



IDW '14

THE 21ST INTERNATIONAL DISPLAY WORKSHOPS

Special Topics of Interest on

- Oxide-Semiconductor TFT
- Augmented Reality and Virtual Reality
- Lighting Technologies
- Printed Electronics

Workshops on

- LC Science and Technologies (LCT)
- Active Matrix Displays (AMD)
- FPD Manufacturing, Materials and Components (FMC)
- EL Displays and Phosphors (PH)
- Field Emission Displays, CRTs and Plasma Displays (FED)
- OLED Displays and Related Technologies (OLED)
- 3D/Hyper-Realistic Displays and Systems (3D)
- Applied Vision and Human Factors (VHF)
- Projection and Large-Area Displays and Their Components (PRJ)
- Electronic Paper (EP)
- MEMS and Emerging Technologies for Future Displays and Devices (MEET)
- Display Electronic Systems (DES)
- Flexible Electronics (FLX)
- Touch Panels and Input Technologies (INP)

Final Program

***TOKI MESSE Niigata Convention Center
Niigata, Japan
December 3 – 5, 2014***

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PROGRAM HIGHLIGHTS

The 21st International Display Workshops will be held as IDW '14 for encouraging aggressive research and development of display technologies throughout the world and especially in the Asian region. IDW '14 focuses on the following four special topics, which are extremely timely, as well as fourteen active workshops.

Special Topics of Interest on

- Oxide-Semiconductor TFT
- Augmented Reality and Virtual Reality
- Lighting Technologies
- Printed Electronics

Workshops on

- LC Science and Technologies
- Active Matrix Displays
- FPD Manufacturing, Materials and Components
- EL Displays and Phosphors
- Field Emission Displays, CRTs and Plasma Displays
- OLED Displays and Related Technologies
- 3D/Hyper-Realistic Displays and Systems
- Applied Vision and Human Factors
- Projection and Large-Area Displays and Their Components
- Electronic Paper
- MEMS and Emerging Technologies for Future Displays and Devices
- Display Electronic Systems
- Flexible Electronics
- Touch Panels and Input Technologies

The three-day conference will feature 489 papers, including 2 keynote addresses, 2 invited addresses, 103 invited papers and 165 oral presentations, and 217 poster presentations. Following plenary session of Keynote and Invited addresses in the Wednesday morning, presentations will begin and continue in 7 parallel oral sessions through Friday. Poster sessions and author interviews and demonstrations will enable participants to discuss topics in detail. IDW '14 will also present "IDW Best Paper Award" and "IDW Outstanding Poster Paper Award" based on paper originality and technical significance to information displays. This year, IDW '14 will provide a live demonstration session called the Innovative Demonstration Session. The two-day session, on Thursday and Friday, will feature a total of 31 innovative demonstrations in the Exhibition Hall B. Best Demonstration Award will be awarded to the demonstration that has the biggest impact on the audience. Exhibits by universities and display industry-related businesses will also be featured from Wednesday to Friday in parallel with workshops. IDW '14 should be of interest to not only researchers and engineers, but also managers of companies and institutions in the display community.

Special Topics of Interest on Oxide-Semiconductor TFT (OXT)

Oxide TFTs have a long history going back for almost a half century, but they have been intensively investigated only since the first demonstration of amorphous oxide semiconductor TFTs in 2004, and have now become one of the hottest topics in backplane technologies for active-matrix FPDs. Although we were glad to see and touch the first commercial LCD products using the oxide TFTs in 2012 and the subsequent OLED televisions last year, there still remain many technical issues for further evolution toward better performance, high resolution, robust reliability, low fabrication temperature, and broader applications. In IDW '14, the latest achievements involved in the brand-new challenges of these issues will be found. Neither should you miss the brilliant invited talks

given by world-leading researchers in oxide TFTs nor the contributed presentations with outstanding results.

Special Topics of Interest on Augmented Reality and Virtual Reality (AR&VR)

In recent years, augmented reality (AR) and virtual reality (VR) applications have been making substantial progress with high-performance display devices and sensors including cameras with tracking capabilities and computer graphics technologies. In the 3D-WS sessions, interactive display technologies using high-speed image processing and applications using wide-field imaging will be presented. Presentations in the DES-WS sessions will include AR with a variety of display techniques such as wide-field head mounted display, fog display, head-up display, projection AR, and Diminished Reality (DR). In the DES/VHF-WS, effects of AR/VR will be presented with AR vehicles, 3D display, and monocular AR. In the INP-WS sessions, system design considerations for personal light field displays and MR visual stimulation on tactile sensation will be presented. In the PRJ-WS sessions, see-through glasses and light field display for AR/VR will be presented. In the FMC-WS sessions, floating image displays to represent 3D images of objects, and wide field of view optical combiner for AR head-up displays will be presented.

Special Topics of Interest on Lighting Technologies (LIT)

The Lighting Technologies of STI will cover all aspects of science and technologies of lighting including LED lighting, OLED lighting, flexible lighting, manufacturing of lighting, lighting materials, device structures for lighting and internal or external efficiency enhancement technologies. A highlight for IDW '14 will be the presentations on novel speckle reduction technology using phase-randomizing deformable mirror applied to direct view LED-BLU with blue laser stimulation of the quantum dots (FMC-WS), high efficient backlight with a nanorod-based optical film and EL sheet driven by wireless power (PH-WS), and flexible white lighting device and tunable lighting device (OLED-WS).

Special Topics of Interest on Printed Electronics (PE)

Printing technologies are opening a new era of electronic devices for their high productivity, low cost, large scale and low environmental-burden fabrication advantages. Printed Electronics, a new Special Topics of Interest, will cover all aspects concerning printed electronics from science and technology viewpoints. This year, five oral sessions will be held including devices and displays fabricated with printing technologies, materials suitable for printing and fabricating process.

Workshop on LC Science and Technologies (LCT)

This workshop covers topics from fundamental studies to recent developments in LCD technologies and LC materials. Of special note this year is the six invited presentations related to fast switching technologies, photo alignment technologies, and LC materials technologies. Moreover, new LCD technologies, such as polymer-stabilized LCDs, 3D-LCDs, IPS-LCDs and ferroelectric LCs are discussed.

Workshop on Active Matrix Displays (AMD)

The AMD workshop covers Si-TFT, oxide TFT, organic TFT, OLED, and integrated sensors. Recent paper presentations tend to focus on oxide TFT, which may be expected to play a role in applications for higher-definition LC and OLED displays. We highlight the oxide TFT as a special topic of interest (STI) with four devoted sessions covering a wide area from materials, physics, devices, and processes to applications. We also have prepared one session on printed electronics STI.

Workshop on FPD Manufacturing, Materials and Components (FMC)

The FMC workshop covers recent developments and achievements in the field of flat panel display technologies that include panel manufacturing, materials, measurements and components. The oral presentations contain more than 15 papers of which 5 papers are invited papers. In addition, more than 25 posters will be presented. This also includes joint sessions with the FLX-WS. This year our workshops include the hot topics of laser processing, bonding and de-bonding technologies, light control by submicron structure and quantum dot lighting. The AR/VR session devoted to special topics of interests will present the recent trends in augmented and virtual reality. In the newly planned demonstration session, three papers from the oral session will be presented on December 5.

Workshop on EL Displays and Phosphors (PH)

This workshop presents the latest achievements on devices and phosphors for emissive displays, general lighting and LCD backlighting. Invited talks will cover emerging technologies such as highly efficient backlight with a nanorod-based optical film, electron-beam excited UV light source and wavelength conversion nano phosphors synthesized by the microreaction method. Display and medical applications with novel phosphors using Cu-complex and EL sheet driven by wireless power will also be presented.

Workshop on Field Emission Displays, CRTs and Plasma Displays (FED)

This workshop wholly covers the fields of FED, CRT and PDP technologies. Recent progress in image sensors and displays with field emitter arrays will be discussed. The invited talk will present an optical nano-imaging system with electron beam excitation for living cells. Additionally, fabrication processes, field emission characteristics and mechanism, and field emitter materials such as CNT and PrO, will be discussed. Since the invention of plasma displays in 1964, there has been much progress. The 50th anniversary talk discusses successes and declines in the PDP business. Also covered in the session are the latest PDP technologies and discharge applications for medical use and plant factories.

Workshop on OLED Displays and Related Technologies (OLED)

The OLED workshop covers all aspects of the science and technologies of OLED and other organic devices, ranging from material research, basic device physics to display including backplane technologies and other applications. OLED technologies from micro display to large size TV applications and OLED lighting will be reported. Material and device structure for higher quantum efficiencies supporting these device technologies will also be presented. Soluble OLED materials, printed devices and process technologies focused on Printed Electronics (PE) as STI are special discussions this year.

Workshop on 3D/Hyper-Realistic Displays and Systems (3D)

This workshop focuses on recent progress in 3D, hyper-realistic display systems and related visual sciences. It covers acquisition, processing, 2D/3D conversion, dual-view display, multi-view display, holography, new optical components, crosstalk, measurement, perception, standardization and more for 3D/hyper-reality display technologies. This year, some novel technologies will be presented as invited papers, such as super high frame-rate videos, floating display and electronic holography. Some technologies for omnidirectional video are also introduced, which provided the audience a good opportunity to understand the trends in these fields.

Workshop on Applied Vision and Human Factors (VHF)

The VHF workshop covers all topics on vision, human factors and image quality relating to information display. The oral and poster sessions

include lively discussions on the latest topics ranging from fundamental theories to applications. This year, we have five VHF oral sessions on Optical Measurement, Color and OLEDs, Moving Image Quality, Display Legibility, and Mobile Human Factors and 'Kansei' Evaluation. We also have a joint session with the DES (Display Electronic Systems) workshop on the theme of AR (Augmented Reality) and a joint session with the 3D workshop. Both of these promises groundbreaking interdisciplinary discussions, in addition to our VHF poster session which enables participants to quiz presenters in detail. Two distinguished invited talks will be given in the oral sessions, concerning the latest topics in the FPD Mura Index under the IEC standard and visual effects of curved AMOLEDs.

Workshop on Projection and Large-Area Displays and Their Components (PRJ)

The PRJ workshop covers wearable technologies, vehicle information displays, adaptive headlights, solid-state light sources, projection mapping, augmented reality, 3D measurement, advanced sensing and all the projection technologies. This time, our sessions will focus on miniature optical system technologies, laser and LED materials, projection devices, short throw optics, speckle mitigation, and a laser driving system. Recent studies of advanced technologies such as virtual imaging for wearable and vehicle displays, and an innovative theory of solid-state lighting devices will be presented. There will be 17 oral and four poster presentations, for a total 21 presentations, of which 5 papers are invited presentations.

Workshop on Electronic Paper (EP)

This workshop focuses on current topics in electronic paper including rewritable paper and flexible displays. Newly developed e-Paper technologies are now eagerly sought for emerging applications such as e-Books, e-Notebooks, electronic shelf labels, and signage. Various novel technologies such as electrophoretic, electro/thermo chromic, and twisting ball displays will be presented. There will also be reports on front lighting technology and challenging new approaches in e-Paper technologies. Systems, devices, materials, and applications in this field are expected to be enthusiastically discussed.

Workshop on MEMS and Emerging Technologies for Future Displays and Devices (MEET)

The MEET workshop is unique in covering all aspects of MEMS, nanotechnologies and emerging technologies concerning future displays, imaging devices, and emerging electron devices. It seeks to broaden the horizon of display and imaging technologies into cutting-edge technologies. Research areas such as materials, basic physics and fabrication processes are included. Among all the MEMS and display conferences in the world, this is the only opportunity for MEMS and cutting-edge technology researchers to gather and discuss such devices. This year will mark the 10th anniversary of the founding of the MEET workshop. Authorities from top research institutions around the world in this field have been invited. Invited speakers are from Univ. of Cambridge, MIT (QD Vision), École Polytechnique, CEA-LETI, Brunel Univ., Kyung Hee Univ., Seoul Nat. Univ., Sungkyunkwan Univ., Lumiode, NanoPhotonica, Ostendo, Pacific Light Technologies, Ritsumeikan Univ. and Tohoku Univ. Together with contributed papers with high-quality content, this workshop invites participants who wish to open up new fields in displays, imaging devices and emerging devices.

Workshop on Display Electronic Systems (DES)

This workshop covers all aspects of display electronics and systems in relation to video data processing, interface technologies, cooperative operations between display components such as cells and backlights and sensors. This year, we will have 27 papers including seven invited

talks and 10 poster presentations (excluding late-news). Sessions related to the driving/low-power technologies for LCD/OLED and vehicle display technologies are planned. We will also highlight AR/VR technology as a STI including a joint session with VHF-WS.

Workshop on Flexible Electronics (FLX)

Recently, there has been much attention on flexible display technologies which are spread over a wide range of fields from materials science to practical applications. The sessions cover all aspects of the hottest flexible device / wearable / material technologies including OLED, TFT fabrication, substrate, printing / roll-to-roll processes and evaluation.

Workshop on Touch Panels and Input Technologies (INP)

Conventional interface technologies such as touch panels and interactive technologies are the stars of the session. AR/Interactive systems such as haptics and AR are special topics of INP. Computer vision and natural interface technologies are still important research topics of INP. This year, new topics will be presented: Illusion and its analysis which comes from difference of the movement states between real and virtual objects and a near eye display system using light-field technology. INP papers will open a new window in displays and interactive technologies.

IDW Best Paper Award and IDW Outstanding Poster Paper Award

IDW will present “IDW Best Paper Award” and “IDW Outstanding Poster Paper Award”. The award committee of IDW will select the most outstanding papers from those presented at IDW '14. The award winners will be announced on the IDW website and given a plaque after the conference.

Innovative Demonstration Session

This year, IDW introduces new live demonstration for all oral and poster presenters, which provides a larger space and more time for preparation and demonstration than that of the “Author Interviews and Demonstrations” (Exhibition Hall B).

December 4: 16:45 – 19:30

December 5: 12:30 – 15:15

Best Demonstration Award will be awarded to the demonstration that has the biggest impact on the audience.

Exhibition

The IDW '14 Exhibition, which will be held from December 3 through December 5, covers materials, components, manufacturing and measuring equipment, software systems and other related products for display devices. Please join in and enjoy discussions at exhibitors' booths (Exhibition Hall B).

December 3: 12:40 – 18:00

December 4: 10:00 – 18:00

December 5: 10:00 – 14:00

GENERAL INFORMATION

SPONSORSHIP

IDW '14 is sponsored by the Institute of Image Information and Television Engineers (ITE) and the Society for Information Display (SID).

CONFERENCE SITE

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Niigata 950-0078

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ON-SITE SECRETARIAT

Telephone and fax machines for IDW '14 use will be temporarily set up in the secretariat room (Room 203) at TOKI MESSE (December 2-5).
Phone/Fax: +81-25-246-8511

RECEPTION

A buffet style reception will be held on December 3 from 19:00 to 21:00 at the Room "Continental" (4F) in the Hotel Okura Niigata. As the number of tickets is limited, you are urged to make an advance reservation through the registration website.

EVENING GET-TOGETHER WITH WINE

A get-together will be held on December 2 from 18:00 to 20:00 at Observation Deck (31F) in Hotel Nikko Niigata. Wine (Sponsored by Merck Ltd., Japan) will be served to participants in a relaxed atmosphere for networking.

REGISTRATION

Registration is available in advance and also on-site. However, advance registration is strongly recommended to speed up your registration at the conference site.

Registration Fees

The registration fee for IDW '14 includes admission to the conference and a CD-ROM of the proceedings. Detailed information will be announced on the website.

	Until Oct. 31	On and After Nov. 1
Individual Member (ITE/SID/ASO*)	¥ 35,000	¥ 45,000
Non-Member**	¥ 45,000	¥ 55,000
Student***	¥ 8,000	¥ 10,000
Life Member of ITE/SID	¥ 8,000	¥ 10,000
Reception	¥ 8,000	¥ 10,000

*ASO: Academic Supporting Organizations

(See p.14 as well as "Supporting Organizations and Sponsors" at the end of each workshop section.)

**Non-Member: If you intend to join either ITE or SID, the one year membership fee will be subsidized by IDW '14 committee.

***Photocopy of student ID is required.

Please note that the payment of reduced registration fee is accepted until October 31. The full fee will be charged for payments made on and after November 1. Also note that the number of reception tickets to register on site is limited.

Proceedings Data at the Conference Site

We will provide the data on USB flash drives for copying near Snow Hall. This data can also be accessed from the web-server via the wireless network only in the Free Wi-Fi Area at the conference site.

For **additional proceedings** (CD-ROM)

At the conference site	¥ 8,000
Airmail after the conference	¥ 12,000
Domestic mail after the conference	¥ 10,000

Payment

Three ways are provided for registration.

(1) e-Registration

Access the following URL.

<http://www.idw.or.jp/regist.html>

e-Registration will be accepted until November 21, 2014.

(2) Mail or Fax Registration

Complete the registration form (download from the website) and send it to the secretariat together with the proof of payment no later than November 21, 2014.

IDW '14 Secretariat

c/o Bilingual Group Ltd.

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E-mail: idw@idw.or.jp

The registration fee should be paid by one of the following methods.

1. Credit Card (VISA, MasterCard, JCB, AMEX or Diners)
2. Bank Transfer to:

Bank: Bank of Tokyo-Mitsubishi UFJ
(Swift Code: BOTKJPJT)

Branch: Ichigaya Branch (Branch No. 14)

Account No.: 0167640 (Ordinary Account)

Account: IDW

Please attach a copy of the bank receipt to the registration form to avoid any confusion. Please note that **the remittance charges, including that of Bank of Tokyo Mitsubishi UFJ, should be paid by the payer.**

All above payments should be made in **JAPANESE YEN**.

Also, please note that personal and traveler's checks are not accepted.

(3) On-site Registration

Conference registration desk will open:

December 2 (Tue.) 17:00 – 20:00

December 3 (Wed.) 8:00 – 18:00

December 4 (Thu.) 8:00 – 18:00

December 5 (Fri.) 8:00 – 13:00

On-site registration fee will be payable by:

1. Cash (JAPANESE YEN only)
2. Credit Card (VISA, MasterCard, JCB, AMEX, China Union Pay)

Bank transfer, bank checks, or personal/traveler's checks are not accepted.

Cancellation Policy

Until **October 31**, cancellation is accepted by writing to IDW '14 Secretariat to get refunds for registration and reception. For cancellations received on and **after November 1 or no-shows, refunds will not be made.** However, after IDW '14 closes, a CD-ROM of the proceedings will be sent to the registrants who have paid the registration fees. If it becomes difficult to hold IDW '14 due to the outbreak of infectious diseases and other unavoidable factors, we will substitute the IDW with the mail delivery of the IDW '14 proceedings at a later date to all those who have registered and completed payment.

INQUIRIES

IDW '14 Secretariat

c/o Bilingual Group Ltd.

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ACADEMIC SUPPORTING ORGANIZATIONS (ASO)

- The Chemical Society of Japan
- The Electrochemical Society of Japan
- The Illuminating Engineering Institute of Japan
- The Imaging Society of Japan
- The Institute of Electrical Engineers of Japan
- The Institute of Electronics, Information and Communication Engineers
- The Institute of Image Electronics Engineers of Japan
- International Electrotechnical Commission
- Japan Ergonomics Society
- The Japan Society of Applied Physics
- The Japanese Liquid Crystal Society
- The Society of Polymer Science, Japan
- The Virtual Reality Society of Japan

FUNDS

- The Murata Science Foundation
- Niigata Prefectural Government
- Niigata Visitors & Convention Bureau (Niigata City)
- Support Center for Advanced Telecommunications Technology Research, Foundation

**For final updated information, please visit our website,
<http://www.idw.or.jp/>**

TRAVEL INFORMATION

ACCOMMODATIONS

JTB Kanto Corp. will handle arrangements for your hotel reservations.

Hotel reservations can be made at the IDW website.

<http://www.idw.or.jp/accommodation.html>

Hotel list and the rates are available on the Pullout of this Advance Program.

JTB Kanto Corp.

Corporate Sales Division, Niigata, IDW '14 Desk

Phone: +81-25-255-5101 Fax: +81-25-248-7687

Office Hours: 9:30-17:30 (Weekdays only)

E-mail: jtb_niigata_ec@kanto.jtb.jp

There will be an on-site travel information desk during the conference period to handle arrangements for transportations.

VISAS

Visitors from countries whose citizens must have visas should apply to Japanese consular office or diplomatic mission in their respective countries. For further details, please contact your travel agency or the local consular office in your country.

Attention: For some countries' citizens, official documents prepared by the secretariat will be needed. Please access the IDW website for applications.

<http://www.idw.or.jp/visa.html>

JAPAN RAIL PASS AND JR EAST PASS

Japan Railway (JR) provides the following economical passes. They should be purchased before you leave your country. Please contact your travel agency. Visit following sites for the details.

(1) The JAPAN RAIL PASS is the most economical way to travel throughout Japan by rail and JR buses.

(2) The JR EAST PASS is an economical and flexible rail pass to travel around Eastern Japan.

Japan Rail Pass: <http://www.japanrailpass.net/eng/en001.html>

JR East Pass: <http://www.jreast.co.jp/e/eastpass/>

CLIMATE

The average temperature in Niigata during the conference should be around 9°C (48°F) in the daytime and 3°C (37°F) at night.

NIIGATA CITY

Niigata City is located in the center of the Japanese Islands, 250 km north of Tokyo. The city has a long history as a port, and is distinguished for being the site of one of only five international ports opened in 1868 when Japan resumed contact with other countries after nearly 250 years of isolation. Since that time, Niigata has developed into one of the most important modern international ports in Japan. Geographically, the city is distinctive in that it is surrounded by water. The Shinano and Agano, two of the largest rivers in Japan, run through the heart of Niigata before emptying into the sea. Until relatively recently, the city was also crisscrossed by a series of canals used to transport goods. Although the canals have been filled in to make the construction of modern roadways possible, the willows that lined these canals still remain today and now serve to lend a gentle air to the bustling downtown area.

When Niigata is mentioned, many people often think of the area's delicious rice and sake or the city's beautiful sunsets. But the residents of Niigata themselves take pride, rather, in the spirit of hospitality and community that so distinguishes the city.

PLACES OF INTEREST

Sado Island

Sado Island lies isolated from the mainland by 35 km, and is accessible by Sado Kisen, a ferry service from Niigata City which takes two and a half hours by car ferry or only one hour by jet foil. Sado Island has a perimeter of 261 km, and a total area of 855.26 km². It is one of the largest islands in Japan. Many tourists come from all over the country every year to visit Sado, an island rich in natural beauty and historic monuments.

Niigata Furusatomura

This facility displays and provides information relating to Niigata's history, culture and sightseeing spots. There are shops selling various traditional crafts and local products, such as sake, rice and fish, for which Niigata is famous throughout the country. In addition, there is a food court serving delicious local dishes.

<http://furusatomura.pref.niigata.jp/modules/guide09/index.php?id=2>

Bandai Bridge

The present Bandai Bridge is the third to have spanned the Shinano River (the first was built in 1887, the second in 1909 and the third in 1929). The bridge is 307 m long, 21.9 m wide and consists of 6 arches. Not only was it strong enough to survive the Niigata Earthquake during the 1960s, it has also become one of the symbols of Niigata City.

Prefectural Government Memorial Hall

Built in 1884, this building was formerly home to the Niigata Prefectural Assembly. This Western-style building fuses elements of Western and traditional Japanese architecture. It is the only prefectural assembly building dating from the early Meiji era (1868~1912) still in existence in Japan and is designated as a nationally important cultural property.

The hall is located in Hakusan Park; 10-minute bus ride from Niigata station.

NIIGATA INFORMATION DESK

Information concerning hotels and tours will be available during the conference period.

