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# Welcome Message

On behalf of the Organizing Committee of IMID 2017, we are very honored and delighted to welcome you to the 17th International Meeting onInformation Display (IMID 2017) which is to be held at the Convention Hall, BEXCO, Busan, Korea from August 28 to 31, 2017.

The IMID has been held every year since 2001 and organized by the Korean Information Display Society (KIDS), the Society for Information Display (SID) and the Korea Display Industry Association (KDIA). The IMID has become a premier conference with more than 1,800 attendees each year, where many academic, industry, and business leaders meet, publish R&D results and share knowledge of information displays.

Confidently speaking, IMID 2017 is the largest international platform for sharing and exchanging the latest exciting advances in information display technology.

In the IMID 2017, we have received over 700 abstracts including distinguished invited papers from all over the world, which makes an excellent scientific program for IMID 2017. This conference has also received support from many sponsors and exhibitors, who greatly help to make the IMID 2017 successful. We would like to take this opportunity to express our deepest appreciation for your participation and support for the IMID 2017.

This year, Special Exhibition will be held on an even larger scale than ever. This year's exhibition features three themes including the History of Display, the Enterprise Exhibition and the SF-Zone (Show me the Future Zone) and it will deliver more interesting contents for IMID participants.

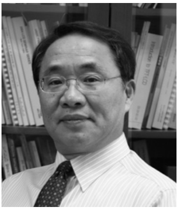
We sincerely hope that the IMID Special Exhibition is a great opportunity for participants to gain diverse information and knowledge on display companies and products as well as the history of display.

Busan, the host city of the IMID 2017, is known as a newly developed city attracting millions of people to the beach annually. We provide many attractive social events for participants to experience and enjoy the Korean culture. We truly hope that you will take this chance to join us in Busan.

Once again, we sincerely welcome you all and appreciate your participation and support for IMID 2017. We hope your attendance of the IMID 2017 is enjoyable, memorable, and scientifically fruitful.

Thank you.

Sang Deog Yeo
General Chair of IMID 2017
President of LG Display Co., Ltd.



Jun Souk
General Co-Chair of IMID 2017
Director of SID Korea Chapter

# Program Overview

## • Tutorials

10:00~17:30, Monday, August 28, 2017 / 2F, Room B (# 205)

| No. | Time | Presentation Title | Speaker |
|---|---|---|---|
| T1 | 10:00-11:30 | Fundamentals of QD-Based Display Technologies | Prof. Jeonghun Kwak (Univ. of Seoul, Korea) |
| T2 | 11:30-13:00 | Psychophysical Methods for Display Research and Engineering | Dr. Joohwan Kim (Nvidia, USA) |
| T3 | 14:30-16:00 | Organic Light Emitting Diodes – State-of-the-Art and Challenges for Applications Beyond Displays | Prof. Malte Gather (Univ. St. Andrews, UK) |
| T4 | 16:00-17:30 | Technical Issues and Trends of Flexible and Stretchable Displays | Prof. Yongtaek Hong (Seoul Nat'l Univ., Korea) |

## • Workshops

10:00~17:30, Monday, August 28, 2017 / 2F, Room A (# 201-202)

| No. | Time | Presentation Title | Speaker |
|---|---|---|---|
| W1 | 10:00-11:00 | Materials and Interfaces in Solution-Processed OLEDs | Prof. Yong-Jin Pu (Yamagata Univ., Japan) |
| W2 | 11:00-12:00 | Next Generation Display: Metal Halide Perovskite LEDs | Prof. Tae-Woo Lee (Seoul Nat'l Univ., Korea) |
| W3 | 12:00-13:00 | OLED Manufacturing - Enabling Better Products through Advanced Manufacturing Processes | Dr. Jae Hoon Jung (Aixtron, Germany) |
| W4 | 14:30-15:30 | Recent Advances in OLED Microdisplays | Dr. Amal Ghosh (eMargin, USA) |
| W5 | 15:30-16:30 | Optimizing Charge Transport in Carbon Nanotube Networks for FETs | Prof. Jana Zaumseil (Univ. of Heidelberg, Germany) |
| W6 | 16:30-17:30 | Stretchable and Foldable Structures of Wearable Devices and Displays | Prof. Jang-Ung Park (UNIST, Korea) |

## • Keynote Addresses

15:30~17:30, Tuesday, August 29, 2017 / Auditorium (2F)

Keynote I: 16:00~16:30

Dr. In Byeong Kang
(LG Display Co., Ltd., Korea)

The Display of Future

Keynote II: 16:30~17:00

Dr. Xiaolin Yan
(TCL Corp., China)

Opportunities and Challenges of OLED & QLED

Keynote III: 17:00~17:30

Prof. Ching W. Tang
(HKUST, Hong Kong)

Thirty and More Years of OLED Research –
A Retrospective

## • Industrial Forum

09:00~17:30, Wednesday, August 30, 2017 / 1F, Room H (# 109-110)

| Time | Title | Speaker |
|---|---|---|
| 08:30~08:50 | Registration | |
| 08:50~09:00 | Welcome & Opening | |
| SESSION 1. Finding New OLED Application Market | | |
| Session Chair: Prof. Sung Tae Shin (Korea Univ., Korea)<br>Panel Discussion Chair: Prof. Hyun Jae Kim (Yonsei Univ., Korea) | | |
| 09:00~09:30 | Boeing commercial airplane cockpit display and passenger entertainment display (past, current and future) | Julian.K.Chang, Associate Tech Fellow Optics and Electronics, Boeing |
| 09:30~10:00 | Alpine Display Business and Technology | Michihisa Onishi, Senior Engineer, Alpine Electronic, Inc |
| 10:00~10:30 | Recent Progress of OLED Technologies in Japan for Display and Lighting Application | Takuya Komoda Professor, Yamagata University |
| 10:30~11:00 | Challenges for realization of real organic electronics | Teruo Tohma Technical Consultant |
| 11:00~11:30 | HMD based mixed reality space communication and media control platform technology. (HMD based Smart Space with mixed reality technology) | Woo-Sug Jung Principal Researcher, ETRI |
| 11:30~11:50 | Coffee Break | |
| 11:50~12:50 | Panel Discussion | |
| 12:50~14:00 | LUNCH | |
| SESSION 2. Which one will be the winner of Future LCD, QDLCD vs OLED? | | |
| Session Chair: Julian K Chang (Boeing Commercial Airplane, USA)<br>Panel Discussion Chair: Prof. Changhee Lee (Seoul Nat'l Univ., Korea) | | |
| 14:00~14:30 | OLED TV Market Forecast followed by the increase of demand from Premium TV market | Choonghoon Yi CEO, UBI Research |
| 14:30~15:00 | [KEY NOTE] Quantum Dot and Advance of LCD-TV | Nam Seok Roh Vice President, Samsung Electronics |
| 15:00~15:30 | [KEY NOTE] OLED, Now and Future | Joon Young Yang Head of OLED Advanced Research Division 1, LG Display |
| 15:30~16:00 | [KEY NOTE] TCL Display Technology with QDs | Weiran Cao, Senior Scientist, TCL Corporate Research |
| 16:00~16:20 | Coffee Break | |
| 16:20~17:20 | Panel Discussion | |

## Young Leaders Conference

16:00~17:30, Wednesday, August 30, 2017 / Room G (# 108)

Young Leaders Conference (YLC) is open to students who would like to share and discuss their research results. After oral presentations, outstanding presenters among all YLC applicants will be selected by committees based upon their research originality and technical significance. In addition, Best Presentation Award will be given right after the session.

## YLC Awards

| Grade | Numbers | Prize (per paper) |
|---|---|---|
| Gold | 1 Paper | KRW 300,000 |
| Silver | 2 Papers | KRW 200,000 |
| Bronze | 3 Papers | KRW 100,000 |

To select the best presentation award, this year, the presentations will be put to a spot poll (Vote) by participants and reviewed by professional experts. So, you can invite your co-authors and colleagues in this session.

## Social Events

<table>
<tr><td>Opening Ceremony</td><td>15:30~16:00, Tuesday, August 29, 2017 / Auditorium (2F)<br>Keynote Addresses will be followed by Opening Ceremony. Do not miss!</td></tr>
<tr><td>Welcome Reception</td><td>18:00~20:00, Tuesday, August 29, 2017 / Auditorium Lobby (2F)<br>Enjoy our Welcome Reception. Please show your drink coupon to drink a beer or juice at the entrance.</td></tr>
<tr><td>Special Tour</td><td>20:00~22:00, Tuesday, August 29, 2017<br>Our organizing committee will provide a night view tour. You can enjoy the beauty of night view in Busan. Registration for the tour is first-come, first serve basis.<br>
<br>※ We will start the bus boarding process for Special Tour at 19:30 in 1F, Convention Hall Entrance, BEXCO.</td></tr>
<tr><td>Banquet</td><td>19:00~21:00, Wednesday , August 30, 2017 /<br>Grand Ballroom, The Westin Chosun Busan (1F)<br>Participants are required to show the ‘Banquet Ticket’ at the entrance. Great food and enjoyable performance will be there!</td></tr>
</table>

## 3DSA 2017

**The 9th International Conference on 3D Systems and Applications held in conjunction with IMID 2017.**
**We would like to inform you that 3DSA program is Session 14, 22, 30, 38, 46, 54, 62.**

- **Venue: Convention Hall, Bexco, Busan**
- **Place: Room F (Room 106-107)**
- **Date: Aug. 29 ~ 31, 2017**

## • IMID 2017 Awards

- Merck Awards
- Merck Young Scientist Awards
- KIDS Awards (Sponsored by LG Display Co., Ltd.)
- KIDS Awards (Sponsored by Samsung Display Co., Ltd.)
- UDC Innovative Research Award in Organic Electronics
- UDC Pioneering Technology Award in Organic Electronics

The awardees have been selected from papers submitted to IMID 2017 based upon their originality and the technical significance to information display industry. The awards will be presented at the Opening Ceremony on Tuesday, August 29, 2017 at Auditorium (2F), Welcome Reception on Tuesday, August 29, 2017 at Auditorium Lobby (2F), BEXCO and Banquet on Wednesday, August 30, 2017 at Grand Ballroom, the Westin Chosun Busan (1F)

- Best Poster Awards

IMID 2017 will present the Best Poster IMID 2017 will present the Best Poster Awards to the nominated presenters during the conference. The assessment will be conducted onsite by the judges. The award certificate will be given at the poster sessions by program committee chair of IMID 2017.

# IMID 2017 Awarded Papers

| Awards | | Winners |
|---|---|---|
| Merck Awards | Merck Award | **See-through 3D Display for Augmented Reality**<br>Byoungho Lee (Seoul Nat'l Univ.) |
| | Merck Young Scientist Award | **Nanoconfined Liquid Crystal Materials for Switchable Coloration**<br>Dong Ki Yoon (KAIST) |
| KIDS Awards | Gold (LGD) | **Light Adaptable Space Adaptable Display**<br>Himchan Oh, Jong-Heon Yang, Gi Heon Kim, Hyunkoo Lee, Byoung-Hwa Kwon, Chunwon Byun, Chi-Sun Hwang, Kyoung Ik Cho, and Jeong-Ik Lee (ETRI, Korea) |
| | Gold (SDC) | **Organic Thin-Film Transistors with Mobility Over 10 $cm^2/Vs$ by Low-Temperature Solution Coating**<br>Chuan Liu (Sun Yat-sen Univ., China), Xuying Liu, Takeo Minari (NIMS, Japan), Masayuki Kanehara (C-ink. Co., Ltd., Japan), and Yong-Young Noh (Dongguk Univ., Korea) |
| | Silver (LGD) | **Full-Color Fresnel Holographic Display based on a Single SLM Using Spatial-Multiplexing and Frequency- Filtering Methods**<br>Shu-Feng Lin, Yong-Seok Hwang, and Eun-Soo Kim (Kwangwoon Univ., Korea) |
| | Bronze (LGD) | **A Practical Approach to Mitigate VR-Sickness for Mobile VR Devices**<br>Sehoon Kim, Wonhee Choe, Nupur Kala, and Jaesung Lee (Samsung Electronics Co., Ltd., Korea) |
| | Bronze (LGD) | **Highly Flexible and Reliable Gas Diffusion Barrier based on Nanolaminate Structure**<br>JeongHyun Kwon, Yongmin Jeon, Seungyeop Choi, Hyuncheol Kim, and Kyung Cheol Choi (KAIST, Korea) |
| | Bronze (SDC) | **Electrochromic Full Color Reflective Display**<br>Ik Jang Ko, Jin Hwan Park, Jin Woo Kim, Gyeong Woo Kim, and Jang Hyuk Kwon (Kyung Hee Univ., Korea) |
| | Bronze (SDC) | **Straight Forward Evidence for Long-Term Interfacial Degradation of Inverted Perovskite Solar Cells**<br>Hyunho Lee and Changhee Lee (Seoul Nat'l Univ., Korea) |
| | Bronze (SDC) | **A Study on the Electric Performance of Amorphous Indium Gallium Zinc Oxide Thin Film Transistor Grown by Atomic Layer Deposition**<br>Minhoe Cho, Hyeonjoo Seul, Jeongoh Kim (Hanyang Univ., Korea), Pilsang Yun, Jong-Uk Bae, Kwonshik Park (LG Display Co., Ltd., Korea), and Jaekyeong Jeong (Hanyang Univ., Korea) |
| UDC Awards | UDC Innovative Research Award in Organic Electronics | **Organic Flash Memory with Low Operating Voltage and Long Retention Time for Low-Power Flexible Electronics**<br>Seungwon Lee, Hyejeong Seong, Junghoo Yun, Sung Gap Im, Hanul Moon, and Seunghyup Yoo (KAIST, Korea) |
| | UDC Pioneering Technology Award in Organic Electronics | **Triplet Exciton Bypass Filter for Superb Operational Stability of Phosphorescent Organic Light- emitting Diodes**<br>Wook Song and Jun Yeob Lee (Sungkyunkwan Univ., Korea) |

# Useful Information

## • Venue


The IMID 2017 will take place at the Busan Exhibition and Convention Centre (BEXCO) in Busan, Korea. The BEXCO is located 30 minutes from Gimhae International Airport and is located in the heart of the Haeundae Beach Resort, one of South Korea's most famous hospitality sites.

BEXCO, opening its doors in May 2001 in the prized location of Haeundae, Korea's greatest tourist spot, continues to set new records for events hosted each year, successfully hosting large-scale international exhibitions, international conferences, a variety of small and medium-scale conferences, corporate events, and others. Based on this continued success, BEXCO is fast establishing itself as "Asia's leading exhibition and convention hub."

## • Registration

Registration fee for the conference includes admission to all Technical Sessions, entrance to the Special Exhibition and Opening Party as well as a copy of the Conference Program and USB proceedings.

• On-Site Registration Fee

| Conference | | On-Site Registration |
|---|---|---|
| Regular | KIDS / SID Member | USD 650 |
| | Non-Member | USD 750 |
| Student | KIDS / SID Member | USD 200 |
| | Non-Member | USD 220 |

• Hours of Operation

The registration desk will be available during August 28~31 at the Lobby, 2F at the following times;

| Date | Time |
|---|---|
| Monday, August 28 | 08:30~18:00 |
| Tuesday, August 29 | 08:00~18:00 |
| Wednesday, August 30 | 08:00~18:00 |
| Thursday, August 31 | 08:00~17:30 |

• Name Badge

For security purposes, participants must wear their name badges during the conference. If your badge needs any correction, please visit the registration desk for a replacement. There will be staff to check your badge at every gate of scientific rooms and poster session hall.

• Conference Kit

Conference kit will be distributed at the kit desk in the lobby of 2F (right beside the registration desk). After registration, please show your congress kit coupon to receive your kit, which includes a Final Program Book, USB Proceedings, and so on.

## • Internet

• Internet Lounge

An internet lounge will be located in # 301 during the conference. All participants will be able to use computers and the internet from 08:30 to 18:00.

• Wi-Fi

Free Wi-Fi is available for IMID 2017 participants.

## • Cloak Room & Lost and Found

You can store your luggage in the cloakroom # 252 during August 28~31. All the lost items should be returned to the Cloak Room (2F). If you lose anything, please report to the cloak room for assistance.

## Tax

Vlaue-added tax (VAT) is levied on most goods and services at a standard rate of 10% and is included in the retail price. In tourist hotels, this 10% tax applies to meals and other services and is added into the bill.

## Tipping

Tipping is not a traditional custom in Korea. A 10% service charge will be added to your bill at all tourist restaurants and hotels. It is also not necessary to tip a taxi driver unless he assists you with heavy luggage or provides an extra service.

## Electricity (220V)

In Korea, electrical outlets are operated at 220V only. Overseas delegates bringing laptop computers and other electrical appliances are advised to check whether a transformer is required.

## Telephone

| | |
|---|---|
| Step 1 | Determine what time it is in Korea before you call.<br>(9 hours ahead of Greenwich Mean Time.) |
| Step 2 | Dial 001, the international access code. |
| Step 3 | Dial 82, the country code of Korea. |
| Step 4 | Dial the area code of the city you wish to call with 0 removed.<br>[Seoul: 2, Daejeon: 42, Busan: 51] |
| Step 5 | Dial the remaining digits. |

001(International Access Code) + Country Code + Area Code + Remaining Digits

EX) Calling Secretariat of IMID 2017, please refer to the following steps; +82-42-472-7460

## Emergency Phone Number

- Medical Emergency: 1339
- Emergencies for Fire, Rescue & Hospital Services: 119
- Police: 112
- First Aid Services: 129

# Information on Technical Program

## • Preview Room

At preview room, oral presentation speaker could check their presentation material. The preview room is # 252. All participants will be able to checking the materials from 08:30 to 18:00 on Aug. 28~31. Oral presentation speakers are required to upload the presentation file to the laptop computer in the session room at least 15 minutes prior to the session.

## • Presentation Time

- [Keynote]: 30 min.
- [Tutorials]: 90 min.
- [Workshops]: 60 min.
- [Invited Talk]: 20 minutes for presentation and 5 minutes for Q&A
- [Oral Presentation]: 10 minutes for presentation and 5 minutes for Q&A

## • Poster Sessions

Each paper's presentation code will be shown on the board and adhesive tapes will be provided in the poster session area. All presenters are required to preside at their poster panels during the session for discussion with participants.

| Place: # 301 (3F) | Poster Session I | Poster Session II |
|---|---|---|
| Date | Tuesday, August 29 | Thursday, August 31 |
| Put-up Time | 08:00~12:00 | |
| Presentation Time | 14:00~15:30 | |
| Take-down Time | 16:00~17:30 | |

# Keynote Addresses

**Date :** Aug. 29, 2017 (Tuesday)
**Time :** 16:00~17:30
**Room :** Auditorium (2F)
**Chair :** Hyun Jae Kim (Yonsei Univ., Korea)

## Keynote I 16:00~16:30

### The Display of Future

*Dr. In Byeong Kang (LG Display Co., Ltd., Korea)*

Displays have been changing throughout the history, offering values that meet the need of the time. Image quality was the most important value in the past CRT days, and image quality and design are important in the current smart device age. In the future, as the 4th industrial revolution prevails, it is expected that everything around us is connected and interact with humans and one another. Based on these anticipated changes, displays will be also changing accordingly. In addition to the fundamental value of transferring visual information, the display of the future will offer new values of being everywhere things are, and of having multi-functionality by integrating functions of things, beyond a simple display.

In order for displays to be everywhere, design flexibility will be an important factor, enabling displays to match other things well. Expandability to bring the functions of other things into the display will also be an essential competitiveness factor. LG Display has recently demonstrated that OLED has much potential in these two characteristics, and here we introduce the change in perception of OLED resulting from these efforts. Based on this perception in the market, LG Display will lead the display market and create the future by tireless research and development and aggressive investment in OLED, the key to the future display.

# Keynote Addresses

**Date :** Aug. 29, 2017 (Tuesday)
**Time :** 16:00~17:30
**Room :** Auditorium (2F)
**Chair :** Hyun Jae Kim (Yonsei Univ., Korea)

## Keynote II 16:30~17:00

### Opportunities and Challenges of OLED & QLED

*Dr. Xiaolin Yan (TCL Corp., China)*

Opportunities & Challenges of OLED & QLED Technology for Next Generation Premium TV Market.

<Contents>
1. Premium TV Market & Technology Trend
2. What's Key Success Factors for Commercialization of Next Generation Premium TV?
3. TCL OLED/QLED Technology Development Update
   (1) Why Printing Technology?
   (2) What's Technical Challenges & Latest Breakthrough of OLED/QLED Printing Technology?
4. TCL Platform OLED/QLED Technology Development Strategy
5. Summary

## Keynote III 17:00~17:30

### Thirty and More Years of OLED Research – A Retrospective

*Prof. Ching W. Tang (HKUST, Hong Kong)*

30 Years since the publication of the milestone paper [Organic Electroluminescent Diodes, Applied Physics Letters 51, 913 (1987)] by Tang and VanSlyke from Kodak Research Laboratories, a premium display technology - OLED - has emerged and increasingly expanded its applications and market shares in serious competition with thedominant LCD technology. In its path from discovery to commercialization, numerous technical problems have been solved by researchers worldwide in achieving what have long been recognized as the intrinsic attributes of OLED – nearly 100% quantum efficiency, vivid full colors, perfect black levels, ultra-fast response, light weight and flexible form factor. The most difficult problem – lifetime – has also been adequately addressed to provide solutions for both small and large displays. This author will recap a few important milestones that marked the development OLED with some personal retrospectives.

# Tutorials

## •August 28, 2017 (Monday)

### Tutorials

**Chairs** : Tutorials Ⅰ : Prof. Jae-Hyeung Park (Inha Univ., Korea)
Tutorials Ⅱ : Prof. Seunghyup Yoo (KAIST, Korea)

| Session | NO | Time | Title | |
|---|---|---|---|---|
| Tutorials Ⅰ | T1 | 10:00~ 11:30 |  | **Fundamentals of QD-Based Display Technologies**<br>Prof. Jeonghun Kwak<br>(Univ. of Seoul, Korea) |
| | T2 | 11:30~ 13:00 |  | **Psychophysical Methods for Display Research and Engineering**<br>Dr. Joohwan Kim<br>(Nvidia, USA) |
| Tutorials Ⅱ | T3 | 14:30~ 16:00 |  | **Organic Light Emitting Diodes – State-of-the-Art and Challenges for Applications Beyond Displays**<br>Prof. Malte Gather<br>(Univ. St. Andrews, UK) |
| | T4 | 16:00~ 17:30 |  | **Technical Issues and Trends of Flexible and Stretchable Displays**<br>Prof. Yongtaek Hong<br>(Seoul Nat'l Univ., Korea) |

# Workshops

## •August 28, 2017 (Monday)

### Workshops

**Chair** : Workshops Ⅰ・Ⅱ: Prof. Byung Doo Chin (Dankook Univ., Korea)

| Session | NO | Time | Title | |
|---|---|---|---|---|
| Workshops Ⅰ | W1 | 10:00~ 11:00 |  | **Materials and Interfaces in Solution-Processed OLEDs**<br>Prof. Yong-Jin Pu<br>(Yamagata Univ., Japan) |
| | W2 | 11:00~ 12:00 |  | **Next Generation Display: Metal Halide Perovskite LEDs**<br>Prof. Tae-Woo Lee<br>(Seoul Nat'l Univ., Korea) |
| | W3 | 12:00~ 13:00 |  | **OLED Manufacturing - Enabling Better Products through Advanced Manufacturing Processes**<br>Dr. Jae Hoon Jung<br>(AIXTRON SE, Germany) |
| Workshops Ⅱ | W4 | 14:30~ 15:30 |  | **Recent Advances in OLED Microdisplays**<br>Dr. Amal Ghosh<br>(eMargin, USA) |
| | W5 | 15:30~ 16:30 |  | **Optimizing Charge Transport in Carbon Nanotube Networks for FETs**<br>Prof. Jana Zaumseil<br>(Univ. of Heidelberg, Germany) |
| | W6 | 16:30~ 17:30 |  | **Stretchable and Foldable Structures of Wearable Devices and Displays**<br>Prof. Jang-Ung Park<br>(UNIST, Korea) |

# 1 Quantum Dot Light-Emitting Diodes

**Date:** Aug. 29, 2017 (Tuesday)
**Time:** 09:00~10:30
**Session Chairs:** Dr. Wan Ki Bae (KIST, Korea)
Prof. Jeonghun Kwak (Univ. of Seoul, Korea)

## A1-1 09:00~09:25

### Invited Quantum Dot Electroluminescence to Achieve Saturated Colours for REC2020 Compatibility: A Comparative Study of CdSe/ZnS and Cd Free QD Systems

*Poopathy Kathirgamanathan, Seenivasagam Ravichandran, Muttulingam Kumaraverl, and Nicola Bramananthan (Brunel Univ., UK)*

Electroluminscent colloidal quantum dots have the potential to offer saturated colours satisfying the new more demanding REC 2020 (ITU-R-BT 2020) standard. This paper reports our attempt to match the REC 2020 colour co-ordinates with red CdSe/ZnS(0.708, 0.292), red CFQD® and green CFQD®. We report here red quantum dot based electroluminescent devices (QLEDs) that meet the colour co-ordinates requirement set by REC2020. We also report the world first dark red CFQD® (heavy metal free) ((x,y), (0.696, 0.303)) devices. The electroluminescent characteristics of devices of both CdSe/ZnS and cadmium free quantum dots are compared. The conduction mechanism and life-time will also presente

## A1-2 09:25~09:50

### Invited New Generation Quantum-Dot Light-Emitting Diode Display: From Materials, Devices to Printing Fabrication

*Lei Qian, Yixing Yang, Weiran Cao, Chaoyu Xiang, Xiangwei Xie, Longjia Wu, and Xiaolin Yan (TCL Corp. Research, China)*

Given the existing key challenges for QLED display technology commercialization, we have achieved important progress regarding high color gamut blue QDs development, improvement of QLEDs performance including efficiency and lifetime, and development of printable QD inks and QLED ink-jet printing technique. The demonstration of ink-jet printed full-color and high resolution QLED display prototype is under way.

# 1 Quantum Dot Light-Emitting Diodes

**Date:** Aug. 29, 2017 (Tuesday)
**Time:** 09:00~10:30
**Session Chairs:** Dr. Wan Ki Bae (KIST, Korea)
Prof. Jeonghun Kwak (Univ. of Seoul, Korea)

## A1-3 09:50~10:15

### Invited Quantum Dot Surface Engineering for Charge Transfer and Optoelectronic Devices

*Sukyung Choi (ETRI, Korea), Ho Jin (Texas A&M Univ., USA), Nam Sung Cho (ETRI, Korea), and Sungjee Kim (POSTECH, Korea)*

Quantum dots (QDs) have received great interest for optoelectronic devices due to their unique optical properties such as sharp symmetric emission peak, and tunability of band gap. Owing to the large surface-to-volume ratio, physical and chemical properties of QDs are dominantly affected by surface environments. Especially, surface ligands of QDs are essential components determining the colloidal stability, luminescence or electronic properties. Recently, inorganic ligands of QDs have been developed for efficient charge transfer in electronic devices. They are promising in decreasing the interparticle spacing and enhancing the electronic coupling between QDs. In this talk, we report how the energy level alignment between QDs and inorganic ligands correlate with their charge transport properties and device performances. Combidning electrochromic materials to the surface of QDs gives potential to dual display mode which controlling the observed color or lights selectively from electrochromic materials or QDs by voltage control.

## A1-4 10:15~10:30

### Multi-Functional Dendrimer Ligands for High Efficiency Quantum Dot Light-Emitting Diodes Using Selective Ligand Exchange Process

*Ikjun Cho (Korea Univ., Korea), Jun Hyuk Chang (KIST, Korea), Jinhan Cho (Korea Univ., Korea), and Wan Ki Bae (KIST, Korea)*

We introduce multi-functional dendrimer ligands that act as the charge injection controlling material as well as the adhesive layer at the interfaces between quantum dots (QDs) and electron transport layer (ETL) in quantum dot light-emitting diodes (QLEDs). Specifically, we use poly(amidoamine) dendrimers (PADs) that bind to the surface of QDs by replacing the native ligands (oleic acids) and also to the surface of ZnO ETL. PAD ligands control the electron injection rate from ZnO ETL into QDs by shifting the electronic energy levels of the surface of ZnO ETL and thereby ameliorate the charge balance within QDs in devices, leading to the augmentation of the device efficiency. As an ultimate achievement, the device efficiency increases by a factor of 3 by substituting the native ligands (3.86%) with PAD ligands (11.36%). Furthermore, multi-branched dendrimer ligands preserve the QD emissive layer undamaged during following solution processing, enabling us to accomplish solution-processed QLEDs.

## 2 OLED Material Ⅰ

**Date:** Aug. 29, 2017 (Tuesday)
**Time:** 09:00~10:15
**Session Chair:** Prof. Jun Yeob Lee (Sungkyunkwan Univ., Korea)

### B2-1 09:00~09:25

**Invited** Recent Progress in Phosphorescent OLED: Operational Lifetime and Color Purity

*Takahisa Shimizu, Hirohiko Fukagawa, Yukiko Iwasaki, Taku Oono, and Toshihiro Yamamoto (NHK Sci. & Tech. Research Laboratories, Japan)*

Phosphorescent OLEDs (PHOLEDs) have been investigated because of their high efficiency. It is often said, when we use those as display device, their problems are high cost and insufficient color purity of the phosphorescent emitter. In this presentation, we would like to describe the methods to solve these two topics.

### B2-2 09:25~09:50

**Invited** Blue Emitters for High Performance OLEDs and Interfacial Engineering for Efficient OPV

*Ziyi Ge (Chinese Academy of Sciences, China)*

Organic light emitting diodes (OLEDs) have attracted extensive attention for their promising applications in flat panel display and solid-state lighting resources. However, the efficiency and lifetime of blue emitters are still lower than the green and red ones, which limit the commercialization of OLEDs, especially in high-efficiency and high-brightness lighting. Here, we designed and prepared a series of efficient blue emitters, which were employed to fabricate the blue fluorescent OLEDs with current efficiency as high as 7-10 cd/A. The emitters are also used as the host of a phosphorescent emitter to fabricate highly efficient fluorescent/phosphorescent (F/P) hybrid white OLEDs with maximum total external quantum efficiency (EQE) of 23.8%, current efficiency (CE) of 56.1 cd/A, and power and power efficiency (PE) of 62.9 lm/W. Further, we will also briefly introduce some interfacial materials for highly efficient OPV, including non-conjugated small molecule electrolyte, hyperbranched polymers etc, which may serve as the interfacial layer for solution processable OLEDs.

## 2 OLED Material Ⅰ

**Date:** Aug. 29, 2017 (Tuesday)
**Time:** 09:00~10:15
**Session Chair:** Prof. Jun Yeob Lee (Sungkyunkwan Univ., Korea)

### B2-3 09:50~10:15

**Invited** State of the Art OLED Materials: Merck's Development Direction

*Remi Anemian (Merck, Germany)*

Organic light emitting diodes (OLEDs) have opened up whole new dimensions in display technology. They allow displays with brilliant colors and sharp picture quality that catch the eye from every angle, as well as being very energy efficient and long-lasting. As a leading manufacturer, Merck offers a complete and unique portfolio of premium materials for OLED displays. These include small molecules for vapor-based processes and soluble material systems for printing processes. Furthermore, Merck cooperates closely with market leaders and develops customized solutions for many of the world's leading OLED display and lighting companies. Finally, boasting one of the largest R&D teams in the industry, Merck has established itself as an OLED global solution provider. In this talk, we will discuss about Merck's latest development.

## Poster Session Ⅰ

- **Date:** August 29 (Tue.), 2017
- **Time:** 14:00 ~ 15:30
- **Location:** # 301, Convention Hall, BEXCO

*** Each paper's code will be shown on the board and tapes will be provided in the poster presentation area. All presenters are required to preside at their poster panels during the session for discussion with participants.**

| Place: # 301, BEXCO | Poster I |
|---|---|
| Put-up Time | 08:00~12:00, Aug, 29 (Tue.), 2017 |
| Presentation Time | 14:00~15:30, Aug, 29 (Tue.), 2017 |
| Take-down Time | 16:00~17:30, Aug. 29 (Tue.), 2017 |

## 3 Nano Materials for Backplane Ⅰ

**Date:** Aug. 29, 2017 (Tuesday)
**Time:** 09:00~10:05
**Session Chairs:** Prof. Jana Zaumseil (Universität Heidelberg, Germany)
Prof. William Wong (Univ. of Waterloo, Canada)

### C3-1 09:00~09:25

**Invited** Highly Functional Light-Emitting Devices based on Electrolytes

*Taishi Takenobu (Nagoya Univ., Japan)*

Although full-color monitors of organic light-emitting diodes (OLEDs) are already available in the market, electrical pumping remains a very challenging problem for conventional OLEDs. Particularly, for electrical excitation of organic semiconductor lasers (OSLs), extremely high current density more than 1 $kA/cm^2$ is required. However, the maximum current density of OLEDs are typically limited to 1-10 $A/cm^2$ due to the effect of exciton quenching and photon loss processes and, consequently, electrical excitation of OSLs has not been realized. Very recently, to address this limitation, we focus on organic electrochemical light-emitting cells. These light-emitting devices have p-i-n homojunction with highly conductive active area owing to electro-chemical carrier doping, which is irrealizable for OLEDs. As the results, we demonstrated the effective light emission with extremely high current density more than 1 $kA/cm^2$, which is the first important milestone for future electrically-pumped OSLs.

### C3-2 09:25~09:50

**Invited** Multicolor Perovskite Light Emitting Diodes for Display and Lighting Applications

*Abd. Rashid bin Mohd Yusoff (Kyung Hee Univ., Korea) and Mohammad Khaja Nazeeruddin (École Polytechnique Fédérale de Lausanne, Switzerland)*

Perovskite light-emitting diodes (PLEDs) have attracted intense research interest over the past few years; however, the brightness, electroluminescence, lifetime and reproducibility of PLEDs are associated with limitations that should be addressed before commercialization. Here, we explored the effects of the energy level, mobility and morphology of the charge transport layers and the triple-cation mixed perovskite (formamidinium, methylammonium and cesium) used in blue, green and infra-red LEDs.

## 3 Nano Materials for Backplane Ⅰ

**Date:** Aug. 29, 2017 (Tuesday)
**Time:** 09:00~10:05
**Session Chairs:** Prof. Jana Zaumseil (Universität Heidelberg, Germany)
Prof. William Wong (Univ. of Waterloo, Canada)

### C3-3 09:50~10:05

### Tips-Pentacene Solution Deposited Bottom-Gate Bottom-Contacts OFETs: What can be the Effect of the Solvent?

*Wenlin Kuai, Emmanuel Jacques, Tayeb Mohammed-Brahim (Univ. Rennes 1, France), Seung Jae Moon , Byung Seong Bae (Hoseo Univ., Korea), and Maxime Harnois (Univ. Rennes 1, France)*

The works deals with the important effect of the solvent in the fabrication of fully organic solution deposited Tips-pentacene Field Effect Transistors where all the layers, particularly the gate insulator and the active layer, are made in organic materials. Bottom gate bottom contacts Tips-pentacene OFETs are fabricated using spin-coated SU8 photoresist as gate insulator. The effect of the solvent is studied and modeled through the electrical parameters of the transostors.Particularly the link between the leakage gated current, the drain current at low grain voltage, the off-current is well highlighted.

# 4 LC Physics

**Date:** Aug. 29, 2017 (Tuesday)
**Time:** 09:00~10:30
**Session Chair:** Prof. Dong Ki Yoon (KAIST, Korea)

## D4-1 09:00~09:25

### Invited The Twist-Bend Nematic Phase

*Corrie T. Imrie (Univ. of Aberdeen, UK)*

The recently discovered twist bend nematic, $N_{TB}$, phase has generated considerable excitement in the liquid crystal community. In the $N_{TB}$ phase, the achiral molecules form a helix and the director is titled with respect to the helical axis. The induced twist may be either left or right handed and equal amounts of both types of helix are expected. To date, the $N_{TB}$ phase has been observed for relatively few materials and the overwhelming majority of these are odd-membered liquid crystal dimers. Given this limited data set, the development of the empirical relationships linking molecular structure to the observation of this exciting new phase is very much at an embryonic stage. Here we present a range of new liquid crystal dimers which exhibit the $N_{TB}$ phase and discuss structure-property relationships. We will also consider the application potential of these types of liquid crystals.

## D4-2 09:25~09:50

### Invited Liquid Crystal Topological Defects for Optics

*Francesca Serra (Johns Hopkins Univ., USA)*

Soft materials are a promising tool in the search for new and tunable optical components. Liquid crystals, in particular, combine reconfigurability, unique optical properties and the possibility of controlling their self-assembly through manipulation of the bounding surfaces. Smectic-A liquid crystals under different boundary conditions create structures that can be used for optical applications, such as microlens arrays made of focal conic domains or fibers in an aqueous solution which can be used as lightguides.

# 4 LC Physics

**Date:** Aug. 29, 2017 (Tuesday)
**Time:** 09:00~10:30
**Session Chair:** Prof. Dong Ki Yoon (KAIST, Korea)

## D4-3 09:50~10:15

### Invited Self-Organized Wrinkling Patterns of a Liquid Crystalline Polymer

*Jun-Hee Na, Jaehyun Sim, Sihwa Oh, Ye-Rin Lee, Yena Lee, and Geonwoo Ko (Chungnam Nat'l Univ., Korea)*

A variety of surface wrinkling and creasing patterns in thin films have attracted much attention from the viewpoints of the fundamental mechanism for the pattern formation as well as the advancement of bottom-up technology. Here, we first describe the fundamental mechanism for self-organized wrinkling in ultraviolet (UV)-cured liquid crystalline polymer films and then demonstrate the single-step fabrication of wrinkling patterns with high fidelity in a well-controlled manner.

## D4-4 10:15~10:30

### Influence of Mobile Ions on Liquid Crystal Behavior in PSVA

*Nakcho Choi, Jonghak Hwang, Dongil Yoo, Youngwoo Lee, Yeogeon Yoon, and Joonhoo Choi (Samsung Display Co., Ltd., Korea)*

In this paper, we made this hypothesis verification by 3D simulation and experiments. In Fig 1, we showed how mobile ions affect the fringe field and the movement of liquid crystals when the voltage is applied between top and bottom electrodes. This is thought as a reason of the distortion of liquid crystals. Also we confirmed the panel transmittances measurement curve over time in two kinds of states. One is normal panel and the other panel has mobile ions under pixel electrodes. As the ions slowly collect in space between electrodes during applying voltage, the transmittance was reduced as according to time in Fig 2.

## 5 2D Materials for Display Ⅰ

**Date:** Aug. 29, 2017 (Tuesday)
**Time:** 09:00~10:35
**Session Chairs:** Dr. Jaehyun Moon (ETRI, Korea)
Prof. Chul-Ho Lee (Korea Univ, Korea).

### E5-1 09:00~09:25

**Invited** **Heterojunctions for Atomically Thin 2D Semiconductors based on Two-Dimensional Transition Metal Dichalcogenides**

*Kazuhito Tsukagoshi (NIMS, Japan)*

We demonstrate homogeneous surface oxidation of atomically thin $WSe_2$ with a self-limiting thickness from single- to trilayers. Exposure to ozone ($O_3$) leads to the lateral growth of tungsten oxide selectively on $WSe_2$. With further $O_3$ exposure, the oxide regions coalesce and oxidation terminates leaving a uniform thickness oxide film. The oxide films formed on $WSe_2$ are nearly atomically flat.

### E5-2 09:25~09:40

**Improvement of Light Extraction Efficiency in Graphene Electrode OLEDs with the Light Extraction Layer**

*Jin-Wook Shin, Hyunsu Cho, Jonghee Lee, Jaehyun Moon, Jun-Han Han, Doo-Hee Cho, Byoung-Hwa Kwon, Jeong-Ik Lee (ETRI, Korea), Kisoo Kim, Seungmin Cho (Hanwha Techwin R&D Center, Korea), Maki Suemitsu (Tohoku Univ., Japan), and Nam Sung Cho (ETRI, Korea)*

In this work, as an effort to improve the light extraction efficiency of graphene-OLEDs, we have applied the scattering layer, which can extract the light trapped in the device due to wave-guided modes. By applying our structure, the external quantum efficiency (EQE) of the graphene-OLED was improved by 34 %. By combining the scattering layer and external light extraction method, it was possible to achieve remarkable enhancement of 110% in the EQE. We will report the derimental effect of absoprtion taking place in the graphene layer and suggest a technical method to minimize its effect. In summary, we will present a stable light extraction method for graphene anode OLEDs, which might improve their performance comparable to existing conventional OLEDs.

# 5 2D Materials for Display Ⅰ

**Date:** Aug. 29, 2017 (Tuesday)
**Time:** 09:00~10:35
**Session Chairs:** Dr. Jaehyun Moon (ETRI, Korea)
Prof. Chul-Ho Lee (Korea Univ, Korea).

E5-3 09:40~09:55

## Atomic Layer Deposition of Pure 2-D SnS Thin Films

*In-Hwan Baek, Jung Joon Pyeon (KIST, Korea), Taek-Mo Chung, Jeong Hwan Han (KRICT, Korea), Cheol Seong Hwang (Seoul Nat'l Univ., Korea), and Seong Keun Kim (KIST, Korea)*

We demonstrate a successful synthesis of single phase and impurity-free p-type SnS thin films using an ALD technique at a low temperature (< 240 ˚C). The use of a Sn precursor with an oxidation state of +2, bis(1-dimethhylamino-2-methyl-2propoxy)tin(II), enabled the synthesis of single phase SnS(II) thin films at a wide temperature range of 90 ℃ - 240 ℃. The SnS grain size increased with increasing the growth temperature. It was also found out that the SnS van der Waals interlayers were well aligned in parallel to the substrate at 240 ℃. Impurities such as carbon, oxygen, and nitrogen were negligibly detected in the SnS(II) films and other phases such as $Sn_2S_3$ and $SnS_2$ are not incorporated. Furthermore, we investigated the feasibility of the SnS(II) thin films grown by ALD the properties as a functional material in emerging devices such as thin film transistors and gas sensors.

E5-4 09:55~10:10

## Structural Coloration of Graphene Oxide Liquid Crystals in Binary Mixtures

*Thilini. K. Ekanayaka and Jang-Kun Song (Sungkyunkwan Univ., Korea)*

Graphene Oxide(GO) is a single layered, 2- dimensional carbon material which can form a stable dispersion in water with spontaneous nematic assembly. GO particles can also disperse in a few other polar and non-polar solvents. Although some organic solvents such as N-methyl-2-pyrrolidone (NMP) and dimethylformamide (DMF) are known to have good GO dispersity, no results have been reported regarding the photonic crystal GO dispersions in these organic solvents. Here we report the structural color variation in GO dispersions in binary mixtures of deionized water and three organic solvents such as 1,4-dioxane, NMP, and DMF. The GO dispersions in the binary mixtures show better color purity than those in pure aqueous GO and exhibit the structural color in the entire range of visible wavelengths and exhibited reasonably good electro-optical switching performance providing a good pathway for developing reflection type display device using GO dispersions in binary organic solvents.

## 5 2D Materials for Display Ⅰ

**Date:** Aug. 29, 2017 (Tuesday)
**Time:** 09:00~10:35
**Session Chairs:** Dr. Jaehyun Moon (ETRI, Korea)
Prof. Chul-Ho Lee (Korea Univ, Korea).

**E5-5** 10:10~10:35

### Invited Single Crystalline Nanobelts Composed of Transition Metal Dichalcogenides

*Soon-Yong Kwon (UNIST, Korea)*

Following the celebrated discovery of graphene, considerable attention has been directed towards the rich spectrum of properties offered by van der Waals crystals. However, studies have been largely limited to their two-dimensional (2D) properties, due to lack of 1D structures. Here, we report the growth of high-yield, single-crystalline 1D nanobelts composed of transition metal ditellurides at low temperatures (T~500°C) and in short reaction times (t £ 10 min) via the use of tellurium-rich eutectic metal alloys. The synthesized semimetallic 1D products are highly pure, stoichiometric, structurally uniform, and free of defects, resulting in high electrical performances. Furthermore, complete compositional tuning of the ternary ditelluride nanobelts is achieved with suppressed phase separation, applicable to the creation of unprecedented low-D materials/devices. This approach may be used as a general strategy for fabricating 1D layered nanostructures and is truly exciting opportunity that can lead to dozens of new 1D nanomaterials of electronic quality.

# 6 Computational Methods for 3D Display

**Date:** Aug. 29, 2017 (Tuesday)
**Time:** 09:00~10:30
**Session Chair:** Dr. Joohwan Kim (Nvidia, USA)

## F6-1 09:00~09:25

### Invited Differences between 3D Displays based on Wavefront Reconstruction and Ray Reconstruction

*Yasuhiro Takaki (Tokyo Univ. of Agriculture and Tech., Japan)*

Holography produces three-dimensional (3D) images based on wavefront reconstruction. In contrast, other 3Ddisplay techniques, such as integral imaging, multi-view displays, and light-field displays, produce 3D imagesbased on ray reconstruction. To solve the vergence? accommodation conflict that causes visual fatigue, sharp 3Dimages on which eyes can focus should be produced in 3D space. In this presentation, the generation of 3D images with blurring less than 0.10 mm is considered using the two reconstruction techniques.

## F6-2 09:25~09:50

### Invited Characteristics of Integral Photography Generated from Multi-View Stereoscopic Images

*Sumio Yano, Yuta katayose (Shimane Univ., Japan), and Min-Chul Park (KIST, Korea)*

Multi-view stereoscopic images were adapted to the generation of the integral photography (hereby IP). The optical axes of the pick-up cameras are focused on a fixation point in the front of cameras. In this method, when the objects were set in the area around the fixation point, the corresponding objects were displayed in the area around the display screen. However, setting the fixation point conduces to the cross-captured multi-view stereoscopic images. There is a possibility that the depth distortion is displayed in this IP. The displayed depth information produced from this IP generation method was calculatedly examined using pick-up and display model. The calculation results suggested the linearity change of depth distance was affirmed around in the front or back from the display screen.

# 6 Computational Methods for 3D Display

**Date:** Aug. 29, 2017 (Tuesday)
**Time:** 09:00~10:30
**Session Chair:** Dr. Joohwan Kim (Nvidia, USA)

F6-3 09:50~10:15

## Merck Award See-through 3D Display for Augmented Reality

*Byoungho Lee (Seoul Nat'l Univ., Korea)*

See-through 3D display has been developed with the virtue of rapid progress in computational and optical technologies. Recently, several methodologies to provide realistic and immersive 3D experience are emerging such as multi-plane displays, computational layered displays, and retinal scanning displays. Also, novel optical elements are introduced to implement see-through 3D displays for augmented reality such as holographic optical elements and index-matched anisotropy crystal lens. In this talk, I will demonstrate see-through 3D displays that combine multi-plane displays with either holographic optical elements or index-matched anisotropy crystal lens. These systems are competitive candidates for see-through head-mounted displays as having large field of view, compact form factor, and high definition of floated images. Our researches also include holographic displays, retinal scanning displays, and light field displays which may contribute realization of see-through 3D displays. In conclusion, experimental results and conceptual prototypes are presented.

F6-4 10:15~10:30

## Digital Holographic Head-Mounted Display based on the Macro-Pixel

*Sungjin Lim, Muguen Kim (Kyungpook Nat'l Univ., Korea), Hwi Kim (Korea Univ., Korea), and Joonku Hahn (Kyungpook Nat'l Univ., Korea)*

The holographic display has been considered the most ultimate display since it reconstructs desirable wave-fronts of object wave and solves the three-dimensional(3D) sickness. But, the holographic display is still practically imperfect owing to some significant problems. First of all, one significant problem is the size of data capacity. The more data capacity is additionally required for extending the viewing angle and the screen size simultaneously. We proposed a method which reduces pixels with small computations burden for reconstructing hologram by devising the macro-pixel with locally coherence and using micro-optics. In this idea, it is possible to expand the viewing angle in comparison of traditional methods. Our method has an advantage to construct a slim holographic system in comparison to existing systems because of using micro optics. In this paper, we realize the digital holographic head-mounted display.

# 7 Touch and Interactive Displays

**Date:** Aug. 29, 2017 (Tuesday)
**Time:** 09:00~10:25
**Session Chair:** Dr. Seong-Deok Ahn (ETRI, Korea)

## G7-1 09:00~09:25

### Invited Optically Clear Adhesives Enabling Flexible and Foldable OLED Display Bonding

*C. J. Campbell, Y. Zhang, and J.E. Abrahamson (3M, USA)*

Optically clear adhesives (OCA) have been used for more than a decade to bond rigid LCD and AMOLED displays for consumer electronics applications, offering optical, mechanical and electrical performance benefits. The performance requirements of an OCA to bond cover window, touch sensors, and circular polarizers in a plastic OLED display to bent coverglass or a flexible, foldable OLED display are drastically different from a flat, rigid device.

## G7-2 09:25~09:40

### Localized Haptic Feedback on Flexible PMOLED Display for Mechanical Button Replacement

*Mesut G. Eraslan and Mukulvarma Penmatcha (Flex Innovation Labs, USA)*

Keeping drivers' eyes on the road while interacting with touchscreens has been challenging, as touchscreens do not provide accurate haptic feedback when icons are pushed. We invented a technique where we integrate piezo haptic discs behind a flexible thin OLED display. Our technique allows localized haptic feedback on every icon or menu touch interaction. The flexible and thin display efficiently transfers the button-like haptic feedback to the tip of the finger at the place of the icon or the menu. 3mm thin form factor eliminates centimeters of volume required for mechanical buttons, hence allowing such display modules to be used in new volume limited locations. Customization of the display menus allow re-use of the same hardware module in multiple locations, hence creating economies of scale in automobile manufacturing.

## 7 Touch and Interactive Displays

**Date:** Aug. 29, 2017 (Tuesday)
**Time:** 09:00~10:25
**Session Chair:** Dr. Seong-Deok Ahn (ETRI, Korea)

### G7-3 09:40~09:55

### Organic Light Emitting Board for Direct Visualization

*Eui Hyuk Kim, SeungWon Lee, Hyowon Han, and Cheolmin Park (Yonsei Univ., Korea)*

Interactive displays involve the interfacing of a stimuli-responsive sensor with a visual human-readable response. Here, we describe a polymeric electroluminescence-based stimuli-responsive display method that simultaneously detects external stimuli and visualizes the stimulant object. This organic light-emitting board is capable of both sensing and direct visualization of a variety of conductive information. Simultaneous sensing and visualization of the conductive substance is achieved when the conductive object is coupled with the light emissive material layer upon application of alternating current. A variety of conductive materials can be detected regardless of their work functions, and thus information written by a conductive pen is clearly visualized, as is a human fingerprint with natural conductivity. Furthermore, we demonstrate that integration of the organic light-emitting board with a fluidic channel readily allows for dynamic monitoring of metallic liquid flow through the channel, which may be suitable for biological detection and imaging applications.

### G7-4 09:55~10:10

### Overlaid Dielectric Layer with High-k Materials in High Resolution Flexible Fingerprint Sensor

*Seunghee Lee, Guk-Jin Jeon, Yong ho Kim, Byeong-Soo Bae (KAIST, Korea), Paul Yoon, Daniel Ahn (Shinsung C&T, Korea), and Sang-Hee Ko Park (KAIST, Korea)*

To strengthen security, we use authentication of fingerprint for confirmation of identity in mobile phone. The principle of capacitive fingerprint sensor is the measurement of the capacitance difference in the capacitor generated between touch electrode and finger. In this study, we present overlaid dielectric layer to enhance change of capacitance value between ridge and valley for flexible high resolution fingerprint sensing. The overlaid dielectric layer consists of a high dielectric layer and a flexible hard coating layer (Flex9H®, Solip Tech Co., Ltd). The high-k thin layer laminated with $TiO_2/Al_2O_3$ is necessary to increase sensing sensitivity by complementing capacitance of the overlaid dielectric layer, because the hard coating layer has a relatively low dielectric constant compared with reinforced glass. This thinner overlaid layer increases not only the difference of capacitance but also flexibility of the device. The material design of overlaid dielectric layer in fingerprint sensor will provide practical flexible identification system.

# 7 Touch and Interactive Displays

**Date:** Aug. 29, 2017 (Tuesday)
**Time:** 09:00~10:25
**Session Chair:** Dr. Seong-Deok Ahn (ETRI, Korea)

## G7-5 10:10~10:25

### A Photosensitive Transparent a-IGZO Diode with High Rectifying Ratio

*Myeong-ho Kim and Duck-kyun Choi (Hanyang Univ., Korea)*

In this study, we introduce a new concept transparent oxide diode that has high rectifying ratio and low leakage current compared with previously reported oxide diodes such as oxide p-n junction and metal-semiconductor (MS) schottky diode. The oxide diode has a metal-semiconductor-insulator-metal (MSIM) stacking structure, which is similar to bottom gate structure of oxide TFT [2]. For this reason, the oxide diode could be easily applied in active matrix(AM) display back-plane as in-cell photo sensors. The in-cell photo sensors have a merit in terms of reduction of process cost and RC delay compared with out-cell photo sensors [3]. The electrical characteristics of the oxide diode are on-current density of $10^{0}$ - $10^{-1}$ A/cm$^2$, off-current density of $10^{-9}$ - $10^{-10}$ A/cm$^2$, ideality factor of 2.53, and high rectifying ratio of $10^{8}$ - $10^{9}$. Also, the oxide diode has a dark/bright current ratio of ~$10^{9}$ and ~$10^{4}$ at reverse bias region under ultra-violet (UV) and visible light, respectively.

# 8 Novel Materials for Deformable Electronic

**Date:** Aug. 29, 2017 (Tuesday)
**Time:** 09:00~10:05
**Session Chair:** Prof. Seong Jun Kang (Kyung Hee Univ., Korea)

## H8-1 09:00~09:25

### Invited Biocompatible Transparent Flexible Substrate Film from Biogenic Chitin Nanofibers

*Jungho Jin (Univ. of Ulsan, Korea) and Byeong-Soo Bae (KAIST, Korea)*

Herein, we introduce a novel transparent, biocompatible substrate film made of biogenic structural polysaccharide, chitin, and demonstrate its potential as substrate film for flexible electronics. Chitin is the 2$^{nd}$ most abundant bipolymer on earth only after cellulose, and can be sourced plentifully from exoskeletons of arthropods (crab, shrimp, insect) and cephalopods (squid pen and beak). In nature, biogenic chitin occurs as supramolecular semicrystalline nanofiber (3-5 nm in diameter) which is highly biocompatible and mechanically robust (E~150GPa), making it a promising building-block for biocompatible flexible substrate film. In this work, we report on the fabrication of the chitin nanofiber substrate film along with its basic properties compared to some commercial plastic films. Using the chitin film as substrate film, we also demonstrate typical displays and electronic devices such as OLED, touch screen panel, and perovskite solar cells.

## H8-2 09:25~09:50

### Invited Stretchable Flexible and Self-healable Electronics

*Lu Li (CUAS/UCLA, China/USA), Jiang Cheng (CUAS, China), Jiajie Liang (UCLA, USA), and Qibing Pei (CUAS/UCLA, China/USA)*

I will introduce a solution processed flexible polymer nanocomposite conductor to replace ITO/glass for the fabrication of high-efficiency PLEDs. The nanocomposite comprises a layer of single-walled carbon nanotubes (SWNT) and a layer of silver nanowires (AgNWs) embedded in the surface of a barium strontium titanate (BST) nanoparticle-polymer nanocomposite. The SWNT layer on the outer layer of the nanocomposite interfaces with the polymer semiconductor layer(s) to smoothen the surface roughness and to increase the conductive surface coverage, while the AgNW layer underneath the SWNT provides long range electrical conductivity. The BST nanoparticles embedded in the polymer substrate disrupt the substrate mode of trapped light. Finite-difference time-domain (FDTD) simulation indicates that the enhancement factor of the nanocomposite electrode as compared ITO/glass could be as high as 361%. The experimentally obtained enhancement factors are 246% and 224% for green and white PLEDs, respectively, comparing the nanocomposite substrate to ITO/glass substrate. The maximum external quantum efficiency of solution- processed green and white PLEDs are 38.9% and 30.5%, respectively. Furthermore, these PLEDs are highly flexible and can be bent to 3 mm radius.

# 8 Novel Materials for Deformable Electronic

**Date:** Aug. 29, 2017 (Tuesday)
**Time:** 09:00~10:05
**Session Chair:** Prof. Seong Jun Kang (Kyung Hee Univ., Korea)

H8-3 09:50~10:05

## Smart Contact Lens Sensor for Wireless Ocular Diagnostics

*Joohee Kim and Jang-Ung Park (UNIST, Korea)*

Wearable electronics which can detect physiological changes noninvasively with function of wireless transmission have attracted substantial interests. Especially, many efforts have been made to develop a smart contact lens that can detect tear fluids and diagnose the disease. However, previously reported contact lens sensors can only monitor a single analyte at a time. Furthermore, electronics on soft contact lenses pose demanding challenges because the system requires reliability upon repeated eye-blinks, flexibility, stretchability and optical transparency for unobstructed vision. Here, we presented a transparent and stretchable, multifunctional sensors on real soft contact lenses for the wireless detection of glucose and intraocular pressure. By integrating the components into a resistance, inductance and capacitance circuit operating at a radio frequency, we demonstrate real-time *in-vivo* glucose detection on a rabbit eye and *in-vitro* monitoring of intraocular pressure of a bovine eyeball wirelessly.

