

# Table of Contents

## Preface

## Chapter 1: Growing and Forming of Layers

<b>Polarity Effect on the Heteroepitaxial Growth of <math>B_xC</math> on 4H-SiC by CVD</b>	3
F. Cauwet, Y. Benamra, L. Auvray, J. Andrieux and G. Ferro	
<b>Vertical Current Transport in Monolayer MoS<sub>2</sub> Heterojunctions with 4H-SiC Fabricated by Sulfurization of Ultra-Thin MoO<sub>x</sub> Films</b>	9
S.E. Panasci, E. Schiliro, M. Cannas, S. Agnello, A. Koos, M. Nemeth, B. Pécz, F. Roccaforte and F. Giannazzo	
<b>Estimation of Influence on Carbon Vacancy Regarding 4H-SiC Substrate Grown by HTCVD Method</b>	15
H. Uehigashi, T. Okamoto, A. Horiai, H. Fujibayashi, T. Kanda, T. Kanemura and K. Tsuruta	
<b>Resistivity as a Witness of Local Crystal Growth Conditions</b>	20
A. Soukhojak and G. Chung	
<b>GaN Cap UV Spectroscopy Assessment in AlGaN/GaN HEMT</b>	28
C. Calabretta, N. Piluso, H.J. Chauveau, E. Roy, C. Iatosti, F. La Via and A. Severino	
<b>SNDM Study of the MOS Interface State Densities on the 3C-SiC / 4H-SiC Stacked Structure</b>	33
H. Nagasawa, Y. Cho, M. Abe, T. Tanno, M. Musya, M. Sakuraba, Y. Sato and S. Sato	
<b>Development of 200mm SiC Technology - Epitaxial Thickness Uniformity Observation on Different 8 Inch 4H-SiC Substrates</b>	41
R. Anzalone, D. Raciti, M. Arena, C. Calabretta, N. Piluso and A. Severino	
<b>4H-SiC Crystal Growth Using Recycled SiC Powder Source</b>	46
S.J. Lee, C.Y. Lee, J.W. Choi, J.H. Park, J.G. Kim, K.R. Ku, J.H. Na and W.J. Lee	
<b>High-Quality SiC Crystal Growth by Temperature Gradient Control at Initial Growth Stage</b>	51
C.Y. Lee, S.J. Lee, J.H. Park, J.W. Choi, J.G. Kim, K.R. Ku, J.H. Na, M.G. Kang and W.J. Lee	
<b>The Role of Air-Pocket in Crucible Structure for High Quality SiC Crystal Growth</b>	56
S.J. Lee, S.H. Kim, J.W. Choi, J.H. Park, J.G. Kim, K.R. Ku, H.L. Lee, G.U. Lee and W.J. Lee	
<b>Influence of the Size Distribution of the SiC Powder Source on the Shape of the Crystal Growth Interface during PVT Growth of 4H-SiC Boules</b>	62
J. Schultheiß, J. Ihle, S. Usseglio Nanot, S. Bonanomi, D. Callejo Munoz, R. Hammer and P.J. Wellmann	
<b>Confirmation of the Growth Mechanism of the Buffer Layer in Epitaxial Graphene on SiC</b>	68
V.S. Prudkovskiy, R. Templier, A. Moulin, N. Troutot, G. Gelineau, S. Huet, V. Le, K. Mony, G. Lapertot, M. Delcroix, S. Caridroit, S. Barbet and J. Widiez	
<b>Suppressing the Memory Effect in Al Doped 3C-SiC Grown Using Chlorinated Chemistry</b>	73
G. Colston, A.B. Renz, K. Perera, P.M. Gammon, M. Antoniou, P.A. Mawby and V.A. Shah	
<b>Investigations into the Impact of Deposition or Growth Techniques on the Field Oxide TID Response for 4H-SiC Space Applications</b>	78
V. Kotagama, A.B. Renz, V. Kilchyska, D. Flandre, Y. Qi, V.A. Shah, M. Antoniou and P.M. Gammon	
<b>Characterization of Growth Sectors in Gallium Nitride Substrate Wafers</b>	84
Y. Liu, S. Hu, Z.Y. Chen, Q.Y. Cheng, M.K. Cheng, W. Zhao, T. Buyuklimanli, B. Raghothamachar and M. Dudley	
<b>Doping Efficiency and Long-Term Stability of Various SiC Epitaxial Reactors and Process Chemistries</b>	92
R. Spetik, T. Novak, M. Soroka, H. Vemolova and R. Ctvrtlik	

## Chapter 2: Wafers and Substrates

<b>Surface Structuring of Patterned 4H-SiC Surfaces Using a SiC/Si/SiC Sandwich Approach</b>	101
Y. Joussemae, P. Kumar, M.E. Bathen, F. Cauwet, U. Grossner and G. Ferro	