More information is available from these websites:

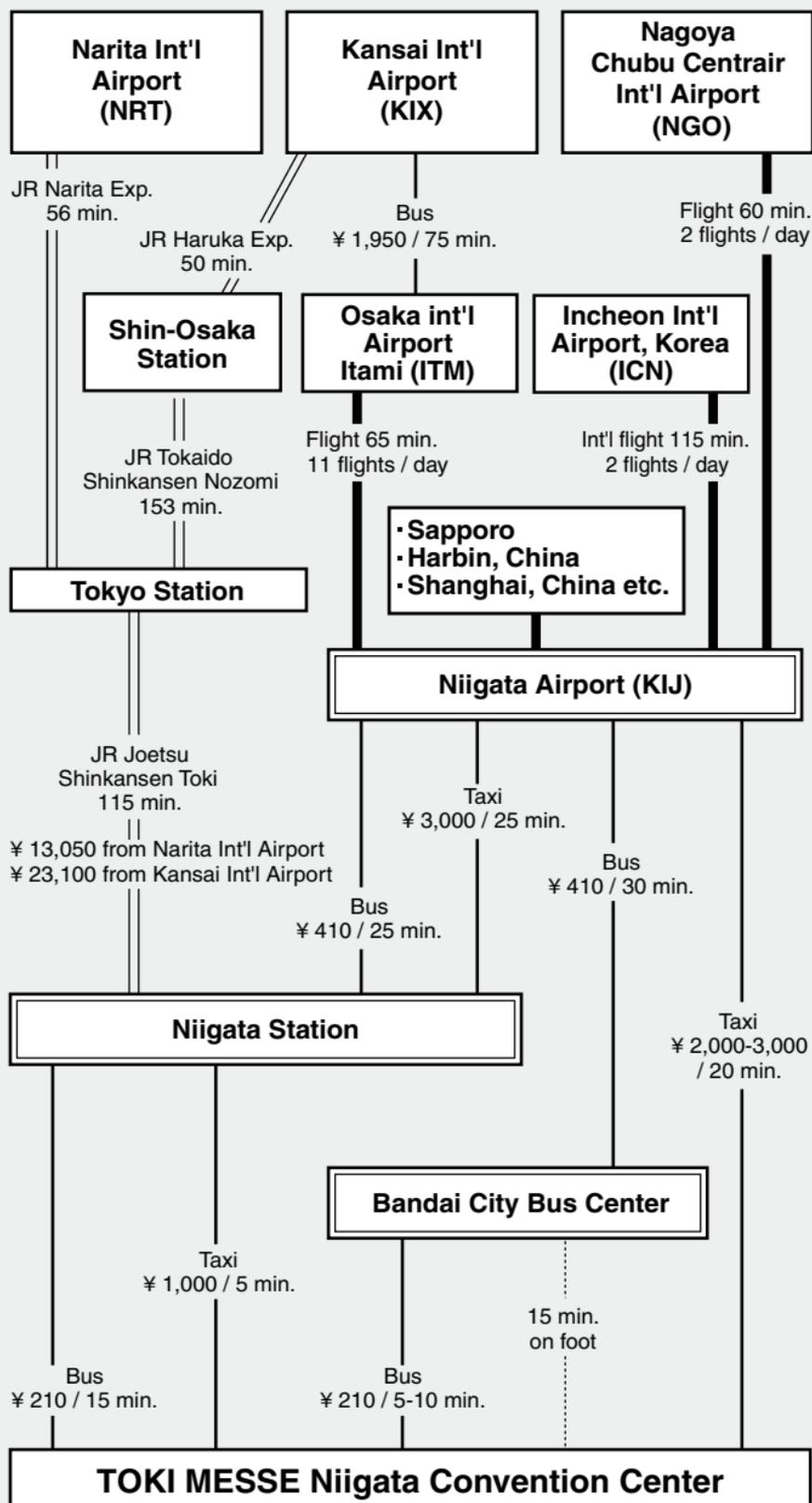
(Niigata City Online)

http://www.city.niigata.lg.jp/multilingual/e_index/index.html

Niigata Prefecture Tourism Guide

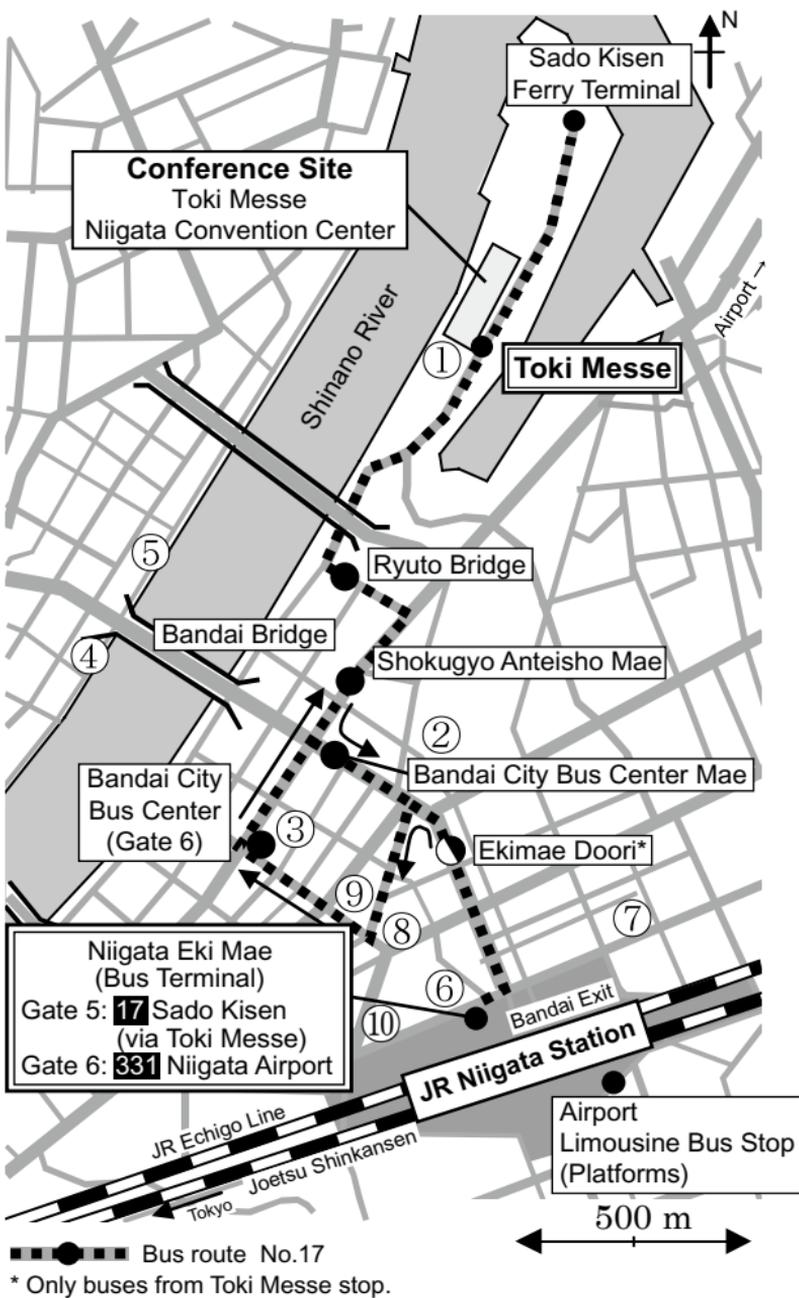
enjoyniigata.com

Access to Conference Site



(as of Oct, 2014)

Niigata Downtown and Hotel Locations



- | | |
|--------------------------|------------------------|
| ① Hotel Nikko Niigata | Phone: +81-25-240-1888 |
| ② ANA Crowne Plaza Hotel | Phone: +81-25-245-3333 |
| ③ Bandai Silver Hotel | Phone: +81-25-243-3711 |
| ④ Hotel Okura Niigata | Phone: +81-25-224-6111 |
| ⑤ Niigata Grand Hotel | Phone: +81-25-228-6111 |
| ⑥ Niigata Tokyu Inn | Phone: +81-25-243-0109 |
| ⑦ Hotel Sunroute Niigata | Phone: +81-25-246-6161 |
| ⑧ Niigata Toei Hotel | Phone: +81-25-244-7101 |
| ⑨ Court Hotel Niigata | Phone: +81-25-247-0505 |
| ⑩ Comfort Hotel Niigata | Phone: +81-25-242-0611 |

“Innovative Demonstration Session” by *Oral and Poster Presenters*

Live demonstrations of emerging information
display technologies

16:45 – 19:30 Thursday, December 4, 2014

12:30 – 15:15 Friday, December 5, 2014

Exhibition Hall B

IDW Best Paper Award

IDW Outstanding Poster Paper Award

These awards will go to the most outstanding papers
selected from those presented at IDW '14.

The 2014 award winners will be announced on the
IDW website: <http://www.idw.or.jp/award.html>

Evening Get-Together with Wine

Tuesday, December 2, 2014

18:00 – 20:00

Observation Deck (31F),

Hotel Nikko Niigata

(Sponsored by Merck Ltd., Japan)

See page 12 for details

Plenary Sessions

Wednesday, December 3

9:30 - 9:50

Snow Hall

Opening

Master of Ceremony: S. Komura, Executive Chair, Japan Display, Japan

Opening Remarks

9:30

K. Azuma, General Chair, IDW
A. Ghosh, President of SID
K. Kubota, President of ITE
A. Mikami, Program Chair, IDW

9:50 - 11:10

Snow Hall

Keynote Addresses

Chair: A. Mikami, Program Chair, IDW

Co-Chair: K. Azuma, General Chair, IDW

Keynote Address - 1 Recent Progress in 8K Super Hi-Vision

9:50

M. Sugawara
NHK, Japan

8K Super Hi-Vision has been developed as the next-generation television to the current HDTV with the feature to provide viewers with a superior sensation of reality. The efforts in Japan are aimed at conducting trial broadcasting in 2016 and starting broadcast service in 2018.

Keynote Address - 2 Display Technologies in Mobile Applications

10:30

J. Hong
Qualcomm MEMS Technologies, USA

We introduce next generation Mirasol display technology that integrates an optical MEMS structure with an IGZO TFT backplane to implement a reflective color display system that supports great image quality in virtually all viewing conditions and a power efficiency advantage that can be an order of magnitude better than competing technologies.

----- Break -----

11:20 - 12:30

Snow Hall

Invited Addresses

Chair: M. Kimura, Vice-Program Chair, IDW

Co-Chair: Y. Gotoh, Vice-Program Chair, IDW

Invited Address - 1 Research and Development of Oxide TFTs
11:20*S.-H. K. Park, S. H. Cho*, C.-S. Hwang***KAIST, Korea***ETRI, Korea*

We overviewed technology and development status of oxide TFT in terms of active, dielectric materials, source/drain and device structure. Recent development issues of oxide TFT for the application to the high resolution display was also presented.

Invited Address - 2 Ultraflexible Electronics Using Organic
11:55 Devices*T. Someya**Univ. of Tokyo, Japan*

We have fabricated ultrathin, ultra-lightweight, ultraflexible, organic devices, such as organic thin-film transistors (TFTs), organic photovoltaic (OPV) cells, and organic light-emitting diodes (OLEDs) on polymeric films with the thickness of only 1 μm . Then, we apply ultraflexible and stretchable organic devices for biomedical applications and for interactive surfaces.

IDW '15

The 22nd International Display Workshops

December 9 – 11, 2015

Otsu Prince Hotel
Otsu, Japan<http://www.idw.or.jp>

Special Topics of Interest on Oxide-Semiconductor TFT

Wednesday, December 3

14:00 - 17:00

Exhibition Hall B

Poster AMDp1: Oxide TFT

AMDp1 - 1 **Withdrawn**

AMDp1 - 2 **A 31-in. FHD AMOLED TV Driven by Amorphous IGZO TFTs**

*H.-J. Zhang, C.-Y. Su, W.-H. Li, L.-Q. Shi, X.-W. Lv,
Y.-T. Hu, C.-Y. Tseng, Y.-F. Wang, C.-C. Lo
Shenzhen China Star Optoelect. Tech., China*

A 31-in. FHD (1920x1080) AMOLED TV was developed with a-IGZO backplane. The IGZO (1:1:1:4) AC sputtering system was applied to fabricate ESL type a-IGZO TFTs at Gen 4.5 glass substrate. TFTs with different a-IGZO etch stopper layers were also studied to realize excellent TFT characteristics and reliability under gate bias-stress.

AMDp1 - 3 **5.8-in. Indium Gallium Zinc Oxide TFT LCD with Slim Border**

*E.-C. Liu, Y.-H. Chen, S.-C. Chiang, Y.-J. Lu, Y.-Y. Huang
Chunghwa Picture Tubes, Taiwan*

In this study, 5.8-in. indium gallium zinc oxide TFT LCDs were fabricated with slim border. The slim border used by 7T2C gate-driver in panel. Due to the high mobility, the GIP circuit designed to be lower than 1 mm in 5.8-in. indium gallium zinc oxide TFT LCDs was also demonstrated.

AMDp1 - 4 **Investigation of Hysteresis in Dual-Gate a-IGZO TFTs**

*Y.-H. Kim, J. G. Um, S. Lee, M. Mativenga, J. Jang
Kyung Hee Univ., Korea*

Hysteresis in dual-gate a-IGZO TFTs was investigated. The top-gate was swept in forward and reverse modes, while the bottom-gate was biased negatively, grounded or biased positively. The hysteresis was found to be largest when the bottom-gate was biased positively – consistent with electron trapping into the top gate-insulator.

AMDp1 - 5 CVD-Free and Low Temperature Amorphous InGaZnO TFTs for Flexible Display Applications

*W.-T. Lin, C.-C. Cheng, C.-Y. Liu, M.-F. Chiang
AU Optronics, Taiwan*

A low temperature (< 220°C) process flow without plasma enhanced chemical vapor deposition (PECVD) of preparing a-IGZO TFTs is presented. All the inorganic dielectrics have been replaced to the organic materials by the coating process, and the CVD-Free a-IGZO TFTs also show the excellent stability under the gate bias stresses.

AMDp1 - 6 Investigation for the Time-Dependent Characteristics of Sol-Gel Processed Zinc-Tin-Oxide (ZTO) Transistors

*Y. W. Wang, C. M. Jian, H. H. Wang, W. L. Liu
Nat. Chang Hua Univ. of Education, Taiwan*

We report the effect of time-dependent characteristics variation of sol-gel zinc-tin-oxide (ZTO) transistors. The sol-gel ZTO transistor could achieve a maximum field effect mobility of 2.7 cm²/Vs, on/off ratio over 10⁵ and a sharpest sub-threshold slope of 0.9 V/decade. The devices have a trend to perform better as time passing.

AMDp1 - 7 Electrical Characteristics and Stability of Bottom Gate a-InGaZnO TFTs with Different Geometric Structures

*H.-W. Li, C.-P. Chang, H.-H. Lu
AU Optronics, Taiwan*

The bottom gate a-IGZO TFTs with difference geometric structures were investigated. The effective channel length is mainly related to the source/drain space not the island layer length. With increasing the effective channel length, the stability of the a-IGZO TFTs could be greatly improved without degradation of the electrical characteristics.

AMDp1 - 8 Hysteresis Improvements by Introducing a Double-Active-Layered Structure in a-InGaZnO TFTs

*Y.-C. Tsai, F.-J. Chan, P.-T. Liu, H.-P. D.-D. Shieh
Nat. Chiao Tung Univ., Taiwan*

a-IGO/a-IGZO TFTs exhibited S.S of 0.4 V/decade and hysteresis of 0.40 V, whereas a-IGZO TFTs showed S.S of 0.93 V/decade and hysteresis of 1.35 V. A smoother surface roughness of 0.25 nm in a-IGZO film was obtained by a double-active-layered structure with a-IGO/a-IGZO. a-IGO/a-IGZO TFTs also presented less charge trapping under NBIS stressing.

AMDp1 - 9 Self Heating Induced Hole Trapping at Back-Channel Edge of Flexible a-InGaZnO TFTs under Gate and Drain Bias Stress

G. Li^{*}, B.-R. Yang^{*,**}, Y.-C. Tsai^{***}, R. Zhan^{*}, C.-Y. Su^{****},
C.-Y. Lee^{****}, C.-Y. Tseng^{****}, C.-C. Lo^{****}, A. Lien^{*****},
S. Deng^{*}, N. Xu^{*}, H.-P. D.-D. Shieh^{*,***}

^{*}Nat. Sun Yat-Sen Univ., China

^{**}SYSU-CMU Shunde Int. Joint Res. Inst., China

^{***}Nat. Chiao Tung Univ., Taiwan

^{****}Shenzhen China Star Optoelect. Tech., China

^{*****}TCL Corporate Res., China

Self heating enhanced positive V_{th} shift in a-IGZO TFTs has been widely reported. In this paper, the authors further observed hump formation during positive V_{th} shift. This hump is speculated to result from the combination effect of self heating induced hole trapping and edge effect.

AMDp1 - 10 Enhancement of Performance and Storage Stability of Thin-Film Transistor with InZnSnO/InGaZnO Bilayer Stack Channel Layers

X.-Y. Yeh, C.-S. Fuh, P.-T. Liu, C.-H. Chang, C.-C. Chang,
Y.-C. Tsai

Nat. Chiao Tung Univ., Taiwan

We investigated on electrical performance and storage issues of high efficiency amorphous In-Zn-Sn-O (IZTO) thin film transistor. By capping additional In-Ga-Zn-O (IGZO) layer on IZTO to form the bilayer channel. The threshold voltage and substrate swing were improved proportionally with the thickness of IGZO capping layer.

AMDp1 - 11 Effects of Negative-Gate-Bias with Illumination Stress on the Hysteresis in the Transfer Curve of a-IGZO TFT Measured by the New Sampling Method

Y.-J. Chen, Z.-H. Cai, Y.-H. Tai, C.-Y. Chang, C.-J. Li^{*},
Y.-H. Yeh^{*}

Nat. Chiao Tung Univ., Taiwan

^{*}ITRI, Taiwan

In the study, the hysteresis in the transfer curve of a-IGZO TFTs with bias stress and illumination is analyzed. The threshold voltage difference between the two curves in the hysteresis keeps the same, even the threshold voltages shift severely with stress time. The difference increases with the light intensity.

AMDp1 - 12 Withdrawn

AMDp1 - 13 Reduction of Hysteresis in Transfer Characteristics of Solution Processed IZTO TFT by Plasma Treatment

T.-H. Kim, C. Avis, H.-R. Hwang, J. Jang

Kyung Hee Univ., Korea

We fabricated solution-processed IZTO TFT with zirconium doped AlO_x (ZAO) as the gate insulator. Plasma treatment on ZAO improves TFTs' performances as follows: μ_{sat} , V_{th} , S.S., and hysteresis varied from 4.6 to 45.1 cm^2/Vs , 0.8 to 0.2 V, 268 to 81 mV/dec., and 1.2 V to 0.4 V, respectively.

AMDp1 - 14 Effect of Solution Processed AlO_x Passivation on Back Channel Etch a-IGZO TFTs

S. An, M. Mativenga, X. Lee, J. Jang

Kyung Hee Univ., Korea

The back surface of amorphous-indium-gallium-zinc-oxide (a-IGZO) thin-film transistors (TFTs) with a back-channel-etched (BCE) structure was treated with a solution-processed aluminum oxide (AlO_x) passivation layer. The result was a chemical reaction between the AlO_x solution and the a-IGZO at the back surface, which significantly improved the stability of the BCE TFTs.

AMDp1 - 15 Impact of Negative Bias and Illumination Stress on Channel Resistance of Back Channel Etched a-IGZO TFTs

M. Chun, J. Um, M. Mativenga, J. Jang

Kyung Hee Univ., Korea

The impact of negative-bias-illumination-stress (NBIS) on the channel resistance (R_{CH}) and series resistance (R_{SD}) of back-channel-etched (BCE) amorphous-indium-gallium-zinc-oxide (a-IGZO) thin-film transistors (TFTs) is investigated. It is found that while the R_{CH} decreases, R_{SD} increases with increasing NBIS time, indicating defect creation under source/drain electrodes.

AMDp1 - 16L Printability of Screen Printed Silver for Oxide Thin-Film Transistor toward a Printable Device

S. Urakawa, Y. Ishikawa, Y. Osada, M. N. Fujii, M. Horita, Y. Uraoka

Nara Inst. of S&T, Japan

Oxide semiconductor has superior properties more than organic semiconductor, which is one of the printable materials for all printed devices. To realize it an oxide thin-film transistor was fabricated by solution process. Amorphous InZnO was formed by spin-coating method and Silver as electrode was printed by screen print method.

AMDp1 - 17L Stable Electrical Characteristics of Solution Processed Amorphous InZnO Thin-Film Transistors with Organic Passivation Layers

J. Okada, T. Nagase, T. Kobayashi, H. Naito

Osaka Pref. Univ., Japan

Solution-processed organic passivation layers for amorphous InZnO thin-film transistors (TFTs) have been shown. Solution-processed amorphous InZnO TFTs with the organic passivation layers exhibit good electrical stability of the threshold voltage shift of less than 1.9 V after bias stress time of 10000 s.

AMDp1 - 18L ITO Interlayer to Improve the Electrical Performance of HfInZnO-TFTs

J. Li, J.-H. Zhang, H. Zhang, X.-Y. Jiang, Z.-L. Zhang

Shanghai Univ., China

We have fabricated hafnium-indium-zinc-oxide (HfInZnO) thin film transistors (TFT) with indium-tin-oxide (ITO) interlayer. Compared with conventional HfInZnO-TFT, the electrical performance and bias stability of HfInZnO-TFTs with ITO interlayer are improved. The performance enhancement is attributed to a decrease in interface trap state and an increase in carrier concentration.

Thursday, December 4

9:00 - 10:15

Snow Hall A

AMD1: High Resolution Displays Using LTPS and Oxide TFTs

Chair: T. Kamiya, Tokyo Inst. of Tech., Japan

Co-Chair: K. Takatori, NLT Techs., Japan

AMD1 - 1: Invited High PPI Technologies for Mobile Displays

9:00

A. Takimoto

Japan Display, Japan

High pixel density LCD technologies have been continuously developed. Recently, high pixel density displays with touch interface have become the standard for smartphones. Tablet PCs follow the same trend. However, further development may face technical challenges. In this paper, the latest developments to tackle these problems are discussed.

AMD1 - 2: Invited Advantages of IGZO Platform in Ultra-High-Resolution LCD Applications

9:25

*N. Ueda, Y. Ogawa, K. Okada, A. Oda, S. Katoh,
S. Uchida, K. Yamamoto, T. Matsuo, H. Kawamori
Sharp, Japan*

This paper describes the advantages of Oxide TFT platform technology in ultra high resolution displays making use of Channel Etch (CE) Type Oxide TFT. It also explores the latest and future approach to resolve emerging concerns, such as panel driving power consumption, aperture ratio, and narrow bezel.

AMD1 - 3: Invited Ultra High-Definition OLED Display Using C-Axis Aligned Crystalline Oxide Semiconductor FETs

9:50

*H. Miyake, S. Kawashima, S. Inoue, M. Shiokawa,
A. Suzuki, S. Eguchi, Y. HIRAKATA, J. Koyama,
S. Yamazaki, T. Sato*, T. Shigenobu*, Y. Ohta**,
S. Mitsui**, N. Ueda**, T. Matsuo***

Semiconductor Energy Lab., Japan

**Advanced Film Device, Japan*

***Sharp, Japan*

We fabricated an 8K OLED display. Channel-etch type c-axis aligned crystalline oxide semiconductor (CAAC-OS) FETs demonstrate good properties even in the channel length of 1.5 μm . Gap spacers between pixels suppress leakage current through an intermediate layer of the tandem OLED.

9:00 - 12:00

Exhibition Hall B

Poster FMCp4: Oxide TFT/Printed Electronics**FMCp4 - 1 Effect of Cu Dopant on Structural and Optical Properties of Zinc Oxide Nanorods**

9:00

*Z. Jin, T. Umakoshi, Y. Abe, M. Kawamura, K. H. Kim
Kitami Inst. of Tech., Japan*

We investigated structural and optical properties of Cu-doped zinc oxide (CZO) nanorods (NRs) fabricated by chemical solution deposition. With incorporation of Cu (10 at%) dopant, the length and crystallinity of NRs increased and improved, respectively, compared to ZnO NRs. However, the transmittance of CZO NRs was lower than ZnO NRs

FMCP4 - 2 Post-Annealing Effect of Zinc Oxide Nanorods Grown on Al-Doped Zinc Oxide Seed Layers

*T. Umakoshi, Y. Abe, M. Kawamura, K. H. Kim
Kitami Inst. of Tech., Japan*

We fabricated zinc oxide (ZnO) nanorods (NRs) grown on ZnO and Al-doped ZnO (AZO) seed layers and investigated post-annealing effects on their structural and optical properties. Length of NRs increased by adding Al dopant in seed layer. The morphology and transmittance were less changed after post-annealed at 500°C.

FMCP4 - 3 Application of Microwave-Detected Photoconductivity Decay Technique to Process Monitoring in Back Channel Etching-Type TFT Fabrication

*H. Goto, M. Ochi, H. Tao, S. Morita, Y. Takanashi,
A. Hino, K. Hayashi, T. Kugimiya
Kobe Steel, Japan*

We have conducted a feasibility study on the application of microwave-detected photoconductivity decay (μ -PCD) technique to process monitoring in back channel etching-type (BCE) TFTs. By measuring the μ -PCD at the back channel area of the TFTs in each process steps, variations of the film characteristics can be precisely detected.

FMCP4 - 4 Copper Nano Particle Ink for Reverse Offset Printing and the Application to Thin Film Transistors

M. Koutake^{,**}
*JAPER, Japan
**DIC, Japan*

Copper nanoparticle ink specialized for reverse offset printing has been developed and applied to make electrodes for OTFTs. The copper ink sintered by Xe intense flash light in ambient atmospheric conditions showed good conductivity and compatibility with an organic semiconductor.

FMCP4 - 5L Hard X-ray Photoelectron Spectroscopic Study under Bias Voltage for Interface States at SiO₂/a-InGaZnO Interface

*S. Yasuno, H. Oji, T. Watanabe, I. Hirose
JASRI, Japan*

The energy distribution of the interface states for SiO₂/a-IGZO interface was evaluated using hard X-ray photoelectron spectroscopy (HAXPES) under bias voltage. It was found that the interface states are observed throughout the band gap of a-IGZO and there exists the largest gap state near the conduction band edge.

10:45 - 12:20

Snow Hall A

AMD2: Physics of Oxide Semiconductors

Chair: J. Jang, Kyung Hee Univ., Korea

Co-Chair: N. Morosawa, Sony, Japan

AMD2 - 1: Invited Multiple Origins of Near-VBM Defects and Its Passivation Effects in a-In-Ga-Zn-O

10:45

*T. Kamiya, H. Kumomi, H. Hosono**Tokyo Inst. of Tech., Japan*

Amorphous oxide semiconductor, represented by a-IGZO, exhibits high electron mobilities $> 10 \text{ cm}^2/\text{Vs}$ even if deposited at room temperature. Several defects and effects of hydrogen and oxygen have been reported to date. This paper reviews recent results on these issues and discuss their effects on optimum deposition condition for a-IGZO.

Oxide TFT

AMD2 - 2: Invited Thermalization Energy Analysis of the Stability of Amorphous Oxide Thin Film Transistors

11:10

*A. J. Flewitt**Univ. of Cambridge, UK*

TFTs incorporating amorphous oxide semiconductors as the channel material are known to suffer from threshold voltage shifts under both positive and negative gate bias conditions. The thermalization energy will be covered as a means of converting measurements as a function of time into measurements as a function of energy.

AMD2 - 3: Invited Origin of High Photoconductivity Gain and Persistent Photoconductivity in Nanocrystalline Oxide Photo-Sensors

11:35

*S. Jeon**Korea Univ., Korea*

We present the mechanism of high photoconductivity gain and persistent photoconductivity in nano-crystalline oxide photo-transistor. Under the illumination, sub-gap optical absorption in oxide semiconductor causes the ionization of oxygen vacancy, which leads to high photocurrent in an operation condition. Also, the origin of persistent photoconductivity will be discussed.

RECEPTION

Wednesday, December 3, 2014

19:00 – 21:00

Room "Continental" (4F)

Hotel Okura Niigata

See page 12 for details

**AMD2 - 4 Differences in Crystalline Morphology among
12:00 Crystalline Oxide Semiconductors**

*K. Dairiki, Y. Nonaka, M. Koyama, Y. Yamada,
A. Shimomura, N. Sorida, E. Takahashi, M. Takahashi,
S. Yamazaki*

Semiconductor Energy Lab., Japan

We compared crystalline morphologies of c-axis aligned crystalline In-Ga-Zn-O (CAAC-IGZO) with those of single crystalline and polycrystalline IGZO. The CAAC-IGZO has c-axis alignment but does not have alignment along a-b plane and clear grain boundaries. Therefore, the crystalline morphology of CAAC-IGZO is clearly distinguishable from those of other crystalline states.

----- Lunch -----

13:30 - 14:55

Snow Hall A

AMD3: Stability of Oxide TFT

Chair: S. Jeon, Korea Univ., Korea
Co-Chair: M. Kimura, Ryukoku Univ., Japan

**AMD3 - 1: *Invited* Improved Electrical Characteristics and
13:30 Stability Using Various Post Treatments on
 Sputtered In-Ga-Zn-O Thin-Film Transistors**

*Y. J. Tak, S. P. Park, H. Lee, H. J. Kim
Yonsei Univ., Korea*

We have demonstrated various post treatments including high pressure annealing, simultaneous UV and thermal treatment, and doped passivation layer. These treatments have been performed to improve stabilities and electrical characteristics on sputtered In-Ga-Zn-O thin film transistors by reducing defect sites related to oxygen vacancies and increasing metal oxide bonds.

**AMD3 - 2 Reliability of Amorphous InGaZnO Thin Film
13:55 Transistors with Low Water-Absorption Passivation
 Layer**

*S. Ishikawa, T. Miyasako, H. Katsui, K. Tanaka,
K. Hamada, C. Kulchaisit*, M. Fujii*, Y. Ishikawa*,
Y. Uraoka**

JSR, Japan

**Nara Inst. of S&T, Japan*

Polymer passivation with low water absorption has been investigated for high reliable amorphous InGaZnO (a-IGZO) TFT. The photosensitive siloxane/silsesquioxane (SSQ) material is coated by a solution process without plasma etching process to avoid serious damage to the channel layer. The stability of a-IGZO TFTs was improved by polarity controlled siloxane material.