# 9 Quantum Dot for Down Conversion Display Ⅰ

**Date:** Aug. 29, 2017 (Tuesday)
**Time:** 11:00~12:30
**Session Chairs:** Prof. Heesun Yang (Hongik Univ., Korea)
Dr. Wan Ki Bae (KIST, Korea)

## A9-1 11:00~11:25

### Invited Cd Free Quantum Dot Display

*Shinae Jun and Eunjoo Jang (Samsung Electronics Co., Ltd. , Korea)*

Now display technology is heading to give reality-like experience, like give a feeling as if we are watching a real object simply through window, not watching a display. Therefore, since around 2010, there have been continuous increases in the demand for large sized display products with higher resolution. Nowadays, UHD (Ultra High Definition), which is also called as 4K, is a new standard resolution of large sized display over 55 inch size. To give a more cinematic and immersive experience, TV size is increasing up to 110” and the curved design is also suggested to provide wider field view. These displays approach the limits of human perception in resolution and produce more than enough luminance in most cases. Differentiation strategy is now wide color gamut display bringing high color reproducibility.

## A9-2 11:25~11:50

### Invited Near Unity Quantum Yield from Cadmium-Free Quantum Dots

*Matthew R. Bergren, Karthik Ramasamy, Nikolay Makarov, Aaron Jackson, and Hunter McDaniel (UbiQD, USA)*

UbiQD, LLC a New Mexico-based quantum dot manufacturer, has achieved greater than 80% quantum yield, some near-unity, for its quantum dots (QDs) over a broad spectrum, from the visible to the near infra-red (550 nm to 1000 nm peak emission). The company also manufactures QDs with peak emissions further out into the near infra-red, but typically with QYs < 70%. The quantum yields achieved at UbiQD are comparable to the best cadmium-containing nanomaterials that currently exist, which positively impacts all QD applications including lighting, displays, security, biotechnology, and design. While there are many potential markets for UbiQD's patented technology, the company's primary focus is enabling windows to generate electricity using products known as luminescent solar concentrators. In this talk, the above technologies that are enabled by the high optical performance QDs manufactured by UbiQD will be discussed, as well as updates on recent R&D progress in these areas.

## 9 Quantum Dot for Down Conversion Display Ⅰ

**Date:** Aug. 29, 2017 (Tuesday)
**Time:** 11:00~12:30
**Session Chairs:** Prof. Heesun Yang (Hongik Univ., Korea)
Dr. Wan Ki Bae (KIST, Korea)

### A9-3 11:50~12:15

### Invited Innovation in Heavy Metal-Free Quantum Dot Display Technology

*Nigel L. Pickett and Nathalie C. Gresty (Nanoco Technologies Ltd., UK)*

Since the advent of quantum dot (QD) displays onto the consumer electronics market in 2013, continuing efforts have been made to improve their performance in terms of efficiency and colour gamut, while also extending the range of products to which the technology can be applied. The first displays to enter the market contained cadmium-based QDs, but sales have since been overtaken by cadmium-free QD displays, which captured almost two thirds of the market in 2015, a figure that is predicted to continue to rise. Herein, we report on the development of QDs free of cadmium and other toxic heavy metals, and associated technologies, for display and other applications.

### A9-4 12:15~12:30

### MolecuLED$^{TM}$: Organic based Down-Conversion Technology

*Daniel Szwarcman (StoreDot Ltd., Israel)*

MolecuLED$^{TM}$ technology which is fully organic is a color conversion layer that provides wide-color-gamut. The production process is simple and also very attractive with its cost offering which is merely 10% of the QD competing technology. The main drawback of organic fluorescent molecules is the sensitivity of their excited state to chemical and physical alterations that lead to degradation or photo-bleaching of the molecule. By manipulating the molecular structure of each active molecule together with the tailored embedment matrix, the properties of these molecules are tunable to optimize the HOMO-LOMO parameters of the emitting layer. The ability to optimize the molecular structure enables to tune not only the RGB color peaks, but also the FWHM, PLQY and photostability parameters.We also show the feasibility of incorporation of MolecuLED film within a modified LCD panel structure to enable high flux photostability adequate for HDR content.

# 10 OLED Material II

**Date:** Aug. 29, 2017 (Tuesday)
**Time:** 11:00~12:40
**Session Chairs:** Prof. Hui Xu (Heilongjiang Univ., China)
Prof. Ken-Tsung Wong (Nat'l Taiwan Univ., Taiwan)

## B10-1 11:00~11:25

### Invited Organic Radical for High Performance OLEDs

*Zhengyang Bin and Lian Duan (Tsinghua Univ., China)*

Balaned charge injection and transport are essential for high performance organic light-emitting diodes (OLEDs). Here, thermally decomposable precursors of organic radicals have been employed as n-type dopants in OLEDs, because of their air stability, low decomposition temperature, and eliminated atom diffusion. A series of 1,3-dimethyl-2-phenyl-2,3-dihydro-1H-benzoimidazole derivatives have been designed and synthesized and their electron donating properties can be tuned by varing the number of methoxy moieties. Highly efficient and stable OLEDs are fabricated using the organic radicals as n-type dopants, showing an incredible boom in both current efficiency and lifetime. The enhanced efficiency and stability are attributed to the improved balance of holes and electrons in the emissive layer, and also the eliminated diffusion of metal atoms such as cesium.

## B10-2 11:25~11:50

### Invited Computer-Assisted Material Design Toward Highly Efficient Dry and Wet Processed OLEDs and Multiscale Charge Transport Simulations

*Hironori Kaji (Kyoto Univ., JAPAN)*

In the presentation, we will show highly efficient OLEDs containing our recently-developed thermally activated delayed fluorescence (TADF) materials. A TADF material, named DACT-II, allows all the electrically excited triplet excitons to be converted into singlet excitons by reverse intersystem crossing. In addition, DACT-II shows very high photoluminescence quantum yield of 100%. These properties enable us to fabricate excellent OLEDs with internal quantum efficiencies of 100%. DACT-II has additional advantages as an emitter for OLEDs, including small efficiency roll-off, high thermal stability, molecular orientation favorable for effective light out-coupling, and high performance over a wide temperature range. Results on boron-containing emitters, solution-processable emitters, and host-free solution-processable emitters are also described. We also show our recent studies on multiscale charge transport simulations. The calculations are performed by explicitly considering organic molecules, which allow detailed molecular level analysis. The multiscale calculations well reproduce experimental charge mobilities in amorphous organic thin films without using any adjustable parameters.

# 10 OLED Material II

**Date:** Aug. 29, 2017 (Tuesday)
**Time:** 11:00~12:40
**Session Chairs:** Prof. Hui Xu (Heilongjiang Univ., China)
Prof. Ken-Tsung Wong (Nat'l Taiwan Univ., Taiwan)

## B10-3 11:50~12:15

### Invited Development of Highly Efficient Multi-Functional Emitting Materials for Organic Light-Emitting Diode Applications

*Sung-Ho Jin (Pusan Nat'l Univ., Korea)*

We have been synthesized the various colors of phosphorescent Ir(III) complexes for phosphorescent organic light-emitting diodes (PhOLEDs) applications. A new series of highly efficient deep-blue phosphorescent Ir(III) complexes, $(F_2CH_3ppy)_2Ir$(pic-N-oxide) and $(F_2CF_3CH_3ppy)_2Ir$(pic-N-oxide), based on phenylpyridine (ppy) as the main ligand and picolinic acid N-oxide (pic-N-oxide) as the ancillary ligand, were synthesized for applications in PhOLEDs. High performance PhOLEDs showed bright deep blue emissions with the CIE coordinates of (0.147, 0.210) and high external quantum (23.3%) and current (36.1 cd/A) efficiencies. Recently, we reported a highly efficient and soluble red-emitting tris(4-phenyl-2-(thiophen-2-yl) quinoline)iridium(III) complex, $(Th\text{-}PQ)_3Ir$, that was designed and successfully synthesized for use in solution-processed PhOLED. Upon replacing the benzene in the cyclometalated phenylquinoline main ligand by thiophene shifts PL emission to red and enhances thermal stability. PhOLED with $(Th\text{-}PQ)_3Ir$ was successfully fabricated with a GraHIL as high work function HIL and a mixed host EML, which is composed of electron and hole transporting host materials (TCTA, TPBI). Using this simple structure, we achieved a PhOLED with very high luminous current efficiency of ~ 26 cd/A and EQE of ~ 21% with good CIE coordinates (0.64, 0.34).

## B10-4 12:15~12:40

### Invited The Advantage of Silicone Chemistry in Next Generation Displays

*Sunny Yu (Momentive, Korea)*

Momentive Performance Materials (MPM) Inc. is a global leader in silicones and advanced materials, with a 75-year heritage of being first to market with performance applications for major industries that support and improve everyday life. We deliver science-based solutions by linking custom technology platforms to opportunities for customers. Recently, silicone material is getting more important in display industry due to their inherent features like very good thermal stability, high transparency, excellent reliability, easy process-ability and high flexibility.

# 11 Nano Materials for Backplane II

**Date:** Aug. 29, 2017 (Tuesday)
**Time:** 11:00~12:30
**Session Chairs:** Prof. Taishi Takenobu (Nagoya Univ., Japan)
Prof. Mohammad Khaja Nazeeruddin
(École Polytechnique Fédérale de Lausanne, Switzerland)

## C11-1 11:00~11:25

### Invited Aerosol-Jet Printing of Sorted Semiconducting Carbon Nanotubes for Field-Effect Transistors

*Jana Zaumseil (Universität Heidelberg, Germany)*

Networks of semiconducting single-walled carbon nanotubes (s-SWCNTs) are a promising material for future printed and flexible electronics due to their high carrier mobilities, stretchability and transparency. Highly purified dispersions of long (>1 μm) s-SWCNT are a prerequisite for large-scale printing of nanotube networks and have become available through polymer-wrapping with shear-force -mixing. Here we present aerosol-jet printed networks of (6,5) SWCNTs as the semiconducting layer in field-effect transistors and demonstrate highly reproducible device characteristics even after long printing cycles. The network transistors exhibit high on/off current ratios (up to $10^8$) and mobilities of up to 6 $cm^2\ V^{-1}s^{-1}$.

## C11-2 11:25~11:50

### Invited Electrical Contact Analysis of Multilayer $MoS_2$ Thin Film Transistor

*Min Suk Oh (KETI , Korea)*

We demonstrate a two-dimensional (2D) multilayered molybdenum disulfide ($MoS_2$) transistor with molybdenum (Mo) side and edge contacts, which is deposited using a dc-sputtering method. It exhibits field-effect mobility of 23.9 $cm^2/Vs$ and ON/OFF ratio of $10^6$ in a linear region. A current–voltage study under different temperatures (300–393 K) reveals that the Mo–$MoS_2$ transistor shows a band transport characteristics, and a Schottky barrier height of 0.14 eV is estimated using a thermionic emission theory. Finally, the side and edge contacts of Mo–$MoS_2$ are confirmed through the transmission electron microscope analysis. Our results not only show that Mo can be an alternative contact metal to other low work-function metals but also that the edge contact may play an important role in resolving the performance degradation over thickness increase of the $MoS_2$ channel layer.

# 11 Nano Materials for Backplane II

**Date:** Aug. 29, 2017 (Tuesday)
**Time:** 11:00~12:30
**Session Chairs:** Prof. Taishi Takenobu (Nagoya Univ., Japan)
Prof. Mohammad Khaja Nazeeruddin
(École Polytechnique Fédérale de Lausanne, Switzerland)

## C11-3 11:50~12:15

### Invited Considerations for Large-Area Flexible Displays from Thin-Film to Nano-Scale Devices

*William Wong (Univ. of Waterloo, Canada)*

Conventional monolithic integration methods are reaching a practical limit for large-area electronics where miniaturization is not the major constraint for scaling the technology. This platform may benefit more from heterogeneous integration as a means to enhance micro- and nano-system functionality. Examples of enhanced micro-system functionality will be given using novel approaches to materials and device integration employing ink-jet printing of thin-film transistors (TFTs). An overview of novel printing approaches to fabricate TFTs on flexible polymeric substrates for displays and image sensor applications will be presented. The effect of low-temperature processing will be discussed along with long-term device stability of organic and inorganic semiconductor TFTs under both electrical bias and mechanical strain. Finally, a comparison of the advantages and disadvantages between organic/polymeric and Si-based semiconductor devices on flexible platforms will be reviewed.

## C11-4 12:15~12:30

### Improvement in a-Si:H TFT Properties for Novel Tail Reduced 4-Mask Process of G8.5 LCDs

*Xiao Di Liu, Xiang Yong Kong, Su Chang I, Jian Xin Xie, Mian Zeng, Wen Ying Li, Li Mei Zeng, Yi Feng Yang, Dong Luo, Cong Wei Liao, Yi Fang Chou, and CHIA YU LEE (Shenzhen China Star Optoelectronics Tech. Co., Ltd., China)*

Silicon nitride gate insulator structure and component is investigated for improving the TFT properties manufactured in the novel 4-Mask process architecture for LCD TV display to decrease the side effect of the $O_2$ ashing process. The average TFT electrical properties in 13 point over G8.5 glass indicated that the highest Ion (112.4%), the lowest Ioff (109.3%) were attained and kept the bias stress unchanged.

# 12 LC Chemistry

**Date:** Aug. 29, 2017 (Tuesday)
**Time:** 11:00~12:05
**Session Chair:** Prof. Corrie T. Imrie (Univ. of Aberdeen., UK)

## D12-1 11:00~11:25

### Invited Novel Alignment Layer and Insulation Materials for Advanced LCD

*Hiroaki Tokuhisa (JSR Corp., Japan)*

The novel materials for advanced LCD are summarized in terms of the required properties especially for TV, mobike and etc. The required properties such as high transmittance and high resolution are reviewd from the view point of new materials of alighnment layer. On the other hand, not only for the display properties, display should show the development in terms of its production. The required properties in the materials to accomplish the tolerant production are high through put and low temperature cure process. In this presentation, alignment layer technique for high transmittance, high resolution and low temperature process is proposed. On the other hand, novel insulation materials are proposed for high transmittance, high resolution and high througput process.

## D12-2 11:25~11:50

### Invited Development of a Novel High Reactive and High Reliable Monomer for Polymer-Sustained-Alignment Liquid Crystal Displays

*Yuichi Inoue, Marina Gushiken, Go Sudo, Shota Kosaka, Masanao Hayashi, Kenta Shimizu, and Manabu Takachi (DIC Corp., Japan)*

We have developed a novel high reactive and high reliable monomer for Polymer-Sustained-Alignment Liquid Crystal Displays. And, also we found UV irradiation condition has huge impact on Image Sticking issue, so we have developed the optimal UV condition for high reliable LCD too.

## 12 LC Chemistry

**Date:** Aug. 29, 2017 (Tuesday)
**Time:** 11:00~12:05
**Session Chair:** Prof. Corrie T. Imrie (Univ. of Aberdeen., UK)

D12-3 11:50~12:05

### Doping of High-Birefringence Liquid Crystal for High Haze in a Cholesteric Liquid Crystal Cell

*Jae-Won Huh, Young-Seo Jo, Jin-Hun Kim, Seong-Min Ji (Pusan Nat'l Univ., Korea), Young Beom Seo, Jae-Won Ka, Jinsoo Kim (KRICT, Korea), and Tae-Hoon Yoon (Pusan Nat'l Univ., Korea)*

Cholesteric liquid crystal devices have been actively studied for various applications, such as reflective displays and smart windows. For smart window applications, we can use the focal-conic state. In the focal-conic state, the objects behind can be hidden by control the haze with randomly oriented helical structures which scatter the incident light. In this work, we propose a smart window using cholesteric liquid crystals doped with high birefringence liquid crystal materials. For a high haze in the focal-conic state, we mixed cholesteric liquid crystals with a high birefringence liquid crystal material. The fabricated cholesteric liquid crystals cell exhibits a haze value of 79.7 % much higher than that of a cholesteric liquid crystals cell without doping high birefringence liquid crystal material of 68.6 %.

## Poster Session I

- **Date:** August 29 (Tue.), 2017
- **Time:** 14:00 ~ 15:30
- **Location:** # 301, Convention Hall, BEXCO

*** Each paper's code will be shown on the board and tapes will be provided in the poster presentation area. All presenters are required to preside at their poster panels during the session for discussion with participants.**

| Place: # 301, BEXCO | Poster I |
|---|---|
| Put-up Time | 08:00~12:00, Aug, 29 (Tue.), 2017 |
| Presentation Time | 14:00~15:30, Aug, 29 (Tue.), 2017 |
| Take-down Time | 16:00~17:30, Aug. 29 (Tue.), 2017 |

# 13 2D Materials for Display II

**Date:** Aug. 29, 2017 (Tuesday)
**Time:** 11:00~12:20
**Session Chairs:** Dr. Nam Sung Cho (ETRI, Korea)
Prof. Woong Choi (Kookmin Univ., Korea)

## E13-1 11:00~11:25

### Invited Recent Progress in Numerical Simulations for 2D-Material Device Applications

*Gyu Chull Han, AbdulAziz AlMutairi, Yiju Zhao, Demin Yin, and Youngki Yoon (Univ. of Waterloo, Canada)*

Investigating novel 2D material systems by means of modeling and simulation is of paramount importance, as the current understanding of 2D-materialdevices has been largely limited partially due to many barriers in direct experiments. Here we will discuss the state of the art in numerical simulations for 2D-material device applications. Several approximations to describe the electronic properties of layered materials shall be introduced and the trade-off will be analyzed. Using self-consistent quantum transport simulations based on non-equilibrium Green's function (NEGF) method, we investigate 2D semiconductors such as $MoS_2$, BP and GeH for different target applications: low-power and high-performance electronics, high-frequency applications as well as photodetectors. In addition, we will also discuss the design strategy for 2D material electronics, considering the number of layers.

## E13-2 11:25~11:50

### Invited Two-Dimensional van der Waals Heterostructures Based Ultrafast Light Source

*Young Duck Kim (Columbia Univ., USA), Takashi Taniguchi, Kenji Watanabe (NIMS, Japan), Tony F. Heinz (Stanford Univ., USA), Dirk Englund (MIT, USA), and James Hone (Columbia Univ., USA)*

Two-dimensional (2D) van der Waal materials such as graphene, hexagonal boron nitride (hBN), and tungsten diselenide ($WSe_2$) have attracted increasing attention for applications in advanced optoelectronics, due to their unique electrical and optical properties. Furthermore, each isolated van der Waals materials can be assembled to the heterostructures by precise layer by layer stacking, which allows the realization of artificial multifunctional materials. Here I will talk about the various 2D van der Waals heterostructures based electrically driven light source. They exhibit broad range radiation spectrum from visible to near-infrared and allows the radiation spectrum engineering by the strong light-matter interactions. Furthermore, ultrafast energy and charge transfer between van der Waals interface enable the light modulation up to GHz range. Atomically thin van der Waal heterostructure based light source will pave the way for the development of next-generation flexible and transparent display module and ultrafast on-chip optical interconnects.

## 13 2D Materials for Display II

**Date:** Aug. 29, 2017 (Tuesday)
**Time:** 11:00~12:20
**Session Chairs:** Dr. Nam Sung Cho (ETRI, Korea)
Prof. Woong Choi (Kookmin Univ., Korea)

### E13-3 11:50~12:05

### Gen 2 (370 mm x 470 mm) Sized Graphene Anode OLED

*Jaehyun Moon, Jun-Han Han, Jin-Wook Shin, Hyunsu Cho, Byoung-Hwa Kwon, Jeong-Ik Lee (ETRI, Korea), Nam Sung Cho (Hannwha Techwin R&D Center, Korea), and Seungmin Cho (ETRI, Korea)*

By combining advanced CVD graphene growth/transfer processes and display process technologies, we have realized fully functional Gen 2 (370 mm·470 mm) sized graphene anode OLEDs. Our result signifies the techinical feasibility of graphene as a commerically serviceable component in display and, in general, optoelectric devices. In this talk, we will address process issues, which have hurdled the realization of graphene OLED realization. In particular, we emphasize the importance of patterning graphene into dimensionally correct pixels without deteriorating their quality. Also, we present our integration scheme. Our result is a departure of graphene from laboratory scale researches and preludes the occurrence of system level commercial products in which graphene are used.

### E13-4 12:05~12:20

### Tunable Charge Transport of Graphene Electrode in Metal-Oxide Based Thin-Film Transistors

*Ick-Joon Park, Tae In Kim, Hongkeun Park, Sung Gap Im, and Sung-Yool Choi (KAIST, Korea)*

Graphene has great potentials[1-3] as a transparent conducting material for future electronics. Especially, tunable work function of graphene enables integration of graphene with electronic devices. To achieve high performance graphene-based devices, effective charge transport between graphene and semiconducting material is an important issue that is closely related to a modulation of the Schottky barrier (SB). Here, we investigated the tunable charge transport characteristics of metal-oxide based thin-film transistors (TFTs) with doped graphene electrodes. Alkali metal carbonates largely tuned the work function of graphene, leading to a significant change of SB in TFTs. In addition to extraction of electrical characteristics of the TFTs such as hysteresis, field-effect mobility, and contact property, LFN behavior was evaluated for investigating charge transport properties. This study opens up a new perception in which tunable charge transport properties in graphene-based electronic devices may become a general approach for achieving the high performance flexible and transparent displays.

# 14 3D & Holography (3DSA Joint Session)

**Date:** Aug. 29, 2017 (Tuesday)
**Time:** 11:00~12:25
**Session Chairs:** Dr. Kenji Yamamoto (NICT, Japan)
Prof. Nam Kim (Chungbuk Nat'l Univ., Korea)

## F14-1 11:00~11:25

### Invited Smoothness of Motion Parallax in High Density Muti-View (HDMV) 3D Display

*Hyunwoo Kim, Yongjoon Kwon, Seon Kyu Yoon, and Ki-Hyuk Yoon (KIST, Korea)*

Conventional muti-view type autostereoscopic 3D display has a problem of discrete motion parallax and jumping over effect. Therefore we define HDMV which gives natural motion parallax. And HDMV can expand to SMV area when we consider monocular depth cue. PC is position dependent crosstalk, therefore PC varies at each view-position at optimal viewing distance (OVD). Therefore distance between nearby viewpoints and position dependency of PC is important parameter for natural and smooth motion parallax. We introduce HDMV and average PC for smooth motion parallax.

*(3DSA Paper)*

## F14-2 11:25~11:40

### Full-Color Holographic Display Capable of Interactive Handling by Gesture Detection

*Shota Yamada, Takashi Kakue, Tomoyoshi Shimobaba, and Tomoyoshi Ito (Chiba Univ., Japan)*

This paper describes an interactive handling system of a full-color electro-holographic image in real-time by gesture detection. The system detects a touch gesture and switches between display and non-display of the red, green, or blue reconstructed image, depending on the touch position. To detect the touch gesture, we use Leap Motion which is a gesture detection device that specializes in motion detection of hands and fingers. In real-time handling, it was considered that the system has to be calculated at more than 30 fps. As a result, the system can display the full-color reconstructed image at more than 30 fps. Therefore, it was successfully demonstrated that the system could provide an interactive handling of full-color reconstructed images by the touch gesture.

*(3DSA Paper)*

# 14 3D & Holography (3DSA Joint Session)

**Date:** Aug. 29, 2017 (Tuesday)
**Time:** 11:00~12:25
**Session Chairs:** Dr. Kenji Yamamoto (NICT, Japan)
Prof. Nam Kim (Chungbuk Nat'l Univ., Korea)

## F14-3 11:40~11:55

### Floating Image System based on Holographic Optical Element

*Yu-Ming Weng, Wen-Kai Lin (Nat'l Changhua Univ. of Education, Taiwan), Bor-Shyh Lin (Nat'l Chiao Tung Univ., Taiwan), Wei-Chia Su, and Fu-Li Hsiao (Nat'l Changhua Univ. of Education, Taiwan)*

In this study, we have implmented a holographic floating image system by using a holographic optical element (HOE). In this system, the HOE is employed to replace the imaging lens and the combiner. The HOE recorded the wavefront of a spherical wave with a tilted reference planar wave. The HOE only works on the light from direction. Therefore, the floating image will be produced by the HOE and the system can provide the see-through characteristic. Finally, we presents a floating image composed of a LCD, a holographic film and a mirror to combine a smaller system which is easy to carry and have a simple optical imaging properties. The future can apply on 3D floating image design.

*(3DSA Paper)*

## F14-4 11:55~12:10

### Experimental Verification of Electronic Holography with a Random Mask

*Kouichi Nitta, Yuma Matsuda, Kazuki Yamasaki, Osamu Matoba (Kobe Univ., Japan), and Kyoji Matsushima (Kansai Univ., Japan)*

We have proposed a method for electronic holography. This method is effective to enlarge viewing angle for image reconstruction. In the proposed method, a half area of a pixel on the spatial light modulator (SLM) for phase modulation is covered with a mask in order to reduce size of the pixel. For the covering, a random mask is employed to avoid undesired signal due to higher order diffraction. this study, the proposed method is experimentally demonstrated. From experimental results, it is shown that the proposed method is effective to enlarge viewing angle.

*(3DSA Paper)*

## 14 3D & Holography (3DSA Joint Session)

**Date:** Aug. 29, 2017 (Tuesday)
**Time:** 11:00~12:25
**Session Chairs:** Dr. Kenji Yamamoto (NICT, Japan)
Prof. Nam Kim (Chungbuk Nat'l Univ., Korea)

**F14-5** 12:10~12:25

### Imaging Distance Reduction Using SLM/Mask Hetero-Structures

*Minho Choi, Hongki Park (Kyung Hee Univ., Korea), Kwan-Jung Oh, Hyon-Gon Choo, JinWoong Kim (ETRI, Korea), and Jaewu Choi (Kyung Hee Univ., Korea)*

In this research, we aim at developing the way to overcome the limit given by typical spatial light modulators (SLM) using the SLM/mask hetero-structure. The pitches of SLMs are often several ten times larger than the wavelength of visible light. Due to this, the diffraction properties of SLMs become very poor. To overcome this, we employed facilely manufacturable passive masks with small pitch compared to that of a SLM. Through this study, we find out a noble approach to increase the appreciable images and reduce the minimum image formation distance by using the masks.

*(3DSA Paper)*

**3DSA 2017**

**The 9th International Conference on 3D Systems and Applications held in conjunction with IMID 2017.**
**We would like to inform you that 3DSA program is Session 14, 22, 30, 38, 46, 54, 62.**

- **Venue: Convention Hall, BEXCO, Busan**
- **Place: Room F (Room 106-107)**
- **Date: Aug. 29 ~ 31, 2017**

# 15 Applied Vision / Human Factors

**Date:** Aug. 29, 2017 (Tuesday)
**Time:** 11:00~11:45
**Session Chair:** Prof. Mincheol Whang (Sangmyung Univ., Korea)

## G15-1 11:00~11:15

### Perceptual Evaluation of a Wallpaper OLED and a Curved QD-LCD

*Pei-Li Sun, Qi-Lun Wu, Yu-Ting Hsiao, Hung-Shing Chen, M. Ronnier Luo (NTUST, Taiwan), and Stephen Westland (Univ. of Leeds, UK)*

The goal of this study is to have a better understanding of the perceptual feelings of two types of display, a wallpaper OLED and a curved quantum dot LCD. The study was divided into two parts: the first used real 65 inch displays for the investigation, and the second used a VR head-set to simulate the two displays under different viewing conditions. Twelve young observers were asked to evaluate Immersive, Broad, Novel, Decorative, Multifunctional, Realistic, Luxurious, Brighter, Vivid, Clear, Natural, Contrastive, Comfortable and Like of the two displays. As image quality cannot be accurately simulated in the VR environment, the image quality related items were excluded in the second part of experiment. The results of the two experiments show that the wallpaper OLED is superior to the QD-LCD in almost all evaluation items. The wallpaper OLED therefore will be highly welcome in the future living rooms.

## G15-2 11:15~11:30

### Improvement for Images in D-LED Backlight Unit Display Application

*Yu Zhang, Wei Zhang, Hao Zhou, Wei-hao Hu, Hai Chi, Wei Zhong, Ming Chen, Yan-ping Liao, and Xi-bin Shao (Beijing BOE Display Tech. Co., Ltd., China)*

In order to improvement the performance of corner and side mura of D-LED backlight unit, the optical structure of LED has been defined and a mathematical model of LED array and its chromatic light coupling were established. The experimental results indicate that the high uniformity of light field distribution can be obtained for D-LED backlight unit.

## 15 Applied Vision / Human Factors

**Date:** Aug. 29, 2017 (Tuesday)
**Time:** 11:00~11:45
**Session Chair:** Prof. Mincheol Whang (Sangmyung Univ., Korea)

G15-3 11:30~11:45

### Ergonomic Advantages of Curved Displays: Productivity, Safety, and Well-being

*Sungryul Park, Jihhyeon Yi, Donghee Choi, Songil Lee (UNIST, Korea), Byeonghwa Choi, Seungbae Lee (Samsung Display Co., Ltd., Korea), and Gyouhyung Kyung (UNIST, Korea)*

Though International Ergonomics Association recommends that new display products should be evaluated in terms of productivity, safety, and well-being, few studies on curved display products considered these three aspects. In consideration of these three aspects, we conducted three studies on curved displays. We examined the effect of display curvature on visual task performance, visual fatigue, and watching experience. In the first study, visual task performance and visual fatigue were measured for visual search tasks at 50" multi-monitor settings. In the second study, visual task performance, visual fatigue, and satisfaction were measured for proofreading tasks at 27" monitor settings. In the third study, the viewer's presence and satisfaction were assessed using 55" TV settings. In consideration of these three aspects, we conducted three studies on curved displays. If carefully selected, display curvature can thus increase productivity, safety, and/or well-being.

# 16 Novel Processes for Stretchable Electronic

**Date:** Aug. 29, 2017 (Tuesday)
**Time:** 11:00~12:20
**Session Chair:** Prof. Jungho Jin (Univ. of Ulsan, Korea)

## H16-1 11:00~11:25

### Invited Optoelectronics Using Quantum-Dots for Transparent and Soft Interactive Devices

*Seong Jun Kang (Kyung Hee Univ., Korea)*

This talk will focus to introduce a new type of optoelectronics based on nanomaterials, such as quantum-dots and metal nanoparticles. These kinds of optoelectronics are considered as an emerging science and technology due to the potential applications including transparent and soft interactive devices. During the presentation, the interfacial physics of quantum-dots light emitting diodes(QLEDs) will be considered as well as the fabrication process of red, greed, and blue QLEDs. In addition, a method to fabricated transparent photosensors, which can be perfectly turned on and off by a visible light, based on quantum-dots and metal nanoparticles will be discussed in detail. The measurements and analysis of interfacial electronic structure of optoelectronics based on quantum-dots will be introduced in detail as well.

## H16-2 11:25~11:50

### Invited A Microfluidic Approach for Stretchable Electronics

*Zhigang Wu (Huazhong Univ. of Sci. and Tech., China)*

By introducing microfluidics into RF electronics, we found it an excellent way to make high performance RF stretchable electronics from antennas to various RF based sensors. This marriage of microfluidics with electronics brings not only a lot of opportunities for the researchers as a radically new research field but also potential commercial benefits for in the industries in the future. This presentation intended to our works from fundamentals, material and its processing, and to relevant applications.

## 16 Novel Processes for Stretchable Electronic

**Date:** Aug. 29, 2017 (Tuesday)
**Time:** 11:00~12:20
**Session Chair:** Prof. Jungho Jin (Univ. of Ulsan, Korea)

### H16-3 11:50~12:05

### Effect of Inorganic Passivation Layer for Stretchable Display based on Low Temperature Polycrystalline Silicon Thin Film Transistor

*Jae Min Shin, Sangwoo Kim, Jong-Ho Hong, Hyejin Joo, Gun Mo Kim, Gyung Soon Park, In Bom Hwang, Min Woo Kim, Won-Sang Park, Hye Yong Chu, and Sungchul Kim (Samsung Display Co., Ltd., Korea)*

Recently, we reported a three-dimensional (3-D) freeform stretchable active-matrix organic light-emitting diode (AMOLED) display based on conventional low-temperature polycrystalline silicon (LTPS) technology. To realize stretchability without degradation of image quality and device characteristics, micro-cavity structures were fabricated on a polyimide (PI) substrate by using an unusual dry etching process. In this work, we present the strategy to fabricate p-type thin film transistors (TFTs) on micro-cavity structured PI substrate without significant degradation of electrical characteristics. To acquire stable backplane characteristics after dry etching process, silicon nitride inorganic passivation layer was introduced above contact holes. Highly stable p-type TFT for stretchable AMOLED display was successfully fabricated by using this method.

### H16-4 12:05~12:20

### Highly Effective Medical Care Using Attachable Flexible Organic Light-Emitting Diodes

*Yongmin Jeon (KAIST, Korea), Hye-Ryung Choi (Seoul Nat'l Univ. Bundang Hospital, Korea), Myungsub Lim, Seungyeop Choi, Hyuncheol Kim, Jung Hyun Kwon (KAIST, Korea), Kyoung-Chan Park (Seoul Nat'l Univ. Bundang Hospital, Korea), and Kyung Cheol Choi (KAIST, Korea)*

In this paper, we report the attachable flexible OLEDs that have significantly improved wound healing effect compared to conventional LEDs array. Also, attachable flexible OLEDs have the advantages of a form factor that can solve problems such as localized heat, non-uniformity, non-flexibility, and limited treatment space due to the rigid point light source characteristics of LEDs array.

# 17 Quantum Dot for Down Conversion Display II

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 09:00~10:20
**Session Chairs:** Dr. Sohee Jeong (KIMM, Korea)
Prof. Jeonghun Kwak (Univ. of Seoul, Korea)

## A17-1 — 09:00~09:25

### Invited Development of Trevista™ Cadmium Free Quantum Dot for Next Generation Displays

*Jake Joo (Dow Chemical Company, USA)*

Semiconductor quantum dots (QDs) have very unique electronic and optical properties such as narrow spectrum photoluminescence (PL) with tunable peak wavelength and electroluminescence (EL) without spin restriction. By utilizing narrow spectrum width, QD film successfully demonstrated the enhanced color gamut of liquid crystal display. In this paper, we present Dow's cadmium free QD development efforts toward alternative integration options (on-chip, color filter, and QD EL device) that can further reduce QD loading, improve system efficiency and color purity. We will describe the key parameters of QD required to achieve peak device performance for each applications. For on-chip and color filter application, we demonstrate that engineering the surface chemistry of QD enhances overall thermal stability to meet high temperature operation conditions. For QD EL device, we investigate the impact of QD energy level to hole transport layer (HTL) and electron transport layer (ETL) by comparing energy band structure and experimental results.

## A17-2 — 09:25~09:50

### Invited Patterning Cadmium Free Quantum Dots for Color Conversion in High Resolution MicroLED Displays

*Heejae Kim, Ernie Lee, Chunming Wang, Charlie Hotz, Jeff Yurek, ZhongSheng Luo, Shihai Khan, David Olmeijer (Nanosys, USA), and Heng Liu (Silicon Core, USA)*

Direct-view microLED technology shows great promise for a new generation of high brightness, wide color gamut displays with excellent lifetime. However, costly and complex manufacturing processes such as "pick-and-place" as well as limited color conversion options have limited adoption to date. This paper reports recent advances in quantum dot (QD) materials engineering that enable QDs to be patterned for use as a color converter suitable for microLED device applications. We show that cadmium-free QDs are suitable for high resolution patterning with a wide process window while exhibiting excellent pixel uniformity and lifetime. This can lead to both improved microLED display performance and reduced manufacturing costs.

## 17 Quantum Dot for Down Conversion Display II

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 09:00~10:20
**Session Chairs:** Dr. Sohee Jeong (KIMM, Korea)
Prof. Jeonghun Kwak (Univ. of Seoul, Korea)

### A17-3 09:50~10:05

### High Color Gamut System Achieved by using Quantum Dot Photo Resist

*Yonglian Qi, Lianjie Qu, Bingqiang Gui, Zhiyong Liu, Xiaogai Chun, Hebin Zhao, Yun Qiu, and Dan Wang (Beijing BOE Display Tech. Co., Ltd., China)*

Wide color gamut of White OLED TV was restricted by traditional white electroluminescence(EL) BLU spectrums and color filter(CF) spectrum,the narrower the peak, the higher the color gamut, in order to achieve higher color gamut in WOLED area, we developed a novel quantum dot resist which can displace color filter and improve color pure, This quantum dot resist could be patterned through photo process including cleaning, coating, exposure, developing and post bake.Howerev, current WOLED displays can commonly achieve about 80% NTSC, in order to achieve higher color gamut,Quantum dots(QD) were introduced into color filter resist(QDCF).In this paper,we developed the new QD PR materials and researched the spectrum of white electroluminescence BLU and Red QD PR, the results showed that the color gamut of WOLED which used the red QD PR was higher 12% than narmal CF display's.

### A17-4 10:05~10:20

### Photo-Aligned Quantum Rods Enhancement Films for Liquid Crystal Display Devices

*A. K. Srivastava (HKUST, Hong Kong), W. Zhang, J. Schneider (City Univ. of Hong Kong, Hong Kong), V. G. Chigrinov, H. S. Kwok (HKUST, Hong Kong), and A. L. Rogach (City Univ. of Hong Kong, Hong Kong)*

We used the photo-aligned QREF for the enhancement of the optical efficiency of the LCDs.

# 18 TADF

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 09:00~10:30
**Session Chairs:** Dr. Patrick Pingel (Cynora GmbH, Germany)
Prof. Lixin Xiao (Peking Univ., China)

## B18-1 09:00~09:25

### Invited Phosphide Materials for TADF Lighting

*Hui Xu, Jing Zhang, Chunbo Duan, and Jing Li (Heilongjiang Univ., China)*

Recently, we reported a tris-phosphine-oxide compound, 2,2',4-tris (di(phenyl) phosphoryl)-diphenylether (DPETPO) as electroactive high-energy-gap host material for thermally activated delayed fluorescence (TADF) diodes, which endowed to its DMAC-DPS-based devices with the best results among true-blue TADF diodes reported so far, including the record efficiencies with maxima of 23.0% for external quantum efficiency (EQE), the smallest EQE roll-off of 15% at 1000 cd m-2, the lowest onset voltage of 2.8 V and the excellent color purity with emission peak at 464 nm and CIE coordinates of (0.16, 0.21). A novel spirocyclic phosphine oxide host SFXSPO was further constructed on the basis of short-axis linkage strategy, giving rise to the extremely twisted, rigid and asymmetric conformation, as well as highly disordered molecular packing in its solid states. As the results, SFXSPO successfully provided the state-of-the-art performance to its full-color devices, e.g. the record $h_{ext}$ of 22.5% and 19.1% and $h_{int}$ of ~100% for its yellow TADF diodes and single-host full-TADF complementary nearly-white devices, respectively.

## B18-2 09:25~09:50

### Invited Highly Efficient TADF Materials based on Intramolecular or Intermolecular Charge Transfer Approaches

*Ken-Tsung Wong (Nat'l Taiwan Univ., Taiwan)*

Organic molecules with efficient thermally activated delayed fluorescence (TADF) are emerging as attractive emitters in OLEDs because of the achievable 100% internal quantum efficiency. One of our TADF materials exhibits nearly 100% PLQY, excellent thermal stability, and a horizontal dipole ratio of 83%, leading to extremely efficient blue device with EQE of ~37%. In addition, efficient and tunable blue-green to yellow TADF emitters capable of generating OLED EQEs of >31% are developed adopting acridine as donor unit and CN-substituted benzene, pyridine and pyrimidine as acceptor units. These materials permit one to systematically probe the influence of different acceptor strengths and also the influence of tunable conformations within the acceptor moieties through controlling the orientation of asymmetric heteroaromatic ring relative to the donor component. TADF can also be achieved by exciplex formed through intermolecular charge transfer between a hole-transporting material and an electron-transporting material.

# 18 TADF

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 09:00~10:30
**Session Chairs:** Dr. Patrick Pingel (Cynora GmbH, Germany)
Prof. Lixin Xiao (Peking Univ., China)

## B18-3 09:50~10:15

### Invited Short Exciton Lifetime Thermally Activated Delayed Fluorescence Emitters for Highly Efficient Organic Light Emitting Diodes

*Gyeong Heon Kim, Ju Young Lee, Raju Lampande, and Jang Hyuk Kwon (Kyung Hee Univ., Korea)*

Blue and green TADF emitters with short exciton lifetime and high efficiency by incorporating structurally rigid goups and good HOMO and LUMO seperation chemical moieties were developed and evaluated. Measured $\Delta E_{ST}$ (singlet-triplet energy gap) of our synthesized blue and green TADF emitters were 0.01 and 0.08 eV, respectively. The PLQYs of blue and green TADF emitters were very high as 87% and 90% and the delayed ($\tau_d$) fluorescence exciton lifetimes of synthesized emitters were 1~3 μs ranges. Fabricated devices of blue and green TADF-OLEDs show high maximum EQE of 22.5 and 31.4%, respectively. Especially, color characteristic of blue TADF-OLED demonstrated deep blue of (0.14, 0.15) CIE color coordinates with the EL peak of 468 nm, and green TADF-OLED had (0.31, 0.57) CIE color coordinates with a EL peak of 526 nm.

## B18-4 10:15~10:30

### 2,2'-Bipyrimidine-based Thermally Activated Delayed Fluorescent Emitters

*Hee-Jun Park, Si Hyun Han, and Jun Yeob Lee (Sungkyunkwan Univ., Korea)*

Two twisted donor(D)-acceptor(A)-donor(D) type thermally activated delayed fluorescence (TADF) materials (Ac-bpm, Px-bpm) using acridine (Ac) or phenoxazine (Px) as an electron donor and 2,2'-bipyrimidine (bpm) as a novel electron acceptor were developed and used as the emissive dopants in organic light-emitting diode (OLEDs). The EL devices fabricated using Ac-bpm and Px-bpm displayed a green emission ($CIE_x$, $CIE_y$ = 0.29, 0.53) with an EQE of 17.1% and a yellow emission ($CIE_x$, $CIE_y$ = 0.41, 0.54) with an EQE of 14.4%, respectively. A device using Px-bpm showed a reduced efficiency roll-off compared to that of Ac-bpm, presumably due to a shorter excited state lifetime for the TADF emission.

## 19 Oxide Materials for Backplane Ⅰ

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 09:00~10:30
**Session Chairs:** Prof. Toshio Kamiya (Tokyo Inst. of Tech., Japan)
Prof. Fukai Shan (Qingdao Univ., China)

### C19-1 09:00~09:25

**Invited** **Excellent Optical Performance and Reliability Improvement on a IGZO-Driven Flexible LCD**

*Yen-Yu Huang (Chunghwa Picture Tubes, Taiwan)*

We had successfully developed a 5.5-in. flexible LCD and adopted IGZO as the driving TFT to exhibit a excellent optical and reliability performances. A lamination of plastic substrate on carrier glass is carried out to the accessible handling for the runs of process. The laser lift off (LLO) procedure is conducted to remove the 2 outer carrier glasses for the final infrastructure of "glass-plastic-plastic-glass" layer stacking LCD device. We overcome the difficulty of 2 carrier glasses removal compared to the conventional AMOLED and enhance the yield rate as well. Panel specifications of this flexible TFT-LCD are 5.5-in. in diagonal with HD (720x1080, 268PPI) resolution, 400nits in brightness, FFS mode and the total thickness (backlight unit included) with ca. 0.6mm. Due to the ultra thin thickness, the bending radius can down to less than 10mm.

### C19-2 09:25~09:50

**Invited** **Highly Reliable Top Gate Oxide TFT for AMOLED Applications**

*Chen-Shuo Huang, Yang-shun Fan, Ling-Ying Lin, Yun-Rong Yang, Ching-Hao Wang, Shang-Lin Wu, Guan-Yu Lin, Kuo-Kuang Chen, Ya-Ling Chen, Kuo-Che Tseng, Chien-Ya Lee, Wei-Yuan Wang, Che-Ming Hsu, Ya-Pei Kuo, Hsueh-Hsing Lu, and Yu-Hsin Lin (AU Optronics Corp., Taiwan)*

AMOLED has attracted much attention on display applications duo to its fast response time, high contract ratio and flexible panel design. High performance and stable low temperature polysilicon TFT is appropriate for backplane of AMOLED display, but it surfers from non-uniformity issue. Amorphous oxide semiconductor, especially In-Ga-Zn-O (IGZO), is promising alternative backplane due to the properties of uniform and ultra-low leakage current. In this paper, we will present top-gate IGZO thin-film transistor (TFT) for AMOLED display applications. Channel hydrogen control and buffer layer are the key processes for device uniformity and reliability improvement. After optimizing processes, the top-gate IGZO TFT exhibits 0.19V and 0.04V of threshold voltage shift after the fixed current stress and negative gate bias stress of 85°C for 45,000s, respectively. Furthermore, we developed a 12.3 inch AMOLED display with this highy reliable oxide TFT.

# 19 Oxide Materials for Backplane Ⅰ

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 09:00~10:30
**Session Chairs:** Prof. Toshio Kamiya (Tokyo Inst. of Tech., Japan)
Prof. Fukai Shan (Qingdao Univ., China)

## C19-3 09:50~10:15

### Invited Mobility and Reliability in Oxide Thin Film Transistors: The Key Role of Conduction Path

*Chuan Liu (Sun Yat-sen Univ., China)*

To combine high mobility and good reliability in oxide thin-film transistors (TFTs) is crucial to for actual display applications[1]. We review our recent efforts in improving the carrier mobility as well as stability of a-InGaZnO (IGZO) and a-InZnSnO (IZTO) TFTs. We focus on using controlling atmosphere in fabricating active layers such as oxygen or nitrogen airflows. It is found that by reducing oxygen vacancies by adding oxygen or nitrogen in the active film can efficiently improve the stability in a series bias tests including positive gate-bias, negative gate-bias, and negative gate-bias with illuminations.

## C19-4 10:15~10:30

### A 31-in UD AM-OLED Display Using Self-Aligned Top Gate IGZO TFTs

*Yanhong Meng, Shan Li, Shimin Ge, Xiangyong Kong, Chunsheng Jiang, Wen Shi, Wei Wu, Feng Zhu, Xiang Liu, and Chia Yu Lee (Shenzhen China Star Optoelectronics Tech. Co., Ltd., China)*

We fabricated self-aligned top gate IGZO TFTS with two structure, light shielding metal floating and un-floating, respectively. It is found that the floating light shield induced DIBL effect, and the un-floating light shield structure TFT show good switching properties, including an averaged mobility of 9.17cm$^2$/Vs, a threshild voltage of 0.52V, and a subthreshold gate swing of 0.25V/dec. Finally, a 31-inch UD(3840 x 2160, pentile) AM-OLED TV was developed by using self-aligned top gate IGZO TFTs with the un-floating light shield structure.

## 20 LC Optics / Photonics

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 09:00~10:40
**Session Chairs:** Dr. Hiroaki Tokuhisa (JSR Corp., Japan)
Prof. Yoonseuk Choi (Hanbat Nat'l Univ., Korea)

### D20-1 09:00~09:25

**Invited** **Liquid Crystalline Blue Phase for Photonic Crystal Applications**

*Suk-Won Choi (Kyung Hee Univ., Korea)*

An attempt was made to obtain polymer-stabilized blue phase II (PSBPII) with three reflective elementary colors (red, green, and blue). By controlling the amount of chiral dopant, we fabricated PSBPII with red, green, and blue reflective colors. PSBPII tended to easily achieve a relatively uniform alignment via rubbing treatment. The fabricated PSBPII samples exhibited wide temperature ranges over 40 °C including room temperature (RT). In addition, PSBPII showed robustness to lattice deformation by an applied electric field.

### D20-2 09:25~09:50

**Invited** **Fast-Response, Low Anamorphic Phase Modulation 2K1K LCoS-SLM for Holographic Applications**

*Huang-Ming (Philip) Chen and Jhou-Pu Yang (Nat'l Chiao Tung Univ., China)*

A new series of high resolution (>1080p), 0~2p modulation LCoS panel have been developed. The panel uniformity is less than 1.5% and response time is 3.4 ms. The average phase accuracy error of horizontal binary grating increases from 2.92 to 5.87 % when spatial frequency varied from 12.8 to 76.8 lines/mm. The deviation of the vertical binary grating is from 3.49 % to 12.78 % corresponding to the spatial frequency from 12.8 to 76.8 lines/mm. The average phase accuracy error form ideal phase is due to the unsymmetrical LC deformation under electric field. The lower average phase accuracy error on both horizontal and vertical gratings is crucial for the practical phase application.

# 20 LC Optics / Photonics

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 09:00~10:40
**Session Chairs:** Dr. Hiroaki Tokuhisa (JSR Corp., Japan)
Prof. Yoonseuk Choi (Hanbat Nat'l Univ., Korea)

## D20-3 09:50~10:15

### Invited Twist Structure Liquid Crystal and its Photonic Application

*Jiangang Lu (Shanghai Jiao Tong Univ., China)*

Twist structure liquid crystals show potential for application in photoelectric and photonic devices due to their interesting features including self-assembly structure, fast response time, and coexistence of twist structures and defects. After the temperature range of blue phase liquid crystal (BPLC) has been broaden to more than 60 ˚C by introduction of polymer networks into the declinations, there are several issues should be solved before the wide applications of polymer stabilized- blue phase liquid crystal (PS-BPLC): high operation voltage, hysteresis, and residual birefringence. Several recent advances in reducing operation voltage, improving response time, and suppressing hysteresis is presented in this article. Meanwhile, a reconstruction process of both BPLC and sphere phase liquid crystal (SPLC) is discussed in this article. The reconstruction capability of the polymer template is investigated and several applications of the templated BPLC and SPLC are demonstrated.

## D20-4 10:15~10:40

### Merck Award Nanoconfined Liquid Crystal Materials for Switchable Coloration

*Dong Ki Yoon (KAIST, Korea)*

Photonic crystals (PCs) and plasmonic film have received considerable attention, with much effort devoted to photonic bandgap (PBG) and dielectric/metal nanostructure control for varying the reflected color. In this talk, fabrication of one-dimensional (1D) anodic aluminum oxide (AAO) nanochannels combined with stimuli-responsive liquid crystal (LC) materials will be introduced. The color of the fabricated PC and plasmonic films can be reversibly changed by switching the ultraviolet (UV) light on/off and heating/cooling the sample, respectively. The switchable structural coloration based on PC and plasmonic structure is reliable over many cycles, suggesting that the fabricated device can be used in optical and photonic applications such as display, light modulators, smart windows, and sensors.

# 21 AR/VR: Technical Challenges and Approaches

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 09:00~10:20
**Session Chairs:** Prof. Hong Hua (The Univ. of Arizona, USA)
Prof. Dewen Cheng (BIT, China)

## E21-1 09:00~09:25

### Invited Technical Challenges and Approaches to Developing Displays for AR/MR Applications

*Hong-Seok Lee, Wontaek Seo, Yun-Tae Kim, Juwon Seo, Geeyoung Sung, Jungkwuen An, Chil-Sung Choi, Sunil Kim, Hojung Kim, Yongkyu Kim, Young Kim, Kanghee Won, Yunhee Kim, Hoon Song, and Sungwoo Hwang (Samsung Electronics Co., Ltd., Korea)*

The future of AR/MR(Augmented Reality/ Mixed Reality) technology is promising, which was shown by the amounts of investments and the number of startup companies related to it. There are loads of applications for the AR/MR technology such as education, entertainment, medical, etc. If you magine something, it can be virtually realized and seen in the real world. One of the most important devices is an optical see-through display which differs from a video see-through display such as Pokemon Go on a smartphone. In order to penetrate the consumer market, an optical see-through display should give the user an immersive, realistic experience with minimal physical and eye fatigue. Therefore, it is necessary that the product have a wide field of view, large eye motion box, light and slim form factor, and a fatigue-free focusing effect (3D). This talk will present some approaches to overcome challenges of meeting these requirements.

## E21-2 09:25~09:50

### Invited Computational Projection Display for AR/VR

*Daisuke Iwai (Osaka Univ., Japan)*

Projection displays have been applied in augmented reality (AR) and virtual reality (VR) systems. In AR/VR applications, images are projected onto non-planar and textured surfaces. Because projectors are generally designed to project images onto a planar and uniformly white surface, they are not suitable to display images on such unsuitable surfaces on which the image quality of the projected result is much degraded. We have been tackling this issue by applying the computational projection displays approach to realize “ubiquitous projection” environment where any surfaces in our daily space become a seamless cyber-physical interface for AR and VR applications. In this talk, I introduce our recent research activities in this research field.

# 21 AR/VR: Technical Challenges and Approaches

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 09:00~10:20
**Session Chairs:** Prof. Hong Hua (The Univ. of Arizona, USA)
Prof. Dewen Cheng (BIT, China)

## E21-3 09:50~10:05

### A Practical Approach to Mitigate VR-Sickness for Mobile VR Devices

*Sehoon Kim, Wonhee Choe, Nupur Kala, and Jaesung Lee (Samsung Electronics Co., Ltd., Korea)*

In this paper, we present a practical approach to mitigate the VR-sickness using FoV restricting manners. We render the restricted FoV of contents statically according to the contents' type and we let users to be able to select or to adjust the FoV on setting UI. We found the recommended FoV and the minimum FoV through lots of experiments. Our research shows a significant decrease in sickness about 30% with the recommended FoV.

## E21-4 10:05~10:20

### Multi-Layer Head-Mounted Display with Active Mask LCD

*Mugeon Kim, Daerak Heo, and Joonku Hahn (Kyungpook Nat'l Univ., Korea)*

Various studies of near-eye display systems have been reported. Among them, the double layer display has great advantages to integrate lots of pixels within a given area by stacking the pixels vertically. However, the background image is overlapped with object images. Also, the object image is expressed by the background image light, the color of the object image is blended when the background image is not white. The study by M. Holroyed shows the possibility of natural three-dimensional view with multi-layered structure. In this paper, we propose the multi-layer head-mounted display for depth fuse effect and occlusion effect.

## 22 Holographic Display and Imaging Systems (3DSA Joint Session)

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 09:00~10:35
**Session Chair:** Prof. Boaz Jessie Jackin (NICT, Japan)

### F22-1 09:00~09:25

### Invited Application of Holographic Optical Elements for Head-Mounted Display and Integral Imaging Microscopy

*Nam Kim (Chungbuk Nat'l Univ., Korea)*

A holographic optical element (HOE) is a kind of diffraction optical elements (DOE), and some bulky, heavy or complicated optical devices can be stored onto the single thin HOE film, so it has highlighted as a useful technique recently. HOE can be a mirror, lens or directional diffuser, because it can implement various functions on a single material according to high diffraction efficiency, and narrow-band frequency characteristics. Therefore, the HOEs are widely applied in many fields such as holographic memory, holographic printer, head-mounted display, integral imaging microscopy, and so on. In this report, first, the principle and characteristics of the holographic optical elements are discussed in detail, and several HOE-based applications such as head-mounted display, integral imaging microscopy, and solar concentrator, are introduced. Finally, the futuristic research concepts for HOE-based applications and contents are discussed. *(3DSA Paper)*

### F22-2 09:25~09:50

### Invited Challenges in Practical Realization of 3D Holographic Display and Solutions

*Boaz Jessie Jackin (NICT, Japan)*

The practical difficulties that has kept holography away from achieving commercial success will be reviewed in short. The solutions we propose are, i) to use a curved curved display panels instead of the conventional flat ones to display hologram that overcomes the view angle issue and ii) to decompose hologram computation algorithm that enables efficient utilization of computing power on parallel computers. The calculation methods, procedures and algorithms we have developed based on the above two points will be explained. The significance of the proposed techniques will be demonstrated with experimental and simulation results. Future possibilities will be discussed at the end.

## 22 Holographic Display and Imaging Systems (3DSA Joint Session)

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 09:00~10:35
**Session Chair:** Prof. Boaz Jessie Jackin (NICT, Japan)

### F22-3 09:50~10:05

### Design of 360-Degree Non-Mechanical Table Top Electronic Holographic Display System

*Soobin Kim (Korea Univ., Korea), Taeone Kim (ETRI, Korea), Jeongbeom Choi, and Hwi Kim (Korea Univ., Korea)*

In this paper, we propose a new table top 3D holographic display system that can substitute the conventional mechanical table top system. Unlike conventional system, our proposed system is constituted as non-motorized type and substitute the motor with a diffraction optical elements (DOEs) called multi-focus grating (MFG). We demonstrate the system and its all processes through the simulation. With this system, a more compact and safe 3D holographic display system can be realized. The ultimate goal of this research is implementation the non-mechanical table top system to replace the MFG and increase the viewpoint experimentally.

*(3DSA Paper)*

### F22-4 10:05~10:20

### Augmented Reality System based on Computer-Generated Hologram and Waveguide Element

*Wen-Kai Lin, Bor-Shyh Lin (Nat'l Chiao Tung Univ., Taiwan), and Wei-Chia Su (Nat'l Changhua Univ. of Education, Taiwan)*

In this study, we present a compact HMD system that displays a holographic image with waveguide and HOE. The image source is a Fresnel hologram which is generated by using the FFT-based method and it is displayed on SLM. In order to reduce the noise from DC term, a focal beam was employed to be the probe beam and the DC term was blocked by an iris. This system can provide a holographic image at infinity without the noise from the DC term. The HOE which recorded by two plane wave was employed to couple the image light out of the waveguide. The limitation of the viewing angle depends on the pixel size of SLM. In this system, the pixel size is 19mm and the biggest full viewing angle is 1.6°.

*(3DSA Paper)*

# 22 Holographic Display and Imaging Systems (3DSA Joint Session)

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 09:00~10:35
**Session Chair:** Prof. Boaz Jessie Jackin (NICT, Japan)

F22-5 10:20~10:35

## Full-Color Fresnel Holographic Display based on a Single SLM Using Spatial-Multiplexing and Frequency-Filtering Methods

*Shu-Feng Lin, Yong-Seok Hwang, and Eun-Soo Kim (Kwangwoon Univ., Korea)*

In this paper, we proposed a white light full-color Fresnel holographic display based on a single SLM using the spatial-multiplexing and frequency-filtering methods. In the proposed system, the SLM is spatially divided into three areas, which correspond to each of the R, G and B-holograms. Three R, G, B-color holograms of an input object are then generated by using the novel-look-up-table (NLUT) method and multiplexed into a so-called color-multiplexed hologram (CMH) based on the shift-invariance property of the NLUT method. This CMH is then loaded on a SLM and illuminated with a white-light source on the 4-*f* lens system, where a specially-designed optical pinhole mask is used on its Fourier plane only to filter the original three-color frequency-spectrum components among nine spectrum components occurred due to the illumination of a multi-color light source. Each of those filtered R, G and B frequency spectrums is reconstructed by the 2$^{nd}$ lens of the 4-*f* system and combined into together to finally display the full-color object image.

