

# **2023 IEEE Workshop on Wide Bandgap Power Devices and Applications in Asia (WiPDA Asia 2023)**

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# Technical Sessions (Oral Sessions)

13:00-14:30

Aug. 28, Monday

## M1: Wide Bandgap Power Converters and Systems

### Ballroom A

Chair: Prof. Tzung-Lin Lee (National Sun Yat-Sen University)

Co-Chair: Prof. Cheng-Yu Tang (National Taipei University of Technology)

#### M1-1

##### *Invited Paper:*

***Dense, Conformal APF Amorphous Carbon Film for SiC Power Device Processing and Integration...N/A***

Yi Zheng\*, Ricky Fang, Ludovico Megalini, Fengshou Wang, Joseph Lee, Dustin Ho, Jang Seok Oh, Bryan Turner, David Britz, Durga Chaturvedula and Zheng Yuan (Applied Materials, USA)

#### M1-2

***Why Are Conventional Si MOSFETs Better Than Sic And Gan In Low Power Applications?...1***

Michael Glashauser\* and Otto Kreuzera (Degendorf Institute of Technology, Germany)

#### M1-3

***High-frequency All SiC Improved Quadratic Boost Converter...7***

Lucky Angelico Nagpala\* and Alberto Castellazzia (Kyoto University of Advanced Science, Japan)

#### M1-4

***Design and Control Strategy of High Voltage Power Module for Double Pulse Testing Applications of Wide Band Gap Devices...13***

Chi-Yuan Huang\* and Yaow-Ming Chen (National Taiwan University, Taiwan)

#### M1-5

***Sinusoidally-Modulated 3mhz-Switching Gan Step-Down Converter For Non-Resonant 150khz WPT Applications...18***

Yutaro Sakuraba\*, Souichi Onishi, Yonghwa Lee and Alberto Castellazzi (Kyoto University of Advanced Science, Japan)

#### M1-6

***Comparison between Experimental and FEM Simulation Results of Differential-Mode Noise in SiC MOSFET based Full-Bridge Power Module...23***

Deepankar\* and Tsuyoshi Funaki (Osaka University, Japan)

14:50-16:15

Aug. 28, Monday

**M2: Power Module and Device Reliability**

**Ballroom A**

**Chair: Prof. Bing-Yue Tsui (National Yang Ming Chiao Tung University)**

**Co-Chair: Dr. Tao-Chih Chang (Industrial Technology Research Institute)**

M2-1

**Invited Paper:**

***Illuminating Horizons: Exploring Market Revenue Forecast Trends and Boundless Possibilities for Wide Bandgap Semiconductors...N/A***

Kiran Kesavan (Sciencetech Corporation, Taiwan)

M2-2

***Parametric Analysis for Filter Design in Extracting Transient Thermal Model Parameters of SiC***

***Power Modules...27***

Shuhei Fukunaga\*, and Tsuyoshi Funaki (Osaka University, Japan)

M2-3

***Analysis of Factor Impacts on On-resistance for Power MOSFET Layout Design with Fully Automatic Flow...31***

Lingge Liu, Wangge Zuo, Tian Zhao and Jing Wan\* (Fudan University, China)

Bijian Lan and Jingxiao Zhang (Suzhou Fohu Technology Co., Ltd., China)

M2-4

***The Development of 1.7kV 100A SiC MOSFET Power Module for Automotive Application...35***

Po-Kai Chiu\*, Hsin-Han Lin, Yuan-Cheng Huang, Ji-Yuan Syu, Yan-Cheng Liu, Yan-Bo Fang, Yu-Hua Cheng, Chien-Wei Chang, Yung-Min Hsieh, Kuo-Shu Kao and Chu-Han Tsai (Industrial Technology Research Institute, Taiwan)

M2-5

***Investigation of Positive Bias Temperature Instability of 4H-SiC MOS Capacitors and Deep Interface States Extraction at 300°C...39***

Yu-Xin Wen\*, Chia-Hua Wang, and Bing-Yue Tsui (National Yang Ming Chiao Tung University, Taiwan)

Yi-Kai Hsiao and Chia-Lung Hung (Hon Hai Research Institute, Taiwan)