AMD3 - 3 **Channel Length Dependent Bias and Light Stability of Bulk Accumulation a-IGZO TFTs with Top Gate Offsets**
14:15

S. Lee, M. Mativenga, J. Jang
Kyung Hee Univ., Korea

Effect of bulk-accumulation on the negative-bias-illumination-stress (NBIS) stability of dual gate-driven a-IGZO TFTs with 2- μm top-gate offsets is investigated. By varying the channel length, it is shown that the TFTs are immune to NBIS, as long as half of the channel region is light shielded and under bulk-accumulation.

AMD3 - 4 **Effect of Parasitic Capacitance on Pixel Compensation Circuit Developed by Oxide TFT**
14:35

C.-Y. Lee, W.-C. Hsu, M.-W. Shih, Y.-L. Chen,
C.-C. Huang, L.-W. Liu, C.-K. Lo, H.-G. Chang, C.-H. Liu,
L.-F. Lin, H.-S. Lin, L.-H. Chang, Y.-H. Lin
AU Optronics, Taiwan

We have developed the pixel compensation circuit of 65-in. AMOLED Display, which was demonstrated in 2013. The effect of inherent parasitic capacitance, will be presented in this paper. To achieve a better performance of panel uniformity and reduce the influence of parasitic capacitance, the optimization of pixel design is necessary.

----- Break -----

15:15 - 16:45

Snow Hall A

AMD4: Higher Performance Oxide TFT

Chair: H. J. Kim, Yonsei Univ., Korea
 Co-Chair: H. Kumomi, Tokyo Inst. of Tech., Japan

AMD4 - 1: *Invited* Bulk Accumulation Oxide TFTs for High Resolution Displays
15:15

J. Jang, M. Mativenga, D. Geng
Kyung Hee Univ., Korea

Owing to bulk-accumulation, dual-gate amorphous-indium-gallium-zinc-oxide (a-IGZO) thin-film transistors (TFTs) with top- and bottom-gates electrically tied together exhibit higher on-current, better turn-on voltage uniformity and lower sub-threshold voltage swing compared to single-gate-driven a-IGZO TFTs. In this talk, their optimization and application to fast TFT circuits and high resolution displays, are reviewed.

AMD4 - 2 High Mobility Zn-Free Oxide Thin Film Transistors

15:40

*T. Kugimiya, M. Ochi, A. Hino, H. Goto, Y. Takanashi, M. Kanamaru***Kobe Steel, Japan***Kobelco Res. Inst., Japan*

We have developed a new Zn-free oxide thin-film transistor (TFT) with high field effect mobility above 60 cm²/Vs. The TFT of etch stop layer structure requires no additional process to conventional process for a TFT. The new oxide-TFT shows excellent characteristics with a positive threshold voltage of 0.5 V, sub-threshold swing (SS) of 0.19 V/decade.

AMD4 - 3 Amorphous In₂O₃-Based Thin Film Transistors Fabricated by Low-Thermal Budget Process with High Mobility and Transparency

16:00

C.-H. Chang, C.-S. Fuh, C.-J. Chang, C.-C. Chang, X.-Y. Yeh, P.-T. Liu, H.-H. Lin, K.-L. Fang*, Y.-C. Kao*, C.-L. Lee*, P.-L. Shih*, W.-C. Chang*, I.-M. Lu***Nat. Chiao Tung Univ., Taiwan***Yeh Hsin Tech., Taiwan*

In this work, the influence of annealing on In-W-O (a-IWO) TFTs was investigated. The 100°C-annealed a-IWO TFTs exhibited an optimized performance with mobility of 39.16 cm²/Vs. Owing to the energy from annealing process, the structural relaxation can be enhanced leading to a better electrical characteristic of a-IWO TFTs.

AMD4 - 4L: Invited Large-Sized and UHD Curved OLED TV Employing White OLEDs and Oxide TFTs

16:20

*C.-W. Han, H. Kang, Y.-H. Shin, H.-J. Shin, B.-C. Kim, H.-S. Kim, B.-S. Kim, Y.-H. Tak, C.-H. Oh, B.-C. Ahn**LG Display, Korea*

In this paper, we will introduce technological progress for commercializing large-sized and UHD curved OLED TV. Those technologies including WOLEDs, Oxide TFTs, compensation circuit and solid phase encapsulation enable panel size scalability as well as mass production with lifetime reliability.

Author Interviews and Demonstrations

18:30 – 19:30

Friday, December 5

9:00 - 10:15

Marine Hall

AMD6: Chemistry of Oxide Semiconductors and TFT

Chair: K.-H. Su, Evonik Inds., Germany
 Co-Chair: K. Takatori, NLT Techs., Japan

AMD6 - 1L **Improvement of Positive Bias and Temperature
 9:00** **Stress Stability by Fluorine Passivated In-Ga-Zn-O
 Thin-Film Transistors**

*J. Jiang, T. Toda, D. Wang, M. Furuta
 Kochi Univ. of Tech., Japan*

Positive bias and temperature stress (PBTS) stability of InGaZnO (IGZO) thin-film transistors (TFTs) with SiO_x and fluorinated silicon nitride passivation were investigated. It was found that fluorine effectively passivated traps and weakly bonded oxygen in IGZO and/or at gate insulator/IGZO interface, resulting in the improvement of PBTS for oxide TFTs.

Oxide TFT

AMD6 - 2L **Chemical Analysis of Fluorine in Highly Reliable
 9:15** **Oxide Thin Film Transistor with Silicon Nitride Gate
 Insulator**

*H. Yamazaki, Y. Ishikawa, M. N. Fujii, J. P. S. Bermundo,
 E. Takahashi*, Y. Andoh*, Y. Uraoka
 Nara Inst. of S&T, Japan
 Nissin Elec., Japan

We propose highly stable amorphous In-Ga-Zn-O thin-film transistors (a-IGZO TFTs) with fluorinated silicon nitride (SiN_x:F) gate insulator against voltage bias and temperature stress. Result of X-ray photoelectron spectroscopy (XPS) measurement revealed that Indium bound with fluorine in a-IGZO plays the dominant role to improve the TFT reliability.

AMD6 - 3L **Quantitative Verification Method of IGZO TFT
 9:30** **Characteristics Using Oxygen Incorporation
 Calculation**

*J. Noh, H. J. Koo, J. S. Seo, S. H. Park, P. S. Yun,
 J. U. Bae, K.-S. Park, I. Kang
 LG Display, Korea*

The amount of Oxygen incorporation on IGZO film during deposition is one of the main factors that significantly affect the electrical properties IGZO TFTs. In this work, we report the quantitative verification method of IGZO TFT characteristics using oxygen incorporation calculation and investigate the correlation between calculation and TFT characteristics.

AMD6 - 4L 9:45 Excimer Laser Annealing of Amorphous Oxide Thin-Film Transistors Passivated with Hybrid Passivation Layer

*J. P. S. Bermundo, Y. Ishikawa, M. N. Fujii,
M. V. D. Zwan*, T. Nonaka**, R. Ishihara*, Y. Uraoka*

Nara Inst. of S&T, Japan

**Delft Univ. of Tech., The Netherlands*

***AZ Elect. Materials Manufacturing Japan, Japan*

We performed excimer laser annealing on passivated amorphous oxide semiconductor thin-film transistors such as amorphous InZnO and InGaZnO. These thin-film transistors were passivated by a hybrid passivation known as polysilsesquioxane. We show that excimer laser annealing is a good low temperature annealing method for high performance amorphous oxide thin-film transistors.

AMD6 - 5L 10:00 Effect of Wet-O₂ Annealing on the Characteristics of Solution-Derived Amorphous InZnO Thin-Film Transistors

Y. Osada, Y. Ishikawa, M. N. Fujii, Y. Uraoka

Nara Inst. of S&T, Japan

We investigated the effect of wet-O₂ annealing on the characteristics of amorphous InZnO thin-film transistor fabricated by spin-coating process. The wet-O₂ annealing improved the field-effect mobility and the sub-threshold swing value. Furthermore, the device yield was significantly improved.

----- Break -----

10:45 - 11:45

Marine Hall

AMD7: Back-Channel Etched Oxide TFT

Chair: T. Noguchi, Univ. of the Ryukyus, Japan

Co-Chair: H. Kumomi, Tokyo Inst. of Tech., Japan

AMD7 - 1L 10:45 Fabrication of Back-Channel-Etch (BCE) a-InGaZnO TFT with a Damage Free Wet Chemical Etchant

T.-C. Fung, C. Kim, T. Chang, J. Hong, P. Vermeulen,
P. Janseen*, Y. Lu*, S. Collins*, L. Robichaux**

Qualcomm MEMS Technologies, USA

**SACHEM, USA*

A-IGZO TFTs with back-channel-etch structures were demonstrated. Mo source/drain electrodes were patterned by SACHEM's proprietary formulation. With a high etch selectivity; BCE can be performed without damaging the IGZO layer. Our BCE TFTs exhibit a sub-threshold swing, Von and mobility comparable with those of conventional ESL-type TFT.

**AMD7 - 2L Oxide Semiconductor Thin Film Transistor
11:00 Compatible with Cu Interconnection Fabricated by
Back Channel Etching**

*S. Morita, M. Ochi, H. Tao, H. Goto, T. Kugimiya,
M. Kanamaru**

Kobe Steel, Japan

**Kobelco Res. Inst., Japan*

We report successful fabrication of back channel etch type oxide semiconductor TFTs with Cu interconnection. By using originally developed amorphous oxide semiconductor which is highly resistive to acid etchants, etching damage to a channel portion was prevented. The TFTs show a low sub-threshold swing 0.22 V/decade and high reliability.

**AMD7 - 3L Application of High Stable Solution-Process Metal-
11:15 Oxide Semiconductor in a Back-Channel-Etching
Thin-Film Transistor**

*K.-H. Su, M. Marinkovic, D.-V. Pham, A. Merkulov, A.
Hoppe, R. Anselmann*

Evonik Inds., Germany

Evonik has been working on solution-process metal oxide for a few years, and we now present a more highly etching-resistive metal-oxide semiconductor than the sputter one. We have achieved high mobility (10 cm²/Vs) and stable and homogeneous characteristics in the oxide-TFT by introducing iXsenic semiconductor into the BCE structure. With its remarkable performance, our material is also successfully applied in a high-resolution display product for mobile applications.

**AMD7 - 4L Back-Channel Etched Amorphous IGZO TFTs Using
11:30 the Copper as the Gate/Data Line Metal**

*C.-Y. Hou, C.-Y. Tu, C.-N. Lin, S.-F. Wu, S.-C. Lee,
W.-C. Tsai*

AU Optronics, Taiwan

BCE structure IGZO TFT using copper as the source/drain metal and different passivation layer were studied. The device characteristics and reliability of Cu BCE structure IGZO TFT can be improved by modifying the annealing temperature and passivation layer.

----- Lunch -----

Author Interviews and Demonstrations

18:30 – 19:30

Special Topics of Interest on Augmented Reality and Virtual Reality

Thursday, December 4

9:00 - 10:35

Room 302 B

DES1: Display Technologies in Augmented Reality

Chair: K. Kiyokawa, Osaka Univ., Japan

Co-Chair: K. Makita, AIST, Japan

**DES1 - 1: *Invited* Diminished Reality Based on Image
9:00 Inpainting for Visually Removing Real Objects in
Real Time**

N. Kawai

Nara Inst. of S&T, Japan

We introduce our diminished reality method that removes real objects from video images in real time. The proposed method achieves generation of high-quality background textures and temporal coherence of textures for 3D scenes by analyzing the background geometry using a Visual-SLAM method.

Also presented in Innovative Demonstration Session (see p. 213)

DES1 - 2: *Invited* HMD Technologies for AR

9:25

K. Kiyokawa

Osaka Univ., Japan

This article introduces technology trends and future visions of head mounted displays (HMDs) for augmented reality. Specifically, recent research on wide field-of-view head mounted visual displays, and multi-focal head mounted displays will be introduced, and future challenges and visions will be discussed.

Also presented in Innovative Demonstration Session (see p. 213)

**DES1 - 3: *Invited* Fog Display as a Co-creative Expression
9:50 Media**

Y. Miwa, S. Itai, Y. Terada

Waseda Univ., Japan

In our view, fog displays are characterized by the lack of any clear distinction between the image and actual spaces. That is, fog displays are essentially borderless. The development of the embodied media and support of co-creative expression are demonstrated in the "Massive fog display" and "Fog box" systems, respectively.

Also presented in Innovative Demonstration Session (see p. 213)

DES1 - 4 Security Door

10:15

H.-F. Wang, C.-C. Lan, J.-Y. Huang, T.-H. Lin, H.-S. Chen
Nat. Taiwan Univ. of S&T, Taiwan

This paper presents a practical "security door" to create an illusion of seeing outdoor view through the indoor. This illusion is achieved by transferring information from two cameras which are disposed at outdoor area, and then their images are cast on the indoor by a display.

----- Break -----

10:45 - 11:50

Room 301

PRJ4: Wearable Display

Chair: S. Shikama, Setsunan Univ., Japan

Co-Chair: S. Ouchi, Hitachi, Japan

PRJ4 - 1: Invited Laser Light Field Display Based on a Retinal Scanning Array

10:45

M. Ide, K. Yoda, S. Kato
Citizen Holdings, Japan

AR & VR

We present a near-to-eye laser light field display system using a MEMS scanner in combination with a microlens array. The system functions as a high-resolution tiled retinal-scanning array and creates multiple projection images on the retina. This gives the system a refocusing feature that can be applied to near-to-eye displays.

Also presented in Innovative Demonstration Session (see p. 212)

PRJ4 - 2 Compact Optical Engine for SmartGlass

11:10

H. Baba, T. Totani, T. Hashizume
Seiko Epson, Japan

After commercializing SmartGlass "MOVERIO-BT100" in Nov. 2011, EPSON has commercialized compact and lighter weight SmartGlass "MOVERIO-BT200" in June this year. New design of compact projection lens and light-guide, and finer micro display is discussed and summarized.

Also presented in Innovative Demonstration Session (see p. 213)

PRJ4 - 3 Light-Guide Optical Element Utilizing Notch Filters for See-Through Glasses

11:30

X. Xiao, X. Lin, X. Tan
Beijing Inst. of Tech., China

Eyewear display is a new type of portable mobile devices. A new way to achieve see-through glasses is proposed. Light-guide with an array of notch filters designed to partially reflect special narrow bands of the spectrum are used to coupling light from the microdisplay to the eye of the viewer.

----- Lunch -----

13:30 - 14:45

Room 301

INP3: AR Interactive Systems

Chair: N. Hashimoto, Citizen Holdings, Japan
 Co-Chair: N. Berkner, Ricoh Innovations, USA

**INP3 - 1: Invited System Design Considerations for Personal
 13:30 Light Field Displays for the Mobile Information
 Gateway**

*W. Wu, N. Balram, I. Tošić, K. Berkner
 Ricoh Innovations, USA*

Existing mobile devices are fundamentally limited with their small screen sizes. A promising direction in the quest for next generation human interfaces is the development of personal near-eye light field displays. We present a review of existing techniques in this field and discuss their system design considerations and tradeoffs.

**INP3 - 2: Invited Further Analysis of the R-V Dynamics
 13:55 Illusion on Sense of Weight**

*S. Hashiguchi, Y. Kataoka, F. Shibata, A. Kimura
 Ritsumeikan Univ., Japan*

In mixed reality space, we can change appearances of a real object (R) and virtual object (V). In this study, we visually change movements of the real and virtual objects and observe the influences of the virtual object's dynamics on the sense of the weight of the real object.

**INP3 - 3L: Invited Interactive Technologies with Applied
 14:20 Perception**

J. Watanabe, S. Hirabara, T. Maeda*, H. Ando*
 NTT, Japan
 Osaka Univ., Japan

When we develop display technologies, the features of human action and perception are potential resources of information presentation. We introduce information displays that work on the basis of the characteristics of the human perceptual system.

Also presented in Innovative Demonstration Session (see p. 215)

----- Break -----

15:15 - 16:45

Room 301

3D2: Interactive 3D Display Technology

Chair: M. Tsuchida, NTT, Japan

Co-Chair: K. Yamamoto, NICT, Japan

3D2 - 1: 15:15 Invited Interactive Display Technologies Using High-Speed Image Processing*M. Ishikawa**Univ. of Tokyo, Japan*

Design concepts for implementing low latency interface using high speed image processing and immersive interactive 2D/3D display systems such as commercial 3D display, emerging aerial display, dynamic projection mapping, high speed information environment, volume slicing display, and deformable workspace will be shown by using videos of those systems.

3D2 - 2: 16:00 Invited Floating Digital Signage Based on Aerial Imaging Techniques*H. Yamamoto^{*,**,*}, S. Suyama^{***}**^{*}Utsunomiya Univ., Japan**^{**}JST-CREST, Japan**^{***}Univ. of Tokushima, Japan*

This paper reviews our floating digital signage techniques. After introducing design issues for floating LED signage, we introduce and show experimental results on two types of optical components: crossed-mirror array enables floating visual and thermal display; AIRR (aerial imaging by retro-reflection) forms floating LED screen with wide viewing angle.

Also presented in Innovative Demonstration Session (see p. 214)

3D2 - 3L 16:30 Comparison of Material Combinations for Bright and Clear Floating Image by Retro-Reflective Re-imaging Technique*Y. Tokuda, A. Hiyama, M. Hirose, T. Large^{*}**Univ. of Tokyo, Japan**^{*}Microsoft Appl. Scis. Group, USA*

We investigate a solution to create clear and bright floating images from LCD display by comparing 16 different kinds of retro-reflectors and beam-splitters for a pseudo-phase-conjugation-effect. We found a reflective polarizer film can enhance the brightness and corner-cube array retro-reflectors can create clearer results than glass beads type for LCD.

Also presented in Innovative Demonstration Session (see p. 214)

----- Break -----

17:00 - 18:40

Room 301

3D3: Omnidirectional Hyper-Realistic System

Chair: K. Yamamoto, NICT, Japan

Co-Chair: M. Tsuchida, NTT, Japan

3D3 - 1: Invited Characteristic of the Ultra-Realistic Dome Images Estimated from Viewing Behavior

17:00

*M. Okyudo, C. Yoshizumi**Wakayama Univ., Japan*

The audience can feel realistic sensation by the dome images better than by the general flat images. We studied the characteristic of the dome images estimated from viewing behavior. As a result, the head's motion is raising the realistic. Then, we propose the dome viewing to watch Tokyo Olympic 2020.

3D3 - 2: Invited Development of Spherical Image Camera

17:25

RICOH THETA*M. Shohara**Ricoh, Japan*

A spherical image camera RICOH THETA is an emerging digital camera. The development of a spherical image camera is different from a conventional digital camera. We had to optimize the ways of the lens design, image processing and user interface. This paper explains the technical challenges during the development.

3D3 - 3: Invited Omnidirectional Video Streaming System with HMD

17:50

*D. Ochi**NTT, Japan*

An interactive video streaming technology that lets users view their favorite sections of events recorded with a 360° omnidirectional camera is proposed. This technology provides an immersive experience with an interactive view of any direction through an HMD following the user's head orientation within a reasonable amount of network bandwidth.

Also presented in Innovative Demonstration Session (see p. 214)

3D3 - 4: Invited Holographic HMD with Wide Visual Field

18:15

*Y. Sakamoto**Hokkaido Univ., Japan*

An electro-holographic display has a potential to be an ultimate three-dimensional (3D) display, however the visual field is narrow due to insufficient resolutions of the electronic devices. This paper reports our color electro-holographic head mounted display (HMD) with a wide visual field.

Author Interviews and Demonstrations

18:30 – 19:30

Friday, December 5

9:00 - 10:00

Snow Hall B

FMC4: Augmented Reality and Virtual Reality

Chair: H. Okumura, Toshiba, Japan

Co-Chair: M. Shinohara, Omron, Japan

**FMC4 - 1: Invited Wide Field of View Optical Combiner for
9:00 Augmented Reality Head-Up Displays***H. Okumura, A. Hotta, T. Sasaki, K. Horiuchi, N. Okada
Toshiba, Japan*

Wide field of view combiners for head-up displays are reviewed and our originally developed combiner using Fresnel reflector that acts both as a concave reflector for reflected light and a flat plate for transmitted light has been introduced.

Also presented in Innovative Demonstration Session (see p. 214)

**FMC4 - 2 Panoramic 3D Floating Image Display Using Dual
9:20 Concave Reflectors***K. Li
Wavien, USA*

This paper discloses 3D floating image systems that uses parabolic and elliptical reflectors with the ability of displaying floating images with a full 360-degree horizontal viewing angles. This will have applications in merchandizing displays, museums, theme parks, etc. Several optical configurations will be presented.

**FMC4 - 3 Fabrication of Special Glass-Beads Retroreflector
9:40 for Aerial Imaging by Retro-Reflection***Y. Tomiyama^{*}, S. Suyama^{*}, H. Yamamoto^{*,**,*}
^{*}Univ. of Tokushima, Japan
^{**}JST-CREST, Japan
^{***}Utsunomiya Univ., Japan*

AIRR (Aerial Imaging by Retro-Reflection) enables floating LED signage. In order to prevent blurring with floating distance, we propose a special glass-beads retroreflector. We have fabricated a retroreflector with glass beads whose refractive index is 2.0. As paraxial approximation suggests, the fabricated retroreflector reduced beam spread with floating distance.

Also presented in Innovative Demonstration Session (see p. 214)

----- Break -----

10:45 - 12:30

Room 201

DES3/VHF5: System Design and Evaluation in Augmented Reality

Chair: K. Morita, Nat. Traffic Safety & Environment Lab., Japan

Co-Chair: K. Sakamoto, Panasonic, Japan

**DES3/
VHF5 - 1: Invited Simulation of Traffic Accident Scenarios with
an Augmented Reality Vehicle**

10:45

*N. Uchida, T. Tagawa, K. Sato**Japan Automobile Res. Inst., Japan*

Observing drivers' behaviours by reproducing traffic accidents and conflict situations is important for developing advanced driver assistant systems. For the purpose, an instrumented vehicle, named the JARI-ARV (Japan Automobile Research Institute - Augmented Reality Vehicle), was developed to reproduce realistic traffic accident and conflict scenarios without endangering the driver.

**DES3/
VHF5 - 2: Invited The Realistic 3D Image Display Using Direct
Light Scanning Method**

11:10

H. Horimai, K. Hattori, T. Umezaki**3Dragons LLC, Japan***Chubu Univ., Japan*

The realistic 3D image displays using Direct Light Scanning Method, so-called Holo-Table/Holo-Deck have become available. The features of these displays are not only large number views but also high density of views. Because of these features, users can see a 3D scene from any directions with smooth motion parallax.

Also presented in Innovative Demonstration Session (see p. 215)

**DES3/
VHF5 - 3: Fast Calculation Algorithm Based on Point-Based
Method for CGHs Using Polygon Model**

11:35

*Y. Ogihara, Y. Sakamoto**Hokkaido Univ., Japan*

Computer-generated holograms (CGHs), which are made by simulating light propagation using a computer, are able to represent virtual objects. However, an enormous amount of calculation time is needed to make CGHs. We propose the fast calculation algorithm with point-based method to make CGHs of the polygon model.

SID Display Week 2015

May 31 – June 5, 2015

San Jose Convention Center

San Jose, California, U.S.A.

**DES3/
VHF5 - 4
11:55** **The Superiority of Widespread Monocular
Augmented Reality Presentation in a Manual Tracing
Task**

A. Kitamura, H. Naito, T. Kimura, K. Shinohara,
T. Sasaki**, H. Okumura***

Osaka Univ., Japan

**Kansai Univ. of Welfare Scis., Japan*

***Toshiba, Japan*

We conducted two experiments involving a tracing task with augmented reality image presentation covering a visual field observed in monocular or binocular mode. Performance on the tracing task was better in monocular mode relative to binocular mode, demonstrating the superiority of monocular AR presentation for performance of a manual task.

**DES3/
VHF5 - 5L
12:15** **A Fundamental Study of an Augmented Reality
System for Road Maintenance Services**

*K. Makita, C.-T. Chang, R. Ichikari, T. Okuma, T. Kurata
AIST, Japan*

In this paper, a fundamental study of an augmented reality system for supporting road maintenance is described. For realizing efficient road maintenance, we implemented a prototype augmented reality system using a camera fixed in the environment and a hand held device to visualize degenerate parts of the roads.

Author Interviews and Demonstrations

16:45 – 17:45

**Innovative Demonstration Session
by Oral and Poster Presenters**

Live demonstrations of emerging information
display technologies

16:45 – 19:30 Thursday, December 4, 2014

12:30 – 15:15 Friday, December 5, 2014

Exhibition Hall B

See Page 212 - 215 for details

Special Topics of Interest on Lighting Technologies

Thursday, December 4

9:00 - 12:00

Exhibition Hall B

Poster FMCp3: Lighting Technologies

FMCp3 - 1 Construction of a Backlight Module by Connecting Unit Cells with an Optical Fiber

*T. Kojima, Y. Asakura, T. Ogawa, I. Fujieda
Ritsumeikan Univ., Japan*

A backlight module can be constructed by connecting unit cells with a curved optical fiber. In a unit cell, a trench fabricated on one surface of a transparent plate houses the optical fiber and output couplers are placed on the other surface of the plate.

FMCp3 - 2 Effect of LGP Outline on Edge-Lit LED TV Design

*H. He, Y.-Y. Qiu
Shenzhen China Star Optoelect. Tech., China*

Uniformity issues were usually found in Edge-lit LED TV, due to LGP outline affected the light propagation. In this study, one novel method was introduced to quantify the phenomenon of DARK CORNER MURA. Also, several different LGP conditions were simulated to come out optimized outline parameters of LGP.

FMCp3 - 3 Solution for Achieving an Optimized LED Spectrum for LCM

*C.-T. Kang, M. C. Chien, Y.-Y. Qiu, Z.-J. Su, H. He
Shenzhen China Star Optoelect. Tech., China*

By adjusting LED spectrum, consist of W_d of Blue chip shift and phosphor adjustment to match the confirmed CF & BLU spectrum, to increase the brightness of LCM. To specific LCM system, by LED chip red shift, LCM brightness will increase 6% effectively with correct white chromaticity coordinates.

FMCp3 - 4 Portable LED Illuminating Device for Personal Photodynamic Treatment and Cell Culturing

*C.-J. Ou, Z.-W. Lin, Y.-S. Lin, P.-Y. Lin, J.-Y. Chen,
Y.-K. Tsai
Hsiuping Univ. of S&T, Taiwan*

We demonstrate an LED based wearable photodynamic therapy device that can conduct the designed illuminating energy to a specific tissue region for targeting reaction. This device is designed based on the 4R rules. Most important of all, the microdisplay techniques can also integrate with this medical device.