# 23 OLED Manufacturing

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 09:00~10:30
**Session Chair:** Prof. Toshihide Kamata (AIST, Japan)

## G23-1 09:00~09:25

### Invited Next Generation Evaporation Technology for Future AMOLEDs

*Changhun Hwang, Sung Su Kim, Sung Min Jo, and Byung Doo Chin (Dankook Univ., Korea)*

The conventional linear source evaporation technology known for manufacturing tool of the large size AMOLED panels has a critical limitation for very fine patterns to be overlapped. It is known as "shadow distance effect" being caused by the low n-cosine distribution of the organic gas emission from the linear source. The shadow distance is known to be as of 3 to 8um. In plane source evaporation as new method for the next generation, the plane source evaporation beam has known to be very high n-cosine (n=25) distribution as a nearly vertical collimated emission and it could suppress the shadow angle to 80 degrees. Recently, we have been developing the prototype of plane source set up to measure the sub-micron shadow distances as of 0.5 to 0.9um. In this paper, the very small numbers of shadow data will be reported to wider discuss with many of OLED experts in order to achieve the breakthrough evaporation technology for the super-ultra-high- definition AMOLED industry.

## G23-2 09:25~09:50

### Invited Monolithic Integration for Robust and Foldable AMOLED Displays

*Jan-Laurens P.J. van der Steen, Hylke B. Akkerman, Joris de Riet (Holst Centre/TNO, Netherlands), Soeren Steudel (IMEC, Belgium), Auke J. Kronemeijer, and Gerwin H. Gelinck (Holst Centre/TNO, Netherlands)*

Although curved displays are slowly entering the market, the advent of truly flexible displays will open up a whole range of new applications. Their flexible or even foldable form factor allows unprecedented design freedom and seamless integration into everyday objects. However, with flexibility comes the need for robustness. From a technological point of view, we are facing an interesting challenge: to be truly foldable, the display needs to be extremely thin. The thickness of an OLED display is essentially determined by the substrate and moisture barrier layers. Hence, our technological efforts towards foldable displays focus on these key aspects. In this work, we present our latest results on flexible thin-film encapsulation for foldable displays. Furthermore, we will show a route to achieve improved mechanical stability and robustness.

# 23 OLED Manufacturing

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 09:00~10:30
**Session Chair:** Prof. Toshihide Kamata (AIST, Japan)

## G23-3 09:50~10:15

### Invited Proprietary Process Technologies for Cost-Efficient OLED Manufacturing

*Jae H. Jung, Soeren Hartmann, Boerge Wessling, Juergen Kreis, and Markus Gersdorff (AIXTRON SE, Germany)*

Taking the basic principle, AIXTRON has added its proprietary Close Coupled Showerhead® (CCS) technology as well as novel source technologies specifically developed for efficient evaporation of organic materials. These core technologies enable the precise deposition of organic thin films with excellent thickness uniformity and high material utilization efficiency at high throughput. The approach realizes cost advantages through economies of scale, thus leading to significantly lower manufacturing costs.

## G23-4 10:15~10:30

### Fine Metal Mask Laser Solution for 1k-ppi OLED Display

*Jong Kab Park, Jungyu Hur, Boram Kim, Doh Hoon Kim, Chi Woo Kim, and Kiro Jung (AP Systems Corp., Korea)*

Laser processes are widely used in display industry such as annealing, cutting, repairing and etching, etc. There have been lots of effort for fabricating Fine Metal Mask by laser process since conventional wet-chemical processing has a technical limitation and yield issue to go super high resolution such as Ultra High Definition and beyond regime. There is no doudt that laser processing would only be the way to overcome issues for high density metal mask, however, most of laser approaches face harmful thermal effect when exposing energetic laser pulses onto the reactive thin invar material as conventional laser ablation process is made in such a way that continuos accumulation of laser pulses is done until the ablation is completed without giving sufficient cooling time. By circumventing such issue, we have developed thermal effect free laser processing strategy and successfully demonstrated deformation free fine metal mask with 1000 ppi grade resolution.

## 24 Industrial Forum Ⅰ

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 09:00-12:50
**Session Chair:** Prof. Sung Tae Shin (Korea Univ., Korea)
**Panel Discussion Chair:** Prof. Hyun Jae Kim (Yonsei Univ., Korea)

### Speaker 1

**Boeing Commercial Airplane Cockpit Display and Passenger Entertainment Display (Past, Current and Future)**

Julian. K. Chang
Associate Tech Fellow Optics and Electronics, Boeing (USA)

### Speaker 2

**Alpine Display Business and Technology**

Michihisa Onishi
Senior Engineer, Alpine Electronic, Inc (Japan)

### Speaker 3

**Recent Progress of OLED Technologies in Japan for Display and Lighting Application**

Takuya Komoda
Professor, Yamagata Univ. (Japan)

### Speaker 4

**Challenges for Realization of Real Organic Electronics**

Teruo Tohma
Technical Consultant (Japan)

### Speaker 5

**HMD Based Mixed Reality Space Communication and Media Control Platform Technology. (HMD based Smart Space with Mixed Reality Technology)**

Woo-Sug Jung
Principal Researcher, ETRI (Korea)

* Depending on the speaker’s circumstances, the schedule/topics are subject to change.

# 25 Panel Technologies for Flexible Displays

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 11:00~12:30
**Session Chair:** Prof. MunPyo Hong (Korea Univ., Korea)

## A25-1 11:00~11:25

### Invited Technical Challenges for Flexible and Rollable OLED Display

*Seyeoul Kwon, Kwonhyung Lee, Jonghyun Park, Chan Il Park, Weonseo Park, Joon Young Yang, Sooyoung Yoon, and In Byeong Kang (LG Display Co., Ltd., Korea)*

Flexible and rollable OLED display provides various electronic applications such as curved, rollable, and commertial displayes because of thin, light, and design freedom[1-3]. In this study, the technical issues to fabricate a large flexible and rollable OLED display will be discussed as shown in Fig. 1. First, the requirements of transparent plastic substrate will be studied in terms of material properties to apply oxide TFT process. Second, it will be introduced to optimize oxide TFT characteristics on polyimide plastic substrate considering process compatibility. Further more, the panel stack structure will be discussed in order to apply a rollable display with a stress distribution study in a cross sectional panel structure. Finally, a flexible module process will be discussed with some challenging issues.

## A25-2 11:25~11:50

### Invited Foldable Touch AMOLED Integrated with Plastic Window and Optical Film

*Kuan-Ting Chen, Yung-Hui Yeh, Glory Chen, Jia-Chong Ho, Cheng-Chung Lee, and Janglin Chen (ITRI, Taiwan)*

For flexible devices development, we wished to develop a unique technology which is able to use existing TFT and OLED manufacturing facilities. A variety of flexible devices using the flexible universal plane (FlexUP$^{TM}$) technology have been fabricated and demonstrated. FlexUP$^{TM}$ is made by coating polyamic acid (PAA) and thermally cured to form a polyimide film over a pre-deposited debonding layer (DBL) on glass substrate. Based on ITRI's FlexUP$^{TM}$ technology, we have successfully developed the flexible TFT backplane, flexible OLED and, more recently, multifunction front plate including on-cell touch sensor, gas barrier, hard coat and optical layer are also successfully developed. Finally, the multifunction front plate were integrated with 7" flexible AMOLED and exhibit high flexibility, good optical performance and mechanical strength.

# 25 Panel Technologies for Flexible Displays

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 11:00~12:30
**Session Chair:** Prof. MunPyo Hong (Korea Univ., Korea)

## A25-3 11:50~12:15

### Invited Flexible Inorganic Electronic Systems

*Keon Jae Lee (KAIST, Korea)*

Recent progresses that can extend the application of self-powered flexible inorganic electronics. This talk will introduce flexible electronics including large scale integration (LSI) and high density memory. Flexible memory is an essential part of electronics for data processing, storage, and radio frequency (RF) communication. To fabricate flexible large scale integration and fully functional memory, we integrated flexible single crystal silicon transistors with 0.18 CMOS process and memristor devices. the next part will discuss the flexible GaN/GaAs LED for implantable biomedical applications. light emitting diodes (LEDs) have superior characteristics, such as long term stability, high efficiency, and strong birghtness. Our flexible GaN/GaAs thin film LED enable the dramatic extension of not only consumer electronic applications but also the biomedical devices such as biosensor or optogenetics.

## A25-4 12:15~12:30

### Light Adaptable Space Adaptable Display

*Himchan Oh, Jong-Heon Yang, Gi Heon Kim, Hyunkoo Lee, Byoung-Hwa Kwon, Chunwon Byun, Chi-Sun Hwang, Kyoung Ik Cho, and Jeong-Ik Lee (ETRI, Korea)*

We present flexible dual-mode display operable in reflective and emissive mode according to ambient light for optimal visibility on nonplanar surface. Flexible backplane embedding organic light emitting diodes (OLEDs), thin film transistors (TFTs) and control electrodes for liquid crystal (LC) shutter is realized by laser lift-off (LLO) method and newly developed polyimide (PI) delamination technique. Novel colour-filter-less LC shutter with colour dyes is merged to this flexible backplane for operation in reflective mode. Our work opens up a promising approach to build displays which is adaptive to surrounding environment for better usability.

# 26 OLED Emitter

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 11:00~12:15
**Session Chairs:** Prof. Yong-Jin Pu (Yamagata Univ., Japan)
Prof. Zhao-Kui Wang (Soochow Univ., China)

## B26-1 11:00~11:25

### Invited Highly Efficient Blue Fluorescent OLED by using Triplet Energy

*Mengying Bian, Xing Xing, Jiaxiu Luo, Fan Lv, Jiannan Gu, and Lixin Xiao (Peking Univ., China)*

An unusual heavy atom effect has been identified in an organic light-emitting device (OLED) containing polyvinylcarbazole (PVK) as the host, the red fluorescent dye DCM2 as the emitter, and non-emitting 1,8-diiodooctane (RI) or carbazole bromide (CzBr) as a heavy atom source instead of a rare metal. The intensity of electroluminescence (EL) of DCM2 changes with the concentration of RI, with a maximum EL intensity obtained for DCM2 at a concentration of 0.25% of RI. Photoluminescence (PL) spectra of PVK–DCM2 films show increased singlet emission from DCM2 in the presence of iodide at 12 K. The enhanced fluorescence induced by iodide is caused by energy transfer from both the singlet and triplet states of PVK to the singlet states of DCM2. These results suggest an alternative way to use the triplet energy of fluorescent materials with external heavy atoms rather than conventional phosphorescent dyes containing rare heavy metal atoms.

## B26-2 11:25~11:50

### Invited Recent Progress in Highly Efficient Blue TADF Emitter Materials for OLEDs

*Thomas Baumann, Patrick Pingel, and Daniel Volz (Cynora GmbH, Germany)*

The need for increased efficiency in blue pixels for AMOLED displays is addressed with organic thermally activated delayed fluorescence (TADF) emitters as replacement for conventional fluorescent emitter systems. This allows for a reduced power consumption while maintaining deep blue colour coordinates.

## 26 OLED Emitter

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 11:00~12:15
**Session Chairs:** Prof. Yong-Jin Pu (Yamagata Univ., Japan)
Prof. Zhao-Kui Wang (Soochow Univ., China)

### B26-3 11:50-12:15

**Invited** **Highly Efficient and Stable Pure Blue Organic Light-Emitting Diodes based on Imidazole Derivatives**

*Tong Shan and Ping Lu (Jilin Univ., China)*

To promote the application of organic light emitting diodes (OLEDs) in various areas, achieving high performance blue OLEDs with outstanding efficiencies at high luminance is still desired. Herein, we focus on realizing stable and highly efficient pure blue OLED capable of harvesting triplets via triplet-triplet annihilation (TTA). Three fused polycyclic aromatic substituents, naphthalene, pyrene and anthracene, are selected to construct phenanthroimidazole-functionalized molecules (1–3), among which pyrene and anthracene comprised ones display TTA characteristics in electroluminescence devices. The nondoped OLED of 2 exhibits pure blue emission with CIE coordinates of (0.15, 0.14) and demonstrates a maximum external quantum efficiency (EQE) of 5.11%, stable EQE over 5% at luminance of 300~3000 cd $m^{-2}$, EQE of 4.76% at an ultra-bright luminance of 10000 cd $m^{-2}$ and a maximum luminance of 54300 cd $m^{-2}$. Such good device performance benefits from the appreciable TTA contribution substantially.

### 47. Young Leaders Conference

**Young Leaders Conference (YLC) is open to students who would like to share and discuss their research results. In Young Leaders Conference, each presentation will be evaluating by panel of judges and participants for the awards. The awards ceremony of YLC will be held right after the presentation. Please participate in this session.**

- **Place: Room G (# 108), Convention Hall, BEXCO**
- **Date & Time: Aug. 30, 2017 (Wed.) / 16:00~17:30**

# 27 Oxide Materials for Backplane II

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 11:00~12:30
**Session Chairs:** Prof. Chuan Liu (Sun Yat-Sen Univ., China)
Dr. Yen-Yu Huang (CPT, Taiwan)

## C27-1 11:00~11:25

### Invited Current Understanding of Defects in Amorphous Oxide Semiconductors

*Toshio Kamiya and Hideo Hosono (Tokyo Inst. of Tech., Japan)*

Amorphous oxide semiconductor (AOS) represented by a-In-Ga-Zn-O (a-IGZO) is employed for the state-of-the-art flat-panel displays from very high-resolution LCD to large size (up to 77”) OLED displays.[1-3] On the other hand, practical issues such as bias/current/light illumination instability are still unsolved satisfactory, and understanding and control of defects in AOSs are inevitably important to solve them. We and other groups have reported several defects, which are related to oxygen [4], hydrogen [5,6] etc. In this paper, we will discuss the current understanding of these defects.

## C27-2 11:25~11:50

### Invited Solution Combustion Synthesis: the Low-Temperature Processing for p-Type Cupper-Doped Nickel Oxide Thin Films for Transparent Electronics

*Ao Liu, Guoxia Liu, and Fukai Shan (Qingdao Univ., China)*

Low-temperature solution process opened a new window for the fabrication of metal-oxide semiconductors due to its low cost, simple manipulation, large-area uniformity, and flexible capability. In despite of the great progress, the research works on p-type oxide semiconductors are still sluggish compared to the n-type counterparts. Achieving high performance p-type oxide thin-film transistors (TFTs), that have an advantage over n-type TFTs since the TFT supplies hole current for the anode of the organic light emitting device without affecting the drain current in the saturation mode) will definitely promote a new era for electronics in rigid and flexible substrates, away from silicon.

## 27 Oxide Materials for Backplane II

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 11:00~12:30
**Session Chairs:** Prof. Chuan Liu (Sun Yat-Sen Univ., China)
Dr. Yen-Yu Huang (CPT, Taiwan)

### C27-3 11:50~12:15

### Invited Alternating Current Polymer Electroluminescence for Dynamic Interactive Display

*Cheolmin Park, Eui Hyuk Kim, Sung Hwan Cho, and Beomjin Jeong (Yonsei Univ., Korea)*

Field induced electroluminescence of either organic or inorganic fluorescent materials under alternating current (AC) has been of great attention as a potential candidate for next generation displays, lightings and sensors. Unique device architecture in which an emitting layer is separated with an insulator from electrode offers a new platform for designing and developing a variety of types of ELs. Here, we demonstrate high-performance field-induced AC polymer electroluminescence (AC-PEL) devices with high brightness, high efficiency and color-tunability.[1] We also present a non-volatile EL memory in which arbitrarily chosen EL states are programmed and erased repetitively with long EL retention.

### C27-4 12:15~12:30

### Dependence of Poly-Si TFT Performance on Scanning Direction of BLDA (Blue Laser Diode Annealing)

*Yuya Ishiki, Futa Gakiya, Tatsuya Okada, and Takashi Noguchi (Univ. of the Ryukyus, Japan)*

The a-Si film was crystallized using the BLDA method. TFT channels were fabricated by scanning the laser beam to both parallel or vertical direction to the laser scanning direction and electric characteristics were measured. TFT performance such as field effect mobility and subthreshold swing were evaluated, and the carrier conduction was discussed.

# 28 LC Mode

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 11:00~11:50
**Session Chairs:** Prof. Philip Chen (Nat'l Chiao Tung Univ., China)
Prof. Seung Hee Lee (Chonbuk Nat'l Univ., Korea)

## D28-1 11:00~11:25

### Invited Fast Flexoelectric Switching in Bimesogen-doped Polymer Stabilized Uniform Lying Helix and Vertical Standing Helix of Cholesteric Liquid Crystals

*Andrii Varanytsia, Vinay Joshi, Kai-Han Chang (Kent State Univ., USA), Daniel A. Paterson, John M.D. Storey, Corrie T. Imrie (Univ. of Aberdeen, UK), and Liang-Chy Chien (Kent State Univ., USA)*

We report flexoelectric liquid crystal displays based on polymer-stabilized cholesteric liquid crystals with both uniform lying helix (PSULH) and vertical standing helix (PSVSH) modes. A method to enhance the flexoelectric switching of the CLC mixture is achieved by mixing nematic liquid crystal (NLC) constituents with the addition of a giant flexoelastic coefficient bimesogenic LC dimer into a low dielectric anisotropy commercial NLC mixture. Fast flexoelectric switching with submillisecond response time has been achieved with both the PSULH and PSVSH modes.

## D28-2 11:25~11:50

### Invited Flexoelectric in-Plane Switching (IPS) for Ultra-High Electro-Optic Performances: Low-Frequency Driving, Low-Voltage Driving, High-Transmittance, and Flicker-Free

*MinSu Kim (Johns Hopkins Univ., USA), Hyeong Gyun Ham, Seung Jae Lee, and Seung Hee Lee (Chonbuk Nat'l Univ., Korea)*

The flexoelectric effect in liquid crystals has long been of interest from both scientific and industrial application perspectives. Recently, low-frequency driving in LCDs was attempted for power-saving while displaying static-images. However, an image-flicker becomes significantly obvious owing to the flexoelectric effect. Besides reports that propose to solve the image-flicker in a fringe-field switching (FFS) mode, we proposed an in-plane switching (IPS) mode with inherently better electrode-structural solution. That is, in FFS mode, both static and dynamic image-flickers exist whereas, in IPS mode, ideally no static flicker occurs owing to the symmetry of an electric field formation between frames. Here, we propose an IPS mode for ultra-high electro-optic performance with fine-patterned electrodes and liquid crystals with high-magnitude of negative dielectric anisotropy to overcome relatively low-transmittance in IPS mode than that in FFS mode.

# 29 AR/VR: Head Mounted Displays

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 11:00~12:05
**Session Chair:** Dr. Hong-Seok Lee (Samsung Electronics Co., Ltd., Korea)

## E29-1 11:00~11:25

### Invited Head-Mounted Light Field Displays

*Hong Hua (The Univ.of Arizona, USA)*

Several methods have been explored in HMD designs to address the VAC problem and approximate the visual effects created by focus cues when viewing a real-world scene [2]. Examples include Maxvillan view displays that attempt to extend the depth of field of the display [3], vari-focal plane displays that dynamically compensates the focal distance of a single-plane display based on a viewer's fixation point [4], a multi-focal plane (MFP) display method that creates a stack of focal planes in space- or time-multiplexing fashion [5], micro-integral imaging (InI) method that reconstructs the full-parallax light fields of a 3D scene through pinhole or lenslet array [6], and multi-layer method which utilizes multi-layers of spatial light modulators (SLM) to modulate a uniform backlighting and render apparently directional light rays [7]. To some extent these methods are able to overcome the VAC problem with different levels of limitations. In this presentation, we focus on reviewing recent advancements of head-mounted light field displays for VR and AR applications.

## E29-2 11:25~11:50

### Invited Designs and Evaluation of AR Near Eye Display with Freeform Optics

*Dewen Cheng, Chen Xu, Yongtian Wang (BIT, China), Yang Wang (Beijing NED+AR Display Technology Corp,. Ltd., China)*

Near eye displays (NEDs) are playing indispensable roles in the rapid development of augmented reality (AR) technology. As wearable devices, one trend of NEDs is to become compact and lightweight while providing a good display performance. In the design of such systems, it is challenging to balance the aberration and meet the request of optical see-through while keeping an elegant optical structure with conventional spherical or aspheric elements. Thus, freeform optics is adopted to both simplify the optical structure of NEDs and obtain a good optical performance.

## 29 AR/VR: Head Mounted Displays

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 11:00~12:05
**Session Chair:** Dr. Hong-Seok Lee (Samsung Electronics Co., Ltd., Korea)

### E29-3 11:50~12:05

**A 3D Interaction Technique for Augmented Reality on Smart Glasses**

*Keyu Wang, Yang Li, Chao Ping Chen, Bing Yu, Lei Zhou, and Yishi Wu (Shanghai Jiao Tong Univ., China)*

We propose a low-latency, 3-dimenional (3D) interaction technique for augmented reality (AR), which is implemented on a smart glasses that is equipped with a binocular depth camera. Instead of tracking user's hands, our technique detects the motion vectors surrounding the virtual 3D objects and then recognizes the gestures. With this technique, the latency can be substantially improved.

# 30 Light Field Display (3DSA Joint Session)

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 11:00~12:25
**Session Chair:** Prof. Sumio Yano (Shimane Univ., Japan)

## F30-1 11:00~11:25

### Invited Analysis on the Requirements for Light Field Displays to Drive Accommodation

*Joohwan Kim (Nvidia, USA)*

Most commercially available three-dimensional (3D) displays provide correct cues to vergence (the counter rotation of the two eyeballs to fuse the binocular views of a target) but not accommodation (the change in the focal power of the crystalline lens in the eye). This leads to a mismatch between vergence and accommodation, which can distort depth perception and cause discomfort[1]. Among many ways to overcome vergence-accommodation conflict, light field displays are considered one of the most promising approaches. Light field displays aim to solve vergence-accommodation conflict by providing two or more perspective views within the pupil of an eye[2]. The underlying hypothesis is that the provided multi-view perspectives will act as valid cues to accommodation. Several studies have reported evidences that support the hypothesis[3].

## F30-2 11:25~11:40

### Switchable Light-Field Display Using a Common TN Liquid Crystal Panel and a Cholesteric Liquid Crystal Film

*Toru Iwane (NIKON Corp., Japan)*

I introduce a switchable light-field display based on our novel electrically controlled micro-mirrors system. The display has two conditions; it shows selectively light-field 3-D image or ordinal 2-D image. As is well known, there are mainly two problems in a light-field or IP display due to lens array. One is that image resolution is degraded and granularity-look of the display's surface is nuisance to see. To solve or mitigate problems, there have been several attempts to realize switchable 3-D display. Generally, they are complicated and difficult to produce. Our proposal system is rather simple. Our switchable optical devise composes linear polarized reflector, circular polarized reflector and common TN LC panel. Cholesteric Liquid Crystal (CLC) polymer film functions as a reflector for circular polarized light; left circular polarized light is transmitted and right circular light is reflected.

*(3DSA Paper)*

# 30 Light Field Display (3DSA Joint Session)

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 11:00~12:25
**Session Chair:** Prof. Sumio Yano (Shimane Univ., Japan)

F30-3 11:40~11:55

## Analysis of Influences of a Micro Lens Array on a 3D Image Quality in a Full Parallax Flat Panel Light Field Display

*Jaejoong Kwon, Beomshik Kim, Sujung Huh, Joowoan Cho, Juhwa Ha (Samsung Display Co., Ltd., Korea), Junghoon Lee (Sekonix Co., Ltd., Korea), Keunkyu Song, and Hye Yong Chu (Samsung Display Co., Ltd., Korea)*

3D display is getting attention again along with the development of AR/VR display and the development of highresolution display panel. Among various 3D display technologies, the light field display that is composed of a flatpanel and a micro lens array is most promising because it has a merit that it can realize thin and light form factorand the viewers do not need to wear special glasses to watch 3D images. In a light field display, accordingto a viewer position, the light propagating directions and focusing positions are designed carefully. The lens arraygenerates the designed light fields by focusing and re-directing lights of display pixels. Therefore, the high qualitylens array is the key factor for a high quality 3D imaging in a light field display.

*(3DSA Paper)*

F30-4 11:55~12:10

## Oblique Viewing Floating 3D Image System with Gradient Focal Length of Lens Array

*Yu-Ching Cheng, Jui-Yi Wu, Chih-Hung Ting, Ping-Yen Chou, and Yi-Pai Huang (Nat'l Chiao Tung Univ., Taiwan)*

Floating 3D technology would be the target for the next generation. In order to provide a more user-friendly experience, we proposed an oblique viewing floating 3D image system. A floating and standing 3D image at the oblique viewing angle is generated by adjusting the effective oblique viewing object distance and image tilt angle. However, different oblique viewing angles also means various effective oblique viewing object distances. It would make the image quality worse in the oblique viewing angle because of the different image distances by geometric optics. Therefore, we optimized the system by using the gradient focal length of lens array. With the designed system, we can create oblique viewing floating 3D images without adding any additional components but still keep the image quality at oblique viewing angle.

*(3DSA Paper)*

# 30 Light Field Display (3DSA Joint Session)

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 11:00~12:25
**Session Chair:** Prof. Sumio Yano (Shimane Univ., Japan)

## F30-5

12:10~12:25

### Calibration and Quality Improvement of Projection Type Integral 3D Display

*Jackin BOAZ JESSIE, Lode JORISSEN, Ryutaro OI, and Yasuyuki ICHIHASHI (NICT, Japan)*

A projection type integral photography (IP) based 3D display is developed that uses a commercial projector for display and holographic optical element (HOE) as lens array. A method for calibrating the commercial projector for lens distortion and other misalignment errors is reported. The focal length, tilt and position of each elemental lens in the HOE based lens array was also optimized for best viewing conditions. The improvement in quality of 3D reconstruction due to the usage of HOE lens array and calibration technique is demonstrated.

*(3DSA Paper)*

## F30-6

12:10~12:25

### The Characteristics of Luminance Addition/Subtraction System by Using Linear Polarization Operation in Layered TN-LCDs

*Zijian Fan (Tokushima Univ., Japan), Hirotsugu Yamamoto (Utsunomiya Univ., Japan), Haruki Mizushina, and Shiro Suyama (Tokushima Univ., Japan)*

We propose a new method to add/subtract luminances in layered TN-LCDs (Twisted nematic liquid crystal displays) by using polarization operation. Our system is composed of two layered TN-LCDs without polarization film and a half-wave plate sandwiched between them. Our method can successfully achieve the complete control of whole luminance even when one LCD has any luminance.

*(3DSA Paper)*

# 31 Display Manufacturing

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 11:00~12:45
**Session Chair:** Dr. Jan-Laurens van der Steen
(Holst Centre/TNO, Netherlands)

## G31-1

11:00~11:25

### Invited Organic TFTs for Flexible Displays: Opportunities and Challenges

*Xiaojun Guo, Jiaqing Zhao, Yukun Huang, and Wei Tang (Shanghai Jiao Tong Univ., China)*

This paper will discuss the competitiveness of the organic thin-film transistor (OTFT) technology for developing flexible displays. Then, the technical challenges associated with the development will be highlighted. Especially, the work on developing processes compatible with existing photolithographic and dry-etching processes, and low voltage and stable OTFTs with thick low-k/high-k bilayer polymer gate dielectric will be presented.

## G31-2

11:25~11:50

### Invited Flexible Sheet Device Manufacturing with All-Printed High Resolution TFT Backplane

*Toshihide Kamata (AIST, Japan), Hitoshi Kondoh, Shinichi Nishi, and Yasuyoshi Mishima (JAPERA, Japan)*

We have been developing all-print fabrication techniques of flexible sheet devices. In this paper, we will introduce our newly developed compact printing process with high resolution, flexible alignment technique with high accuracy and automated continuously operated manufacturing line technology. By applying these techniques, we have succeeded in the development of an all-printed flexible TFT backplane, and demonstrated a flexible display and sensors with various sensor heads.

# 31 Display Manufacturing

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 11:00~12:45
**Session Chair:** Dr. Jan-Laurens van der Steen
(Holst Centre/TNO, Netherlands)

## G31-3 11:50~12:15

### Invited Fixed Array Technologies for Ultra-Fine Resolution Applications

*R.C. Liang, S.L. Liu, G.W. Lin, C.T. Hsiao, and J. D. Chen (Trillion Science, USA)*

A variety of fixed array anisotropic conductive adhesive films (ACF) having a particle density ranging from 3000 pcs/mm$^2$ to more than 50,000 pcs/mm$^2$ have been developed and manufactured by cost effective roll-to-roll microfluidic process. A significantly higher particle capture efficiency and uniform particle distribution on the bonded electrodes as compared with conventional ACF have been demonstrated. Depending on the adhesive rheology, particle morphology, electrode/bump design and the bonding conditions, a conductive particle capture rate of 35-65% was typically observed for various applications. Devices with a min. bonding area as low as 300 mm$^2$ and a min. bonding space of about 4-5 mm have been demonstrated with fixed array ACFs having a particle density as low as 25,000-32,000 pcs/mm$^2$. A low contact resistance in the connected area as well as a low degree of short and/or leakage current in the non-connected space area were also observed.

## G31-4 12:15~12:30

### Development of a Roll-to-Roll Vacuum Evaporation System for Flexible Organic Light-Emitting Devices

*Jaehoon Jung, Minsoek Kim (GJM Co., Ltd., Korea), Sin Kwon (KIMM, Korea), and Moonyoung Lee (GJM Co., Ltd., Korea)*

A flexible organic light emitting devices (OLEDs) will be the ultimate technology to customers and industries in the near future. For flexible OLED, a roll-to-roll evaporation system was developed. The developed roll-to-roll evaporation system is suitable for mass production. The roll-to-roll evaporation system consists of effusion sources for continuous depositions, a roll-to-roll web handling module for flexible substrates and a 6-axis alignment module for mask alignment under vacuum environment. In order to fabricate OLED devices, 3-layers of organic materials and 2-layers of metal electrodes were deposited on a flexible substrate consecutively. And an additional e-beam evaporator with an oxide material and a glove box were used for thin film encapsulation. Based on the developed roll-to-roll system, flexible patterned OLED lightings could be successfully fabricated.

## 31 Display Manufacturing

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 11:00~12:45
**Session Chair:** Dr. Jan-Laurens van der Steen
(Holst Centre/TNO, Netherlands)

### G31-5 12:30~12:45

### Analysis of Thermal Bending Deformation of Ultra - Thin TV Module

*Li Xiang, Wang Bochang, Bu Zhanchang, Chen Ming, and Shao Xibin*
*(BOE Display Tech. Co., Ltd., China)*

Thinning is one of the trends in the development of large-size TV. Based on the 65inch 8K glass panel and the module thickness of 9.9mm. In this paper, the deformation of the module after lighting up is analyzed, and the experimental conditions of module deformation less than 2mm are obtained.

# 32 Industrial Forum II

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 11:00-12:30
**Session Chair:** Prof. Sung Tae Shin (Korea Univ., Korea)
**Panel Discussion Chair:** Prof. Hyun Jae Kim (Yonsei Univ., Korea)

## Speaker 1

**Boeing Commercial Airplane Cockpit Display and Passenger Entertainment Display (Past, Current and Future)**

Julian. K. Chang
Associate Tech Fellow Optics and Electronics, Boeing (USA)

## Speaker 2

**Alpine Display Business and Technology**

Michihisa Onishi
Senior Engineer, Alpine Electronic, Inc (Japan)

## Speaker 3

**Recent Progress of OLED Technologies in Japan for Display and Lighting Application**

Takuya Komoda
Professor, Yamagata Univ. (Japan)

## Speaker 4

**Challenges for Realization of Real Organic Electronics**

Teruo Tohma
Technical Consultant (Japan)

## Speaker 5

**HMD Based Mixed Reality Space Communication and Media Control Platform Technology. (HMD based Smart Space with Mixed Reality Technology)**

Woo-Sug Jung
Principal Researcher, ETRI (Korea)

* Depending on the speaker’s circumstances, the schedule/topics are subject to change.

## 33 Materials for Transparent and Flexible Displays

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 14:00~15:45
**Session Chairs:** Prof. Hyun-Joong Chung (Univ. of Alberta, Canada)
Dr. Taewoong Kim (Samsung Display Co., Ltd., Korea)

A33-1 14:00~14:15

### A Novel Polysulfide Polymer Material for Flexible Displays

*Tolis Voutsas, Radu Reit, Adrian Avendano, and David Arreaga (Ares Materials, Inc., USA)*

Ares Materials, Inc. has developed Pylux$^{TM}$: a novel electronic-grade polysulfide substrate material that is more than 90% transparent in the visible spectrum and with an intrinsic surface roughness less than 0.5 nm. Thin films of Pylux$^{TM}$ (20+ μm) can be cast solvent-free and cured in less than one hour. Specialty release chemistries developed at Ares Materials can tune the adhesion of Pylux$^{TM}$ to any carrier substrate chosen, such that no laser-liftoff is required for mechanical release with a release stress below 1 MPa. Initial prototyping in an R&D fabrication line utilized 50um Pylux$^{TM}$, where Indium Gallium Zinc Oxide (IGZO) thin-film transistors (TFTs) were fabricated on 6-inch Si carrier wafers using standard photolithographic processes with excellent performance characteristics.

A33-2 14:15~14:40

### Invited Novel Colorless Polyimide for Flexible Displays

*Shinichi Komatsu, Asako Kyoubu, Takeshi Koike, and Akira Shiibashi (JXTG Nippon Oil & Energy Corp., Japan)*

In this presentation, we introduce an alicyclic acid dianhydride (CpODA) that was developed by JXTG Nippon Oil & Energy as a monomer for producing polyimides, and the features of some novel transparent, colorless, and highly heat resistant polyimides obtained from CpODA.
A transparent, colorless, and highly heat resistant polyimide film (PI-A-type) was obtained by combining CpODA with commercially available diamines. Also obtained were a transparent polyimide film with high heat resistance and low CTE (PI-B-type), a polyimide film with a very low CTE (PI-C-type), a transparent polyimide film with high heat resistance and low Rth (PI-D-type), and a transparent film with zero Rth (PI-E-type). With these features, it is possible these films could be used with a variety of materials for flexible displays.

# 33 Materials for Transparent and Flexible Displays

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 14:00~15:45
**Session Chairs:** Prof. Hyun-Joong Chung (Univ. of Alberta, Canada)
Dr. Taewoong Kim (Samsung Display Co., Ltd., Korea)

## A33-3 14:40~15:05

### Invited Applications of Transparent Polyimide for Flexible Electronics

*Chung-Seock Kang, Sangmin Song, Hak-Gee Jung, and Sangkyun Kim (KOLON Industries Inc., Korea )*

Flexible electronics have attracted people's huge interests, mainly due to their unique features such as lightness, thinness, and design freedom. As a material company, KOLON has been concentrating on R&D of the flexible polymeric substrate. We have developed "colorless polyimide (CPI$^{TM}$)", which have no color and high thermal stability unlike conventional polyimides. They can be used as not only a bottom substrate for flexible transparent display but also a cover window to replacing the cover glass for flexible display. Besides the flexible displays, CPI$^{TM}$ also can be used for many more functional applications such as automotive, FPCB and semiconductors.

## A33-4 15:05~15:30

### Invited Parylene AF4 Its Preparations, Characteristics and Applications

*Nelson Yang, and Chun-Hsu Lin (Yuan-Shin Materials Tech. Corp., Taiwan)*

Among the common polymers of parylene N,C,D and AF4,Parylene AF4 tendency is toward more interest and importance as a potential surface coating precursor.Just because its thin film bearing teflon-like moiety characteristics. With unparalleled properties of hydrophobic, high aspect ratio, HT thermal stability (350), UV resistance, a variety of coating applications in the fields of flexible technology (AMOLED), HT power electronic, MEMS packaging, and porous composite membrane are presented for reliability and protection from harsh and corrosive environments.

## 33 Materials for Transparent and Flexible Displays

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 14:00~15:45
**Session Chairs:** Prof. Hyun-Joong Chung (Univ. of Alberta, Canada)
Dr. Taewoong Kim (Samsung Display Co., Ltd., Korea)

A33-5 15:30~15:45

### Highly Flexible and Reliable Gas Diffusion Barrier based on Nanolaminate Structure

*JeongHyun Kwon, Yongmin Jeon, Seungyeop Choi, Hyuncheol Kim, and Kyung Cheol Choi (KAIST, Korea)*

We demonstrated the newly designed TFE layer by combining with various materials with effective advantages. The hybrid functional TFE is composed of ZnO, $Al_2O_3$, and MgO films. Each 1-nm-thick ZnO, $Al_2O_3$, and MgO film was utilized for formation of nanolaminate (NL) structure, 1-nm-thik ALD-deposited film have barrier properties due to the rapid thinning of the film by self-limiting reaction. The ZAM/$Al_2O_3$/MgO (ZAM) NL structure was defect decoupling effect between each layer and gas diffusion delay in barrier film as shown in Figure 1. The nanolaminate structure We could fabricate the superior GDB compared to the previously studied $Al_2O_3$, $Al_2O_3$/ZnO, and $Al_2O_3$/MgO etc by manipulating the thickness and structural control. The ZAM/$Al_2O_3$/MgO (ZAM) NL structure with ultra-thin film achieve the very low WVTR value of $2.03 \times 10^{-5}$ g/m$^2$/day and showed mechanical reliability about intrinsic and extrinsic stress.

# 34 Printed OLEDs

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 14:00~15:40
**Session Chairs:** Prof. Juan Qiao (Tsinghua Univ., China)
Prof. Hideyuki Murata (JAIST, Japan)

## B34-1 14:00~14:25

### Invited Improved Device Stability of Organic Light-Emitting Devices with Solution-Processed Charge Injection Layers

*Yong-Jin Pu, Takayuki Chiba, Satoru Ohisa, Sho Kagami, Takafumi Ide, Hitoshi Fukuda, Junji Kido (Yamagata Univ., Japan)*

Electron and hole injection layers (EILs and HILs) have an important role in OLEDs to facilitate charge injection from electrodes into electron transporting, hole transporting, or light-emitting materials, reduce driving voltage, and improve power efficiency (lm/W). In spite of their importance, solution-process of electron and hole injection materials has remained as a very complicated issue; it requires several properties such as solubility to a coating solvent, insolubility of the underlayer to the coating solvent, film-forming property, and electron injection ability. Most importantly, these required conditions have to be satisfied with device stability at the same time.

## B34-2 14:25~14:50

### Invited Solution-Processable Interfacial Materials for High-Performance OLEDs

*Zhao-Kui Wang (Soochow Univ., China)*

The solution processing technique is a very simple and inexpensive method of fabricating organic films in OLEDs. In addition, carrier injection and transport play important role in the device performance of multilayer OLEDs. However, the energy barrier between the electrode and the organic material prevents the carrier injection to some extent. Therefore, solution-processable functional interfacial layers with suitable energy levels are always introduced into OLEDs to enhance carrier injection and transport. In this talk, I will introduce some effective interfacial materials based on solution-processing to improve OLED performance in our group. For examples, thick molybdenum trioxide ($MoO_3$) films (ca. 120 nm), acting as a hole injection layer in 150×150 $mm^2$ OLED lighting panels, were successfully deposited by an aqueous solution-processed method; $MoO_3$ doped copper phthalocyanine-3,4′,4″,4‴-tetra-sulfonated acid tetra sodium salt (TS-CuPc) was developed as a hole injection and transport layer in OLEDs via an environmentally-friendly and easy fabrication process; a solution processed hole injection bilayer, HAT-CN:$F_4$-TCNQ/TS-CuPc:$MoO_3$, for blue phosphorescent OLEDs; a flash evaporation method, the pre-coated organic film on silicon wafer are re-deposited undergoing an instantaneous high temperature (~ 1000 °C) in a rough vacuum, was developed to fabricate the small molecule based multilayer OLEDs.

# 34 Printed OLEDs

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 14:00~15:40
**Session Chairs:** Prof. Juan Qiao (Tsinghua Univ., China)
Prof. Hideyuki Murata (JAIST, Japan)

B34-3 14:50~15:15

## Invited Stable Organic Light-Emitting Diode by Blade Coating with Mixed Hosts

*Yu-Fan Chang, Hsin-Chang Chiang, Hsin-Fei Men, and Lan-Sheng Yang (Nat'l Chiao Tung Univ., Taiwan)*

Small-molecule blue fluorescent organic light-emitting diode (OLED) is fabricated by blade coating. For phosphorescent device with mixed-host emission layer and without the electron transport layer, the half lifetime is about 300 hr at initial luminance of 1000 cd/m$^2$. Such idea of simplified device structure is applied to fluorescent device. For the device with the electron transport layer of $Alq_3$ over the emission layer the efficiency and lifetime at initial brightness of 500 cd/ m$^2$ are 7.5 cd A and 150 hours for CsF/Al cathode. When the $Alq_3$/CsF/Al is replaced by simply CsF/Al over the mixed-host emission layer the efficiency are lifetime are 6.4 cd /A and 300 hours. The orange emitter rubrene is added to obtain white emission. The half lifetime is estimated to be over 1000 hrs.

B34-4 15:15~15:40

## Invited Complete Roll-to-Roll Fabrication from a Plastic Roll to an OLED Roll

*Eun Jung, Haksoo Lee, Chanho Kim, and Sung Min Cho (Sungkyunkwan Univ., Korea)*

Starting from a plane PET roll, an organic light-emitting diode (OLED) roll was fabricated on the PET roll by full roll-to-roll processes. The roll-to-roll processes include a moisture-barrier deposition, transparent electrode preparation, insulator-pattern printing, OLED vacuum deposition, and encapsulation. The width and thickness of the PET roll was 150 mm and 100 μm, respectively. Since all processes were carried out in roll-to-roll, the moisture barrier and transparent electrode should be flexible enough to be safe during the processes. An organic/inorganic hybrid moisture-barrier structure was utilized to ensure the flexibility. The deposition of the moisture barrier was done by an atomic layer deposition and plasma-enhanced chemical vapor deposition at the temperature of 80°C. The flexible transparent electrode was silver-nanowire networks embedded in an ultra-violet curable resin. The silver-nanowire electrode was smooth enough for the OLED to have a low leakage current and utilized as the OLED anode without an additional conducting electrode. After the roll-to-roll vacuum deposition of OLED on the transparent electrode, the same moisture-barrier film was face-sealed on the OLED using a commercial sealant containing dessicant particles.

# 35 High Quality Crystalline Film

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 14:00~15:05
**Session Chair:** Prof. Takashi Noguchi (Univ. of the Ryukyus, Japan)

## C35-1 14:00~14:25

### Invited Ultra-High-Frequency Fiber-Laser-Based Spot-Beam Crystallization of Si Films for Advanced AMOLED Displays

*James S. Im, Wenkai Pan, Ruobing Song, Vernon K. Wong, Miao Yu, Insung Choi, and Akhilesh K. Suresh (Columbia Univ., USA)*

Spot-Beam Crystallization (SBC) is a recently introduced beam-induced crystallization method. The method isnoteworthy in that it is procedurally and technically, but not fundamentally, distinctfrompreviously demonstrated laser-crystallization techniques.In contrast particularly to excimer-laser-based and/or line-beam-based approaches, SBC utilizes a small spot beam that raster scans overSi films at extremely highvelocities (~ around or greater than hundreds of m/s) to rapidly heat, melt, and crystallize thefilms on high-temperature-intolerant glass or plastic substrates.When configured and implementedoptimally, the SBC method can potentially provide numerous and substantial benefits over existinglaser-crystallization techniques.

## C35-2 14:25~14:50

### Invited (211) and (100) Surface Oriented Poly-Si Thin Film Transistors with Continuous-Wave Laser Lateral Crystallization

*Shin-Ichiro Kuroki, Thi Thuy Nguyen, and Mitsuhisa Hiraiwa (Hiroshima Univ., Japan)*

We have been developing two types of poly-Si TFTs using Continuous-Wave Laser Lateral Crystallization. The one is poly-Si TFT with (110)-(111)-(211) bi-axially oriented crystal grains, and the another one is (100) poly-Si TFT. By using (100) poly-Si thin films, ultra-high mobility poly-Si TFTs have been developed. The highest field effect mobility was 1010 $cm^2/Vs$. The ratio of (100) orientation measured by XRD was 96.7%. Variation of the TFT characteristics was caused by the variation of crystal orientation. Uniformity control to (100) crystal is the next issue for the (100) poly-Si TFTs.

## 35 High Quality Crystalline Film

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 14:00~15:05
**Session Chair:** Prof. Takashi Noguchi (Univ. of the Ryukyus, Japan)

### C35-3 14:50-15:05

**Sputtered InSb Film After RTA for Magnetic Sensor Applications**

*Koswaththage Charith Jayanda, Tatsuyuki Higashizako, Tatsuya Okada, and Takashi Noguchi (Univ. of the Ryukyus, Janpan)*

InSb film with very high carrier mobility of 319 $cm^2/(Vs)$ was obtained with sputtering at Ar atmosphere after RTA at 520ºC for 30 sec withoutadopting epitaxial growth. Based on the very high mobility, attractive device applications such as high resolution IR detectors, magnetic field sensors and ultra-high-speed transistors as a TFT system are expected by crystallizing the InSb film on the glass.

## Banquet

**Welcome to our Banquet!**
**Participants are required to show the 'Banquet Ticket' at the entrance.**
**Great food and enjoyable performance will be there!**

- **Place: 1F, Grand Ballroom, The Westin Chosun Busan**
- **Date & Time: Aug. 30, 2017 (Wed.) / 19:00~21:00**

# 36 High Performance LC Device

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 14:00~15:05
**Session Chair:** Prof. Hak-Rin Kim (Kyungpook Nat'l Univ., Korea)

## D36-1 14:00~14:25

### Invited Anisotropic and Asymmetrical Light Scattering by Polymer Network Liquid Crystals

*Cheng-Kai Liu, Wei-Hsuan Chen, and Ko-Ting Cheng (Nat'l Central Univ., Taiwan)*

Broadband scattering-type optical isolators/linear polarizers with their properties of electrically switchable and asymmetrical transmission using Polymer network 90° twisted nematic liquid crystals (PN-90° TNLCs) have been reported. Briefly, the doped reactive mesogen will be polymerized and aligned along 90° TNLCs. LC alignment can continuously rotate from one substrate to the other. Accordingly, the generated polymer network structures will be consistent with that of the 90° TNLCs. Without the application of external voltage, PN-90° TNLCs work as common 90° TNLCs. However, with suitable external voltage application, incident lights with a specifically linear polarization direction can penetrate PN-90° TNLCs from one direction; the linearly polarized light, which comes from the opposite direction, can be scattered. The reason for such light scatterings results from the refractive index mismatch of the generated multi LC domains. The electrically switchable optical isolators and linear polarizers are believed to have great potential for display and information technologies.

## D36-2 14:25~14:50

### Invited Effect of Energy Transfer of Host LC in Polymer Stabilization of Vertically Aligned Liquid Crystals

*Sudarshan Kundu (Jasper Display Corp., Taiwan) and Shin-Woong Kang (Chonbuk Nat'l Univ., Korea)*

After the development of liquid crystal (LC) with negative dielectric anisotropy and homeotropic alignment polyimide materials, vertically aligned LC (VALC) mode display became popular in the market due to its higher contrast and faster switching time over conventional twisted nematic (TN) display. However, the polymerization efficiency of the monomers in the LC host plays a crucial role in stabilization of the LC molecules on the substrate. It has been found that LC host with terphenyl singles increases the polymerization rate. The reason behind it has not been studied well. Energy transfer from terphenyl singles of the host LC influences the rate of polymerization, yielding a higher rate of of polymerization.

# 36 High Performance LC Device

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 14:00~15:05
**Session Chair:** Prof. Hak-Rin Kim (Kyungpook Nat'l Univ., Korea)

## D36-3 14:50~15:05

### Enhancement of Response Characteristic of Liquid Crystal Display at Low Temperature using Over Driving Circuits

*Songyi Jeong, Wontaeck Kim, Soo In Jo, Sangsoon Yoon, Seungryull Park, Jounho Lee, Mike Jun, and In Byeong Kang (LG Display Co., Ltd., Korea)*

Recently, various electronic technologies are converged into auto-mobile appplications owing to improvement of communication. Among them, display panel is one of the most important components to visualize those informations. To realizean uniform image quality at various circumstances such as low temperature, over-driving circuit(ODC) is generally used, which applies a higher elecric field during 1 frame time before intended gray level. Using ODC at room temperature, response time is greatly reduced by promoting movement of LC molecules. In this paper, we propose a new ODC techniques in two approaches which can operate well at low temperature condition.

# 37 Oxide TFTs: Stability

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 14:00~15:30
**Session Chair:** Prof. Jae Kyeong Jeong (Hanyang Univ., Korea)

## E37-1 14:00~14:25

### Invited Experimental Decomposition of the Positive Gate-bias Temperature Stress-induced Instability and its Modeling in InGaZnO Thin-film Transistors

*Dae Hwan Kim, Sungju Choi, Juntae Jang, Hara Kang, Dong Myong Kim, Sung-Jin Choi (Kookmin Univ., Korea), Yong-Sung Kim (KRISS, Korea), Saeroonter Oh (Hanyang Univ., Korea), Ju Heyuck Baeck, Jong Uk Bae, Kwon-Shik Park, Soo Young Yoon, and In Byeong Kang (LG Display Co., Ltd., Korea)*

The positive gate-bias temperature stress (PBTS)-induced instability in top gate self-aligned coplanar InGaZnO thin-film transistors is experimentally decomposed into contributions of distinct mechanisms by combining the stress-time-divided measurements and the extraction of subgap density-of-states (DOS) from the optical response of C-V characteristics. It is found that a total threshold voltage shift ($DV_{T,tot}$) under PBTS is decomposed into three mechanisms: 1) increase of DOS due to excess oxygen in the active region ($DV_{T,DOS}$), 2) shallow ($DV_{T,shallow}$) and 3) deep charge trapping in the gate insulator components ($DV_{T,deep}$). All $DV_T$ components are well fitted with the stretched-exponential (SE) functions with individual parameters and the $DV_{T,tot}(t)$ is well described by the superposition of multiple SE functions. Our results can be easily applied universally to any device with any stress conditions, along with guidelines for joint optimization of the dielectrics, the active layer, and the interfaces towards ultimate PBTS stability.

## E37-2 14:25~14:50

### Invited On the Reliability of an InGaZnO Thin-Film Transistor under Negative Bias Illumination Stress

*Jiapeng Li, Lei Lu, Hoi-Sing Kwok, and Man Wong (HKUST, Hong Kong)*

Persistent photo-conductivity as a mechanism to account for the negative shift in turn-on voltage during negative gate bias and illumination stress has been excluded by studying the characteristics of TFTs under pure illumination stress. The hole-trapping model has been examined by considering the field-dependent transport of photo-generated holes in the channel under both negative and positive gate bias illumination stress. It is further verified that the population of holes depends on the amount of oxygen vacancy defects.

# 37 Oxide TFTs: Stability

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 14:00~15:30
**Session Chair:** Prof. Jae Kyeong Jeong (Hanyang Univ., Korea)

## E37-3 14:50~15:15

### Invited On the Origin of NBS and NBIS in Amorphous IGZO

*Paul Heremans, Albert de Jamblinne de Meux, Ajay Bhoolokam, and Geoffrey Pourtois (imec, Belgium)*

We study the root cause of common reliability problems of amorphous IGZO, being Negative Bias Stress and Negative Bias Illumination Stress, by developing a reliable ab-initio kit for amorphous IGZO and comparing ab-initio investigations to experiments. Regarding NBS, we show that oxygen vacancies are created that are perfect donors. We discuss the possible role of first-neighbor metal-metal bonds. For NBIS, we show the role of the generated holes. In relation to that, we also explain the role of hydrogen on NBIS. The NBIS itself is shown to be caused by peroxide creation. Finally, we draw conclusions on how to improve bias stress of amorphous IGZO.

## E37-4 15:15~15:30

### Highly Reliable Source/Drain Region Formation of In-Ga-Sn-O TFT with Self-Aligned Top-Gate Coplanar Structure by Wet-etch process

*Kwang Hwan Ji, Pil Sang Yun, Jiyong Noh, Jong-Uk Bae, Kwon-Shik Park, SooYoung Yoon, and In Byeong Kang (LG Display Co., Ltd., Korea)*

In this paper, we investigated the high mobility In-Ga-Sn-O TFTs with self-aligned source/drain regions ($n^+$-IGTO) formed by wet etch process. In case of conventional G.I dry-etching process, $n^+$-IGTO region is easily recovered by oxidation as following thermal annealing process. We achieved the improvement of thermal stability of $n^+$-IGTO region by G.I wet-etch and H-incorporation. The resistivity and thermal stability of $n^+$-IGTO by wet-etch was comparable to the conventional dry-etch, 5.3x10-3Ω·cm and 109%. In these results, we imply that the M-OH bonding by H-incorporation is more stable than re-oxidation of oxygen vacancies by plasma treatment in thermal oxidation atmosphere. Therefore, the $n^+$-IGTO electrical characteristics formed by G.I wet-etch process is comparable to that of dry-etch process.

## 38 3D Display for VR and AR Applications (3DSA Joint Session)

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 14:00~15:35
**Session Chair:** Prof. Wei-Chia Su
(Nat'l Changhua Univ. of Education, Taiwan)

### F38-1 14:00~14:25

### Invited Virtual Reality Enhanced by Human Intelligence

*Hideaki Kimata (NTT Corp., Japan)*

Immersiveness is a main feature of virtual reality technology. It is a notional goal to have complete virtual reality since human feels reality while referring to their memory. But first of all, many studies on audio-visual environment for virtual reality have been reported, because high quality audio-visual information is commonly necessary. We also have developed high quality video streaming technology for head mount display and achieved video streaming from Las Vegas in the U.S. to Tokyo in Japan for many consumers in 2016. In this trial, it was demonstrated that high quality video actually improves user experience in consumer service.

*(3DSA Paper)*

### F38-2 14:25~14:50

### Invited Aerial Projection of Three-Dimensional Images based on Integral Photography and Fog Display

*Takashi Kakue, Keisuke Uchigata, Yutaka Endo, Tomoyoshi Shimobaba (Chiba Univ., Japan), Yasuyuki Ichihashi, Kenji Yamamoto (NICT, Japan), and Tomoyoshi Ito (Chiba Univ., Japan)*

We report a three-dimensional (3D) aerial-projection system based on integral photography (IP) and fog display. IP records a light field from an object as an IP image by using a lens array comprising many convex lenses. For the reconstruction process, the recorded IP image is projected onto the lens array. Then, the recorded light field of the object is reconstructed via the lens array and the 3D image of the object is reconstructed. The proposed system projects the 3D image on a fog display. We generated an IP image from 3D objects using a 3DCG modeling tool. We constructed the fog display which can spout fog having a depth in the z-direction. We successfully demonstrated that the proposed system projected 3D images on the fog display.

## 38 3D Display for VR and AR Applications (3DSA Joint Session)

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 14:00~15:35
**Session Chair:** Prof. Wei-Chia Su
(Nat'l Changhua Univ. of Education, Taiwan)

F38-3 14:50~15:05

### Numerical Modeling and Analysis of Augmented Reality Optical System of Hololens

*JongHa Park, SooBin Kim, JungBeom Choi, and Hwi Kim (Korea Univ., Korea)*

In January 2016, Microsoft announces the AR(Augmented Reality) device 'Hololens'. It showed a new possibilities of AR devices. Hololens provides augmented reality through thin diffractive light combiner without using conventional lens. To analyze the optical structure of the combiner, we developed numerical modeling of Hololens optics. In this paper, the optical structure of a hololens is numerically modeled, analyzed and simulated in terms of geometrical optics and electromagnetics. Also, we will propose a novel structure to improve yield of the grating process, FOV(Field of View) and light emitting efficiency.

*(3DSA Paper)*

F38-4 15:05~15:20

### Diminished Reality Using Plane-based Reconstruction Method

*Megumi Isogai, Daisuke Ochi, and Hideaki Kimata (NTT Corp., Japan)*

Diminished reality (DR) technology removes unnecessary target objects from video images and reconstructs the missing regions with background images. To apply applications that need to show actual scenes in real-time, we propose an observation-based DR method that needs less calculation cost. The method selects the optimum camera captured the background of the target objects from multiple cameras, and overlays projective transformed images of selected cameras on the target object area.

*(3DSA Paper)*

## 38 3D Display for VR and AR Applications (3DSA Joint Session)

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 14:00~15:35
**Session Chair:** Prof. Wei-Chia Su
(Nat'l Changhua Univ. of Education, Taiwan)

F38-5 15:20~15:35

### A Novel Watermarking Method against VR Panoramic Distortion

*I-Seul Kang, Young-Ho Seo, and Dong-Wook Kim (Kwangwoon Univ., Korea)*

In this paper, we propose a novel watermarking method using SIFT features that is robust against distortion occurred in creating VR panorama image of 360 degrees. A 360 degree VR panoramic image has a lot of distortion due to stitching of multiple images and projecting spherical space to two dimension space. This distortions could be considered one of the non-malicious attack.Since the service standard for VR images has not been defined until now, a watermarking method use Equirectagular panoramic image for target, which is currently used in VR image service. The proposed algorithm inserts a watermark on the original image acquired from the camera and extracts from equirectangular images.