<b>HYPREZ Wafering Solutions: A Novel Approach of SiC Wafering Solution</b> G. Lee, A. Hartmann and S. Kassir	107
<b>Poly-SiC Characterization and Properties for SmartSiC™</b> H. Biard, A. Drouin, W. Schwarzenbach, K. Alissaad, L. Coeurdray, V. Chagneux, M. Coche, S. Ledrappier, S. Monnoye, H. Mank, S. Rouchier, T. Barge, D. Radisson, A. Moulin, S. Barbet, J. Widiez, S. Odoul and C. Maleville	114
<b>Application of Advanced Characterization Techniques to SmartSiC™ Product for Substrate-Level Device Performance Optimization</b> A. Drouin, R.B. Simon, D. Radisson, W. Schwarzenbach, M. Zielinski, E. Guiot, E. Cela, A. Chapelle and H. Biard	119
<b>A Novel Approach for Thin 4H-SiC Foil Realization Using Controlled Spalling from a 4H-SiC Wafer</b> S.N. Wahid, M. Leitgeb, G. Pfusterschmied and U. Schmid	127
<b>High-Temperature Reorganization Behavior of Single-Crystalline Porous 4H-SiC Thin Foils</b> M. Perazzi, M. Leitgeb, A. Vengattoor Raghu, C. Zellner, R. Hahn, A. Kirnbauer, S. Schwarz, G. Pfusterschmied and U. Schmid	134
<b>Dicing Process for 4H-SiC Wafers by Plasma Etching Using High-Pressure SF<sub>6</sub> Plasma with Metal Masks</b> Y. Sano, Y. Nakanishi, M. Oshima, S. Iden, J. Yamada, D. Toh and K. Yamauchi	141
<b>Investigations on the Recovery of the Electrical Properties of Smart Cut™-Transferred SiC Thin Film Using SiC-on-Insulator Structures</b> G. Gelineau, C. Masante, E. Rolland, S. Barbet, L. Corbin, A. Papon, S. Caridroit, M. Delcroix, S. Huet, A. Moulin, V.S. Prudkovskiy, N. Troutot, S. Rouchier, L. Turchetti, K. Mony and J. Widiez	146
<b>Demonstration of SiC-on-Insulator Substrate with Smart Cut™ Technology for Photonic Applications</b> S. Huet, S. Guerber, E. Rolland, B. Szelag, G. Gelineau, A. Moulin, V.S. Prudkovskiy, N. Troutot, C. Licitra, P. Gergaud, S. Barbet, M. Delcroix, S. Caridroit, V. Amalbert, C. Alonso-Ramos, D. Melati, S. Edmond, L. Vivien, K. Mony, G. Lapertot and J. Widiez	155
<b>A Novel Contactless SiC Wafer Planarization Processing after Mechanical Slicing by Dynamic Thermal Annealing Processes</b> K. Toda, D. Kakutani, D. Dojima, Y. Nakajima, H. Mihara and T. Kaneko	165
<b>Proposal of Damage-Free SiC Wafer Dicing Using Water Jet Guided Laser</b> S. Kadoya, S. Takahashi, M. Michihata, N. Ohtani, K. Abe and S. Arimura	173
<b>In-Line Characterization of HPSI SiC Wafers Using High Resolution Surface Photovoltage Spectroscopy (HR-SPS)</b> T. Clausen, N. Schüler and K. Dornich	178
<b>Characterization of Very Thin 3C-SiC Epilayers on Si</b> M. Zielinski, M. Bussel, M. Portail, A. Michon and Y. Cordier	184

## Chapter 3: Defects of Solid Semiconductor Structures

<b>Evaluation of Basal Plane Dislocation Behavior near Epilayer and Substrate Interface</b> Y. Nishihara, T. Shiono, Y. Mabuchi and K. Kamei	193
<b>Body Diode Reliability of 4H-SiC MOSFETs as a Function of Epitaxial Process Parameter</b> S. Kochoska, J. Franchi, S. Maslougkas, M. Domeij, T.T. Pham, S. Sunkari, J. Justice and H. Das	198
<b>Accuracy of EVC Method for the PiN Diode Pattern on SiC Epi-Wafer</b> K. Takano, T. Morita, Y. Matsushita and Y. Igarashi	205
<b>Study on Quantification of Correlation between Current Density and UV Irradiation Intensity, Leading to Bar Shaped 1SSF Expansion</b> Y. Igarashi, K. Takano, Y. Matsushita and T. Morita	212
<b>Early Detection of Bar-Shaped 1SSF before Expansion by PL Imaging</b> T. Morita, Y. Matsushita, Y. Igarashi and K. Takano	221
<b>Analysis of Forward Bias Degradation Reduction in 4H-SiC PiN Diodes on Bonded Substrates</b> H. Uchida, M. Kobayashi, N. Hatta, S. Ishikawa, K. Ozono, K. Masumoto, S. Kurihara, S. Harada and K. Kojima	227