FMCP3 - 5 A Glare Detection for the High-Brightness LED Display Boards Using a Digital Camera

Y.-H. Siao, P.-J. Wu^{}, B.-J. Pong^{**}, S.-W. Hsu^{**},
C.-H. Wen^{***}, C.-Y. Chen*

Nat. Yunlin Univ. of S&T, Taiwan

^{}Nat. Chiao Tung Univ., Taiwan*

*^{**}ITRI, Taiwan*

*^{***}Nat. Taiwan Univ. of S&T, Taiwan*

This study proposes an easy way to obtain the glare distribution of the area is full of the high-brightness LED display boards by using a digital camera. The measurement is modified by the color correction and the uniformity correction and results of this detection are consistent with the physiological questionnaire.

FMCP3 - 6 The Design of Personal Privacy and Wide Viewing Functions LCM Model Design

Y. W. Chang

AU Optronics, Taiwan

We successfully develop a new LCM system with privacy and wide view functions. With our design, the users do not have to take off any components to change the viewing status so that they can keep the privacy or share the information of the display immediately.

9:00 - 12:00

Exhibition Hall B

Poster PHP2: Phosphors for Lighting Application

PHP2 - 1 Study on Luminescence Property of $Ba_3(Sc_{1-x}Ho_x)_4O_9$ Phosphors

*K. Sugimoto, S. W. Kim, T. Ishigaki, K. Uematsu, K. Toda,
M. Sato*

Niigata Univ., Japan

Blue light excitable green emitting $Ba_3(Sc_{1-x}Ho_x)_4O_9$ phosphors were synthesized in a single phase form by a conventional solid-state reaction method. These phosphors showed a green emission under the blue light excitation (455 nm) and the main green emission peak observed at 555 nm corresponding to 4f-4f transition of Ho^{3+} .

PHP2 - 2 The Effect of $Sr_{2-x}Si_3O_2N_4: xEu^{2+}$ Synthesizing by Different Phase Si_3N_4 on Luminescence Characteristic

C.-H. Chiang, T.-S. Zhan, S.-Y. Chu

Nat. Cheng Kung Univ., Taiwan

In this paper, the dependence of the raw material of Si_3N_4 with different phase on the luminescence of $Sr_{1.9}Si_3O_2N_4: 0.1Eu^{2+}$ phosphors were investigated. It's obvious that the emission peak at 530 nm is enhanced at 450 nm excitation light source by using β -phase Si_3N_4 .

PHP2 - 3 A Novel Reddish Orange-Emitting $\text{BaLa}_2\text{Si}_2\text{S}_8:\text{Eu}^{2+}$ Thiosilicate Phosphor for White Light-Emitting Diodes

S.-P. Lee, T.-M. Chen

Nat. Chiao Tung Univ., Taiwan

A novel reddish orange-emitting $(\text{Ba}_{1-x}\text{Eu}_x)\text{La}_2\text{Si}_2\text{S}_8$ thiosilicate phosphor was synthesized and evaluated for potential application in white light LEDs. The Eu^{2+} -doped thiosilicate phosphor can be excited by UV to blue light and shows reddish orange broadband emission. The preparation, spectroscopic characterization, decay lifetime, and related LED device data are also presented.

----- Lunch -----

13:30 - 16:30

Exhibition Hall B

Poster OLEDp1: OLED Poster

OLEDp1 - 1 Flexible Hybrid White Light Emitting Diodes Based on Small Molecules and Quantum Dots

W. Wu, F. Li, H. Hu, J. Lin, T. Guo

Fuzhou Univ., China

A flexible hybrid white light emitting diode, in which the QDs acted as an orange emitter and organic small molecules as the blue emitter in a multilayered structure was fabricated. The device could produce white light emission and the current efficiency has a maximum of 0.97 cd/A.

OLEDp1 - 2 Novel Phosphorescent Host Material for Tunable Hybrid White OLED Devices

H.-L. Huang, B. Balaganesan, H.-M. Kuo, B.-W. Xie, T.-C. Chao, M.-R. Tseng

eRay Optoelect. Tech., Taiwan

The novel phosphorescent host for phosphorescent yellow dopant was designed and prepared with easy scale-up reaction procedures. The hybrid WOLED can be tuned from warm white 30 lm/W@ (0.42,0.49), 21 lm/W@ CIE(0.39,0.45) to cold white 15 lm/W@ CIE(0.32,0.39) under different thickness of the blue layer.

OLEDp1 - 3L Synthesis Yellow and Green Color Iridium(III) Complexes Containing Thieno[3, 2-C]pyridine Functional Group for Organic Light Emitting Diode.

C. A. Wu, J. S. Lin, M. H. Chang, P. C. Liu, M. R. Tseng

ITRI, Taiwan

Thieno[3, 2-C]pyridine based OLED dopants were successfully prepared by our research group. These phosphorescent dopants showed excellent device performances. The yellow and green color devices revealed the EQE of 21.02, 13.6% and current efficacy of 67.6, 48.8 cd/A and power efficacy of 38.6, 30.6 lm/W at 1000 nits.

OLEDp1 - 4L Blue Top-Emissive Organic Light-Emitting Diodes on Stainless Steel

J. Shin, E. Jung, S. H. Lim, S. M. Cho
Sungkyunkwan Univ., Korea

We have fabricated blue top-emissive organic light-emitting diodes using stainless steel substrate and investigated the characteristics of these OLEDs compared with glass-based OLEDs that have same structure. The angle dependency of OLEDs on stainless steel was found much less than that on glass.

OLEDp1 - 5L Highly-Efficient Solution-Processed Yellow Organic Light-Emitting Diodes

H.-C. Yeh, T.-C. Chao, C.-H. Chou, J.-Y. Liao,
M.-R. Tseng
ITRI, Taiwan

A small molecular yellow iridium complex, PO-08, is prepared and characterized. A solution-processed yellow emission OLED using PO-08 as dopant exhibits very high performance with a current efficacy of 45.2 cd/A and a power efficacy of 36.7 lm/W at 1,050 cd/m².

OLEDp1 - 6L The Viewing Angle Dependency of Diffuser Layer on the Organic Light Emitting Diode with Microcavity Structure

B. W. Lim, M. C. Suh
Kyung Hee Univ., Korea

We have developed randomly dispersed nano-scattering films having nano-hemispherical shapes and nano-concave structures by nanoimprinting or simple spin coating processes. Those films were utilized as a diffuser layer to obtain desirable emission pattern like Lambertian distribution.

Friday, December 5

9:00 - 10:25

Room 302 A

PH3: Phosphors for Lighting Application

Chair: W. Chen, Univ. of Texas at Arlington, USA
 Co-Chair: K. Ohmi, Tottori Univ., Japan

PH3 - 1: Invited Quantum Rods Optical Film for Backlight 9:00

D. Glozman, E. Shaviv, H. Arbell, Y. Bonfil, U. Banin,*
S. Amir

Qlight Nanotech, Israel

**Hebrew Univ. of Jerusalem, Israel*

Semiconductor quantum rods offer unique opportunities in the field of displays. Qlight is developing a film for LCD backlight enabling wide color gamut and the design of an energy-efficient polarized backlight. Another application being developed is QPixel, novel display technology based on electric field modulation of the quantum rods emission.

PH3 - 2 **Thermal Degradation of Green-Emitting**
9:25 **SrSi₂O₂N₂:Eu²⁺**

C. Wang, R.-J. Xie, T. Takeda*, T. Suehiro*, N. Hirosaki**
Univ. of S&T of China, China
**NIMS, Japan*

SrSi₂O₂N₂:Eu²⁺ is a very promising green phosphor for solid state lighting, which has a high quantum efficiency and small thermal quenching. However, this phosphor cannot be practically used because the degradation of white LEDs using it over time is not acceptable. In this work, we investigated the thermal degradation and its mechanism of SrSi₂O₂N₂:Eu²⁺.

PH3 - 3 **Wireless Power Transmission Method of a Powder**
9:45 **EL Sheet Device**

K. Wani, T. Kanda, E. Hashimoto
TAZMO, Japan

A thin and flexible EL lighting device was driven by a wireless power source. There is no other electrical component in the EL lighting unit except a planar secondary coil, which makes the lighting unit almost as thin as the EL sheet only.

Also presented in Innovative Demonstration Session (see p. 214)

PH3 - 4 **Studies of Electroluminescence from Individual**
10:05 **Phosphor Particles**

J. Silver, P. G. Harris
Brunel Univ., UK

Measurements of the radiance of powder a.c. electroluminescent devices have in the past been carried out on lamps containing large numbers of particles. In this work studies of individual ACEL particles of different sizes and in a variety of environments have been made to understand how they behave.

----- Break -----

EXHIBITION

12:40 – 18:00 Wednesday, Dec. 3, 2014

10:00 – 18:00 Thursday, Dec. 4, 2014

10:00 – 14:00 Friday, Dec. 5, 2014

Exhibition Hall B

TOKI MESSE Niigata Convention Center

Free admission with your registration name tag

10:45 - 12:05

Snow Hall B

FMC5: Lighting Technologies

Chair: F. Shevlin, Dyoptyka, Ireland

Co-Chair: K. Kälantär, Global Optical Solutions, Japan

FMC5 - 1 Light Guide Plate Illumination with Blue Laser and Quantum Dot Emission

10:45

*F. Shevlin**DYOPTYKA, Ireland*

A Blue laser diode is used to excite emission from a strip of “quantum dot” materials at the edge of an LCD display light guide plate. Optical efficiency is improved by reflecting emission that would otherwise be lost. A phase randomizing deformable mirror is used to minimize speckle noise.

Also presented in Innovative Demonstration Session (see p. 214)

FMC5 - 2 Design and Perception of an Edge Lit HDR Display

11:05

*P. Cirkel, L. Penninck**TP Vision, Belgium*

Advances in LED efficiency and thermal conductivity were used to design an HDR display with an edge-lit backlight. The advantage of improvements in thermal conductivity is depending on the backlight design. An HDR TV set was made, and compared to a wide color gamut TV in a perception test.

FMC5 - 3 Predicting Color Appearance under Non-Uniform Lighting Environments

11:25

H.-C. Li, P.-L. Sun*, S.-Y. Chang*, R. Luo*,*****Nat. Taiwan Univ. of S&T, Taiwan****Univ. of Leeds, UK*

Two psycho-visual experiments were conducted to investigate the color appearance under non-uniform surround conditions. A weighted function is derived to estimate the luminance of adapting field for a CIECAM02 based color appearance model to improve its color prediction.

FMC5 - 4 The Design of Anti-Glare Lens Applied to Direct LED Panel Lighting

11:45

*J.-W. Pan, Y.-K. Hsu, C.-W. Chiang**Nat. Chiao Tung Univ., Taiwan*

The anti-glare lens had been proposed to reduce the glare effect and enhance the illumination uniformity for indoor lighting. Compared with traditional panel light with Lambertian intensity distribution, the Unified Glare Ratio (UGR) had been controlled at 17.3 and the uniformity had been enhanced 28%.

----- Lunch -----

Author Interviews and Demonstrations

16:45 – 17:45

Special Topics of Interest on Printed Electronics

Thursday, December 4

9:00 - 10:25

Snow Hall B

OLED3: OLED Process Technologies

Chair: T. Shimizu, NHK, Japan

Co-Chair: T. Komatsu, Panasonic, Japan

OLED3 - 1: *Invited* OLED Device Fabrication by Ink-Jet Printing Technology

9:00

*T. Sonoyama, M. Uchida, T. Sago, S. Watanabe,
K. Ishida, M. Ito, M. Ishida, M. Yamada, Y. Okawa,
S. Tanabe, H. Kiguchi
Seiko Epson, Japan*

Here we present the result of OLED device fabricated by Ink-jet method. We use a structure in which Red and Green EML are patterned by Ink-jet and Blue EML is formed by vapor deposition. We can make a good emission profile by improving uniformity of HIL and EML.

OLED3 - 2: *Invited* Important Technologies of Ink Jet System for OLED Display Fabrication

9:25

T. Hayashi, K. Oshima, S. Takei, A. Shimamura,
Y. Konta, S. Tanabe*
Tokyo Electron, Japan
Seiko Epson, Japan

We reported the advantages of ink jet printing (IJP) and the important technologies for MURA/Defect free panel fabrication by IJP. The swath-mura caused by IJ head variations, the ink mixed color issue in dry process and the oval-mura issue in baking process were already resolved by IJP equipment technologies.

OLED3 - 3 UV-Activated Transparent Desiccant for Practical OLED Encapsulation Process

9:50

*H. Katsui, T. Miyasako, T. Arai, M. Takahashi,
N. Onimaru, N. Takamatsu, T. Yamamura, K. Konno,
K. Kuriyama
JSR, Japan*

We have developed a new-type desiccant material for practical OLED encapsulation process. Since a water absorbent function was activated via UV irradiation, we could handle the material in atmosphere until just before UV-sealing process. Such property would offer process simplicity and low equipment costs in OLED encapsulation process.

OLED3 - 4L Flexible AMOLED Display with Self-Aligned Top Gate Oxide TFTs and Novel Barrier Structures
10:10

*A. Kanegae, E. Kobayashi, Y. Honda, G. Sakamoto,
Y. Isaji, Y. Tsutsui, I. Ueno, T. Ukeda, K. Okada, Y. Izawa,
A. Kamitani, T. Mifune, K. Morita
Panasonic, Japan*

We have developed flexible AMOLED displays with self-aligned top gate oxide TFTs and novel barrier structures. Reactive sputtered aluminum oxide is used to lower the resistivity of IGZO. Newly developed moisture absorption barrier was also integrated. We could successfully demonstrate the 220-ppi full-color flexible AMOLED display for the first time.

----- Break -----

10:45 - 12:10

Snow Hall B

OLED4: OLED Materials (1)

Chair: K. Nakayama, Yamagata Univ., Japan
Co-Chair: K. Monzen, Nissan Chem. Inds., Japan

OLED4 - 1: *Invited* Blue Fluorescent OLEDs for Printed Display Applications
10:45

*E. Böhm, C. Pflumm, H. Heil, S. Meyer, F. Knoch,
L.-I. Rodriguez, B. Burkhart, F. Eckes, K. Stegmaier,
H. Buchholz
Merck KGaA, Germany*

A solution processable host material for fluorescent blue OLEDs is presented. The contribution of triplet-triplet annihilation and emitter orientation to the external quantum efficiency for different OLEDs is investigated. Both effects enhance efficiency for devices manufactured by thermal evaporation. This is not the case for solution processed OLEDs.

PM

OLED4 - 2: *Invited* Development and Manufacture of Solution-Processed White OLED Lighting Panel
11:10

*T. Ogata
Mitsubishi Chem. Group S&T Res. Ctr., Japan*

High-performance, solution-processable OLED materials have been developed. By the joint development with Pioneer Corporation, Mitsubishi Chemical Corporation started the mass production and shipment of OLED lighting panels with wet-processed platform and light emitting layers, which allow to reduce the manufacturing cost than conventional modules by vapor deposition process.

**OLED4 - 3 The Soluble Hole Injection Materials and the Inks
11:35 Applicable to OLED Devices**

*N. Otani, H. Koga, S. Moriyama, T. Endo, N. Nakaie,
K. Monzen*

Nissan Chem. Inds., Japan

We are developing the soluble hole injection materials and the ink, named ELsource that can be used as hole injection layer in OLED devices. Optimization of ink formulation applicable to wet coating process and new hole injection material with higher transmittance are reported.

**OLED4 - 4L Triplet-Energy Control of PAHs by BN Replacement
11:55 for Development of Ambipolar Host Materials for
 PHOLEDs**

T. Hatakeyama, T. Ikuta, S. Hashimoto**, K. Shiren*,
S. Nakatsuka, J. Ni*, M. Nakamura***

Kwansei Gakuin Univ., Japan

**JNC PetroChem., Japan*

***Kyoto Univ., Japan*

The triplet-energy control of polycyclic aromatic hydrocarbons (PAHs) was achieved by replacing the CC unit with a BN unit. The PAH containing the BN unit, 4b-aza-12b-boradibenzo[g,p]chrysene, showed a large E_T value and ambipolar carrier-transport abilities and enable us to build phosphorescent organic light-emitting diodes of high performance.

----- Lunch -----

13:30 - 15:00

Snow Hall B

FLX3: Advanced Printing Technologies

Chair: M. Ito, Toppan Printing, Japan

Co-Chair: H. Hirata, Toray Eng., Japan

**FLX3 - 1: Invited Novel Roll-to-Roll Screen Printing Machine
13:30 for Flexible Devices**

D. Kobayashi, N. Naoi, T. Suzuki*, T. Sasaki*,
T. Furukawa***

Tokai Shoji, Japan

**Tokai Seiki, Japan*

***Yamagata Univ., Japan*

Novel roll-to-roll screen printing machine was developed for printing on flexible substrates. By this machine, technical problems of the conventional screen printing machines have been solved, such as the problems of "distortion of the image" and "stability in the condition of peeling-off of the printing stencil mask from the substrate."

FLX3 - 2: Invited Technologies for Fully Integrated Printed Displays
13:55

N. Fruehauf, D. Benzel, M. Strecker
Univ. of Stuttgart, Germany

Ultra low cost applications such as packaging demand the use of low cost technologies, which create previously not addressed challenges, even if their lower optical performance is acceptable. These include low voltage printed organic thin film transistors, low cost encapsulation processes and redundant circuit design for printed electronics based systems.

FLX3 - 3: Invited Flexible Transparent Conductive Films Based on Metal Mesh Technology
14:20

Z. Cui
Chinese Ac. of Sci., China

A new technique for making flexible transparent conductive substrates based on metal mesh structures is presented. The metal mesh structures are made by embedding silver nanoparticles inks into imprinted grooves on a flexible transparent substrate. The new technology has been successfully implemented in high volume manufacturing of touch panel sensors for displays.

FLX3 - 4L Patterned ITO Film by Roll-to-Roll Process on Ultra-Thin Glass
14:45

T. Furukawa, K. Mitsugi, S. Akiyama*, H. Itoh**,
D. Kobayashi***, T. Suzuki****, H. Kuroiwa*****,
M. Sakakibara*****, K. Tanaka*****, N. Kawamura,
M. Koden*

Yamagata Univ, Japan
**Nippon Elec. Glass, Japan*
***Teijin, Japan*
****Tokai Syoji, Japan*
*****Tokai Seiki, Japan*
******FEBACS, Japan*
******DNP, Japan*
******Kobe Steel, Japan*

We have recently succeeded in patterning ITO film for OLED lighting on 50- μm ultra-thin glass by 'Roll-to-Roll' process and confirming luminescence of OLED on the substrate. 'Roll-to-Roll' wet cleaning equipment, 'Roll-to-Roll' deposition equipment, and the new type of 'Roll-to-Roll' screen printing equipment were used for this study.

13:30 - 16:30

Exhibition Hall B

Poster OLEDp2: OLED Poster**OLEDp2 - 1 High-Mobility Solution-Processed Organic Field-Effect Transistors with Channel Length of 5 μm**

R. Nakamichi, T. Nagase, T. Kobayashi, Y. Sadamitsu,
H. Naito*

Osaka Pref. Univ., Japan

**Nippon Kayaku, Japan*

We have fabricated short-channel organic FETs with top-gate configurations by conventional spin-coating processes. The solution-processed organic FETs with a channel length of 5 μm exhibit high field-effect mobilities of $1 \text{ cm}^2\text{V}^{-1}\text{s}^{-1}$ in both the linear and saturation regions and show electrically stable operations against gate bias stress.

OLEDp2 - 2L A Novel Orange Emitter for Solution Processed White OLEDs

J.-Y. Liao, H.-C. Yeh, T.-C. Chao, J.-S. Lin, M.-R. Tseng

ITRI, Taiwan

A novel orange emitter, PO-10, is studied. The PO-10 dopant performs ultra-high efficacies of 44.3 lm/W and 45.8 cd/A in NPB host. Two-emitter white devices using PO-10, Flrpic and a tri-host system are also characterized. Efficacies of 24.8 lm/W and 39.5 cd/A are recorded at brightness of ca. 2000 nits.

15:15 - 16:45

Snow Hall B

FLX4: Printed TFT Technologies

Chair: Y. Uraoka, Nara Inst. of S&T, Japan

Co-Chair: T. Furukawa, Yamagata Univ., Japan

FLX4 - 1: Invited Fully Printed Flexible TFT Array for Electronic Paper

15:15

*M. Ito, H. Chujo, K. Murata, M. Nishizawa, N. Ikeda,
K. Hatta, M. Yokoo, R. Matsubara, O. Kina, S. Akao,
M. Takeji, M. Kumagai, M. Ishizaki, K. Morosawa,
M. Matsumura*

Toppan Printing, Japan

Flexible organic TFT arrays are fabricated by fully printed method for electronic paper. Taking advantage of flexible feature, electronic paper with extraordinary laterally elongated shape, whose size is 15 mm by 900 mm is demonstrated. This novel electronic paper can be applied to rail-type ESL (Electronic Shelf Label).

FLX4 - 2: Invited Fully-Printed Organic TFTs and Circuits on Ultra-Flexible Substrates

15:40

*K. Fukuda, Y. Takeda, S. Tokito
Yamagata Univ., Japan*

In this paper, we report on fully-printed organic thin-film transistor (TFT) devices fabricated on ultra-flexible films in large area with good electrical performances. The resulting devices were extremely light and exhibited excellent mechanical stability. The devices remained operational even under 50% compressive strain, without significant changes in their performances.

FLX4 - 3 Flexible Electronics on Backmolded Plastic Foils

16:05

P. Gaucci, N. Fruehauf, A. Ilchmann, B. Polzinger*,
W. Eberhardt*, H. Kueck*
Univ. of Stuttgart, Germany
HSG-IMAT, Germany

Inkjet-printed organic thin film transistors and unipolar inverters with different combination of channel length and channel width have been fabricated on plastic foil, which was afterwards implemented for the first time on the 3D curved surface of an injection molded plastic object by back-injection molding.

FLX4 - 4L: Invited Automated Continuously-Manufacturing Line of All-Printed Organic TFT Array Flexible Film

16:25

S. Nishi^{,**}, T. Kamata^{**,***}
*JAPER, Japan
**Konica Minolta, Japan
***AIST, Japan*

We have constructed a sheet-to-sheet (S2S) manufacturing line in order to prove the possibility and reality of production technologies and integrated processes of all-printed electronics devices. We acquired an organic TFT array on a flexible film of G1 size in a reasonable high yield, whose electrical properties were highly uniform.

----- Break -----

PE

17:00 - 18:30

Snow Hall A

AMD5: Printed Electronics

Chair: Y. Fujisaki, NHK, Japan
Co-Chair: H. Minemawari, AIST, Japan

AMD5 - 1: Invited High Performance Polymer Semiconductors

17:00

*A. Ohno
Mitsubishi Chem., Japan*

Solution processable polymer semiconductors whose mobility is up to 23.7 cm²/Vs have been developed. The mobility number opens up a new ground for applications with mobility more than 10 cm²/Vs range, such as TFTs for OLED and HF(High Frequency) communication.

AMD5 - 2: Invited Flexible Printed Organic TFT Arrays and Integrated Circuits

17:25

*S. Tokito**Yamagata Univ., Japan*

Newly developed silver nanoparticle ink and organic semiconductor materials for printed TFT (OTFT) devices have been applied to transistor arrays and exhibited very good electrical performance. Integrated circuits based on the OTFT devices were also fabricated using printing methods. In addition, ultra-thin and flexible circuits were successfully demonstrated.

AMD5 - 3 Alignment Control of Patterned Organic Semiconductor Crystals in Short Channel Organic Thin-Film Transistors

17:50

Y. Fujisaki, D. Takahashi, Y. Nakajima, H. Tsuji, M. Nakata, T. Yamamoto**NHK, Japan***Tokyo Univ. of Sci., Japan*

Patterning deposition of crystalline organic semiconductor film is key issue to achieve high mobility organic thin-film transistor arrays. We present a patterning method which can control alignment direction of organic crystals. The corresponding short channel TFTs showed a high mobility of over $1 \text{ cm}^2/\text{Vs}$.

AMD5 - 4L: Invited Small Molecule/Polymer Formulations for High Performance, High Uniformity Top Gate OTFTs

18:10

*M. Cowin, C. Watson, J. Carter, K. Crowley, R. Griffiths, B. Brown**Smartkem, UK*

Small molecule/polymer organic semiconductor blends have been formulated to give transistors with mobilities of $>3 \text{ cm}^2/\text{Vs}$ at channel length of $4 \mu\text{m}$. The uniformity of on-current is $<10\%$ across a 100 mm substrate using both curved and linear transistor configurations. The devices also have excellent bias stress stability.

Author Interviews and Demonstrations

18:30 – 19:30

IDW '15

The 22nd International Display Workshops

December 9 – 11, 2015

Otsu Prince Hotel
Otsu, Japan<http://www.idw.or.jp>

Workshop on LC Science and Technologies

Wednesday, December 3

14:00 - 15:20

Room 301

LCT1: Fast Switching LCD

Chair: M. Ozaki, Osaka Univ., Japan

Co-Chair: H. Okada, Univ. of Toyama, Japan

**LCT1 - 1: *Invited* Fast Response LCDs by Doping
Nanoparticles and Optical Compensation**

14:00

*S. Kobayashi, Y. Shiraishi, H. Takatsu**

Tokyo Univ. of Sci., Yamaguchi, Japan

**DIC, Japan*

Response time τ_{off} of NTN-LCD is reduced by 40% at 0°C by doping nanoparticles of Aerosil 812 (EVONIK) into the host NLC cell and the τ_{off} of optically compensated TB cell is reduced by 50% when their optical phase difference is $\pi/2-\alpha$, where $\alpha \ll 1$.

**LCT1 - 2 Polymer-Wall Stabilization of Ultra-Short-Pitch
TN-LCDs**

14:25

M. Akimoto, S. Ando, T. Yamashita, K. Takatoh

Tokyo Univ. of Sci., Yamaguchi, Japan

In this study, we apply the polymer-wall stabilization method to the Ultra-Short-Pitch TN-LCDs using UV curable LC monomers. By optimizing the UV irradiation condition, we succeeded in fabricating stable USP TN-LCDs which keep shorter response time as well as lower driving voltage and high contrast ratio.

**LCT1 - 3 Fast Switching PSV-FLC Using Low Birefringence
LCs**

14:45

T. Fujisawa, Y. Aoki, A. Koiso, I. Nishiyama, H. Takatsu,

*S. Kobayashi**

DIC, Japan

**Tokyo Univ. of Sci., Yamaguchi, Japan*

We have succeeded in the first ferroelectric liquid crystals exhibiting a 0.11 of birefringence with a wide temperature range in SmC* phase over 100°C. In polymer stabilized V-shaped switching FLCs, a 1:900 of contrast ratio is achieved with a fast switching less than 800 μs (Tr+Td).

