Si p-Type Tunnel FETs Integrated on Si—Part 1: Experimental Devices .....	4233
..... <i>K. E. Moselund, D. Cutaia, H. Schmid, M. Borg, S. Sant, A. Schenk, and H. Riel</i>	
Lateral InAs/Si p-Type Tunnel FETs Integrated on Si—Part 2: Simulation Study of the Impact of Interface Traps .....	4240
..... <i>S. Sant, K. Moselund, D. Cutaia, H. Schmid, M. Borg, H. Riel, and A. Schenk</i>	
Calibration of the Effective Tunneling Bandgap in GaAsSb/InGaAs for Improved TFET Performance Prediction .....	4248
..... <i>Q. Smets, A. S. Verhulst, S. El Kazzi, D. Gundlach, C. A. Richter, A. Mocuta, N. Collaert, A. V.-Y. Thean, and M. M. Heyns</i>	
RF Performance of Trigate GaN HEMTs .....	4255
..... <i>M. Alsharef, M. Christiansen, R. Granzner, E. Ture, R. Quay, O. Ambacher, and F. Schwierz</i>	
Influence of Al/Si Codiffusion on Current Gain Deterioration in AlGaN/GaN Single Heterojunction Bipolar Transistors .....	4262
..... <i>Y. T. Tseng, C. W. Lin, W. C. Yang, K. Y. Chen, and K. Y. Cheng</i>	
Study of Inherent Gate Coupling Nonuniformity of InAs/GaSb Vertical TFETs .....	4267
..... <i>C.-Y. Hsu, Y. Zeng, C.-Y. Chang, C. Hu, and E. Y. Chang</i>	
<b>Memory Devices and Technology</b>	
1-kb FinFET Dielectric Resistive Random Access Memory Array in 1× nm CMOS Logic Technology for Embedded Nonvolatile Memory Applications .....	4273
..... <i>K. P. Huang, H. W. Pan, S. Y. Chen, P. C. Peng, C.-H. Kuo, Y.-D. Chih, C. J. Lin, and Y.-C. King</i>	
Postcycling Degradation in Metal-Oxide Bipolar Resistive Switching Memory .....	4279
..... <i>Z. Wang, S. Ambrogio, S. Balatti, S. Sills, A. Calderoni, N. Ramaswamy, and D. Ielmini</i>	
Modifying Indium-Tin-Oxide by Gas Cosputtering for Use as an Insulator in Resistive Random Access Memory .....	4288
..... <i>P.-H. Chen, K.-C. Chang, T.-C. Chang, T.-M. Tsai, C.-H. Pan, Y.-T. Su, C.-H. Wu, W.-C. Su, C.-C. Yang, M.-C. Chen, C.-H. Tu, K.-H. Chen, I. Lo, J.-C. Zheng, and S. M. Sze</i>	
Self-Selection RRAM Cell With Sub-μA Switching Current and Robust Reliability Fabricated by High-K/Metal Gate CMOS Compatible Technology .....	4295
..... <i>P. Huang, S. Chen, Y. Zhao, B. Chen, B. Gao, L. Liu, Y. Chen, Z. Zhang, W. Bu, H. Wu, X. Liu, and J. Kang</i>	
Statistical Write Stability Characterization in SRAM Cells at Low Supply Voltage .....	4302
..... <i>H. Qiu, K. Takeuchi, T. Mizutani, Y. Yamamoto, H. Makiyama, T. Yamashita, H. Oda, S. Kamohara, N. Sugii, T. Saraya, M. Kobayashi, and T. Hiramoto</i>	
<b>Thin Film Transistors</b>	
Subgap State Engineering Using Nitrogen Incorporation to Improve Reliability of Amorphous InGaZnO Thin-Film Transistors in Various Stressing Conditions .....	4309
..... <i>G. T. Li, R. Z. Zhan, B.-R. Yang, C. Liu, C. Y. Dong, C.-Y. Lee, Y.-C. Wu, P.-Y. Lu, S. Z. Deng, H.-P. D. Shieh, and N. S. Xu</i>	
High-Mobility and Good-Stability Thin-Film Transistors With Scandium-Substituted Indium Oxide Semiconductors .....	4315
..... <i>W. Song, L. Lan, P. Xiao, Z. Lin, S. Sun, Y. Li, E. Song, P. Gao, P. Zhang, W. Wu, and J. Peng</i>	
Improved Negative Bias Illumination Stability and Thermal Stability of HfZnSnO/ZnSnO Thin-Film Transistor Using Double-Channel Structure by Cosputtering .....	4320
..... <i>C.-X. Huang, J. Li, C.-Y. Zhao, Y.-Z. Fu, J.-H. Zhang, X.-Y. Jiang, and Z.-L. Zhang</i>	
<b>Optoelectronics, Displays, and Imaging</b>	
Time-Sequential Ultraviolet Exposure to Alignment Layers Embedded With Reactive Mesogen for High-Speed In-Plane Switching Liquid Crystal Cell .....	4326
..... <i>B.-J. Mun, K.-W. Park, J.-H. Baek, B. K. Kim, H. C. Choi, C. Kim, B. Kang, S. H. Lee, and G.-D. Lee</i>	
<b>Solid-State Power and High Voltage Devices</b>	
Repetitive Unclamped-Inductive-Switching-Induced Electrical Parameters Degradations and Simulation Optimizations for 4H-SiC MOSFETs .....	4331
..... <i>S. Liu, C. Gu, J. Wei, Q. Qian, W. Sun, and A. Q. Huang</i>	
Characterization and Modeling of a 1.2-kV 30-A Silicon-Carbide MOSFET .....	4339
..... <i>Y. Mukunoki, Y. Nakamura, T. Horiguchi, S.-I. Kinouchi, Y. Nakayama, T. Terashima, M. Kuzumoto, and H. Akagi</i>	
Investigations on the Degradation of 1.2-kV 4H-SiC MOSFETs Under Repetitive Short-Circuit Tests .....	4346
..... <i>X. Zhou, H. Su, Y. Wang, R. Yue, G. Dai, and J. Li</i>	
Analytical Model and Optimization for Variable Drift Region Width SOI LDMOS Device .....	4352
..... <i>Y. Wang, X.-F. Meng, P.-P. Tang, and S.-F. Cui</i>	
A Novel 3-D Analytical Method for Curvature Effect-Induced Electric Field Crowding in SOI Lateral Power Device .....	4359
..... <i>J. Zhang, Y.-F. Guo, D. Z. Pan, and K.-M. Yang</i>	
Intertwined Design: A Novel Lithographic Method to Realize Area Efficient High-Voltage SiC BJTs and Darlington Transistors .....	4366
..... <i>H. Elahipanah, A. Salemi, C.-M. Zetterling, and M. Östling</i>	