*(3DSA Paper)*

**Banquet**

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**Great food and enjoyable performance will be there!**

- **Place: 1F, Grand Ballroom, The Westin Chosun Busan**
- **Date & Time: Aug. 30, 2017 (Wed.) / 19:00~21:00**

# 39 Photometry and Measurement

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 14:00~15:30
**Session Chairs:** Prof. Jae-Hyeon Ko (Hallym Univ., Korea)
Prof. Dong-Sing Wuu (Nat'l Chung Hsing Univ., Taiwan)

## G39-1 14:00~14:25

### Invited Photometry of LED and OLED Devices

*Tony Bergen (Photometric Soultions Int'l Pty Ltd., Australia)*

LEDs have drastically changed the way that we do lighting. They are dynamic, versatile and colourful. They can easily be dimmed, tuned and pulsed; they are rugged; they have long lifetimes; and in different combinations they can make vivid and interesting shapes as well as engaging and vibrant illuminated scenes. But they also create problems when it comes to measurement and standardisation. Not all of these problems are particularly new or unique, but they have become more significant or apparent with the advent of LED and OLED lighting and require careful consideration.

## G39-2 14:25~14:50

### Invited Photometry Measurement for Curved Surface Sources

*Hsueh-Ling Yu (Singularity Optics Corp., Taiwan), Richard Young (Instrument Systems GmbH, Germany), Chin-Chai Hsiao, and Wen-Chun Liu (Center for Measurement Standards, Taiwan)*

The development trend for high-tech products is towards the capability of flexibility, for example flexible lighting, display, and so on. The traditional photometry measurement methods for flat and rigid products may not be applicable for flexible products. Refining the measurement method to characterize the photometry characteristics of flexible products will help the manufacturers incorporate good metrology that will enable better products, decrease manufacturing costs, and reduce business disputes. As curved is the most common shape of current flexible products, this paper focuses on the luminance, luminous flux, colour, and reflectance measurement of curved surface sources, since curved surface sources are the basic components of flexible displays and flexible lighting, and those quantities are the most important characteristic for surface source.

# 39 Photometry and Measurement

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 14:00~15:30
**Session Chairs:** Prof. Jae-Hyeon Ko (Hallym Univ., Korea)
Prof. Dong-Sing Wuu (Nat'l Chung Hsing Univ., Taiwan)

## G39-3 14:50~15:15

### Invited Psychophysical Approach for Evaluating Performance of OLED Panels for Lighting

*Yasuki Yamauchi (Yamagata Univ., Japan)*

OLED is expected as one of the next generation lighting devices. As OLED panel is a planar surface-emitting lighting device, non-uniformity of OLED due to several production process and non-uniform current density is easily detected. Therefore, luminance uniformity inside the panel, and the angular dependent uniformity in chromaticity are both important aspects in assessing the performance of the OLED panel. We tried to find an evaluation index to assess the uniformity of the OLED panel based on human perception. We simulated several non-uniform patterns on a LCD monitor, asking subjects to evaluate the non-uniformity of the stimulus. In my talk, the experimental results on luminance gradients perception and chromatic change depending on the direction of the panel will be introduced. I will also try to compare the results with the present indexes proposed in IEC standards.

## G39-4 15:15~15:30

### The Design of Optimized Pattern on Light Guide Plate with a Curve of 20R

*Sungrae Lee, Hee Cheol Kim, Yong Hun Jeong, Byuong Ku Kim, and Seung Jun Han (LG Display Co., Ltd., Korea)*

In this study, we have designed an optimized pattern of a 8-inch light guide plate (LGP) with a curved radius of 20R to increase output illuminance uniformity. The uniformity of output illuminance from LGP at a curve of 20R was improved by controlling the interval of pattern along light propagation axis and the result is 80%. We have found that the pattern interval of 20R curved LGP near light source decreased up to 12% while the pattern interval far from light source increased up to 44% in comparison to pattern interval of flat LGP. This results comes from the change of the total internal reflection at the top surface of LGP and at the surface of pattern. This numerical analysis will be considered for the possibility of designing backlight units for extremely curved display.

# 40 Industrial Forum Ⅲ

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 14:00-17:20
**Session Chair:** Julian K Chang (Boeing Commercial Airplane, USA)
**Panel Discussion Chair:** Prof. Changhee Lee(Seoul Nat'l Univ., Korea)

## Speaker 6

**OLED TV Market Forecast Followed by the Increase of Demand from Premium TV Market**

Choonghoon Yi
CEO, UBI Research (Korea)

## Speaker 7

**[KEY NOTE]**
**Quantum Dot and Advance of LCD-TV**

Nam Seok Roh
Vice President, Samsung Electronics (Korea)

## Speaker 8

**[KEY NOTE]**
**OLED, Now and Future**

Joon Young Yang
Head of OLED Advanced Research Division 1, LG Display (Korea)

## Speaker 9

**[KEY NOTE] TCL Display Technology with QDs**

Weiran Cao
Senior Scientist, TCL Corporate Research (China)

* Depending on the speaker's circumstances, the schedule/topics are subject to change.

# 41 Transparent and Flexible Devices

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 16:00~17:15
**Session Chair:** Prof. Han-Ki Kim (Kyung Hee Univ., Korea)

A41-1 16:00~16:25

## Invited Tough Hydrogels: Key Material for the Translation of Flat Panel Display Technology to Wearable Bioelectronics

*Hyun-Joong Chung (Univ. of Alberta, Canada)*

Hydrogels, polymer networks that contain large amount of water up to 99% of the total system, are started to be utilized in unprecedented applications, including wearable electronics that employs macroelectronics fabrications developed for flat panel display technology. The burgeoning of new application was powered by breakthroughs in recent decade to make tough and stretchable synthetic hydrogel by fundamental understanding of fracture mechanics and smart application of synthetic chemistry. In my presentation,, I review the mechanisms for toughening the hydrogel. Then, I review recent advances in the proof-of-concept devices that are directly relevant with flat panel displays. Finally, I introduce recent works from my research laboratory at the University of Alberta, including freeze-resistant hydrogels and their application in low-temperature supercapacitors and smart window arrays harnessing phase separation behavior of hydrogels.

A41-2 16:25~16:50

## Invited Transparent and Stretchable Electrodes for Wearable Electronics

*Jang-Ung Park (UNIST, Korea)*

Recently, wearable electronics detecting the physiological change for the diagnosis of disease have attracted extensive interests globally. Among them, contact lens is one of the most attractive candidate for the continuous and wireless health monitoring. To realize these personal see-through, devices all device components are required to be transparent and stretchable in order to be integrated into the multiplexed sensor system including wearable soft contact lenses. However, the transparent and stretchable sensors integrated on the biomaterials are not yet been realized. In this talk, we presented an unconventional approach to form transparent, flexible and sensitive multiplexed sensors for diagnosing diabetes and glaucoma based on hybrid nanostructures using one-dimensional metal nanowires and two-dimensional graphene.

# 41 Transparent and Flexible Devices

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 16:00~17:15
**Session Chair:** Prof. Han-Ki Kim (Kyung Hee Univ., Korea)

## A41-3 16:50~17:15

### Invited Molecular Conformational Control for High Performance Blue Polymer LEDs

*Ji-Seon Kim (Imperial College, UK)*

Solution processing is considered as one of the key factors in the economic and energy efficiency case for organic LED-based lighting applications, enabling high throughput for large area manufacturing at low energy and capital cost. Tremendous efforts have been made so far to develop efficient deep-blue light emitting polymers for use in displays, with the latter requirement essential to achieving the colour gamut needed for high quality display applications, however their device performance and stability lags far behind that of red and green emitters. In this talk, I will show a new approach we take to the achievement of deep-blue, high efficiency polymer LEDs via a simple, scalable molecular level conformational control in the conjugated backbone of a fluorene based copolymer. I will discuss the role of (i) the charge transporting units in the copolymer acting as efficient charge trapping/ exciton generation sites and (ii) the intra and intermolecular energy transfer to the emitting segments.

# 42 OLED Stability & Lifetime

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 16:00~17:30
**Session Chairs:** Dr. Axel Fischer (TU Dresden, Germany)
Prof. Shi-Jian Su (South China Univ., China)

## B42-1 16:00~16:25

### Invited Molecular Understanding of the Inferior Lifetime of Blue OLEDs and Implications for the Design of New Materials

*Juan Qiao (Tsinghua Univ., China)*

With the realization of high efficiency, limited operational stability becomes instead the key impediment to wide commercialization of OLEDs, in particular for high-energy blue-emitting devices. Most recent studies suggest that the intrinsic device degradation is mainly resulted from the chemical deterioration of organic materials in OLEDs. To enable the development of novel materials with enhanced durability, it is of high importance to deepen the understanding the relationship between molecular structure and chemical stability of the materials. We conducted comprehensive experiments and theoretical calculations to comparatively investigate the intrinsic chemical stability of a series of host and blue-emitting materials. Quantum chemical calculations fully supported the experimental results and suggested that the weak chemical bonds with bond strength lower than the singlet/triplet energies of the molecules would determine the intrinsic chemical stability of the corresponding organic materials. Several implications have been drawn for the design of new blue-emitting materials.

## B42-2 16:25~16:50

### Invited Kinetic Analysis of Degradation Process of Organic Light Emitting Diodes based on a Linear Combination of First-Order Reactions

*Hideyuki Murata (JAIST, Japan)*

In this study, we analyzed luminance-time (*L*–*t*) curve of the OLEDs by combined-exponential decay (CED) functions, which composed of a linear combination of exponential terms by assuming that the entire degradation reaction consists of parallel first-order reactions. For the fitting with CED functions, we vary the number of exponential terms from two to four. The OLED with the device structure of ITO/$MoO_3$ (0.75 nm)/α–NPD (90 nm)/ $Alq_3$ (70 nm)/Al (100 nm) was operated at a constant current density of 50 mA/$cm^2$. We found that the degradation of $Alq_3$-based OLEDs is caused by three degradation reactions. In another word, we uncovered a hidden degradation reaction (*the third model*) in addition to the previously known degradation models such as creation of quenchers due to the decomposition of α–NPD and the cationic $Alq_3$ for the first time.

# 42 OLED Stability & Lifetime

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 16:00~17:30
**Session Chairs:** Dr. Axel Fischer (TU Dresden, Germany)
Prof. Shi-Jian Su (South China Univ., China)

## B42-3 16:50~17:15

### Invited Thermal Stability of Amorphous Films in OLEDs — Why are vacuum-processed films more stable than solution-processed ones? —

*Daisuke Yokoyama (Yamagata Univ., Japan)*

As the range of applications of OLEDs has been growing broader, the demand for high stability of their films and devices have also become more severe. However, thermal stability of the OLED films and devices has not yet been sufficiently understood because of the complexity and variety of amorphous organic films. In this presentation, some topics about thermal stability of small-molecule amorphous OLED films will be discussed: (1) the difference between the thermal stabilities of vacuum- and solution-processed films, (2) the formation mechanism of the relatively stable vacuum-processed films, (3) the relationship between molecular orientation and thermal stability, and (4) the thermal stabilities at the surface, at the interface, and in the bulk of the films. Our findings are important to understand the formation mechanism and stability of OLED films and also to overcome the disadvantages of solution-processed films for the future.

## B42-4 17:15~17:30

### Extended Lifetime in Conventional Fluorescent Organic Light-Emitting Diodes via Energy Transfer Process

*Hyun-Gu Kim, Kwon-Hyeon Kim, and Jang-Joo Kim (Seoul Nat'l Univ., Korea)*

Harvesting triplet excited states in the light emitting process has been an important issue for efficient organic light-emitting diodes (OLEDs). Heavy metal complexes, thermally activated delayed fluorescence (TADF) materials and exciplexes resulted in efficient OLEDs, but device stability has been issued because of a slow decay process due to spin-mixing process in the emitters. Recently, we demonstrated a method to use both sensitization and induced heavy atom effects to utilize triplet excited states for efficient fluorescent OLED. However, the device lifetime has not yet been reported. In this work, we reoprt highly efficient fluorescent organic light-emitting diodes (OLEDs) with the maximum external quantum efficiency exceeding 25.0% and extended lifetime using iridium (Ir) complex sensitizers doped in an exciplex host. Energy transfer processes reduce the lifetime of the exciplex and excitons on the Ir complexes and enable an excited state to exist in a conventional fluorescent emitter, thereby increasing device lifetime.

# 43 Structure Engineering of LTPS Device

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 16:00~17:15
**Session Chairs:** Prof. Shin-Ichiro Kuroki (Hiroshima Univ., Japan)
Prof. James S. Im (Columbia Univ., U.S.A)

## C43-1 16:00~16:25

### Invited Four-Terminal LTPS TFTs on a Glass Substrate

*Akito Hara and Hiroki Ohsawa (Tohoku Gakuin Univ., Japan)*

We have evaluated the performance of the 4T CLC LT poly-Si TFTs and they exhibited excellent controllability of $V_{th}$, small subthreshold swing (s.s.), and high electron field-effect mobility. Using the high controllability of Vth of the n-channel and p-channel 4T CLC LT poly-Si TFTs, the operation of CMOS inverter under Vdd=1.0 V was succeded.

## C43-2 16:25~16:50

### Invited Challenges for Application of LTPS TFT in Flexible AMOLED Display

*Shixing Cai, Kun Hu, Li Lin, Xiaoyu Gao, and Xiuqi Huang (Visionox, China)*

Active-Matrix Organic Light-Emitting Diode (AMOLED) has been widely used in flat panel displays due to its excellent performance, such as wide viewing angle, light weight and vivid color. And the flexible display has become the most anticipated application for AMOLED. Besides its ultra-thin and light, it is extraordinarily flexible. But when the substrate changes from rigid glass to flexible polyimide, LTPS TFT would face many challenges for array design, process issues related to flexible substrate, module integration, stress management, and so on. When the device experiences certain strain, the critical function layer will rupture and the electrical properties will fail when the strain exceeds their critical strain.

## 43 Structure Engineering of LTPS Device

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 16:00~17:15
**Session Chairs:** Prof. Shin-Ichiro Kuroki (Hiroshima Univ., Japan)
Prof. James S. Im (Columbia Univ., U.S.A)

C43-3 16:50~17:15

### Invited Recent Flexible LTPS TFT Reliability Issues: Challenges of 100,000 Repetitive Bends

*Ting-Chang Chang, Bo-Wei Chen, Yu-Ju Hung (Nat'l Sun Yat-Sen Univ., Taiwan), Wei-Han Chen, Terry Tai-Jui Wang, and Tsu-Chiang Chang (ITRI, Taiwan)*

In this talk, the instability of flexible low-temperature polycrystalline silicon thin film transistors (LTPS TFTs) after undergoing 100,000 iterations mechanical bending is deeply discussed. Neither metal contact crack nor degradation in the active layer, we suggest the major challenge of TFTs is how to reduce the mechanical bends-induced degradation in gate insulator (GI). By observing the I-V characteristics after undergoing 100k iterations mechanical bending at R=2mm, three kinds of degradation can be found. Firstly, there is an apparent hump generation. Besides, there is also a positive threshold voltage shift. Last but not the least, an on-current increase can be observed. These effects can be attributed to the change of GI quality. By adopting the mechanical stress simulation and electrical field simulation, the mechanical stress while bending tends to induce inhomogeneous traps in GI and further cause the carrier injection into them.

# 44 New Display Systems and Electronics

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 16:00-17:25
**Session Chair:** Prof. Kee Chan Park (Konkuk Univ., Korea)

D44-1 16:00~16:25

## Invited Power Consumption Reduction Technique for Gate Driver Circuits

*Chih-Lung Lin, Mao-Hsun Cheng, and Po-Cheng Lai (Nat'l Cheng Kung Univ., Taiwan)*

Power consumption has been an important issue for various circuit designs. In terms of gate driver circuits with n-type thin-film transistors (TFTs) for active-matrix flat-panel displays (AMFPDs), several approaches have been revealed, mainly focusing on the pull-up TFT; (a) overlapping clock signals as the main driving signals, (b) a DC voltage source as the main driving signal, (c) applying a negative off voltage to the pull-up TFT, and (d) clock signals with lower duty ratios as the main driving signals. To further reduce the overall power consumption of a gate driver circuit, we turned to improvement on the pull-down circuit.

D44-2 16:25~16:40

## Wall-Paper OLED Display Technologies for Large-Size & Lowest Thickness TVs

*Sung-Woo Park, Sung-hoon Kim, Gi-Hyon Jun, An-Soo Kim, Young-Jun Hong, Sin-Kyun Park, In-Joo Kim, Han-Seop Kim, Hyeon-Woo Lee, and Chang-Ho Oh (LG Display Co., Ltd., Korea)*

In this paper, we present the Wall-paper OLED Display module technologies of LG Display. Wall-paper TV of LG Electronics got the Best of best award in 2017 CES. LG Display and LG Electronics studied and developed this wall-paper TV for two years. Finally Wall-paper TV has an inovative mimumun thickness, min. 2.57mm & max. 3.85mm. It is the lowest thickness of the Large-Size TVs.To overcome the limitation of 4mm thicness of OLED TV, LG Display has developed the four major technologies. These tecnologies are the new thinest structure of OLED module, the new back-cover to use magnetic sheets for complete wall-fitting, the world's first hybrid cable for high power and high speed data, and new LG interface ICs has HDCP for illegal data copy protection.Because of these Wall-paper TV technologies, 65inch TV weight has dramatically reduced from 24.7kg to 7.6kg. So women are easily able to carry out Large-Size TV.

# 44 New Display Systems and Electronics

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 16:00-17:25
**Session Chair:** Prof. Kee Chan Park (Konkuk Univ., Korea)

## D44-3 16:40~16:55

### Novel Display Using Fluorescent Color Filter and In-Cell Polarizer with High Image Quality under Ambient Light

*Norio Koma (Polatechno Co., Ltd., Japan), Takahiro Ishinabe (Tohoku Univ., Japan), Hiroki Kato (Polatechno Co., Ltd., Japan), and Hideo Fujikake (Tohoku Univ., Japan)*

We proposed a new display system with improved visibility under ambient light without decreased visibility in dark places by using fluorescent color filter and in-cell polarizer. We confirmed that in experiments the new display provided high image quality under ambient light.

## D44-4 16:55~17:10

### Electrochromic Full Color Reflective Display

*Ik Jang Ko, Jin Hwan Park, Jin Woo Kim, Gyeong Woo Kim, and Jang Hyuk Kwon (Kyung Hee Univ., Korea)*

From the past few years ago, wearable display technology have been attracting great attention with growth market of smart watch and google glass. For these applications, reflective display is more suitable than emissive display because their display mechanism using ambient light, not inner light source causing low contrast ratio and high power consumption. Full-color reflective displays have advantages to reallize full color, whereas the brightness of the white color is reduced due to the optical loss at least 70% in filtered light. In this research, we report a new full-color reflective electrochromic device combined B/W reflective electrochromic device (RECD) and color electrochromic device (CECD) as reflectivity control unit and color display unit, respectively. Due to the high transmittance of CECD at the transparent state, very high average of diffuse reflectance in the range of 400~700 nm of 47.17% (red: 46.85%, green: 44.10%, blue: 50.56%) was achieved in the white color.

## D44-5 17:10~17:25

### Reverse Tone Mapping with Adaptive Mapping Curve

*Yong Deok Ahn, Gwon Hwan An, Young-Sun Kim, and Suk-Ju Kang (Sogang Univ., Korea)*

This paper proposes a reverse tone mapping using an adaptive mapping curve. The proposed mapping curve which are suitable for HDR rendering with highlight expansion and reduce the perceptual image degradation.

# 45 Oxide TFTs: Novel Process

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 16:00~17:30
**Session Chairs:** Dr. Jong Uk Bae (LG Display Co., Ltd., Korea)
Prof. I-Chun Cheng (Nat'l Taiwan Univ., Taiwan)

## E45-1 16:00~16:25

### Invited Rational Design of Molecular Precursor and Processing Method for High Performance and Low Temperature Solution-Processed Oxide Electronics

*Myung-Gil Kim (Chung-Ang Univ., Korea)*

Solution processed metal oxide electronics could potentially meet the requirements of commercial large area electronics, such as high-throughput fabrication processes and a choice of materials with appropriate electrical performance. However, this area still faces several challenges, such as low performance, high annealing temperatures, and the inability to fine-tune intrinsic properties. An intensive study of interface optimization, novel fabrication concepts, and new materials development can addresses critical issues in solution processed metal oxide semiconductor electronics. The new precursor designing principle, processing concepts and hybrid interface afford the development of high performance electronic materials (conductor, semiconductor, insulator), low processing temperature ($T_{process}$ ~ 60˚C) and device stabilzation against Cu ion and gas diffusion. Compared to the conventional sol-gel precursors, the novel precursor design concepts, such as combustion precursors and molecular metal-hydroxy-oxo cluster, dramatically reduce the processing temperature as low as 60 ~ 200 ˚C, in combination with the photochemical activation process.

## E45-2 16:25~16:50

### Invited Metal Oxide based Printed Devices

*Jaewon Jang (Kyungpook Nat'l Univ., Korea), Will Scheideler, and Vivek Subramanian (California Univ., USA)*

Conventional IC fabrication is normally a vacuum-based deposition technique and photolithography process. The conventional vacuum-based technology requires an expensive and time consuming high vacuum conditioning process before deposition or etching. Therefore, we have chosen an alternative fabrication process suitable for large area applications with high throughput and a reduced cost. This alternate printing technology originates with the newspaper media and graphic arts fields. The sol-gel process is a promising method to deposit metal oxides, where the starting materials are liquid phase precursors. By controlling the physical properties of the liquid phase precursors, inkjet-printed thin-film transistors, complementary resistive switching memory, and transparent metal oxide electrodes were successfully realized.

# 45 Oxide TFTs: Novel Process

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 16:00~17:30
**Session Chairs:** Dr. Jong Uk Bae (LG Display Co., Ltd., Korea)
Prof. I-Chun Cheng (Nat'l Taiwan Univ., Taiwan)

## E45-3 16:50~17:15

### Invited High-Performance Oxide Transistors, and the Road to Roll-to-Roll Manufacturing

*Gerwin Gelinck (Holst Centre/TNO, Netherlands), Joris de Riet, Auke Kronemeijer (Eindhoven Univ. of Tech., Netherlands), Ilias Katsouras, and Paul Poodt (Holst Centre/TNO, Netherlands)*

Amorphous oxide thin-film transistors offer advantages in terms of process simplification, performance and compatibility with flexible plastic substrates[1]. These n-type transistors form the fundamental building blocks for a wide range of applications such as foil-based display and sensor backplanes, intelligent labels, and other forms of flexible electronics. Today's approach, based on photolithography, vacuum processing and etching steps of the oxide TFTs, allows FPD industry to utilize today's equipment and fab infrastructure that is based on large (glass) sheets.

## E45-4 17:15~17:30

### A Study on the Electric Performance of Amorphous Indium Gallium Zinc Oxide Thin Film Transistor Grown by Atomic Layer Deposition

*Minhoe Cho, Hyeonjoo Seul, Jeongoh Kim (Hanyang Univ., Korea), Pilsang Yun, Jong-uk Bae, Kwonshik Park (LG Display Co., Ltd., Korea), and Jaekyeong Jeong (Hanyang Univ., Korea)*

Amorphous indium gallium zinc oxide (a-IGZO) thin films were fabricated by atomic layer deposition (ALD) using [3-(dimethylamino) propyl] dimethyl indium (DADI), trimethyl gallium (TMGa), diethyl zinc (DEZ) and ozone ($O_3$) as the indium, gallium, zinc precursor and reactant, respectively. The layer of IGZO was grown by sequential ALD cycles in order injection of indium oxide ($In_2O_3$), zinc oxide (ZnO) and gallium oxide ($Ga_2O_3$) at 250°C. IGZO layer was treated Post-deposition annealing by different temperature. The amorphous IGZO TFTs exhibited high electron mobility of 36.8 $cm^2/V \cdot s$, $V_{TH}$ of 1.49 V, SS of 0.45 V/decade, and $I_{ON/OFF}$ ratio of 7 ´ $10^8$.

# 46 3D System Ⅰ(3DSA Joint Session)

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 16:00~17:10
**Session Chairs:** Dr. Toru Iwane (Nikon, Japan)
Prof. Jar-Ferr Yang (Nat'l Cheng-Kung Univ., Taiwan)

## F46-1 16:00~16:25

### Invited Optimized Design for Light Field Near to Eye Display

*Fu Ming Chuang (Coretronic Corp., Taiwan), Jui Yi Wu (Nat'l Chiao-Tung Univ., Taiwan), Hsin Hsiang Lo (Coretronic Corp, Taiwan), Yu-Ching Cheng (Nat'l Chiao-Tung Univ., Taiwan), Chuan Chung Chang (Coretronic Corp., Taiwan), and Yi-Pai Huang (Nat'l Chiao-Tung Univ., Taiwan)*

Light Field Near to Eye Diaply (LFNED) with comprehensive analysis for best range of design first order parameters is discussed, and gap between lens array and display panel lower than 10mm is suggested, which providing balence performance between eye relief, eye box, field of view and angular resolution. Based on suggested range of parameters, Fig. 1 shows self-designed lens array with lower field curvature compare with stock lens, and LFNED with 200 cycle per radian in angular resolution and enlarged field of view 51.6$^{o}$ when using 0.7 inch display panel.

*(3DSA Paper)*

## F46-2 16:25~16:40

### Depth Map Preprocessing based on Inflection of Gradient for Virtual View Synthesis

*Kuan-Ting Lee, Bin-Da Liu, and Jar-Ferr Yang (Nat'l Cheng Kung Univ., Taiwan)*

The performance of virtual views generated by depth-image-based rendering (DIBR) depends on the quality of depth map. The artifacts occur on the object boundary because of that the foreground depth does not cover through the edge of the foreground image. The pixels which contain foreground information were marked as background and be left behind after image warping. The incorrect pixels might be filled in the virtual views.This paper proposed a method for depth preprocessing to solve this problem. The depth of the foreground object boundary is extended based on the inflection point of the gradient of the texture image. The new edge of foreground depth could cover through the mostly pixels with the foreground information. Therefore, the entire foreground object will be shifted after image warping, and there are hardly any artifacts left behind. In the virtual views, the proposed method maintains the mostly foreground information after view synthesis.

*(3DSA Paper)*

# 46 3D System I (3DSA Joint Session)

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 16:00~17:10
**Session Chairs:** Dr. Toru Iwane (Nikon, Japan)
Prof. Jar-Ferr Yang (Nat'l Cheng-Kung Univ., Taiwan)

## F46-3 16:40~16:55

### Formation of Both-Sided Aerial 3D Image by Use of Arc 3D with AIRR

*Kazuki Kawai and Hirotsugu Yamamoto (Utsunomiya Univ., Japan)*

This paper proposes a new method to form both-sided aerial 3D image formed with AIRR and Arc 3D. We show the different information at the same position in the mid-air to both sides.

*(3DSA Paper)*

## F46-4 16:55~17:10

### Full Parallax Crystal Ball Three-Dimensional Display

*Daerak Heo, Mugeon Kim, Geunseop Choi, and Joonku Hahn (Kyungpook Nat'l Univ., Korea)*

Recently, various technologies have been studied for realizing three-dimensional (3D) display. Multi-view display is one of the promising methods for realizing 3D display. When observers watch a display, they get different views dependent on their position in multi-view system. Among multi-view system, the tabletop display has a great potential to present the information in various applications and it is different from conventional flat 3D. The tabletop display presents stereoscopic images in 360-degree directions and it is useful for exhibition. On the application of exhibition, crystal ball 3D display has an advantage due to its spherical symmetry. But previous study has a critical problem that the optics are large to generate each view. So, the conflicts between the optics are inevitable and it is difficult to increase the number of views sufficiently. We devised a full parallax crystal ball 3D dispaly using time-multiplexing technique to overcome this conflicts.

*(3DSA Paper)*

# 47 Young Leaders Conference

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 16:00~17:30
**Session Chair:** Prof. Sang-Hee Ko Park (KAIST, Korea)

G47-1 16:00~16:15

## Modification of Metal Mesh Structure Fabricated by Cracked Template for Transparent Electrode

*Yeong-gyu Kim, Young Jun Tak, Sung Pyo Park, Hee Jun Kim, and Hyun Jae Kim (Yonsei Univ., Korea)*

We successfully fabricated highly interconnected metal mesh structure (MMS) for transparent and flexible electrodes based on lift-off process using self-formable cracked template. The cracked template which was used in this study could be easily formable and removable so that it is a simple and cost-effective way to make a randomly and uniformly networked MMS. The fabricated MMS showed well-interconnected mesh structure, and the structure of metal mesh could be controlled by varying the spin-coating rpm during coating of template solution or by multi-stacking the MMS layer. The structural modification resulted in the variation of the sheet resistance and transmittance of MMS. In addition, flexibility test was conducted for multi-stacked MMS. The more the MMS layers were stacked, the better flexibility was obtained, so the multi-stacked MMS is more suitable for flexible applications than the single-layered MMS.

G47-2 16:15~16:30

## A See-through Near-Eye Display for Presbyopia

*Chao Ping Chen, Yishi Wu, Lei Zhou,Yang Li, Bing Yu, and Huayi Jin (Shanghai Jiao Tong Univ., China)*

We propose a compact design of see-through near-eye display that is dedicated to presbyopia. Our solution is characterized by a plano-convex waveguide, which is essentially an integration of a corrective lens and two volume holograms. Its design rules are set forth in detail, followed by the results and discussion regarding the diffraction efficiency, field of view, modulation transfer function, distortion, and simulated imaging.

# 47 Young Leaders Conference

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 16:00~17:30
**Session Chair:** Prof. Sang-Hee Ko Park (KAIST, Korea)

## G47-3 16:30~16:45

### Flexible Device Fabrication Using Organic Vapor-Jet Printing with Reduced Heat Transfer

*Sungyeon Kim, Hyuk-yun Kwon, Gilho Lee, Dahm Yoo, Sung Jin Kim, Seunghyup Yoo (KAIST, Korea)*

Organic vapor-jet printing (OVJP) is a promising technique for low-cost fabrication of organic electronic devices, with advantages such as mask-less direct on-demand patterning, high material utilization efficiency, and the elimination of solvent use. However, due to high thermal load from the heated nozzle, the use of plastic substrates and organic materials with low glass transition temperature was limited. We have adopted a simple low-emissivity coating on the nozzle to drop the surface emissivity, which is directly proportional to the radiative heat flux. Under real printing conditions, a substrate temperature drop of 60 ℃ was realized with the low-emissivity-coated nozzle, enabling the use of plastic substrates such as PET. In addition, heat transfer analysis was done to control the substrate temperature while maintaining other conditions. This study shows that OVJP could be extended to fabrication of flexible organic devices with little compromise in patterning resolution, organic vapor throughput, or device performance.

## G47-4 16:45~17:00

### Highly Efficient Deep-blue Organic Light-Emitting Diodes Using Novel 2′,6′-Difluoro-4-(trimethylsilyl)-2,3′-Bipyridine Ligand-based Ir-complexes with Horizontally Oriented Transition Dipole Moment

*Yeon Hee Ha, Ran Kim, Yun-Hi Kim, Soon-Ki Kwon (Gyeongsang Nat'l Univ., Korea), Jang-Joo Kim, and Hyun Shin (Seoul Nat'l Univ., Korea)*

Newly designed Ir-complexes containing 2',6'-difluoro-4-(trimethylsilyl)-2,3'-bipyridine (dfpysipy) main ligands, which have the strongly horizontal orientation of the emitting dipole, were synthesized. Three Ir-complexes were prepared by varying their ancillary ligands, namely, pic, mpic, and fptz. The horizontal orientation of the emitting dipoles (Θ) for the Ir-complexes was 74%, 86%, and 77% for $Ir(dfpysipy)_2(pic)$, $Ir(dfpysipy)_2(mpic)$, and $Ir(dfpysipy)_2(fptz)$, respectively. Time-dependent density functional theory calculations were performed to understand the origin of the high Θ. This demonstrated that the ancillary ligands possess the largest negative electrostatic potential (ESP), which may strongly interact with host molecules with a positive ESP. Owing to this interaction, the preferred orientation of Ir-complexes assists in the horizontal transition dipole moments (TDM). Using these emitters, organic light-emitting diodes (OLEDs) were fabricated and achieved the highest external quantum efficiency (EQE) (31.9%) among reported deep-blue OLEDs having under 0.2 of CIEy coordinate.

# 47 Young Leaders Conference

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 16:00~17:30
**Session Chair:** Prof. Sang-Hee Ko Park (KAIST, Korea)

## G47-5 17:00~17:15

### Mobility and Stability Enhancement of Amorphous InSnZnO TFTs with Low Temperature Atomic Layer Deposited $SiO_2$ Insulators

*Jiazhen Sheng, Ju-Hwan Han, Jung-Hoon Lee, Wan-Ho Choi, Tae-Hyun Hong, and Jin-Seong Park (Hanyang Univ., Korea)*

In this paper, we investigated the effect of growth temperature (50~200˚C) on deposited $SiO_2$ thin film applied as gate insulator layer of TFT for both of transfer performance and stability compare to the thermal oxidation and PECVD deposited $SiO_2$ thin films. It was found the $SiO_2$, that when growth temperature increased, exhibit saturated dielectric constant value of 3.7 from 150˚C with low leakage current ($10^{-12}$A) similar to thermal and PECVD deposited $SiO_2$. we compared the performance of ITZO TFTs on thermal/ PECVD/ PEALD (150˚C), the results exhibited best transfer performance for PEALD $SiO_2$ (linear mobility 68.5cm$^2$/Vs, threshold voltage -0.71V, subthreshold voltage 0.23V/decade and hysteresis 0.27V) and stability performance (threshold voltage shift of 1.2V in 1 hour under 20V positive bias stress.

## G47-6 17:15~17:30

### All Organic AMOLED Panel Using OLED-Stacked-on-OTFT Structure on PET Fabric Substrate

*Jae Seon Kim and Chung Kun Song (Dong-A Univ., Korea)*

Electronic textiles (e-textiles) are attracting much attention as a prominant approach to wearable devices in future. R&D activities of e-textiles mostly focus on developing electronic devices woven by functionalized fibers. Besides, it is also very important to develop displays suitable for fabric substrates as I/O devices of wearable electronics [1]. In this study, AMOLED panel was fabricated on polyethylene terephthalate (PET) fabric substrate to demonstrate the world first fabric display. The panel has the follwoing key features. First, it used only flexible organic materials for all layers of AMOLED panel in order to keep the unique drapery property of fabric substrate in the final panel. Second, it adopted a special stacked-structure for pixel in which OLED was deployed on OTFTs as shown in Fig.1a to improve the pixel aperture ratio. Finally, the surface roughness of PET fabirc substrate, 10 mm, was drastically reduced to 0.3 mm suitbale for devcies by using a special palnarization process; PA/PU on PET.

## 48 Industrial Forum Ⅳ

**Date:** Aug. 30, 2017 (Wednesday)
**Time:** 14:00-17:20
**Session Chair:** Julian K Chang (Boeing Commercial Airplane, USA)
**Panel Discussion Chair:** Prof. Changhee Lee (Seoul Nat'l Univ., Korea)

### Speaker 6

**OLED TV Market Forecast Followed by the Increase of Demand from Premium TV Market**

Choonghoon Yi
CEO, UBI Research (Korea)

### Speaker 7

**[KEY NOTE]**
**Quantum Dot and Advance of LCD-TV**

Nam Seok Roh
Vice President, Samsung Electronics (Korea)

### Speaker 8

**[KEY NOTE]**
**OLED, Now and Future**

Joon Young Yang
Head of OLED Advanced Research Division 1, LG Display (Korea)

### Speaker 9

**[KEY NOTE] TCL Display Technology with QDs**

Weiran Cao
Senior Scientist, TCL Corporate Research (China)

* Depending on the speaker's circumstances, the schedule/topics are subject to change.

# 49 Novel Materials for Solution Processed OLEDs

**Date:** Aug. 31, 2017 (Thursday)
**Time:** 09:00-10:35
**Session Chairs:** Prof. Tae-Woo Lee (Seoul Nat'l Univ., Korea)
Dr. Takeshi Yamada (Sumitomo Chemical, Japan)

## A49-1 09:00~09:25

### Invited Soluble Hole Injection Material with High Transmittance for OLED Devices

*Daisuke Maeda, Toshiyuki Endo, Yuta Kanno, Naoki Nakaie, and Kazuhiro Monzen (Nissan Chemical Industries, Ltd., Japan)*

We are developing the soluble hole injection materials and the ink, named ELsoruce® that can be used as hole injection layer in OLED devices. This time, we developed hole injection material with characteristic physical properties. New HIL formed by the ink consist of our developed hole injection material can obtain high transmittance than our conventional HIL. The transparency of HIL is one of important film properties in order to further improve OLED device performance. New HIL is expected to contribute to device performance improvement. In this report, we introduce new ink and device performance by using the developed hole injection material.

## A49-2 09:25~09:50

### Invited Solution Processed Oxide Interlayers and Electrodes for OLEDs and OPVs

*M. A. McLachlan (Imperial College London, UK)*

Here, I detail some recent results discussing the development of low-temperature solution based routes for oxide interlayers. Paying particular attention to chemistry and processing conditions to enable interlayer deposition before and after deposition of the organic functional layers allowing a variety of device architectures to be probed and additional functionality e.g.emission tunability to be demonstrated. In the final part I will discuss recent efforts to combine metal oxide systems with PEDOT:PSS, the conventionally used anode interlayer, where blends result in significantly devices.

# 49 Novel Materials for Solution Processed OLEDs

**Date:** Aug. 31, 2017 (Thursday)
**Time:** 09:00-10:35
**Session Chairs:** Prof. Tae-Woo Lee (Seoul Nat'l Univ., Korea)
Dr. Takeshi Yamada (Sumitomo Chemical, Japan)

## A49-3 09:50~10:05

### High-Efficiency Solution-Processed Perovskite Light-Emitting Diodes based on Mixed Cations

*Himchan Cho, Joo Sung Kim, Young-Hoon Kim (Seoul Nat'l Univ., Korea), Christoph Wolf (POSTECH, Korea), Hyung Joong Yun (KBSI, Korea), and Tae-Woo Lee (Seoul Nat'l Univ., Korea)*

Metal halide perovskites are emerging high color-purity emitters with low material cost. Here, we report on the realization of high-efficiency perovskite light-emitting diodes (PeLEDs) based on stable formamidinium (FA) and cesium (Cs) cations. We achieved high-efficiency PeLEDs (maximum current efficiency = 5.39 cd $A^{-1}$ for $CsPbBr_3$ and 14.5 cd $A^{-1}$ for $FA_{0.9}Cs_{0.1}PbBr_3$) by improving the uniformity of perovskite emission layers and optimizing FA:Cs molar proportion. To the best of our knowledge, this is the highest current efficiency among the reported PeLEDs based on FA and Cs cations. The gradual changes in peak positions of X-ray diffraction patterns, steady-state PL and EL spectra demonstrated that $FA_{1-x}Cs_xPbBr_3$ are composed of single-phase polycrystals. Furthermore, to investigate the origins of luminescence quenching, we observed the temperature dependence of current hysteresis and EL spectrum; Current hysteresis occurred at all temperatures and increased exponentially as temperature increased, which can be ascribed to migration of $Br^-$ anions.

## A49-4 10:05~10:20

### Development of Solution Processed Blue TADF Device with above 25% External Quantum Efficiency Using a Solubility-Enhanced Host Material

*Sang Kyu Jeon, Hee-Jun Park, and Jun Yeob Lee (Sungkyunkwan Univ., Korea)*

High-efficiency solution processed blue thermally activated delayed fluorescent(TADF) organic light-emitting diodes were developed by synthesizing host material designed for solution process.

## 49 Novel Materials for Solution Processed OLEDs

**Date:** Aug. 31, 2017 (Thursday)
**Time:** 09:00-10:35
**Session Chairs:** Prof. Tae-Woo Lee (Seoul Nat'l Univ., Korea)
Dr. Takeshi Yamada (Sumitomo Chemical, Japan)

A49-5 10:20~10:35

### Room Temperature Solution Processing Alginate/Silver Nanowire Composite Transparent Electrode for Organic Light Emitting Diode

*Lu Lian, Dan Dong, Dongxu Feng, and Gufeng He (Shanghai Jiao Tong Univ., China)*

We have developed a room temperature solution processing method to achieve a novel alginate/silver nanowire composite transparent electrode with highly smooth surface, enhanced adhesion and stability. The AgNWs embed into NaAlg film forming a particularly smooth surface by mechanical pressing, and micro cracks are observed on the wire-junctions. After $CaCl_2$ treatment, the $Cl^-$ in the $CaCl_2$ solution renovate the cracks, resulting in a great increase of the electrical conductivity. Meanwhile, the alginate is cross-linked by the $Ca^{2+}$ to form water resist gel, which bonds the AgNWs to the substrate tightly and enhances the film stability. The alginate/AgNW composite film can reach a sheet resistance of 2.3 Ω/sq with a transmittance of 83% at 550 nm. Using this composite film as anode, the OLED demonstrates current density comparable to the device with indium tin oxide (ITO) anode, and the current efficiency is 1.4 times as high as that of ITO device.

## Poster Session II

- **Date:** August 31 (Thu.), 2017
- **Time:** 14:00 ~ 15:30
- **Location:** # 301, Convention Hall, BEXCO

*** Each paper's code will be shown on the board and tapes will be provided in the poster presentation area. All presenters are required to preside at their poster panels during the session for discussion with participants.**

| Place: # 301, BEXCO | Poster II |
|---|---|
| Put-up Time | 08:00~12:00, Aug. 31 (Thu.), 2017 |
| Presentation Time | 14:00~15:30, Aug. 31 (Thu.), 2017 |
| Take-down Time | 16:00~17:30, Aug. 31 (Thu.), 2017 |

## 50 OLED Device Ⅰ

**Date:** Aug. 31, 2017 (Thursday)
**Time:** 09:00~10:20
**Session Chairs:** Prof. Bin Wei (Shanghai Univ., China)
Prof. Malte Gather (Univ. of St. Andrews, UK)

### B50-1 09:00~09:25

**Invited** Realizing High-performance and Low-cost Fluorescent OLEDs

*Shi-Jian Su (South China Univ., China)*

We proposed a simple strategy towards high-performance fluorescent OLEDs which are composed of stacked p-type hole-transport layer and n-type electron-transport layer, resulting in a planar pn heterojunction configuration. The excitons are generated and decay at the pn junction interface due to the synergetic interaction of p-type and n-type materials, finally giving the light emission. In addition, a novel strategy towards simultaneously low-driving voltage and high efficiency fluorescent OLEDs was also proposed using an active planar pn heterojunction as the exciton generation region and conventional fluorescent dye or thermally activated delayed fluorescence material as the emitter.

### B50-2 09:25~09:50

**Invited** Understanding Electrothermal Feedback in OLEDs for Super Bright Applications

*Axel Fischer (TU Dresden, Germany)*

Organic light-emitting diodes (OLEDs) are now considered for use in the automobile sector. Especially, monochrome devices emitting in the red spectral regime are interesting. They have a long lifetime, are very efficient, and are ideally suited for applications such as turn light, tail light, or brake light. However, the brightness has to be above 10.000 cd/m$^2$, which is 10 times higher than what is needed for lighting applications. The increased power dissipation results in Joule self-heating which causes a strong electrothermal feedback due to a temperature-activated electrical conductivity. As a consequence, operation in a regime of negative differential resistance (NDR) is revealed, leading to brightness inhomogeneities and device instability. In this contribution, our findings are summarized and a full electrothermal will be introduced.

## 50 OLED Device Ⅰ

**Date:** Aug. 31, 2017 (Thursday)
**Time:** 09:00~10:20
**Session Chairs:** Prof. Bin Wei (Shanghai Univ., China)
Prof. Malte Gather (Univ. of St. Andrews, UK)

### B50-3 09:50~10:05

### Triplet Exciton Bypass Filter for Superb Operational Stability of Phosphorescent Organic Light-emitting Diodes

*Wook Song and Jun Yeob Lee (Sungkyunkwan Univ., Korea)*

Triplet exciton-polaron annihilation (TPA) has been known as one of key factors for the degradation of phosphorescent organic light emitting diodes(PhOLEDs). Therefore it is very important to reduce TPA to improve the lifetime of PhOLEDs. As a method to improve the lifetime of PhOLEDs, a triplet exciton bypass filter (TEBF) mixed host system was developed to manage TPA by separating the triplet excitons and polarons in the emitting layer. In the emitting layer made up of a host and a triplet emitter, a triplet exciton filtering material was added, which could improve the operational stability of PhOLEDs by more than five times. Key requirements of the triplet exciton filtering material were the triplet energy in between that of host and emitter and wider bandgap than that of host. The TPA reducing mechanism by the TEBF was confirmed by triplet energy transfer, single carrier device test and TPA rate constant study.

### B50-4 10:05~10:20

### Computational Study on Molecular Orientation in Vapor-deposited Organic Light-emitting Diodes

*Dongsun Yoo, Yong Youn, Hochul Song, and Seungwu Han (Seoul Nat'l Univ., Korea)*

Molecular orientation in vapor-deposited organic films has attracted much attention because it can increase light outcoupling efficiency and charge carrier mobility of the film.1 Furthermore, vapor-deposited glasses have exceptional thermal stability compared to ordinary glasses.2 However, the detailed mechanism of the formation of molecular orientation and the origin of higher thermal stability are still open questions. We studied the molecular orientaion with computational modeling. Vapor-deposition process is simulated with classical molecular dynamics. The effects of substrate temperature and molecular shape are well reproduced in the simulations. It is also shown that host molecules affect the molecular orientation of dopant molecules. Enhanced thermal stability is demonstrated by onset temperature of phase transition. Films deposited at lower temperature have higher onset temperature, which indicates higher thermal stability. We suggest a mechanism of the formation of molecular orientation considering kinetics and energetics at the surface.

# 51 Organic Transistors I

**Date:** Aug. 31, 2017 (Thursday)
**Time:** 09:00~10:30
**Session Chair:** Dr. Jan Genoe (imec, Belgium)

## C51-1 09:00~09:25

### Invited Bias Stability of Low Crystalline Conjugated Polymers

*Byungho Moon and Kilwon Cho (POSTECH., Korea)*

Organic field-effect transistors (OFETs) have attracted considerable attention in the past two decades because of their potential applications for flexible printed electronics. However, although remarkable advances in the performances of OFETs in recent years, the device stabilitity (bias stress stability) remains a critical obstacle to their commercial use. Here we investigated the correlation between molecular structure and bias stress stability of low crystalline conjugated polymers by using spectroscopy analysis and photo-induced trapping experiments.

## C51-2 09:25~09:50

### Invited Development of Organic Semiconducting Materials for Organic Electronics

*Yun-Hi Kim (Gyeongsang Nat'l Univ., Korea)*

Over the past two decades, organic electronics, such as organic fi eld-effect transistors, organic light emitting diodes, organic photovoltaic cells, and organic photodetectors have recently received significant attention for use in flexible low-cost electronics applications. In these fields of research, organic thin film transitors have been developed to act as amplifying and switching devices. For the commercialization, high-performance OFETs will be satified several issues to be address, including increasing the field-effect mobility, improving operation stability, developing passivation methods and improving performance reproducibility. Many efforts have been tried forsolving these problems. The molecular design of organic semiconductors is a useful strategy for solving these problems because tailoring the molecular structures can tune the properties of the organic semiconductors dramatically. Various classes of conjugated small molecules and polymers have been synthesized, their properties have been studied and they have been found to display high performances and offer chemically stable conjugated systems.

# 51 Organic Transistors Ⅰ

**Date:** Aug. 31, 2017 (Thursday)
**Time:** 09:00~10:30
**Session Chair:** Dr. Jan Genoe (imec, Belgium)

## C51-3

09:50~10:15

### Invited Highly Oriented Semiconducting Polymers for Flexible Electronics

*Byoung Hoon Lee (Ewha Womans Univ., Korea)*

As a result of the quasi-one-dimensional transport pathways of charge carriers along the backbone, charge transport in polymer semiconductors is limited by their nanomorphology. Structural disorders, arising from the high degree of conformational freedom of polymer chains (causing chain folding, torsion, and structural defects) lead to electronic localization. Thus, highly oriented polymer packing is needed for achieving minimized structural disorder and associated high mobility in semiconducting polymers. Here, we show that highly oriented semiconducting polymers can be obtained by directed self-assembly onto nanogrooved substrates. The oriented polymer thin films along nanogrooves in the substrate exhibited strong anisotropy, implying the possibility of achieving high mobility along the polymer backbone. With semiconducting polymers aligned and oriented on nanogrooved polymer substrates, we have demonstrated high-performance polymer field-effect transistors with enhanced mobilities fabricated onto rigid and flexible substrates.

## C51-4

10:15~10:30

### Organic Thin-Film Transistors with Mobility over 10cm$^2$/Vs by Low-Temperature Solution Coating

*Chuan Liu (Sun Yat-sen Univ., China), Xuying Liu, Takeo Minari (NIMS, Japan), Masayuki Kanehara (C-ink. Co., Ltd., Japan), and Yong-Young Noh (Dongguk Univ., Korea)*

Recent studies on organic thin-film transistors (OTFTs) have reported high mobility values, but many of them show the non-ideal current-voltage characteristics that may lead to overestimation of mobility values. Here, we briefly investigate the non-ideal transistor behaviour by considering the effect of charge injection and reveal the method to overcome the effect. Correspondingly, we have developed various charge injection layers and studied their effects on modifying metal contacts, including work-function tuning and interfacial doping. The materials have been coated form good metal-semiconductor interface by fine manipulation in the wetting and dewetting of selected liquid. With such electrodes, the OTFTs were fabricated at room temperature and exhibit almost ideal transistor behaviour in current-voltage characteristics, featuring high field-effect mobility over 10 cm$^2$/Vs.

# 52 Organic Photovoltaic Ⅰ

**Date:** Aug. 31, 2017 (Thursday)
**Time:** 09:00~10:30
**Session Chair:** Dr. Daniele Di Luzzo (Univ. of Cambridge, UK)

## D52-1 09:00~09:25

### Invited High-Performance Graphene-based Organic Solar Cells with High Yields

*Seungon Jung, Junghyun Lee, Yunseong Choi, Sang Myeon Lee, Changduk Yang, and Hyesung Park (UNIST, Korea)*

The demand for high-efficiency flexible optoelectronic devices is ever-increasing because next-generation electronic devices that comprise portable or wearable electronic systems are set to play an important role. Graphene has received extensive attention as it is considered to be a promising candidate material for transparent flexible electrode platforms owing to its outstanding electrical, optical, and physical properties. Despite these properties, the inert and hydrophobic nature of graphene surfaces renders it difficult to use in optoelectronic devices. In particular, commonly used charge transporting layer (CTL) materials for organic solar cells (OSCs) cannot uniformly coat a graphene surface, which leads to the inevitable devices failing. Herein, this paper proposes an approach that will enable CTL materials to completely cover a graphene electrode; this is done with the assistance of commonly accessible polar solvents.

## D52-2 09:25~09:50

### Invited Hybrid Hole Transport Materials Towards Efficient Organic Photovoltaic Devices

*Sangcheol Yoon, Hyebin Kim, and Inchan Hwang (Kwangwoon Univ., Korea)*

We discuss the effects of a hole transport layer on photovoltaic performances of organic solar cells. The energy level alignment with the active layer determines the open-circuit voltage. The fill factor is determined by the rate of hole extraction. In this talk, we show a potential of copper (I) iodide as a hole transport layer, with discussion of the effects on photovoltaic performance and photo-stability. The reproducibility of the photovoltaic performance when the CuI interlayer is used is discussed. The thermal evaporation of the molybedenum trioxdie was conducted to smooth the CuI surface. Interestingly, we found that the evapoarted CuI molecules form new chemical complexes with $MoO_3$, resuting in some oxygen vacancies in the layer. This enhnaces the hole extraction efficiency, which is indirectly evidenced by the reflectance measurements. Our results show that combining CuI and $MoO_3$ can enhance photovoltaic efficiency by facilitating hole extraction.

## 52 Organic Photovoltaic Ⅰ

**Date:** Aug. 31, 2017 (Thursday)
**Time:** 09:00~10:30
**Session Chair:** Dr. Daniele Di Luzzo (Univ. of Cambridge, UK)

### D52-3 09:50~10:15

### Invited Material Design and Device Engineering for Realizing Over 12% Efficiency in Polymer Solar Cells

*Jianhui Hou, Wenchao Zhao, Sunsun Li, Shaoqing Zhang, and Huifeng Yao (Chinese Academy of Sciences, China)*

Fullerene-free polymer solar cells (NF-PSCs), consisting of the non-fullerene small molecules or polymers as the electron acceptor, have emerged as the most promising alternatives to the conventional fullerene-based PSCs for further efficiency breakthrough at present. During the past few years, we focused on investigating the photovoltaic properties of 2D-conjugated donor polymers in the NF-PSCs. Recently, by employing polymer PBDB-T as the electron donor, over 11% efficiency were realized. By introducing the weak electron-donating methyl groups on ITIC, uplifted LUMO levels of acceptors, thus improved open-circuit voltages from 0.90 V to 0.97 V were realized, and therefore, a record power conversion efficiency (PCE) of 11.6% has been achieved based on PBDB-T and IT-M. We further introduced BisPCBM as the third component, and the PCE of the ternary PSCs based on PBDB-T:IT-M:Bis[70]PCBM (1:1:0.2) exhibited a PCE of 12.2%.

### D52-4 10:15~10:30

### Organic Photovoltaics : Enabling Production of Commercially Viable Modules

*Ji-Young Lee (Merck Performance Materials Co., Ltd., Korea), Stephane Berny, Nico Seidler, Luca Lucera, Kornel Ocytko (Merck Chemicals Co., Ltd., UK), and Stephan Wieder (Merck Chemicals KGaA, Germany)*

Development OPV formulations of active materials for industrial coating and mass-production of OPV modules toward commercialization of OPV products and state of the art of overall device and modules lifetime by tailoring the chemical and physical properties of the materials.

## 53 Oxide TFTs: High Performance

**Date:** Aug. 31, 2017 (Thursday)
**Time:** 09:00~10:30
**Session Chair:** Prof. Yukiharu Uraoka (NAIST, Japan)

### E53-1 09:00~09:25

### Invited Quantitative Analysis of Coplanar a-IGZO TFTs for High Reliability Device

*Jiyong Noh, Ju-heyuck Baeck, Jong Uk Bae, Kwon-Shik Park, Soo Yong Yoon, and In Byeong Kang (LG Display Co., Ltd., Korea)*

We has been investigating on high reliability (specially PBTS characteristics) oxide device for a few years, and we currently expand more application of large sized OLED display based on the high reliability oxide TFT backplane. In this paper, we report that the PBTS instability of coplanar InGaZnO TFTs can be improved by the minimization of Non-Bridging Oxygen Hole Centers (NBOHC) and optimization of hydrogen passivation in the GI/ACT interface region. Furthermore, we define and propose the diffusion behavior of light elements by the quantitative analysis of hydrogen and oxygen in each region. For interpretation of physical properties of light elements we perform a diversity of analysis such as XRR, RBS, and ERDA measurements. Finally, trap density in GI/ACT interface layer is obtained by photonic capacitance-voltage measurements which are correlated with PBTS characteristics. A decrease of under coordinated bonding states lessens electron trap density, which brings improvement in PBTS from $V_{th}$ = 2.61V to 0.21V by process optimization.

### E53-2 09:25~09:50

### Invited Stability Investigation on Amorphous InSnZnO Thin Film Transistors with a Top Nitrogen Doped Active Layer

*Gongtan Li, Chuan Liu, and Bo-Ru Yang (Sun Yat-Sen Univ., China)*

The top nitrogen doped active layer takes the advantage of the high mobility in the pristine a-IZTO films as well as the good stability in the a-IZTO:N films. As shown in Fig. 2 (a), the front channel dominates the conduction, thus the high conduction underlying layer acts as a "high-way" for electron transport, while the nitrogen doping layer is for stability improvement. The field-effect mobility as a function of Vg and the Vth shift under NBLS are shown in Figs. 2b and c to compare the top-doped device (red curves) and the single layer device with or without N-doping (blue and black curves, respectively). The top doped TFTs exhibited a high mobility (~31.75 $cm^2/Vs$) and good NBLS instability (ΔVth=1.24 V for 3600 s), simultaneously. Importantly, fabrication of such top doping TFTs only requires adjustment in gas flow rate and does not break vacuum, and thus it is rather simple and highly compatible with traditional fabrication methods.

# 53 Oxide TFTs: High Performance

**Date:** Aug. 31, 2017 (Thursday)
**Time:** 09:00~10:30
**Session Chair:** Prof. Yukiharu Uraoka (NAIST, Japan)

## E53-3 09:50~10:15

### Invited Short Channel Oxide TFTs for Digital Holography

*Chi-Sun Hwang, Jong-Heon Yang, JiHun Choi, Jae-Eun Pi, Kyunghee Choi, Chi-Young Hwang, Yong-Hae Kim, Gi Heon Kim (ETRI, Korea), Sang-Hee Ko Park (KAIST, Korea), and Jinwoong Kim (ETRI, Korea)*

Holography, which has been known as final goal of realistic display, will be a crucial form of next generation media. But, for the fullfilment of wide viewing angle for holgraphy, the SLM, which modulate light wave, demands ultra high resolution display panel with pixel pitch less than 1 μm. For the example of applying oxide TFTs for holography will be presented. Oxide TFTs with BCE structure can be a good candidate as switching device for such a high resolution display. Another method for achieving ultra high resolution is that adapting 3D channel structure, such as vertical channel for oxide TFTs. Until now MOSFETs based on crystalline Si wafer substrate have been thought as a solution for such small pixel pitch. The impact of applying oxide TFT for such small pixel pitch is that realistic digital holgram which will show large images with wide viewing angle will be realized in near future.

