Final Program Book

# 제 27회 The 27th Korean Conference on Semiconductors
# 한국반도체학술대회

*Intelligent Semiconductor for Technology Convergence*

2020년 2월 12일[수] – 14일[금]

강원도 하이원 그랜드호텔[컨벤션타워]

주관 | 연세대학교 YONSEI UNIVERSITY, KSIA 한국반도체산업협회, COSAR 한국반도체연구조합

주최 | KPS 한국물리학회 The Korean Physical Society, MRS 한국재료학회, 대한전기학회, IEIE 대한전자공학회, IDEC 반도체설계교육센터, ISE 반도체공학회, 한국반도체디스플레이기술학회 The Korean Society of Semiconductor & Display Technology

후원 | GWCVB 강원국제회의센터, SAMSUNG, SK 하이닉스, DB하이텍, ASML, TEL, Applied Materials, WONIK IPS, Lam Research, ETRI, Synopsys Silicon to Software, PSK, 케이케이테크, SEMILAB, AUROS Technology, Silicon Works, TechwidU Technology with you, semi, EUGENETEC, NEXTIN Solutions, WAVICE, NPP NEW POWER PLASMA, dialog Semiconductor, IEEE Electron Device Society Korea Chapter, IEEE SSC Seoul Chapter

# Program at a Glance

| 2월 12일(수) | 5층 | | |
|---|---|---|---|
| | 컨벤션홀 L | 에메랄드 | 사파이어 |
| 10:30~13:00 | Short Course I<br>"Trends and Challenges in Nanoelectronics" | | |
| 13:00~14:00 | 점심 [그랜드볼룸 III / 4층] *Short Course I 참가자께만 제공 | | |
| 14:00~18:00 | Short Course I<br>"Trends and Challenges in Nanoelectronics" | Short Course II<br>"원자층증착(ALD)과 원자층식각(ALE) 공정 및 소재" | Short Course III<br>"차세대 컴퓨팅을 위한 인공지능 반도체 기술" |

| 2월 13일(목) | 5층 | | | | | | 6층 | | | | | | | 전시 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 컨벤션홀 W | Room A<br>에메랄드 I | Room B<br>에메랄드 II+III | Room C<br>사파이어 I | Room D<br>사파이어 II+III | Room E<br>루비 II | Room F<br>스페이드 I | Room G<br>스페이드 II+III | Room H<br>하트 I | Room I<br>하트 II | Room J<br>하트 III | Room K<br>다이아몬드 I | Room L<br>다이아몬드 II | |
| 09:00~10:30 | ETRI 특별세션<br>(9:00~10:45) | TA1-E<br>Compound Semiconductor Technology I | TB1-F<br>Emerging Device Technology I | TC1-R<br>Semiconductor Software Optimization | TD1-G<br>Modeling of Semiconductor Devices | TE1-L<br>Analog | TF1-C<br>2D Materials | TG1-K<br>Devices for Neuromorphic Computing I | TH1-N<br>System & Circuit Design Analysis and Optimization | TI1-S<br>Selected Papers on Chip Design Contest | TJ1-M<br>RF Design I | TK1-D<br>Thin Film Process I | TL1-J<br>페로브스카이트 LED - I | |
| 10:30~10:45 | 휴식 (& 커피, 다과) | | | | | | | | | | | | | |
| 10:45~12:30 | KAERI 특별세션<br>(11:00~12:00) | TA2-E<br>Compound Semiconductor Technology II | TB2-F<br>New Applications of Silicon Technology | TC2-H<br>Image Engineering & Sensors | TD2-G<br>Atomistic Modeling | ★TE2-SS<br>Beyond 7-nm Technology | TF2-B<br>Patterning Technology: Photolithography and Etch | TG2-K<br>Emerging Memory I | TH2-J<br>뉴로모픽 소자 - I | TI2-A<br>Interconnect & Packaging | TJ2-M<br>RF Design II | TK2-D<br>Thin Film Process II | TL2-J<br>소자 적용 나노 소재 | |
| 12:30~14:00 | 점심 [그랜드볼룸 / 4층] | | | | | | | | | | | | | |
| 14:00~14:50 | 기조강연 I [컨벤션홀 K+W / 5층]<br>"Wide Bandgap Semiconductors: The New Revolution in Power Electronics"<br>Prof. Florin Udrea (Cambridge Univ., UK) | | | | | | | | | | | | | |
| 14:50~15:00 | 휴식 | | | | | | | | | | | | | |
| 15:00~15:50 | 기조강연 II [컨벤션홀 K+W / 5층]<br>"Technology Opportunities toward Next-Generation Computing"<br>Dr. Myung-hee Na (IMEC, Belgium) | | | | | | | | | | | | | |
| 15:50~16:00 | 휴식 (& 커피, 다과) | | | | | | | | | | | | | |
| 16:00~17:45 | [TP1] 포스터 세션 I [컨벤션홀 L 및 로비 / 5층] | | | | | | | | | | | | | |
| 17:45~18:00 | 휴식 | | | | | | | | | | | | | |
| 18:00~20:00 | 만찬 [컨벤션홀 K+W / 5층] | | | | | | | | | | | | | |
| 20:00~22:00 | Rump Session I [에메랄드홀 / 5층]<br>"파운드리 산업의 미래" | | | | | | Rump Session II [사파이어홀 / 5층]<br>"반도체 교육과 연구 이대로 좋은가?" | | | | | | | |

