제 27회 The 27th Korean Conference on Semiconductors
한국반도체학술대회
Intelligent Semiconductor for Technology Convergence

2020년 2월 12일[수] - 14일[금]
강원도 하이원 그랜드호텔[컨벤션타워]
# Program at a Glance

## The 27th Korean Conference on Semiconductors

**2020년 2월 12일(수) - 14일(금), 강원도 하이원 그랜드호텔단지**

### Short Course I
- Trends and Challenges in Nanoelectronics

### 10:00-10:45
- **Short Course II**
- Trends and Challenges in Nanoelectronics

### 10:45-11:00
- **Rump Session**
- "Wide Bandgap Semiconductors: The New Revolution in Power Electronics"
- Prof. Roomide (Cambridge Univ., UK)

### 11:00-11:40
- **Short Course II**
- Technology Opportunities toward Next-Generation Computing
- Prof. S. R. Gogate (KMIT, Belgium)

### 12:00-12:30
- **Rump Session II**
- "Bandwidth Extension in 5G/6G"
- "Bandwidth Extension in 5G/6G"

## 2nd Floor

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
<th>Room</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>11:00</td>
<td>Session 1</td>
<td>A</td>
<td>General Introduction and Overview of the Conference</td>
</tr>
<tr>
<td>11:15</td>
<td>Session 1</td>
<td>B</td>
<td>Overview of the Conference</td>
</tr>
<tr>
<td>11:30</td>
<td>Session 1</td>
<td>C</td>
<td>Overview of the Conference</td>
</tr>
<tr>
<td>11:45</td>
<td>Session 1</td>
<td>D</td>
<td>Overview of the Conference</td>
</tr>
<tr>
<td>12:00</td>
<td>Session 1</td>
<td>E</td>
<td>Overview of the Conference</td>
</tr>
</tbody>
</table>

## 3rd Floor

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
<th>Room</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>12:45</td>
<td>Session 2</td>
<td>E</td>
<td>Overview of the Conference</td>
</tr>
<tr>
<td>13:00</td>
<td>Session 2</td>
<td>F</td>
<td>Overview of the Conference</td>
</tr>
<tr>
<td>13:15</td>
<td>Session 2</td>
<td>G</td>
<td>Overview of the Conference</td>
</tr>
<tr>
<td>13:30</td>
<td>Session 2</td>
<td>H</td>
<td>Overview of the Conference</td>
</tr>
<tr>
<td>13:45</td>
<td>Session 2</td>
<td>I</td>
<td>Overview of the Conference</td>
</tr>
</tbody>
</table>

## 4th Floor

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
<th>Room</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>14:00</td>
<td>Session 3</td>
<td>A</td>
<td>Overview of the Conference</td>
</tr>
<tr>
<td>14:15</td>
<td>Session 3</td>
<td>B</td>
<td>Overview of the Conference</td>
</tr>
<tr>
<td>14:30</td>
<td>Session 3</td>
<td>C</td>
<td>Overview of the Conference</td>
</tr>
<tr>
<td>14:45</td>
<td>Session 3</td>
<td>D</td>
<td>Overview of the Conference</td>
</tr>
<tr>
<td>15:00</td>
<td>Session 3</td>
<td>E</td>
<td>Overview of the Conference</td>
</tr>
</tbody>
</table>

## 5th Floor

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
<th>Room</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>15:15</td>
<td>Session 4</td>
<td>A</td>
<td>Overview of the Conference</td>
</tr>
<tr>
<td>15:30</td>
<td>Session 4</td>
<td>B</td>
<td>Overview of the Conference</td>
</tr>
<tr>
<td>15:45</td>
<td>Session 4</td>
<td>C</td>
<td>Overview of the Conference</td>
</tr>
<tr>
<td>16:00</td>
<td>Session 4</td>
<td>D</td>
<td>Overview of the Conference</td>
</tr>
<tr>
<td>16:15</td>
<td>Session 4</td>
<td>E</td>
<td>Overview of the Conference</td>
</tr>
</tbody>
</table>