<b>Investigation of Dislocation Behaviors in 4H-SiC Substrate during Post-Growth Thermal Treatment</b>	
H.Y. Peng, Y.H. Gao, Z.Q. Shi, Y.N. Pan, C. Zhu, C. Gao, B. Raghorthamachar and M. Dudley	233
<b>The Role of Defects on SiC Device Performance and Ways to Mitigate them</b>	
H. Das, J. Justice, S. Sunkari, P. Kostelník, T. Novak, S. Kochoska and D. An	238
<b>Emission of Trapped Electrons from the 4H-SiC/SiO<sub>2</sub>-Interface via Photon-Irradiance at Cryogenic Temperatures</b>	
M. Weger, M. Bockstedte and G. Pobegen	247
<b>SiC MOSFET Gate Oxide Quality Improvement Method in Furnace Thermal Oxidation with Lower Pressure Control</b>	
Y.B. Im, I.K. Kim, S.P. Son, Y. Kang, C.J. Kim, J. Lee, J. Lee, J. Lim and C. Jeong	253
<b>Investigating Dislocation Arrays Induced by Seed Scratches during PVT 4H-SiC Crystal Growth Using Synchrotron X-Ray Topography</b>	
Q.Y. Cheng, Y. Liu, Z.Y. Chen, S. Hu, B. Raghorthamachar, M. Dudley, V. Pushkarev, K. Moeggenborg, G. Chung, E. Sanchez and A. Soukhojak	257
<b>Crystal Originated Defect Monitoring and Reduction in Production Grade SmartSiC™ Engineered Substrates</b>	
E. Cela, K. Alissaad, A. Chapelle, S. Rouchier, W. Schwarzenbach, A. Drouin, V. Chagneux, M. Zielinski and C. Maleville	267
<b>Analysis of Lattice Damage in 4H-SiC Epiwafers Implanted with High Energy Al Ions at Elevated Temperatures</b>	
Z.Y. Chen, Y. Liu, Q.Y. Cheng, S. Hu, B. Raghorthamachar, R. Ghandi, S. Kennerly, C. Carlson, D. Steski and M. Dudley	272
<b>Near-Interface Defect Decomposition during NO Annealing Analyzed by Molecular Dynamics Simulations</b>	
Y. Ohuchi, H. Saeki, H. Sakakima and S. Izumi	278
<b>Differences between Polar-Face and Non-Polar Face 4H-SiC/SiO<sub>2</sub> Interfaces Revealed by Magnetic Resonance Spectroscopy</b>	
R. Kondo, H.Y. Zeng, M. Sometani, H. Hirai, H. Watanabe and T. Umeda	284
<b>Investigation of BPD Faulting under Extreme Carrier Injection in Room vs High Temperature Implanted 3.3kV SiC MOSFETs</b>	
N.A. Mahadik, M.E. Liao, M.E. Mastro, E.M. Kallon, R.E. Stahlbush, J. Soto and B. Odekirk	289
<b>Epitaxial Defectivity Characterization Combining Surface Voltage and Photoluminescence Mapping on 200mm 4H-SiC Wafers</b>	
J. Thörnberg, G. Polisski, E. Carria, M. Isacson and B. Magnusson	295
<b>Buffer Layer Dependence of Defectivity in 200mm 4H-SiC Homoepitaxy</b>	
D. Raciti, R. Anzalone, M. Isacson, N. Piluso and A. Severino	300
<b>A Study of Process Interruptions during Pre- and Post-Buffer Layer Epitaxial Growth for Defect Reduction in 4H SiC</b>	
T. Rana, J. Wu, V. Pushkarev and I. Manning	305
<b>Practical Improvement of Noncontact Production Monitoring of Doping in SiC Wafers with Extended Epilayer Defects</b>	
A. Savtchouk, M. Wilson, B. Schrayer, L. Gutierrez, C. Almeida and J. Lagowski	310
<b>Analysis of Defect Structures during the Early-Stages of PVT Growth of 4H-SiC Crystals</b>	
S. Hu, Y. Liu, Z.Y. Chen, Q.Y. Cheng, B. Raghorthamachar, M. Dudley, D. Dukes, V. Torres, L. Young, S. Griswold, H. Bricetti, C.H. Liu and Y.M. Zhu	316
<b>Development of 3-Channel Inspection Analysis Technique for Defects of SiC Epitaxial Wafers Using Optical Inspection, Photoluminescence and X-Ray Topography</b>	
J. Senzaki, J. Nishino and T. Osanai	324
<b>High-Volume SiC Epitaxial Layer Manufacturing-Maintaining High Materials Quality of Lab Results in Production</b>	
B. Thomas, D. Baierhofer, F. Staiger and C. Bierhoff	329
<b>Non-Destructive Quantification of In-Plane Depth Distribution of Sub-Surface Damage on 4H-SiC Wafers Using Laser Light Scattering</b>	
D. Dojima, K. Shigematsu, K. Tayake, K. Toda and T. Kaneko	336
<b>Macro Step Bunching/Debunching Engineering on 4° off 4H-SiC (0001) to Control the BPD-TED Conversion Ratio by Dynamic AGE-Ing®</b>	
D. Dojima, K. Tayake, K. Shigematsu, K. Toda and T. Kaneko	343
<b>Charge Carrier Capture by Prominent Defect Centers in 4H-SiC</b>	
O. Samperi, L. Vines, A. Hallén and M.E. Fragalà	351