16:15-17:15

Aug. 28, Monday

**M3: Other Topics of Interest**

**Ballroom A**

**Chair: Prof. Le-Ren Chang-Chien (National Cheng Kung University)**

**Co-Chair: Prof. Lu-Sheng Hong (National Taiwan University of Science and Technology)**

M3-1

***3D Simulation Platform for Semiconductor Crystal Growth Based on Taiwanese Companies Requirements...44***

Amir R. A. Dezfoli\* (National Chin-Yi University of Technology, Taiwan)

M3-2

***Enabling Next-Generation Power Electronics: Development of the First 3.3kV SiC Power Module in Taiwan...N/A***

Yu-Ming Peng, I-Hung Chiang\*, Yan Bo Fang, Chien Wei Chang, Hong-Yu Chen, Chih-Ming Tzeng, Shi-Feng Hsu, Hsin-Han Lin, and Kuo-Shu Kao (Industrial Technology Research Institute, Taiwan)

M3-3

***Comparison of Bidirectional Flyback and Split-Inductor Boost Converter Topologies for Photovoltaic Differential Power Processing Systems...47***

Lien-Chieh Chen, F. Selin Bagci and Katherine Kim\* (National Taiwan University, Taiwan)

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***A Design Parametric Effect Study on Floating Guard Ring for 1200V SiC Power MOSFET Application...53***

Chia Lung Hung\*, Yi Kai Hsiao and Hao Chung Kuo (Hon Hai Research Institute, Taiwan)

# Technical Sessions (Poster Sessions)

17:15-18:00

Aug. 28, Monday

## Poster I

### Pre-Function Area

Chair: Prof. Yue-Ming Hsin (National Central University)

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#### ***A 1700 V-Class Self-Aligned Channel and Split Gate (SASG) Architecture of 4H-SiC VDMOSFET for High Frequency Application...56***

Chia Lung Hung\*, Yi Kai Hsiao and Hao Chung Kuo (Hon Hai Research Institute, Taiwan)

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Po-Jui Huang\*, Tung-Sheng Wu, Lak Mohammadreza, and Tzung-Lin Lee (National Sun Yat-sen University, Taiwan)

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#### ***A Study on the Impact of Gamma Rays Irradiation on 4H-SiC CMOSFETs...59***

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Der-Sheng Chao (National Tsing Hua University, Taiwan)

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Fu-Jen Hsu\* (Fast SiC Semiconductor Incorporated & National Tsing Hua University, Taiwan)

Cheng-Tyng Yen, Hsiang-Ting Hung, Ting-Fu Chang and Yu-Lien Chiu (Fast SiC Semiconductor Incorporated, Taiwan)

Jia-Wei Hu and Chih-Fang Huang (National Tsing Hua University, Taiwan)

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#### ***Substrate Bias Effect of 28 nm-node HK/MG nMOSFETs with DPN Temperature Treatments...67***

Shou-Yen Chao and Mei-Yuan Zheng and Mu-Chun Wang\* (Minghsin University of Science and Technology, Hsinchu, Taiwan)

Ming-Han Wang (Hsinchu Chien-Kung Senior High School, Taiwan)

Wen-How Lan (National University of Kaohsiung, Taiwan)

P1-6

**Novel Guard Ring Structure formed by Self-align Trench Implant in SiC MOSFET...71**

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Hao-Chung Kuo\* (Hon Hai Research Institute & National Yang Ming Chiao Tung University, Taiwan)

P1-7

**A Direct Liquid Cooling and Low Inductive Packaging Structure for SiC MOSFET Power Module...N/A**

Junhui Yang\*, Yongmei Gan, Hongchang Cui, Cheng Zhao, Yan Nie, and Laili Wang (Xi'an Jiaotong University, China)

P1-8

**Comparisons of Performance and Reliability In 4H-SiC Tri-Gate and Planar MOSFETs...74**

Jia-Wei Hu\*, Tsung-yuan Lu and Chih-Fang Huang (National Tsing Hua University, Taiwan)  
Bang-Ren Chen and Tian-Li Wu (National Yang Ming Chiao Tung University, Taiwan)

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**Effect of Post Deposition Annealing on the Electrical Characteristics of NiO/4H-SiC and Cu<sub>2</sub>O/4H-SiC PiN Diodes Deposited by RF-Sputtering...N/A**

Hyung-Jin Lee, Soo-Young Moon and Sang-Mo Koo\* (Kwangwoon University, Korea)  
Kung-Yen Lee (National Taiwan University, Taiwan)