LCT

**LCT1 - 4L Polymer Stabilized Electrically Suppressed Helix
15:05 Ferroelectric Liquid Crystal**

*L. Shi, Y. Ma, A. K. Srivastava, V. G. Chigrinov,
H. S. Kwok*

Hong Kong Univ. of S&T, Hong Kong

A polymer stabilized ferroelectric liquid crystal (FLC) is proposed. With the expose of UV light, the doped monomer formed a polymer network and thus stabilize the FLC working in electrically suppressed helix mode. Therefore, we are able to achieve a high contrast ratio, fast response and low driving voltage display.

----- Break -----

15:45 - 17:10

Room 301

LCT2: Novel Optics for LCD

Chair: S. Kobayashi, Tokyo Univ. of Sci., Yamaguchi, Japan
Co-Chair: M. Suzuki, Merck, Japan

**LCT2 - 1: *Invited* Scattering-Free, Microsecond Electro-Optic
15:45 Response Based on Polymer/LC Nanocomposite**

M. Ozaki, Y. Inoue, J. Kobashi, H. Kim, H. Yoshida*

Osaka Univ., Japan

**Kyoto Univ., Japan*

We report a high-speed electro-optic modulation of a polymer/liquid-crystal composite containing nano-sized LC pores inside an anisotropic polymer matrix. The fast decay response $< 20 \mu\text{s}$ was demonstrated in the composite film. Only the effective refractive index can be tuned without disturbing the molecular orientation in the polymerized LC matrix.

**LCT2 - 2 Stacked LC Micro Lens Array Designed for 2D/3D
16:10 Switching on Compound-Eye Camera**

*M. Ito, Y. Kizu, H. Kwon, Y. Kizaki, K. Suzuki, R. Ueno,
M. Kobayashi, H. Funaki, Y. Nakai*

Toshiba, Japan

We have developed a stacked liquid crystal micro lens array (LC MLA) designed for the compound-eye camera application. The fabricated LC MLA could switch by voltage driving between compound-eye (3D) imaging mode to get depth information and 2D imaging mode to get high resolution.

LCT2 - 3 Polarizer-Free Imaging of LC Lens Using Reference Image
16:30

C. Cui, R. Bao, S. Yu, X. Gong, M. Ye
SuperD, China

This paper presents an imaging method where focusing is achieved by a liquid crystal (LC) lens of single nematic LC layer without using polarizer. A simple and efficient image processing method is proposed to enhance the image contrast and reduce undesired low frequency components introduced by the non-modulated ordinary wave.

Also presented in Innovative Demonstration Session (see p.212)

LCT2 - 4 Anisotropic Photoluminescence from an LC-Dye System
16:50

T. Masuda, T. Kamimura, S. Itaya, I. Fujieda
Ritsumeikan Univ., Japan

Photoluminescence of a homogeneously-aligned liquid crystal cell containing elongated dye molecules is anisotropic. Its spectrum, intensity and polarization state depend on the orientation of the dye molecules and the emitting direction. Such a cell with tunable emission characteristics might find applications in lightings, displays as well as in energy harvesting.

Author Interviews and Demonstrations

17:15 – 18:15

Thursday, December 4**10:45 - 11:50****Marine Hall****LCT3: Photo Alignment**

Chair: R. Yamaguchi, Akita Univ., Japan

Co-Chair: K. Miyachi, Sharp, Japan

LCT3 - 1: *Invited* Ideal Photoalignment Technology for IPS-LCDs
10:45

N. Kunimatsu, H. Sonoda, Y. Hyodo, Y. Tomioka
Japan Display, Japan

An ideal photoalignment technology for IPS-LCDs has been developed using our original material and process design, which increases azimuthal anchoring strength, reduces photoirradiation energy, and enables the use of negative LC. We have since realized the practical use of this technology and improved the panel specification.

LCT3 - 2: Invited New Photo-Aligning Materials Having Cinnamoyl Moieties
11:10

H. Hasebe, K. Maruyama, M. Takashima, S. Amano, F. Kodaera, S. Yamamoto, I. Nishiyama, Y. Saito, Y. Kadomoto, H. Ito, K. Obi, T. Kusumoto, H. Takatsu, Y. Tani, K. Yamauchi, K. Fujisawa, H.-S. Kwok, V. G. Chigrinov*, M. Schadt***

DIC, Japan

**Hong Kong Univ. of S&T, Hong Kong*

***MS High-Tech Consulting, Switzerland*

We present two types of novel side-chain photo-polymers with cinnamoyl moieties for photo-alignment of liquid crystal displays (LCDs). The planar aligning materials are highly UV sensitive (315 nm, 150 mJ/cm²). They target in-plane switched (IPS)-LCDs with excellent AC-image sticking, comparable to brushed polyimides. Correlations between photo-dimerization and image sticking are discussed.

LCT3 - 3 Withdrawn

LCT3 - 4L Grayscale Generation for Optically Rewritable e-Paper Based on Polarization Rotator
11:35

W. Zhang, J. Sun, F. Fan, A. K. Srivastava, V. G. Chigrinov, H.-S. Kwok

Hong Kong Univ. of S&T, Hong Kong

In this paper, grayscale images for optically rewritable (ORW) electronic paper are generated by the polarization rotator. The polarization plane could be rotated from 0° to 90° by applying square waveform from 4 V to 10 V linearly. This polarization rotator could be the most important part of printer for ORW.

----- Lunch -----

13:30 - 14:50

Marine Hall

LCT4: LC Materials

Chair: S. Ishihara, Osaka Inst. of Tech., Japan

Co-Chair: H. Hasebe, DIC, Japan

LCT4 - 1: Invited High-HTP Macrocyclized Phenyl Cinnamate Dimer Utilizable as Photo-Responsive Chiral Dopant for Nematic LCs
13:30

J. Watanabe, M. Itoh, K. Marumo, Y. Harada, S. Kang, K. Sakajiri, M. Tokita

Tokyo Inst. of Tech., Japan

Photo-dimerisation of cyclized phenyl cinnamate dimer with chiral spacer was examined. The rate of dimerization in cyclic dimer was 20 times larger than that in linear one. With this photo-dimerization, cyclic dimer decreased helical twisting power of cholesteric LC from 30 to 7 μm^{-1} , which is applicable for optical materials.

LCT4 - 2 Photoswitchable Bent and U-Shaped LCs**13:55**

L. M. Rahman, M. M. Yusoff, S. M. Sarkar, S. Kumar,
C. Tschierske***

Univ. Malaysia Pahang, Malaysia

**Raman Res. Inst., India*

***Martin-Luther-Univ., Germany*

Three series of liquid crystalline compounds comprised of bent-shaped and U-shaped molecules incorporating azobenzene in side arms and terminal double bonds, were synthesized and characterized. The bent-shaped compounds exhibited B₆ and B₁ phases whereas U-shaped molecules showed SmA phase. These molecules exhibit strong photoisomerisation behaviour in solutions and solid state.

LCT4 - 3 LC Semiconductors Bearing Cyclotetrasiloxane Rings and Their Ring-Opening Polymerization**14:15**

*M. Funahashi, Y. Funatsu, K. Takenami, K. Seike,
A. Sonoda**

Kagawa Univ., Japan

**AIST, Japan*

In contrast to conventional liquid crystalline semiconductors bearing linear alkyl chains, we have synthesized π -conjugated liquid crystals bearing cyclotetrasiloxane rings. Their thin films produced by a spin-coating method can be insolubilized by exposure to vapor of trifluoromethanesulfonic acid.

LCT4 - 4L Negative Dispersion of Birefringence of Smectic Liquid Crystal-Polymer Composite Film**14:35**

H. Lee, J.-H. Lee

Chonbuk Nat. Univ., Korea

We achieved a negative dispersion of birefringence using self-organized smectic liquid crystal (LC) and polymers. The smectic LC was used as two dimensional template and the polymers were formed between the layers of LC. n_e was more smoothly decreased than n_o and the birefringence was increased with a longer wavelength.

----- Break -----

IDW Best Paper Award**IDW Outstanding
Poster Paper Award**

These awards will go to the most outstanding papers selected from those presented at IDW '14.

The 2014 award winners will be announced on the IDW website: <http://www.idw.or.jp/award.html>

15:15 - 16:35

Marine Hall

LCT5: LC Evaluation

Chair: H. Wakemoto, Japan Display, Japan

Co-Chair: M. Inoue, Apple, Japan

LCT5 - 1: Invited Azimuth Easy Axis and Anchoring Control of Rubbed Polymers by LC Mixture

15:15

*R. Yamaguchi, M. Nishimura, A. Kodate**Akita Univ., Japan*

An easy axis of rubbed polymers with aromatic side-chains depends on LC materials. Two LCs which align parallel and perpendicular to the rubbing direction are mixed and the alignment direction is investigated. An azimuthal anchoring energy is varied by using the LC mixture more than one order of magnitude.

LCT5 - 2 A Method to Determine the Degree of Jet Mura for Curved Display

15:40

*K. H. Chen, W. F. Sung, W. S. Kao, Y. Cheng**AU Optronics, Taiwan*

We propose a method to quantify a kind of mura of curved display, named as jet mura (JM) caused by bending stress, via converting the bending offset of up and low glass substrates to an index. Through developing index, more precise definition and further control of JM will be achieved.

LCT5 - 3 Premeditate Display Quality of FFS-LCD Using Negative LC by DC Stress

16:00

*Y. Tang, H. Cui, J. Liu, X. Jiang, P. Liao, C. Yu**InfoVision Optoelect., China*

We compare the concentration of impure ion, and the contact match character of different materials in different FFS-LCD using negative LC by analyzing the change of brightness and image quality when DC voltage is applied to the data signal.

LCT5 - 4L Tilted Dipole Model for an LC-Dye System

16:20

*I. Fujieda**Ritsumeikan Univ., Japan*

A model is proposed to understand anisotropic photoluminescence from an LC-Dye system. Its LC layer is divided into sub-layers containing electric dipoles with specific tilt angles. Radiation pattern from each sub-layer is weighted by the power absorbed and added together. A simplified model is applied for our latest experiment.

Author Interviews and Demonstrations

18:30 – 19:30

Friday, December 5

9:00 - 12:00

Exhibition Hall B

Poster LCTp1: Fast Switching LCD**LCTp1 - 1 Electro-Optic Response of a Chiral Nematic LC with Low Dielectric Anisotropy***I. Onodera, M. Kimura**Nagaoka Univ. of Tech., Japan*

The change of the transmittance and the electro-optic response of a chiral nematic liquid crystal mixture with positive dielectric anisotropy in Uniform Standing Helix (USH) configuration are investigated. Relatively high response of 80% is observed. However, the texture was found to be unstable, and was easily broken applied voltage.

LCTp1 - 2 Enhanced Optical Response in Homogeneously Aligned LC Cells via He-Ne Laser Holographic Exposure*C.-Y. Chien, C.-R. Sheu**Nat. Cheng Kung Univ., Taiwan*

We use a way of holographic exposure via a He-Ne laser to process homogeneously aligned liquid crystals (LCs) cells. As a result, the possibly expected film-like horizontally polymer network is generated to enhance optical response of LC cells. Experimental results are demonstrated and discussed.

LCTp1 - 3 Effect of Polymer Wall Formation on Stability and Electro-Optical Properties of Reverse TN-LCDs*M. Akimoto, K. Nagao, K. Takatoh**Tokyo Univ. of Sci., Yamaguchi, Japan*

Here we show the basic properties of polymer-wall stabilized RTN-LCD whose retention time exceeds over a month and a half and it shows no degradation. The polymer-wall stabilized RTN-LCD achieves the great reduction of driving voltage, while its response time gets slower after polymer-wall formation.

LCTp1 - 4L Sub-Millisecond Switching of a Nematic Liquid Crystal Cell Aided by a Vertical Bias Field*Y.-J. Park, J.-W. Kim, T.-H. Choi, T.-H. Yoon**Pusan Nat. Univ., Korea*

We propose a method for sub-millisecond response time in a LC cell using a vertical bias electric field. While the vertical bias electric field is applied for the dark state, an in-plane electric field is applied for the bright state.

LCTp1 - 5L Fast Switching Alignment-Controlled Polymer-Dispersed LCs for Local Dimming Backlight*E. Uchida, T. Ishinabe, H. Fujikake**Tohoku Univ., Japan*

We have proposed a novel local dimming backlight system using alignment-controlled PDLC to improve contrast ratio and power consumption of LCDs. We clarified that bifunctional LC monomer and high refractive index nematic LC material were effective to achieve the PDLC cell with fast response speed and high light diffusion efficiency.

9:00 - 12:00**Exhibition Hall B****Poster LCTp2: LC Application****LCTp2 - 1 The See-Through Screen Based on a Polarization-Dependent LC Device***W.-K. Lin, W.-C. Su**Nat. Changhua Univ. of Education, Taiwan*

A polarization-dependent diffuser based on liquid-crystals is fabricated as a projection screen. For a specific linear polarized light, it is a diffuser screen. For the other orthogonal polarization, the screen becomes transparent. Therefore, a see-through screen but with diffuser function is presented.

LCTp2 - 2 Evaluation of Resolving Capabilities at Different Incident Angles of an Imaging System with LC Lens*R. Bao, C. Cui, S. Yu, X. Gong, M. Ye**SuperD, China*

The distributions of modulation transfer function along two orthogonal directions in the object plane for an imaging system with a liquid crystal lens are measured. The MTF50 remains almost constant across the incident angle of 26° along the rubbing direction, and 36° along the direction perpendicular to the rubbing direction.

LCTp2 - 3 LC Tuning Slow Light Photonic Crystal Waveguide*G.-H. Li, F.-L. Hsiao**Nat. Changhua Univ. of Education, Taiwan*

We demonstrate a tunable 1D PhC nanobeam with infiltrated nematic liquid crystals. The band structure and group velocity can be tuned by changing applied voltage to modify the direction of LC molecules. A large tuning range of about 49 nm at a low operating voltage of 10 V is achieved.

LCTp2 - 4 Surface Morphology Investigation of UV-Glue Composition in PDLC Films

C.-T. Su, C.-S. Hsieh, J.-T. Lien

Chunghwa Picture Tubes, Taiwan

In this paper, comparing the variation of surface morphology of polymer dispersed liquid crystal (PDLC) was included. Our results demonstrate an interesting from variation of droplet feature and reveal that the contrast ratio can be increased and decreased the driving voltage by heating, which reveal a great potential property.

LCTp2 - 5 Features of the Optical Response and Relaxation of the Nematic LC Doped with CdSe/ZnS Quantum Dots

E. Konshina, I. Galin, D. Shcherbinin, E. Gavrish

ITMO Univ., Russia

This study is devoted to the dynamics of electro-optical response and relaxation time of LC cells with nematic LC doped with CdSe/ZnS semiconductor quantum dots (QDs) and homogeneously oriented by rubbed polyimide. The influence of the nanoparticle concentration as well as the parameters of alternating electric field has been studied.

LCTp2 - 6 A New Low-Power and High Aperture Ratio for High-Resolution Mobile TN Panels

W. Q. Song, Y. C. Chang, D. L. Fu, J. F. Wu

InfoVision Optoelect., China

In this paper, we propose a new twisted nematic (TN) pixel structure for high PPI. Compared with the original SUD I structure, aperture ratio (AR) of the new structure can be increased by 43%. At the same time, power consumption of the new structure can be decreased by 23.3%.

LCTp2 - 7 Study on Improving the Image Quality Using Single Compensation Film

B. Hai, C.-T. Kang

Shenzhen China Star Optoelect. Tech., China

In this article, we study how to improve the image quality using single compensation film on our PS-VA cell, and we will provide some measured data and pictures to prove our idea.

LCTp2 - 8L Excitation Energy for the Laser Emission in a Well-Aligned Liquid Crystalline Blue Phase II

K.-B. Kim, S.-W. Choi

Kyung Hee Univ., Korea

A well-aligned Blue Phase II (BP_{II}) with mono-platelet domains is produced and it is found that the excitation energy of the laser emission can be drastically reduced.

LCTp2 - 9L Fabrication and Evaluation of Flexible Blue Phase LC Devices with Polymer Walls

H. Sakai, T. Ishinabe, H. Fujikake

Tohoku Univ., Japan

To develop the flexible liquid crystal display with wide viewing angle range and high contrast ratio, we proposed a blue phase liquid crystal device with polymer walls. We clarified that polymer walls can suppress a distortion of alignment of the blue phase liquid crystal layer in a bending state.

LCTp2 - 10L Liquid Crystal Molecular Orientation State of Micropatterned Twisted Nematic Liquid Crystal Cells: A Computer Simulation Investigation

M. Honma, K. Takahashi, R. Yamaguchi*, T. Nose*

Akita Pref. Univ., Japan

**Akita Univ., Japan*

We investigate the voltage-dependent liquid crystal molecular orientation state in micropatterned twisted nematic liquid crystal (LC) cells using a computer simulation. Particularly, we discuss the voltage-dependent bulk LC directors for different micropattern periods. It is revealed that the driving voltage greatly decreases as the micropattern period decreases.

LCTp2 - 11L New Electrode Structure of FFS Mode for Blocking of Electrostatics

J. H. Kim, D. H. Kim, T. H. Kim, H. S. Choi, S. Kundu, Y. J. Lim, S. H. Lee

Chonbuk Nat. Univ., Korea

In the FFS mode, ITO coating is required in a backside of top glass substrate in order to prevent electrostatics because the top substrate is purely insulator, which results in troublesome during glass etching to make displays thinner and lighter. To resolve the issue, we proposed a new FFS which has an electrode on inner top substrate, which makes glass etching easier for lightweight and thinness.

LCTp2 - 12L An Extra Photoresist Film Fabricated in Liquid Crystal Lens Array to Prevent Occurrence of Disclination Lines

C.-S. He, P.-H. Tang, W.-Y. Lu, Y.-T. Yang, C.-H. Lin, C.-R. Sheu

Nat. Cheng Kung Univ., Taiwan

A proposed method used to prevent the disclination line occurrence in liquid crystal lens array, which is usage of an extra non-patterned or patterned SU8 photoresist films coated on surfaces of patterned ITO films in lens structures. As a result, the problem of disclination line occurrence is effectively prevented.

LCTp2 - 13L Light Shutter Using Dye-Doped Polymer-Networked Liquid Crystals with Crossed Patterned Electrodes

J. Heo, J.-W. Huh, B.-H. Yu, T.-H. Yoon

Pusan Nat. Univ., Korea

We propose an initially transparent light shutter using dye-doped polymer-networked liquid crystals with crossed patterned electrodes. This device, which is switchable between the transparent and opaque states, shows fast response time and low operation voltage. We expect that the proposed light shutter can increase the visibility of a transparent display.

LCTp2 - 14L Memory Characteristics of LC Orientation Assisted by Polymer Filaments Spun by Electrospinning Method - Application for Quasi-VA Bistable LCDs with Nn-LC -

S. Dohi, T. Terasawa, Y. Kudoh, T. Takahashi

Kogakuin Univ., Japan

A bistable nematic LCD with $\Delta\epsilon < 0$ has been investigated. The S90° (quasi-vertical alignment) and the AS270° states were used. However, the memory characteristic was poor in the AS270° state. Then, polymer filaments spun by electrospinning were attempted to use to improve the holding condition in the AS270° state.

LCTp2 - 15L Molecular Orientation and Phase Shift Properties of Microstrip-Line-Type LC Phase Shifter Combined with n-Type LC Materials

M. Nagasawa, T. Komuro, T. Sasamori, Y. Isota, T. Watanabe, K. Ito*, R. Ito, M. Honma, T. Nose*

Akita Pref. Univ., Japan

**Yurikogyo, Japan*

Planar-type millimeter-wave (MMW) LC phase shifter is designed based on the microstrip-line (MSL). LC layer, which acts as a tunable material, can be easily introduced on the MSL by the novel structure. This paper reports basic performance of the MSL-type phase shifter combined with negative type (n-type) LC materials.

LCTp2 - 16L Modified Microscopic Structure and Its LC Molecular Orientation Effects in the Stretched Porous PMMA Films

S. Ohno, N. Toshima, R. Ito, M. Honma, T. Nose

Akita Pref. Univ., Japan

Porous PMMA materials can easily be obtained by using ethanol/water solution. They provide ease in fabrication of bulky LC layer, which is advantageous for MMW and/or THz application. Modification effect of microscopic porous structure by film stretching is investigated to introduce some anisotropic molecular orientation effect.

LCTp2 - 17L Single Crystal Growth of Soluble Organic Semiconductor Controlled by Liquid Crystal Solvents under Electric Field

T. Matsuzaki, T. Ishinabe, H. Fujikake

Tohoku Univ., Japan

To increase the mobility of organic semiconductors, it is necessary to form a single crystal whose crystal orientation is controlled uniformly. In this paper, orientation control of single crystal of the organic semiconductors in a liquid crystal solvent was reported, where the liquid crystal were aligned by electric field.

9:00 - 12:00

Exhibition Hall B

Poster LCTp3: Photo Alignment

LCTp3 - 1 Multi-Domain IPS LC Cell Using the Photo Alignment Method

B.-J. Mun, K.-W. Park, G.-D. Lee

Dong-A Univ., Korea

We proposed the photo-aligned multi-domain IPS mode by double exposing the UV light to achieve both the high brightness and wide-viewing angle properties. Also, the optical performance of the proposed IPS cell is demonstrated from the experiments in this paper.

LCTp3 - 2 Localized Cell Parameter Comparison of Photo Alignment and Rubbing Type in FFS-LCD

K.-T. Huang, Y.-W. Hung, Y.-T. Chao, T. Lee, R.-X. Fang, C. Lee, S.-C. Lin, C. Kuo, T.-S. Jen

HannStar Display, Taiwan

Fringe-Field Switch (FFS) mode LCD have been widely used in portable device due to its excellent performance of display. In order to improve the image quality of panel, photo alignment technology is being applied to FFS mode LC panel. In this paper, the cell parameters have been compared.

LCTp3 - 3 Fast Switchable Ferroelectric LC Grating and Analysis for the Parameters

Y. Ma, L. Shi, A. K. Srivastava, V. G. Chigrinov, H. S. Kwok

Hong Kong Univ. of S&T, Hong Kong

A method for the fabrication Ferroelectric liquid crystal switchable grating based on photo-alignment technique has been proposed. The first order diffraction efficiency is 65% and response time is 69 μ s at the electric field of 1.33 V/ μ m. Theoretical calculation is given and different FLC parameters' effects on the efficiency are analysis.

LCTp3 - 4L Rubbing Method for Liquid Crystal Alignment with Zero Pretilt*J.-H. Park, S.-W. Oh, T.-H. Yoon**Pusan Nat. Univ., Korea*

We propose a negative liquid crystal (LC) alignment method for zero pretilt angle using polyimide (PI) mixed with the reactive mesogen (RM). Zero pretilt angle can be obtained by UV curing of RM monomers under an applied vertical electric field before rubbing of PI.

9:00 - 12:00**Exhibition Hall B****Poster LCTp4: LC Materials****LCTp4 - 1 Modeling of LC/Dendrimer Mixtures by Using Hard Repulsive Molecules***T. Koda, M. Uchida, A. Nishioka, O. Haba, K. Yonetake, M. Kwak*, Y. Momoi*, N. Kim*, S. Hong*, D. Kang*, Y. Choi***Yamagata Univ., Japan***LG Display, Korea*

We propose model systems for molecular simulation to discuss behaviors of alignment of liquid crystal molecules with dendrimers on substrates. We used hard cylinders for liquid crystal molecules and hard spheres for dendrimers. Results showed both cases of homeotropic alignment and homogeneous alignment depending on simulation condition and procedure.

LCTp4 - 2 Withdrawn**LCTp4 - 3 Pretilt Angle Control of LC on Doping Silica Nanoparticles and Reactive Monomers***C.-J. Hsu, C.-C. Kuo, C.-D. Hsieh, C.-Y. Huang**Nat. Changhua Univ. of Education, Taiwan*

The pretilt angle of liquid crystals (LCs) is controlled by simultaneously doping silica nanoparticles (SNs) and reactive monomers into the LC cell. In the co-doping system, the pretilt angle of LCs is effectively controlled in a wide range without markedly increasing response time of the cells.

LCTp4 - 4L Effects of Polymer-Stabilization on Electro-Optical Properties in an Amorphous Blue Phase III*T. Hirose*,**, A. Yoshizawa****Hirosaki Univ., Japan****Tohoku Chem., Japan*

We prepared a blue phase III mixture consisting of a nematic liquid crystal and a chiral dopant. The BPIII structure was stabilized in a wide temperature range more than 50 K by a polymer network. We demonstrated fast response and hysteresis-free switching in the polymer-stabilized BPIII at room temperature.

9:00 - 12:00

Exhibition Hall B

Poster LCTp5: LC Evaluation**LCTp5 - 1 Analysis on Flexoelectric Effect in AH-IPS LC Mode under Low Frame Rate Driving Using a High Speed Camera***D.-J. Lee^{*,**}, G.-Y. Shim^{**}, S.-H. Yoo^{**}, J.-H. Lee^{*}, J.-H. Baek^{*}, H. Choi^{*}, Y. M. Ha^{*}, H.-R. Kim^{**}**^{*}LG Display, Korea**^{**}Kyungpook Nat. Univ., Korea*

We investigated the flicker behavior of advanced high performance in-plane switching mode with positive dielectric LC and negative dielectric LC under low frame rate operating. For the precise analysis on brightness distribution change between positive and negative frame, we used a high speed camera and analyzed the positional brightness variation.

LCTp5 - 2 Proposal of Measuring the Difference in Flexoelectric Coefficient of a TN-LC Cell by Transmission Ellipsometry*Z. A. B. Filzah, H. Matsumoto, M. Kimura, T. Akahane**Nagaoka Univ. of Tech., Japan*

A technique on how to measure the difference values of Splay and Bend flexoelectric coefficient in nematic liquid crystal (LC) is proposed. In this proposal, the effect of several parameters for twisted nematic (TN) cell with in-plane electric field will be presented.

LCTp5 - 3 Analysis of the Vertical Crosstalk of Advanced Super Dimension Switch Mode TFT-LCD*S. Wang, J. Li, S. Q. Huang, W. Xue, Y. J. Wang, Y. Shi, Q. Y. Guo, K. H. Park, Y. B. Lee, C. C. Che, D. Chen, S. K. Lee**Hefei BOE Optoelect. Tech., China*

This paper introduced the vertical crosstalk of ADS (Advanced Super Dimension Switch) mode TFT-LCD. Ioff and Cpd have been studied. The results indicated that decreasing the distance of active exceed gate could improve Ioff, and increasing the distance of pixel ITO and common ITO to data line could decrease Cpd.

LCTp5 - 4 Measurement for Sum of Flexoelectric Coefficients for Nematic LCs by Using Capacitance Characteristics under Applying the DC Voltage*S. Nakamura, Y. Kudoh, T. Takahashi**Kogakuin Univ., Japan*

The flexo-coefficients ($e_{11}+e_{33}$) was attempted to determine by the capacitance characteristics against applying the dc voltage to the HAN cell. Furthermore, the chromatographic isolation phenomenon was used to avoid the influence of impurity ions, when the LC material was injected into the cell by capillary action.