## **Chapter 4: Formation, Processing and Characteristics of Solid-State Structures**

<b>Free-Standing 3C-SiC P-Type Doping by Al Ion Implantation</b> M. Canino, F. Torregrosa, M. Zielinski, V. Boldrini, C. Bidini, M. Russo, P. Maccagnani and F. La Via	363
<b>Investigation of Potential Impact of Nitridation Process on Single Event Gate Rupture Tolerance in SiC MOS Capacitors</b> M. Takahashi, E. Kagoshima, T. Makino, M. Iwata, N. Ohtani, N. Nemoto, S. Narita, T. Tawara, J. Senzaki, K. Kobayashi, T. Suematsu, S. Harada, A. Takeyama, T. Ohshima, J. Saito, H. Fujiwara and H. Shindou	369
<b>Venus Surface Environmental Chamber Test of SiC JFET-R Multi-Chip Circuit Board</b> P.G. Neudeck, L.Y. Chen, L.C. Greer, D.J. Spry, N.F. Prokop, D. Lukco, M.J. Krasowski and G.W. Hunter	375
<b>TEM Investigation on High Dose Al Implanted 4H-SiC Epitaxial Layer</b> C. Calabretta, N. Piluso, C. Bongiorno, S. Boninelli, F. La Via and A. Severino	381
<b>Evolution of the Substitutional Fraction on Post-Implantation Annealing in Al/4H-SiC Systems</b> V. Boldrini, A. Parisini and M. Pieruccini	386
<b>Coupled Non-Destructive Methods, Kelvin Force Probe Microscopy and <math>\mu</math>-Raman to Characterize Doping in 4H-SiC Power Devices</b> E. Vuillermet, K.T. Wu, A. Sedilot, R. Deturche, N. Bercu, E. Usureau, J. Beal and M. Lazar	394
<b>Low Resistivity Aluminum Doped Layers Formed Using High Dose High Temperature Implants and Laser Annealing</b> F. Mazzamuto, Z. Chehadi, F. Roze, M. Opprecht, A. Gupta, S. Kerdilès, T. Tabata, M. Ameen, D. Roh, C. Sohl, M. Lazar, L.M. Rubin and L. Thuries	403
<b>Concept and Technology for Full Monolithic MOSFET and JBS Vertical Integration in Multi-Terminal 4H-SiC Power Converters</b> R. Makhoul, N. Beydoun, A. Bourennane, L.V. Phung, F. Richardeau, M. Lazar, P. Godignon, D. Planson, H. Morel and D. Bourrier	411
<b>Improving <math>HfO_2</math> Thick Films for SiC Power Devices by Si, Y and La Doping</b> S. Krause, T. Mikolajick and U. Schroeder	419
<b>Comparing 4H-SiC NPN Buffer Layers by Epitaxial Growth and Implantation for Neural Interface Isolation</b> S. Greenhorn, E. Bano, V. Stambouli and K. Zekentes	425
<b>Dopant Activation Comparison in Phosphorus and Nitrogen Implanted 4H-Silicon Carbide</b> S. Das, D.J. Lichtenwalner, H. Dixit, S. Rogers, A. Scholze and S.H. Ryu	430
<b>Modeling the Charging of Gate Oxide under High Electric Field</b> D. Scholten and J. Baringhaus	435
<b>Transient-Enhanced Diffusion of Implanted Aluminum in 4H-SiC</b> K.L. Mletschnig, P.P. Michałowski and P. Pichler	442
<b>Complementary Two Dimensional Carrier Profiles of 4H-SiC MOSFETs by Scanning Spreading Resistance Microscopy and Scanning Capacitance Microscopy</b> P. Fiorenza, M. Zignale, E. Zanetti, M.S. Alessandrino, B. Carbone, A. Guarnera, M. Saggio, F. Giannazzo and F. Roccaforte	448
<b>Calibration of Aluminum Ion Implantation Monte-Carlo Model for TCAD Simulations in 4H-SiC</b> A. Scholze, A.V. Suvorov, D.J. Lichtenwalner, S. Rogers, H. Dixit and S.H. Ryu	453
<b>Temperature Dependence of 4H-SiC Gate Oxide Breakdown and C-V Properties from Room Temperature to 500 °C</b> A. May, L. Baier and M. Rommel	458
<b>The Effect of Nitrogen Plasma Treatment Process on Ohmic Contact Formation to N-Type 4H-SiC</b> A.H. Yeo, V.Q.G. Roth, L.K. Bera, N. Singh, U. Chand, S. Chung, A. Ranjan, G. Ho, S.K. Lim and X. Gong	466
<b>Detection of Very Fast Interface Traps at 4H-SiC/AlN and 4H-SiC/<math>Al_2O_3</math> Interfaces</b> A.M. Vidarsson, A.R. Persson, J.T. Chen, D. Haasmann, J. Ul-Hassan, S. Dimitrijev, N. Rorsman, V. Darakchieva and E.Ö. Sveinbjörnsson	471