P1-10

**Effects of High-k Field Plate on Vertical  $\beta$ -Ga<sub>2</sub>O<sub>3</sub> Schottky Barrier Diodes...N/A**

Se-Rim Park, Min-Yeong Kim, Soo-Young Moon, Hyung-Jin Lee, Geon-Hee Lee, Chulhwan Park, Minkyung Kim, Jong-Min Oh, Weon Ho Shin and Sang-Mo Koo\* (Kwangwoon University, Korea)

P1-11

**Comparison Of Self-Heating Effects In GaN-HEMTs on SiC and Sapphire Substrates...N/A**

Tsung Po Chuang, Chia Hao Yu and Ray Hua Horng\* (National Yang Ming Chiao Tung University, Taiwan)

P1-12

***Effect of Post-Deposition Annealing on Electrical Properties of Lithium Phosphate on Silicon Carbide...N/A***

Hyung-Jin Lee, Soo-Young Moon, Geon-Hee Lee, Young-Hun Cho, Minkyung Kim and Sang-Mo Koo\*

(Kwangwoon University, Korea)

Kung-Yen Lee (National Taiwan University, Taiwan)

P1-13

***Design of Active Gate Driver for Silicon Carbide Devices...N/A***

I-Chan Tsai and Le-Ren Chang-Chien\* (National Cheng Kung University, Taiwan)

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***Comparison of Drain Current Transient Characteristics of AlGaN/GaN HEMTs in the Linear and Saturation Regions after OFF-state Stress...78***

Chih-Wei Cho and Yue-Ming Hsin\* (National Central University, Taiwan)

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***Epitaxial Growth and Characterization of Si on 4H-SiC substrate for High Power Devices...N/A***

Seonwoo Park, Kyoung Hwa Kim\*, Suhyun Mun, Hyung Soo Ahn, Min Yang, Young Tea Chun and Sam Nyung Yi (Korea Maritime and Ocean University, Korea)

Myeong-Cheol Shin and Sang-Mo Koo (Kwangwoon University, Korea)

Jae Hak Lee (Korea Maritime and Ocean University & LNBS Co., Ltd., Korea)

Won Jae Lee (Dong-Eui University, Korea)

P1-16

***Growth of Hexagonal Germanium Microcrystal Using Hydride Vapour Phase Epitaxy Method...N/A***

Suhyun Mun, Kyoung Hwa Kim\*, Seonwoo Park, Hyung Soo Ahn, Min Yang, Young Tea Chun and Sam Nyung Yi (Korea Maritime and Ocean University, Korea)

Myeong-Cheol Shin and Sang-Mo Koo (Kwangwoon University, Korea)

Jae Hak Lee (Korea Maritime and Ocean University & LNBS Co., Ltd., Korea)

Won Jae Lee (Dong-Eui University, Korea)



P1-17

***Deep Level Defects in 4H-SiC Schottky Barrier Diodes and PiN and JBS Diodes...N/A***

Myeong-Cheol Shin\*, Seung-Hwan Chung, Hyung-Jin Lee, and Sang-Mo Koo (Kwangwoon University, Korea)

Hong-ki Kim and Sang woo Pak (Powermaster Semiconductor Co., Ltd., Korea)

Jung-Hyuk Koh (Chung-Ang University, Korea)

Ey-Goo Kang (Far East University, Korea)

P1-18

***A 1.9kV, 80kVA Modular Multilevel Converter(MMC) for Single-Phase Grid-Connected Power Conversion System Based on 3.3kV SiC Module...N/A***

Ming-Hung Yu\*, Kuan-Wen Chen, Yeh-Hsiang Ho, Yu-Shen Lee, and Bo-Hong Chen

(Industrial Technology Research Institute, Taiwan)

# Technical Sessions (Poster Sessions)

13:00-14:00

Aug. 29, Tuesday

## Poster II

### Pre-Function Area

Chair: Prof. Hui-Hsin Hsiao (National Taiwan University)

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#### ***An Optimized Miller Clamp Circuit with Gate Voltage Controllable Function for High Voltage SiC Module...N/A***

Ming-Hung Yu\*, Kuan-Wen Chen, Bo-Hong Chen, Yeh-Hsiang Ho, and Yu-Shen Lee  
(Industrial Technology Research Institute, Taiwan)