## E53-4 10:15~10:30

### Development of a 55-in 4K UHD OLED TV with High Reliability and Short Channel IGZO TFTs

*Mijeong Park, Hyunmin Cho, Woocheol Jeong, Jaeyong Park, and Jongwoo Kim (LG Display Co., Ltd., Korea)*

We investigated the phenomenon of degradation of short channel length TFTs such as negative threshold voltage and increasing deviation. We have two optimization processes to alleviate the short channel effect of 4.5um channel length device. First, the condition A is carrier reduction process of IGZO layer during sputter deposition. Condition B is the optimized process of thermal annealing for minimized ΔL diffusion length. Applying both conditions A and B, we can attain Vth deviation of only Δ0.4V at short channel devices. In addition, we improved long-term PBTS stability by controlling NBO site in gate insulator of a-IGZO TFTs with H-passivation process. Finally, we developed the short channel device (L=4.5um) with high reliability characteristics for narrow bezel size (5.5mm) OLED TV.

# 54 3D System II (3DSA Joint Session)

**Date:** Aug. 31, 2017 (Thursday)
**Time:** 09:00~10:25
**Session Chair:** Prof. Hideki Kakeya (The Univ. of Tsukuba, Japan)

F54-1 09:00~09:25

## Invited How to Hand-Make a High Quality Full-HD Autostereoscopic Display

*Hideki Kakeya (Univ.of Tsukuba, Japan)*

The author has published several papers on the autostereoscopic display based on time-division quadruplexing parallax barrier. The main merit of this system is realization of full-HD 3D image with a low cost. Since the materials needed to build up the display are all available in the consumer market, anyone can make the same display system in principle. Though we have written the principle and the theory throughout the previous papers, some technical recipes are needed to produce this display hardware in practice. The recipes include: the choice of LCD panels; the choice of graphic boards; how to decompose the LCD display; how to remove the polarization filter from a LCD panel; how to realize a bright backlight with a low cost; tips to realize a 3D image with little crosstalk in the whole screen.

*(3DSA Paper)*

F54-2 09:25~09:40

## Multiview Image Acquisition based on an Aperture Sharing in Mirrorless Camera

*Hyoung Lee, Jung Kim (Konyang Univ., Korea), Do Hyung Kim (ETRI, Korea), and Sumio Yano (Shimane Univ., Japan)*

In this study, we introduce a method of acquiring a Multiview image by aperture sharing camera. The aperture sharing camera consists of mirrorless camera and a high-speed LC shutter array which is located at the entrance pupil of the camera's objective, to divide the pupil into a number of sections with an equal dimension. The high-speed LC shutters in the array is opened one at a time in synchronizing with the camera shutter. The images from neighboring shutters reveal a constant disparity between them. The disparity between the images from the camera matches closely with that calculated from theory and is proportional to the distance of each LC shutter from the camera's optical axis.

*(3DSA Paper)*

## 54 3D System Ⅱ(3DSA Joint Session)

**Date:** Aug. 31, 2017 (Thursday)
**Time:** 09:00~10:25
**Session Chair:** Prof. Hideki Kakeya (The Univ. of Tsukuba, Japan)

### F54-3 09:40~09:55

### Detecting Touch at an Aerial Image with a Camera Inside Aerial Display with Polarized AIRR

*Kengo Fujii, Kenta Onuki, Kazuki Kawai, Shusei Ito, and Hirotsugu Yamamoto (Utsunomiya Univ., Japan)*

This paper proposes new technique that Aerial Imaging by Retro-Reflection (AIRR) interaction with inside camera by use of scattered light at palm. This camera observes the internally reflected light at the beam splitter. we solved this problem by using a two polarizing plates. Polarizer 1 and reflective polarizer are arramged in a cross nicol state and Polarizer 2 and reflective polarizer are arranged in a parallel nicol state. As a result, a inside camera doesn't observe the reflected light and observes scattered light at palm. We observed the scattered light in the palm of the hand with the inside camera about the three primary colors of light. As a result, The scattered light is most reflected in the three colors at the distance of 0 cm. On the other hand, our proposed technique needs to cope with the change of scattered light due to the color of the target hand.

*(3DSA Paper)*

### F54-4 09:55~10:10

### Stereoscopic Image and Display for a Mobile Phone with the Micro-Prism Array

*Chun-Chi Chan (NTUST, Taiwan), Chi-Hao Chuang, Hoang Yan Lin (Nat'l Taiwan Univ., Taiwan), Chien-Yu Chen (NTUST, Taiwan), and Pei Jun Wu (Nat'l Chiao Tung Univ., Taiwan)*

This study proposes a stereo mobile phone system with single camera and a micro-prism array. The advantages of the micro-prism array are light and portable, so it could be applied on any mobile phone. After obtaining the stereo image pair, a 3D anaglyph image will be generate with android system. By using this method, we can freely catch 3D image from any mobile phone with android system.

*(3DSA Paper)*

# 54 3D System II (3DSA Joint Session)

**Date:** Aug. 31, 2017 (Thursday)
**Time:** 09:00~10:25
**Session Chair:** Prof. Hideki Kakeya (The Univ. of Tsukuba, Japan)

F54-5 10:10~10:25

## Multi-View Arc DFD Display with Wide Viewing Zone by Fusing Arc DFD and Multi-View Displays

*Wataru Kinoshita, Haruki Mizushina, and Shiro Suyama (Tokushima Univ., Japan)*

In order to apply for public viewing applications, such as digital signage, 3D display should have a long viewing distance and a horizontally wide viewing zone without glasses. In this paper, we propose a new Multi-view Arc DFD display by fusing Arc DFD and multi-view displays for 3D display with a long and wide viewing zone. Perceived depth can be successfully obtained at various viewing positions. Thus, Multi-view Arc DFD display has a longer and wider viewing zone than conventional stereoscopic display. Our Multi-view Arc DFD display is promising for various public applications because of long and wide viewing zone.

*(3DSA Paper)*

# 55 Advanced LED Technologies I

**Date:** Aug. 31, 2017 (Thursday)
**Time:** 09:00~10:15
**Session Chairs:** Prof. Ray-Hua Horng (Nat'l Chung Hsing Univ., Taiwan)
Prof. Yong-Hoon Cho (KAIST, Korea)

## G55-1 09:00~09:25

### Invited Development of High Performance (0001) LEDs: Tunnel Junctions and Green LEDs

*James S. Speck (Univ. of California, U.S.A)*

In this presentation, we highlight two recent areas of development of high performance c-plane GaN-based LEDs.

## G55-2 09:25~09:50

### Invited Performance enhancement of InGaN/GaN LEDs: Nano-technological Approaches

*In-Hwan Lee (Korea Univ., Korea)*

Nanotechnological approaches have been widely explored for improved light output in InGaN/GaN light emitting diodes (LEDs). In this talk, I will introduce the application of $SiO_2$ nanoparticle (NP) embedded in GaN nanopillar template for high optical extraction, of Ag/$SiO_2$ core/shell NP for a localized surface plasmon (LSP) LED, and of porous GaN templates made by combined wet chemical etchings.

## G55-3 09:50~10:15

### Invited Electron Retarding N-electrodes: A New Approach for Enhancing Nitride LED Performance

*Ching-Ho Tien (Nat'l Chung Hsing Univ. Taiwan), Sin-Liang Ou (Da-Yeh Univ., Taiwan), and Dong-Sing Wuu (Nat'l Chung Hsing Univ., Taiwan)*

The extremely large difference between electron and hole mobilities always exists in the nitride LED, which easily results in the electron overflow phenomenon and the reduction of recombination rate. At present, the electron tunneling barrier (ETB) and electron blocking layer (EBL) are commonly used in the epitaxial structure. However, when ETB and EBL were inserted in the LED structures, the increment of the defect density in the active region and the hole blocking problem are always accompanied, respectively. To solve this problem, the dilute magnetic film is proposed as an electron retarding n-electrode (ERN) for the nitride LEDs. In comparison to the conventional blue and green LEDs, there were 16% and 18% enhancements in the output power after fabricating the ERN on the n-GaN layer. Details of the ERN effect on the LED efficiency and possible device mechanism will be reported in this talk.

# 56 Stretchable / Deformable Applications

**Date:** Aug. 31, 2017 (Thursday)
**Time:** 09:00~10:35
**Session Chair:** Prof. Zhigang Wu (Huazhong Univ. of Sci. and Tech., China)

## H56-1 09:00~09:25

### Invited Stretchable and Foldable Hydrogel Based Deformable Interactive Devices

*Pooi See Lee (Nanyang Technological Univ., Singapore)*

Stretchable and wearable electronics have been extensively investigated in a broad range of applications, including electronic skins, flexible displays, health monitoring devices, and energy harvesting devices. Using a matrix of conductive hydrogel, extremely stretchable self-healing strain sensors have been fabricated. The strain sensor based on SWCNT/hydrogel recovers with 98±0.8% within 3.2 healing time. The stretchable matrix enables the strain sensor to be highly reproducible and reliable with sensing ability from 2% stretching strain to extreme elastic strain up to 1000% stretching strain with gauge factor of 1.51. Furthermore, with the addition of Ethyl Viologen Diperchlorate and Sodium Anthroaquinone- 2-sulfonate dissolved into the hydrogel matrix, a solid state electrochromic slime can be created that has a good flexibility that allows it to fold and deform freely. This is due to the hydrogen bonding that provides the soft nature of the matrix. A lateral configuration is designed using Ag based transparent nanopaper as working electrode to construct a foldable electrochromic device.

## H56-2 09:25~09:50

### Invited 3D Printed Deformable Electrical Circuities Using Unconventional Materials

*Sunho Jeong (KRICT, Korea)*

Use of 3-dimensional (3D) printable materials have gained significant attention for various applications because of their ability to form unconventional geometrical architectures that cannot be realized with traditional 2-dimensional printing techniques. To resolve the major requisites in printed electrodes for practical applications, we have designed a chemically-reinforced multi-dimensional filler system. It is demonstrated that both high conductivity, 22,939 S/cm, and low-temperature processability, below 80 ˚C, are achievable with the introduction of chemically anchored carbon-to-metal. We demonstrate the fabrication of 3D-printed electrical circuitry consisting of embedded electrical components and conformal-printed electrode features on the surfaces of pre-formed 3D polymer and paper structures. It is also suggested that 3D-printed origami structures are achievable via the formation of 3D-shaped electrodes inside paper structures owing to the intrinsic deformation stability of electrodes printed from the conductive dough. In addition, 3D-printable, piezoresistive stretchable materials will be introduced for applications toward body-patchable strain sensors.

# 56 Stretchable / Deformable Applications

**Date:** Aug. 31, 2017 (Thursday)
**Time:** 09:00~10:35
**Session Chair:** Prof. Zhigang Wu (Huazhong Univ. of Sci. and Tech., China)

## H56-3 09:50~10:05

### Organic Flash Memory with Low Operating Voltage and Long Retention Time for Low-Power Flexible Electronics

*Seungwon Lee, Hyejeong Seong, Junghoo Yun, Sung Gap Im, Hanul Moon, and Seunghyup Yoo (KAIST, Korea)*

While organic electronic devices have been significantly developed and OLEDs are successfully commercialized, non-volatile organic flash memories have been left behind with a conflicting demand for reducing operating voltage and extending retention time. Most of the flash memories with organic dielectric layers proposed so far suffered from significantly high operating voltages or short retention time that were much far from commercialization level.This paper shows the first demonstration of flexible organic flash memory exhibiting both low operating voltage of ±5 V and long retention time of ca. 1 year. Key success factors are 1) using ultra-thin polymer dielectric layers of excellent insulating property by initiated chemical deposition, 2) careful design of the thickness of two dielectric layers consisting flash memories, tunneling and blocking dielectric layers based on modified flash memory theorem for thin-film devices, and 3) surface work-function control of metallic floating gate electrodes by a self-assembled monolayer.

## H56-4 10:05~10:20

### Market Trends for Flexible and Stretchable Electronics

*Guillaume Chansin, James Hayward, and Raghu Das (IDTechEx, UK)*

This presentation will look at the latest trends in flexible and stretchable electronics. It will cover displays, sensors, e-textiles, as well as stretchable electronics materials.

## 56 Stretchable / Deformable Applications

**Date:** Aug. 31, 2017 (Thursday)
**Time:** 09:00~10:35
**Session Chair:** Prof. Zhigang Wu (Huazhong Univ. of Sci. and Tech., China)

### H56-5 10:20~10:35

**Stretchable Organic Light-Emitting Diodes on Membranes Connected by Serpentine Bridges**

*Myung Sub Lim, Young Hyun Son, and Kyung Cheol Choi (KAIST, Korea)*

In this study, we introduced a stretchable substrate combined with membranes and bridges, and driven an organic light-emitting diodes (OLEDs) on the substrate. The substrate of the membranes and bridges structure was patterned using a negative photoresist SU-8, and the OLEDs was fabricated by thermal deposition. Conventionally, elastic lighting devices required new materials and new structures, but in this study we implemented stretchable OLEDs as a general process and materials through the structural change of the substrate. And, the substrate has simple process steps and structures that can be applied to OLEDs as well as to stretchable devices. About bridge or wiring structures, there have been previous studies of driving inorganic light-emitting diodes in the study of stretchable devices, but there have been no previous studies that fabricated devices by depositing OLEDs.

# 57 High Performance Solution Processed OLEDs

**Date:** Aug. 31, 2017 (Thursday)
**Time:** 11:00~12:45
**Session Chair:** Prof. Hong-Bo Sun (Jilin Univ., China)

## A57-1 11:00~11:25

### Invited Printed Device Performance of Polymer-OLED Materials

*Takeshi Yamada (Sumitomo Chemical Co., Ltd., Japan)*

We will present the latest status of high performance OLED material development based on our conjugated polymer technology. The material is very suitable for printing OLED panel fabrication. We also show the comparison of the performance between ink-jet (IJ) and spin devices, and its theoretical fundamentals to obtain high performance in IJ printing.

## A57-2 11:25~11:50

### Invited Performance Improvements of Solution-Processed Multi-SMOLED

*Kazuhiro Oikawa, Kunimasa Hiyama, Hiroshi Kita (KONICA MINOLTA, Inc., Japan), Yong-Jin Pu, Takayuki Chiba, Satoru Ohisa, and Junji Kido (Yamagata Univ., Japan)*

OLED technology based on a vacuum deposition process is improving rapidly. Nowadays, the technology has been adopted to various types of displays. The technology has also reached an applicable level in the lighting market. Recently, solution-processed OLEDs has also been investigated around the world, to realize the potential for low-cost fabrication. Multi-OLED comprising two or three stacked light-emitting units and charge generation layers has demonstrated its potential to the high performance in a vacuum-processed OLED. However, in general, it is difficult to form such a multilayered structure by the solution process because of the low solvent-resistance to the upper layer. In order to achieve both high luminance and long lifetime, we have successfully fabricated a solution-processed all-phosphorescent white multi-OLED. This OLED device contained a nine-layer stacked structure with two light emitting units and a CGL. This all-phosphorescent OLED device was fabricated with small molecules. However, although the device showed a high performance on the efficiency and luminance, it is not sufficient level considering phosphorescent tandem system. In this study, the degradation factor and the current improvement of solution processed multi-OLED, especially small molecule phosphorescent materials and layer stack design technologies, will be discussed.

# 57 High Performance Solution Processed OLEDs

**Date:** Aug. 31, 2017 (Thursday)
**Time:** 11:00~12:45
**Session Chair:** Prof. Hong-Bo Sun (Jilin Univ., China)

## A57-3 11:50~12:15

### Invited Advanced Device Architectures for Efficient Solution Processed OLEDs

*Min Zhang, Joshua A. Fragoso Garcia, Lorenz Graf von Reventlow, Stefan Höfle, and Alexander Colsmann (KIT, Germany)*

Whereas vacuum processed organic light emitting diodes (OLEDs) were successfully introduced into the consumer electronics market, their solution processed counterparts lag behind. The performance of solutions processed OLEDs is often limited by the number of functional layers which in turn is limited by the choice of solvents. In this presentation, we will demonstrate that – by employing orthogonal solvents, cross-linking and other layer deposition concepts – solution-based device fabrication concepts are well suitable to yield highly efficient OLEDs, closing the gap between vacuum and solution processed devices. We will present all-solution processed OLEDs and tandem OLEDs and discuss their fabrication, performance and lifetime. Moreover, large-area OLEDs can be laser structured into arrays of OLEDs to reduce ohmic losses and to enhance the device performance.

## A57-4 12:15~12:30

### Boosting the Luminescence Efficiency of Solution-Processed Thermally Activated Delayed-Fluorescence Organic Light-Emitting Diodes by Managing the Exciton Quenching and Charge Injection Capability

*Young-Hoon Kim and Tae-Woo Lee (Seoul Nat'l Univ., Korea)*

We develop the highly efficient, solution processed thermally activated delayed-fluorescence (TADF) organic light-emitting diodes (OLEDs). We use a multi-functional buffer hole injection layer (Buf-HIL) composed of poly(3,4-ethylenedioxythiophene)/poly(styrene sulfonate) (PEDOT:PSS) and perfluorinated ionomer (PFI) to facilitate the hole injection to the emitting layer (EML) due to its high work function (~5.95 eV). The enriched PFI on top of the Buf-HIL surface can also prevent the exciton quenching which occurs at the HIL/EML interface. Furthermore, we reduce the surface roughness and exciton quenching in the EML by using polar aprotic solvent which can improve the solubility of pure-organic TADF emitters, thus, increase the device efficiency. With these strategies, we achieve high external quantum efficiency ~ 24 %, current efficiency ~ 73 cd/A and power efficiency ~ 58 lm/W in a simplified, solution-processed TADF-OLEDs. We also demonstrate the high-efficiency red-emitting and blue-emitting solution-processed TADF-OLEDs with simple structure for the first time.

## 57 High Performance Solution Processed OLEDs

**Date:** Aug. 31, 2017 (Thursday)
**Time:** 11:00~12:45
**Session Chair:** Prof. Hong-Bo Sun (Jilin Univ., China)

### A57-5 12:30~12:45

### Extremely Efficient Solution-Processed Small-Molecule Organic Light-Emitting Diodes with Simple Structure

*Tae-Woo Lee, Tae-Hee Han (Seoul Nat'l Univ., Korea), Mi-Ri Choi (POSTECH, Korea), Chan-Woo Jeon, Yun-Hi Kim, and Soon-Ki Kwon (Gyeongsang Nat'l Univ., Korea)*

We report ultrahigh-efficiency solution-processed small-molecule organic light-emitting diodes (OLEDs) using novel electron-transporting host materials based on tetraphenylsilane with pyridine moieties, which have high triplet energy levels (> 2.8 eV), wide band gaps (> 4.0 eV), and high glass transition temperature. We have improved solution-processed OLEDs by using heteroleptic iridium complex, and by introducing a bipolar host material that has both high electron and hole mobilities. As a result, electroluminescent efficiencies of orange-red (~97.5 cd/A, ~35.5% ph/el) and green (~103.7 cd/A, ~29.0% ph/el) phosphorescent OLEDs are the highest recorded values among solution-processed OLEDs reported to date despite their simple device structure. Our approaches to achieve simple device structure, high efficiency, and reduced efficiency roll-off characteristics of solution-processed small-molecule OLEDs will paves the way for practical low-cost production of OLEDs.

## Poster Session II

- **Date:** August 31 (Thu.), 2017
- **Time:** 14:00 ~ 15:30
- **Location:** # 301, Convention Hall, BEXCO

*** Each paper's code will be shown on the board and tapes will be provided in the poster presentation area. All presenters are required to preside at their poster panels during the session for discussion with participants.**

| Place: # 301, BEXCO | Poster II |
|---|---|
| Put-up Time | 08:00~12:00, Aug. 31 (Thu.), 2017 |
| Presentation Time | 14:00~15:30, Aug. 31 (Thu.), 2017 |
| Take-down Time | 16:00~17:30, Aug. 31 (Thu.), 2017 |

# 58 OLED Device II

**Date:** Aug. 31, 2017 (Thursday)
**Time:** 11:00~12:05
**Session Chairs:** Prof. Jianxin Tang (Soochow Univ., China)
Prof. Seunghyup Yoo (KAIST, Korea)

## B58-1 11:00~11:25

### Invited Low-Energy Consumption Inverted Organic Light-Emitting Diodes by Exploiting Sulfide-Based Double Electron Injection Layers

*Shuanglong Wang, Kunping Guo, and Bin Wei (Shanghai Univ., China)*

Inverted organic light-emitting diodes (IOLEDs) have attracted considerable interest over the last decade due to their potential use in general lighting and active-matrix displays [1,2]. High energy consumption, efficiency roll-off, and poor electron injection are key issues limiting the use of IOLEDs. We present IOLEDs with extremely low driving voltage, high efficiency and efficiency roll-up by employing double electron injection layers (D-EILs) composed of metal sulfide and cesium carbonate ($Cs_2CO_3$)-doped 4,7-diphenyl-1,10-phenanthroline (Bphen)(Fig. 1). We have investigated the effect of the thickness and species of sulfide film on the electroluminescence characteristics of blue florescent and green phosphorescent devices. In our blue florescent device, the 2 nm-zinc sulfide/Bphen: $Cs_2CO_3$ structure with enhanced electron injection resulted in an excellent carrier balance for radiative recombination

## B58-2 11:25~11:50

### Invited Color Tunable OLEDs and Applications of OLEDs in Biology

*Malte Gather (Univ. of St Andrews, UK)*

A new device concept for highly efficient OLEDs is introduced that allows to tune the emission color of the device over a broad range of the CIE color gamut. The approach exploits the different polarities of the positive and negative half-cycles of an alternating current driving signal to independently address two vertically stacked emission units with complementary color. The required ultrathin metal electrodes are fabricated by a wetting layer approach and we find that this achieves good electrical contact to each stack with minimal impact on optical performance. We discuss potential applications of this new device type for display and lighting. Beyond this, we also explore applications of OLEDs for biotechnology and biomedicine, where they can be highly useful light sources due to their low toxicity, fast switching, high brightness, and ability to provide patterned illumination with very high spatial resolution application.

## 58 OLED Device Ⅱ

**Date:** Aug. 31, 2017 (Thursday)
**Time:** 11:00~12:05
**Session Chairs:** Prof. Jianxin Tang (Soochow Univ., China)
Prof. Seunghyup Yoo (KAIST, Korea)

B58-3 11:50~12:05

### Improved Efficiency and Viewing Angle Characteristics of Top Emitting OLED by Wavy Patterns

*Sung Min Jo and Byung Doo Chin (Dankook Univ., Korea)*

To improve the angular dependancy of TOLED, we fabricated wavy line patterns. Those wavy patterns with various depth(aspect ratio) were applied to the bottom of the TOLED. The effect of wavy patterns on device performances including luminous properties and angular properties was investigated. In case of the light extraction efficiency, there was a slight increase, while effects of decreased light output can be seen at the specific aspect ratio. However, angular dependency tended to be generally improved, as shown in Figure 1(c). Unlike the wavy patterns formed on the surface of the translucent cathode of top emission OLED, patterns underneath the bottom electrodes were found to be more sensitively affects the viewing angle characteristics.

# 59 Organic Transistors II

**Date:** Aug. 31, 2017 (Thursday)
**Time:** 11:00~12:30
**Session Chair:** Prof. Byoung Hoon Lee (Ewha Womans Univ., Korea)

## C59-1 11:00~11:25

### Invited Controlling Charge Carrier Density in Organic Field-Effect Transistors by Solid-State Electrolyte Polymer Dielectrics

*Yong-Young Noh (Dongguk Univ., Korea)*

In this paper, we study the effect of the molecular structure of conjugated polymers on electron and hole transport in organic solid-state electrolyte-gated transistors (SEGTs) using three N,N' -difunctionalized naphthalene diimide (NDI) core polymers with 5-methylselenophen-2-yl)vinyl)selenophen-2-yl [P(NDI-SVS)], 2,29-bithiophene [P(NDI2OD-T2)] and 3,3'-dichloro-2,2'-bithiophene [P(NDI2HD-T2Cl2)], respectively. The polymer transistors show electron mobility in the order of $10^{-2}$ ~$10^{-3}$ $cm^2V^{-1}s^{-1}$ with very low operating voltage (2 V) using a solution processed solid-state electrolyte gate insulator which is composed of poly(vinylidene fluoride-trifluoroethylene) (99.5 vol.%) and ion gel, based on poly(vinylidene fluoride-co-hexafluoropropylene) and 1-ethyl-3-methylimidazolium bis(trifluoromethylsulfonyl) imide ion liquid (0.5 vol.%). Interestingly, P(NDI-SVS) SEGTs showed remarkable hole mobility of 0.14±0.02 $cm^2V^{-1}s^{-1}$ owing to the large hole accumulation compared to ~0.03 $cm^2V^{-1}s^{-1}$ using the poly(methyl methacrylate) (PMMA) gate dielectric. By controlling the molecular structure, we demonstrate high performance ambipolar SEGTs with P(NDI-SVS).

## C59-2 11:25~11:50

### Invited Organic Thin-Film Transistors and Circuits by Solution-Processed Selective Metalization

*Takeo Minari, Xuying Liu (NIMS, Japan), Chuan Liu (Sun Yat-sen Univ., China), and Masayuki Kanehara (C-INK. Co., Ltd., Japan)*

Solution-processed fabrication of electronic devices and circuits is an emergent subject for the low-cost and large-area fabrication of flexible electronic devices. Direct printing of organic thin-film transistors is a particularly promising fabrication method that offers lower production costs, reduced energy consumption, and a smaller environmental burden. In this talk, we report the two solution-based methods for fabrication of electronic circuits by solution-process with ultra-high resolution. The first is printing of metal nanoparticle ink using surface selective deposition. The homogeneous formation of electrode lines with high resolution of 1-micron was realized, which is comparable to the resolution of common photolithographic process. The other is selective electroless plating which also enables formation of electronic circuits with a-few-micron resolution. These solution-based methods can be used in the semiconductor industry as large-scale fabrication methods at low cost.

## 59 Organic Transistors II

**Date:** Aug. 31, 2017 (Thursday)
**Time:** 11:00~12:30
**Session Chair:** Prof. Byoung Hoon Lee (Ewha Womans Univ., Korea)

### C59-3 11:50~12:15

### Invited 3D Integration of Printed Organic Transistors and Circuits

*Sungjune Jung (POSTECH., Korea)*

We introduce the inkjet-printed vertically stacked 3D complementary organic transistors and circuits, which can double the transistor density. We fabricate a p-type organic field-effect transistor that is inkjet-printed on top of an n-type organic field-effect transistor that is also printed with a shared gate joining the two transistors. We further develop dual-gate organic NAND technology fabricated by printing technique with a demonstration of flexible logic circuits. The vertical stacking of independent-gate controlled dual gate transistors offers the potential for higher capacity in a smaller physical space as well as enhanced on-current and device stability than 2D planar NAND structure. The present study fulfills the essential requirements for the fabrication of organic printed complex ICs (increased transistor density, 100% yield, high uniformity, and long-term stability), and the findings can be applied to realize more complex digital/analogue ICs and intelligent devices.

### C59-4 12:15~12:30

### Flexible Organic WORM Memory with Polymer Dielectric as Charge Trapping Layer

*Junghoo Yun, Junhwan Choi, Seungwon Lee, Hanul Moon, Sung Gap Im, and Seunghyup Yoo (KAIST, Korea)*

As internet of things (IOT) starts to get commercialized, demand for non-volatile memory devices having various form-factors is also increasing. low-cost flexible write once read many (WORM) memory devices are considered potentially useful in many IOT devices. Up to now, two-terminal WORM memory devices have been more intensively studied than transistor-based WORM memories due to their simple configurations and easy fabrication process. However, these diode-based WORM memories have native disadvantages, such as small data read-out margin. Here we report flexible, transistor-based organic WORM memory devices that are composed of C8-BTBT channel layers and three polymer dielectric layers. With the superior dielectric characteristics of iCVD polymer dielectrics and a device structure based on rational design and material choice, we demonstrate a flexible organic WORM memory with a strain of over 2% exhibiting large memory window about 8V and 10 years retention time.

# 60 Organic Photovoltaic II

**Date:** Aug. 31, 2017 (Thursday)
**Time:** 11:00~12:30
**Session Chair:** Prof. Shinuk Cho (Ulsan Univ., Korea)

## D60-1 11:00~11:25

### Invited All-Polymer Solar Cells vs. Fullerene-Based Solar Cells: The Importance of Molecular Packing, Orientation and Morphology Control

*Bumjoon J. Kim (KAIST, Korea)*

Polymer-polymer solar cells (so called all-polymer solar cells, all-PSCs) have emerged as good candidates for applications in flexible and portable devices because these devices offer much superior thermal and mechanical endurance than conventional polymer-fullerene solar cells. However all-PSCs often suffer from low short-circuit current density, and thus power-conversion efficiency. In this talk, we will discuss three major challenges that need to be addressed in improving the photovoltaic performance of all-PSCs, i.e., (1) the low electron transport ability of polymer acceptor, (2) the precise control of molecular packing structure and orientation of polymer acceptor, and (3) polymer donor-acceptor demixing (unfavorable blend morphology). We will also discuss the advantage and potential of all-PSCs over polymer-fullerene PSCs systems.

## D60-2 11:25~11:50

### Invited Eco and Human-Friendly Fabrication of Polymer Solar Cells

*Han Young Woo (Korea Univ., Korea)*

In this contribution, we report eco- and human-friendly fabrication of OFETs and PSCs using only ethanol as a processing solvent. New ethanol-processable p- and n-type electroactive polymer (PPDT2FBT-A) and bis-adduct fullerene acceptor (Bis-$C_{60}$-A) were synthesized by incorporation of oligoethylene glycol (OEG) side-chains. PPDT2FBT-A showed a broad light absorption in the range of 300–700 nm and highly crystalline interchain ordering with interlamellar scattering up to (400) with strong edge on p–p stacking. An interpenetrating nano-fibrillar morphology was observed in BHJ films with Bis-$C_{60}$-A, leading to efficient exciton separation. A power conversion efficiency (PCE) of 0.75% was achieved for the ethanol-processed device, demonstrating significant photovoltaic performance for the first time.

# 60 Organic Photovoltaic II

**Date:** Aug. 31, 2017 (Thursday)
**Time:** 11:00~12:30
**Session Chair:** Prof. Shinuk Cho (Ulsan Univ., Korea)

## D60-3 11:50~12:15

### Invited Effect of the Active Layer Nano-Morphology on the Efficiency of Organic Photovoltaic Cells

*Daniele Di Nuzzo (Cambridge Univ., UK)*

I will describe how the efficiency of organic solar cells is strongly affected by the nano-scale morphology of the active layer, which in turn can be controlled by the processing conditions during fabrication. We showed that recombination of charges to form intramolecular triplet excitons is an important efficiency loss mechanism in solar cells, which can be prevented by tuning phase separation and intermolecular order in the donor:acceptor blend. Optimal phase separation and intermolecular order were achieved by using additives in the spin-coating solution. Furthermore, we showed that the same type of blend nano-morphology allows to reduce the open-circuit voltage loss involved in charge separation. Finally, we demonstrated that inter-chain aggregation enables the direct photo-generation of free charges in a pristine semiconducting polymer, without the need of electron or hole acceptors. Overall, our results indicate universal active layer design and processing strategies to achieve high power conversion efficiency in organic photovoltaics.

## D60-4 12:15~12:30

### High Efficient Large-Area Organic Solar Cells by Blade Coating

*Hsin-Fei Meng , Kuan-Min Huang, Hsiao-Wen Zan (Nat'l Chiao Tung Univ., Taiwan), and Ying Qian Wong (Multimedia Univ., Malaysia)*

In this work, we propose high efficiency semitransparent OSCs with good color perception and good color rendering using blade coating technique. Blade coating has the advantages of having high film uniformity, high throughput due to its roll-to-roll potential and rapid-drying mechanism [3], and it is easily scalable to large area [4]. We first fabricate small area devices with active area of 0.04 $cm^2$, followed by large area devices with active area of 216 $cm^2$. The polymer blend poly[4,8-bis(5-(2-ethylhexyl)thiophen-2-yl) benzo[1,2-b;4,5-b']dithiophene-2,6-diyl-alt-(4-(2-ethylhexyl)-3-fluorothieno[3,4-b]thiophene-)-2-carboxylate-2-6-diyl)]:PC71BM (PBDTTT-EFT:PC71BM) show promising results. For small area devices, semitransparent PBDTTT-EFT:PC71BM achieve a power conversion efficiency (PCE) of 5.6% and opaque small area device achieve a PCE of 9.4%. For large area semitransparent and opaque devices, they are found to produce a PCE of 3.7% and 4.4%. For color rendering, it demonstrates high color rendering index (CRI) of 87.1. These combined high performances indicate high-quality transmitted light, which is suitable for window application.

# 61 Oxide TFTs: Advanced Materials

**Date:** Aug. 31, 2017 (Thursday)
**Time:** 11:00~12:30
**Session Chair:** Prof. Jin-Seong Park (Hanyang Univ., Korea)

## E61-1 11:00~11:25

### Invited Correlation between Electronic Structures and Instabilities in Amorphous Oxide Semiconductors: Strategies for High- Performance and Stable AOS-TFTs

*Junghwan Kim, Toshio Kamiya, and Hideo Hosono (Tokyo Inst. of Tech., Japan)*

In this paper, we focus on the origins of instabilities in AOSs in terms of differences in the electronic structures: optical bandgap, donor levels, ionization potential, etc. The energy levels of a variety of AOSs are measured using in situ ultraviolet photoemission spectroscopy (UPS). It was revealed that the donor levels ($E_D$) vary significantly depending on electronic structures. On the other hand, these observations raise some questions. Which one is the dominant factor for determining electrical properties of AOSs, the amount of oxygen vacancies or donor levels? What would happen if the same amount donor-like impurities diffuse into two different AOS layers with largely different donor levels? Details, including the origins of the differences in electronic structures and electrical properties, will be presented at the conference.

## E61-2 11:25~11:50

### Invited Pulse I–V Approach to Understanding Defects in Oxide Semiconductor Transistor

*Sanghun Jeon (Korea Univ., Korea)*

High-mobility and high-reliability amorphous oxide semiconductor transistors are necessary switch and driving elements for active matrix back-planes. The carrier transport and device instability of amorphous oxide semiconductor devices are influenced by defects that are exponentially distributed in energy. Thus, understanding defects and charge trapping in oxide semiconductor transistors is required. In this paper, we present the transient charging effect, the charge trapping mechanism, and the dynamic charge transport of various oxide semiconductor transistors. To this end, we exploited microsecond ramps, pulse $I_D$–$V_G$, transient current, and discharge current analysis methods. Additionally, the charge trapping phenomena follow the multi-trap model with multi time constants. Transient charge trapping can be classified to temperature insensitive fast charging and thermally activated slow charging with two different trap energies. Insignificant fast transient charging of a oxide semiconductor thin film transistor (TFT) can be explained by the low density of sub-gap states in the oxide semiconductor. Understanding defects and transient charging in the oxide semiconductor helps to determine the origin of device instability of oxide TFT.

# 61 Oxide TFTs: Advanced Materials

**Date:** Aug. 31, 2017 (Thursday)
**Time:** 11:00~12:30
**Session Chair:** Prof. Jin-Seong Park (Hanyang Univ., Korea)

## E61-3 11:50~12:15

### Invited Complementary Metal Oxide Semiconductor (CMOS) Inverters based on Tin Oxide ($SnO_x$) Thin-Film Transistors

*I-Chun Cheng, Yun-Shiuan Li, Shu-Ming Hsu, Wen-Liang Huang, and Jian-Zhang Chen (Nat'l Taiwan Univ., Taiwan)*

Complementary-oxide-semiconductor (CMOS) inverters are essential building blocks to realizing versatile large-area electronic circuits with low power consumption. Tin oxide ($SnO_x$) TFTs are recently regarded as one of the most promising candidates for oxide CMOS technology. It has been known that the behavior of $SnO_x$ TFT can be modulated by the stoichiometry of the $SnO_x$ active layer. In this work, we report low-temperature-processed CMOS inverters based on $SnO_x$ TFTs, which are realized by using single-step deposited $SnO_x$ active layer along with selective deposition of a zirconium dioxide ($ZrO_2$) capping layer. The $SnO_x$ TFTs have an inverted-staggered bottom-gate configuration. Without the $ZrO_2$ capping layer, the $SnO_x$ TFT exhibits p-channel behavior. After depositing the $ZrO_2$ capping layer, followed by a low-temperature annealing process, the $SnO_x$ TFT becomes n-type. Complementary inverters based on monolithic integration of the p-channel and n-channel $SnO_x$ TFTs are demonstrated. A static voltage gain of ~11 is achieved.

## E61-4 12:15~12:30

### Hybrid TFT for High Quality Organic Light Emitting Diode Display

*Lianjie Qu, Bingqiang Gui, Yonglian Qi, Dan Wang, Yun Qiu, Hebin Zhao (Beijing BOE Display Tech. Co., Ltd., China), and Chengshao Yang (Hefei BOE Display Tech. Co., Ltd., China)*

In this paper, we propose a potential fabrication process and design structure of hybrid TFT. It can improve the performance of OLED. By this method ,we can get a better performance of oxide TFT in the hybrid TFT with low cost and simple process.

## 62 3D Application (3DSA Joint Session)

**Date:** Aug. 31, 2017 (Thursday)
**Time:** 11:00~12:25
**Session Chairs:** Prof.Chien-Yu Chen (NTUST, Taiwan)
Dr. Gi-Mun Um (ETRI, Korea)

### F62-1 11:00~11:25

**Invited** **The First 3D Television Broadcasting System with Centralized Texture Depth Packing Formats Launched in Taiwan**

*Guan-Cheng Chen, We-Jong Yang, and Jar-Ferr Yang (Nat'l Cheng Kung Univ., Taiwan)*

In the recent years, the demand of the 3D entertainment develops rapidly. To fit the existing 2DTV broadcasting channels, frame compatible 3D formats are used to deliver the 3D video information. As a result, we propose a 3D compatible format named centralized texture depth packing (CTDP) formats, which shows much better PSNR and SSIM performances than SbS and TaB formats. Thus, the CTDP formats will be adopted by Hsin Yeong An Cable TV Co., Ltd. The HYA Company, which was the first cablevision corporation in Taiwan to complete 100% cable television digitization, will first promote 3D TV programs broadcasting in Taiwan. For those users who have CTDP depackers, 3D programs can support four modes: traditional glasses 3D displays, new glasses 3D displays, naked-eyes 3D displays, and 2D displays with RB-glasses to enjoy 3D visualization.

*(3DSA Paper)*

### F62-2 11:25~11:40

**Single Built-in-Camera 3D Interactive System based on Fingertip Position Estimation**

*Tai-Yu Lu, Chun-Ho Chen, Yi-Pai Huang, and Han-Ping D. Shieh (Nat'l Chiao Tung Univ., Taiwan)*

A camera-based 3D interactive system for portable device was developed. A majority of commercial products obtained 3D coordinate with a RGB camera and a depth Camera. In this paper, we propose a single built-in-camera 3D interactive system. Through pre-processing and segmentation of the entire hand with Gaussian Mixture Model, we get fingertips in 2D morphology. For depth information, the finger's width on captured images is proposed as the depth cue. After overcoming the issues of rotated fingers and finding a precise width, the finger's width is related to the depth prediction.

*(3DSA Paper)*

## 62 3D Application (3DSA Joint Session)

**Date:** Aug. 31, 2017 (Thursday)
**Time:** 11:00~12:25
**Session Chairs:** Prof.Chien-Yu Chen (NTUST, Taiwan)
Dr. Gi-Mun Um (ETRI, Korea)

### F62-3 11:40~11:55

### Depth Estimation from a Single Image with a Communication Module between Global Network and Local Network

*Minki Jeong and Changick Kim (KAIST, Korea)*

Depth estimation is a core technology in understanding 3D geometry of an image. There are plenty of studies to estimate depth from multiple images, but depth estimation from a single image has been relatively less addressed because a single image does not preserve depth information. However, with deep neural network, it is possible to estimate depth of a single image despite its problems. In this paper, we suggest a novel DNN architecture to estimate depth of a single image. Our architecture employs three deep networks: one estimates depth based on the entire image, another one estimates depth based on local patches of the image, and the other one refines the outputs from the previous two networks. Between the first and the second network, we introduced communication module. It exchanges features between the two networks, to improve performance. The architecture is evaluated on NYU depth, and result improved performance.

*(3DSA Paper)*

### F62-4 11:55~12:10

### Robust Depth Image-based Rendering Using Gradient Cost Pre-processing and Hole-filling

*Ting-An Chang, Keng-Jung Hsu, and Jar-Ferr Yang (Nat'l Cheng Kung Univ., Taiwan)*

Depth image-based rendering (DIBR) by using texture frame and depth map is a 2D to 3D view synthesis technology operated in the spatial domain. The DIBR system requires at least a single color image and an associated depth map to generate synthesized autostereoscopic 3D views. Warping process, which is the first step in DIBR engine, generates the required virtual views but with a number of disocclusion areas. The disocclusion filling process, called hole-filling, is the main challenge in the DIBR process. In this paper, the gradient cost depth extension (GCDE) and the gradient cost hole-filling (GCHF) algorithms are proposed, which are based on the texture and gradient analyses. Simulations show that the proposed method could effectively reduce the blur effect and annoy foreground and background mixing noise.

*(3DSA Paper)*

## 62 3D Application (3DSA Joint Session)

**Date:** Aug. 31, 2017 (Thursday)
**Time:** 11:00~12:25
**Session Chairs:** Prof.Chien-Yu Chen (NTUST, Taiwan)
Dr. Gi-Mun Um (ETRI, Korea)

### F62-5 12:10~12:25

### Effective Hole Filling Method through Speed Enhancement of VST Technique in Extrapolated Image

*Gyu-Cheol Lee and Jisang Yoo (Kwangwoon Univ., Korea)*

In this paper, we propose a new hole filling method based on View Spatial Temporal (VST) Method to fill disocclusion regions generated from the extrapolated image. In order to solve the problem of speed reduction caused by the high complexity of the VST technique, the range of the image to be searched should be reduced. In the experiment, the ratio of selecting blocks in the previous frame and next frame is 2% and 5%, and frames are removed from the search range because the ratio of selecting blocks is relatively small.

*(3DSA Paper)*

# 63 Advanced LED Technologies II

**Date:** Aug. 31, 2017 (Thursday)
**Time:** 11:00~12:30
**Session Chair:** Prof. James S. Speck (Univ. of California, USA)

## G63-1 11:00~11:25

### Invited All Inorganic Nanocrystals for Display and Energy Device Applications

*Jong-Soo Lee (DGIST, Korea)*

In this work, we present the synthesis of highly luminescent Cd-Free QDs with tunable emission from 488 to 641 nm and high color purity. We found that the addition of zinc during the conventional SILAR growth of shell, deteriorates the absorption features of core QDs and resulted in broader emission linewidths. We have solved this issue by synthesizing Zn carboxylate covered core QDs in a single step and dramatically decreased the emission FHWM to as low as 36 nm with quantum yields (QYs) up to 67% for the green emitting QDs. We also demonstrate an effective SILAR method to continuously tune the core Cd-Free QDs size from 1.6 to 3.6 nm with narrow size distribution. This enables us to tune the emission up to 641 nm with FWHM values less than 45 nm and QY up to 56% for red emission.

## G63-2 11:25~11:50

### Invited Phosphor-less White LEDs and Single Photon Sources Using 3D Nitride Semiconductor Structures

*Yong-Hoon Cho (KAIST, Korea)*

We present intriguing nitride-based quantum structures grown on various three-dimensional nano- and micro-structures as a template. First, we demonstrated phosphor-less white light emitting diodes (LEDs) based on three-dimensional GaN-based nano-/micro-structures. The annular and double concentric truncated pyramidal LEDs provide broad-band, white light generation from the QWs formed on various planes. Second, we demonstrate a novel approach of the self-aligned deterministic coupling of single quantum dots (QDs) to nanofocused plasmonic modes. We achieved strong spontaneous emission enhancement of QDs over a wide spectral range from a single QD from a pyramidal structure. Third, we found that the majority of the extracted light from single QD from the pyramidal structure can be effectively guided toward the bottom of the pyramid with high directionality. Finally, by using the tapered GaN/InGaN core–shell QW semiconductor rods, we observed highly asymmetric photonic diode behavior and exciton-polariton formation at room temperature.

# 63 Advanced LED Technologies II

**Date:** Aug. 31, 2017 (Thursday)
**Time:** 11:00~12:30
**Session Chair:** Prof. James S. Speck (Univ. of California, USA)

## G63-3 11:50~12:15

### Invited Roll Transfer Technology for Manufacturing Micro LED Display

*Jae-Hyun Kim, Yun Hwangbo, Seong-Min Hong, Yeon-Woo Jeong, Bongkyun Jang, Kwang-Seop Kim, Kyung-Shik Kim, Seung-Mo Lee, Hyun-Sung Park, Hak-Joo Lee, Byung-Ik Choi, and Sang-Rok Lee (KIMM, Korea)*

In this talk, roll-based transfer technology is introduced to overcome the productivity issue in manufacturing micro LED displays. The roll-based transfer technology is composed of two steps. One is the picking step and the other is the placing step. During the picking step, the rearranged micro LED chips on a carrier film or a handling wafer is transferred to a roll-based stamp with a transfer film. The picked micro LED chips on the roll-based stamp is transferred to a target substrate by controlling mechanical contact force. For the high productivity, the transfer process should provide the electrical connection of LED chips as well as mechanical movement of them. The roll-based transfer of micro LEDs is demonstrated with high yield and overlay alignment.

## G63-4 12:15~12:30

### Ligand Density Control for Improvement of All-inorganic Perovskite QLED

*Young-Soo Chae, Sun-Kyo Kim, and Yong-Seog Kim (Hongik Univ., Korea)*

In this study, ethyl acetate was adopted as the flocculation solvent in the purification process because of its intermediate polar characteristics. By adjusting the ratio of the good solvent and flocculation solvent, the ligand density on QDs was reduced without causing surface reaction of the perovskite QDs. The weight loss in the range of 200~300°C in TG data represents the vaporization of oleylamine and oleic acid, which act as ligands of perovskite. The minimum amount of ligand that can maintain good dispersion stability of Perovskite QD was ~5%. Using the material, uniform layer was formed via spin-coating of the QDs as shown in Fig. 2 and its PLQY was enhanced as well.

# 64 Power Systems for Stretchable / Deformable Electronics

**Date:** Aug. 31, 2017 (Thursday)
**Time:** 11:00~12:20
**Session Chair:** Dr. Sunho Jeong (KRICT, Korea)

## H64-1 11:00~11:25

### Invited Textile-Based Energy Storage Devices

*Qiyao Huang and Zijian Zheng (The Hong Kong Polytechnic Univ., China)*

Wearable supercapacitor textiles are supercapacitors that made use of and/or shaped into textile fibers, yarns, and fabrics, which are inevitable energy storage devices for wearable electronic applications. To date, the major challenge in the development of wearable supercapacitors is how to improve the electrochemical properties of the device while acquiring high flexibility and durability under wearing conditions. Recently, our laboratory has developed several supercapacitor yarns and fabrics, which show record–high electrochemical performances of their kinds as well as excellent flexibility. These textile–based devices can be readily integrated into different textile forms by means of weaving, embroidery, and heat pressing for wearable applications.

## H64-2 11:25~11:50

### Invited Deformable Ag-Coil/Ferrite Wireless Power Transfer (WPT) Module Fabricated by a Printing Technology

*Murali Bissannagari and Jihoon Kim (Kongju Nat'l Univ., Korea)*

Inkjet-printed NiZn-ferrite films were detached from rigid substrate after annealing at elevated temperatures with an aid of a sacrificial layer. A sacrificial layer was prepared onto the rigid substrate in order to minimize a intermixing at the interface between the inkjet-printed NiZn-ferrite film and the rigid substrate. The detached NiZn-ferrite films were embedded into flexible substrates such as polydimethylsiloxane (PDMS) or polyimide (PI). Structural and Magnetic properties of the embedded NiZn-ferrite films were investigated by various characterization techniques such as X-ray diffraction, Field-emission SEM, vibrating sample magnetometer (VSM), and impedance analyzer. In order to apply the embedded NiZn-ferrite films to wireless power transfer (WPT), Ag spiral inductor coil pattern was printed on the detached NiZn-ferrite film by inkjet printing before the embedding process. Flexibility of the embedded coil/NiZn-ferrite structure was investigated by a bending test. The crack propagation during the bending test was monitored by the change in the resistance of the inductor coil. The WPT performance was demonstrated by applying the embedded coil/NiZn-ferrite structure as a power receiving unit (Rx) with a commercial power transmitting unit (Tx). A series of LED lights were successfully turned on by the wireless power received by the flexible Rx unit.

## 64 Power Systems for Stretchable / Deformable Electronics

**Date:** Aug. 31, 2017 (Thursday)
**Time:** 11:00~12:20
**Session Chair:** Dr. Sunho Jeong (KRICT, Korea)

### H64-3 11:50~12:05

### High-Performance, Ultra-Flexible and Transparent Embedded Metallic Mesh Electrodes for Solid-State Supercapacitors

*Jian-Long Xu (Soochow Univ., China)*

In this talk, I will introduce our recent works about high-performance, ultra-flexible and transparent embedded metallic mesh electrodes and thus fabricating flexible transparent supercapacitors. We propose a novel approach via selective electrodeposition process combined with inverted film-processing methods for the first time to fabricate large-scale embedded metallic mesh TCEs with excellent optoelectronic properties ($R_s$ ~ 0.2 Ω/sq & $T$ ~ 91.3%), high Figure of Merit (*FOM* ~ 1.0´10$^4$) and mechanical durability, arising from embedded inverted T-type shape of electrodeposited Ni mesh. The resultant embedded Ni mesh/poly (3,4-ethylenedioxythiophene): poly (styrenesulfonate) hybrid electrodes are utilized both as current collectors and active electrode materials for supercapacitors, which show high transparency (~ 83%), superior electrochemical performances, excellent mechanical flexibility and high capacitance retention. Moreover, embedded Ag grid TCE is fabricated with a facile soft ultraviolet imprinting lithography method combined with scrap techniques, based on which high-performance flexible transparent supercapacitors are also constructed and obtained.

### H64-4 12:05~12:20

### Large-Area, Stretchable and Transparent Heaters Using Metal Nanofibers with Wireless Operations

*Jiuk Jang, Byung Gwan Hyun, Sangyoon Ji, Eunjin Cho, and Jang-Ung Park (UNIST, Korea)*

The rapidly-emerging interest in wearable electronics has engendered the need for the development of stretchable and transparent heating films to replace the conventional heaters. Although indium tin oxide (ITO) has been used as the heater, it has mechanical limitations due to its intrinsic fragility. Here, we demonstrate a stretchable, transparent and large-area resistive heater on various substrates using the ultra-long Ag nanofibers (AgNFs). Optical transmittance and the sheet resistance of electrode can be controlled by adjusting area fraction of AgNF random networks; therefore, various temperature range can be achieved depending on the purpose. The heater presents high temperature (250 °C) at a low operating voltage (5 V, Fig. 1.) and excellent temperature reliability under large strain (40%). Furthermore, we demonstrate the wireless operation of the heating film for fine control of its temperature using smart devices via Bluetooth.

## 65 Novel Processes for Solution OLED

**Date:** Aug. 31, 2017 (Thursday)
**Time:** 16:00~17:35
**Session Chair:** Dr. Alexander Colsmann
(Karlsruhe Institute of Technology, Germany)

### A65-1 16:00~16:25

**Invited** High Efficiency Perovskite Quantum-Dot Light-Emitting Devices by Effective Washing Process

*Takayuki Chiba, Keigo Hoshi, Yong-Jin Pu, Yuya Takeda, Yukihiro Hayashi, Satoru Ohisa, and Junji Kido (Yamagata Univ., Japan)*

Here, we fabricated low driving voltage and high efficiency $CsPbBr_3$ perovskites quantum dots (PeQDs) light-emitting devices (PeQD-LEDs) using a PeQDs washing process and energy level alignment of the device. The PeQD-LED with butyl acetate-washed PQDs exhibited a maximum power efficiency of 31.7 lm W–1 and EQE of 8.73%. Control of the interfacial PeQDs through ligand removal and energy level alignment in the device structure are promising methods for obtaining high PLQYs in film state and high device efficiency.

### A65-2 16:25~16:40

Blade-Coated Dual Color Polymer Light-Emitting Diodes (PLEDs) for Optoelectronic Sensors

*Donggeon Han, Yasser Khan, Jonathan Ting, and Ana Arias (UC Berkeley, USA)*

Here, a blade coating technique for printing multicolor PLEDs on one substrate using surface energy patterning is presented. By selectively creating hydrophilic regions on the substrate, green, red, and near-infrared PLEDs are fabricated. Since this method allows printing of multicolor PLEDs, a reflection-mode pulse oximeter sensor composed of red and green PLEDs and a silicon photodiode on a flexible substrate is demonstrated on the wrist. Finally, it is demonstrated that the reflection-mode pulse oximeter can accurately record pulse and oxygenation values at the wrist.

### A65-3 16:40~16:55

A New Method to Achieve High Resolution OLED Displays by Ink-Jet Printing

*Dejiang Zhao, Wei Huang, Bo Jiang, Shan-chen Kao, Guangcai Yuan, Lu Wang, and Jaiil Ryu (BOE Tech. Group Co., Ltd., China)*

We designed a new bank structure,this structure has two layers bank, the bottom one is pixel defined layer and the top one is ink resistant layer (also named printing pxiel). The PLED ink is printed into the printing pixel at first, during the dry process, the ink can be divided into four subpixels equally and then become symmetrical film in each subpixel, ppi can reach four times higher based on this design. In our test cell, the resolution had been updated to 248ppi by this method.

# 65 Novel Processes for Solution OLED

**Date:** Aug. 31, 2017 (Thursday)
**Time:** 16:00~17:35
**Session Chair:** Dr. Alexander Colsmann
(Karlsruhe Institute of Technology, Germany)

## A65-4 16:55~17:20

### Invited Full-Color Quantum Dots Active Matrix Display based on Ink-Jet Printing

*Junbiao Peng (South China Univ. of Tech., China)*

Full-color active matrix quantum dot light emitting diodes (AM-QLEDs) with ink-jet printing technology have attracted much attention because of their potential manufacture advantages of large screen size, wide color gamut and low cost. In the presentation, an efficient full-color AM-QLEDs display with pixel density fabricated by ink-jet printing technique.

## A65-5 17:20~17:35

### High-Efficiency Solution-Processed Organic Light-Emitting Diodes

*Le Yang, Dawei Di, and Richard H Friend (Univ. of Cambridge, UK)*

Vacuum-deposition is the mainstream technology for producing high-efficiency OLEDs, as it can maintain high precision control and render versatility in the fabrication process. But the high cost and material wastage pose a problem. Solution-processing routes could be a cheaper option and a possible pathway towards printable electronics. Material consumption can be minimised, though current technologies that use a very thick emissive layer can still be materials-costly. Solution-processed devices often produce lower efficiencies, due to irreproducibility and less interfacial control. Herewe present a versatile multilayer solution-processable route that can be commercially competitive. Our efficiencies rival that from vacuum-deposited devices. We also only require a minute amount of emissive materials in a very thin emissive layer, thus lowering material wastage. Besides, it is a versatile architecture that accommodates many commercially-available emitters. Lastly, it is noteworthy that all layer thicknesses in the multilayer structure can be retained, ensuring all underlying interfaces are intact and preserved. Examples of this architecture are shown in two recent publications: 1) a multicolour series of fluorescent OLEDs are studied for their triplet fusion-enhanced electroluminescence; 2) a newly discovered emission mechanism (Rotationally-accessed spin-state inversion, RASI) in new materials has led to record-efficient solution-processed OLEDs.

# 66 OLED Optics

**Date:** Aug. 31, 2017 (Thursday)
**Time:** 16:00~17:10
**Session Chair:** Prof. Ziyi Ge (Chinese Academy of Sciences, China)

## B66-1 16:00~16:15

### Fabrication and Characteristics of Multidirectionally Wrinkable Clothing Shaped Organic Light-Emitting Devices

*Seungyeop Choi, Myung Sub Lim, Seonil Kwon, Hyuncheol Kim, Jung Hyun Kwon, Yongmin Jeon, Yong Min Kim, and Kyung Cheol Choi (KAIST, Korea)*

Fabrication methods and characteristic evaluations of a clothing shaped wearable display device were introduced here. Organic light-emitting diodes (OLEDs) having ultrathin and flexible properties were used for human-friendly and ergonomic design to overcome limitations of LED, and a fabrication method of an extremely pliable and OLED-compatible fabric substrate with a crack arrestor structure was suggested.

## B66-2 16:15~16:40

### Invited Optical Design of OLEDs: From Lighting and Display Perspectives

*Seunghyup Yoo, Eunhye Kim, Jinouk Song, Jaehyuk Park, Jaeho Lee, Jin Chung, and Hyeon-Woo Lee (KAIST, Korea)*

This talk will discuss on the design aspects of OLEDs from both lighting and display perspectives. For lighting devices, we will describe a case of OLEDs employing simple light extraction structures such as scattering layers or microlens array foils. As they are already well-known structures, we will focus on how one can maximize their light extraction effect in OLEDs employing them. Trans-scale simulation that combines both incoherent and coherent effects will be presented as a tool to provide a global yet quantitative optimization method. In case of display devices, we will introduce a systematic method to balance both enhancement in efficiency and suppression of angular color shift. Finally, we will discuss on optical design aspects applicable to wearable sensor applications involving OLEDs. A careful optical design is shown to play a key role in achieving power savings particularly important in wearable applications.