<b>A Voltage Adjustable Diode Integrated SiC Trench MOSFET with Barrier Control Gate</b> S.J. Li, X.C. Deng, X. Li, X. Li and Y. Wen	477
<b>Ni/4H-SiC Ohmic Contact Formation Using Multipulse Nanosecond Laser Annealing</b> M. Opprecht, S. Kerdilès, J. Biscarrat, P. Godignon, C. Masante, R. Laviéville, N. Vaxelaire, P. Gergaud, A. Grenier, C. Jung, F. Roze, Z. Chehadi, L. Thuries, L. Lu and T. Tabata	483
<b>Lift-Off Process for Patterning of a Sputter-Deposited Thick Metal Stack for High Temperature Applications on 4H-SiC</b> A. Fuchs, K. Brueckner, K. Ehrensberger and O. Rusch	489
<b>Effects of High Gate Voltage Stress on Threshold Voltage Stability in Planar and Trench SiC Power MOSFETs</b> A.K. Biswas, D.J. Lichtenwalner, S. Das, C. Isaacson, S. Ganguly and D.A. Gajewski	496
<b>Design of Al<sub>2</sub>O<sub>3</sub>/LaAlO<sub>3</sub>/SiO<sub>2</sub> Gate Stack on Various Channel Planes for High-Performance 4H-SiC Trench Power MOSFETs</b> L.H. Huang, Y. Liu, X. Peng, T. Tsuji, Y. Onozawa, N. Fujishima and J.K.O. Sin	503
<b>Plasma Treatment after NiSi-Based Ohmic Contact Formation on 4H-SiC to Enhance Adhesion of Subsequent Backside Metallization</b> T. Becker, C. Hellinger, A. Fuchs, J. Koerfer and O. Rusch	512
<b>Effect of Substrate Heating on Low Contact-Resistance Formation by Excimer Laser Doping for 4H-SiC</b> Y. Kakimoto, T. Yasunami, K. Katayama, D. Nakamura, T. Goto and H. Ikenoue	518
<b>Channel Density Design Guidelines for the Transient Characteristics of SiC Trench Gate MOSFETs</b> S. Kimoto, R. Iijima and S. Harada	524
<b>Nickel Ohmic Contacts Formed on 4H-SiC by UV Laser Annealing</b> J.F. Michaud, C. Berger and D. Alquier	531
<b>Electrical and Structural Properties of Ohmic Contacts of SiC Diodes Fabricated on Thin Wafers</b> P. Badalà, C. Bongiorno, P. Fiorenza, G. Bellocchi, E. Smecca, M. Vivona, M. Zignale, M. Massimino, I. Deretzis, S. Rascunà, M. Fazzica, M. Boscaglia, F. Roccaforte, A. La Magna and A. Alberti	537
<b>Analysis of On-State and Short-Circuit Capability in 3D Trench SiC MOSFET Designs</b> K. Melnyk, L.Y. Zhang, P.M. Gammon, A.B. Renz and M. Antoniou	544
<b>Revised Channel Mobility Model for Predictive TCAD Simulations of 4H-SiC MOSFETs</b> H. Dixit, D.J. Lichtenwalner, A. Scholze, J. Kim, K.J. Han and S.H. Ryu	550
<b>Empirical Model of Low-Ohmic Nickel-Based Contact Formation on N-Type 4H-SiC Depending on Thermal Budget</b> C. Hellinger, M. Rommel and A.J. Bauer	555
<b>Improvement of Reflectance Spectroscopy for Oxide Layers on 4H-SiC</b> J. Koerfer, M. Rommel, A. Fuchs and O. Rusch	563
<b>Low-Ohmic Nickel Contacts on N-Type 4H-SiC by Surface Roughness Dependent Laser Annealing Energy Density Optimization</b> C. Hellinger, M. Rommel and A.J. Bauer	569
<b>Doping and Temperature Dependence of Carrier Lifetime in 4H SiC Epitaxial Layers</b> L. Lilja and J.P. Bergman	575
<b>Long Term Reliability and Deterioration Mechanisms of High-Temperature Metal Stacks on 4H-SiC</b> K. Brueckner and O. Rusch	581
<b>Fail-to-Open Short Circuit Failure Mode of SiC Power MOSFETs: 2-D Thermo-Mechanical Modeling</b> I. Kovacevic-Badstuebner, S. Race, N. Luethi, M. Nagel and U. Grossner	587
<b>Metal Contact Processing Experiments towards Realizing 500 °C Durable RF 4H-SiC BJTs</b> S. Rajgopal, D.J. Spry, D. Lukco and P.G. Neudeck	593
<b>Performance Improvement by Carbon-Dioxide Supercritical Fluid Treatment for 4H-SiC Vertical Double Diffusion MOSFETs</b> H.M. Chen, C.H. Yen, W.C. Hung, W.C. Hung, H.M. Kuo, F.C. Liang and T.C. Chang	598
<b>Fast Estimation of the Lateral Fidelity of Ion Implantation in 4H-SiC through Calibration to JFET Transfer Characteristics in TCAD</b> K. Sakai, N. Boettcher, M. Szabo, S. Beuer and M. Rommel	603

<b>Hydrogen Etching Process of 4H-SiC (0001) in Limited Regions</b>	
A. Mancuso, S. Boninelli, M. Camarda, P. Fiorenza, A. Mio, V. Scuderi, P. Godignon, S. Aslanidou, L. Calcagno and F. La Via	611
<b>Comparative Study of the Self-Aligned Channel Processes for 4H-SiC VDMOSFET</b>	
J.T. Hsiao, C.L. Hung, Y.K. Hsiao and B.Y. Tsui	618
<b>Demonstration of Low Interface Trap Density (<math>\sim 3 \times 10^{11} \text{ eV}^{-1} \text{ cm}^{-2}</math>) SiC/SiO<sub>2</sub> MOS Capacitor with Excellent Performance Using H<sub>2</sub>+NO POA Treatment for SiC Power Devices</b>	
U. Chand, L.K. Bera, N. Singh, T. Fidler, P. Schmid, S. Kumar, V.Q.G. Roth, A.H. Yeo, H. Cakmak, A. Ranjan, V.P. Reddy, M. Camalleri, L. Scalia, M. Saggio, A. Guarnera, M.K. Teoh, M. Castorina and S. Chung	623
<b>Increasing Mobility in 4H-SiC MOSFETs with Deposited Oxide by <i>In-Situ</i> Nitridation of SiC Surface</b>	
M. Yakut, A. Roy, F. Arith, A. Whitworth, A. Alexander, J. Gryglewicz, J. Sheriff, S. Olsen, K. Vasilevskiy and A. O'Neill	628
<b>Demonstrating SiC <i>In Situ</i> Rounded Trench Processing Technologies for Future Power Trench MOSFET Applications</b>	
B. Jones, A. Croot, J. Mitchell, C. Bolton, J.E. Evans, F. Monaghan, K. Riddell, M. Jennings, O.J. Guy and H. Ashraf	634
<b>High Mobility 4H-SiC P-MOSFET via Ultrathin ALD B<sub>2</sub>O<sub>3</sub> Interlayer between SiC and SiO<sub>2</sub></b>	
E.K. Ashik, V. Misra and B.M. Lee	642
<b>Quality Improvement of SiC Substrate Surface with Using Non-Abrasive CMP Slurry</b>	
S.J. Lee, B.H. Park, C.H. Lee, I.K. Lee, J.D. Seo, K.R. Ku, B.H. Choi, E.O. Kim, N.R. Shin, S.Y. Jung, D.W. Kim, J.H. Na and W.J. Lee	652
<b>Addition of Transition Metal Ion CMP Slurry for Forming Ultra-Flat SiC Crystal</b>	
S.H. Kim, H.S. Ryu, C.H. Lee, M.O. Kyun, J.D. Seo, K.R. Ku, J.W. Lee, B.H. Choi, E.O. Kim, N.R. Shin, S.Y. Jung, D.W. Kim, H.L. Lee, Y.J. Choi and W.J. Lee	658
<b>Increasing 4H-SiC Trench Depth by Improving the Dry Etch Selectivity towards the Oxide Hard Mask</b>	
O. Rusch, K. Brueckner and T. Erlbacher	663
<b>A Comparison between Different Post Grinding Processes on 4H-SiC Wafers</b>	
B. Cafra, A. Grasso, N. Piluso and A. Severino	671
<b>Influence of Active Area Etching Method on the Integrity of Gate Oxide on 4H-SiC</b>	
C.H. Wang, L.J. Lin, C.L. Hung, Y.K. Hsiao and B.Y. Tsui	681
<b>High-K Gate Dielectric for High-Performance SiC Power MOSFET Technology with Low Interface Trap Density, Good Oxide Lifetime (<math>t_{tddb} \geq 10^4 \text{ s}</math>), and High Thermal Stability (<math>\geq 800 \text{ }^\circ\text{C}</math>)</b>	
U. Chand, L.K. Bera, N. Singh, C. Zhixian, S. Kumar, V.Q.G. Roth, A.H. Yeo, B. Varghese, V.P. Reddy, H. Cakmak, A. Ranjan, H. Lin and S. Chung	686