P2-2

#### ***Demonstration of High Voltage GaN-on-Si p-GaN gate HEMTs (>1000V) with Enhancement of Forward Gate TDDB using Oxygen Plasma Treatment...82***

Tzu-Heng Lin, You-Shiun Chou, Hung-Chun Chen, and Tian-Li Wu\* (National Yang Ming Chiao Tung University, Taiwan)

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Yu-Kai Chen\*, Tzu-Hsiang Chang, Chung-En Hsiao and Hung-Yu Chen (National Formosa University, Taiwan)

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#### ***Comparative Efficiency Analysis For Common Types Of Three-Level Neutral Point Clamped Inverters...N/A***

Po-Jui Huang\*, Lak Mohammadreza, and Tzung-Lin Lee (National Sun Yat-sen University, Taiwan)

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#### ***Charge Pump Based Gate Driver Integrated Circuit for SiC MOSFET...89***

Mao-Hong Jiang\* and Chung-Hsun Huang (National Chung Cheng University, Taiwan)  
Chan-Liang Wu (National Tsing Hua University, Taiwan)

P2-6

#### ***230061: Simulation Study of Tri-gate High-Voltage LDMOS in 4H-SiC...N/A***

Yu-Chen Fei, Yi-Ching Chan, Jia-Wei Hu\* and Chih-Fang Huang (National Tsing Hua University, Taiwan)

P2-7

***Analysis and Mitigation of Gate Oscillation in Multichip Power Module of Paralleled Half-Bridges...N/A***

Yan Nie\*, Junhui Yang, Hongchang Cui and Laili Wang (Xi'an Jiaotong University, China)

P2-8

***Implementation of a High Power Density Active-Clamp Flyback Converter Using GaN Device and Improved ER Core-based Planar Transformer...N/A***

Ching-Ming Lai\* and Tien-Yu Chen (National Chung Hsing University, Taiwan)

Tomokazu Mishima (Kobe University, Japan)

P2-9

***A Single-Stage Electronic Lighting Driver for a Deep Ultraviolet LED Disinfection and Sterilization Lamp...93***

Chun-An Cheng\*, Long-Fu Lan, Sheng-Hong Hou and Cheng-Kuan Lin (I-Shou University, Taiwan)

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***The Development Of The Process For Low-Temperature Surface Carbonization Of Si(111) Substrate And The Subsequent Growth Of 3C-SiC Epitaxial Buffer Layer...96***

Pei-Chun Tsai, Jhong-Ren Huang, and Lu-Sheng Hong\* (National Taiwan University of Science and Technology, Taiwan)

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***Investigation Of Carrier Lifetime Behavior In The 4H-SiC Homoepitaxial Layer...100***

Shang-Lin Chung\*, Jhong-Ren Huang, and Lu-Sheng Hong (National Taiwan University of Science and Technology, Taiwan)

P2-12

***Design and Implementation of 3.5 kW Digital Controlled Battery Charge System...N/A***

Shi-Quan Chen, Tsorng-Juu Liang\*, Yu-Shao Cheng, Kim Kien Nghiep Huynh, Guan-Ting Peng (National Cheng Kung University, Taiwan)

P2-13

***Design and Implementation of Two-Stage Boost and Full-Bridge Resonant Converter for Wide-Range APMs...N/A***

Chia-Yu Chen, Tsorng-Juu Liang\*, Sheng- Chieh Wen, Kim Kien Nghiep Huynh, Guan-Ting Peng (National Cheng Kung University, Taiwan)

P2-14

***Improving the electric field of the gate oxide of a 1700V 4H-SiC Split-Gate Super-Junction DMOSFET...N/A***

Ping-Kai Chang\*, Kung-Yen Lee, Shih-Hsuan Cheng, Chun-Ju Cheng, Chih-Jung Chang  
(National Taiwan University, Taiwan)

P2-15

***Switching Performance Improvement of a SiC MOSFET SPICE Model via Body Diode Characteristics Optimization...N/A***

Chien-Neng Huang\*, Kung-Yen Lee, Chih-Jung Chang, Yan-Yu Wen (National Taiwan University, Taiwan)