| 2월 14일(금) | 5층 | | | | | 6층 | | | | | | 5-6층 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Room A<br>에메랄드 I | Room B<br>에메랄드 II+III | Room C<br>사파이어 I | Room D<br>사파이어 II+III | Room E<br>루비 II | Room F<br>스페이드 I | Room G<br>스페이드 II+III | Room H<br>하트 I | Room I<br>하트 II | Room J<br>하트 III | Room K<br>다이아몬드 I | Room L<br>다이아몬드 II | 로비 |
| 09:00~10:30 | FA1-E<br>Compound Semiconductor Technology III | FB1-F<br>Emerging Device Technology II | FC1-H<br>OLED & Display Technology | FD1-G<br>Characterization of Semiconductor Devices | FE1-I<br>Gas Sensing Technology | FF1-C<br>Wide Bandgap Materials I (Ga2O3 & etc) | FG1-K<br>Emerging Memory II | FH1-Q<br>Nanoanalysis and Characterization | FI1-P<br>Low Dimensional Materials: Peorperties and Energy Device Applications | FJ1-D<br>2-dimensional System I | FK1-D<br>Ferroelectric Materials | FL1-J<br>페로브스카이트 양자점 | |
| 10:30~10:45 | 휴식 (& 커피, 다과) | | | | | | | | | | | | |
| 10:45~12:30 | FA2-D<br>Artificial Intelligent Circuits and Systems | FB2-F<br>Neuromorphic Technology | FC2-H<br>Oxide Thin-Film Transistors | FD2-G<br>TCAD Simulation and Beyond | FE2-I<br>Chemical and Biological Sensors | FF2-C<br>Wide Bandgap Materials II (SiC, diamond & etc) | FG2-K<br>Devices for Neuromorphic Computing II | FH2-Q<br>Metrology, Inspection, and Yield Enhancement | FI2-P<br>Next Generation Battery Devices | FJ2-D<br>2-dimensional System II | FK2-D<br>Thin Film Process III | FL2-J<br>페로브스카이트 LED - II | 전시 |
| 12:30~14:00 | 점심 [그랜드볼룸 / 4층] | | | | | | | | | | | | |
| 14:00~15:30 | [FP1] 포스터 세션 II [컨벤션홀 L 및 로비 / 5층] | | | | | | | | | | | | |
| 15:30~15:45 | 휴식 | | | | | | | | | | | | |
| 15:45~17:30 | FA3-D<br>VLSI System Design and Application | FB3-F<br>Nano-electromechanical and 3D Integration Technology | FC3-H<br>TFTs & Display Technology | FD3-G<br>Compact Modeling | FE3-I<br>MEMS and Sensor Systems for Biomedical Applications | FF3-C<br>Wide Bandgap Materials III (Oxide & Nitride) | FG3-K<br>Emerging Memory III | FH3-J<br>양자점 & 뉴로모픽 소자 - II | FI3-P<br>Photo-Catalytic Mateirlas for Energy Devices | FJ3-D<br>Memory Devices | FK3-D<br>Thin Film Transistors | FL3-J<br>이차원 물질 | |
| 17:30~17:45 | 폐회식 [Room B(에메랄드 II+III) / 5층] | | | | | | | | | | | | |