## Chapter 5: Circuitry and Characterizations of Solid-State Power Devices

<b>3<sup>rd</sup> Quadrant Surge Current SOA of SiC MOSFETs with Different Voltage Class</b>	
M. Alaluss, C. Böhm, C. Herrmann, T. Basler, R. Elpelt and G. Zeng	693
<b>Reliability of SiC MOSFETs in the High Cycle Fatigue Regime under Fast Power Pulses</b>	
C. Schwabe, N. Seltner and T. Basler	701
<b>Investigation of the Trapping and Detrapping Behavior by the On-State Resistance at Low Off-State Drain Bias in Schottky p-GaN Gate HEMTs</b>	
M. Goller, J. Franke, J. Lutz, S. Mouhoubi, G. Curatola and T. Basler	707
<b>Study of the Bias Driven Threshold Voltage Drift of 1.2 kV SiC MOSFETs in Power Cycling and High Temperature Gate Bias Tests</b>	
R. Boldyrjew-Mast, P. Heimler, X. Liu, K. Reiter, C. Schwabe, N. Thönelt, J. Lutz and T. Basler	714
<b>Junction-Controlled-Diode-Embedded SiC-MOSFET for Improving Third Quadrant and Turn-On Characteristics</b>	
Q. Lou, X. Li, Z.Y. Yang, L.F. Li, S.J. Li, X.C. Deng and B. Zhang	722
<b>Dependence of the Silicon Carbide Radiation Resistance on the Irradiation Temperature</b>	
A.A. Lebedev, V.V. Kozlovski, M.E. Levinstein, K.S. Davydovskaya and R.A. Kuzmin	727