---

**Materials, Processing and Packaging**

Electrical Contact Resistance of Coated Spherical Contacts .....	W. Ren, Y. Chen, Z. Wang, S. Xue, and X. Zhang	4373
--	--	------

**Solid State Device Phenomena**

Trap Assisted Tunneling and Its Effect on Subthreshold Swing of Tunnel FETs .....	R. N. Sajjad, W. Chern, J. L. Hoyt, and D. A. Antoniadis	4380
Operation and Design of van der Waals Tunnel Transistors: A 3-D Quantum Transport Study .....	J. Cao, D. Logoteta, S. Özkaya, B. Biel, A. Cresti, M. G. Pala, and D. Esseni	4388
An EBIC Model for TCAD Simulation to Determine the Surface Recombination Rate in Semiconductor Devices ....	A. Kraxner, F. Roger, B. Loeffler, M. Faccinelli, E. Fisslthaler, R. Minixhofer, and P. Hadley	4395
Investigation of Transport Modeling for Plasma Waves in THz Devices .....	Z. Kargar, T. Linn, D. Ruić, and C. Jungemann	4402
Reliability Degradation Mechanisms of Horizontal Current Bipolar Transistor .....	J. Žilak, M. Koričić, and T. Suligoj	4409
Negative Capacitance Behavior in a Leaky Ferroelectric .....	A. I. Khan, U. Radhakrishna, K. Chatterjee, S. Salahuddin, and D. A. Antoniadis	4416