LCTp5 - 5L Basic Performance of the Birefringence Measurement System Using $\pm 45^\circ$ TNLC

*T. Takeuchi, M. Honma, R. Ito, N. Fuzita, K. Okano,
J. Murata, H. Muraguchi, N. Ozaki, T. Nose*

Akita Pref. Univ., Japan

Precision birefringence measurement system have been proposed with a combination of the rotary-analyzer method and the rotary-phase-plate method. However, they require some mechanical rotation devices. In this study, birefringence measurement system without any mechanical movements is investigated by replacing the mechanical rotation components to the TNLC cells.

**The 50th Anniversary Speech of PDPs
“Summing Up of the PDP History
and a Peek at Plasma
Technologies Beyond Displays”
(FED4 – 1)**

Friday, December 5, 2014

15:15 - 15:55

Room 302B

See page 118 for detail

**Evening Get-Together
with Wine**

Tuesday, December 2, 2014

18:00 – 20:00

Observation Deck (31F),

Hotel Nikko Niigata

(Sponsored by Merck Ltd., Japan)

See page 12 for details

Workshop on Active Matrix Displays

Wednesday, December 3

14:00 - 17:00

Exhibition Hall B

Poster AMDp1: Oxide TFT
Special Topics of Interest on Oxide-Semiconductor TFT

AMDp1 - 1 **Withdrawn**

AMDp1 - 2 **A 31-in. FHD AMOLED TV Driven by Amorphous IGZO TFTs**

*H.-J. Zhang, C.-Y. Su, W.-H. Li, L.-Q. Shi, X.-W. Lv,
 Y.-T. Hu, C.-Y. Tseng, Y.-F. Wang, C.-C. Lo
 Shenzhen China Star Optoelect. Tech., China*

A 31-in. FHD (1920x1080) AMOLED TV was developed with a-IGZO backplane. The IGZO (1:1:1:4) AC sputtering system was applied to fabricate ESL type a-IGZO TFTs at Gen 4.5 glass substrate. TFTs with different a-IGZO etch stopper layers were also studied to realize excellent TFT characteristics and reliability under gate bias-stress.

AMDp1 - 3 **5.8-in. Indium Gallium Zinc Oxide TFT LCD with Slim Border**

*E.-C. Liu, Y.-H. Chen, S.-C. Chiang, Y.-J. Lu, Y.-Y. Huang
 Chunghwa Picture Tubes, Taiwan*

In this study, 5.8-in. indium gallium zinc oxide TFT LCDs were fabricated with slim border. The slim border used by 7T2C gate-driver in panel. Due to the high mobility, the GIP circuit designed to be lower than 1 mm in 5.8-in. indium gallium zinc oxide TFT LCDs was also demonstrated.

AMDp1 - 4 **Investigation of Hysteresis in Dual-Gate a-IGZO TFTs**

*Y.-H. Kim, J. G. Um, S. Lee, M. Mativenga, J. Jang
 Kyung Hee Univ., Korea*

Hysteresis in dual-gate a-IGZO TFTs was investigated. The top-gate was swept in forward and reverse modes, while the bottom-gate was biased negatively, grounded or biased positively. The hysteresis was found to be largest when the bottom-gate was biased positively – consistent with electron trapping into the top gate-insulator.

AMDp1 - 5 CVD-Free and Low Temperature Amorphous InGaZnO TFTs for Flexible Display Applications

*W.-T. Lin, C.-C. Cheng, C.-Y. Liu, M.-F. Chiang
AU Optronics, Taiwan*

A low temperature (< 220°C) process flow without plasma enhanced chemical vapor deposition (PECVD) of preparing a-IGZO TFTs is presented. All the inorganic dielectrics have been replaced to the organic materials by the coating process, and the CVD-Free a-IGZO TFTs also show the excellent stability under the gate bias stresses.

AMDp1 - 6 Investigation for the Time-Dependent Characteristics of Sol-Gel Processed Zinc-Tin-Oxide (ZTO) Transistors

*Y. W. Wang, C. M. Jian, H. H. Wang, W. L. Liu
Nat. Chang Hua Univ. of Education, Taiwan*

We report the effect of time-dependent characteristics variation of sol-gel zinc-tin-oxide (ZTO) transistors. The sol-gel ZTO transistor could achieve a maximum field effect mobility of 2.7 cm²/Vs, on/off ratio over 10⁵ and a sharpest sub-threshold slope of 0.9 V/decade. The devices have a trend to perform better as time passing.

AMDp1 - 7 Electrical Characteristics and Stability of Bottom Gate a-InGaZnO TFTs with Different Geometric Structures

*H.-W. Li, C.-P. Chang, H.-H. Lu
AU Optronics, Taiwan*

The bottom gate a-IGZO TFTs with difference geometric structures were investigated. The effective channel length is mainly related to the source/drain space not the island layer length. With increasing the effective channel length, the stability of the a-IGZO TFTs could be greatly improved without degradation of the electrical characteristics.

AMDp1 - 8 Hysteresis Improvements by Introducing a Double-Active-Layered Structure in a-InGaZnO TFTs

*Y.-C. Tsai, F.-J. Chan, P.-T. Liu, H.-P. D.-D. Shieh
Nat. Chiao Tung Univ., Taiwan*

a-IGO/a-IGZO TFTs exhibited S.S of 0.4 V/decade and hysteresis of 0.40 V, whereas a-IGZO TFTs showed S.S of 0.93 V/decade and hysteresis of 1.35 V. A smoother surface roughness of 0.25 nm in a-IGZO film was obtained by a double-active-layered structure with a-IGO/a-IGZO. a-IGO/a-IGZO TFTs also presented less charge trapping under NBIS stressing.

AMDp1 - 9 Self Heating Induced Hole Trapping at Back-Channel Edge of Flexible a-InGaZnO TFTs under Gate and Drain Bias Stress

G. Li*, B.-R. Yang**, Y.-C. Tsai***, R. Zhan*, C.-Y. Su****, C.-Y. Lee****, C.-Y. Tseng****, C.-C. Lo****, A. Lien****, S. Deng*, N. Xu*, H.-P. D.-D. Shieh***

*Nat. Sun Yat-Sen Univ., China

**SYSU-CMU Shunde Int. Joint Res. Inst., China

***Nat. Chiao Tung Univ., Taiwan

****Shenzhen China Star Optoelect. Tech., China

*****TCL Corporate Res., China

Self heating enhanced positive V_{th} shift in a-IGZO TFTs has been widely reported. In this paper, the authors further observed hump formation during positive V_{th} shift. This hump is speculated to result from the combination effect of self heating induced hole trapping and edge effect.

AMDp1 - 10 Enhancement of Performance and Storage Stability of Thin-Film Transistor with InZnSnO/InGaZnO Bilayer Stack Channel Layers

X.-Y. Yeh, C.-S. Fuh, P.-T. Liu, C.-H. Chang, C.-C. Chang, Y.-C. Tsai

Nat. Chiao Tung Univ., Taiwan

We investigated on electrical performance and storage issues of high efficiency amorphous In-Zn-Sn-O (IZTO) thin film transistor. By capping additional In-Zn-Sn-O (IGZO) layer on IZTO to form the bilayer channel. The threshold voltage and substrate swing were improved proportionally with the thickness of IGZO capping layer.

AMDp1 - 11 Effects of Negative-Gate-Bias with Illumination Stress on the Hysteresis in the Transfer Curve of a-IGZO TFT Measured by the New Sampling Method

Y.-J. Chen, Z.-H. Cai, Y.-H. Tai, C.-Y. Chang, C.-J. Li*, Y.-H. Yeh*

Nat. Chiao Tung Univ., Taiwan

*ITRI, Taiwan

In the study, the hysteresis in the transfer curve of a-IGZO TFTs with bias stress and illumination is analyzed. The threshold voltage difference between the two curves in the hysteresis keeps the same, even the threshold voltages shift severely with stress time. The difference increases with the light intensity.

AMDp1 - 12 Withdrawn

AMDp1 - 13 Reduction of Hysteresis in Transfer Characteristics of Solution Processed IZTO TFT by Plasma Treatment

T.-H. Kim, C. Avis, H.-R. Hwang, J. Jang

Kyung Hee Univ., Korea

We fabricated solution-processed IZTO TFT with zirconium doped AlO_x (ZAO) as the gate insulator. Plasma treatment on ZAO improves TFTs' performances as follows: μ_{sat} , V_{th} , S.S. and hysteresis varied from 4.6 to 45.1 cm^2/Vs , 0.8 to 0.2 V, 268 to 81 mV/dec., and 1.2 V to 0.4 V, respectively.

AMD

AMDp1 - 14 Effect of Solution Processed AlO_x Passivation on Back Channel Etch a-IGZO TFTs

S. An, M. Mativenga, X. Lee, J. Jang

Kyung Hee Univ., Korea

The back surface of amorphous-indium-gallium-zinc-oxide (a-IGZO) thin-film transistors (TFTs) with a back-channel-etched (BCE) structure was treated with a solution-processed aluminum oxide (AlO_x) passivation layer. The result was a chemical reaction between the AlO_x solution and the a-IGZO at the back surface, which significantly improved the stability of the BCE TFTs.

AMDp1 - 15 Impact of Negative Bias and Illumination Stress on Channel Resistance of Back Channel Etched a-IGZO TFTs

M. Chun, J. Um, M. Mativenga, J. Jang

Kyung Hee Univ., Korea

The impact of negative-bias-illumination-stress (NBIS) on the channel resistance (R_{CH}) and series resistance (R_{SD}) of back-channel-etched (BCE) amorphous-indium-gallium-zinc-oxide (a-IGZO) thin-film transistors (TFTs) is investigated. It is found that while the R_{CH} decreases, R_{SD} increases with increasing NBIS time, indicating defect creation under source/drain electrodes.

AMDp1 - 16L Printability of Screen Printed Silver for Oxide Thin-Film Transistor toward a Printable Device

S. Urakawa, Y. Ishikawa, Y. Osada, M. N. Fujii, M. Horita, Y. Uraoka

Nara Inst. of S&T, Japan

Oxide semiconductor has superior properties more than organic semiconductor, which is one of the printable materials for all printed devices. To realize it an oxide thin-film transistor was fabricated by solution process. Amorphous InZnO was formed by spin-coating method and Silver as electrode was printed by screen print method.

AMDp1 - 17L Stable Electrical Characteristics of Solution Processed Amorphous InZnO Thin-Film Transistors with Organic Passivation Layers

*J. Okada, T. Nagase, T. Kobayashi, H. Naito
Osaka Pref. Univ., Japan*

Solution-processed organic passivation layers for amorphous InZnO thin-film transistors (TFTs) have been shown. Solution-processed amorphous InZnO TFTs with the organic passivation layers exhibit good electrical stability of the threshold voltage shift of less than 1.9 V after bias stress time of 10000 s.

AMDp1 - 18L ITO Interlayer to Improve the Electrical Performance of HfInZnO-TFTs

*J. Li, J.-H. Zhang, H. Zhang, X.-Y. Jiang, Z.-L. Zhang
Shanghai Univ., China*

We have fabricated hafnium-indium-zinc-oxide (HfInZnO) thin film transistors (TFT) with indium-tin-oxide (ITO) interlayer. Compared with conventional HfInZnO-TFT, the electrical performance and bias stability of HfInZnO-TFTs with ITO interlayer are improved. The performance enhancement is attributed to a decrease in interface trap state and an increase in carrier concentration.

14:00 - 17:00

Exhibition Hall B

Poster AMDp2: Active-Matrix Devices

AMDp2 - 1 Withdrawn

AMDp2 - 2 Driving Circuit of Fast Current Programming and Leakage Current Compensation for External Compensation on AMOLED Panel

*C.-C. Chen, K.-Y. Lee, H.-S. Lin, L.-H. Chang, Y.-H. Lin
AU Optronics, Taiwan*

To improve current charge time and leakage current issues on AMOLED panel, a driving circuit is proposed in this study. By operating this circuit, sensing speed and compensated accuracy can further be improved when utilizing external algorithm to compensate large-sized AMOLED panel.

AMDp2 - 3 Compensation Circuit for Active Matrix Organic Light Emitting Diode with Organic Thin-Film Transistors

G.-T. Zheng, P.-T. Liu, R.-J. Chen*, C.-Y. Tsai*,
H.-H. Hsieh***

Nat. Tsing Hua Univ., Taiwan

**Nat. Chiao Tung Univ., Taiwan*

***Polyera Taiwan, Taiwan*

This work presents pixel circuit using organic thin-film transistors. The simulation results show that the current change rate is less than 2% with 6 V threshold voltage variation of driving TFT by using scan signals as the majority signals to decrease the cost of ICs.

AMDp2 - 4 Simple Pixel Circuit Using LTPS TFTs with Mirror Compensation for AMOLED Displays

P.-S. Chen, Y.-T. Liu, F.-H. Chen, C.-L. Lin

Nat. Cheng Kung Univ., Taiwan

This work presents a new pixel circuit using low-temperature polycrystalline-silicon (LTPS) thin-film transistors (TFTs) for active-matrix organic light-emitting diode (AMOLED) displays. The proposed circuit can effectively compensate for the threshold voltage variation of TFTs and power line I-R drop by a simple mirror structure.

AMDp2 - 5 New AMOLED Pixel Circuit to Compensate for V_{TH} Variation with an Eliminated V_{DD} Line

Y.-T. Liu, P.-S. Chen, P.-S. Shieh, C.-L. Lin

Nat. Cheng Kung Univ., Taiwan

A new pixel circuit for active-matrix organic light-emitting diode is presented. The circuit utilizes a scan line as V_{DD} line to gain aperture ratio. The simulation results of this work demonstrate that the circuit has good immunity against V_{TH} variation of driving TFT and resolution of displays.

AMDp2 - 6 Circuit of Gate Driver on Array with Direct Threshold Voltage Compensation for the Pull-Down Transistors

Z.-H. Cai, Y.-J. Chen, Y.-H. Tai, C.-Y. Chang, C.-L. Wu,
Y.-H. Yeh**

Nat. Chiao Tung Univ., Taiwan

**ITRI, Taiwan*

A highly reliable circuit of gate driver on array with compensation for the pull-down transistors has been developed. The proposed circuit uses capacitance to store the threshold voltage of TFT and use it for compensation. Even with threshold voltage shift, its capability of pulling down the scan-bus can be kept.

AMDp2 - 7 Design of High Reliable and Self-Healing Integrated Gate Driving Circuit Applied for Amorphous Silicon TFT-LCDs

*C. Dai, C.-Y. Lee, T.-C. Lai, C.-C. Lo, A. Lien**

Shenzhen China Star Optoelect. Tech., China

**TCL Corporate Res., China*

32-in. tri-gate HD panels with high reliable and self-healing integrated gate driver on array substrate were designed and manufactured by amorphous silicon technology. Moreover, several severe reliability tests have been passed, including 2000 h high-temperature high-humidity operation, 2000 h low-temperature operation and 168 h image sticking test.

AMDp2 - 8L Reduction of Offset Voltage in Poly-Si Hall Devices by Enlarging Channel Size

D. Tadokoro, M. Kimura*,**, A. Yoshikawa*,*

T. Matsumoto, T. Matsuda*,**,**

**Ryukoku Univ., Japan*

***Joint Res. Ctr. for S&T, Japan*

****High-Tech Res. Ctr., Japan*

We are developing magnetic area sensors using poly-Si Hall devices. One issue is offset voltage in the Hall voltage, which occurs even without the magnetic field and is due to the zigzag path of the electric current. We have succeeded in reducing the offset voltage by enlarging the channel size.

AMDp2 - 9L High Performance CLC LTPS TFTs on Glass Substrate Using Sputtered HfO₂ Gate Dielectric

T. Meguro, A. Hara

Tohoku Gakuin Univ., Japan

We reported on the performance of CLC LTPS TFTs, which were fabricated at 550°C with a sputtered HfO₂ gate dielectric on a glass substrate. The output current of the HfO₂ TFTs achieved four and two times the magnitude of those of the SiO₂ TFT and Al₂O₃ TFT, respectively.

AMDp2 - 10L Working Confirmation under Low Illuminance for a Photosensor Pixel Using Thin-Film Phototransistor

S. Oyama, T. Kadonome*, T. Tanaka*, T. Fuchiya*,*

T. Matsuda,**, M. Kimura*,**,**

**Ryukoku Univ., Japan*

***Joint Res. Ctr. for S&T, Japan*

****High-Tech Res. Ctr., Japan*

We are developing photosensor pixels using thin-film phototransistors for various applications including artificial retinas. Until now, we have merely executed working confirmation under high illuminance. In this research, we try working confirmation under low illuminance. It is found that this photosensor pixel can detect a minimum illuminance of 5 lx.

AMDp2 - 11L Top-Gate LT Polycrystalline-Germanium TFTs on Glass Substrate Using CW Laser Crystallization

*Y. Nishimura, T. Sasaki, W. Tsuda, T. Meguro, A. Hara
Tohoku Gakuin Univ., Japan*

LT poly-Ge TFT was fabricated using CW laser crystallization and a thin Al₂O₃ gate dielectric. The poly-Ge film was crystallized by the mechanism of solid-phase self-sustaining crystallization with grains 20 nm in size. A mobility of 17 cm²/Vs was achieved, and the ability to operate at 5 V was demonstrated.

AMDp2 - 12L Hybrid Simultaneous Emission Pixel Circuit for High Brightness AMOLED Displays

*S.-J. Song, H. Nam
Kyung Hee Univ., Korea*

This paper describes a new simultaneous emission AMOLED pixel circuit where the programming operation occurs at the same time with light emission leading to high brightness. The SPICE simulation ensures that the proposed scheme reduces the average current error to 1.5% regarding the threshold voltage variation of ±0.2 V.

AMDp2 - 13L Improve Abnormal Defect of AMOLED Panel through both Side Suppressed GIDL Current

*W. S. Kim, Y. M. Kim, T. Cheng
Ordos Yuansheng Optoelect., China*

AMOLED panel has performed transistor aging process what suppressed GIDL for clear unable controlled abnormal defect. This method is drain edge side stress aging effect. In this paper discuss to improve of unable controlled abnormal defect through to both side suppressed GIDL.

AMDp2 - 14L Analysis and Improvement Method of Image Sticking in ADS Mode Applied Four-Mask Process

S. J. Choi, Y. S. Song, J. Y. Jung, Z. W. Chen*, J. Niu,
G. B. Hui, J. I. Ryu, J. M. Jun
BOE Tech. Group, China
Hefei Xinsheng Optoelect. Tech., China

In ADS mode, common and gate electrode can be patterned by one mask. However, due to its characteristics, under the gate, ITO is wholly patterned and even bigger, thus, that part, we call it ITO wing. Therefore, we had studied how ITO wing affects image sticking (I.S) of panels and how to solve it.

AMDp2 - 15L Pixel Circuit Structure of Compensated Voltage Program for AMOLED

S. Yang, X. Dong, H. Wang, H. Xue, Z. Chen, Y. Zhang, P. Wang

BOE OptoElect. Tech., China

In this paper, We propose a pixel compensating drive circuit, the voltage compensation process which can effectively solve the driving TFT threshold voltage V_{th} of the variation, thereby causing the current through the OLED non-uniformity problems. The results simulated by SmartSpice also can demonstrate the feasibility of this compensation.

AMDp2 - 16L High-Performance Organic TFTs with an Organic Gate Insulator Having Molecular Alignment Capability

Y. Nagatsuka, H. Tokuhisa, Y. Iimura*

Tokyo Univ. of A&T, Japan

**JSR, Japan*

We have presented device properties of OTFTs, in which two types of newly-developed organic gate insulators with molecular alignment capabilities are used. An OTFT with a pentacene layer deposited on a gate insulator with planar alignment capability gives extra-high carrier mobility of $\sim 5 \text{ cm}^2/\text{Vs}$ indicating high crystallinity of the film.

IDW '14 Tutorial in Japanese

Organized by SID Japan Chapter

Tuesday, December 2, 2014

Room 301, 3F

TOKI MESSE Niigata Convention Center

Detailed information is available on

<http://www.sid-japan.org>

EXHIBITION

12:40 – 18:00 Wednesday, Dec. 3, 2014

10:00 – 18:00 Thursday, Dec. 4, 2014

10:00 – 14:00 Friday, Dec. 5, 2014

Exhibition Hall B

TOKI MESSE Niigata Convention Center

Free admission with your registration name tag

Thursday, December 4

9:00 - 10:15

Snow Hall A

**AMD1: High Resolution Displays Using LTPS and Oxide TFTs
Special Topics of Interest on Oxide-Semiconductor TFT**

Chair: T. Kamiya, Tokyo Inst. of Tech., Japan

Co-Chair: K. Takatori, NLT Techs., Japan

AMD1 - 1: Invited High PPI Technologies for Mobile Displays

9:00

*A. Takimoto**Japan Display, Japan*

High pixel density LCD technologies have been continuously developed. Recently, high pixel density displays with touch interface have become the standard for smartphones. Tablet PCs follow the same trend. However, further development may face technical challenges. In this paper, the latest developments to tackle these problems are discussed.

AMD1 - 2: Invited Advantages of IGZO Platform in Ultra-High-Resolution LCD Applications

9:25

*N. Ueda, Y. Ogawa, K. Okada, A. Oda, S. Katoh,
S. Uchida, K. Yamamoto, T. Matsuo, H. Kawamori**Sharp, Japan*

This paper describes the advantages of Oxide TFT platform technology in ultra high resolution displays making use of Channel Etch (CE) Type Oxide TFT. It also explores the latest and future approach to resolve emerging concerns, such as panel driving power consumption, aperture ratio, and narrow bezel.

AMD1 - 3: Invited Ultra High-Definition OLED Display Using C-Axis Aligned Crystalline Oxide Semiconductor FETs

9:50

*H. Miyake, S. Kawashima, S. Inoue, M. Shiokawa,
A. Suzuki, S. Eguchi, Y. Hirakata, J. Koyama,
S. Yamazaki, T. Sato*, T. Shigenobu*, Y. Ohta**,
S. Mitsui**, N. Ueda**, T. Matsuo****Semiconductor Energy Lab., Japan***Advanced Film Device, Japan****Sharp, Japan*

We fabricated an 8K OLED display. Channel-etch type c-axis aligned crystalline oxide semiconductor (CAAC-OS) FETs demonstrate good properties even in the channel length of 1.5 μm . Gap spacers between pixels suppress leakage current through an intermediate layer of the tandem OLED.

----- Break -----

10:45 - 12:20

Snow Hall A

AMD2: Physics of Oxide Semiconductors
Special Topics of Interest on Oxide-Semiconductor TFT

Chair: J. Jang, Kyung Hee Univ., Korea

Co-Chair: N. Morosawa, Sony, Japan

AMD2 - 1: *Invited* Multiple Origins of Near-VBM Defects and Its Passivation Effects in a-In-Ga-Zn-O
10:45

T. Kamiya, H. Kumomi, H. Hosono
Tokyo Inst. of Tech., Japan

Amorphous oxide semiconductor, represented by a-IGZO, exhibits high electron mobilities $> 10 \text{ cm}^2/\text{Vs}$ even if deposited at room temperature. Several defects and effects of hydrogen and oxygen have been reported to date. This paper reviews recent results on these issues and discuss their effects on optimum deposition condition for a-IGZO.

AMD2 - 2: *Invited* Thermalization Energy Analysis of the Stability of Amorphous Oxide Thin Film Transistors
11:10

A. J. Flewitt
Univ. of Cambridge, UK

TFTs incorporating amorphous oxide semiconductors as the channel material are known to suffer from threshold voltage shifts under both positive and negative gate bias conditions. The thermalization energy will be covered as a means of converting measurements as a function of time into measurements as a function of energy.

AMD2 - 3: *Invited* Origin of High Photoconductivity Gain and Persistent Photoconductivity in Nanocrystalline Oxide Photo-Sensors
11:35

S. Jeon
Korea Univ., Korea

We present the mechanism of high photoconductivity gain and persistent photoconductivity in nano-crystalline oxide photo-transistor. Under the illumination, sub-gap optical absorption in oxide semiconductor causes the ionization of oxygen vacancy, which leads to high photocurrent in an operation condition. Also, the origin of persistent photoconductivity will be discussed.

**AMD2 - 4 Differences in Crystalline Morphology among
12:00 Crystalline Oxide Semiconductors**

*K. Dairiki, Y. Nonaka, M. Koyama, Y. Yamada,
A. Shimomura, N. Sorida, E. Takahashi, M. Takahashi,
S. Yamazaki*

Semiconductor Energy Lab., Japan

We compared crystalline morphologies of c-axis aligned crystalline In-Ga-Zn-O (CAAC-IGZO) with those of single crystalline and polycrystalline IGZO. The CAAC-IGZO has c-axis alignment but does not have alignment along a-b plane and clear grain boundaries. Therefore, the crystalline morphology of CAAC-IGZO is clearly distinguishable from those of other crystalline states.

----- Lunch -----

13:30 - 14:55

Snow Hall A

AMD3: Stability of Oxide TFT
Special Topics of Interest on Oxide-Semiconductor TFT

Chair: S. Jeon, Korea Univ., Korea

Co-Chair: M. Kimura, Ryukoku Univ., Japan

**AMD3 - 1: *Invited* Improved Electrical Characteristics and
13:30 Stability Using Various Post Treatments on
 Sputtered In-Ga-Zn-O Thin-Film Transistors**

Y. J. Tak, S. P. Park, H. Lee, H. J. Kim

Yonsei Univ., Korea

We have demonstrated various post treatments including high pressure annealing, simultaneous UV and thermal treatment, and doped passivation layer. These treatments have been performed to improve stabilities and electrical characteristics on sputtered In-Ga-Zn-O thin film transistors by reducing defect sites related to oxygen vacancies and increasing metal oxide bonds.

**AMD3 - 2 Reliability of Amorphous InGaZnO Thin Film
13:55 Transistors with Low Water-Absorption Passivation
 Layer**

*S. Ishikawa, T. Miyasako, H. Katsui, K. Tanaka,
K. Hamada, C. Kulchaisit*, M. Fujii*, Y. Ishikawa*,
Y. Uraoka**

JSR, Japan

**Nara Inst. of S&T, Japan*

Polymer passivation with low water absorption has been investigated for high reliable amorphous InGaZnO (a-IGZO) TFT. The photosensitive siloxane/silsesquioxane (SSQ) material is coated by a solution process without plasma etching process to avoid serious damage to the channel layer. The stability of a-IGZO TFTs was improved by polarity controlled siloxane material.

AMD3 - 3 **Channel Length Dependent Bias and Light Stability of Bulk Accumulation a-IGZO TFTs with Top Gate Offsets**
14:15

S. Lee, M. Mativenga, J. Jang
Kyung Hee Univ., Korea

Effect of bulk-accumulation on the negative-bias-illumination-stress (NBIS) stability of dual gate-driven a-IGZO TFTs with 2- μm top-gate offsets is investigated. By varying the channel length, it is shown that the TFTs are immune to NBIS, as long as half of the channel region is light shielded and under bulk-accumulation.