## Special Session
- Special Session

<table>
<thead>
<tr>
<th>Session</th>
<th>Venue</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>Room A</td>
<td>1. Overview of the Conference</td>
</tr>
<tr>
<td>F</td>
<td>Room B</td>
<td>1. Overview of the Conference</td>
</tr>
<tr>
<td>C</td>
<td>Room C</td>
<td>1. Overview of the Conference</td>
</tr>
<tr>
<td>D</td>
<td>Room D</td>
<td>1. Overview of the Conference</td>
</tr>
<tr>
<td>E</td>
<td>Room E</td>
<td>1. Overview of the Conference</td>
</tr>
<tr>
<td>F</td>
<td>Room F</td>
<td>1. Overview of the Conference</td>
</tr>
<tr>
<td>G</td>
<td>Room G</td>
<td>1. Overview of the Conference</td>
</tr>
<tr>
<td>H</td>
<td>Room H</td>
<td>1. Overview of the Conference</td>
</tr>
<tr>
<td>I</td>
<td>Room I</td>
<td>1. Overview of the Conference</td>
</tr>
<tr>
<td>J</td>
<td>Room J</td>
<td>1. Overview of the Conference</td>
</tr>
<tr>
<td>K</td>
<td>Room K</td>
<td>1. Overview of the Conference</td>
</tr>
<tr>
<td>L</td>
<td>Room L</td>
<td>1. Overview of the Conference</td>
</tr>
</tbody>
</table>

* TAI: Event Room A in the conference building is temporarily available.
* FB: Event Room B in the conference building is temporarily available.
## CONTENTS

### I. 대회 조직

<table>
<thead>
<tr>
<th>대회 조직</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>상임운영위원회</td>
<td>7</td>
</tr>
<tr>
<td>조직위원회</td>
<td>7</td>
</tr>
<tr>
<td>분과위원회</td>
<td>8</td>
</tr>
</tbody>
</table>

### II. 주요행사 일정

<table>
<thead>
<tr>
<th>일정</th>
<th>13</th>
</tr>
</thead>
<tbody>
<tr>
<td>2월 12일(수)</td>
<td>13</td>
</tr>
<tr>
<td>Short Course</td>
<td>13</td>
</tr>
<tr>
<td>2월 13일(목)</td>
<td>14</td>
</tr>
<tr>
<td>기조강연</td>
<td>14</td>
</tr>
<tr>
<td>만찬 / 시상식</td>
<td>15</td>
</tr>
<tr>
<td>Rump Session</td>
<td>15</td>
</tr>
<tr>
<td>2월 14일(금)</td>
<td>15</td>
</tr>
<tr>
<td>폐회식 및 경품추첨식</td>
<td>15</td>
</tr>
</tbody>
</table>

### III. 강대원상

<table>
<thead>
<tr>
<th>16</th>
</tr>
</thead>
</table>

### IV. 전시안내

<table>
<thead>
<tr>
<th>19</th>
</tr>
</thead>
</table>

### V. 기조강연

<table>
<thead>
<tr>
<th>29</th>
</tr>
</thead>
</table>

### VI. 구두/포스터 발표 안내

<table>
<thead>
<tr>
<th>일정</th>
<th>31</th>
</tr>
</thead>
<tbody>
<tr>
<td>2월 13일(목)</td>
<td>34</td>
</tr>
<tr>
<td>구두발표</td>
<td>34</td>
</tr>
<tr>
<td>포스터발표</td>
<td>61</td>
</tr>
<tr>
<td>2월 14일(금)</td>
<td>94</td>
</tr>
<tr>
<td>구두발표</td>
<td>94</td>
</tr>
<tr>
<td>포스터발표</td>
<td>131</td>
</tr>
</tbody>
</table>