<b>Effect Evaluation and Modeling of p-Type Contact and p-Well Sheet Resistance of SiC MOSFET with Respect to Switching Characteristics</b> Y. Nagase, S. Nakata and T. Tominaga	732
<b>Anomalous Electrical Behavior of 4H-SiC Schottky Diodes in Presence of Stacking Faults</b> M. Vivona, P. Fiorenza, V. Scuderi, F. La Via, F. Giannazzo and F. Roccaforte	737
<b>Ohmic Contact Resistance in SiC Diodes with Ti and NiSi P<sup>+</sup> Contacts</b> M. Mazzillo, D. Momeni, Z. Yu, J. Stache, J. Urresti, C. Liguda and S. Habenicht	743
<b>Early-Stage Reliability Evaluation of Passivation Stack and Termination Designs in SiC MPS Diodes</b> D. Momeni, M. Mazzillo, S. Laha, M.S.B.A. Sani, J. Urresti, T.X. Dai, C. Liguda and S. Habenicht	750
<b>Influence of Material Properties on Ruggedness Evaluation of Package Architectures for SiC Power Devices</b> H.J. Funke, Z. Li, H. Fan, O. Dong, A.J. Garete, T. Birkoben, C. Liguda and S. Habenicht	756
<b>A Unique Failure Mode of SiC MOSFETs under Accelerated HTRB</b> P. Moens, M. Domeij, J.F. Cano, L. de Schepper, S. Verleye and F. Allerstam	764
<b>1.2 kV SiC MOSFET with Low Specific ON-Resistance and High Immunity to Parasitic Turn-On</b> T.T. Pham, J. Franchi, S.H. Kang, K.S. Park, D.J. Choi and M. Domeij	771
<b>Design Optimization and Reliability Evaluation in 1.2 kV SiC Trench MOSFET with Deep P Structure</b> K.W. Lee, J. Choi, Y.H. Seo, K.S. Park, M. Domeij and F. Allerstam	776
<b>Analysis of Electrothermal Imbalance of Hard-Switched Parallel SiC MOSFETs through Infrared Thermography</b> A. Borghese, S. Angora, M. Boccarossa, M. Riccio, L. Maresca, V.R. Marrazzo, G. Breglio and A. Irace	782
<b>Experimental Demonstration of Ultra-Fast SiC MOSFET Overload Protection Using Embedded Current and Temperature Sensors</b> D. Tournier, T. Vadébout, P. Bevilacqua, P. Brosselard and J.F. de Palma	789
<b>Dynamic Bias-Temperature Instability Testing in SiC MOSFETs</b> E. Martino, S. Kicin, Y. Zong, A. Nasralla, G. Romano, R. Burkart, A. Mesemanolis and S. Wirths	795
<b>Non-Linear Gate Stack Effect on the Short Circuit Performance of a 1.2-kV SiC MOSFET</b> M. Boccarossa, L. Maresca, A. Borghese, M. Riccio, G. Breglio, A. Irace and G.A. Salvatore	801
<b>UIS Ruggedness of Parallel 4H-SiC MOSFETs</b> P. Steinmann, M. Atzeri, I.H. Ji, J. Langan, K. Myers, N. Oldham, J.H. Park, R. Potera, C. Rinderer and E. van Brunt	808
<b>A Geometry-Scalable Physically-Based SPICE Compact Model for SiC MPS Diodes Including the Snapback Mechanism</b> V. Terracciano, A. Borghese, M. Boccarossa, V. d'Alessandro and A. Irace	813
<b>The Impact of Gamma Irradiation on 4H-SiC Bipolar Junction Inverters under Various Biasing Conditions</b> A. Metreveli, A. Hallén, I. di Sarcina, A. Cemmi, A. Verna and C.M. Zetterling	821
<b>SiC GAA MOSFET Concept for High Power Electronics Performance Evaluation through Advanced TCAD Simulations</b> L. Maresca, V. Terracciano, A. Borghese, M. Boccarossa, M. Riccio, G. Breglio, A. Mihaila, G. Romano, S. Wirths, L. Knoll and A. Irace	827
<b>Single Event Effects in 3.3 kV 4H-SiC MOSFETs due to MeV Ion Impact</b> Z. Yuan, J.K. Lim, A. Metreveli, H. Krishna Murthy, M. Bakowski and A. Hallén	833
<b>High-Speed and High-Temperature Switching Operations of a SiC Power MOSFET Using a SiC CMOS Gate Driver Installed inside a Power Module</b> A. Yao, M. Okamoto, F. Kato, H. Hozoji, S. Sato, D. Yamaguchi, T. Ando, S. Harada and H. Sato	840
<b>AFM-sMIM Characterization of the Recombination-Enhancing Buffer Layer for Bipolar Degradation Free SiC MOSFETs</b> R.C. Germanicus, T. Phulpin, K. Niskanen, A. Michez and U. Lüders	847
<b>Normally-Off 1200V Silicon Carbide JFET Diode with Low V<sub>F</sub></b> K.K.H. Cho, C.J. Park, Y.J. Kim, K.S. Park and F. Allerstam	854
<b>Modelling-Augmented Failure Diagnostics in Planar SiC MOS Devices Using TDDB Measurements</b> D. Cornigli, H. Schlichting, T. Becker, L. Larcher, T. Erlbacher and M. Pesic	860

<b>On the TCAD Modeling of Non-Permanent Gate Current Increase during Short-Circuit Test in SiC MOSFETs</b>	866
J. Roig, S. Kochoska, B. Vlachakis, J. Franchi and T.T. Pham	
<b>High Single-Event Burnout Resistance 1.2 kV 4H-SiC Schottky Barrier Diode</b>	873
Y. Qi, A.B. Renz, V. Kotagama, M. Antoniou and P.M. Gammon	
<b>Study of Parasitic Effects for Accurate Dynamic Characterization of SiC MOSFETs: Comparison between Experimental Measurements and Numerical Simulations</b>	879
T. Arai, R. Takeda, T. Neville and M. Hawes	
<b>Investigation of Threshold Voltage Instability and Bipolar Degradation in 3.3 kV Conventional Body Diode and Embedded SBD SiC MOSFET</b>	887
H. Krishna Murthy, J.K. Lim and M. Bakowski	
<b>Demonstration of 800°C SiC MOSFETs for Extreme Temperature Applications</b>	893
E. Andarawis, D. Shaddock, T. Johnson, S. Goswami and R. Ghandi	
<b>Analytical Modelling of the Quasi-Static Operation of a Monolithically Integrated 4H-SiC Circuit Breaker Device</b>	899
N. Boettcher, M. Rommel and T. Erlbacher	
<b>Dynamic On-State Resistance and Threshold-Voltage Instability in SiC MOSFETs</b>	907
A.J. Lelis, R. Green Jr., D.B. Habersat, D.P. Urciuoli and E.S. Schroen	
<b>Visualization of P<sup>+</sup> JTE Embedded Rings Used for Peripheral Protection of High Voltage Schottky Diodes by the Optical Beam Induced Current (OBIC) Technique</b>	912
D. Planson, D. Tournier, P. Bevilacqua, C. Sonneville, P. Brosselard, G. Moulin, L.V. Phung and P. Godignon	
<b>Design and Characterization of an Optical 4H-SiC Bipolar Junction Transistor</b>	919
P. Brosselard, D. Planson, D. Tournier, P. Bevilacqua, C. Sonneville, L.V. Phung, M. Lazar, B. Vergne, S. Scharnholz and H. Morel	
<b>Temperature-Dependent Evaluation of Commercial 1.2 kV, 40 mΩ 4H-SiC MOSFETs: A Comparative Study between Planar, One-Side Shielded Trench, and Double Trench Gate Structures</b>	924
V.P. Reddy, U. Chand, L.K. Bera, C.H.M. Chua, N. Singh and S. Chung	
<b>Excellent Avalanche Capability in SiC Power Device with Positively Beveled Mesa Termination</b>	929
Y.C. Liu, X.Y. Tang, Y. Zhou, H. Yuan, L.J. Sun, Q.W. Song and Y.M. Zhang	
<b>Frequency Investigation of SiC MOSFETs C-V Curves with Biased Drain</b>	935
I. Matacena, L. Maresca, M. Riccio, A. Irace, G. Breglio and S. Daliento	
<b>Experimental Demonstration and Analysis of 3.3kV 4H-SiC Common-Drain Bidirectional Charge-Balanced Power MOSFETs</b>	940
M. Torky, Z. He, C. Hitchcock, R. Ghandi, S. Kennerly and T.P. Chow	
<b>Comparison of Si CMOS and SiC CMOS Operational Amplifiers</b>	945
R. Kobayashi and M. Yamamoto	
<b>Comparative Performance Evaluation of High-Voltage Bidirectional, Conventional and Superjunction Planar DMOSFETs in 4H-SiC</b>	950
M. Torky and T.P. Chow	
<b>Comparison of the Surge Current Capabilities of SBD-Embedded and Conventional SiC MOSFETs</b>	955
K. Kawahara, K. Sugawara, A. Iijima, S. Hino, K. Fujiyoshi, Y. Oritsuki, T. Murakami, T. Takahashi, Y. Kagawa, Y. Hironaka and K. Nishikawa	
<b>The First Optimisation of a 16 kV 4H-SiC N-Type IGCT</b>	962
Q. Cao, P.M. Gammon, A.B. Renz, M. Antoniou, P.A. Mawby and N. Lophitis	
<b>Influence of Channel Length and Gate Oxide Thickness Variations in 3300 V 4H-SiC VDMOSFET</b>	968
S. Rathi, D. Macdonald, A. Murphy, M. Bell, R. Young and D.T. Clark	
<b>Investigation of the Short-Circuit Withstand Time and On-Resistance Trade-Off of 1.2 kV 4H-SiC Power MOSFETs</b>	973
J. Kim, B. Fetzer, S. Sabri, B. Hull and S.H. Ryu	
<b>Power Cycling Performance of 3.3 kV SiC-MOSFETs and the Impact of the Thermo-Mechanical Stress on Humidity Induced Degradation</b>	978
M. Hanf, F. Hoffmann, A. Brunko, J.H. Peters, S. Clausner and N. Kaminski	
<b>Estimation of Electron Drift Mobility along the c-Axis in 4H-SiC by Using Vertical Schottky Barrier Diodes</b>	988
R. Ishikawa, M. Kaneko and T. Kimoto	