| | 분과 |
|---|---|
| A | Interconnect & Package |
| B | Patterning |
| C | Material Growth & Characterization |
| D | Thin Film Process Technology |
| E | Compound Semiconductors |
| F | Silicon and Group-IV Devices and Integration Technology |
| G | Device & Process Modeling, Simulation and Reliability |
| H | Display and Imaging Technologies |
| I | MEMS & Sensor Systems |
| J | Nano-Science & Technology |
| K | Memory (Design & Process Technology) |
| L | Analog Design |
| M | RF and Wireless Design |
| N | VLSI CAD |
| O | System LSI Design |
| P | Device for Energy (Solar Cell, Power Device, Battery, etc.) |
| Q | Metrology, Inspection, and Yield Enhancement |
| R | Semiconductor Software |
| S | Chip Design Contest |
| SS | Special Session |

| 요일 | | 세션룸 | | 세션순서 | | 분과 | |
|---|---|---|---|---|---|---|---|
| T | 목요일 | A | Room A | 1 | 첫번째 세션 | A | M |
| F | 금요일 | B | Room B | 2 | 두번째 세션 | B | N |
| | | C | Room C | 3 | 세번째 세션 | C | O |
| | | D | Room D | | | D | P |
| | | E | Room E | | | E | Q |
| | | F | Room F | | | F | R |
| | | G | Room G | | | G | S |
| | | H | Room H | | | H | SS |
| | | I | Room I | | | I | |
| | | J | Room J | | | J | |
| | | K | Room K | | | K | |
| | | L | Room L | | | L | |

※ TA1-E: 목요일 Room A에서 첫타임에 진행되는 E분과의 세션

※ FB1-F-1: 금요일 Room B에서 첫타임에 진행되는 F분과 세션의 첫번째 발표

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The 27th Korean Conference on Semiconductors

# 구두 I 포스터

## 발표 안내

**2020년 2월 14일(금)**

제 27회 The 27th Korean Conference on Semiconductors
한국반도체학술대회

심사위원: 백록현 교수 (POSTECH), 우지용 박사 (한국전자통신연구원)

| | |
|---|---|
| FP1-112 | **Compact Model for P-type L-shaped Tunneling Field-effect-transistor**<br>Faraz Najam and Yun Seop Yu<br>*Department of Electrical and Control Engineering and IITC, Hankyong National University* |
| FP1-113 | **High Performance Graphene Photodetector with Van Der Waals Heterostructure through Tuning Carrier Tunneling**<br>Kye Whan Cho and Woo Jong Yu<br>*Department of Electronic and Electrical Engineering, Sungkyunkwan University* |
| FP1-114 | **Development of High Performance SCR-based ESD Protection Device with High Holding Voltage for 0.18um BCD Technology**<br>Youngbum Eom, Myoungchul Lim, Sanghyun Lee, Sangwook Nam, Jaehee Lee, and Young Chung<br>*R&D Center, SK Hynix Inc.* |
| FP1-115 | **Study of 3D TCAD Simulation on CMOS-compatible Avalanche Photodetectors**<br>Won-Yong Ha[1], Woo-Young Choi[1], and Myung-Jae Lee[2]<br>*[1]Department of Electrical and Electronic Engineering, Yonsei University, [2]Post-silicon Semiconductor Institute, KIST* |
| FP1-116 | **Analysis of the Evolution of Internal Bias Field and Dopants Effects of Ferroelectric $HfO_2$ by First-order Reversal Curve Diagrams**<br>SeungHyeon Hong, Yoseop Lee, Dante Ahn, WooRi Ham, Sungmun Song, and Seung-Eon Ahn<br>*Department of Nano-Optical Engineering, Korea Polytechnic University* |
| FP1-117 | **Electrical Analysis of NC Effect based on Equivalent Circuit for Silicon Doped $HfO_2$ Thin Film**<br>Dante Ahn, Yoseop Lee, Seunghyeon Hong, Woori Ham, Sungmun Song, and Seung-Eon Ahn<br>*Department of Nano-Optical Engineering, Korea Polytechnic University* |
| FP1-118 | **TCAD Study of Uniaxial Stress Effect on the Threshold Voltage of MOSFET**<br>Dongyean Oh, Seong-Dong Kim, Seokkiu Lee, and Jinkook Kim<br>*Research and Development Division, SK Hynix Inc.* |
| FP1-119 | **충돌 이온화를 이용한 Underlap 피드백 트랜지스터의 전기적 특성 연구**<br>손재민, 임두혁, 우솔아, 김상식<br>*고려대학교 전기전자공학과* |
| FP1-120 | **Highly Reliable Gate Driver Circuit to Prevent Ripple Voltage Using AC-driven Method**<br>Jungwoo Lee[1], Jongsu Oh[1], Eun Kyo Jung[1], KeeChan Park[2], and Yong-Sang Kim[1]<br>*[1]Department of Electrical and Computer Engineering, Sungkyunkwan University, [2]Department of Electronics Engineering, Konkuk University* |