# 66 OLED Optics

**Date:** Aug. 31, 2017 (Thursday)
**Time:** 16:00~17:10
**Session Chair:** Prof. Ziyi Ge (Chinese Academy of Sciences, China)

## B66-3 16:40~16:55

### A Nano-lens Array Fabrication Using a Mask-free Deposition for Highly Efficient and Pixel Blur-free Top-emitting OLEDs

*Young-Sam Park (ETRI, Korea), Kyung-Hoon Han (Seoul Nat'l Univ., Korea), Doo-Hee Cho (ETRI, Korea), Jehan Kim (Pohang Accelerator Lab., Korea), Byounggon Yu, Nam Sung Cho (ETRI, Korea), Jang-Joo Kim (Seoul Nat'l Univ., Korea), and Jeong-Ik Lee (ETRI, Korea)*

We report a highly process compatible nano-lens array (NLA) technology, which effectively supresses image blurring and enhances light extraction efficiency. NLA is fabricated by using a vacuum deposition method. Neither a mask nor additional treatment is required, thus greatly simplifying the overall process. NLA is formed by the crystallization of organic molecules, which provides a driving force for dewetting and droplet formation. NLA is easily integrated on green OLEDs by directly forming it on the top electrode. Current efficiencies of the OLEDs without and with the NLAs at 1 mA/cm$^2$ are 79 and 123 cd/A, respectively, indicating an increase ratio of 1.55 by employing it. The ratio is similar to that of simulation results, showing that NLA is an optically effective scattering structure. NLA equipped red and blue OLEDs are also investigated in this work. Furthermore, the NLA effects on flexible OLEDs having plastic film substrtates will be discussed.

## B66-4 16:55~17:10

### Simulation Analysis of Color Tunable Organic Light Emitting Diodes with Color Filter Electrode

*Jun Hee Han, Do-Hong Kim, and Kyung Cheol Choi (KAIST, Korea)*

In this study, simulation analysis of color tunable organic light emitting diodes (OLED) with color filter electrode was conducted in order to verify the application of color filter electrode in the OLED device. Based on the analysis results, it was confirmed that the color tuning would be possible through the color filter electrodes applied to OLED. This study shows that the color filter electrodes which were used for OLED have the potential to be used in the future display such as large area display, flexible display, and virtual reality display etc.

# 67 Organic Transistors Ⅲ

**Date:** Aug. 31, 2017 (Thursday)
**Time:** 16:00~17:30
**Session Chairs:** Prof. Sungjune Jung (POSTECH, Korea)
Dr. Takeo Minari (NIMS, Japan)

## C67-1 16:00~16:25

### Invited Pixel Current Calibration in Digital-Driven Active Matrix Displays

*Jan Genoe, Lynn Verschueren, Florian De Roose, Wim Dehaene, and Paul Heremans (imec, Belgium)*

In this presentation, we elaborate the accuracy at which the real-time calibration of digital Pulse Width Modulation (PWM) of the AMOLED displays can be done. Calibration is done to compensate for a-IGZO TFT non-uniformity, OLED non-uniformity, temperature variation effects, resistive drops on the power lines and a-IGZO TFT VT shift due to bias stress. This calibration substantially increases the design complexity of the external silicon drivers but we demonstrate that calibration can be done in real-time at typical display refresh rates.

## C67-2 16:25~16:50

### Invited Flexible and Stretchable Sensors based on Organic and Polymeric Materials

*Joon Hak Oh (POSTECH, Korea)*

Sensors based on molecules covering small organic molecules and polymers have recently attracted great interest due to their high potential for use in flexible, low-cost, solution-processable, large-area electronics. In this talk, the development of high-performance organic and polymeric semiconductors will be presented with viable approaches to selectively tune the dominant polarity of charge carriers and achieve efficient charge transport. Unconventional organic and polymeric nanomaterials covering single-crystalline nanowires, nanoporous films, core-shell nanomaterials, multiple-patterned plasmonic nanostructures, and chiral supramolecules will be described with their applications in flexible and wearable sensors including photodetectors, chemical and biological sensors. In addition, the fundamental charge transport and photophysical phenomena of molecule-based active layers will be discussed.

# 67 Organic Transistors Ⅲ

**Date:** Aug. 31, 2017 (Thursday)
**Time:** 16:00~17:30
**Session Chairs:** Prof. Sungjune Jung (POSTECH, Korea)
Dr. Takeo Minari (NIMS, Japan)

C67-3 16:50~17:15

## Invited Molecular Doping and Orientation of Conjugated Polymers for High-Performance Electronic Circuits and Flexible Displays

*Kang-Jun Baeg, Dong-Hyeon Lee (Pukyong Nat'l Univ., Korea), Minji Kang, Jihong Kim, and Dong-Yu Kim (GIST, Korea)*

Flexible and printed electronics based on nanocarbon-based or π-conjugated organic materials have been extensively studied and have experienced rapid growth over the last two decades. This technology enables the development of unconventional soft electronics applications, including light-weight, low-cost, and large-area fabrication, as well as their flexible and stretchable properties. Many efforts have been made to optimize and finely tune the electrical characteristics, mostly to increase the charge carrier mobility by synthesis of new materials and optimizing the fabrication processes. Here we report the structural changes in semiconducting polymer thin-films to enhance the charge transport properties by blending with conjugated small molecules and molecular doping.

C67-4 17:15~17:30

## Massive Self-Alignment of Micro-Spheres on Fast-Moving Ball Actuator

*Ho Won Yoon and MunPyo Hong (Korea Univ., Korea)*

Dielectrophoretic force based self-alignment technic has been useful application for in various fields such as lap-on-a-chips, bio-sensors, and displays. We have been investigating on the micro-sphere self-alignment using dielectrophoretic force for fabricating the novel e-paper display, Fast-moving Ball Actuator (FMBA). In our early works, directly and indirectly self-aligning individual Conductor Coated Polymer Ball (CCPB, diameter 10um) on every pixels were developed. Because of least process required, direct self-alignment was adapted to make 1 x 1 cm$^2$ active area FMBA display working sample. 15~45 V, 1~100 kHz sinusoid voltage signal was applied between contact and hold electrode to generate pDEP and CCPB mixed silione oil (KF-96, 100cs) flow rate was 3~20 μl/min. Some vacancies were verified, but direct self-aligning CCPB method made it possible to arrange ten thousands of micro-sized particles neatly and complete the fabrication.

## 68 Organic Photovoltaic Ⅲ

**Date:** Aug. 31, 2017 (Thursday)
**Time:** 16:00~17:30
**Session Chair:** Prof. Inchan Hwang (Kwangwoon Univ., Korea)

### D68-1 16:00~16:25

**Invited** **Plasmonic Organic Solar Cells: A New Class of Simultaneous Plasmon – Optical and – Electrical Effects from Plasmonic Asymmetric Modes**

*Wallace C.H. Choy (Hong Kong Univ., China)*

The plasmon-optical effects have been utilized to optically enhance active layer absorption in organic solar cells (OSCs). The exploited plasmonic resonancesof metal nanomaterialsare typically from the fundamental dipole/high-order modes with narrow spectral widths for regional OSC absorption improvement.

### D68-2 16:25~16:50

**Invited** **Interface Engineering and Vertical Concentration Controlling for High Performance Polymer Solar Cells**

*Zhan'ao Tan, Cong Li, and Yaping Wang (North China Electric Power Univ., China)*

For polymer solar cells (PSCs), the interfaces between the back and front contacts with the photoactive layer play a crucial role for charge extraction. Herein, we present our recent study on the interface engineering for high performance PSCs with dual functional tantalum methoxide (Ta-OMe) cathode interfacial layer, which can reduce the interface energy barrier and form a light trapping structure with reflective metal electrode.

# 68 Organic Photovoltaic III

**Date:** Aug. 31, 2017 (Thursday)
**Time:** 16:00~17:30
**Session Chair:** Prof. Inchan Hwang (Kwangwoon Univ., Korea)

## D68-3 16:50~17:15

### Invited Modified Fullerenes for Efficient Electron Transport Layer-Free Perovskite: Fullerene Blend-Based Solar Cells

*Juan Luis Delgado (Univ. of the Basque Country UPV/EHU, Spain)*

A variety of novel chemically modified fullerenes, showing different electron accepting capabilities, has been synthesized and used to prepare electron transport layer(ETL)-free solar cells based on perovskite:fullerene blends. In particular, isoxazolino[60] fullerenes are proven to be a good candidate for processing blend films with $CH_3NH_3PbI_3$ and obtaining enhanced power conversion efficiency (PCE) ETL-free perovskite solar cells, improving state-of-the-art PCE (i.e. 14.3%) for this simplified device architecture (figure 1). Beneficial impact for pyrazolino and methano[60]fullerene derivatives versus pristine [60] fullerene is also shown. Furthermore, a clear correlation between the LUMO energy level of the fullerene component and the open circuit voltage of the solar cells is found. Apart from the new knowledge on innovative fullerene derivatives for perovskite solar cells, the universality and versatility of perovskite:fullerene blend films to obtain efficient ETL-free perovskite solar cells is demonstrated.

## D68-4 17:15~17:30

### Straight Forward Evidence for Long-term Interfacial Degradation of Inverted Perovskite Solar Cells

*Hyunho Lee and Changhee Lee (Seoul Nat'l Univ., Korea)*

In this study, we observed long-term stability (over 1000 hours) of inverted perovskite solar cells. We focused on the interfacial degradation of the devices, especially interface between electron transport layer (ETL) and Ag electrode. We will suggest the direct evidence of interfacial degradation sources with the TOF-SIMS analysis. The temperature varied photovoltaic measurement provides trap related activation energy and energetic disorder which explain the open circuit voltage change dynamics. Finally, we will suggest the degradation mechanism of inverted perovskite solar cells for 1000 hours.

# 69 Oxide TFTs: New Applications

**Date:** Aug. 31, 2017 (Thursday)
**Time:** 16:00~17:05
**Session Chair:** Dr. Paul Heremans (imec, Belgium)

## E69-1

16:00~16:25

### Invited Printed Metal Oxide TFTs for Biosensor Applications

*You Seung Rim (Sejong Univ., Korea), Huajun Chen, Sang-Hoon Bae, Anne M. Andrew, Paul S. Weiss, and Yang Yang (California Univ., U.S.A.)*

We demonstrated printed ultrathin $In_2O_3$ field-effects transistors (FETs) for biological sensor platforms. $In_2O_3$ solution could be formed with an ultrathin layer (3.5 nm), high-density, and uniform films over large areas. Ultrathin-$In_2O_3$ FETs had a high sensitivity (1 $pH^{-1}$) and a large transconductance (~9 mS) under the physiological environment with different pH levels as well as small LOD (0.0005 pH). Specific detection of glucose was also demonstrated with an extremely low LOD (<7 fM). Based on this result, we successfully constructed $In_2O_3$ biosensors on polyimide films (~1.5 μm) and performed the measurement of the glucose with tear levels. Low mechanical stress, and conformal contact could be demonstrated having complex curvilinear surfaces or an artificial eye. Additionally, we have expanded to clinical biosensor applications to detect subnanomolar concentrations of neurotransmitters for degenerative brain disorder diagnosis. These platforms will be highly expected that can offer new opportunities for wearable healthcare technologies.

## E69-2

16:25~16:50

### Invited Memory TFT Application: Under 150 °C, Low Temperature Processed Oxide TFT with Mobile Proton Inserted Gate Dielectric for Stretchable AMOLED

*DongHyeok Lee, JangWon Yun, and MunPyo Hong (Korea Univ., Korea)*

We will present the nonvolatile memory (NVM) functionality of indium gallium zinc oxide (IGZO) thin film transistors (TFTs) using mobile protons inserted silicon oxide ($SiO_2$) gate dielectric that are generated by very short time (within 5 minutes) hydrogen neutral beam (H-NB) treatment at room temperature (25 °C). The H-NB based hydrogen insertion process does not need any additional annealing process but only H-NB irradiation on the $SiO_2$ insulator surface during gate dielectric formation process. Also, whole fabrication processes for the NVM-TFT have kept under 150 °C including the IGZO thin film formation and the post annealing processes; the randomly generated Ar neutral beam (A-NB) during plasma sputtering process achieves excellent performances of metal oxide thin films even without post annealing process, combining with our novel physical deposition technology named as Magnetic Field Shielded Sputtering (MFSS) to prevent the negative oxygen ions (NOIs) bombardment damages [2]. The low temperature processed NVM-TFT devices have exhibited reproducible hysteresis, reversible switching, and nonvolatile memory behaviors in comparison with those of the conventional TFT devices.

## 69 Oxide TFTs: New Applications

**Date:** Aug. 31, 2017 (Thursday)
**Time:** 16:00~17:05
**Session Chair:** Dr. Paul Heremans (imec, Belgium)

E69-3 16:50~17:05

### Active Matrix Fingerprint Sensor Integrating Oxide Thin-Film Transistor

*Guk-Jin Jeon, Jae-Sung An, Seunghee Lee, Yunyong Nam, Jongbeom Ko, Kwang-Heum Lee (KAIST, Korea), Oh-Kyong Kwon (Hanyang Univ., Korea), and Sang-Hee Ko Park (KAIST, Korea)*

There are self-capacitive method and mutual capacitive method in the fingerprint sensors. While the mutual capacitive method driven in matrix has less routing number, the sensitivity of mutual capacitive method is rather low compared to that of self-capacitive method driven by each segment. The integration of TFT, therefore, is necessary in order to achieve matrix driving and high sensitivity. The self-capacitive type fingerprint sensor in matrix with thin film transitor makes multi-sensing possible with high sensitivity. In this study, we present self-capacitive type fingerprint sensor driven by Al-InSnZnO TFT (Al-ITZO) with 500 ppi resolution. When a finger touched the surface of fingerprint sensor, each pixel was composed of a TFT and a capacitor. BCE-structured high mobility Al-ITZO TFT can provide enough charge to capacitor at that time. A high k material for the passivation of fingerprint sensor can yield a good difference between the ridges and valleys.

## 70 OLED Lighting

**Date:** Aug. 31, 2017 (Thursday)
**Time:** 16:00~17:00
**Session Chairs:** Prof. Yasuki Yamauchi (Yamagata Univ., Japan)
Prof. Jae Soo Yoo (Chung-Ang Univ., Korea)

### G70-1 16:00~16:15

### A New Approach to Enhancing Color Rendering Index and Light Extraction of Down-Conversion White OLEDs for Lighting Applications

*Deok Su Jo, Sung Min Cho, Heeyeop Chae, and Ho Kyoon Chung (Sungkyunkwan Univ., Korea)*

Down-conversion white OLEDs for lighting applications have attracted much interest in a simple structure consisting of color-conversion layer (CCL) and blue OLED. This paper introduces adhesive transfer (AT) to improve the light extraction and CRI. The AT is based on a dry process, and it produced a high dense monolayer with phosphor particles on the adhesive layer. The CCL by AT (AT-CCL) process showed a surface fill factor of 91.6%, and ~50μm thickness. In particular, the AT-CCL/blue OLED achieved a balanced white emission with the highest CRI of 93 and the color temperature of 3,500K. The white OLED achieved the power efficiency of 11 lm/W which was enhanced by 1.9 times from that of the blue OLED. The effect of an extra non-emitting particle layer on top of AT-CCL was also investigated, and significant improvement was observed in both areal and angular uniformities (up to 99%).

### G70-2 16:15~16:30

### Electronic Structures and Emission Processes of Exciplex depending on Dimer Geometries in Solid States

*Chang-Ki Moon, Jin-Suk Huh, Jae-Min Kim, and Jang-Joo Kim (Seoul Nat'l Univ., Korea)*

Excited state charge transfer complex (exciplex) is of great interest for organic light-emitting diodes (OLEDs) as a thermally activated delayed fluorescent emitter and an efficient charge-recombining host layer. Employing the exciplex enhances the efficiecny of OLEDs to the levels sufficient to be applied in lghtings and displays industries. The exciplex emission following the excitation, the intermolecular charge transfer, and the dimeric relaxation processes exhibit singular emissive characteristics so we need a different point of view to understand the exciplex in compared to the monomeric chromophores. Here, we investigate that a gradual shift of the emitting dipole orientation of exciplex depending on the photon energy. The energy difference between the charge-transferred state and the ground state depends on the coupling geometries of monomers, the perpendicular coupling of the monomers leading to the low exciplex energy, demonstrated by density functional therory (DFT) and contrained density functional theory (CDFT) calculations. The large distribution of the dimeric coupling is responsible for the broad energy band of the exciplex resulting in the broad emission spectrum and the multi-exponential transient photoluminescence curve.

## 70 OLED Lighting

**Date:** Aug. 31, 2017 (Thursday)
**Time:** 16:00~17:00
**Session Chairs:** Prof. Yasuki Yamauchi (Yamagata Univ., Japan)
Prof. Jae Soo Yoo (Chung-Ang Univ., Korea)

### G70-3 16:30~16:45

### High Triplet Energy Bipolar Host Materials for Highly Efficient Blue Thermally Activated Delayed Fluorescent Organic Light-emitting Diodes

*Ji Su Moon, Gyeong Heon Kim, Dae Hyun Ahn, Joon Beom Im, Si Woo Kim, Seung Yeon Lee, Ju Young Lee, and Jang Hyuk Kwon (Kyung Hee Univ., Korea)*

In this work, we report newly synthesized two bipolar host materials, KHU-TBH 1 and KHU-TBH 2. The measured T1 of KHU-TBH 1 and KHU-TBH 2 values were 2.98 eV and 2.97 eV, respectively. We also evaluate our two host materials with well-known hole-transport type host, 1,3-bis(N-carbazolyl)benzene (mCP). For a blue TADF dopant, DMAC-DPS was employed for the device fabrication. As expected, the current density-voltage-luminance characteristics of KHU-TBH 1 and KHU-TBH 2 are better than mCP due to the bipolar characteristics. The efficiencies of two hosts were higher than that of mCP. The maximum EQEs of KHU-TBH 1, KHU-TBH 2, and mCP were 22.9%, 18.8%, and 17.5%. The reduced efficiencies from the maximum to 1,000 cd/m$^2$ were 0.16, 0.22, and 0.38, respectively. Our bipolar hosts show much higher efficiency and reduced efficiency roll-off characteristics compared to mCP host.

### G70-4 16:45~17:00

### Changes in Photophysical and Thermodynamic Properties of N,N'-diphenyl-N,N'-bis(1-naphthyl)-1,1'-biphenyl-4,4'-diamine (NPB) Under Extreme Storage Conditions

*Seob Shim, Jong-Ki An, Goru Kang, Yeontae Kang, Ha-Yeong Kim, Jin-Tae Kim, Nak-Kwan Chung, and Ju-Young Yun (KRISS, Korea)*

Changes in purity, photoluminescence, and thermodynamic properties of N,N’-diphenyl-N,N’-bis(1-naphthyl)-1,1’-biphenyl-4,4’’-diamine (NPB), which is commonly used as hole transporting materials in organic light emitting diodes, occurring during thermal stability assessment over an extended time period under high vacuum was investigated. After a total test time of around 50 hours, the purity and photoluminescence of tested materials, and electroluminescence and lifetime of devices fabricated from them were characterized using liquid chromatography-mass spectrometry technique and photoluminescence and electroluminescence measurement system. In addition to these chemical and photophysical changes, its influence on their thermodynamic properties including the vapor pressure and the enthalpy of vaporization could be observed. Here, we measured the temperature dependence of the vapor pressure of a group of NPB molecule subjected to long-term thermal stability assessment employing a Knudsen effusion cell and a quartz crystal microbalance and their enthalpies and entropies of vaporization were derived from a fit of the Clausius–Clapeyron equation.

## Poster Session I

**Date:** Aug. 29, 2017 (Tuesday)
**Time:** 14:00-15:30

### P1-1

A Microstructure Analysis of Low Temperature Poly-Si Thin Films by Electron Diffraction Method

*Jongkwon Choi (LG Display Co., Ltd., Korea)*

### P1-2

Solution-Processed Copper Thiocyanate for Efficient Hole Injection Layers of Quantum-Dot Light-Emitting Diodes

*Heeyoung Kim and Heeyeop Chae (Sungkyunkwan Univ., Korea)*

### P1-3

Polymer Ligand Formation on Quantum Dots for High Compatibility with Resins

*Bokyoung Kim, Chang Min Lee, Ho Kyoon Chung, and Heeyeop Chae (Sungkyunkwan Univ., Korea)*

### P1-4

Enhanced Performances of Quantum Dot Light-Emitting Diodes with Doped Polymer-Quantum Dot Emitting Layer

*Dan Dong, Weijie Wu, Lu Lian, Dongxu Feng, Wanwan Li, and Gufeng He (Shanghai Jiao Tong Univ., China)*

### P1-5

Hydrophilic Carbon Quantum Dot Layers for Quantum-Dot Light Emitting Diodes (QLED)

*Wei Jiang and Heeyeop Chae (Sungkyunkwan Univ., Korea)*

### P1-6

Colloidal Thick-Shell Quantum Dots with Near-Unity Quantum Yield and Suppressed Blinking

*Byeong Guk Jeong (KIST, Korea), Donghyo Hahm (Seoul Nat'l Univ., Korea), Doh Chang Lee (KAIST, Korea), and Wan Ki Bae (KIST, Korea)*

### P1-7

A Simple Strategy toward Improved Photo- and Thermal Stability of InP/ZnSeS/ZnS Quantum Dots through TiOx Passivation

*Min-Seok Kim, Jung-Ho Jo, Eun-Pyo Jang, Seok-Young Yoon, and Heesun Yang (Hongik Univ., Korea)*

# Poster Session I

Date: Aug. 29, 2017 (Tuesday)
Time: 14:00-15:30

## P1-8

**Excellent Color Rendering White Lighting Devices Comprising I-III-VI Type Cu-X-S (X=Ga, In) Quantum Dots**

*Jong-Hoon Kim, Bu-Yong Kim, Jong-Woo Shin, and Heesun Yang (Hongik Univ., Korea)*

## P1-9

**Fabrication of Blue Electroluminescent Device based on Highly Efficient Non-Cd Zn-Cu-Ga-S Quantum Dots**

*Bu-Yong Kim, Jong-Hoon Kim, Ki-Heon Lee, Chang-Yeol Han, and Heesun Yang (Hongik Univ., Korea)*

## P1-10

**The Effect of Electron and Hole Transfer Layers on the Electro-Optical Properties of Solution-Processed QD-LED**

*Yun-Soon Ka, Young-Jin Kwack, NamHoon Baek, Thuy Can, Canh Nguyen, and Woon-Seop Choi (Hoseo Univ., Korea)*

## P1-11

**Synthesis of Perovskite Quantum Dots ($CsPbBr_3$) for High Efficiency Light Emitting Diodes**

*Jin-Beom Kwon, Sae-Wan Kim, Jae-Sung Lee, Ok-Sik Kim, In-Su Lee, Cheol-Eon Park, and Shin-Won Kang (Kyungpook Nat'l Univ., Korea)*

## P1-12

**Role of Zinc Precursors in the Synthesis of Colloidal Indium Phosphide Quantum Dots**

*Sungjun Koh, Taedaehyeong Eom, Hyungjun Kim, and Doh C. Lee (KAIST, Korea)*

## P1-13

**CdSe Nanoplatelets with Controlled Morphology and Their Linearly Polarized Emission**

*Da-Eun Yoon and Doh C. Lee (KAIST, Korea)*

## P1-14

**Study of Enhanced Photoluminescence in Assembled Copper-Doped Colloidal CdSe Nanoplatelets**

*Whi Dong Kim, Da-Eun Yoon, and Doh C. Lee (KAIST, Korea)*

## Poster Session I

**Date:** Aug. 29, 2017 (Tuesday)
**Time:** 14:00-15:30

### P1-15

**Morphology Control of $CH_3NH_3PbBr_3$ Perovskite Quantum Dot under Room Temperature for Highly Photoluminance**

*Sunjoong Park, Hyunjin Cho, Dodam Kim, Yonghee Lee, Jeong Myeong Park, and Duk Young Jeon (KAIST, Korea)*

### P1-16

**Synthesis and Characterization of Cd-Free Gallium-Alloyed InP Quantum Dots for Blue Emission**

*Taeyoung Song, Myeongseon Cho, and Duk Young Jeon (KAIST, Korea)*

### P1-17

**Highly Enhanced Efficiency of Quantum Dots Films Conjugated with Self-Assembled Block Copolymer**

*Chulhee Lee, Geonyeong Kim, Hoon Hee Yim, Jinyoung Choi, Dongchan Lee, Yeon Sik Jung, and Duk Young Jeon (KAIST, Korea)*

### P1-18

**Synthesis of CdZnS/ZnS Blue-Emitting Quantum Rod and Enhancing its PL Quantum Yield and Stability via Two-Step Shell Growth**

*Hyunjin Cho, Yonghee Lee, Wonseok Choi, Moo Hyun Kim, and Duk Young Jeon (KAIST, Korea)*

### P1-19

**Synthesis and Luminescence Properties of $YF_3$:$Yb^{3+}$/$Er^{3+}$ Upconversion Nanowires**

*Young Cheol Chae, G. Murali, Sandeep Kaur, Jeasmin Akter (Chonbuk Nat'l Univ., Korea), Dong-Kwon Lim (Korea Univ., Korea), and Seung Hee Lee (Chonbuk Nat'l Univ., Korea)*

### P1-20

**Highly Flexible, Easily Attachable Inverted Quantum-Dot Light-Emitting Diode on Elastic Polyurethane (PU) Substrate**

*Yeon Ju Lee, Hong Hee Kim (KIST, Korea), Heon-Jin Choi, Cheolmin Park (Yonsei Univ., Korea), Jea Won Shim, Young-Jun Yoo (Dongguk Univ., Korea), Do Kyung Hwang, and Won Kook Choi (KIST, Korea)*

## Poster Session I

**Date:** Aug. 29, 2017 (Tuesday)
**Time:** 14:00-15:30

### P1-21

QD/PVK Hybrid Light-Emitting Electrochemical Cells with Effective Hole Injection

*Jeehye Yang, Seunghan Kim, Jong Ik Lee, Hyunwoo Joo and Moon Sung Kang (Soongsil Univ., Korea)*

### P1-22

Functional Film Having Field Assisted Unidirectional Alignment of Quantum Nanorods with Emission of a Polarized Light

*Sandeep Kaur, G. Murali, Young Cheol Chae, Ramesh Manda, and Seung Hee Lee (Chonbuk Nat'l Univ., Korea)*

### P1-23

White LEDs Using CdTe / ZnO / GO as a Single Luminescent Material

*Hong Hee Kim, Joon-Suh Park, Il Ki Han, Sung Ok Won, Cheolmin Park, Do Kyung Hwang, and Won Kook Choi (KIST, Korea)*

### P1-24

Novel Switching Structure Using Core/Shell Quantum Rods for WCG Display

*Byunggeol Kim, Kyungkook Jang, Taeyang Lee, Wyyong Kim, and Jinook Kim (LG Display Co., Ltd., Korea)*

### P1-25

Stacked Hole Transport Layers for High Performances of Inverted Green Quantum Dot Light Emitting Diodes

*Chae Young Lee, Raju Lampande, and Jang Hyuk Kwon (Kyung Hee Univ., Korea)*

### P1-26

Non-Hydrazine Based High Mobility Metal Chalcogenide Quantum Dot Thin Film Transistors

*Sumin Jung (Chung-Ang Univ., Korea), Hanrim Kang (Korea Univ., Korea), Myung-Gil Kim, and Sung Kyu Park (Chung-Ang Univ., Korea)*

### P1-27

Effect of Oxidation Degree of Graphene Oxide as Hole Injection Layer for Quantum Dot Light Emitting Diode

*Dae-Ho Song, Suk-Ho Song, Tian-Zi Shen, Jun-Seo Lee, Won-Hyuk Park, Sang-Soo Kim, and Jang-Kun Song (Sungkyunkwan Univ., Korea)*

## Poster Session I

**Date:** Aug. 29, 2017 (Tuesday)
**Time:** 14:00-15:30

### P1-28

Quantum Dot Light Emitting Diode with Vanadium Pentoxide and PEDOT:PSS Bilayer for Hole Injection Layers

*Suk-Ho Song, Dae-Ho Song, Jun-Seo Lee, Sang-Soo Kim, and Jang-Kun Song (Sungkyunkwan Univ., Korea)*

### P1-29

Quantum-Dot Volumetric Display

*Geunseop Choi, Mugeon Kim (Kyungpook Nat'l Univ., Korea), Junho Jeong, Sohee Jeon (KIMM, Korea), Hwi Kim (Korea Univ., Korea), and Joonku Hahn (Kyungpook Nat'l Univ., Korea)*

### P1-30

Color Selective Phototransistor Using Oxide Semiconductor with Quantum Dots

*Jiin Yu, Jae Eun Cho, Yun Jae Jeong, and Seong Jun Kang (Kyung Hee Univ., Korea)*

### P1-31

Flexible Quantum Dot Light Emitting Diode on Silver Nanowire Conductive Film

*Seok Hyeon Cho and Seong Jun Kang (Kyung Hee Univ., Korea)*

### P1-32

Selectively Light Adjustment by Oxide/Metal/Oxide Multilayer Coating on Quantum Dot Light Emitting Diodes

*Hyungin Lee, Jae Min Kim, and Jiwan Kim (Kyonggi Univ., Korea)*

### P1-33

Fabrication of the Quantum Dots Light Emitting Device based on Templated Self-Assembly

*Jinwoong Kim, Gyeong Seok Hwang, Byung Doo Chin, and Dong Hyun Lee (Dankook Univ., Korea)*

### P1-34

Properties of Inverted Quantum Dot Light-Emitting Diodes Using ZnMgO Electron Transport Layer

*Jaeyun Kim and Jeonghun Kwak (The Univ. of Seoul., Korea)*

# Poster Session I

**Date:** Aug. 29, 2017 (Tuesday)
**Time:** 14:00-15:30

### P1-35

Effects of Defect Concentration on Electron Mobility of ZnO Electron Injection Layer for QLED

*Sun-Kyo Kim, Young-Soo Chae, and Yong-Seog Kim (Hongik Univ., Korea)*

### P1-36

Synthesis of InP Quantum Dots using Nanocluster Heating Up Method

*Youngsik Kim, Ju Young Woo, and Sohee Jeong (KIMM, Korea)*

### P1-37

Stabilization of All Inorganic Cesium Lead Halide Perovskite Nanocrystals through Surface Engineering

*Ju Young Woo (KAIST, Korea), Youngsik Kim (KIMM, Korea), Doh C. Lee (KAIST, Korea), and Sohee Jeong (KIMM, Korea)*

### P1-38

Shape Control of InP Colloidal Quantum Dots

*Hyekyoung Choi, Dongwoon Shin, and Sohee Jeong (KIMM, Korea)*

### P1-39

Fabrication of Bank Structures for High Inkjet-Printed Quantum Dot Light-Emitting Diodes

*Donghyun Ko, Jongseok Han, Heebum Roh, Yeseul Park, and Changhee Lee (Seoul Nat'l Univ., Korea)*

### P1-40

Zinc Sulfide Nanotubes for Efficient Field Emission Displays

*Alireza Khorami (IRIB Univ., Iran) and Shirin Ghanbari (IRIB Technical Research Center, Iran)*

### P1-41

Increasing Transfer Yield of Contact Imprinting Process for High Resolution Quantum Dot Light-Emitting Diodes

*Kyunghwan Kim, Heeyoung Jung, and Changhee Lee (Seoul Nat'l Univ., Korea)*

## Poster Session I

**Date:** Aug. 29, 2017 (Tuesday)
**Time:** 14:00-15:30

### P1-42

Adaptive Duty Ratio Control for Flicker Reduction on Head Mounted Display

*Hoyoung Jung and Wonhee Choe (Samsung Electronics Co., Ltd., Korea)*

### P1-43

Evaluation of Display Diffuser to Reduce the Screen Door Effect

*Seungheon Lee, Wonhee Choe, Sehoon Kim, and Jiyoung Yum (Samsung Electronics Co., Ltd., Korea)*

### P1-44

Metal Mesh Touch Screen Panel by Using Silver-Metal Oxide Nanoparticle Paste

*Gun-Woo Lee (Green Ind. Co., Ltd., Korea), Sang Bo Sim (Chang Nanotech Co., Ltd., Korea), Ki Yeon Ryu (UNIST, Korea), Su Yong Nam (Bukyong Nat'l Univ., Korea), and Lee Soon Park (UNIST, Korea)*

### P1-45

Textile-Based Strain/Touch Sensors Using Mechanically Robust Conductive Fibers

*Jimi Eom, Woobin Lee, Minho Kim, Seungho Song, and Yong-Hoon Kim (Sungkyunkwan Univ., Korea)*

### P1-46

High Flexible and Stable Thin-Film Iron Corrosion Sensors Encased by Anion Exchange Membrane to Monitor Chloride Ions Penetration through Reinforced Concrete

*Healin Im (Sungkyunkwan Univ., Korea), Yun-su Lee (Hanyang Univ., Korea), and Sunkook Kim (Sungkyunkwan Univ., Korea)*

### P1-47

Stretchable Transparent Eelectrodes based on Silver Nanowires for Stretchable Organic Light Emitting Diodes

*Hyunsu Jung, Hyeck Go, Eun Mi Kim, Tae-Won Ha (KITECH, Korea), Gye-Choon Park (Mokpo Nat'l Univ., Korea), and Changhun Yun (KITECH, Korea)*

## Poster Session I

Date: Aug. 29, 2017 (Tuesday)
Time: 14:00-15:30

### P1-48

**Highly Flexible Transparent Conducting Electrodes with Amorphous Oxide for Conformable Display Application**

*Jae-Bum Jeong, Seung-Yun Jang (KITECH, Korea), ByeongGon Kim, Hak-Rin Kim (Kyungpook Nat'l Univ., Korea), and Hyeok Kim (KITECH, Korea)*

### P1-49

**Fabrication and Characteristics of Multidirectionally Wrinkable Clothing Shaped Organic Light-Emitting Devices**

*Seungyeop Choi, Myung Sub Lim, Seonil Kwon, Hyuncheol Kim, Jung Hyun Kwon, Yongmin Jeon, Yong Min Kim, and Kyung Cheol Choi (KAIST, Korea)*

### P1-50

**Optimizing Anti-Stressed Moisture Barrier Structure for Flexible Thin-Film Encapsulation**

*Dong-Won Choi, Ju-Hwan Han, Jung-Hoon Lee, and Jin-Seong Park (Hanyang Univ., Korea)*

### P1-51

**A Sensitive and Flexible Thin Film Humidity Sensor by Using Enhanced Hydrophilic PTFE**

*Seok Hwan Jeong, Heekyeong Park, Na Liu (Sungkyunkwan Univ., Korea), Joonhyung Lee (Samsung Advanced Inst. of Tech., Korea), and Sunkook Kim (Sungkyunkwan Univ., Korea)*

### P1-52

**Structure and Property Relationship of Polyimide Substrates for Flexible Organic Light-Emitting Devices**

*Jingying Li and Byung Doo Chin (Dankook Univ., Korea)*

### P1-53

**Study of Metal Structure for Stretchable Transparent Electrode**

*Jae Ik Lim, Jinwoo Choi, Hae Yun Choi, Euna Yang, Min Woo Kim, Won-Sang Park, Hye Yong Chu, and Sungchul Kim (Samsung Display Co., Ltd., Korea)*

## Poster Session I

Date: Aug. 29, 2017 (Tuesday)
Time: 14:00-15:30

### P1-54

Development of Stretchable and Transparent Organic Semiconducting Layer through Polymer Blending Strategy

*Eunjoo Song, Boseok Kang, and Kilwon Cho (POSTECH, Korea)*

### P1-55

Solution-Processed 2 Dimensional Boron Nitride Thin Films for Flexible Displays

*Ban-Suk Park, Byoung-Soo Yu, Anne Henry (Linköping Univ., Sweden), and Tae-Jun Ha (Kwangwoon Univ., Korea)*

### P1-56

Composite Film for Reflective LCD Product

*Juan Chen, Yuqiong Chen, Yue Shi (BOE Tech. Group Co., Ltd, China), Kun Qian (SAPO Photoelectric Co., Ltd., China), Jian Gao, and Chunbo Wang (BOE Tech. Group Co., Ltd, China)*

### P1-57

Highly Sensitive Multilayer $MoSe_2$ Phototransistors

*Hyejoo Lee, Seong Yeoul Kim, and Woong Choi (Kookmin Univ., Korea)*

### P1-58

Analysis on Bulk and Interface Trap Densities in P-type Tungsten Diselenide Thin-Film Transistors

*Hee-Joong Kim, Sae-Young Hong, Dae-Hwan Kim, Chan-Yong Jeong, Jeong-Hwan Lee, and Hyuck-in Kwon (Chung-Ang Univ., Korea)*

### P1-59

Synthesis and Characterization of Diketo-Pyrrolo-Pyrrole Pigment for LCD Color Filter

*Hun-Soo Kim, Soo-Youl Park (KRICT, Korea), Dong-A Park, Dong-Gue Lee (GP&E Co., Ltd., Korea), See-Woo Lee, and Kyong-Gue Lee (Iridos Ltd., Korea)*

### P1-60

Fabrication of Coatable Polarizer by Guest-Host System for Flexible Display Applications

*Rui He, Seung Eun Paik, Min Jae Lee, and Myong Hoon Lee (Chonbuk Nat'l Univ., Korea)*

# Poster Session I

Date: Aug. 29, 2017 (Tuesday)
Time: 14:00-15:30

## P1-61

Synthesis and Characterization of New Chiral Dopant for Cholesteric LC Display Application

*Hong-Min Kim, Sung-Jun Lee, Da-Som Han, and Myong-Hoon Lee (Chonbuk Nat'l Univ., Korea)*

## P1-62

Effect of Ultraviolet-Ozone Treatment on the Optoelectronic Properties of Single Layer $MoS_2$

*Hae In Yang, Seonyoung Park, and Woong Choi (Kookmin Univ., Korea)*

## P1-63

Electro-Optical Switching of α-ZrP Particles

*Chi-Hyo Ahn, A. R. Masud, and Jang-Kun Song (Sungkyunkwan Univ., Korea)*

## P1-64

Fabrication of Highly Conductive Graphene/ITO Transparent Bi-Film through CVD and Organic Additives-Free Sol-Gel Techniques

*Bastian Waduge Naveen Harindu Hemasiri, Jae-Kwan Kim, and Ji-Myon Lee (Sunchon Nat'l Univ., Korea)*

## P1-65

Graphene and Silver Nanowire Grid Structure Based Electrode for Ultra-Transparency

*Wimalananda M. D. S. L., Jae-Kwan Kim, and Ji-Myon Lee (Sunchon Nat'l Univ., Korea)*

## P1-66

2D Materials Graphene Oxide for Photonic Crystallinity

*Tian-Zi Shen, Seung-Ho Hong, and Jang-Kun Song (Sungkyunkwan Univ., Korea)*

## P1-67

Two-Dimensional Nanocomposite Based Antibacterial Film for Display Device Applications

*Tae In Kim, Ick-Joon Park, Buki Kwon, YongKeun Park, and Sung-Yool Choi (KAIST, Korea)*

# Poster Session I

**Date:** Aug. 29, 2017 (Tuesday)
**Time:** 14:00-15:30

## P1-68

**CVD-Grown $MoS_2$ Driver Circuit for Flexible OLED Display**
*Youngjun Woo, Woonggi Hong, Sang Yoon Yang, Jae Eun Lee, and Sung-Yool Choi (KAIST, Korea)*

## P1-69

**The Synthesis of Two-Dimensional Single Phase $SnS_2$ by Sulfurization of Atomic Layer Deposited SnO**
*Jung Joon Pyeon, In-Hwan Baek (KIST, Korea), Taek-Mo Chung, Jeong Hwan Han (KRICT, Korea), Chong-Yun Kang, and Seong Keun Kim (KIST, Korea)*

## P1-70

**Two Dimensional $MoS_2$-$WSe_2$ Heterojunction Combined with PbS Quantum Dot for High Performance Photodetector**
*Hyosun Lee, Juyoung Kim (KIST, Korea), Woo young Sim (Yonsei Univ., Korea), and Do Kyung Hwang (KIST, Korea)*

## P1-71

**Two-Dimensional $MoS_2$ and Black Phosphorus Based Ferroelectric Field-Effect Transistors for Nonvolatile Memory**
*Juyoung Kim, Hyosun Lee, and Do Kyung Hwang (KIST, Korea)*

## P1-72

**Effect of Contact Metal on Low-Frequency Noise in $WSe_2$ Field Effect Transistors**
*Jong In Kim, Won-Mook Kang, and Jong-Ho Lee (Seoul Nat'l Univ., Korea)*

## P1-73

**Transformation of Solid Carbon Source to Crystallized Graphene**
*Ju Ho Lee and Eunju Lim (Dankook Univ., Korea)*

## P1-74

**Trapping/Detrapping Analysis on Carbon Nanotube Thin Film Transistors Using Non-Quasi Static Measurement**
*Hyeonwoo Shin (Seoul Nat'l Univ., Korea), Tae-Jun Ha (Kwangwoon Univ., Korea), and Changhee Lee (Seoul Nat'l Univ., Korea)*

## Poster Session I

**Date:** Aug. 29, 2017 (Tuesday)
**Time:** 14:00-15:30

### P1-75

**Thin Film Encapsulation by Atomic Layer Deposition Using Mixture of Zr and Al- Precursors**

*Jong-Ki An, Seob Shim, Goru Kang, Yeon-Tae Kang (KRISS, Korea), Sung-Ho Hahm (Kyungpook Nat'l Univ., Korea), Jin-Tae Kim, and Ju-Young Yun (KRISS, Korea)*

### P1-76

**A New Method of Area Luminance Measurement by Optical Microscope**

*Me-You Kim and Seung Won Jung (LG Display Co., Ltd., Korea)*

### P1-77

**Mimicking Synaptic Processes from Ion Gel-Gated IGZO Transistors with Au Trapping Layers**

*Jaemok Koo, Seunghan Kim, Hyunwoo Jo, and Moon Sung Kang (Soongsil Univ., Korea)*

### P1-78

**Reflectivity's Performance of R-LCD and E-Paper Under Different Lighting Conditions**

*Yingtao Wang, Kuanjun Peng, Jinqian Wang, Tingting Zhou, Fangzhen Zhang, and Jikai Yao (BOE Tech. Group, China)*

### P1-79

**Color Evaluation Method of Display Device in L*a*b* Color Space**

*Xiaolong Li, Chunfang Zhang, Wei Qin, and Kuanjun Peng (BOE Tech. Group, China)*

### P1-80

**Analysis of Image Quality by Self-Reflected Light for Curved Display with High Curvature**

*JungBok Lee, Min-Gi Kwak, and Chan-Jae Lee (KETI, Korea)*

### P1-81

**A High Contrast Smart Windows**

*Yin-long Zhang, Zhi-ming Meng, Zong-ze He, Rui Guo ,Wei-hao Hu, Shu-lin Yao, Zhi-hua Sun, Bao-yu Liu, and Yan-ping Liao (Beijing BOE Display Tech. Co., Ltd., China)*

## Poster Session I

**Date:** Aug. 29, 2017 (Tuesday)
**Time:** 14:00-15:30

### P1-82

**The LG Interface for OLED Wall Paper with HDCP**

*Eui-Taek Jeong, An-Su Kim, Bong-Seok Kang, Hwak-Dong Park, Han-Seop Kim, and Chang-Ho Oh (LG Display Co., Ltd., Korea)*

### P1-83

**Robust Shift Register Circuit in a-Si TFT Backplane for In-Cell Touch Application**

*Jeongrim Seo, Seok-Jeong Song, Dowon Kim, Ki-Hyuk Seol, and Hyoungsik Nam (Kyung Hee Univ., Korea)*

### P1-84

**Solution-Processed a-InGaZnO Thin Film Transistor Based Operational Amplifier for the Flexible Display Driving System**

*Yongchan Kim, Daejung Kim, Keun-Yeong Choi, Dayoon Lee, and Hojin Lee (Soongsil Univ., Korea)*

### P1-85

**IGZO TFT-Based Gate Driver Circuit without QB Node**

*Jongsu Oh, Jin-Ho Kim (Sungkyunkwan Univ., Korea), Kee-Chan Park (Konkuk Univ., Korea), and Yong-Sang Kim (Sungkyunkwan Univ., Korea)*

### P1-86

**Backlight Uniformity Evaluation Method for 1-D Local Dimming Display**

*Gwon Hwan An, Yong Deok Ahn, and Suk-Ju Kang (Sogang Univ., Korea)*

### P1-87

**2.45GHz Frequency Selective Surface Manufactured by Screen Printing Method**

*Hyunho Park (KETI, Korea), Jun Lee (Aramsolution, Korea), Eunju Choi, and Sun Hong Yoon (KETI, Korea)*

### P1-88

**A New Low-Power Technology for VR Display**

*Byung-Chang Yu, Seung-Ryeol Kim, and Seung-Woo Lee (Kyung Hee Univ., Korea)*

## Poster Session I

Date: Aug. 29, 2017 (Tuesday)
Time: 14:00-15:30

### P1-89

Silicone Based High Thermal Durability OCR for Automotive Display

*Tae Soo Jo, Junha Hwang, Jae Chul Hwang, Jaeyeong Kim, Wonbong Jang (LG Display Co., Ltd., Korea), Juyoung Yook, Myunghwa Jung (Dow Corning Korea Ltd., Korea), and Jinook Kim (LG Display Co., Ltd., Korea)*

### P1-90

ITO as Copper Metal Buffer Layer Applied in ADSDS TFT-LCD with Four-Mask Process

*Jin-cheng Gao, Tao Jiang, Guan-bao Hui, Ji Zhang, Wei-Wei Hu, Tao Wang, Liang Chen, Jong-won Moon, and Byung-cheon Lim (Hefei BOE Display Tech. Co., Ltd., China)*

### P1-91

The Influence of Tandem $n^{+}$a-Si:H Layer on the Performance of Hydrogenated Amorphous Thin Film Transistor

*Fei Teng, Guan-bao Hui, Jin-cheng Gao, Tao Jiang, Wei-Wei Hu, Ji Zhang, Tao Wang, Liang Chen, Jong-won Moon, and Byung-cheon Lim (Hefei BOE Display Tech. Co., Ltd., China)*

### P1-92

Scratch Analysis of Liquid Crystal Display

*Zongjie Bao, Hongyu Zhao, Jie Liu, and Kai Diao (Fuzhou BOE Optoelectronics Technology Co., Ltd., China)*

### P1-93

The Drying Micro-Environment of Uniform Silver Electrodes by Inkjet Printing

*Honglong Ning, Ruiqiang Tao, Jianqiu Chen, Caigui Yang, Yicong Zhou, Rihui Yao, Lei Wang, Miao Xu, Linfeng Lan, and Junbiao Peng (South China Univ. of Tech., China)*

### P1-94

Precision Web Control of Roll-to-Roll Thermal Evaporation System for Fabrication of Flexible OLED Devices

*Hyuntae Kim, Kyoohee Woo, Yejin Shin (KIMM, Korea), Moonyong Lee, Minseok Kim, Jaehoon Jung, Jaeil Jang (GJM Co., Ltd., Korea), and Sin Kwon (KIMM, Korea)*

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### P1-95

A Simple Masking Method for High Speed Roll to Roll System
*Jun-Ho Song, Se-Jin Lim, and Jae-Woong Yu (Kyung Hee Univ., Korea)*

### P1-96

Analysis of Dark Spot Defect on RGB Color Filter Patterns
*Yi Zeng, Ji Li, Bao Zha, Min Tang, Xiaoping Yu, Sudi Rao, Ying Li, Zhiwei Zhang, and Xiaoxian Chen (Shenzhen China Star Optoelectronics Tech. Co., Ltd., China)*

### P1-97

The Pixel Image Analysis Using a High-Speed Camera
*Byeollim Kim (LG Display Co., Ltd., Korea)*

### P1-98

Effect of UV/ozone Treatment Position on Pentacene Thin-Film Transistor with Double-Stacked Organic Gate Insulator Layers
*Min Su Kim (Sungkyunkwan Univ., Korea), Kee-Chan Park (Konkuk Univ., Korea), and Yong-Sang Kim (Sungkyunkwan Univ., Korea)*

### P1-99

Highly Efficient WOLEDs by Solution Processing of Hole Transport and Emission Layers
*Tae-Yong Kim, Min-Jae Lee, and Dae-Gyu Moon (Soonchunhyang Univ., Korea)*

### P1-100

Analysis of Thermal Bending Deformation of Ultra - Thin TV Module
*Li Xiang, Wang Bochang, Bu Zhanchang, Chen Ming, and Shao Xibin (BOE Display Tech. Co., Ltd., China)*

### P1-101

Novel Manufacturing Process for Solvent-Free Solution OLEDs
*Dai Geon Yoon, Kyung Tae Kang, and Kwan Hyun Cho (KITECH, Korea)*

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## P1-102

**The Effect of Liquid Crystal Diffusion on Quality of Thin Film Transistor Liquid Crystal Displays in One Drop Fill Process**

*Hongpeng Li, Nannan Du, Haiyun Lin, Tingze Dong, Jingpeng Li, Dongsheng Huang, Wei Wang, and Xuezhi Zhang (Beijing Optoelectronics Tech. Co., Ltd., China)*

## P1-103

**Annealing Effect of Rapid Thermal Process (RTP) Utilizing UV and DUV Light Source on the Electrical Characteristics of BCE Al-IZTO TFTs**

*Yunyong Nam (KAIST, Korea), Jong-Heon Yang (ETRI, Korea), Pilseong Jeong (AP Systems Corp., Korea), Oh-Sang Kwon, Jae-Eun Pi, Hee-Ok Kim, Sung Haeng Cho, Chi-Sun Hwang (ETRI, Korea), Jeahan Ahn (KAIST, Korea), Sanghyun Ji (AP Systems Corp., Korea), and Sang-Hee Ko Park (KAIST, Korea)*

## P1-104

**Design of Advanced Slit Die Structural for OLED-Display Module Lamination**

*Byung-Chul Lee (Dankook Univ., Korea), Da-Som Hong, Woo-Sang Park (Inha Univ., Korea), and Kwan Young Han (Dankook Univ., Korea)*

## P1-105

**Influence of Deposition Rate of MoOx on Hole Injection Property for Inverted OLEDs**

*Koji Yamamoto, Junghwan Kim, and Hideo Hosono (Tokyo Inst. of Tech., Japan)*

## P1-106

**Deposition System of Organic-Inorganic Multilayer Passivation Film with a Single Chamber**

*Akpeko Gasonoo, Sang-Hun Shin, Ji-Yeon Han, Min-Hoi Kim, Yoonseuk Choi, and Jae-Hyun Lee (Hanbat Nat'l Univ., Korea)*

## P1-107

**Neutral Beam Assisted Roll-to-Roll Sputter Forming High Density Gas Barrier for OLEDs**

*YunSung Jang, SeungMin Shin, Seungjun Yi, and MunPyo Hong (Korea Univ., Korea)*

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## P1-108

**Enhancement of Luminous Efficiency on Large LED Display**

*Alireza Khorami (IRIB & Applied Science Univ., Iran), Sepehr Khorami, Sahand Khorami, Sima Shirzadi (Azad Univ., Iran), and Shirin Ghanbari (IRIB Technical Research Center, Iran)*

## P1-109

**Plasma-Erosion Properties of Sprayed Ceramic Coating in Display Production Equipment**

*Je-Boem Song, Seung-Su Lee, Minjoong Kim, Jongho So, Jin-Tae Kim (KRISS, Korea), Seong-Geun Oh (Hanyang Univ., Korea), and Ju-Young Yun (KRISS, Korea)*

## P1-110

**Investigation of Photo-Spacer Induced Moiré Pattern in Liquid-Crystal-Lentiular Lens Based Autostereoscopic 2D/3D Display**

*Linfeng Liu, JianHong Chen, ChihMing Yang, ChungYi Chiu, and ChiaYu Lee (Shenzhen China Star Optoelectronics Tech. Co., Ltd., China)*

## P1-111

**Nanoindentation Study of Optically Patterned Surface Relief Grating of Azobenzene Polymers**

*Kang-Han Kim and Yong-Cheol Jeong (KITECH, Korea)*

## P1-112

**High Speed and Resolution Three-Dimensional Reconstruction Algorithm Using Pixel Rearrangement Technique with Reduced Memory Usage**

*Min-Chul Lee (Kyushu Inst. of Tech., Japan), Kotaro Inoue, and Myungjin Cho (Hankyong Nat'l Univ., Korea)*

## P1-113

**High-Speed Reconstruction Technique in Photon Counting Integral Imaging**

*Naohiro Kikutake (Kyushu Inst. of Tech., Japan), Kotaro Inoue, Myungjin Cho (Hankyong Nat'l Univ., Korea), and Min-Chul Lee (Kyushu Inst. of Tech., Japan)*

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### P1-114

Driver's Gaze Adaptive Head-Up Display System

*Young-Yoon Lee, Jiwhan Woo, Tejas Nair, Jaehee Kwak, and Taeyoung Na (Samsung Electronics Co., Ltd., Korea)*

### P1-115

Color Dispersion Free Holographic Screen based on Volume Holographic Optical Element for Augmented Reality Space Projection Display

*Hyoung Sik Kim, Yong Seok Hwang, and Eun Soo Kim (Kwangwoon Univ., Korea)*

### P1-116

Resolution Enhanced Integral Holography for Obtaining the Hologram of 3-D Real Scene

*Ling-Yu Ai and Eun-Soo Kim (Kwangwoon Univ., Korea)*

### P1-117

Fast Generation of CGHs Based on the Principle Fresnel Pattern (PFP) Redundancy

*Hong-kun Cao, Ling-yu Ai, ShuFeng Lin, and Eun-Soo Kim (Kwangwoon Univ., Korea)*

### P1-118

A Multi-View Capturing System with a Single 360-Degree Camera and Mirrors

*Jaehee Seo, Minyoung Park, Hanul Lee, and Hee-Jin Choi (Sejong Univ., Korea)*

### P1-119

Analysis on the Range of Clear Perception of an Augment Reality Devices by Measuring the Recognition Time of the Observer

*Hanul Lee, Minyoung Park, Jaehee Seo, and Hee-Jin Choi (Sejong Univ., Korea)*

### P1-120

Accommodative Response Analysis of Super Multi-View Displays Considering Diffraction by Lenticular Lens and Ray Spread by Finite Subpixel Area

*Sang-Hoo Kim and Jae-Hyeung Park (Inha Univ., Korea)*

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### P1-121

**An Efficient Mutual Occlusion Processing in Fully Analytical Mesh Based Computer Generated Holography**

*Mehdi Askari and Jae-Hyeung Park (Inha Univ., Korea)*

### P1-122

**Enhanced Occlusion Removal of Synthetic Aperture Integral Imaging Using Multiple Variances**

*Tomoaki Fujishima (Kyushu Inst. of Tech., Japan), Kotaro Inoue, Myungjin Cho (Hankyong Nat'l Univ., Korea), Naohiro Kikutake, Naoki Konishi, and Min-Chul Lee (Kyushu Inst. of Tech., Japan)*

### P1-123

**Integration of Holographic Rendering and Leap Motion's Hand-Tracking**

*Manith Eath, Vuthea Chheang, and Kwan-Hee Yoo (Chungbuk Nat'l Univ., Korea)*

### P1-124

**Ultra Thin Sheet-Less Backlight Unit with Brilliant Light-Extracting Microstructure**

*Kwangsoo Bae, Jungsuk Bang, Haeju Yun, Minjoeng Oh, Sungman Kim, Donchan Cho, and Junho Song (Samsung Display Co., Ltd., Korea )*

### P1-125

**Pickup for Elemental Image of Multi-View Display Using Light Field Camera**

*Dongyeon Kim, Youngmo Jeong, and Byoungho Lee (Seoul Nat'l Univ., Korea)*

### P1-126

**Design of Self-Interference Incoherent Digital Holography (SIDH) Using Geometrical Phase Lens**

*Ki-Hong Choi, Seunghwi Yoo, Hyeongkyu Do, and Sung-Wook Min (Kyung Hee Univ., Korea)*

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### P1-127

Novel Design of Hybrid Light Extracting Structure for Sheetless Backlight Unit with High Luminance

*Jungsuk Bang, Kwangsoo Bae, Minjeong Oh, Donchan Cho, and Junho Song (Samsung Display Co., Ltd., Korea)*

### P1-128

Performance Research on Wide Temperature Range LC with ADS LCD

*Yuqiong Chen, Mengjie Wang, Xiaona Liu, Shuai Yuan, Ning Li, and Chenchen Wu (BOE Display Tech. Co., Ltd., China)*

### P1-129

Optical Switching of Cholesteric Liquid Crystals

*Seung-Won Oh, Jong-Min Baek, Sang-Hyeok Kim, and Tae-Hoon Yoon (Pusan Nat'l Univ., Korea)*

### P1-130

Liquid Crystal Phase Grating Device for Fast Switching between Transparent and Translucent States

*Tae-Hoon Choi, Jae-Won Huh, Jae-Hyeon Woo, Jin-Hun Kim, Young-Seo Jo, and Tae-Hoon Yoon (Pusan Nat'l Univ., Korea)*

### P1-131

Retarder with Negative Dispersion of Birefringence achieved by Stacking Reactive Mesogen on Polystyrene Film

*Hee Jung Ryu, Jiyong Hwang, and Ji-Hoon Lee (Chonbuk Nat'l Univ., Korea)*

### P1-132

The Study on the IPS Nano Color Display

*Joo Bin Lee, Kyung Suk Min, In Su Baik, Sang Min Lee, Jin Ho Kim, Jeom Jae Kim, Joo Hong Lee (LG Display Co., Ltd., Korea), and Seung Hee Lee (Chonbuk Nat'l Univ., Korea)*

### P1-133

Initially-Focal-Conic Light Shutter Using Chiral-Nematic Liquid Crystals without Polymer Structure

*Jong-Min Baek, Seung-Won Oh, Sang-Hyeok Kim, and Tae-Hoon Yoon (Pusan Nat'l Univ., Korea)*

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### P1-134

**Bistable Switching of an Ion-Doped Cholesteric Liquid Crystal Cell**

*Jin-Hun Kim, Jae-Won Huh, Seong-Min Ji, Young-Seo Jo, Byeong-Hun Yu, and Tae-Hoon Yoon (Pusan Nat'l Univ. Korea)*