P2-16

***The Impact of Temperature on Switching Characteristics of 4H-SiC DMOSFET Via Double Pulse Test...N/A***

Kung-Yen Lee\*, Pei-Chun Liao, Ruei-Ci Wu, Wan-Ting Hsieh, Chih-Lun Liu (National Taiwan University, Taiwan)

P2-17

***Improved Reverse Recovery Characteristics Of A 1.2kV 4H-SiC Embedded Schottky Barrier Diode MOSFET...N/A***

Wan-Ting Hsieh\*, Kung-Yen Lee, Hsiang-Min Hsieh, Shih-Hsuan Chen, Chun-Ju Chen (National Taiwan University, Taiwan)

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***A Study on the Electrical Properties of High Voltage SiC Power MOSFET with Double Trench Structures...105***

Jang Hyoun Lee and EyGoo Kang\* (Far East University, Korea)

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***On-Chip Current-Mode Communication Circuits for Stackable Li-ion Battery Management System Using 0.18 $\mu$ m BCD HV Process...111***

Tzung-Je Lee\* and Yi-Ting Deng (National Sun Yat-Sen University, Taiwan)

# Technical Sessions (Oral Sessions)

14:00-15:30

Aug. 29, Tuesday

## T1: Circuits and Device Characterization

### Ballroom A

Chair: Prof. Po-Hung Chen (National Yang Ming Chiao Tung University)

Co-Chair: Prof. Alberto Castellazzia (Kyoto University of Advanced Science)

#### T1-1

##### *Invited Paper:*

##### ***Ion Implantation Process and Applications in SiC and GaN Device Fabrication...N/A***

Causon Jen\* and Fulvio Mazzamuto (Axcelis Technologies, Inc., US)

#### T1-2

##### ***Switching Behavior Equivalent Circuit Model for SiC Driver IC...115***

Siang-Yung Duan, Ching-Jan Chen and Yen-Ming Chen\* (National Taiwan University, Taiwan)

Wen-Shang Lai (Delta Electronics, Inc, Taiwan)

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Vanessa Heumessera (Reutlingen University, Germany)

Jih-Sheng Lai\* and Hsin-Che Hsieh (Virginia Polytechnic Institute and State University, USA)

Johnny C.-S. Hsu, Chih-Yi Yang, and Edward Y. Chang (National Yang Ming Chiao Tung University, Taiwan)

Leon Y.-M. Lind (Industrial Technology Research Institute, Taiwan)

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Jih-Sheng Lai\* and Hsin-Che Hsieh (Virginia Polytechnic Institute and State University, USA)

Johnny C.-S. Hsu, Chih-Yi Yang, Edward Y. Chang, ChingYao Liu and Wei-Hua Chieng

(National Yang Ming Chiao Tung University, Taiwan)

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Alessandro Borghesea and Andrea Irace (University of Naples, Italy) Alberto

Castellazzia\* (Kyoto University of Advanced Science, Japan)

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Aug. 29, Tuesday

**T2: Device Fabrication, Characterization and Modeling**

**Ballroom A**

**Chair: Prof. Shuhei Fukunaga (Osaka University)**

**Co-Chair: Prof. Vin-Cent Su (National United University)**

T2-1

***Developing Physics-Based TCAD Model for AlGaIn/GaN Power HEMTs...142***

Wei-Chih Cheng\*, Po-Heng Lin, Chih-Hung Lin, Yi-Wei Lien, Chih-Yen Chen, Chia-Hao Lee, Shyh-Chiang Shen, Chih-Cheng Liao, and Chun-Ming Liu (Vanguard International Semiconductor Corporation, Taiwan)

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Catherine Langpoklakpam\*, Chun-Hsiung Lin and Hao-Chung Kuo (National Yang-Ming Chiao Tung University) Yi-Kai Hsiao (Hon Hai Research Institute, Tawian)

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Hongyue Wang and Yuebo Liu (China Electronic Product Reliability and Environmental Testing Research Institute, China)

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***Experimental analysis of mismatch in electro-thermal device parameter within parallel connected SiC MOSFETs: Considerations for multi-chip power module design...159***

Asad Fayyaz\*, Ying Li, Paul Evans, Alan Watson, Pat Wheeler, and Chris Gerada (University of Nottingham, UK)

T2-6

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Chia-Wei Liu, Yen-Wei Liu, Hsin-Jou Ho and Tian-Li Wu\* (National Yang Ming Chiao Tung University, Taiwan)