# Study of 3D TCAD Simulation on CMOS-Compatible Avalanche Photodetectors

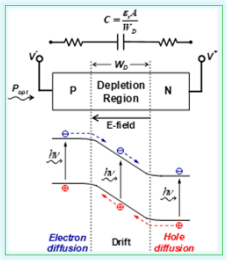

**Won-Yong Ha[1], Woo-Young Choi[1*], and Myung-Jae Lee[2*]**

*[1]Departement of Electrical and Electronic Engineering, Yonsei University, Korea*

*[2]Post-Silicon Semiconductor Insititute, Korea Institute of Science and Technology, Korea*

***Email:*** *mj.lee@kist.re.kr, jamesha@o365.yonsei.ac.kr*

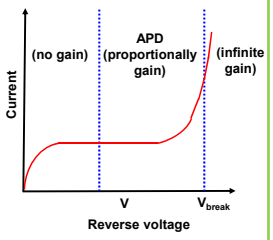

## ❖ CMOS-APD Principles and Applications



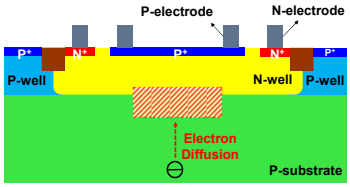

➢ **Important parameters**

- ***Responsivity*** **[A/W]**
  - Sufficient absorption region
  - Wider depletion width
  - Avalanche gain
- ***Photodetection Bandwidth***
  - Photogenerated-carrier transit time
  - RC time constant
  - Parasitics

➢**APD IV curve**




➢**Cross section of a CMOS-APD**



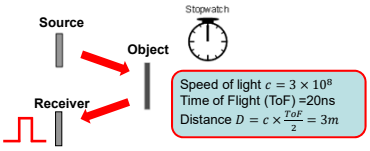

➢ **P⁺/N-well Junction**

- Elimination of slow diffusion currents from P-substrate

➔ **Bandwidth enhancement**

➔ **Reduced Responsivity**

➢**Application(Lidar, Biomedical Application)**

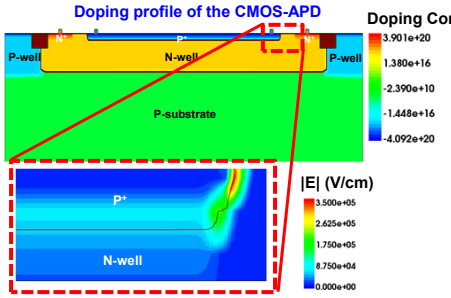


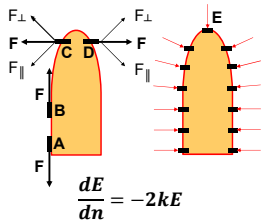

***From a pulse of light reflected by an object We can get distance from object to receiver***

Autonomous Vehicle

Time-of-Flight Positron Emission Tomography (TOF PET)