### P1-135

**Electro-Optical Response of Ferroelectric Liquid Crystals Doped with an Azo Dye on the Slippery Interfaces Stabilized by Gelation**

*Waki Sakatsuji, Yoichi Takanishi (Kyoto Univ., Japan), Isa Nishiyama (JST-CREST, Japan), and Jun Yamamoto (Kyoto Univ., Japan)*

### P1-136

**Fast Switching of a Polymer-Stabilized In-Plane Switching Liquid Crystal Cell with Little Decrease in Transmittance**

*Jae-Hyeon Woo, Tae-Hoon Choi, Yeongyu Choi, Byoung-Gyu Jeon, and Tae-Hoon Yoon (Pusan Nat'l Univ., Korea)*

### P1-137

**Electro-Optic Characteristics and Mechanical Stability Against Bending of a Flexible Light Shutter with Polymer Structure**

*Seong-Min Ji, Jae-Won Huh, Jin-Hun Kim, Yuong-Seo Jo, Byeong-Hun Yu, and Tae-Hoon Yoon (Pusan Nat'l Univ., Korea)*

### P1-138

**A New Prediction Method of Gas Chromatography Retention Times for Liquid Crystals by MLR and ANN**

*Hyekyung Park (LG Display Co., Ltd., Korea)*

### P1-139

**Swollen Effect on Twist Elastic Constant in Hyper Swollen Smectic C Phase**

*Kanako Hata, Yoichi Takanishi (Kyoto Univ., Japan), Isa Nishiyama (DIC Corp., Japan), and Jun Yamamoto (Kyoto Univ., Japan)*

### P1-140

**Broadening of Reflection Bandwidth of Polymer-Stabilized Cholesteric Liquid Crystal by Heterogeneous Surface Layers between Top and Bottom Plate**

*Jongyoon Kim, Hyuungmin Kim, and Ji-Hoon Lee (Chonbuk Nat'l Univ., Korea)*

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### P1-141

Dye-Doped Polymer-Stabilized Liquid Crystal Light Shutter Using Thermocurable Polymer

*Byeong-Hun Yu, Seong-Min Ji, Jin-Hun Kim, Jae-Won Huh, and Tae-Hoon Yoon (Pusan Nat'l Univ., Korea)*

### P1-142

Fabrication of Highly Oriented and Ordered Semiconductor by Micromolding in Capillaries

*Moon Jong Han and Dong Ki Yoon (KAIST, Korea)*

### P1-143

Orientational Control of H-bonded Coaxial Columnar Liquid Crystal via Physico-Chemical Confinement

*Wongi Park (KAIST, Korea), Hyungju Ahn (POSTECH, Korea), Tae Joo Shin (UNIST, Korea), Beatriz Feringán, Teresa Sierra, Raquel Gimenez (ICMA, CSIC-Universidad de Zaragoza, Spain) and Dong Ki Yoon (KAIST, Korea)*

### P1-144

Visible and Infrared Switchable Liquid Crystal Light Shutter

*Chang Suk Lee, Young Jin Lim, Kyeong Jun Cho, Myong-Hoon Lee (Chonbuk Nat'l Univ., Korea), Jin Seog Gwag (Yeungnam Univ., Korea), and Seung Hee Lee (Chonbuk Nat'l Univ., Korea)*

### P1-145

Manipulation of Quantum Dots in Liquid Crystal Medium via Dielectrophoresis of Isotropic Droplets

*Jun-Seo Lee and Jang-Kun Song (Sungkyunkwan Univ., Korea)*

### P1-146

Flexoelectric Effect depending on the Magnitude of Negative Dielectric Anisotropy LC in FFS Mode

*Heui Seok Jin, Seung Jae Lee, Hyeong Gyun Ham (Chonbuk Nat'l Univ., Korea), Deng- Ke Yang (Kent State Univ., USA), and Seung Hee Lee (Chonbuk Nat'l Univ., Korea)*

### P1-147

Shortening UV Irradiation Time through Synthesis of Photo-Initiators Using Cyclohexanone Oxime

*In-Hye Lee and Dong-Myung Shin (Hongik Univ., Korea)*

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## P1-148

**Variation of the Polymer-Stabilized Cholesteric Liquid Crystal Properties with the Diacrylate and Monoacrylate Reactive Mesogen Molecules Length**

*Yonghwan Oh, Jongyoon Kim, and Ji-hoon Lee (Chonbuk Nat'l Univ., Korea)*

## P1-149

**Optical Vortex Generation from Isolated Nematic Liquid Crystal Cell Defects**

*H. S. Lee, L. K. Migara, C. M. Lee, K. Kwak, and J. K. Song (Sungkyunkwan Univ., Korea)*

## P1-150

**External Pressure Defects in Vertically Aligned Nematic Cells and Director Orientation Patterns**

*L. K. Migara, H. S. Lee, K. Kwak, and J. K. Song (Sungkyunkwan Univ., Korea)*

## P1-151

**In-Situ Pretilt Angle Control of Homeotropic Aligned Nematic Liquid Crystals by Linearly Polarized Visible Light**

*Vineet Kumar (Chonbuk Nat'l Univ., Korea), Ho Lim, Keun Chan Oh, Jae Jin Lyu (Samsung Display Co., Ltd., Korea), Myong-Hoon Lee, and Shin-Woong Kang (Chonbuk Nat'l Univ., Korea)*

## P1-152

**In-Plane Alignment of Nematic Liquid Crystals Doped by Photoresponsive Additives and Induced by In Situ Polarized Visible Light**

*Aboozar Nasrollahi, Vineet Kumar, Vijay Kumar Baliyan, Myong-Hoon Lee, Shin-Woong Kang (Chonbuk Nat'l Univ., Korea), Ho Lim, Keun Chan Oh, and Jae Jin Lyu (Samsung Display Co., Ltd., Korea)*

## P1-153

**Viewing Angle Control of Liquid Crystal Displays Using Active Prism Array**

*Heewon Park, Min-Kyu Park, Kyung-Il Joo, and Hak-Rin Kim (Kyungpook Nat'l Univ., Korea)*

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### P1-154

**Electro-Optic Characteristics according to Top Electrode in Fringe In-plane Switching Mode**

*Wan Seok Kang, In-Ho Lee, Hyun-Su Park, Le Van Doan, and Gi-Dong Lee (Dong-A Univ., Korea)*

### P1-155

**Tailoring Thermomechanical and Actuation Properties of Liquid Crystalline Elastomers**

*Hyeong-ho Yoon and Suk-kyun Ahn (Pusan Nat'l Univ., Korea)*

### P1-156

**Effect of LC Alignment Using Particle-Rubbing Methods Induced by Magnetic Fields**

*Heekeun Lee, Taejin Kong, Keunwoo Park, Yeogeon Yoon, Kichul Shin, Jangsu Kim, and Jinho Park (Samsung Display Co., Ltd., Korea)*

### P1-158

**Shrinking Force Analysis in Bi-directional Dielectrophoresis System**

*Bomi Lee and Jang-Kun Song (Sungkyunkwan Univ., Korea)*

### P1-159

**Black Pixel Defining Layer Materials and Photolithographic Process for Organic Light Emitting Diode**

*Hyung Duk Yun, Sung Hoon Park, Genggongwo Shi (UNIST, Korea), Dae Won Lee (Duksan Techopia, Korea), Sun Hong Ahn (Duksan Neolux, Korea), and Lee Soon Park (UNIST, Korea)*

### P1-160

**High Performance White Organic Light-Emitting Diodes Using Down-Conversion Light Outcoupling Films**

*Joo Won Han, Siti Aisyah Nurmaulia Entifar (Pukyong Nat'l Univ., Korea), Chul Woong Joo, Jonghee Lee (ETRI, Korea), and Yong Hyun Kim (Pukyong Nat'l Univ., Korea)*

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## P1-161

### Highly Conductive PEDOT:PSS Transparent Electrodes with 2-ethoxyethanol for Efficient ITO-free Organic Light-Emitting Diodes

*Siti Aisyah, Nurmaulia Entifar, Yoon kyung Seo (Pukyong Nat'l Univ., Korea), Chul Woong Joo, Jonghee Lee (ETRI, Korea), and Yong Hyun Kim (Pukyong Nat'l Univ., Korea)*

## P1-162

### Efficient ITO-free Organic Light-Emitting Diodes Using Highly Conductive PEDOT:PSS Films

*Dong Jin Lee, Jin Hee Kim (Pukyong Nat'l Univ., Korea), Chul Woong Joo, Jonghee Lee (ETRI, Korea), and Yong Hyun Kim (Pukyong Nat'l Univ., Korea)*

## P1-163

### Analysis of the Propagation Characteristics of Waveguide Modes in Top-Emitting Organic Light-Emitting Diodes with a Finite Pixel Size

*Kyungnam Kang and Jungho Kim (Kyung Hee Univ., Korea)*

## P1-165

### Study on Implementation of Stereo Sound Using OLED Panel

*Sungtae Lee, Kwanho Park, Hanseop Kim, and Changho Oh (LG Display Co., Ltd., Korea)*

## P1-166

### Probing Photophysical Properties of Isomeric N-heterocyclic Carbene Ir(III) Complexes and their Applications to Deep Blue Phosphorescent Organic Light-Emitting Diodes

*Jin-Hyoung Kim, Yang-Jin Cho, So-Yoen Kim (Korea Univ., Korea), Jiwon Lee (Seoul Women's Univ., Korea), Dae Won Cho, Ho-Jin Son (Korea Univ., Korea), Won-Sik Han (Seoul Women's Univ., Korea), Sang Ook Kang, and Seungjun Yi (Korea Univ., Korea)*

## P1-167

### Important Role of Ancillary Ligand in the Emission Behaviours of Blue-Emitting Heteroleptic Ir(III) Complexes

*Mi Rang Son, Yang-Jin Cho, So-Yoen Kim, Jin-Hyoung Kim (Korea Univ., Korea), Won-Sik Han (Seoul Women's Univ., Korea), Ho-Jin Son, Sang Ook Kang, and Seungjun Yi (Korea Univ., Korea)*

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### P1-168

Thermal Analysis of Top-Emitting Organic Light-Emitting Diodes in a Finite Pixel Structure

*Seonggil Kang, Kyungnam Kang, and Jungho Kim (Kyung Hee Univ., Korea)*

### P1-169

High Efficient and Viewing Angle Independent OLEDs with Nanosized Random Structure and Planarization Layer

*Cheol Hwee Park (Korea Univ., Korea), Young Wook Park (Sun Moon Univ., Korea), and Byeong-Kwon Ju (Korea Univ., Korea)*

### P1-170

Large-Area OLED TVs with Monolithic Black Reflective Color Utilizing the New Noble Circular Polarizer

*Sang-Ho Choi, Sang Hyun Na, Chung-Sun Lim, Young-Hoon Shin, Hyun-Jong Noh, Tae-Woon Ko (LG Display Co., Ltd., Korea), Yeonok Jung, Hyuk Yoon, Donghoon Chung (LG Chem. Co., Ltd, Korea), Jae-Hyuk Lee, Byoung-Chul Choi, Jung-Ku Lim, Min-Soo Yang (Dongwoo Fine-Chem. Co., Ltd, Korea), Myung-chul Jun, Jin-Mog Kim, In Byeong Kang, and Chang-Ho Oh (LG Display Co., Ltd., Korea)*

### P1-171

A Modal Analysis of the Radiation Mode Affected by the Waveguide Mode Near the Critical Angle in Top-Emitting Organic Light-Emitting Diodes

*Jiyong Kim, Kyungnam Kang (Kyung Hee Univ., Korea), Kyoung-Youm Kim (Sejong Univ., Korea), and Jungho Kim (Kyung Hee Univ., Korea)*

### P1-172

Spectral-Distortion-Free Light Outcoupling Strategy of Photonic Crystal Structure Embedded Organic Light-Emitting Diodes

*Yong Sub Shim (Korea Univ., Korea), Young Wook Park (Sun Moon Univ., Korea), and Byeong-Kwon Ju (Korea Univ., Korea)*

### P1-173

Optical Analysis of Microshuttered OLEDs

*Dong Jun Lee, Yong Sub Shim (Korea Univ., Korea), Young Wook Park (Sun Moon Univ., Korea), and Byeong-Kwon Ju (Korea Univ., Korea)*

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## P1-174

Effect of Hierarchical Surface Relief Grating on Light Extraction of Polymer Light-Emitting Diodes

*Kang-Han Kim and Yong-Cheol Jeong (Hanyang Univ., Korea)*

## P1-175

Directly/Voluntarily Fabricated Nano Random Patterns on Flexible Substrate for Internal/External Light Extraction in Flexible OLEDs

*Bong Han Bae (Korea Univ., Korea), Young Wook Park (Sun Moon Univ., Korea), and Byeong-Kwon Ju (Korea Univ., Korea)*

## P1-177

Encapsulation of Flexible OLED with an Auxiliary Sealing Line

*Min-Sang Kim, Cha-Mi Lee, Geon-Min Gu (Hoseo Univ., Korea), Kyung-Min Park, Hyun-Su Choi (Cinos, Korea), and Cheol-Hee Moon (Hoseo Univ., Korea)*

## P1-178

Highly Efficient Thermally Activated Delayed Fluorescence Organic Light-Emitting Diodes with Simple Structure

*Chan Hyuk Park (Korea Univ., Korea), Young Wook Park (SUN MOON Univ., Korea), and Byeong-Kwon Ju (Korea Univ., Korea)*

## P1-179

Characteristic Times of Charge Carriers in Organic Light-Emitting Diodes

*Ho Keun Jo, Beom Yong Heo (Hongik Univ., Korea), Jin Woong Hong (Kwangwoon Univ., Korea), Min Jong Song (Gwangju Health Univ., Korea), and Tae Wan Kim (Hongik Univ., Korea)*

## P1-180

Charge Transportthrough Polymer Semiconductor Confined in Organosilane Interpenetrated Network

*Jihye Shin, Jeehye Yang, Hae Jung Hwang, Han Wool Park, Miju Jung, Wansoo Huh, Do Hwan Kim, and Moon Sung Kang (Soongsil Univ., Korea)*

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### P1-181

Efficiency Improvement in Deep-Blue Fluorescent Organic Light Emitting Devices Using Electron and Hole Blocking Layer

*Hyeong Woo Bae, Gyeong Woo Kim, and Jang Hyuk Kwon (Kyung Hee Univ., Korea)*

### P1-182

Advanced Pixel Architecture for OLED Displays with Yellow Common Layer

*Jongseok Han and Changhee Lee (Seoul Nat'l Univ., Korea)*

### P1-183

Control of Spatial Distribution and Diffusion of Excitons in PHOLED by Double EML

*DEHO YUNE, Wonhyeok Park, Younghoon Kang, Hyeonjun Lim, Taekki Lee, Sangwon Kim, and Sang Soo Kim (Sungkyunkwan Univ., Korea)*

### P1-184

Investigation of the Exciton Diffusion Characteristics in Phosphorescent Light Emitting Diode by Double Quantum Well EML Structure

*Younghoon Kang, Wonhyeok Park, Hyunjun Lim, Deho Yune, Taekki Lee, Sangwon Kim, and Sang Soo Kim (Sungkyunkwan Univ., Korea)*

### P1-185

Characteristics of the Exciton Dispersion in Hole-Excess PHOLED Using Partial Co-host Emitting Material Layer

*Hyun Jun Lim, Wonhyeok Park, Younghoon Kang, Deho Yune, Taekki Lee, Sangwon Kim, and Sang Soo Kim (Sungkyunkwan Univ., Korea)*

### P1-186

Effects of Functionalized Graphene Oxide as a Hole Injection Layer in Phosphorescence Organic Light-Emitting Diodes

*Wonhyeok Park, Daeho Song, Hyunjun Lim, and Sang Soo Kim (Sungkyunkwan Univ., Korea)*

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### P1-187

**Transparent Conducting Film for Touch Screen Panel by Metal Mesh Method Utilizing Ag and Cu@Ag Nanoparticle Pastes**

*Duck Min Seo (UNIST, Korea), Hyun Min Nam, Su Yong Nam (Pukyong Nat'l Univ., Korea), Deuk Young Lee (ELK Corp., Korea), and Lee Soon Park (UNIST, Korea)*

### P1-188

**A PCB Design for Low EMI of AIT**

*Jae Kwon Chae, Byung Woong Kim, Su Ho Ha, and Seung Hyun Cho (LG Display Co., Ltd., Korea)*

### P1-189

**The EMI Prediction Program for In-Cell Touch Displays of Automobiles**

*Byung Woong Kim (LG Display Co., Ltd., Korea)*

### P1-191

**Infrared Sensor Array-Based Spatial Touch Display Panel**

*Jung-Gun Yoon, Yong Seok Hwang, Hee-Min Choi, Jae-Kwan Choi (Kwangwoon Univ., Korea), Suk-Pyo Hong (HoloSpace Co., Ltd., Korea), and Eun-Soo Kim (Kwangwoon Univ., Korea)*

### P1-192

**Light Field Display Aids Object Recognition for Poor Identifier**

*Marie Shoda and Toru Iwane (NIKON Corp., Japan)*

*(3DSA Paper)*

### P1-193

**Development of 3D Display Device Using Smartphone and Depth Fused 3-D (DFD) Phenomenon**

*Takuho Sanpei, Tomoyoshi Shimobaba, Takashi Kakue, and Tomoyoshi Ito (Chiba Univ., Japan)*

*(3DSA Paper)*

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### P1-194

**Experimental Demonstration of an Electronic-Holography 3D Display Using High-Speed Binary Phase-Mode SLM**

*Syo Harada, Kouichi Nitta (Kobe Univ., Japan), Yoichi Nagata, Shinya Sato, Nobuyuki Hashimoto (CITIZEN Watch Co., Ltd., Japan), and Osamu Matoba (Kobe Univ., Japan)*

*(3DSA Paper)*

### P1-195

**Image Equality Enhancement by Error Diffusion Technique in Binary-Phase Holographic 3D Display**

*Takahiro Uemae, Kouichi Nitta (Kobe Univ., Japan), Kenichiro Kimura, Ayano Tanabe, Nobuyuki Hashimoto (CITIZEN Watch Co., Ltd., Japan), and Osamu Matoba (Kobe Univ., Japan)*

*(3DSA Paper)*

### P1-196

**Full Parallax Visually Equivalent Light Field 3D Display Using Linear Blending**

*Munekazu Date, Hiroshi Fujii, and Hideaki Kimata (NTT Corp., Japan)*

*(3DSA Paper)*

### P1-197

**Multi-GPU Acceleration of Color-Hologram Generation based on a Ray-Sampling Plane**

*Hirochika Sato, Takashi Kakue (Chiba Univ., Japan), Koki Wakunami, Yasuyuki Ichihashi, Ryutaro Oi, Kenji Yamamoto (NICT, Japan), Tomoyoshi Shimobaba, and Tomoyoshi Ito (Chiba Univ., Japan)*

*(3DSA Paper)*

### P1-198

**Influence on Reconstructed 3D Image of Point Cloud Model by Overlapping Printing in Wavefront Printer**

*Shinya Sato, Tsuyoshi Egami (Chiba Univ., Japan), Yasuyuki Ichihashi, Kenji Yamamoto (NICT, Japan), Takashi Kakue, Tomoyoshi Shimobaba, and Tomoyoshi Ito (Chiba Univ., Japan)*

*(3DSA Paper)*

# Poster Session I

**Date:** Aug. 29, 2017 (Tuesday)
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## P1-199

### Geometric Transformation to Form a Cylindrical Information Screen on an Omnidirectional Aerial Display

*Erina Abe, Sho Onose, and Hirotsugu Yamamoto (Utsunomiya Univ., Japan)*

*(3DSA Paper)*

## P1-200

### Simulation of Off-Axis Type Holograms Generated by Wavefront Printer for Realizing a Multiplex-Type Hologram

*Tsuyoshi Egami, Shinya Sato (Chiba Univ., Japan), Yasuyuki Ichihashi, Kenji Yamamoto (NICT, Japan), Takashi Kakue, Tomoyoshi Shimobaba, and Tomoyoshi Ito (Chiba Univ., Japan)*

*(3DSA Paper)*

## P1-201

### Glassless 3D Screen Using HOE for Spherical Wave Compensation

*Ryutaro OI (NICT, Japan), Pingyen CHOU (Nat'l Chiao Tung Univ., Taiwan), Koki WAKUNAMI, Kenji YAMAMOTO, Yasuyuki ICHIHASHI, Makoto OKUI, and Jackin BOAZ JESSIE (NICT, Japan)*

*(3DSA Paper)*

## P1-202

### Projective Holographic Display based on Toroidal Mirror

*Keehoon Hong (ETRI, Korea), Youngju Kim (Yunam Optics Inc., Korea), Yongjun Lim, Minsik Park, and Jinwoong Kim (ETRI, Korea)*

*(3DSA Paper)*

## P1-203

### Aerial Dual-View Display by Use of Polarization-Processing Display with Retarder Film and Retro-Reflector

*Shusei Ito, Keitaro Uchida (Utsunomiya Univ., Japan), Haruki Mizushina, Shiro Suyama (Tokushima Univ., Japan), and Hirotsugu Yamamoto (Utsunomiya Univ., Japan)*

*(3DSA Paper)*

## Poster Session I

**Date:** Aug. 29, 2017 (Tuesday)
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### P1-204

Acceleration Method of Computer Generated Hologram Using GPGPU

*Yoon-Hyuk Lee, Young-Ho Seo, and Dong-Wook Kim (Kwnagwoon Univ., Korea)*

*(3DSA Paper)*

### P1-205

Interferometric Approach to Improve the Image Quality of Viewing-Window Digital Holograms

*Yongjun Lim, Keehoon Hong, Minsik Park, and Jinwoong Kim (ETRI, Korea)*

*(3DSA Paper)*

### P1-206

2D/3D Convertible Color Holographic Display Method

*Hyon-Gon Choo, Keehoon Hong, Kwan-Jung Oh, and Minsik Park (ETRI, Korea)*

*(3DSA Paper)*

### P1-207

Both-Sided Aerial Display with AIRR

*Kazuki Shimose, Kazuki Kawai, and Hirotsugu Yamamoto (Utsunomiya Univ., Japan)*

*(3DSA Paper)*

### P1-208

Increasing Depth Cue in Aerial 3D Display by Use of Two 3D-Shaped Screen with AIRR

*Nao Kurokawa and Hirotsugu Yamamoto (Utsunomiya Univ., Japan)*

*(3DSA Paper)*

### P1-209

Replication of Hologram Fabricated by Wavefront Printing Technique

*Makoto OKUI, Koki WAKUNAMI, Ryutaro OI, Yasuyuki ICHIHASHI, JackinBOAZ JESSIE, and Kenji YAMAMOTO (NICT, Japan)*

*(3DSA Paper)*

# Poster Session I

**Date:** Aug. 29, 2017 (Tuesday)
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## P1-210

**Development of the 2D and 3D Switchable Light-Field Camera Using Polarization Dependent Micro Lens Array**

*So-Dam Lee, Kyung-Il Joo, Heewon Park, Hee-Dong Jeong, Min-Kyu Park (Kyungpook Nat'l Univ., Korea), Ki-Chul Kwon, Young-Tae Lim, Munkh-Uchral Erdenebat (Chungbuk Nat'l Univ., Korea), Hyun Lee, Gwangsoon Lee (ETRI, Korea), Nam Kim (Chungbuk Nat'l Univ., Korea), and Hak-Rin Kim (Kyungpook Nat'l Univ., Korea)*

*(3DSA Paper)*

## P1-211

**Noise-Robust Pattern Image Acquisition Method for Multi-Projector Calibration**

*Injae Lee, Sangwoo Ahn, Seungjun Yang, Jeongil Seo (ETRI, Korea), and Ohseok Kwon (Chungnam Nat'l Univ., Korea)*

*(3DSA Paper)*

## P1-212

**Influence of Tiny Smooth Motion Parallax for Perceived Depth Change by Increasing Visual Acuity Difference**

*Yoko Awata, Haruki Mizushina, and Shiro Suyama (Tokushima Univ., Japan)*

*(3DSA Paper)*

## P1-213

**Bidirectional Aerial Display by Use of a Half Mirror**

*Yoshiki Terashima, Tomohumi Kobori, Nao Kurokawa, and Hirotsugu Yamamoto (Utsunomiya Univ., Japan)*

*(3DSA Paper)*

## P1-214

**High Mobility Sol-Gel Oxide Transistor for 3D Display Application**

*Wen-Kai Lin, Cheng Xi-Gei, Chen-Yui Huang, Su Wei-Chia, and Wang Yu Wu (NCUE, Taiwan)*

*(3DSA Paper)*

## Poster Session I

**Date:** Aug. 29, 2017 (Tuesday)
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### P1-215

**Design and Implementation of Shutter Glasses for Auto-Stereoscopic Display**
*Chih-I Lu, Jian-Hong Chen, and Yu-Cheng Fan (Taipei Univ. of Tech., Taiwan)*

*(3DSA Paper)*

### P1-216

**Multi-Edge Constant Hue Algorithm Design of Color Filter Array for 3D Camera Application**
*Mao-Chun Chi, Pei-Cian Li, and Yu-Cheng Fan (Taipei Univ. of Tech., Taiwan)*

*(3DSA Paper)*

### P1-217

**Haze Elimination Algorithm for Smart Surveillance Camera System**
*Sang-Jun Lee and Jisang Yoo (Kwangwoon Univ., Korea)*

*(3DSA Paper)*

### P1-218

**Halving Thickness of Double-layered Arrays of Rectangular Mirrors (WARM) to Form Aerial Heater in 3D Spance**
*Makoto Sasaki, Tomoyuki Okamoto, Ryosuke Kujime, Takaho Itoigawa, and Hirotsugu Yamamoto (Utsunomiya Univ., Japan)*

*(3DSA Paper)*

### P1-219

**Depth Map Generation from a Single Image by Using a Cascade of Deep Network**
*Jinsu Kim and Changick Kim (KAIST, Korea)*

*(3DSA Paper)*

### P1-220

**Combination of Wavelength and Position Multiplexing for Enhancing Security Level of Optical Phase Only Image Encryption**
*Hsuan T. Chang and Yu-Ting Wang (Nat'l Yunlin Univ. of Sci. and Tech., Taiwan)*

*(3DSA Paper)*

# Poster Session I

**Date:** Aug. 29, 2017 (Tuesday)
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## P1-221

**Temporal Accommodation Response Measurement on 3D Displays**

*Byoungsub Song, Thibault Leportier, and Min-Chul Park (KIST, Korea)*

*(3DSA Paper)*

## P1-222

**Transferring an Input Field Distribution to Multi Target Locations by Applying the MFG (Multi Focusing Grating) Technique**

*Taeone Kim (ETRI, Korea), Soobin Kim, Jungbeom Choi (Korea Univ., Korea), Jinwoong Kim, Minsik Park (ETRI, Korea), and Hwi Kim (Korea Univ., Korea)*

*(3DSA Paper)*

## P1-224

**Fast Generation Algorithm of High-Definition Computer Generated Hologram with Viewing Zone Splitting and Localized Polygon Calculation**

*Sungjae Park, Jonghyun Lee, and Hwi Kim (Korea Univ., Korea)*

*(3DSA Paper)*

## P1-225

**Face Image Generation from Sketch Images Using a Deep Neural Network**

*Youngju Choi and Yongduek Seo (Sogang Univ., Korea)*

*(3DSA Paper)*

## P1-226

**Motion Parallax System with Low Latency can Improve Degradation of Monocular Depth Perception**

*Ippei Kanayama, Shiro Suyama, and Haruki Mizushina (Tokushima Univ., Japan)*

*(3DSA Paper)*

## P1-227

**Flickering Artifact Reduction for Digital Holographic Video**

*Kwan-Jung Oh, Keehoon Hong, Hyon-Gon Choo, and Minsik Park (ETRI, Korea)*

*(3DSA Paper)*

# Poster Session I

**Date:** Aug. 29, 2017 (Tuesday)
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## P1-228

**Super Multi-View Synthesis based on Multi-GPU Using Calibrated Multi-View**

*Byoungkyun Kim, Mingyu Park, Byeongho Choi, and Youngbae Hwang (KETI, Korea)*

*(3DSA Paper)*

## P1-229

**Universal Light Engine for 3D Display Systems**

*Kwang-soo Kim, Geunseop Choi, Daerak Heo, and Joonku Hahn (Kyungpook Nat'l Univ., Korea)*

*(3DSA Paper)*

## P1-230

**Virtual Reality-based Hands-Free Keyboard System Using Electro-Oculogram**

*Byeong-Jun Kim, Ki-Chul Kwon, Young-Ju Nam, Young-Tae Lim (Chungbuk Nat'l Univ., Korea), Jong-Rae Jeong (Suwon Sci. College, Korea), and Nam Kim (Chungbuk Nat'l Univ., Korea)*

*(3DSA Paper)*

## P1-231

**Color Binary Hologram Generation for the Quality Enhancement**

*Eun-Young Chang, Minsik Park, and Jinwoong Kim (ETRI, Korea)*

*(3DSA Paper)*

## P1-232

**Large Aperture Liquid Crystal Lens with Floating Ring Electrode**

*Che-Ju Hsu, Jyun-Jia Jhang, Chao-Ching Wu, and Chi-Yen Huang (Nat'l Changhua Univ. of Education, Taiwan)*

*(3DSA Paper)*

## P1-234

**Fast Computer Cylindrical Hologram Generation Using Double Wave-Front Recording Surfaces**

*Yu Zhao, Seok-Hee Jeon (Chungbuk Univ., Korea), Sang-Keun Gil (Suwon Univ., Korea), Shahinur Alam, and Nam Kim (Chungbuk Univ., Korea)*

*(3DSA Paper)*

# Poster Session I

**Date:** Aug. 29, 2017 (Tuesday)
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## P1-235

### Making Embedded NFC Antenna Using 3D Printing

*Eunju Choi, Hyunho Park, Ju Hwan Choi, and Sun Hong Yoon (KETI, Korea)*

*(3DSA Paper)*

## P1-236

### Additional Data-Based UHD Autostereoscopic 3D Video Generation System over Hybrid Networks

*Hong-Chang Shin, Youngsoo Park, Kugjin Yun, Gwangsoon Lee, and Jeongil Seo (ETRI, Korea)*

*(3DSA Paper)*

## P1-237

### Moiré Pattern Rreduction by Using Diffractive Optic Overlay Lens Array

*Joonsoo Kim, Keehoon Hong, Gwangsoon Lee, and Jeongil Seo (ETRI, Korea)*

*(3DSA Paper)*

## P1-238

### A Study on Multichannel Sound Rendering for Off Sweet Spot Listening Position

*Jae-hyun Yoo, Sangwon Suh, Daeyoung Jang, and Taejin Lee (ETRI, Korea)*

*(3DSA Paper)*

# Poster Session II

**Date:** Aug. 31, 2017 (Thursday)
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## P2-1

Ultra-High Light Quality Solution-Processed OLEDs

*Meenu Singh, Sujith Sudheendran Swayamprabha, and Jwo-Huei Jou (Nat'l Tsing Hua Univ., China)*

## P2-2

Efficient Electron Transport Layer for High Performance Polymer Light-Emitting Devices

*Mora Veera Madhava Rao and Cheol-Hee Moon (Hoseo Univ., Korea)*

## P2-3

Effect of Solvent on Fabrication of Polymer Light-Emitting Diodes

*Mora Veera Madhava Rao and Cheol-Hee Moon (Hoseo Univ., Korea)*

## P2-4

Emission Characteristics of Hole Carrier Exceed Structured PHOLEDs with Different Doping Section

*Hyunwook Lee, Junekyun Park, Hwayeol Oh, Heungsik Tae, Jongkuk Joo, Hyunjun Lim, and Sangsoo Kim (Sungkyunkwan Univ., Korea)*

## P2-5

Emission Characteristics of Hole blocking Co-host EML Structured PHOLEDs with Different Doping Section

*Hyunwook Lee, Hyunjun Lim, and Sangsoo Kim (Sungkyunkwan Univ., Korea)*

## P2-6

Design of Ir(III) Complexes with Light-Harvesting Functional Moieties for Efficient Solution-Processed Blue and White Phosphorescent OLEDs

*Ganguri Sarada, Woosum Cho, and Sung-Ho Jin (Pusan Nat'l Univ., Korea)*

## P2-7

Organic Light-Emitting Diodes with Polyethylenimine as an Electron Injection Layer: Operational Stability and Aging Mechanisms

*Sebastian Stolz (Light Tech. Inst., Germany), Yingjie Zhang (Univ. of Waterloo, Canada), Uli Lemmer, Gerardo Hernandez-Sosa (Light Tech. Inst., Germany), and Hany Aziz (Univ. of Waterloo, Canada)*

# Poster Session II

Date: Aug. 31, 2017 (Thursday)
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## P2-8

Thermally Cross-Linkable Small Molecular Charge Transporting Materials for Solution Processed Organic Light Emitting Diodes

*Hye Won Choi, Seong Bae Ji, and Kyoung Soo Yook (Sungkyunkwan Univ., Korea)*

## P2-9

Thickness-Dependent Polarized Emission in a Liquid Crystalline Light Emitting Polymer

*Jin-Wook Song, Minho Park, Jae-Hoon Kim, and Chang-Jae Yu (Hanyang Univ., Korea)*

## P2-10

Efficient Solution-Processed Organic Light-Emitting Diodes based on Thermally Activated Delayed Fluorescence Polymers

*Sae Youn Lee (Dongguk Univ., Korea), Takuma Yasuda, Hideaki Komiyama, Jiyoung Lee, and Chihaya Adachi (Kyushu Univ., Japan)*

## P2-11

Improved Stability of All-Solution-Processed Warm Colors Phosphorescent OLEDs

*Yu-Fan Chang, Hsin-Fei Meng (Nat'l Chiao Tung Univ., Taiwan), Heh-Lung Huang (e-Ray Optoelectronics Tech. Co., Ltd., Taiwan), Hsiao-Wen Zan (Nat'l Chiao Tung Univ., Taiwan), and Sheng-Fu Horng (Nat'l Tsing Hua Univ., Taiwan)*

## P2-12

Fluid Flow Simulation of Capillary Phenomenon for Solution-Processed Organic Light-Emitting Diodes

*Dongkyun Shin (KOREATECH, Korea), Yu Seok Seo, Seong Hoon Jang (Youlchon Chemical Co., Ltd., Korea), and Jongwoon Park (KOREATECH, Korea)*

## P2-13

Pre-Drying of Solution-Coated Organic Thin Films for AMOLEDs

*Dongkyun Shin (KOREATECH, Korea), Yu Seok Seo, Seong Hoon Jang (Youlchon Chemical Co., Ltd., Korea), and Jongwoon Park (KOREATECH, Korea)*

## Poster Session II

**Date:** Aug. 31, 2017 (Thursday)
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### P2-14

Highly Reliable, and Long-Lasting Solution-Processed Organic Light-Emitting Diodes with Flexible Multilayer Encapsulation

*Hyuncheol Kim, Seonil Kwon, Yongmin Jeon, Seungyeop Choi, Jeong Hyun Kwon, and Kyung Cheol Choi (KAIST, Korea)*

### P2-15

Exciton Distribution in PHOLED with TCTA as a Host Material

*Heungsik Tae, Deho Yune, Sangsoo Kim, and Jangkun Song (Sungkyunkwan Univ., Korea)*

### P2-16

Fully Solution Processed Multilayer OLEDs Using Low Temperature Cross-linkable Small Molecules

*MinHye Seo and Sungkoo Lee (KITECH, Korea)*

### P2-17

Solution Processed Blue Phosphorescent OLED with New Hole Transport Materials

*Beom Seok Kim, Ji Yoon Hong, Chil Won Lee, and Byung Doo Chin (Dankook Univ., Korea)*

### P2-18

Performance Improvement of QDLEDs by Introducing the TPBi/ZnO ETL

*Sanghyun Lee, Junekyun Park, Seok-won Jeong, and Yonghan Roh (Sungkyunkwan Univ., Korea)*

### P2-19

Self-Polarized Light Emitting Diodes based on Surface Treated $MoS_2$ Nanosheets as Hole Transport and Polarization Layer

*Quyet Van Le and Soo Young Kim (Chung-Ang Univ., Korea)*

### P2-20

Highly Efficient Thermally Cross-Linkable Hole-Transporting Material for Solution-Processed OLEDs

*Ji-Ho Kang, Sang Kyu Kwak, and Min Chul Suh (Kyung Hee Univ., Korea)*

# Poster Session II

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## P2-21

**Brightness Enhancement of Organic Light Emitting Diode by Birefringent Twisted Conjugated Polymer**

*Dong-Myung Lee, Jin-Hyung Jung, Chang-Jae Yu, and Jae-Hoon Kim (Hanyang Univ., Korea)*

## P2-22

**Enhanced Pattern Uniformity of OLED Pixel Printing by Inkjet Printing**

*Ji Yoon Hong, Chil Won Lee, and Byung Doo Chin (Dankook Univ., Korea)*

## P2-23

**Introduction of New Glass+TFE Fabrication Approach in 1.2 Inch Round Panel**

*Ji Cheng, Wenzhi Fan, Yang Du, Xiuqi Huang, Zhiyong Duan, and Xiujian Zhu (Kunshan GoVisionox Optoelectronics Co., Ltd., China)*

## P2-24

**Mechanically Flexible Multilayer $MoS_2$ Transistor Exploiting Solution Polyimide Substrates**

*Uihyun Jung, Muhammad Naqi, Na Liu, Seongin Hong (Sungkyunkwan Univ., Korea), Hyuk-Jun Kwon, Costas P. Grigoropoulos (Univ. of California, USA), Young Ki Hong, and Sunkook Kim (Sungkyunkwan Univ., Korea)*

## P2-25

**Flexible Amorphous Silicon Phototransistor based on Local Bottom Gate Structure for Wearable Pulse Oximeter**

*Seongin Hong, Heekyeoing Park, Healin Im, Seok Hwan Jeong, Uihyun Jeong, Muhammad Naqi, Na Liu, Young Ki Hong, and Sunkook Kim (Sungkyunkwan Univ., Korea)*

## P2-26

**Mechanical Sensor based on Carbon Nanotube Fibers**

*Ga-young Kim, Joo Sung Kim, and Seong Jun Kang (Kyung Hee Univ., Korea)*

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### P2-27

Deformable Fiber-based Reliable Polymer Light Emitting Diodes for Wearable Garment Displays

*Seonil Kwon, Hyuncheol Kim, Seungyeop Choi, Hoseung Lee, Young Cheol Seo, Dohong Kim (KAIST, Korea), Byoung-Cheul Park, Sin-Hyeok Kang (Kolon Glotech, Inc., Korea), and Kyung Cheol Choi (KAIST, Korea)*

### P2-28

Highly Transparent, Stretchable, and Hydrophobic Ag Nanowire Network Electrodes Covered by Sputtered Teflon Layer

*Sang-Mok Lee (Kyung Hee Univ., Korea), Sang-Jin Lee (KRICT, Korea), and Han-Ki Kim (Kyung Hee Univ., Korea)*

### P2-29

Simply Brush Painted Stretchable Ag Nanowire/PEDOT:PSS Electrodes for Stretchable Electronics

*Ji-Eun Lim, Sang-Mok Lee, and Han-Ki Kim (Kyung-Hee Univ., Korea)*

### P2-30

Fabrication of a Full-Printed NFC Tag

*Sun Hong Yoon, Hyunho Park, and Eunju Choi (KETI, Korea)*

### P2-31

All-Organic Triboelectric Nanogenerators for Highly Efficient, Transparent and Flexible Power Sources

*Bo-Yeon Lee, Se-Um Kim, Sujie Kang, Chiwoo Kim, and Sin-Doo Lee (Seoul Nat'l Univ., Korea)*

### P2-32

A Dual-Functional Digital Electrochemical Device Using Functional Elastomer Electrolytes

*Kyeong Ah Nam, Moon Sung Kang, and Do Hwan Kim (Soongsil Univ., Korea)*

### P2-33

Cell-Inspired Electronic Skin Using Visco-Poroelastic Ionic Elastomer

*Eunsong Jee, Joo Sung Kim, and Do Hwan Kim (Soongsil Univ., Korea)*

## Poster Session II

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### P2-34

TFT-LCD Gate Driver on Array Circuits with Electrostatic Protection and Current Restriction

*Xueguang Hao, Hongfei Cheng, Xinyin Wu, Yong Qiao, and Xueguang Hao (BOE Tech. Group, China)*

### P2-35

Method for Optimizing Gamma Parameters for AMOLED Displays

*Liwei Ding, Tao Tang, Xiaobao Zhang, Ji Cheng, Xiujian Zhu, Xiuqi Huang (Kunshan GoVisionox Optoelectronics Co., Ltd., China), Qi Shan, RuboXing, Ping Sun, and Xiaoyu Gao (Kunshan New Flat Panel Display Tech. Center Co., Ltd., China)*

### P2-36

Method for Improving Characteristics of Dual Gate Amorphous Silicon Thin Film Transistors

*Bingqiang Gui, Lianjie Qu, Yonglian Qi, Hebin Zhao, Yun Qiu, and Dan Wang (Beijing BOE Display Tech. Co., Ltd., China)*

### P2-37

Photocurable Polymide Gate Insulator for Thin Film Transistor with Excellent Chemical Resistance by Low Temperature Solution Processing

*Gyeongmin Ki and Taek Ahn (Kyungsung Univ., Korea)*

### P2-38

Surface Energy Control of Soluble Polymide Gate Insulators by Copolymerization Method for High Performance Thin-Film Transistors

*Gyeongmin Ki and Taek Ahn (Kyungsung Univ., Korea)*

### P2-39

Amorphous InGaZnO Thin Film Transistors with Mo Source/Drain Electrodes Deposited at Various Powers

*Lei Zhang, Guochao Liu, Yan Zhou, Haiting Xie, and Chengyuan Dong (Shanghai Jiao Tong Univ., China)*

# Poster Session II

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## P2-40

**Improvement of Photoresponse of Organic Field-Effect Transistor at Low Operating Voltage Using Vertical Configuration**

*Hea-Lim Park, Sin-Hyung Lee, Chiwoo Kim, and Sin-Doo Lee (Seoul Nat'l Univ., Korea)*

## P2-41

**Dirac Voltage Shift of Graphene Transistors According to the Composition of Copolymer Dielectrics Deposited Via Initiated Chemical Vapor Deposition**

*Kwanyong Pak, Joong Gun Oh, Chung Sun Kim, Byung Jin Cho, and Sung Gap Im (KAIST, Korea)*

## P2-42

**Synthesis of High-k, Ultrathin Polymer Gate Dielectrics for Flexible, Low-Power Thin-Film Transistors (TFTs)**

*Junhwan Choi, Munkyu Joo, Kwanyong Pak, and Sung Gap Im (KAIST, Korea)*

## P2-43

**Solution-Processed Solid-State Electrolyte-Gated Transistors**

*Benjamin Nketia-Yawson, Seok-Ju Kang, Grace Dansoa Tabi, and Yong-Young Noh (Dongguk Univ., Korea)*

## P2-44

**Physical Property and Environmental Degradation of Plasma Enhance Atomic Layer Deposited SiNx Thin Film on Low Temperature Process**

*Ju-Hwan Han (Hanyang Univ., Korea), Chang-Nam Kim, Kwang-Su Lim, Sang-Kyu Lee, Hyun-Chul Choi (LG Display Co., Ltd., Korea), and Jin-Seong Park (Hanyang Univ., Korea)*

## P2-45

**Fully Printed Organic Thin-Film Transistor Array with Hole Mobility Exceeding 13cm$^2$ V$^{-1}$ s$^{-1}$**

*Xuying Liu (NIMS, Japan), Chuan Liu (Sun Yat-sen Univ., China), Masayuki Kanehara (C-Ink. Co., Ltd., Japan), and Takeo Minari (NIMS, Japan)*

## Poster Session II

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### P2-46

Control of Charge-Transfer Characteristics in Polymer Semiconductors by Addition of Trifluoromethyl Group on to the Acceptor Moiety

*Chang-Hee Jin, Dong-Wook Chang, and Jiyoul Lee (Pukyong Nat'l Univ., Korea)*

### P2-47

A Systematic Approach to Reducing White Angular Dependence in Cavity-Resonant Organic Light-Emitting Diodes

*Eunhye Kim, Jin Chung, Jaeho Lee, Jinouk Song, and Seunghyup Yoo (KAIST, Korea)*

### P2-48

Parylene Based Bilayer Gate Dielectric for Top-Gated Organic Field-Effect Transistors

*Eul-Yong Shin and Yong-Young Noh (Dongguk Univ., Korea)*

### P2-49

Self-Aligned High Resolution Patterning Process for Large Area Printed Electronics

*Won-Tae Park and Yong-Young Noh (Dongguk Univ., Korea)*

### P2-50

Simple Bar Coating Process for Large Area Polymer LED

*Gi-Seong Ryu and Yong-Young Noh (Dongguk Univ., Korea)*

### P2-51

Influence of Temperature on Charge Transport Mechanism of TIPS-Pentacene Diodes

*Seongjib Cho and Eunju Lim (Dankook Univ., Korea)*

### P2-52

Investigating InSnZnO as an Active Layer for Non-Volatile Memory Devices and Increasing Memory Window by Utilizing Silicon-Rich SiOx for Charge Storage Layer

*Heejun Park, Jungsuo Kim, Donggi Shin, Cam Phu Thi Nguyen, and Junsin Yi (Sungkyunkwan Univ., Korea)*

## Poster Session II

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### P2-53

**1.96” 2250ppi Panel Development for Holographic Display**

*Hyun Sup Lee, Sanghee Jang, Junghun Noh, HyungIl Jeon, Byung-Seok Choi, Yeon Mun Jeon, Keunkyu Song, Junho Song, Hye Yong Chu, and Sungchul Kim (Samsung Co., Ltd., Korea)*

### P2-54

**Method for Optimizing Gamma Parameters for AMOLED Displays**

*Liwei Ding, Tao Tang, Xiaobao Zhang, Ji Cheng, Xiujian Zhu, Xiuqi Huang (Kunshan GoVisionox Optoelectronics Co., Ltd., China), Qi Shan, Rubo Xing, Ping Sun, and Xiaoyu Gao (Kunshan New Flat Panel Display Tech. Center Co., Ltd., China)*

### P2-55

**Thermal Calculation of a-Si Films on Polyimide during Excimer Laser Annealing**

*Tatsuya Okada, Futa Gakiya, Yuya Ishiki, and Takashi Noguchi (Univ. of the Ryukyus, Japan)*

### P2-56

**Electrically Tunable Solid-State Structural Color Based on Block Copolymer Self-Assembly**

*Taehyun Park, Hansol Kang, Minju Kim, and Cheolmin Park (Yonsei Univ., Korea)*

### P2-57

**Study of High-Voltage Ultraviolet AlGaN Light Emitting Diode**

*Ching-Ho Tien, Chen-Hao Kuo, Dong Sing Wuu (Nat'l Chung Hsing Univ., Taiwan), and Ray-Hua Horng (Nat'l Chiao Tung Univ., Taiwan)*

### P2-58

**Optimized Structure of Silane-core Containing Host Materials for Highly Efficient Blue Thermally Activated Delayed Fluorescence Organic Light Emitting Diodes**

*Suna Choi, Ji Hyung Lee, Seo Yeon Park, Gi Eun Park, Min Ju Cho, and Dong Hoon Cho (Korea Univ., Korea)*

## Poster Session II

**Date:** Aug. 31, 2017 (Thursday)
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### P2-59

**Speckle Noise Reduction Using the Multi-Channel Chirped Quasi-Phase Matching Device for Laser Display Systems**

*Seong-Jin Son (GIST, Korea), Lung-Han Peng (Nat'l Taiwan Univ., China), Do-Kyeong Ko, and Nan Ei Yu (GIST, Korea)*

### P2-60

**Non-conjugated Polymer Emitting Materials for Solution-processed Thermally Activated Delayed Fluorescence Organic Light Emitting Diodes (TADF-OLEDs)**

*Hyung Jong Kim, Ye Seul Jung, Min Ju Cho, and Dong Hoon Choi (Korea Univ., Korea)*

### P2-61

**Fractal Structures for Improving the Outcoupling Efficiency of Organic Light Emitting Diodes**

*Ji Soo Park, Jong Wan Lee, and Jae-Hyeon Ko (Hallym Univ., Korea)*

### P2-62

**Influence of Porous Layers on Light-Outcoupling in Organic Light Emitting Diodes**

*Hyeck Go, Hyunsu Jung, Eun Mi Kim, Su Jin Kim (KITECH, Korea), Eun-Mi Han (Chonnam Nat'l Univ., Korea), and Changhun Yun (KITECH, Korea)*

### P2-63

**New Thermally Activated Delayed Fluorescent Emitters with Indolocarbazole Donor Moieties**

*Seung Yeon Lee, Gyeong Heon Kim, Dae Hyun Ahn, Joon Beom Im, Ji Su Moon, Si Woo Kim, Ju Young Lee, and Jang Hyuk Kwon (Kyung Hee Univ., Korea)*

### P2-64

**Bonding of AlGaInP-based Red LEDs and InGaN-based Green LEDs for Display Applications**

*Chang-Mo Kang, Seokjin Kang, Seung-Hyun Mun, Soo-Young Choi (GIST, Korea), Jae-Phil Shim (KIST, Korea), and Dong-Seon Lee (GIST, Korea)*

# Poster Session II

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## P2-65

### Current-Driving for Stable Polymer Light-Emitting Electrochemical Cells with Low Internal Voltage

*Seunghan Kim, Jeehye Yang, Jong Ik Lee, Jaemok Koo, and Moon Sung Kang (Soongsil Univ., Korea)*

## P2-66

### A Field-induced Hole Generation Layer for High Performance and Flexible Alternating Current Electroluminescence

*Seung Won Lee, Eui Hyuk Kim, Ihn Hwang, Taehyun Park, and Cheolmin Park (Yonsei Univ., Korea)*

## P2-67

### Development of New Blue Dual-Core Emitters Using Spirofluorene and Phenylcarbazole

*Beomjin Kim (Kyung Hee Univ., Korea), Suji Lee (Catholic Univ. Korea), Hyocheol Jung (Kyung Hee Univ., Korea), Hayoon Lee, Seokwoo Kang, and Jongwook Park (Kyung Hee Univ., Korea)*

## P2-68

### Synthesis and Electroluminescent Property of Highly Efficient Phosphorescent Red Iridium(III) Complexes based on Modulated Main Ligands

*Seoyun Lee (Hongik Univ., Korea), Anna Euna Yum (Middlesex school, USA), and Dongmyung Shin (Hongik Univ., Korea)*

## P2-69

### Measurement of LED Junction Temperature by Thermoreflectance Light and Diode Forward Voltage

*DongGuang Zheng, YoungMin Park, Dong-Soo Shin, and Jong-In Shim (Hanyang Univ., Korea)*

## P2-70

### Investigation of Potential Fluctuation in Blue InGaN/GaN Quantum-well Light-Emitting Diodes by Macroscopic Optoelectronic Characterizations

*A.B.M. Hamidul Islam, Dong-Soo Shin, and Jong-In Shim (Hanyang Univ., Korea.)*

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## P2-71

**Study on Multi Thin Film Coating Process by Roll-to-Roll System for Printed Electronics**
*M. K. Kim, S. W. Park, C. R. Yoon, and D. H. Sung (Deviceeng, Korea)*

## P2-72

**Hybrid Quantum Dot/Blue Organic Light-Emitting Diodes Using Microcavity Effects with D/M/D Transparent Electrode**
*Jung Hyuk Im, Kyung Tae Kang, Sang Ho Lee, Seong Jin Kim, and Kwan Hyun Cho (KITECH, Korea)*

## P2-73

**Gas Barrier Equipped Flexible Integrated Substrate for OLED Lightings**
*O Eun Kwon, Young-Sam Park, Byoung Gon Yu, Jonghee Lee, and Jaehyun Moon (ETRI, Korea)*

## P2-74

**The Influence of Current Density on Organic-Inorganic Hybrid Perovskite Light-Emitting Diodes Efficiency**
*Yun Ho Ahn and Min Chul Suh (Kyung Hee Univ., Korea)*

## P2-75

**Screen-printed Ag Electrodes for Light-Emitting Electrochemical Cells (LECs)**
*Hyeonseok Lee, Hee-Jin Park, and Jiyoul Lee (Pukyong Nat'l Univ., Korea)*

## P2-76

**The Enhancement of a Color Gamut by the $Mn^{4+}$-doped MgO-$MgF_2$ – $GeO_2$ Phosphor in an LCD Module**
*Hyun Woo Park (Chung-Ang Univ., Korea), Ji Wook Moon (LG Innotek Co., Ltd., Korea), Tae Gil Lim, Yong Nam Ahn, and Jae Soo Yoo (Chung-Ang Univ., Korea)*

## P2-77

**Diagnosis of Degradation for Organic-Light Emitting Diodes based on Luminance-Current Measurement**
*Sang Hoon Park, Gyeong Won Lee (Hanyang Univ., Korea), Heejin Kim, Jongwoo Park (Samsung Display Co., Ltd., Korea), Dong-Soo Shin, and Jong-In Shim (Hanyang Univ., Korea)*

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## P2-78

**The Research of the Root Cause of Cell and BL Peeling**
*Mindy Lu, Mingge Xu, Chunfeng Liu, Jeff Lai (Inst. of Jiangsu, China)*

## P2-79

**Optical Analysis of White Organic Light Emitting Diodes with Randomly Dispersed Nano-pillar Array**
*Sohee Jeon (KIMM, Korea), Sunghun Lee, Kyung-Hoon Han, Hyun Shin, Kwon-Hyeon Kim (Seoul Nat'l Univ., Korea), Jun-Ho Jeong (KIMM, Korea), and Jang-Joo Kim (Seoul Nat'l Univ., Korea)*

## P2-80

**The Optical Design of Lighting Module Control Technology in Smart Vehicle and Medical Industry**
*Sungyoon Chung, Woo Sang Park (Inha Univ., Korea), Hyun-sik Kim, and Kwan Young Han (Dankook Univ., Korea)*

## P2-81

**Effect of Visible Light Absorption on Silicone Encapsulation in High-Power LED**
*Jung Hwa Jung and Hyun Jae Kim (Yonsei Univ., Korea)*

## P2-82

**Molecular Orientation in Organic Light Emitting Devices**
*Sunyoung Sohn (POSTECH, Korea), Hyungju Ahn, Han-Koo Lee (PAL, Korea), Yun-Hi Kim (Gyeonsang Nat'l Univ., Korea), and Sungjune Jung (POSTECH, Korea)*

## P2-83

**Graphene Pressure Sensor for Evaluation of Barrier Film on OLED**
*JuRa Jung (Silla Univ., Korea), Yujin Lee (Korea Inst. of Ceramic Engineering and Tech., Korea), Jung Hoon Cha, and Sung Il Ahn (Silla Univ., Korea)*

## P2-84

**White Organic Light Emitting Diodes Using an Exciplex Emission from Blue Phosphorescent and Delayed Fluorescent Emitters**
*Si hyun Han, Jeong Min Choi, and Jun Yeob Lee (Sungkyunkwan Univ., Korea)*

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### P2-85

Development of High Efficiency Green Fluorescent OLED by Suppressing Retaining Dexter  Energy Transfer to the Dopant

*Seong Bae Ji, Hye Won Choi, Hye Won Choi, and Kyoung Soo Yook (Sungkyunkwan Univ., Korea)*

### P2-86

Synthesis of Dibenzothiophene Based Bipolar Host Materials for High Efficiency and Increased Lifetime in Blue Delayed Fluorescent Organic Light-emitting Diodes

*Ji Han Kim, Si Hyun Han, and Jun Yeob Lee (Sungkyunkwan Univ., Korea)*

### P2-87

Influence of Thermal Stress on Blue Organic Light-Emitting Diodes with Different Hole Transport Materials

*Song Eun Lee, Ho Yong Kim (Hongik Univ., Korea), Geum Jae Yun (Hoseo Univ., Korea), Changmin Kim, Seung Soo Yoon (Sungkyunkwan Univ., Korea), Woo Young Kim (Hoseo Univ., Korea), and Young Kwan Kim (Hongik Univ., Korea)*

### P2-88

Light Extraction by Periodic Structure Composed of Low Refractive Index Material

*Jae Geun Kim (Korea Univ., Korea), Young Wook Park (Sun Moon Univ., Korea), and Byeong-Kwon Ju (Korea Univ., Korea)*

### P2-89

A Study of on the Effect of Substituent Position of Dibenzo [b,d]furan Based Host Materials for Blue Phosphorescence Organic Light-Emitting Diodes

*Ji Gwang Yu, Sung Yong Byeon, Si Hyun Han, and Jun Yeob Lee (Sungkyunkwan Univ., Korea)*

### P2-90

Synthesis of Blue Phosphorescent Host Materials with Long Term Device Stability

*Sung Yong Byeon and Jun Yeob Lee (Sungkyunkwan Univ., Korea)*

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### P2-91

**Molecular Design Strategy of Thermally Activated Delayed Fluorescent Emitters Using Ortho, Meta and Para Substitution**

*Dong Ryun Lee, Jeong Min Choi (Sungkyunkwan Univ., Korea), Chil Won Lee (Dankook Univ., Korea), and Jun Yeob Lee (Sungkyunkwan Univ., Korea)*

### P2-92

**Synthesis of Dopant Materials Using Imide Type New Acceptor Unit for Red Thermally Activated Delayed Fluorescent Organic Light-emitting Diodes**

*Ju Hui Yun and Jun Yeob Lee (Sunkyunkwan Univ., Korea)*

### P2-93

**A Study on the Efficiency and Characteristic Variation According to Co-Deposition Ratio Change in Double EML Structure using TCTA and TPBi**

*Hwayeul Oh, Deho Yune (Sungkyunkwan Univ., Korea), Junho Song (Samsung Display Co., Ltd., Korea.), and Sangsoo Kim (Sungkyunkwan Univ., Korea)*