## **Chapter 6: Materials Application in Quantum, Sensors and Mechatronics Systems**

<b>Spin-Orbit Coupling of Color Centers for Quantum Applications</b>	997
M. Neubauer, M. Schober, W. Dobersberger and M. Bockstedte	
<b>Optical Ionization of Qubits and their Silent Charge States</b>	1004
M. Bockstedte and M. Schober	
<b>Thermochromic Properties of 3C-, 6H- and 4H-SiC Polytypes up to 500°C</b>	1011
G. Ferro, D. Carole and D. Chaussende	
<b>Monitoring of Graphene Properties in the Process of Viral Biosensor Manufacturing</b>	1016
A.A. Lebedev, N.M. Shmidt, E.I. Shabunina, A.V. Nashchekin, E.V. Gushchina, V.N. Petrov, I.A. Eliseev, S.P. Lebedev, S.I. Priobrazhenskii, A.D. Roenkov, E.M. Tanklevskaya, M.V. Puzyk, A.S. Usikov, S.A. Klotchenko, A.V. Vasin, A.Y. Plehanov, V.A. Golyashow and O.E. Tereshchenko	
<b>Fabrication of Wafer-Level Vacuum-Packaged 3C-SiC Resonant Microstructures Grown on &lt;111&gt; and &lt;100&gt; Silicon</b>	1022
S. Sapienza, L. Belsito, M. Ferri, I. Elmi, M. Zielinski, F. La Via and A. Roncaglia	
<b>250 µm Thick Detectors for Neutron Detection: Design, Electrical Characteristics, and Detector Performances</b>	1027
G. Trovato, A. Meli, A. Muoio, R. Reitano, L. Calcagno, M.H. Kushoro, M. Rebai, M. Tardocchi, A. Trotta, M. Parisi, L. Meda and F. La Via	
<b>Stress Fields Distribution and Simulation in 3C-SiC Resonators</b>	1033
V. Scuderi, A. Muoio, S. Sapienza, M. Ferri, L. Belsito, A. Roncaglia and F. La Via	
<b>Design of Monolithically Integrated Temperature Sensors in 4H-SiC JFETs</b>	1038
F. Monaghan, A. Martinez, J.E. Evans, C. Fisher, O.J. Guy and M. Jennings	
<b>Device Modeling of 4H-SiC PIN Photodiodes with Shallow Implanted Al Emitters for VUV Sensor Applications</b>	1046
M. Schraml, M. Rommel, N. Papathanasiou and T. Erlbacher	
<b>Plasmonic Ag Nanoparticles on SiC for Use as SERS Substrate and in Integrated Optical Sensors for Bio-Chemical Applications</b>	1054
V. Cantaro, A. Sciuto, A. Brancato, G. Compagnini and G. D'Arrigo	
<b>Experimental Observation of Raman Assisted and Kerr Optical Frequency Comb in a 4H-Silicon-Carbide on Insulator Microresonator</b>	1061
A.A. Afzadi, Y.Q. Lu, X.D. Shi, R.X. Wang, J.W. Li, Q. Li and H.Y. Ou	