**Molecular and Organic Devices**

Analytical Drain Current Model for Organic Thin-Film Transistors at Different Temperatures Considering Both Deep and Tail Trap States .....	H. He, Y. Liu, B. Yan, X. Lin, X. Zheng, and S. Zhang	4423
Investigation of Mobility Transient on Organic Transistor by Means of DLTS Technique .....	N. Lago, A. Cester, N. Wrachien, E. Benvenuti, S. D. Quiroga, M. Natali, S. Toffanin, M. Muccini, and G. Meneghesso	4432
Improving Mobility and Stability of Organic Field-Effect Transistors by Employing a Tetratetracontane Modifying PMMA Dielectric .....	L. Xiang, W. Wang, and F. Gao	4440

**Sensors and Actuators**

Silicon Carbide for Realization of “Telescope” Ion Detectors .....	L. Torrisi and A. Cannavò	4445
Viability of Piezojunction Effect for Microresonator Applications .....	A. Rasouli and B. Bahreyni	4452

**Vacuum Electron Devices**

I/O System for A 77/154-GHz, 0.5-MW Dual Regime Gyrotron .....	G. S. Baghel, S. Illy, and M. V. Kartikeyan	4459
Electron Beam Transport System for 263-GHz Sheet Beam TWT .....	Y. Zheng, D. Gamzina, B. Popovic, and N. C. Luhmann, Jr.	4466
Numerical Optimization of the Cusp Gun for a W-Band Second-Harmonic Gyro-TWA .....	K. Dong, Y. Luo, W. Jiang, H. Fu, and S. Wang	4473
Ring-Double-Bar Slow Wave Structure for High Power TWTs .....	Y. N. Pchelnikov	4479
An Extended Theoretical Method Used for Design of Sheet Beam Electron Gun .....	H. Liang, C. Ruan, Q. Xue, and J. Feng	4484
Emittance Effects on Gain in W-Band TWTs .....	B. E. Carlsten, K. E. Nichols, D. Y. Shchegolkov, and E. I. Simakov	4493

**Emerging Technologies and Devices**

All-Spin-Orbit Switching of Perpendicular Magnetization .....	M. Kazemi, G. E. Rowlands, S. Shi, R. A. Buhrman, and E. G. Friedman	4499
A Compact Model for Double-Gate Heterojunction Tunnel FETs ....	Y. Dong, L. Zhang, X. Li, X. Lin, and M. Chan	4506
Novel Strategy of Edge Saturation Hamiltonian for Graphene Nanoribbon Devices .....	Y. Lv, Q. Huang, S. Chang, H. Wang, and J. He	4514
The Role of the Fermi Level Pinning in Gate Tunable Graphene-Semiconductor Junctions .....	F. A. Chaves and D. Jiménez	4521
Ultrasensitive Nanoscale Magnetic-Field Sensors Based on Resonant Spin Filtering .....	A. Sharma, A. Tulapurkar, and B. Muralidharan	4527
Annealing Effect on Structural, Functional, and Device Properties of Flexible ZnO Acoustic Wave Sensors Based on Commercial Available Al Foil .....	Y. Liu, J. T. Luo, C. Zhao, J. Zhou, S. A. Hassan, Y. Li, M. Cooke, Q. Wu, W. P. Ng, J. F. Du, Q. Yu, Y. Liu, and Y. Q. Fu	4535

---

**BRIEF PAPERS**

A Novel Double-Side Silicon-Embedded Transformer for 10-MHz, 1-kV-Isolation, Compact Power Transfer Applications .....	R. Wu, N. Liao, X. Fang, and J. K. O. Sin	4542
Reduction of NiGe/n- and p-Ge Specific Contact Resistivity by Enhanced Dopant Segregation in the Presence of Carbon During Nickel Germanidation .....	N. Duan, J. Luo, G. Wang, J. Liu, E. Simoen, S. Mao, H. Radamson, X. Wang, J. Li, W. Wang, C. Zhao, and T. Ye	4546

---