### VII. Author Index

<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Author Index (A-Z)</td>
<td>167</td>
</tr>
<tr>
<td>Author Index (가-힣)</td>
<td>202</td>
</tr>
</tbody>
</table>
구두 및 포스터
발표 안내
2020년 2월 14일(금)
| FP1-112 | Compact Model for P-type L-shaped Tunneling Field-effect-transistor  
Faraz Najam and Yun Seop Yu  
*Department of Electrical and Control Engineering and IITC, Hankyong National University* |
| FP1-113 | High Performance Graphene Photodetector with Van Der Waals Heterostructure through Tunneling Carrier Tunneling  
Kye Whan Cho and Woo Jong Yu  
*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  
Youngbum Eom, Myoungchul Lim, Sanghyun Lee, Sangwook Nam, Jaehee Lee, and Young Chung  
*R&D Center, SK Hynix Inc.* |
| **FP1-115** | Study of 3D TCAD Simulation on CMOS-compatible Avalanche Photodetectors  
Won-Yong Ha¹, Woo-Young Choi¹, and Myung-Jae Lee²  
¹*Department of Electrical and Electronic Engineering, Yonsei University, ²Post-silicon Semiconductor Institute, KIST* |
| FP1-116 | Analysis of the Evolution of Internal Bias Field and Dopants Effects of Ferroelectric HfO₂ by First-order Reversal Curves Diagrams  
Seunghyeon Hong, Yoseop Lee, Dante Ahn, Woo Ri Ham, Sungmun Song, and Seung-Eon Ahn  
*Department of Nano-Optical Engineering, Korea Polytechnic University* |
| FP1-117 | Electrical Analysis of NC Effect based on Equivalent Circuit for Silicon Doped HfO₂ Thin Film  
Dante Ahn, Yoseop Lee, Seunghyeon Hong, Woo Ri Ham, Sungmun Song, and Seung-Eon Ahn  
*Department of Nano-Optical Engineering, Korea Polytechnic University* |
| FP1-118 | TCAD Study of Uniaxial Stress Effect on the Threshold Voltage of MOSFET  
Dongyean Oh, Seong-Dong Kim, Seokkiu Lee, and Jinkook Kim  
*Research and Development Division, SK Hynix Inc.*  |
| **FP1-119** | 충돌 이온화를 이용한 Underlap 피드백 트랜지스터의 전기적 특성 연구  
손재민, 임두혁, 우솔이, 김상식  
고려대학교 전기전자공학과* |
| FP1-120 | Highly Reliable Gate Driver Circuit to Prevent Ripple Voltage Using AC-driven Method  
Jungwoo Lee¹, Jongsu Oh³, Eun Kyo Jung³, KeeChan Park², and Yong-Sang Kim¹  
¹*Department of Electrical and Computer Engineering, Sungkyunkwan University, ²Department of Electronics Engineering, Konkuk University* |
Study of 3D TCAD Simulation on CMOS-Compatible Avalanche Photodetectors

Won-Yong Ha¹, Woo-Young Choi¹*, and Myung-Jae Lee²*
¹Department of Electrical and Electronic Engineering, Yonsei University, Korea
²Post-Silicon Semiconductor Institute, Korea Institute of Science and Technology, Korea
Email: mj.lee@kist.re.kr, jamesha@o365.yonsei.ac.kr

Cross-Section Comparison CMOS-APDs

- **CMOS-APD Principles and Applications**
  - Important parameters
    - Responsivity [A/W]
    - Sufficient absorption region
    - Widened depletion width
    - Avalanche gain
    - Photodetection Bandwidth
    - Photogenerated-carrier transit time
    - RC time constant
    - Parasitics
  - APD IV curve
  - APD IV curve

- **Premature Edge Breakdown**
  - 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.

- **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.

- **3D TCAD Simulation for CMOS-APDs**
  - Doping profile of the rectangular model
  - Doping profile of the octagonal model
  - Not much difference
  - Higher curvature, Higher electric field at the edge

- **Application (Lidar, Biomedical Application)**
  - Lidar
  - Photodetector
  - Reduced Responsivity

- **Cross-section of a CMOS-APD**
  - P+N-well Junction
  - Elimination of slow diffusion currents from P-substrate
  - Bandwidth enhancement
  - Reduced Responsivity

- **Doping profile of the CMOS-APD**
  - Rectangular Model
  - Octagonal Model
  - Without GR
  - With P-well GR
  - With STI GR

- **Solution:** (Guard-ring (GR) structures)
  - Time-of-Flight Positron Emission Tomography (TOF PET)
  - Reduction of slow diffusion currents

- **Study of 3D TCAD Simulation on CMOS-Compatible Avalanche Photodetectors**
  - Won-Yong Ha¹, Woo-Young Choi¹*, and Myung-Jae Lee²*
  - ¹Department of Electrical and Electronic Engineering, Yonsei University, Korea
  - ²Post-Silicon Semiconductor Institute, Korea Institute of Science and Technology, Korea
  - Email: mj.lee@kist.re.kr, jamesha@o365.yonsei.ac.kr

- **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.

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

- **APD IV curve**
  - No gain
  - (proportionally gain)
  - Infinite gain

- **Photodetection Bandwidth**
  - Photogenerated-carrier transit time
  - RC time constant
  - Parasitics

- **Avalanche gain**
  - B
  - E
  - n

- **E-field profile of the CMOS-APD**
  - |E| (V/cm)
  - |E| (V/cm)
  - |E| (V/cm)

- **Doping profile of the CMOS-APD**
  - Rectangular Model
  - Octagonal Model
  - Without GR
  - With P-well GR
  - With STI GR

- **Solution:** (Guard-ring (GR) structures)
  - Reduction of slow diffusion currents

- **Application (Lidar, Biomedical Application)**
  - Lidar
  - Photodetector
  - Reduced Responsivity