AMD3 - 4 **Effect of Parasitic Capacitance on Pixel Compensation Circuit Developed by Oxide TFT**
14:35

C.-Y. Lee, W.-C. Hsu, M.-W. Shih, Y.-L. Chen,
C.-C. Huang, L.-W. Liu, C.-K. Lo, H.-G. Chang, C.-H. Liu,
L.-F. Lin, H.-S. Lin, L.-H. Chang, Y.-H. Lin
AU Optronics, Taiwan

We have developed the pixel compensation circuit of 65-in. AMOLED Display, which was demonstrated in 2013. The effect of inherent parasitic capacitance, will be presented in this paper. To achieve a better performance of panel uniformity and reduce the influence of parasitic capacitance, the optimization of pixel design is necessary.

----- Break -----

15:15 - 16:45

Snow Hall A

AMD4: Higher Performance Oxide TFT
Special Topics of Interest on Oxide-Semiconductor TFT

Chair: H. J. Kim, Yonsei Univ., Korea
 Co-Chair: H. Kumomi, Tokyo Inst. of Tech., Japan

AMD4 - 1: *Invited* Bulk Accumulation Oxide TFTs for High Resolution Displays
15:15

J. Jang, M. Mativenga, D. Geng
Kyung Hee Univ., Korea

Owing to bulk-accumulation, dual-gate amorphous-indium-gallium-zinc-oxide (a-IGZO) thin-film transistors (TFTs) with top- and bottom-gates electrically tied together exhibit higher on-current, better turn-on voltage uniformity and lower sub-threshold voltage swing compared to single-gate-driven a-IGZO TFTs. In this talk, their optimization and application to fast TFT circuits and high resolution displays, are reviewed.

AMD4 - 2 High Mobility Zn-Free Oxide Thin Film Transistors

15:40

*T. Kugimiya, M. Ochi, A. Hino, H. Goto, Y. Takanashi, M. Kanamaru***Kobe Steel, Japan***Kobelco Res. Inst., Japan*

We have developed a new Zn-free oxide thin-film transistor (TFT) with high field effect mobility above 60 cm²/Vs. The TFT of etch stop layer structure requires no additional process to conventional process for a TFT. The new oxide-TFT shows excellent characteristics with a positive threshold voltage of 0.5 V, sub-threshold swing (SS) of 0.19 V/decade.

AMD

AMD4 - 3 Amorphous In₂O₃-Based Thin Film Transistors Fabricated by Low-Thermal Budget Process with High Mobility and Transparency

16:00

C.-H. Chang, C.-S. Fuh, C.-J. Chang, C.-C. Chang, X.-Y. Yeh, P.-T. Liu, H.-H. Lin, K.-L. Fang*, Y.-C. Kao*, C.-L. Lee*, P.-L. Shih*, W.-C. Chang*, I.-M. Lu***Nat. Chiao Tung Univ., Taiwan***Yeh Hsin Tech., Taiwan*

In this work, the influence of annealing on In-W-O (a-IWO) TFTs was investigated. The 100°C-annealed a-IWO TFTs exhibited an optimized performance with mobility of 39.16 cm²/Vs. Owing to the energy from annealing process, the structural relaxation can be enhanced leading to a better electrical characteristic of a-IWO TFTs.

AMD4 - 4L: Invited Large-Sized and UHD Curved OLED TV Employing White OLEDs and Oxide TFTs

16:20

*C.-W. Han, H. Kang, Y.-H. Shin, H.-J. Shin, B.-C. Kim, H.-S. Kim, B.-S. Kim, Y.-H. Tak, C.-H. Oh, B.-C. Ahn**LG Display, Korea*

In this paper, we will introduce technological progress for commercializing large-sized and UHD curved OLED TV. Those technologies including WOLEDs, Oxide TFTs, compensation circuit and solid phase encapsulation enable panel size scalability as well as mass production with lifetime reliability.

----- Break -----

17:00 - 18:30

Snow Hall A

**AMD5: Printed Electronics
Special Topics of Interest on Printed Electronics**

Chair: Y. Fujisaki, NHK, Japan

Co-Chair: H. Minemawari, AIST, Japan

AMD5 - 1: Invited High Performance Polymer Semiconductors

17:00

*A. Ohno**Mitsubishi Chem., Japan*

Solution processable polymer semiconductors whose mobility is up to 23.7 cm²/Vs have been developed. The mobility number opens up a new ground for applications with mobility more than 10 cm²/Vs range, such as TFTs for OLED and HF(High Frequency) communication.

AMD5 - 2: Invited Flexible Printed Organic TFT Arrays and Integrated Circuits

17:25

*S. Tokito**Yamagata Univ., Japan*

Newly developed silver nanoparticle ink and organic semiconductor materials for printed TFT (OTFT) devices have been applied to transistor arrays and exhibited very good electrical performance. Integrated circuits based on the OTFT devices were also fabricated using printing methods. In addition, ultra-thin and flexible circuits were successfully demonstrated.

AMD5 - 3 Alignment Control of Patterned Organic Semiconductor Crystals in Short Channel Organic Thin-Film Transistors

17:50

Y. Fujisaki, D. Takahashi, Y. Nakajima, H. Tsuji,
M. Nakata, T. Yamamoto**NHK, Japan***Tokyo Univ. of Sci., Japan*

Patterning deposition of crystalline organic semiconductor film is key issue to achieve high mobility organic thin-film transistor arrays. We present a patterning method which can control alignment direction of organic crystals. The corresponding short channel TFTs showed a high mobility of over 1 cm²/Vs.

AMD5 - 4L: Invited Small Molecule/Polymer Formulations for High Performance, High Uniformity Top Gate OTFTs

18:10

*M. Cowin, C. Watson, J. Carter, K. Crowley, R. Griffiths,
B. Brown**Smartkem, UK*

Small molecule/polymer organic semiconductor blends have been formulated to give transistors with mobilities of >3 cm²/Vs at channel length of 4 μm. The uniformity of on-current is <10% across a 100 mm substrate using both curved and linear transistor configurations. The devices also have excellent bias stress stability.

Author Interviews and Demonstrations

18:30 – 19:30

RECEPTION

Wednesday, December 3, 2014

19:00 – 21:00

Room "Continental" (4F)

Hotel Okura Niigata

See page 12 for details

Friday, December 5

9:00 - 10:15

Marine Hall

**AMD6: Chemistry of Oxide Semiconductors and TFT
Special Topics of Interest on Oxide-Semiconductor TFT**

Chair: K.-H. Su, Evonik Inds., Germany

Co-Chair: K. Takatori, NLT Techs., Japan

**AMD6 - 1L Improvement of Positive Bias and Temperature
9:00 Stress Stability by Fluorine Passivated In-Ga-Zn-O
Thin-Film Transistors**
J. Jiang, T. Toda, D. Wang, M. Furuta
Kochi Univ. of Tech., Japan

Positive bias and temperature stress (PBTS) stability of InGaZnO (IGZO) thin-film transistors (TFTs) with SiO_x and fluorinated silicon nitride passivation were investigated. It was found that fluorine effectively passivated traps and weakly bonded oxygen in IGZO and/or at gate insulator/IGZO interface, resulting in the improvement of PBTS for oxide TFTs.

**AMD6 - 2L Chemical Analysis of Fluorine in Highly Reliable
9:15 Oxide Thin Film Transistor with Silicon Nitride Gate
Insulator**
*H. Yamazaki, Y. Ishikawa, M. N. Fujii, J. P. S. Bermundo,
E. Takahashi*, Y. Andoh*, Y. Uraoka*
Nara Inst. of S&T, Japan
**Nissin Elec., Japan*

We propose highly stable amorphous In-Ga-Zn-O thin-film transistors (a-IGZO TFTs) with fluorinated silicon nitride (SiN_x:F) gate insulator against voltage bias and temperature stress. Result of X-ray photoelectron spectroscopy (XPS) measurement revealed that Indium bound with fluorine in a-IGZO plays the dominant role to improve the TFT reliability.

**AMD6 - 3L Quantitative Verification Method of IGZO TFT
9:30 Characteristics Using Oxygen Incorporation
Calculation**
*J. Noh, H. J. Koo, J. S. Seo, S. H. Park, P. S. Yun,
J. U. Bae, K.-S. Park, I. Kang*
LG Display, Korea

The amount of Oxygen incorporation on IGZO film during deposition is one of the main factors that significantly affect the electrical properties IGZO TFTs. In this work, we report the quantitative verification method of IGZO TFT characteristics using oxygen incorporation calculation and investigate the correlation between calculation and TFT characteristics.

AMD6 - 4L 9:45 Excimer Laser Annealing of Amorphous Oxide Thin-Film Transistors Passivated with Hybrid Passivation Layer

*J. P. S. Bermundo, Y. Ishikawa, M. N. Fujii,
M. V. D. Zwan*, T. Nonaka**, R. Ishihara*, Y. Uraoka*

Nara Inst. of S&T, Japan

**Delft Univ. of Tech., The Netherlands*

***AZ Elect. Materials Manufacturing Japan, Japan*

We performed excimer laser annealing on passivated amorphous oxide semiconductor thin-film transistors such as amorphous InZnO and InGaZnO. These thin-film transistors were passivated by a hybrid passivation known as polysilsesquioxane. We show that excimer laser annealing is a good low temperature annealing method for high performance amorphous oxide thin-film transistors.

AMD6 - 5L 10:00 Effect of Wet-O₂ Annealing on the Characteristics of Solution-Derived Amorphous InZnO Thin-Film Transistors

Y. Osada, Y. Ishikawa, M. N. Fujii, Y. Uraoka

Nara Inst. of S&T, Japan

We investigated the effect of wet-O₂ annealing on the characteristics of amorphous InZnO thin-film transistor fabricated by spin-coating process. The wet-O₂ annealing improved the field-effect mobility and the sub-threshold swing value. Furthermore, the device yield was significantly improved.

----- Break -----

10:45 - 11:45

Marine Hall

**AMD7: Back-Channel Etched Oxide TFT
Special Topics of Interest on Oxide-Semiconductor TFT**

Chair: T. Noguchi, Univ. of the Ryukyus, Japan

Co-Chair: H. Kumomi, Tokyo Inst. of Tech., Japan

AMD7 - 1L 10:45 Fabrication of Back-Channel-Etch (BCE) a-InGaZnO TFT with a Damage Free Wet Chemical Etchant

T.-C. Fung, C. Kim, T. Chang, J. Hong, P. Vermeulen,
P. Janseen*, Y. Lu*, S. Collins*, L. Robichaux**

Qualcomm MEMS Technologies, USA

**SACHEM, USA*

A-IGZO TFTs with back-channel-etch structures were demonstrated. Mo source/drain electrodes were patterned by SACHEM's proprietary formulation. With a high etch selectivity; BCE can be performed without damaging the IGZO layer. Our BCE TFTs exhibit a sub-threshold swing, Von and mobility comparable with those of conventional ESL-type TFT.

**AMD7 - 2L Oxide Semiconductor Thin Film Transistor
11:00 Compatible with Cu Interconnection Fabricated by
Back Channel Etching**

*S. Morita, M. Ochi, H. Tao, H. Goto, T. Kugimiya,
M. Kanamaru**

Kobe Steel, Japan

**Kobelco Res. Inst., Japan*

We report successful fabrication of back channel etch type oxide semiconductor TFTs with Cu interconnection. By using originally developed amorphous oxide semiconductor which is highly resistive to acid etchants, etching damage to a channel portion was prevented. The TFTs show a low sub-threshold swing 0.22 V/decade and high reliability.

**AMD7 - 3L Application of High Stable Solution-Process Metal-
11:15 Oxide Semiconductor in a Back-Channel-Etching
Thin-Film Transistor**

*K.-H. Su, M. Marinkovic, D.-V. Pham, A. Merkulov,
A. Hoppe, R. Anselmann*

Evonik Inds., Germany

Evonik has been working on solution-process metal oxide for a few years, and we now present a more highly etching-resistive metal-oxide semiconductor than the sputter one. We have achieved high mobility (10 cm²/Vs) and stable and homogeneous characteristics in the oxide-TFT by introducing iXsenic semiconductor into the BCE structure. With its remarkable performance, our material is also successfully applied in a high-resolution display product for mobile applications.

**AMD7 - 4L Back-Channel Etched Amorphous IGZO TFTs Using
11:30 the Copper as the Gate/Data Line Metal**

*C.-Y. Hou, C.-Y. Tu, C.-N. Lin, S.-F. Wu, S.-C. Lee,
W.-C. Tsai*

AU Optronics, Taiwan

BCE structure IGZO TFT using copper as the source/drain metal and different passivation layer were studied. The device characteristics and reliability of Cu BCE structure IGZO TFT can be improved by modifying the annealing temperature and passivation layer.

----- Lunch -----

13:30 - 14:15

Marine Hall

AMD8: Advanced Si Technology

Chair: S. Horita, JAIST, Japan
 Co-Chair: M. Inoue, Huawei Techs., Japan

AMD8 - 1L Poly Si TFTs Formed below 180°C Using Blue Laser Diode Annealing
 13:30

*T. Noguchi, T. Ashitomi, K. Shimoda, T. Gushiken,
 T. Okada, E. Jacques*, H. Dong*, T. Mohammed-Brahim**
Univ. of the Ryukyus, Japan
**Univ. of Rennes 1, France*

After crystallizing the sputtered Si films deposited at room temperature by Blue Diode Laser Annealing at 5 W, TFTs are successfully fabricated below 180°C. Promising transfer curve was obtained with the mobility of 10 cm²/Vs. The TFTs are expected to be formed on flexible sheet.

AMD8 - 2L Area Expansion of Crystallized Si Films on YSZ Layers by Two-Step Method in PLA
 13:45

M. T. K. Lien, M. Yamano, T. Hirata*, S.-I. Kuroki*,
 S. Horita*
JAIST, Japan
**Hiroshima Univ., Japan*

Area expansion of Si thin films crystallized by the two-step method on YSZ layers are performed successfully by moving sample stage in PLA. Crystallinity of Si film is improved and its surface is quite smooth without incubation layer at the interface, indicating the uniform crystallinity of Si on YSZ.

AMD8 - 3L Formation of Solution-Derived SiO₂ Thin Films by CO₂ Laser Annealing for Polycrystalline Silicon Thin Film Transistors
 14:00

D. Hishitani, M. Horita, Y. Ishikawa, Y. Watanabe,
 H. Ikenoue*, Y. Uraoka*
Nara Inst. of S&T, Japan
**Kyushu Univ., Japan*

Formation of perhydropolysilazane based SiO₂ film by CO₂ laser annealing was investigated. Polycrystalline silicon thin film transistors with the SiO₂ film as a gate insulator were fabricated. The TFT showed the field effect mobility of 27 cm²/Vs and hysteresis shift of -0.11 V. We considered the cause of the hysteresis.

Author Interviews and Demonstrations

16:45 – 17:45

Supporting Organizations:

Technical Committee on Electronic Information Displays, Electronics Society, IEICE
 Thin Film Materials & Devices Meeting

Workshop on FPD Manufacturing, Materials and Components

Wednesday, December 3

14:00 - 15:20

Marine Hall

FMC1: Manufacturing Technologies

Chair: M. Kimura, Nagaoka Univ. of Tech., Japan

Co-Chair: P. E. Malinowski, imec, Belgium

FMC1 - 1: *Invited* Visualization Analyses of Replication 14:00 Molding Phenomena in Injection Molding

H. Yokoi

Univ. of Tokyo, Japan

Visualization technologies inside molds play an important role in the clarification of unsolved molding phenomena. This paper reviews topics on visualization analyses of replication molding phenomena, focusing on the behavior of melt filling into the fine grooves of molds, and the demolding process between the replicated surface and mold surface.

FMC1 - 2 Development of Roll to Sheet Gravure Offset- 14:20 Printed Touch Sensor Fabrication

J. W.-C. Yu, S.-A. Kuo, C.-H. Chen

AU Optronics, Taiwan

We report a roll-to-sheet gravure offset printing process to fabricate insulator layer, metal-bridge, and trace (15 μm) on the glass for touch panel application. Printing quality was strongly dominated on printing processes, such as blade doctoring and off step process. A printed 7.85-in. touch panel by roll-to-sheet printing is also demonstrated in this work.

FMC1 - 3 Patterning of Multicolor OLEDs with Ultra-High 14:40 Resolution by Photolithography

P. E. Malinowski^{}, T. Ke^{*}, A. Nakamura^{**}, S. Steudel^{*},
D. Janssen^{**}, Y. Kamochi^{***}, I. Koyama^{***}, Y. Iwai^{****},
P. Heremans^{*,****}*

^{}imec, Belgium*

*^{**}FUJIFILM Elect. Materials (Europe), Belgium*

*^{***}FUJIFILM, Japan*

*^{****}Holst Ctr., the Netherlands*

We report on patterning small-molecule OLEDs by fab-compatible photolithography with non-fluorinated, chemically amplified i-line photoresists. We demonstrate electroluminescence in patterned red-green-blue OLEDs and in side-by-side patterned multicolor OLEDs. Resolution can exceed 1000 ppi; submicron photoresist structures are shown. These results are a step towards realizing ultra-high definition true-color OLED displays.

FMC

**FMC1 - 4 Ultrafast, All-Laser Precision Manufacturing of
15:00 Display Cover Glass for Consumer Devices**

*M. Mielke, D. Gaudiosi, M. Shirk, E. Juban,
M. Greenberg, N. Matthew, T. Booth, S. Srinivas
Raydiance, USA*

We describe the first all-laser precision glass machining system for consumer device cover displays. The femtosecond laser-based method enables cut-outs, interior features and chamfering of unstrengthened or strengthened Gorilla Glass and sapphire crystal. This new all-laser technology approach and the results achieved demonstrate superior edge quality with no post processing.

----- Break -----

15:45 - 16:45

Marine Hall

FMC2: Materials and Components

Chair: R. Yamaguchi, Akita Univ., Japan
Co-Chair: W. I. Milne, Univ. of Cambridge, UK

FMC2 - 1: *Invited* Graphene for Plastic Electronics

15:45

*W. I. Milne, G. Hu, R. C. T. Howe, A. C. Ferrari, F. Torrisci,
T. Hasan*

Univ. of Cambridge, UK

This paper will begin with a description of the liquid phase exfoliation method of graphene production. The remainder of the talk will concentrate on our work on the application of graphene to plastic electronics, including its use as a transparent conductor for transparent pianos and flexible smart windows.

**FMC2 - 2 A New Type of Alignment Material for Double-
16:05 Layered Retarders Composed of Polymerizable LC**

*R. Takasago, A. Tamura, T. Miyahara, S. Morishima,
N. Yanagihara, Y. Takahashi, Y. Furuki, S. Yoshida, Y. Ito
FUJIFILM, Japan*

We have successfully developed a new alignment material for double-layered retarders consisting of polymerizable liquid crystals. The new material concurrently controls both the 1st LC and the 2nd LC layer alignments and provides an excellent achromaticity for quarter-wave-retardation films (QWFs).

FMC2 - 3 Inorganic Wave Plates with High Performance in Visible Region Fabricated by Serial Bideposition
16:25

*N. Koike, K. Sasaki, E. Takahashi, N. Hanashima, A. Takada, M. Suzuki**

Dexerials, Japan

**Kyoto Univ., Japan*

We investigated the optical characteristics and microstructures of wave plates composed of Ta_2O_5 (100-x) + TiO_2 (x) and prepared by the so-called serial bideposition technique. As a result, the inorganic wave plates with optimized TiO_2 content were advantageous for applications where high transmittance and high-temperature durability are essential.

Author Interviews and Demonstrations

17:15 – 18:15

Thursday, December 4

9:00 - 12:00

Exhibition Hall B

Poster FMCp1: Manufacturing Technologies

FMCp1 - 1 High Resolution Technology for FPD Manufacturing

N. Yabu, K. Nagano, N. Izumi

Canon, Japan

Using shorter wavelength for exposure light is one way to achieve high resolution with keeping sufficient depth of focus (DOF). We show exposure results for 1.0 μm resolution to confirm the effect of deep UV (DUV) exposure light. With DUV light, 1.0 μm pattern is resolved while keeping sufficient DOF.

FMCp1 - 2 Realization on Short-Pitch with Wing/Body Patterning Technology

Z. Cao, G. Hui, B. Zhang, X. He, S. J. Choi

BOE Tech. Group, China

In this paper, we have successfully developed short-pitch at fan-out area with wing pattern technology. A short-pitch smaller than 5.5 μm (line width + space) is confirmed to replace the present level about 10 μm , which are able to decrease the fan-out area and obtain slim border for high PPI product.

FMCp1 - 3 Withdrawn

FMCp1 - 4 First Ultra Thin Glass Temporary Bonding Technology Apply in LTPS-LCD

C.-H. Liao, C.-H. Chan, S.-P. Chiao, T.-C. Fan, Y.-H. Lai, J.-K. Lu, N. Sugiura

AU Optonics, Taiwan

We have developed an ultra thin LTPS LCD applying temporary bonding technology not glass thinning process. Our product 4.3-in. ultra thin display is the 0.2 mm thin cell assembled by 0.1 mm thin array and 0.1 mm thin CF. Both feature 512 ppi high resolution with 0.65 mm narrow border.

FMCP1 - 5 Electrostatic Control for Flexible Substrate De-Bonding Process

*C.-C. Tsai, H.-P. Shih, C.-C. Wu, C.-W. Kung, K.-W. Lan
ITRI, Taiwan*

This paper reports the results of investigations into electrostatic charging phenomena of the separation between the flexible substrate and the carrier glass. Water and air ionizer were used to reduce electrostatic charge. The results indicate that water not only reduces the static charge but also affects the de-bonding force.

FMCP1 - 6 Withdrawn**FMCP1 - 7 Direct Morphology Observation of LC-Polymer Boundary Imaged by Atomic Force Microscope**

*K. Ueda, T. Yamamoto, M. Kimura
Nagaoka Univ. of Tech., Japan*

Surface morphology of polymer in contact with liquid crystal layer (LC) was directly observed by atomic force microscope (AFM). Cantilever tip of AFM penetrates the LC layer and traces the polymer surface directly. The real morphology of LC-polymer boundary is directly imaged without removing the LC layer.

FMCP1 - 8L Novel Low-Temperature Activation Method by Soft X-ray Irradiation

*A. Heya, N. Matsuo, K. Kanda
Univ. of Hyogo, Japan*

Novel activation method of B in Si using soft X-ray undulator was proposed. The effect of soft X-ray irradiation was remarkable below 500°C. The activation energy for soft X-ray irradiation was lower than that for thermal annealing. By using B₁₀H₁₄ cluster, the sheet resistance of 55 Ω/sq was obtained.

FMCP1 - 9L UV-Pretreatment and NIR-RTA Enhanced Dehydrogenation for a-Si:H Thin Films at 400°C

S. Ji^{,***}, P. Jeong^{*}, C.-S. Hwang^{**}, S. Lee^{*}, S. H. Cho^{**},
Y. Han^{*}, K. S. Lee^{***}
^{*}AP Syss., Korea
^{**}ETRI, Korea
^{***}Sogang Univ., Korea*

A method using ultra-violet-pretreatment (UVP) and near-infrared-radiation-rapid-thermal-annealing (NIR-RTA) is proposed to enhance the dehydrogenation process in the amorphous silicon thin films. Using the proposed method, the dehydrogenation degree could be improved up to 13%. Additionally, it was observed that the power consumption is reduced and the dehydrogenation temperature is lowered.

9:00 - 12:00

Exhibition Hall B

Poster FMCp2: Materials and Components**FMCp2 - 1** **Withdrawn****FMCp2 - 2** **High Thermal Stability Glass Substrate for High Resolution Display***M. Hayashi, T. Murata, Y. Kato, T. Murata, M. Ohji
Nippon Elec. Glass, Japan*

A new glass substrate "OA-30" has been developed. The high strain point of OA-30 leads to reduced thermal shrinkage of glass substrates during thermal treatment in the Low temperature poly-silicon (LTPS) TFT process. Low thermal shrinkage of OA-30 contributes to the realization of high resolution displays with LTPS TFTs.

FMCp2 - 3 **A Study of Spring Impact Hammer to Define the Specification of Impact Test***K.-C. Chang, B.-C. Huang, C.-Y. Chiu, Y.-C. Liu
G-tech Optoelect., Taiwan*

Spring impact hammer is a practicable method to evaluate the impact energy of glass. It is stable, hitting the particular position accurately, and the energy can be analyzed by Mechanical Energy Equation. It is capable to replace the ball drop test.

FMCp2 - 4 **Effect of N₂O Doping on the Properties of ZnO Thin Films on a-Al₂O₃ Using High-Energy H₂O Generated by a Catalytic Reaction***Y. Ohashi, S. Kanouchi, N. Yamaguchi, Y. Tamayama,
T. Kato, K. Yasui**Nagaoka Univ. of Tech., Japan*

ZnO films were grown on a-plane sapphire substrates using a reaction between alkylzinc (DMZn) and high-temperature H₂O, the latter is generated by a Pt-catalyzed exothermic H₂-O₂ reaction. The influence of the N₂O gas addition during the growth on the properties of the ZnO films was investigated.

Innovative Demonstration Session by Oral and Poster Presenters

Live demonstrations of emerging information
display technologies

16:45 – 19:30 Thursday, December 4, 2014

12:30 – 15:15 Friday, December 5, 2014

Exhibition Hall B

See Page 212 - 215 for details

FMCP2 - 5 Crystalline Structure and Dislocation Distribution of ZnO Thin Film Grown on A-Plane Sapphire Substrate Using High-Temperature H₂O Produced by a Pt-Catalyzed H₂ and O₂ Reaction

T. Nakamura, Y. Ishiduka, N. Yamaguchi, Y. Tamayama, K. Yasui

Nagaoka Univ. of Tech., Japan

Crystalline structure of ZnO thin films, which were grown on a-plane sapphire substrates through a reaction between dimethylzinc and high-temperature H₂O produced by a Pt-catalyzed H₂ and O₂ reaction, was observed. The crystalline structure of a ZnO film grown on an a-Al₂O₃ substrate was observed using cross-sectional transmission electron microscopy.

FMCP2 - 6 Development of Novel Primer Material Suitable for Connecting Cyclolefin Polymer Film and ITO Thin Layer

*T. Yamate, K. Kumazawa, K. Ono, S. Yamada, H. Suzuki, M. Akazome**

Nippon Soda, Japan

**Chiba Univ., Japan*

We have developed a unique organic-inorganic hybrid coating agent suitable for a primer which connects an ITO thin layer to a COP base material. An ITO film, using this material as primer, showed high durability.

FMCP2 - 7 Development of the Li-Doped Potassium Sodium Niobate Piezoelectric Ceramics with High Electromechanical Coupling Coefficient and Applied to Single-Element Ultrasound Transducers

C.-M. Weng, Y.-H. Zou, C.-C. Tsai, C.-S. Hong**, S.-Y. Chu*

Nat. Cheng Kung Univ., Taiwan

**Tung Fang Design Inst., Taiwan*

***Nat. Kaohsiung Normal Univ., Taiwan*

In this study, the development of lead-free (1-x)(Na_{0.535}K_{0.48})NbO₃-xLiNbO₃ (NKLN) ceramics were investigated. The best piezoelectric properties of NKLN ceramics with k_p = 48%, k_t = 52% were obtained at x = 0.05. Furthermore, the ceramics were chose for fabrication of single-element ultrasound transducers.