### P2-94

**Highly Polarized Light Source with Coatable Polarizer for Brightness-Enhanced Liquid Crystal Display**

*Dong-Myoung Lee, Jong-Ha Woo (Hanyang Univ., Korea), Myong-Hoon Lee (Chonbuk Nat'l Univ., Korea), Chang-Jae Yu, and Jae-Hoon Kim (Hanyang Univ., Korea)*

### P2-95

**Effect of Molecular Orientation on Hole Carrier Transport: Multiscale Computational Simulation Study**

*Hochul Song, Dongsun Yoo, Yong Youn, and Seungwu Han (Seoul Nat'l Univ., Korea)*

### P2-96

**Self-Assembled Metallic Nanoparticle Structures for Light Outcoupling of OLEDs: Comparison of Experimental Results and Simulation**

*Mei Meng, Dong-Eun Lee, Dong Hyun Lee, and Byung Doo Chin (Dankook Univ., Korea)*

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## P2-97

### 95.5% Enhancement of Lifetime of Blue OLED with Novel Host Material

*Bo-Yen Lin, Jiun-Haw Lee (Nat'l Taiwan Univ., Taiwan), Ming-Zer Lee, Julie Hsieh, Stanley Chen (Nichem Fine Tech. Co., Ltd., Taiwan), Tien-Lung Chiu (Yuan Ze Univ., Taiwan), and Chi-Feng Lin (Nat'l United Univ., Taiwan)*

## P2-98

### Voltage Reduction and Lifetime Enhancement of White Organic Light-Emitting Diode with a Novel Electron Transporting Material

*Ming-Zer Lee, Julie Hsieh, Stanley Chen (Nichem Fine Techn. Co., Ltd., Taiwan), Bo-Yen Lin, and Jiun-Haw Lee (Nat'l Taiwan Univ., Taiwan)*

## P2-99

### Effect of the Recombination Zone in the Orthogonal Photo-lithography Process on Hole Transport Layer

*Jun Han Bae, Seung Gun Chae (Univ. of Seoul, Korea), Jongchan Son, Woo-Won Park, Jin-Kyun Lee (Inha Univ., Korea), and Byung Jun Jung (Univ. of Seoul, Korea)*

## P2-100

### Novel Core-Shell Type Host Materials for High-Efficiency Blue TADF OLEDs

*Jae-Ryung Cha (Dankook Univ., Korea), Seong Bae Ji, Kyoung Soo Yook (Sungkyunkwan Univ., Korea), and Chil Won Lee (Dankook Univ., Korea)*

## P2-101

### Suppression of Viewing Angle Dependence of Top Emission Organic Light-Emitting Diodes with Nanostructure via Surface Morphology

*Woo Young Lee, Nam Su Kim, Dong Hyun Lee, and Min Chul Suh (Kyung Hee Univ., Korea)*

## P2-102

### High Mobility IWO Anode Prepared by Ion Plating for Organic Light Emitting Diodes

*Jae-Gyeong Kim (Kyung Hee Univ., Korea), Ju-Yeoul Baek (SNTEK Co., Ltd, Korea), Sung Min Jo, Byung Doo Chin (Dankook Univ., Korea), and Han-Ki Kim (Kyung Hee Univ., Korea)*

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## P2-103

Accumulated Polaron in Light-Emitting Layer Governs the Operational Stability of Organic Light-Emitting Diodes

*Jae-Min Kim, Chang-Heon Lee, and Jang-Joo Kim (Seoul Nat'l Univ., Korea)*

## P2-104

Novel Design of TADF Dopant Materials for Efficient Blue Organic Light Emitting Diodes

*Min Hyeong Hwang, Chil Won Lee, and Byung Doo Chin (Dankook Univ., Korea)*

## P2-105

Optimization of Strong Micro-Cavity Blue Top-Emitting Organic Light Emitting Diodes

*Seong Keun Kim, Mi Jin Park, Jun Sik Kim, Min Keun Song, and Jang Hyuk Kwon (Kyung Hee Univ., Korea)*

## P2-106

Improving the Stability and Performance of Inverted Perovskite Solar Cells

*Jae Choul Yu, Ji A Hong, Eui Dae Jung, and Myoung Hoon Song (UNIST, Korea)*

## P2-107

Perylene Diimide Isomers Containing a Simple $sp^3$- Core for Fullerene Free Polymer Solar Cells

*Gi Eun Park, Aesun Kim, Su Hong Park, Chang Geun Park, Min Ju Cho, and Dong Hoon Choi (Korea Univ., Korea)*

## P2-108

Effect of Acceptor Strength in New Acceptor–Donor–Acceptor-Type Molecule on its Miscibility with Donor Polymers for Bulk-heterojunction Fullerene-free Solar Cells

*Seo Yeon Park, Gi Eun Park, Suna Choi, Ji Hyung Lee, Min Ju Cho, and Dong Hoon Choi (Korea Univ. , Korea)*

## P2-109

Enhanced Performance of Perovskite Solar Cell via Polar Solvent Treatment

*Da Bin Kim, Jae Choul Yu, Eui Dae Jung, Seungjin Lee, and Myoung Hoon Song (UNIST, Korea)*

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### P2-110

Single-Component Polymer Solar Cells Using Novel D-A Type Conjugated Block Copolymers

*Dae Hee Lee, Ji Hyung Lee, Hyung Jong Kim, Suna Choi, Gi Eun Park, Min Ju Cho, and Dong Hoon Choi (Korea Univ., Korea)*

### P2-111

Polymer Based Solar Cells Using PEDOT:PSS and GO Composite Layer as a Hole Transport Layer

*Ji A Hong, Jae Choul Yu, and Myoung Hoon Song (UNIST, Korea)*

### P2-112

Highly Efficient Inverted Polymer-Based Optoelectronic Devices by Employing Amine-based Interfacial Molecules

*Seungjin Lee, Eui Dae Jung, and Myoung Hoon Song (UNIST, Korea)*

### P2-113

Various Interfacial Treatment Materials for Highly Efficient Polymer Based Optoelectronic Devices

*Eui Dae Jung, Yun Seok Nam, and Myoung Hoon Song (UNIST, Korea)*

### P2-114

The Poling Effect of Conjugated Polyelectrolytes on Organic Solar Cells

*ChungHyeon Jang, Seungjin Lee (UNIST, Korea), Bo Ram Lee (Univ. of Cambridge, UK), and Myoung Hoon Song (UNIST, Korea)*

### P2-115

Bi-layer Organic Solar Cells with Carbon Nanotubes

*SoYeon Jeon (SungKyunKwan Univ., Korea), and SeGi Yu (Hankuk Univ. of Foreign Studies, Korea)*

### P2-116

Enhanced Efficiency of Semi-Transparent Organic Photovoltaics Using Nanoparticles as Reflector Layer

*Se-Jin Lim, Jun-Ho Song, and Jae-Woong Yu (Kyung Hee Univ., Korea)*

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### P2-117

**Low-Temperature Processed Thin Film Encapsulation for Enhancing Stability of Perovskite Solar Cell**

*Young Il Lee (KAIST, Korea), Nam Joong Jeon (KRICT, Korea), Bong Jun Kim, Hyunjeong Shim (KAIST, Korea), Jangwon Seo (KRICT, Korea), and Sung Gap Im (KAIST, Korea)*

### P2-118

**Asymmetric Indenothiophene Based N-type Small Molecule for Fullerene Free Polymer Solar Cells**

*Young Un Kim, Gi Eun Park, Suna Choi, Dae Hee Lee, Min Ju Cho, and Dong Hoon Choi (Korea Univ., Korea)*

### P2-119

**According to Using the Amino Chiral Ionic Liquids, the Chromatic Shift of 1-D Photonic Crystal Films**

*Yena Oh (Hongik Univ., Korea), Anna Euna Yum (Middlesex School, USA), and Dong Myung Shin (Hongik Univ., Korea)*

### P2-120

**Transparent and Flexible Amorphous InZnGeO Electrode for Flexible Perovskite Solar Cells**

*Jeong-Il Park (Kyung Hee Univ., Korea), Jun Hong Noh (KRICT, Korea), and Han-Ki Kim (Kyung Hee Univ., Korea)*

### P2-121

**Characteristics of Ion-plated W-doped $In_2O_3$electrodes for Flexible Perovskite Solar Cells**

*Jae-Gyeong Kim (Kyung Hee Univ., Korea), Ju-Yeoul Baek (SNTEK Co., Ltd, Korea), Kyung-Jun Ahn (Kyung Hee Univ., Korea), Yong-Jin Noh, Seok-In Na (Chonbuk Nat'l Univ., Korea), and Han-Ki Kim (Kyung Hee Univ., Korea)*

### P2-122

**Grain Size Control of Organic-Inorganic Hybrid Perovskite Solar Cells via Microwave Irradiation**

*Hyebin Kim and Inchan Hwang (Kwangwoon Univ., Korea)*

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## P2-123

**Increase of Efficiency in Bulk Heterojunction Polymer Solar Cell Using Water Soluble Conjugated Polymer**

*Han-Sol Namkung, Chung-Gi Kim, So-Dam Kim, Seong-Jin Cho, Tae-Woo Kwon, Byung-Woo Yoon, and Dong-Kyu Park (Kyungsung Univ., Korea)*

## P2-124

**Characteristics of Protective Film Layers of Flexible Devices Using Spray Coating**

*Sang Hee Lee, Byung Doo Chin, Chil Won Lee, and Ho Jung Chang (Dankook Univ., Korea)*

## P2-125

**Energy-Level Modulation of N-type Acceptors for Highly-Efficient Non-Fullerene Organic Solar Cells**

*Young Woong Lee, Bomee Jang, and Han Young Woo (Korea Univ., Korea)*

## P2-126

**The Influence of Damage-Free Etchant on the Performance of Amorphous- $InGaZnO_4$ thin Film Transistors**

*Jin-cheng Gao (Hefei BOE Display Tech. Co., Ltd., China), Zhan-feng Cao, Zheng-liang Li (BOE Technology Group Co., Ltd., China), Guan-bao Hui (Hefei BOE Display Tech. Co., Ltd., China), Seung-jin Choi (BOE Technology Group Co., Ltd., China), Tao Jiang, Jong-won Moon, and Byung-cheon Lim (Hefei BOE Display Tech. Co., Ltd., China)*

## P2-127

**Cu Ions Diffusion Induced by Self-Heating Effect in a-InGaZnO Thin-Film Transistors**

*Ming-Jiue Yu, Yuan-Jun Hsu, Jang-Soon Im, Po-Yen Lu, Shan Li, and Shi-Min Ge (Shenzhen China Star Optoelectronics Tech. Co., Ltd., China)*

## P2-128

**The TFT Characteristics Optimization of Oxide BCE without Resin Layer**

*FENG Jing, Ce Ning, Zhengliang Li, Fangzhen Zhang, Song Liu, Wenling Zhang, Seung Jin Choi, Gangcai Yuan, Zhanfeng Cao, and Feng Zhang (BOE Tech. Group Co., Ltd., China)*

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### P2-129

**Improvement of PBTS Instability of Self-Aligned Coplanar InGaZnO Thin Film Transistor in High Resolution OLED TV**

*Dohyung Lee, Sungjun Yun, Woocheol Jeong, Jaeyong Park, and Jongwoo Kim (LG Display Co., Ltd., Korea)*

### P2-130

**Improved performanceof a-IGZO TFT with CuSource/Drain Electrodes Using Aluminum Oxide Passivation Layer**

*Honglong Ning, Shiben Hu, Kuankuan Lu, Rihui Yao, Hong Tao, Jianhua Zou, Lei Wang, Miao Xu, Linfeng Lan, and Junbiao Peng (South China Univ., China)*

### P2-131

**Controlled Doping Effect on the Inkjet-Printed Zinc-Tin-Oxide Transistor**

*HunHo Kim, Young-Jin Kwack, NamHoon Baek, Thuy Can, Canh Nguyen, and Woon-Seop Choi (Hoseo Univ., Korea)*

### P2-132

**Leakage Current Reduction Method of IZO Thin Film Transistors Using Patterned Active Layer**

*Dokyeong Lee, Hyunji Shin, Dongwook Kim (Hongik Univ., Korea), Xue Zhang, Jaehoon Park (Hallym Univ., Korea), and Jong Sun Choi (Hongik Univ., Korea)*

### P2-133

**Charge Transport Mechanism over a Wide Range of Temperatures and Realistic Operation Regimes of P-Channel SnO Thin-Film Transistors**

*Hee-Joong Kim, Sae-Young Hong, Chan-Yong Jeong, Sang-Dae Bae, Jeong-Hwan Lee, and Hyuck-In Kwon (Chung-Ang Univ., Korea)*

### P2-134

**The Effect of Moisture on the Electrical Stability of Zinc Oxynitride Thin-Film Transistors**

*Dae-Hwan Kim, Hwan-Seok Jeong, and Hyuck-In Kwon (Chung-Ang Univ., Korea)*

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## P2-135

**Device Degradation by Alternating Drain Stress on the Oxide Semiconductor**

*Hyeon-Jun Lee (DGIST, Korea), Sung Haeng Cho (ETRI, Korea), Katsumi Abe (Silvaco Japan Co., Ltd., Japan), Myeong-Jae Lee, and Min-Kyeong Jeong (DGIST, Korea)*

## P2-136

**Novel Ca-Doped CuO Diffusion Barrier for High Performance a-IGZO Transistors with Cu Source/Drain Material**

*Chang Kyu Lee, Da Young In, Hang Kang, Dong Ju Oh, Sang Ho Lee (ULVAC Korea Co., Ltd., Korea), Ji Won Lee, and Jae Kyeong Jeong (Hanyang Univ., Korea)*

## P2-137

**In-O-N Thin-Film Transistors with High Field-Effect Mobility (> 30cm$^2$/Vs) and Superior Air Stability**

*Hyoung-Do Kim, Jong-Heon Kim, Dae-Gyu Yang, and Hyun-Suk Kim (Chungnam Nat'l Univ., Korea)*

## P2-138

**Transport Property Improvements of Zinc Oxynitride Thin Film Transistor Using Metal Capping Method**

*Taeho Kim, Nuri On, Taejung Gim, and Jae Kyeong Jeong (Hanyang Univ., Korea)*

## P2-139

**Oxygen Plasma Treatment with Thermal-ALD Gate Insulator for Highly Stable High Mobility Oxide TFTs**

*Jong Beom Ko, Yunyong Nam, Seunghee Lee, Kyung Woo Park, and Sang-Hee Ko Park (KAIST, Korea)*

## P2-140

**Effect of Yttrium/Lanthanum Doping on the Positive Bias Stability of Solution-Processed Zinc Tin Oxide Thin-Film Transistors**

*Genmao Huang and Lian Duan (Tsinghua Univ., China.)*

## P2-141

**Oxygen ratio dependent of Contact Resistance in Amorphous IGZO Thin-Film Transistors**

*Nuri On, Taeho Kim, HyeonA Kim, and Jae Kyeong Jeong (Hanyang Univ., Korea)*

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## P2-142

**Determination of Optical Bandgap and Germanium Content of Hydrogenated Microcrystalline $Si_{1-x}Ge_x$ Films by Ultraviolet-visible and Auger Electron Spectroscopy Measurements**

*Jungsoo Kim, Kyungsoo Jang, Cam Phu, Heejun Park, Shin DongGi, and Junsin Yi (Sungkyunkwan Univ., Korea)*

## P2-143

**A Study on the Fabrication FOR Poly-Si Thin Film Transistors by Ela AND ULG Processes Under Gate Bias Stress**

*Dong gi Shin, Kyoung soo Jang, Hee jun Park, Jung suo Kim, and Jun sin Yi (Sungkyunkwan Univ., Korea)*

## P2-144

**ß-diketone Passivated Solution Processed Zinc Oxide Nano-Layers for Application in Thin Film Transistors**

*Jonas Köhling, Marlis Ortel, Nataliya Kalinovich, Gerd-Volker Röschenthaler, and Veit Wagner (Jacobs Univ., Germany)*

## P2-145

**Oxide LCD Flicker Evaluation**

*Zhiqiang Xu, Kuanjun Peng, Wei Qin, Xiangxiang Zou, Jikai Yao, and Yang Yang (BOE Tech. Group Co., Ltd., China)*

## P2-146

**Half Tone Process Improvement for Oxide BCE Mask Reduction Technology**

*Fangzhen Zhang, Shuang Sun, Wusheng Li, Jing Feng, Jing Niu, Seungjin Choi, Kuanjun Peng, and Jikai Yao (BOE Tech. Group Co., Ltd., China)*

## P2-147

**High-Mobility Thin-Film Transistors via Metal Catalytic Crystallization of Amorphous Indium Gallium Zinc Oxide Semiconductors**

*Yeonwoo Shin, Minjae Kim, HyeonA Kim, Jeong Oh Kim, Jiwon Lee, and Jae Kyeong Jeong (Hanyang Univ., Korea)*

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### P2-148

**Photochemical Activation of Solution-Processable AlYOx High-k Gate Dielectric for High-Performance Metal Oxide Field-Effect Transistor**

*Jiwon Lee, Hyeonjoo Seul, MinJae Kim, Baekeun Yoo, Taikyu Kim, and Jae kyeong Jeong (Hanyang Univ., Korea)*

### P2-149

**A New p-type Oxynitride Semiconductor**

*Taejung Gim, Baekeun Yoo, Tai kyu Kim, and Jaekyeong Jeong (Hanyang Univ., Korea)*

### P2-150

**The Influence of $NH_3$ Plasma Treatment on ALD $HfO_2$-IGZO TFTs**

*JaeHo Lee, Beomgil Ha, Donghwan Lim, Andrey Sokolov Sergeevich, Yu-Rim Jeon, HoonHee Han, Myeong Gyoon Chae, and Changhwan Choi (Hanyang Univ., Korea)*

### P2-151

**Solution-Processed Amorphous Indium-Gallium-Zinc-Oxide Thin Film Transistors (a-IGZO TFTs) with AZO Gate Dielectrics**

*So Young Lee, Eung-Kyu Park, Min Su Kim, Jongsu Oh (Sungkyunkwan Univ., Korea), Jae-Hong Jeon (Korea Aerospace Univ., Korea), and Yong-Sang Kim (Sungkyunkwan Univ., Korea)*

### P2-152

**Relationship between the Tunneling Distance and Stretched-Exponential Function Model on the Positive bias Stress-Induced Charge Trapping in IGZO TFTs**

*Jihyun Rhee, Sungju Choi, Jae-Young Kim, Sung-Jin Choi, Dong Myong Kim, and Dae Hwan Kim (Kookmin Univ., Korea)*

### P2-153

**Improvement in the Electrical Characteristics of an IGZO TFT by Control of the Hydrogen and Oxygen**

*Hee Yeon Noh, Joonwoo Kim, Myoung-Jae Lee, Byeongdae Choi, and Hyeon-Jun Lee (DGIST, Korea)*

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### P2-154

Novel Fluorine-doped ZnON Thin-Film Transistors with High Field-Effect Mobility Exceeding 50cm$^2$/Vs

*Hyeon-Su Cho, Hyun-Mo Lee, Kyung-Chul Ok, and Jin-Seong Park (Hanyang Univ., Korea)*

### P2-155

Comparator Circuit Implemented by Operational Amplifier with a-IGZO TFT

*In Hye Kang and Byung Seong Bae (Hoseo Univ., Korea)*

### P2-156

Molybdenum Alloy for Copper Barrier Material of Back-Channel-Etched In-Ga-Zn-O Thin-Film Transistors with Copper Source/ Drain Electrode

*Jung-Cheol Shin, Gwang-Heum Lee, Seung-Hee Lee (KAIST, Korea), Jörg Winkler (PLANSEE SE, Austria), Hennrik Schmidt (PLANSEE High Performance Material Ltd., China), and Sang-Hee Ko Park (KAIST, Korea)*

### P2-157

Effects of Hydrogen on Amorphous InGaZnO Thin-Film Transistors with a $SiO_2$/$SiN_x$/$SiO_2$ Buffer

*Ki-Lim Han, Kyung-Chul Ok, Hyeon-Su Cho, Hyun-Mo Lee, and Jin-Seong Park (Hanyang Univ., Korea)*

### P2-158

The Impact of Mist Chemical Vapor Deposited Indium-Zinc Oxide Thin Film Transistors on In/Zn Precursor Ratios

*Hyun-Jun Jeong, Donghyun Kim, Kyungsub Jung, and Jin-Seong Park (Hanyang Univ., Korea)*

### P2-159

Effect of Plasma Treatment on Electrical Properties of Solution-Processed Oxide Thin-Film Transistors

*Amos Amoako Boampong, Su Eon Lee, Jiwon Park, Ju-Ryong Kim, Sunghun Kim, Yoonseuk Choi, Jae-Hyun Lee, and Min-Hoi Kim (Hanbat Nat'l Univ., Korea)*

# Poster Session II

Date: Aug. 31, 2017 (Thursday)
Time: 14:00-15:30

## P2-160

**The Impact of $Al_2O_3$ Gate Dielectrics Deposited by Atmospheric Mist Chemical Vapor Deposition**

*Dong-Hyun Kim, Hyun-Jun Jung, and Jin-Seong Park (Hanyang Univ., Korea)*

## P2-161

**Electrical Improvement of Oxide Vertical TFT for the Next-Generation Display**

*Kwang-Heum Lee, Hye-In Yeom, Seung-Hee Lee, Jong-Beom Ko (KAIST, Korea), Chi-Sun Hwang (ETRI, Korea), and Sang-Hee Ko Park (KAIST, Korea)*

## P2-162

**Analysis of the Significant Sheet Resistance Reduction of a-IGZO After Excimer Laser Irradiation**

*Juan Paolo Bermundo, Yasuaki Ishikawa, Mami N. Fujii (NAIST, Japan), Hiroshi Ikenoue (Kyushu Univ., Japan), and Yukiharu Uraoka (NAIST, Japan)*

## P2-163

**Enhancement of Reliability for In–Ga–Zn–O Thin-Film-Transistors by TEOS-Based $SiO_2$ Passivation**

*S G Mehadi Aman, Daichi Koretomo, Hirosato Tanaka, and Mamoru Furuta (Kochi Univ. of Tech., Japan)*

## P2-164

**Effect of Deposition Temperature of InGaZnOx Channel on Electrical Properties and Reliability of Thin-Film Transistors**

*Mamoru Furuta, Hirosato Tanaka, and Ryunosuke Higashi (Kochi Univ. of Tech., Japan)*

## P2-165

**Discharge Current Analysis Estimating the Defect Sites in Amorphous Hf-In-Zn-O Oxide Thin Film Transistor**

*Youngin Goh, Minhyun Jung, and Sanghun jeon (Korea Univ., Korea)*

## Poster Session II

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### P2-166

**Broad Spectral Photosensors Based on Solution-Processed Metal-Oxide/CNT Hybrid Thin-Film Transistors**

*Jaehyun Kim, Insik Hwang, Myung-Gil Kim (Chung Ang Univ., Korea), Yong-Hoon Kim (Sungkyunkwan Univ., Korea), and Sung Kyu Park (Chung Ang Univ., Korea)*

### P2-167

**The Study of Substrate Heating Effect at Inkjet Printing for Zinc Tin Oxide Thin Film Transistors**

*Kwang-Ho Kim, Byungwook Yoo, Seul Gi Park (KETI, Korea), and Sung-Kyu Park (Chung-Ang Univ., Korea)*

### P2-168

**PBTS Stability of UV Irradiation Doping Technique Employed Self-Aligned Coplanar Top Gate a-IGZO TFT**

*So-yang Cho, Myeong-ho Kim (Hanyang Univ., Korea), Jun-hyung Lim (Samsung Display Co., Ltd., Korea), and Duck-kyun Choi (Hanyang Univ., Korea)*

### P2-169

**Investigation on Various Low Temperature Annealing Conditions on Amorphous InGaZnO Thin-Film Transistors for Use in Flexible Devices**

*Michael Paul Jallorina, Juan Paolo Bermundo, Yasuaki Ishikawa, and Yukiharu Uraoka (NAIST, Japan)*

### P2-170

**Comparison of ZnO Films Grown by dc Sputtering and rf Sputtering**

*Jaewon Choi, Wonjin Jeon, Jun Meng, and Jungyol Jo (Ajou Univ., Korea)*

### P2-171

**Effects of Magnetic Field Shielded Sputtering Process on the Properties of InGaZnO Thin Film Transistor**

*DongHyeok Lee, KyungDuck Kim, SeulGi Kim, and MunPyo Hong (Korea Univ., Korea)*

## Poster Session II

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### P2-172

Electrical and Optical Properties of Indium Tin Oxide Films Fabricated by Magnetic Field Shielded Sputtering Process

*SeulGi Kim, DongHyeok Lee, KyungDuck Kim, and MunPyo Hong (Korea Univ., Korea)*

### P2-173

Improvement of Field Effect Mobility of ITZO TFT with Crystalline ITZO Film

*Heejun Park, Jungsuo Kim, Donggi Shin, Jayapal Raja, and Junsin Yi (Sungkyunkwan Univ., Korea)*

### P2-174

Self-Patternable InZnO Thin-Films Based on Photosensitive Precursors

*Hee Jun Kim, Ji Hoon Park, Yeong-gyu Kim, Sung Pyo Park, Dongwoo Kim, Na-eun Kim, and Hyun Jae Kim (Yonsei Univ., Korea)*

### P2-175

Amorphous Indium Gallium Zinc Oxide Phototransistors Operating in the Visible Light through a Highly Defective Interface

*Jin Hyeok Lee, Young Jun Tak, Yeong-gyu Kim, Won-Gi Kim, Byung Ha Kang, Jusung Chung, Hee Jun Kim, and Hyun Jae Kim (Yonsei Univ., Korea)*

### P2-176

Development of Amorphous Indium Gallium Zinc Oxide Thin-Film Transistor for Visible Light Detection via Hydrogen Plasma Doping

*Byung Ha Kang, Won-Gi Kim, Young Jun Tak, Yeong-gyu Kim, Jusung Chung, Jin Hyeok Lee, Hee Jun Kim, and Hyun Jae Kim (Yonsei Univ., Korea)*

### P2-177

Dimethylalumnium Hydride as a Novel Precursor for $Al_2O_3$ Passivation on Amorphous InGaZnO Thin-Film Transistors

*Dianne Corsino, Juan Paolo Bermundo (NAIST, Japan), Kiyoshi Takahashi (Nippon Aluminum Alkyls, Ltd., Japan), Yasuaki Ishikawa, and Yukiharu Uraoka (NAIST, Japan)*

# Poster Session II

**Date:** Aug. 31, 2017 (Thursday)
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## P2-179

**Selective Light-Induced Patterning of Carbon Nanotube/Silver Nanoparticle Composite Based Extremely Flexible Conductive Electrodes**

*Kyoohee Woo and Sin Kwon (KIMM, Korea)*

## P2-180

**Flexibility Analysis of Thin Film Encapsulation with Structural Variation**

*Hyunjeong Shim, Cheolgyu Kim, Bong Jun Kim, Young-il Lee, Boo Soo Ma, Taek-Soo Kim, and Sung Gap Im (KAIST, Korea)*

## P2-181

**Flexible Amorphous InGaZnO Thin-Film Transistors with Stacked Gate Dielectrics**

*Guochao Liu, Lei Zhang, Haiting Xie, Yan Zhou, and Chengyuan Dong (Shanghai Jiao Tong Univ., China)*

## P2-182

**Metal Microfiber Transparent Conductors Using Electrospinning for Flexible Organic Light Emitting Diodes**

*Junhee Choi (Korea Univ., Korea), Young Wook Park (Sun Moon Univ., Korea), and Byeong-Kwon Ju (Korea Univ., Korea)*

## P2-183

**Flexible and Durable Cover Window for Foldable Display**

*Kang-Han Kim and Yong-Cheol Jeong (KITECH, Korea)*

## P2-184

**Inkjet Printable and Reusable Block Copolymer Structural Color Film**

*Han Sol Kang and Cheolmin Park (Yonsei Univ., Korea)*

## P2-185

**Effect of Particle Size on the Barrier Properties of Epoxy/Zirconium Phosphate Composite Layer**

*Hana Ra, Haesook Kim, Jae Yong Jang, Jihae Eun, Hye Rim Park, Hyun Gi Kim, and Sung Soo Kim (Kyung Hee Univ., Korea)*

## Poster Session II

**Date:** Aug. 31, 2017 (Thursday)
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### P2-186

**Low Temperature Processed Flexible Indium-Gallium-Zinc Oxide Thin-Film Transistors on Polyimide Substrate**

*Dae-Gyu Yang, Jong-Heon Kim, Hyoung-Do Kim, and Hyun-Suk Kim (Chungnam Nat'l Univ., Korea)*

### P2-187

**Fabrication of Oxide TFT Using Multi-Stack Etch-Mask Imprint Lithography for Flexible Display**

*SungJin Kim, JongHoon Choi, HyungTae Kim, and Sung Min Cho (Sungkyunkwan Univ., Korea)*

### P2-188

**Fast Response and Improving Electro-Optical Properties of Optically Isotropic Liquid Crystals**

*Ramesh Manda, Srinivas Pagidi, Chul Ho Park, Hye Sun Yoo, Akter Jeasmin, Young Jin Lim, and Seung Hee Lee (Chonbuk Nat'l Univ., Korea)*

### P2-189

**Quantum Dots in PS-BPLC; Hysteresis Free and Electro-Optical Properties**

*Srinivas Pagidi, Ramesh Manda, Chul Ho Park, Murali G, Jeasmin Akter, and Seung Hee Lee (Chonbuk Nat'l Univ., Korea)*

### P2-190

**Super Flexible Optically Isotropic Liquid Crystal Display with Polyimide Film**

*Tae Hyung Kim, Rui He, Chul Ho Park, Hyesun Yoo, Young Jin Lim, Myong-Hoon Lee, Jae-Wook Kang, and Seung Hee Lee (Chonbuk Nat'l Univ., Korea)*

### P2-192

**Realization of $Al_2O_3$/MgO Laminated Structure at Low Temperature for Thin Film Encapsulation in Organic Light-Emitting Diodes**

*Hua Xu (South China Univ. of Tech., China), Miao Xu, Jianhua Zou, Hong Tao, Lei Wang, Junbiao Peng (Guangzhou New Vision Optoelectronic Co., Ltd., China), and Min Li (South China Univ. of Tech., China)*

## Poster Session II

**Date:** Aug. 31, 2017 (Thursday)
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### P2-193

Ultra-Flat and Transparent Silver Nanowire Network for Flexible and Leakage-Free Organic Light-Emitting Diodes

*Tae Hong Im, Mina Kim, and Keon Jae Lee (KAIST, Korea)*

### P2-194

Highly Stable Nano-Stratified Moisture Barrier with External Buffer under the Extremely Harsh Environments

*Eun Gyo Jeong, Ki Suk Kang, and Kyung Cheol Choi (KAIST, Korea)*

### P2-195

A Temporary Bonding Method for Device Processing on a Flexible Glass

*PeiLien Tseng, JenChieh Lin (Corning Research Center Taiwan, Taiwan), Prantik Mazumder, Indrani Bhattacharyya, and Theresa Chang (Corning Research and Development Corp., USA)*

### P2-196

Energetic Properties of Transparent Electrode with Dielectric-Metal-Dielectric for the OLED Application

*Gyeong Seok Hwang and Byung Doo Chin (Dankook Univ., Korea)*

### P2-197

Effect of Chemical Composition on Work Function in Amorohous C12A7 Electride Thin Films

*Ayaka Kanai, Junghwan Kim, Koji Yamamoto, and Hideo Hosono (Tokyo Inst. of Tech., Japan)*

### P2-198

Highly Efficient and Flexible Organic Light Emitting Diodes Using Effective Area Engineering onto Dual-Scale Metal Nanowire Electrode

*Kunsik An, Jinhwan Lee, Phillip Won, Yoonseok Ka, Hyejin Hwang, Hyunjin Moon, Yongwon Kwon, Sukjoon Hong, Changsoon Kim, Seung Hwan Ko, and Changhee Lee (Seoul Nat'l Univ., Korea)*

# Poster Session II

Date: Aug. 31, 2017 (Thursday)
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## P2-199

**Characteristics of Novel Colorless Polyimide Films with High Heat-Resistant for Flexible OLED**

*Jang-Ju Lee, Haesook Kim, Sung Soo Kim, and Sang-Hyon Park (Kyung Hee Univ., Korea)*

## P2-200

**Thermally Evaporated Sb-$SnO_2$/Ag-Ti/Sb-$SnO_2$ Multilayer Cathode for Transparent and Flexible AMOLEDs**

*Kyung-Su Cho and Han-Ki Kim (Kyung Hee Univ., Korea)*

## P2-201

**Indium-Free, Highly Transparent, Flexible $Cu_2O$/Cu/$Cu_2O$ Mesh Electrodes for Flexible Electrochromic Devices**

*Hyeong-Jin Seo (Kyung Hee Univ., Korea), Inyoung Cho, Yoon-Chae Nah (KOREATECH, Korea), and Han-Ki Kim (Kyung Hee Univ., Korea)*

## P2-202

**Novel Pseudo Atomic Layer Deposition (p-ALD) of Silicon Nitride as a Thin Film Encapsulation for Flexible AMOLED**

*Jaeseung Lee, Chul Yoon, Dong-eui Hwang (AP Systems, Korea), Sang-joon Seo (Sungkyunkwan Univ., Korea), Mu-gyeom Kim, Chi-woo Kim, Doh-hoon Kim, and Kiro Jung (AP Systems, Korea)*

## P2-203

**Blue Laser Annealing of Ag Nanowire for Flexible and Transparent Film Heater**

*Jin-Yeong Park, Seung-Pyo Hong, Jin-Jang, and Han-Ki Kim (Kyung Hee Univ., Korea)*

## P2-204

**Highly Stable Ag Nanowire Electrode Passivated by Transparent Carbon Films for Flexible Thin Film Heaters**

*Hae-Jun Seok, Han-Ki Kim (Kyung Hee Univ., Korea), and Jong-Kook Kim (KIMS, Korea)*

## Poster Session II

**Date:** Aug. 31, 2017 (Thursday)
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### P2-205

**Transparent and Flexible Oxide TFTs with Thermally Stable Polymer Substrates**

*Hyukyun Kwon, Taejoon Byun, Jong-Heon Yang, Haechang Lee, Sang Youl Kim, and Seunghyup Yoo (KAIST, Korea)*

### P2-206

**A Study on Surface of Substrate with Excellent Self-Healing Properties by Heat Treatment**

*Dong Hoon Jang, Byung Min Park (Dankook Univ., Korea), Kyung Ho Kwon, Moonhor Ree (POSTECH, Korea), Ho Jung Chang, and Kwan-Young Han (Dankook Univ., Korea)*

### P2-207

**Development of Excellent Radiant Heat Sheet with High Thermal Conductivity**

*Jong-Keun Choi, Byung-Min Park, and Kwan-Young Han (Dankook Univ., Korea)*

### P2-208

**Effect of Illuminance Measurement Location on Brightness Perception of Transparent Displays**

*Jeong-Sik Kim, Seung-Ryeol Kim, and Seung-Woo Lee (Kyung Hee Univ., Korea)*

### P2-209

**Nonvolatile Memory Devices Using Mobile Protons by Neutral Particle Beams at Room Temperature**

*JangWon Yun (Korea Univ., Korea), Jin Nyoung Jang (WISOL, Korea), and MunPyo Hong (Korea Univ., Korea)*

### P2-210

**Nitrocellulose Based Gate Insulator for Amorphous Indium Gallium Zinc Oxide Thin Film Transistors**

*Won-Gi Kim, Young Jun Tak, Yeong-gyu Kim, Jusung Chung, Byung Ha Kang, and Hyun Jae Kim (Yonsei Univ., Korea)*

## Poster Session II

Date: Aug. 31, 2017 (Thursday)
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### P2-211

Photosensitive Organic-Inorganic Hybrid Passivation Layers on a-InGaZnO Thin-Film Transistors for Flexible Display Backplane

*Kyungduck Kim, DongHyeok Lee, SeulGi Kim (Korea Univ., Korea), Gerhard Domann, Daniela Collin, Michael Popall (Fraunhofer Inst. für Silicatforschung, Germany), and MunPyo Hong (Korea Univ., Korea)*

### P2-212

Improvement of Luminous Efficiency on Transparent LCD Display

*Alireza Khorami (IRIB & Applied Sci. Univ., Iran), Sima Shirzadi (Azad Univ., Iran), and Shirin Ghanbari (IRIB Technical Research Center, Iran)*

### P2-213

Flexible Transparent Composite Film based on Self-Assembled Chitin Nanofibers and Silk Fibroin

*Moo-Seok Hong and Jungho Jin (Univ. of Ulsan, Korea)*

### P2-214

Flexible Transparent Composite Substrate Film Reinforced with Centrifugal Jet-Spun Hierarchical Chitin Fibers

*Joong-Kwon Kim and Jungho Jin (Univ. of Ulsan, Korea)*

### P2-215

Development of Multiple Object Tracking System based on Oblique View

*Kwang-Yong Kim and Gi-Mun Um (ETRI, Korea)*

*(3DSA Paper)*

### P2-216

Reconfigurable Plasmonic Structures with Phase Change Materials for Reflection-Type Spatial Light Modulation at the Sub-wavelength Scale

*Chi-Young Hwang, Yong-Hae Kim, Gi Heon Kim, Jong-Heon Yang, Jae-Eun Pi, Ji Hun Choi, Kyunghee Choi, and Chi-Sun Hwang (ETRI, Korea)*

*(3DSA Paper)*

## Poster Session II

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### P2-217

A View Warping and Blending Algorithm for Full-Parallax Virtual View Image Synthesis on Light-Field Content

*Youngsoo Park, Hong-chang Shin, Gwangsoon Lee, Won-sik Cheong, and Jeongil Seo (ETRI, Korea)*

*(3DSA Paper)*

### P2-218

The Development of Real-Time Video Capture System for Multi-Channel UHD Video Stream

*Sang-Seol Lee, Eunchong Lee, Sung-Joon Jang, Byeongho Choi, and Je Woo Kim (KETI, Korea)*

*(3DSA Paper)*

### P2-219

Thermal 3D Imaging in The Air with Depth Change by Using Liquid Crystal Varifocal Lens

*Ryo Sasaki, Haruki Mizushina, and Shiro Suyama (Tokushima Univ., Japan)*

*(3DSA Paper)*

### P2-220

Arc 3D Directional Backlight for Flexible Viewing Zones in Multi-View Display

*Shota Koyama, Haruki Mizushina, and Shiro Suyama (Tokushima Univ., Japan)*

*(3DSA Paper)*

### P2-221

Interactive Edutainment System Using Pseudo-Holographic Display

*Hyungki Son (UST, Korea) and Beom-Ryeol Lee (ETRI & UST, Korea)*

*(3DSA Paper)*

### P2-222

A Padding Method for Enhancing Coding Efficiency of 360 Video

*Yong-Uk Yoon, Do-Hyeon Park, Hyun-Ho Kim, and Jae-Gon Kim (Korea Aerospace Univ., Korea)*

*(3DSA Paper)*

# Poster Session II

**Date:** Aug. 31, 2017 (Thursday)
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## P2-223

**Parallel Depth-Map Computer-Generated Hologram Computation Algorithm with Area Segmentation**

*Jonghyun Lee, Jinyoung Roh, Sungjae Park, and Hwi Kim (Korea Univ., Korea)*

*(3DSA Paper)*

## P2-224

**Talbot Apodization Filter for Binocular Holographic Three-Dimensional Display**

*JungBeom Choi, SooBin Kim, SungJae Park, and Hwi Kim (Korea Univ., Korea)*

*(3DSA Paper)*

## P2-225

**Visual Fatigue for The Influence of Different Diffusers Used in Laser-Projection Light-Field 3D Display**

*Yushan Han (Nat'l Taiwan Univ., Taiwan), Chien-Yu Chen (Nat'l Taiwan Univ. of Sci. and Tech., Taiwan), and Hoang Yan Lin (Nat'l Taiwan Univ., Taiwan)*

*(3DSA Paper)*

## P2-226

**Viewer-Oriented Multi-View Video Service System Using Object Tracking and Recognition in Sports Game**

*Gi-Mun Um, Kwang-Yong Kim, Yookyung Kim, Jae-Hyuck Park, Kee-Seong Cho (ETRI, Korea), Jeong-Hun Jang (Illisis Inc., Korea), and Jongho Nang (Sogang Univ., Korea)*

*(3DSA Paper)*

## P2-227

**Device Design and Fabrication for the Floating Image System**

*Hsi-Fu Shih and Cheng-Yu Li (Nat'l Chung Hsing Univ., Taiwan)*

*(3DSA Paper)*

## P2-228

**Holographic Tabletop Display with Streaming of Hologram Data**

*Jaehan Kim (ETRI, Korea), Kisoo Seol (ASTEL, Korea), Eun-Young Chang, Keehoon Hong, Hayan Kim, Minsik Park, and Jinwoong Kim (ETRI, Korea)*

*(3DSA Paper)*

## Poster Session II

**Date:** Aug. 31, 2017 (Thursday)
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### P2-229

Stabilized Conditions for Perceived Depth Directions on Kinetic Depth Effect by Image Switching

*Ippei Kanayama, Shiro Suyama, and Haruki Mizushina (Tokushima Univ., Japan)*

*(3DSA Paper)*

### P2-230

Real World Object-Based Computer-Generated Integral Imaging System for Mobile Device

*Munkh-Uchral Erdenebat, Ki-Chul Kwon, Jae-Min Lee (Chungbuk Nat'l Univ., Korea), Kwon-Yeon Lee (Sunchon Nat'l Univ., Korea), and Nam Kim (Chungbuk Nat'l Univ., Korea)*

*(3DSA Paper)*

### P2-231

A Real-Time Video Player for Full Parallax Autostereoscopic 3D Display

*Homin Eum, Hong-chang Shin, Gwangsoon Lee, Won-sik Cheong, and Jeongil Seo (ETRI, Korea)*

*(3DSA Paper)*

### P2-232

Full Parallax Crosstalk Measurement of Light Field Display Using Projected 3D Images

*Joowoan Cho, Jaejoong Kwon, Beomshik Kim, Sujung Huh, Juhwa Ha, Keunkyu Song, and Hye Yong Chu (Samsung Display Co., Ltd., Korea)*

*(3DSA Paper)*

### P2-233

Generation Technic for Multi-Frame of Digital Hologram on Distributed System

*Changseob Kim (Hanyang Univ., Korea), Hanhoon Park (Pukyoung Nat'l Univ., Korea), and Jong-Il Park (Hanyang Univ., Korea)*

*(3DSA Paper)*

# Poster Session II

**Date:** Aug. 31, 2017 (Thursday)
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## P2-234

**Stereoscopic Wearable Display System Using Holographic 3D Contents**

*Min Sung Yoon, Jihyung Kim, and Il Kwon Jeong (ETRI, Korea)*
*(3DSA Paper)*

## P2-235

**Improvement of Brightness Uniformity for Laser-Projection Light Field Display**

*Kyaw Kyaw Aung and Hoang Yan Lin (Nat'l Taiwan Univ., Taiwan)*
*(3DSA Paper)*

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### 02. Special Session II: LTPS TFTs for Mobile Display

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### 03. Special Session III: Quantum Dots

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| 04. Special Session IV: AR / VR | |
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| 05. Special Session V: Stretchable / Deformable Materials and Electronics | |
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| Chair | Prof. Jang-Ung Park (UNIST, Korea) |
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| 06. 2D Materials for Display | |
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## 07. Active-Matrix Devices

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# IMID 2017 Invited Papers

A1-1 Quantum Dot Electroluminescence to Achieve Saturated Colours for REC2020 Compatibility: A Comparative Study of CdSe/ZnS and Cd Free QD Systems
*Poopathy Kathirgamanathan, Seenivasagam Ravichandran, Muttulingam Kumaraverl, and Nicola Bramananthan (Brunel Univ., UK)*

A1-2 New Generation Quantum-Dot Light-Emitting Diode Display: From Materials, Devices to Printing Fabrication
*Lei Qian, Yixing Yang, Weiran Cao, Chaoyu Xiang, Xiangwei Xie, Longjia Wu, and Xiaolin Yan (TCL Corp. Research, China)*

A1-3 Quantum Dot Surface Engineering for Charge Transfer and Optoelectronic Devices
*Sukyung Choi (ETRI, Korea), Ho Jin (Texas A&M Univ., USA), Nam Sung Cho (ETRI, Korea), and Sungjee Kim (POSTECH, Korea)*

B2-1 Recent Progress in Phosphorescent OLED: Operational Lifetime and Color Purity
*Takahisa Shimizu, Hirohiko Fukagawa, Yukiko Iwasaki, Taku Oono, and Toshihiro Yamamoto (NHK Sci. & Tech. Research Laboratories, Japan)*

B2-2 Blue Emitters for High Performance OLEDs and Interfacial Engineering for Efficient OPV
*Ziyi Ge (Chinese Academy of Sciences, China)*

B2-3 State of the Art OLED Materials: Merck’s Development Direction
*Remi Anemian (Merck, Germany)*

C3-1 Highly Functional Light-Emitting Devices based on Electrolytes
*Taishi Takenobu (Nagoya Univ., Japan)*

C3-2 Multicolor Perovskite Light Emitting Diodes for Display and Lighting Applications
*Abd. Rashid bin Mohd Yusoff (Kyung Hee Univ., Korea) and Mohammad Khaja Nazeeruddin (École Polytechnique Fédérale de Lausanne, Switzerland)*

D4-1 The Twist-Bend Nematic Phase
*Corrie T Imrie (Univ. of Aberdeen, UK)*

D4-2 Liquid Crystal Topological Defects for Optics
*Francesca Serra (Johns Hopkins Univ., USA)*

D4-3 Self-Organized Wrinkling Patterns of a Liquid Crystalline Polymer
*Jun-Hee Na, Jaehyun Sim, and Sihwa Oh, Ye-Rin Lee, Yena Lee, and Geonwoo Ko (Chungnam Nat'l Univ., Korea)*

E5-1 Heterojunctions for Atomically Thin 2D Semiconductors Based on Two-Dimensional Transition Metal Dichalcogenides
*Kazuhito Tsukagoshi (NIMS, Japan)*

E5-5 Single Crystalline Nanobelts Composed of Transition Metal Dichalcogenides
*Soon-Yong Kwon (UNIST, Korea)*

F6-1 Differences between 3D Displays based on Wavefront Reconstruction and Ray Reconstruction
*Yasuhiro Takaki (Tokyo Univ. of Agriculture and Tech., Japan)*

F6-2 Characteristics of Integral Photography Generated from Multi-View Stereoscopic Images
*Sumio Yano, Yuta katayose (Shimane Univ., Japan), and Min-Chul Park (KIST, Korea)*

F6-3 See-through 3D Display for Augmented Reality
*Byoungho Lee (Seoul Nat'l Univ., Korea)*

G7-1 Optically Clear Adhesives Enabling Flexible and Foldable OLED Display Bonding
*C. J. Campbell, Y. Zhang, and J.E. Abrahamson (3M, USA)*

H8-1 Biocompatible Transparent Flexible Substrate Film from Biogenic Chitin Nanofibers
*Jungho Jin (Univ. of Ulsan, Korea) and Byeong-Soo Bae (KAIST, Korea)*

H8-2 Stretchable Flexible and Self-healable Electronics
*Lu Li (CUAS/UCLA, China/USA), Jiang Cheng (CUAS, China), Jiajie Liang (UCLA, USA), and Qibing Pei (CUAS/UCLA, China/USA)*

A9-1 Cd Free Quantum Dot Display
*Shinae Jun and Eunjoo Jang (Samsung Electronics Co., Ltd., Korea)*

A9-2 Near Unity Quantum Yield from Cadmium-Free Quantum Dots
*Matthew R. Bergren, Karthik Ramasamy, Nikolay Makarov, Aaron Jackson, and Hunter McDaniel (UbiQD, USA)*

A9-3 Innovation in Heavy Metal-Free Quantum Dot Display Technology
*Nigel L. Pickett and Nathalie C. Gresty (Nanoco Technologies Ltd., UK)*

B10-1 Organic Radical for High Performance OLEDs
*Zhengyang Bin and Lian Duan (Tsinghua Univ., China)*

B10-2 Computer-Assisted Material Design Toward Highly Efficient Dry and Wet Processed OLEDs and Multiscale Charge Transport Simulations
*Hironori Kaji (Kyoto Univ., JAPAN)*

B10-3 Development of Highly Efficient Multi-Functional Emitting Materials for Organic Light-Emitting Diode Applications
*Sung-Ho Jin (Pusan Nat'l Univ., Korea)*

B10-4 The Advantage of Silicone Chemistry in Next Generation Displays
*Sunny Yu (Momentive, Korea)*

C11-1 Aerosol-Jet Printing of Sorted Semiconducting Carbon Nanotubes for Field-Effect Transistors
*Jana Zaumseil (Universität Heidelberg, Germany)*

C11-2 Electrical Contact Analysis of Multilayer $MoS_2$ Thin Film Transistor
*Min Suk Oh (KETI , Korea)*

C11-3 Considerations for Large-Area Flexible Displays from Thin-Film to Nano-Scale Devices
*William Wong (Univ. of Waterloo, Canada)*

D12-1 Novel Alignment Layer and Insulation Materials for Advanced LCD
*Hiroaki Tokuhisa (JSR Corp., Japan)*

D12-2 Development of a Novel High Reactive and High Reliable Monomer for Polymer-Sustained-Alignment Liquid Crystal Displays
*Yuichi Inoue, Marina Gushiken, Go Sudo, Shota Kosaka, Masanao Hayashi, Kenta Shimizu, and Manabu Takachi (DIC Corp., Japan)*

E13-1 Recent Progress in Numerical Simulations for 2D-Material Device Applications
*Gyu Chull Han, Abdul Aziz AlMutairi, Yiju Zhao, Demin Yin, and Youngki Yoon (Univ. of Waterloo, Canada)*

E13-2 Two-Dimensional van der Waals Heterostructures Based Ultrafast Light Source
*Young Duck Kim (Columbia Univ., USA), Takashi Taniguchi, Kenji Watanabe (NIMS, Japan), Tony F. Heinz (Stanford Univ., USA), Dirk Englund (MIT, USA), and James Hone (Columbia Univ., USA)*

F14-1 Smoothness of Motion Parallax in High Density Muti-View(HDMV) 3D Display
*Hyunwoo Kim, Yongjoon Kwon, Seon Kyu Yoon, and Ki-Hyuk Yoon (KIST, Korea)*

H16-1 Optoelectronics Using Quantum-Dots for Transparent and Soft Interactive Devices
*Seong Jun Kang (Kyung Hee Univ., Korea)*

H16-2 A Microfluidic Approach for Stretchable Electronics
*Zhigang Wu (Huazhong Univ. of Sci. and Tech., China)*

A17-1 Development of Trevista™ Cadmium Free Quantum Dot for Next Generation Displays
*Jake Joo (Dow Chemical Company, USA)*

A17-2 Patterning Cadmium Free Quantum Dots for Color Conversion in High Resolution MicroLED Displays
*Heejae Kim, Ernie Lee, Chunming Wang, Charlie Hotz, Jeff Yurek, Zhong Sheng Luo, Shihai Khan, David Olmeijer (Nanosys, USA), and Heng Liu (Silicon Core, USA)*

B18-1 Phosphide Materials for TADF Lighting
*Hui Xu, Jing Zhang, and Jing Li (Heilongjiang Univ., China)*

B18-2 Highly Efficient TADF Materials based on Intramolecular or Intermolecular Charge Transfer Approaches
*Ken-Tsung Wong (Nat'l Taiwan Univ., Taiwan)*

B18-3 Short Exciton Lifetime Thermally Activated Delayed Fluorescence Emitters for Highly Efficient Organic Light Emitting Diodes
*Gyeong Heon Kim, Ju Young Lee, Raju Lampande, and Jang Hyuk Kwon (Kyung Hee Univ., Korea)*

C19-1 Excellent Optical Performance and Reliability Improvement on a IGZO-Driven Flexible LCD
*Yen-Yu Huang (Chunghwa Picture Tubes, Taiwan)*

C19-2 Highly Reliable Top Gate Oxide TFT for AMOLED Applications
*Chen-Shuo Huang, Yang-shun Fan, Ling-Ying Lin, Yun-Rong Yang, Ching-Hao Wang, Shang-Lin Wu, Guan-Yu Lin, Kuo-Kuang Chen, Ya-Ling Chen, Kuo-Che Tseng, Chien-Ya Lee, Wei-Yuan Wang, Che-Ming Hsu, Ya-Pei Kuo, Hsueh-Hsing Lu, and Yu-Hsin Lin (AU Optronics Corp., Taiwan)*

C19-3 Mobility and Reliability in Oxide Thin Film Transistors: The Key Role of Conduction Path
*Chuan Liu (Sun Yat-sen Univ., China)*

D20-1 Liquid Crystalline Blue Phase for Photonic Crystal Applications
*Suk-Won Choi (Kyung Hee Univ., Korea)*

D20-2 Fast-Response, Low Anamorphic Phase Modulation 2K1K LCoS-SLM for Holographic Applications
*Huang-Ming Philip Chen and Jhou-Pu Yang (Nat'l Chiao Tung Univ., China)*

D20-3 Twist Structure Liquid Crystal and its Photonic Application
*Jiangang Lu (Shanghai Jiao Tong Univ., China)*

D20-4 Nanoconfined Liquid Crystal Materials for Switchable Coloration
*Dong Ki Yoon (KAIST, Korea)*

E21-1 Technical Challenges and Approaches to Developing Displays for AR/MR Applications
*Hong-Seok Lee, Wontaek Seo, Yun-Tae Kim, Juwon Seo, Geeyoung Sung, Jungkwuen An, Chil-Sung Choi, Sunil Kim, Hojung Kim, Yongkyu Kim, Young Kim, Kanghee Won, Yunhee Kim, Hoon Song, and Sungwoo Hwang (Samsung Electronics Co., Ltd., Korea)*

E21-2 Computational Projection Display for AR/VR
*Daisuke Iwai (Osaka Univ., Japan)*

F22-1 Application of Holographic Optical Elements for Head-Mounted Display and Integral Imaging Microscopy
*Nam Kim (Chungbuk Nat'l Univ., Korea)*

F22-2 Challenges in Practical Realization of 3D Holographic Display and Solutions
*Boaz Jessie Jackin (NICT, Japan)*

G23-1 Next Generation Evaporation Technology for Future AMOLEDs
*Changhun Hwang, Sung Su Kim, Sung Min Jo, and Byung Doo Chin (Dankook Univ., Korea)*

G23-2 Monolithic Integration for Robust and Foldable AMOLED Displays
*Jan-Laurens P.J. van der Steen, Hylke B. Akkerman, Joris de Riet (Holst Centre/TNO, Netherlands), Soeren Steudel (IMEC, Belgium), Auke J. Kronemeijer, and Gerwin H. Gelinck (Holst Centre/TNO, Netherlands)*

G23-3 Proprietary Process Technologies for Cost-Efficient OLED Manufacturing
*Jae H. Jung, Soeren Hartmann, Boerge Wessling, Juergen Kreis, and Markus Gersdorff (AIXTRON SE, Germany)*

A25-1 Technical Challenges for Flexible and Rollable OLED Display
*Seyeoul Kwon, Kwonhyung Lee, Jonghyun Park, Chan Il Park, Weonseo Park, Joon Young Yang, Sooyoung Yoon, and In Byeong Kang (LG Display Co., Ltd., Korea)*

A25-2 Foldable Touch AMOLED Integrated with Plastic Window and Optical Film
*Kuan-Ting Chen, Yung-Hui Yeh, Glory Chen, Jia-Chong Ho, Cheng-Chung Lee, and Janglin Chen (ITRI, Taiwan)*

A25-3 Flexible Inorganic Electronic Systems
*Keon Jae Lee (KAIST, Korea)*

B26-1 Highly Efficient Blue Fluorescent OLED by using Triplet Energy
*Mengying Bian, Xing Xing, Jiaxiu Luo, Fan Lv, Jiannan Gu, and Lixin Xiao (Peking Univ., China)*

B26-2 Recent Progress in Highly Efficient Blue TADF Emitter Materials for OLEDs
*Thomas Baumann, Patrick Pingel, and Daniel Volz (Cynora GmbH, Germany)*

B26-3 Highly Efficient and Stable Pure Blue Organic Light-Emitting Diodes based on Imidazole Derivatives
*Tong Shan and Ping Lu (Jilin Univ., China)*

C27-1 Current Understanding of Defects in Amorphous Oxide Semiconductors
*Toshio Kamiya and Hideo Hosono (Tokyo Inst. of Tech., Japan)*

C27-2 Solution Combustion Synthesis: the Low-Temperature Processing for p-Type Cupper-Doped Nickel Oxide Thin Films for Transparent Electronics
*Ao Liu, Guoxia Liu, and Fukai Shan (Qingdao Univ., China)*

C27-3 Alternating Current Polymer Electroluminescence for Dynamic Interactive Display
*Cheolmin Park, Eui Hyuk Kim, Sung Hwan Cho, and Beomjin Jeong (Yonsei Univ., Korea)*

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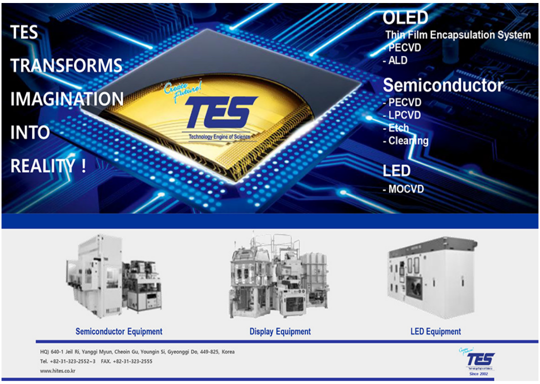

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