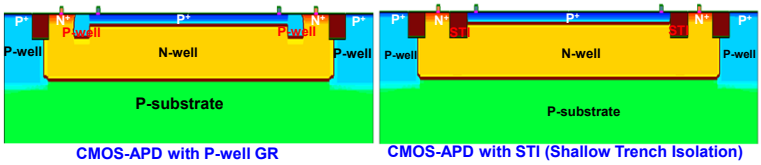

## ❖ Premature Edge Breakdown



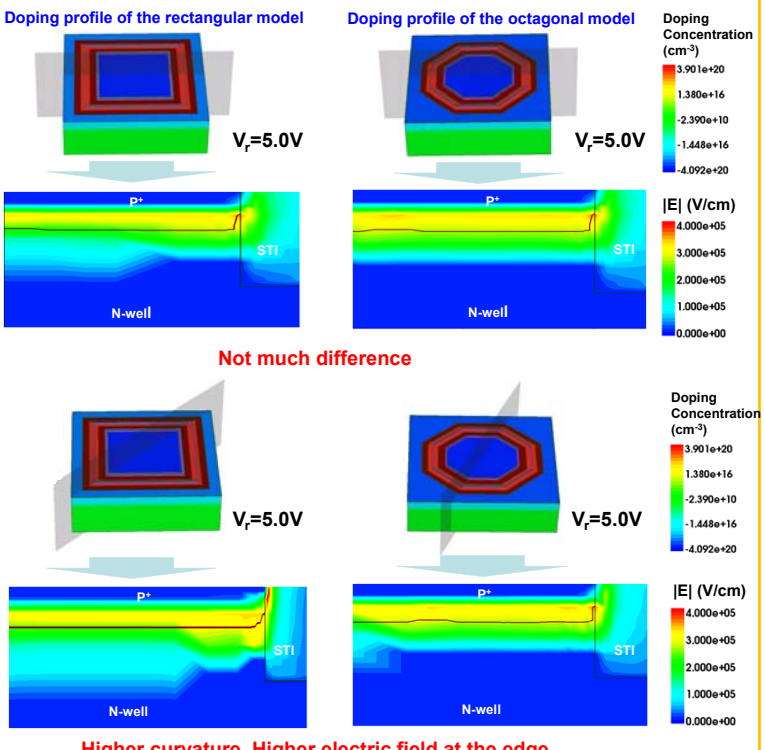

(k: mean curvature, E: electric field, n: normal to material)

**Solution: (Gurad-ring (GR) structures)**

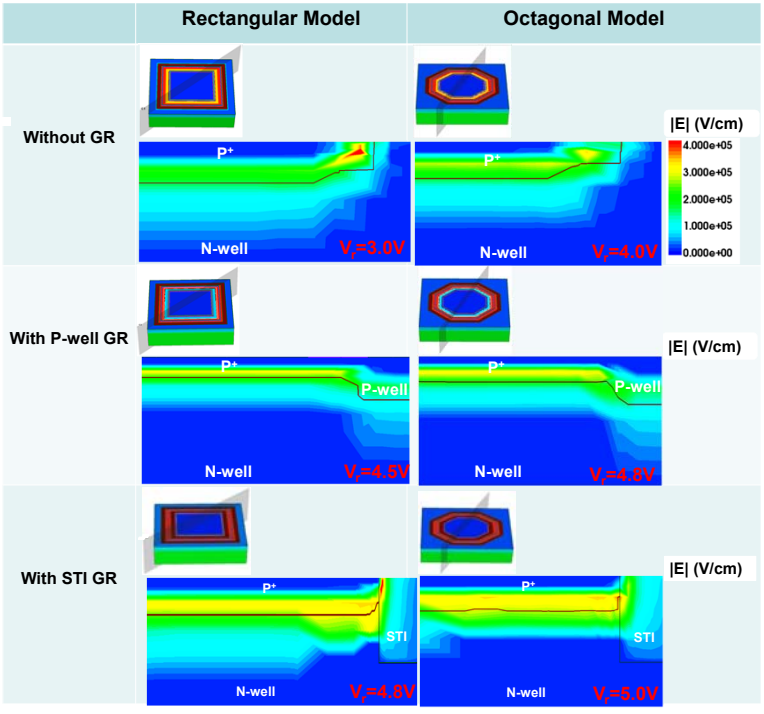



➢ **There have been a few attempts to study CMOS-APD performance using 2D TCAD simulation, but no 3D TCAD simulation of CMOS-APDs yet. To investigate junction curvature effect (e.g, shape and size) 3D TCAD simulation is essential.**

## ❖Cross-Section Comparison CMOS-APDs




## ❖3D TCAD Simulation for CMOS-APDs




**Area of Rectangle: 115.23um² Area of Octagon: 115.47um²**

## ❖Conclusion

➢**Comparing two cut-planes of each the rectangular and octagonal models, the higher electric field observed because of junction curvature effect.**

➢**To prevent the premature edge breakdown, we conclude that inserting STI at the edge of the active region is the most effective way.**

➢**With 3D TCAD simulation, we can clearly check the shape effect. Octagonal shape is better than rectangular shape to prevent edge breakdown.**