IDW '15

The 22nd International Display Workshops

December 9 – 11, 2015

Otsu Prince Hotel

Otsu, Japan

<http://www.idw.or.jp>

FMCP2 - 8 High Dielectric Constant Material of $(1-x)\text{Na}_{0.5}\text{K}_{0.5}\text{NbO}_3 - x\text{SrTiO}_3$

H.-H. Su, C.-S. Lin, C.-S. Hong**, C.-C. Tsai***, S.-Y. Chu*

Nat. Cheng Kung Univ., Taiwan

**Kun Shan Univ., Taiwan*

***Nat. Kaohsiung Normal Univ., Taiwan*

****Tung Fang Design Inst., Taiwan*

In this study, composition of potassium sodium niobate based ceramics were synthesized by the conventional solid-state reaction process. The phase formation and microstructures using X-ray diffraction and scanning electron microscope. The dependence of dielectric constant and these indicate the presence of a relaxation process.

FMCP2 - 9 The Development of Multi-Layer Step-Down Lead-Free Piezoelectric Transformers with High Isolation and Its Applications on the AC-DC Inverters

Z.-Y. Chen, C.-C. Tsai, C.-S. Hong**, S.-Y. Chu, S.-K. Hung, C.-C. Chang-Chien*

Nat. Cheng Kung Univ., Taiwan

**Tung Fang Design Inst., Taiwan*

***Nat. Kaohsiung Normal Univ., Taiwan*

The material of piezoelectric transformer was prepared by low temperature co-fire ceramics technology. The best load is 100 Ω the power and gain are 0.97 W and 0.52 respectively. The PT step-down conversion system which the power and efficiency are 11 W and 96% can combine with the adapters to drive LED successfully.

FMCP2 - 10L Wide-view Circular Polarizers for a High Contrast Ratio on MVA Mode LC Cell

A.-K. Kim, S.-W. Oh, T.-H. Yoon

Pusan Nat. Univ., Korea

We propose an optical compensation scheme by which we can eliminate the off-axis light leakage in a VA-LCD with circular polarizers. By using this scheme, a contrast ratio higher than 1000:1 is achieved over the entire 70° viewing cone in a MVA-LCD with circular polarizers.

IDW Best Paper Award

IDW Outstanding Poster Paper Award

These awards will go to the most outstanding papers selected from those presented at IDW '14.

The 2014 award winners will be announced on the IDW website: <http://www.idw.or.jp/award.html>

FMCp2 - 11L Effect of Thermally Decomposed Hydrazine on Maximizing Potential Electronic Properties of Non-Oxidized Carbon Nanotubes

P.-C. Wang^{}, Y.-C. Liao^{*,**}, Y.-L. Lai^{**}, Y.-C. Lin^{**}, Y.-J. Hsu^{**}*

^{}Nat. Tsing Hua Univ., Taiwan*

*^{**}Nat. Synchrotron Radiation Res. Ctr., Taiwan*

We found the electronic properties of non-oxidized carbon nanotubes could be further improved by a process involving trace hydrazine vapor and subsequent thermal purging. We demonstrated this facile process could improve the conductivity of surfactant-free transparent thin films and on-off ratio of inferior field-effect transistors based on carbon nanotubes.

FMCp2 - 12L Product Design for Cover Glass Based on Fracture Analysis

H. Ohkawa, Y. Kobayashi, S. Akiba, K. Hayashi, T. Nakashima, A. Nakagawa, H. Saiki, N. Ishimaru
Asahi Glass, Japan

Strength is one of the most important properties of cover glasses. Based on the fracture analysis in the world, breakage mechanisms and evaluation methods were investigated. This time consideration of Face/Front breakage mode and the evaluation by set drop were focused. Product design for strong cover glass is showed.

FMCp2 - 13L Development of Achromatic Polarizer Using Novel Dichromatic Dye

D. Fujiwara, N. Mochizuki^{}, T. Ishinabe^{**}, D. Nakamura, N. Koma, H. Fujikake^{**}*

Polatechno, Japan

^{}Nippon Kayaku, Japan*

*^{**}Tohoku Univ., Japan*

We established a method to control the light absorption, dichroic ratio and alignment direction of pigments for polarizers. We clarified that distribution of dichroic pigments and cross-linker before the extension process is important to improve the degree of polarization of polarizer and successfully achieved achromatic polarizers with various transmittance.

SID Display Week 2015

May 31 – June 5, 2015

San Jose Convention Center

San Jose, California, U.S.A.

9:00 - 12:00

Exhibition Hall B

Poster FMCp3: Lighting Technologies
Special Topics of Interest on Lighting Technologies

FMCp3 - 1 Construction of a Backlight Module by Connecting Unit Cells with an Optical Fiber

T. Kojima, Y. Asakura, T. Ogawa, I. Fujieda
Ritsumeikan Univ., Japan

A backlight module can be constructed by connecting unit cells with a curved optical fiber. In a unit cell, a trench fabricated on one surface of a transparent plate houses the optical fiber and output couplers are placed on the other surface of the plate.

FMCp3 - 2 Effect of LGP Outline on Edge-Lit LED TV Design

H. He, Y.-Y. Qiu
Shenzhen China Star Optoelect. Tech., China

Uniformity issues were usually found in Edge-lit LED TV, due to LGP outline affected the light propagation. In this study, one novel method was introduced to quantify the phenomenon of DARK CORNER MURA. Also, several different LGP conditions were simulated to come out optimized outline parameters of LGP.

FMCp3 - 3 Solution for Achieving an Optimized LED Spectrum for LCM

C.-T. Kang, M. C. Chien, Y.-Y. Qiu, Z.-J. Su, H. He
Shenzhen China Star Optoelect. Tech., China

By adjusting LED spectrum, consist of W_d of Blue chip shift and phosphor adjustment to match the confirmed CF & BLU spectrum, to increase the brightness of LCM. To specific LCM system, by LED chip red shift, LCM brightness will increase 6% effectively with correct white chromaticity coordinates.

FMCp3 - 4 Portable LED Illuminating Device for Personal Photodynamic Treatment and Cell Culturing

C.-J. Ou, Z.-W. Lin, Y.-S. Lin, P.-Y. Lin, J.-Y. Chen,
Y.-K. Tsai
Hsiuping Univ. of S&T, Taiwan

We demonstrate an LED based wearable photodynamic therapy device that can conduct the designed illuminating energy to a specific tissue region for targeting reaction. This device is designed based on the 4R rules. Most important of all, the microdisplay techniques can also integrate with this medical device.

FMCP3 - 5 A Glare Detection for the High-Brightness LED Display Boards Using a Digital Camera

Y.-H. Siao, P.-J. Wu^{}, B.-J. Pong^{**}, S.-W. Hsu^{**},
C.-H. Wen^{***}, C.-Y. Chen*

Nat. Yunlin Univ. of S&T, Taiwan

^{}Nat. Chiao Tung Univ., Taiwan*

*^{**}ITRI, Taiwan*

*^{***}Nat. Taiwan Univ. of S&T, Taiwan*

This study proposes an easy way to obtain the glare distribution of the area is full of the high-brightness LED display boards by using a digital camera. The measurement is modified by the color correction and the uniformity correction and results of this detection are consistent with the physiological questionnaire.

FMCP3 - 6 The Design of Personal Privacy and Wide Viewing Functions LCM Model Design

Y. W. Chang

AU Optronics, Taiwan

We successfully develop a new LCM system with privacy and wide view functions. With our design, the users do not have to take off any components to change the viewing status so that they can keep the privacy or share the information of the display immediately.

9:00 - 12:00

Exhibition Hall B

Poster FMCP4: Oxide TFT/Printed Electronics
Special Topics of Interest on Oxide-Semiconductor TFT

FMCP4 - 1 Effect of Cu Dopant on Structural and Optical Properties of Zinc Oxide Nanorods

Z. Jin, T. Umakoshi, Y. Abe, M. Kawamura, K. H. Kim

Kitami Inst. of Tech., Japan

We investigated structural and optical properties of Cu-doped zinc oxide (CZO) nanorods (NRs) fabricated by chemical solution deposition. With incorporation of Cu (10 at%) dopant, the length and crystallinity of NRs increased and improved, respectively, compared to ZnO NRs. However, the transmittance of CZO NRs was lower than ZnO NRs

FMCP4 - 2 Post-Annealing Effect of Zinc Oxide Nanorods Grown on Al-Doped Zinc Oxide Seed Layers

T. Umakoshi, Y. Abe, M. Kawamura, K. H. Kim

Kitami Inst. of Tech., Japan

We fabricated zinc oxide (ZnO) nanorods (NRs) grown on ZnO and Al-doped ZnO (AZO) seed layers and investigated post-annealing effects on their structural and optical properties. Length of NRs increased by adding Al dopant in seed layer. The morphology and transmittance were less changed after post-annealed at 500°C.

FMCP4 - 3 Application of Microwave-Detected Photoconductivity Decay Technique to Process Monitoring in Back Channel Etching-Type TFT Fabrication

*H. Goto, M. Ochi, H. Tao, S. Morita, Y. Takanashi,
A. Hino, K. Hayashi, T. Kugimiya
Kobe Steel, Japan*

We have conducted a feasibility study on the application of microwave-detected photoconductivity decay (μ -PCD) technique to process monitoring in back channel etching-type (BCE) TFTs. By measuring the μ -PCD at the back channel area of the TFTs in each process steps, variations of the film characteristics can be precisely detected.

FMCP4 - 4 Copper Nano Particle Ink for Reverse Offset Printing and the Application to Thin Film Transistors

M. Koutake^{,**}
*JAPER, Japan
**DIC, Japan*

Copper nanoparticle ink specialized for reverse offset printing has been developed and applied to make electrodes for OTFTs. The copper ink sintered by Xe intense flash light in ambient atmospheric conditions showed good conductivity and compatibility with an organic semiconductor.

FMCP4 - 5L Hard X-ray Photoelectron Spectroscopic Study under Bias Voltage for Interface States at SiO₂/a-InGaZnO Interface

*S. Yasuno, H. Oji, T. Watanabe, I. Hirose
JASRI, Japan*

The energy distribution of the interface states for SiO₂/a-IGZO interface was evaluated using hard X-ray photoelectron spectroscopy (HAXPES) under bias voltage. It was found that the interface states are observed throughout the band gap of a-IGZO and there exists the largest gap state near the conduction band edge.

----- Lunch -----

Evening Get-Together with Wine

Tuesday, December 2, 2014
18:00 – 20:00

Observation Deck (31F),
Hotel Nikko Niigata
(Sponsored by Merck Ltd., Japan)
See page 12 for details

17:00 - 18:00

Snow Hall B

FMC3: Optical Films

Chair: H.-M. P. Chen, Nat. Chiao Tung Univ., Taiwan
 Co-Chair: T. Nonaka, AZ Elect. Materials Manufacturing Japan, Japan

FMC3 - 1: *Invited* Microstructure Film for Wide Viewing TN-LCD
17:00

*S. Katsuta, E. Yamamoto, Y. Asaoka, T. Kanno, H. Yui,
 T. Kamada, T. Maeda, Y. Tsuda, K. Kondo*
Sharp, Japan

A microstructure film has been developed to improve the viewing angle characteristics of TN-LCD. This film can completely eliminate the grayscale inversion of TN-LCD by controlling the shape of air microcavities which are fabricated inside the film. Further, this film can be mass-produced efficiently by roll-to-roll self-alignment process.

FMC3 - 2: *Invited* Meta-Surface Film for Heat-Cutting from the Sun Light
17:20

M. Naya, T. Tani, S. Hakuta, H. Yasuda, N. Kiyoto
FUJIFILM, Japan

We developed a new metasurface for spectrally-controlled reflection film. This structure is composed of dispersed silver disk-shaped nanoparticles in a monolayer. Wavelength of reflection light can be artificially engineered by controlling aspect ratio of silver nano discs. We demonstrate that this structure is ideal for heat-cutting from the sun light.

FMC3 - 3 **Square Light-Diffusing Film by Collimated UV Light and a Cross Shaped Light Diffuser**
17:40

B. Katagiri, K. Kusama, T. Orui, S. Shoshi
LINTEC, Japan

Light-diffusing films that contain a refractive microstructure are promising materials because of their superior, unique diffusing properties. This study examined the condition of incident ultraviolet (UV) light and realized square light-diffusing films using an area light source that outputs UV light in a cross shape.

Author Interviews and Demonstrations

18:30 – 19:30

Friday, December 5

9:00 - 10:00

Snow Hall B

FMC4: Augmented Reality and Virtual Reality
Special Topics of Interest on Augmented Reality and Virtual Reality

Chair: H. Okumura, Toshiba, Japan

Co-Chair: M. Shinohara, Omron, Japan

**FMC4 - 1: *Invited* Wide Field of View Optical Combiner for
9:00 Augmented Reality Head-Up Displays**

*H. Okumura, A. Hotta, T. Sasaki, K. Horiuchi, N. Okada
Toshiba, Japan*

Wide field of view combiners for head-up displays are reviewed and our originally developed combiner using Fresnel reflector that acts both as a concave reflector for reflected light and a flat plate for transmitted light has been introduced.

Also presented in Innovative Demonstration Session (see p. 214)

**FMC4 - 2 Panoramic 3D Floating Image Display Using Dual
9:20 Concave Reflectors**

*K. Li
Wavien, USA*

This paper discloses 3D floating image systems that uses parabolic and elliptical reflectors with the ability of displaying floating images with a full 360-degree horizontal viewing angles. This will have applications in merchandizing displays, museums, theme parks, etc. Several optical configurations will be presented.

**FMC4 - 3 Fabrication of Special Glass-Beads Retroreflector
9:40 for Aerial Imaging by Retro-Reflection**

Y. Tomiyama^{}, S. Suyama^{*}, H. Yamamoto^{*,**,*}
^{*}Univ. of Tokushima, Japan
^{**}JST-CREST, Japan
^{***}Utsunomiya Univ., Japan*

AIRR (Aerial Imaging by Retro-Reflection) enables floating LED signage. In order to prevent blurring with floating distance, we propose a special glass-beads retroreflector. We have fabricated a retroreflector with glass beads whose refractive index is 2.0. As paraxial approximation suggests, the fabricated retroreflector reduced beam spread with floating distance.

Also presented in Innovative Demonstration Session (see p. 214)

----- Break -----

10:45 - 12:05

Snow Hall B

FMC5: Lighting Technologies
Special Topics of Interest on Lighting Technologies

Chair: F. Shevlin, Dyoptyca, Ireland

Co-Chair: K. Kälantär, Global Optical Solutions, Japan

**FMC5 - 1 Light Guide Plate Illumination with Blue Laser and
 10:45 Quantum Dot Emission**

*F. Shevlin**DYOPTYKA, Ireland*

A Blue laser diode is used to excite emission from a strip of "quantum dot" materials at the edge of an LCD display light guide plate. Optical efficiency is improved by reflecting emission that would otherwise be lost. A phase randomizing deformable mirror is used to minimize speckle noise.

Also presented in Innovative Demonstration Session (see p. 214)

**FMC5 - 2 Design and Perception of an Edge Lit HDR Display
 11:05**

*P. Cirkel, L. Penninck**TP Vision, Belgium*

Advances in LED efficiency and thermal conductivity were used to design an HDR display with an edge-lit backlight. The advantage of improvements in thermal conductivity is depending on the backlight design. An HDR TV set was made, and compared to a wide color gamut TV in a perception test.

**FMC5 - 3 Predicting Color Appearance under Non-Uniform
 11:25 Lighting Environments**

H.-C. Li, P.-L. Sun*, S.-Y. Chang*, R. Luo*****Nat. Taiwan Univ. of S&T, Taiwan****Univ. of Leeds, UK*

Two psycho-visual experiments were conducted to investigate the color appearance under non-uniform surround conditions. A weighted function is derived to estimate the luminance of adapting field for a CIECAM02 based color appearance model to improve its color prediction.

**FMC5 - 4 The Design of Anti-Glare Lens Applied to Direct
 11:45 LED Panel Lighting**

*J.-W. Pan, Y. K. Hsu, C. W. Chiang**Nat. Chiao Tung Univ., Taiwan*

The anti-glare lens had been proposed to reduce the glare effect and enhance the illumination uniformity for indoor lighting. Compared with traditional panel light with Lambertian intensity distribution, the Unified Glare Ratio (UGR) had been controlled at 17.3 and the uniformity had been enhanced 28%.

----- Lunch -----

13:30 - 14:50

Snow Hall A

FLX6/FMC6: Flexible Materials and Devices

Chair: Y. Mishima, FUJIFILM, Japan
 Co-Chair: T. Tomono, Toppan Printing, Japan

FLX6/ FMC6 - 1: Invited Flexible Substrates and Alternative Electrodes of ITO for OLED Lighting

13:30

*M. Koden, H. Kobayashi, T. Moriya, N. Kawamura,
 T. Furukawa, H. Nakada
 Yamagata Univ., Japan*

"Flexible substrates with alternative electrode of ITO for organic electronics" is being developed in the "Yamagata University Organic Thin Film Device Consortium", in which 21 companies participate. The current status and some of the developmental results on flexible substrates and alternative electrodes of ITO for OLED lighting are reviewed.

FMC

Also presented in Innovative Demonstration Session (see p. 213)

FLX6/ FMC6 - 2: An Analysis Method of Shock Test for Flexible Displays by Using an Image Luminance Measurement Device

13:55

*J.-M. Hsu, S.-W. Hsu, B.-J. Wen, T.-Y. Chung
 ITRI, Taiwan*

The objective of this study is to put forward a new analysis method of shock test for flexible displays. The study utilized an image luminance measurement device to inspect optical properties of flexible organic light emitting diodes before and after shock test.

FLX6/ FMC6 - 3: Plastic Substrate Technology for Flexible LCD

14:15

*Z.-H. Chen, T.-H. Huang, J.-K. Lu, N. Sugiura
 AU Optronics, Taiwan*

Materials and handling method of plastic substrate are the key factor for flexible liquid crystal display (LCD). Different flexible substrate materials and fabrication process will be discussed in this article. Furthermore, 3.5-in. flexible LCD was demonstrated using optical clear fiber-reinforced-plastic substrate and film lamination followed via mechanical peeling process.

IDW '14 Tutorial in Japanese

Organized by SID Japan Chapter

Tuesday, December 2, 2014

Room 301, 3F

TOKI MESSE Niigata Convention Center

Detailed information is available on

<http://www.sid-japan.org>

**FLX6/
FMC6 - 4L Roll-to-Roll Planarized Stainless Steel Foil for OLED
Substrate**

14:35

N. Yamada, H. Kobayashi, S. Yamaguchi,
J. Nakatsuka**, K. Nose, K. Uemura, M. Koden*,
H. Nakada**

Nippon Steel & Sumitomo Metal, Japan

**Yamagata Univ., Japan*

***Nippon Steel & Sumikin Materials, Japan*

Roll samples of planarized stainless steel foil were produced by continuously forming inorganic-organic hybrid layer. The planarization layer endowed both surface flatness and electric insulation to the stainless steel foil, resulting in successful fabrication of OLED prototypes on the roll-to-roll planarized stainless steel foil.

Author Interviews and Demonstrations

16:45 – 17:45

Supporting Organizations:

Japan Electronics Packaging and Circuits Association

Japan Society of Colour Material

RadTech Japan

The Japanese Research Association for Organic Electronics
Materials

The Japanese Society of Printing Science and Technology

The Society of Photography and Imaging of Japan

The Technical Association of Photopolymers, Japan

**The 50th Anniversary Speech of PDPs
“Summing Up of the PDP History
and a Peek at Plasma
Technologies Beyond Displays”
(FED4 – 1)**

Friday, December 5, 2014

15:15 - 15:55

Room 302B

See page 118 for detail

Workshop on EL Displays and Phosphors

Thursday, December 4

9:00 - 12:00

Exhibition Hall B

Poster PHp1: Phosphors

PHp1 - 1 **Printing Artefacts in the Manufacture of AC Electroluminescent Lamps**

J. Silver, P. G. Harris

Brunel Univ., UK

This paper describes a number of printing artefacts that can be detrimental to the manufacture of printed electronic devices and is illustrated with reference to the manufacture of a.c. electroluminescent lamps.

PHp1 - 2 **PL and EL Characteristics in UV to Blue-Green Emitting Bi-Activated Y_2O_3 -Based Oxide Phosphor Thin Films Prepared by Magnetron Sputtering**

T. Miyata, S. Abe

Kanazawa Inst. of Tech., Japan

UV and blue-green electroluminescence were observed from Bi-activated Y_2O_3 -based oxide phosphor thin films. Intense UV EL emissions were observed from thin-film electroluminescent (TFEL) devices fabricated using $Y_3Al_5O_{12}:Bi$ thin film. The highest UV EL intensity was obtained in TFEL devices using $Y_3Al_5O_{12}:Bi$ emitting layer with Bi content of approximately 2.4 at.%.

PHp1 - 3 **Local Structural Effect on Emission Characteristics of Organic-Inorganic Hybrid Phosphor Made from Malic Acids and APTES**

A. Kato, K. Hasegawa, K. Komatsu, T. Kawase

Nagaoka Univ. of Tech., Japan

Organic-inorganic hybrid phosphors made from malic acids and APTES which shows strong green emission were synthesized by sol-gel method. The emission wavelength and intensity were found to depend on heating treatment temperature, which may be due to local structural change. This phosphor has a potential for rare-earth free UV-LEDs application.

PHp1 - 4 Synthesis of $Y_2WO_6:Eu$ Nano-Rod Phosphor for Local Field Enhanced Inorganic Electroluminescent Devices

*A. Kato, S. Matsumoto, D. Imai
Nagaoka Univ. of Tech., Japan*

$Y_2WO_6:Eu^{3+}$ nano-rod phosphors with diameter of ~100 nm were synthesized by flux method using LiCl flux. The emission starting voltage of the EL device using these nano-rods was found to be lowered, which may be due to local field enhanced effect, and have a potential for inorganic EL device applications.

PHp1 - 5 Suppressed Sublimation of Organic Dye Nano-Particles Embedded in Sol-Gel Derived Silica Glass

*T. Yamaki, T. Kurabayashi, T. Fukuda, N. Kamata,
Z. Honda
Saitama Univ., Japan*

9,10-diphenylanthracene and pyrene nanoparticles dispersed in aqueous solutions were obtained by the reprecipitation method, and the sublimation of these materials were successfully suppressed by forming nanoparticle. In addition, further improved stability was realized by embedding in the silica glass thin film fabricated by the sol-gel process.

PHp1 - 6L Observation of Upconversion Emission in $ZnO-TiO_2$ with Yb_2O_3 and Er_2O_3 Crystal Powders on Excitation Using 980 nm Radiation

*K. Ohyama, T. Nonaka, T. Kanamori, S. Yamamoto
Ryukoku Univ., Japan*

Among several liquid-phase methods for the production of upconversion phosphors, the MOD method was studied. As a result of preparing upconversion phosphor using the MOD method, a strong orange upconversion luminescence was obtained when the mixing ratio was $Ti:Zn:Yb:Er = 1:1:0.06:0.02$.

PHp1 - 7L Interdigital Electrodes Technologies for Distributed Inorganic EL Displays

T. Nonaka, Y. Uraoka, N. Taguchi**, S. Yamamoto
Ryukoku Univ., Japan
*Nara Inst. of S&T, Japan
**Image Tech, Japan*

We deposited comb-shaped metal electrodes with narrow gaps on a glass substrate and succeeded in achieving a high electric field intensity. We used a comb-shaped metal (Au) electrode sample and a comb-shaped ITO electrode sample.

PHp1 - 8L Optical Properties of Heavily Mn-Doped ZnS:Mn²⁺ Phosphors*K. Park, G. Deressa, T. Kim*, J. Kim*, J. Kim**Pukyong Nat. Univ., Korea***Lumimicro, Korea*

Heavily doped ZnS:Mn²⁺ phosphors exhibited a strong photoluminescence excitation at 465 nm peak from the forbidden ${}^6A_1({}^6S) \rightarrow {}^4A_1({}^4G)/{}^4E({}^4G)$ transitions of Mn²⁺ ions and a strong photoluminescence at 582 nm peak. It can be explained in terms of Mn-Mn interaction.

PHp1 - 9L Flexible AC Powder Electroluminescent Device Based on Silver Nanowire Electrode*G. Deressa, K. Park, H. Jeong, S. Lim, D. Kim, J. Lee, J. Park, J. Park*, J. Kim**Pukyong Nat. Univ., Korea***AIDEN, Korea*

Silver nanowire (Ag NW) electrode-based AC powder electroluminescent device (ACPELD) is demonstrated. Ag NW electrode with the transparency of 90% and sheet resistance of 50 ohm/sq was bar-coated, and the phosphor/dielectric layers were screen printed. The EL intensity and charge density were as high as that for ITO-based ACPELD.

PH

9:00 - 12:00

Exhibition Hall B

**Poster PHp2: Phosphors for Lighting Application
Special Topics of Interest on Lighting Technologies****PHp2 - 1 Study on Luminescence Property of Ba₃(Sc_{1-x}Ho_x)₄O₉ Phosphors***K. Sugimoto, S. W. Kim, T. Ishigaki, K. Uematsu, K. Toda, M. Sato**Niigata Univ., Japan*

Blue light excitable green emitting Ba₃(Sc_{1-x}Ho_x)₄O₉ phosphors were synthesized in a single phase form by a conventional solid-state reaction method. These phosphors showed a green emission under the blue light excitation (455 nm) and the main green emission peak observed at 555 nm corresponding to 4f-4f transition of Ho³⁺.

PHp2 - 2 The Effect of Sr_{2-x}Si₃O₂N₄: xEu²⁺ Synthesizing by Different Phase Si₃N₄ on Luminescence Characteristic*C.-H. Chiang, T.-S. Zhan, S.-Y. Chu**Nat. Cheng Kung Univ., Taiwan*

In this paper, the dependence of the raw material of Si₃N₄ with different phase on the luminescence of Sr_{1.9}Si₃O₂N₄: 0.1Eu²⁺ phosphors were investigated. It's obvious that the emission peak at 530 nm is enhanced at 450 nm excitation light source by using β-phase Si₃N₄.

PHp2 - 3 A Novel Reddish Orange-Emitting $\text{BaLa}_2\text{Si}_2\text{S}_8:\text{Eu}^{2+}$ Thiosilicate Phosphor for White Light-Emitting Diodes

S.-P. Lee, T.-M. Chen

Nat. Chiao Tung Univ., Taiwan

A novel reddish orange-emitting $(\text{Ba}_{1-x}\text{Eu}_x)\text{La}_2\text{Si}_2\text{S}_8$ thiosilicate phosphor was synthesized and evaluated for potential application in white light LEDs. The Eu^{2+} -doped thiosilicate phosphor can be excited by UV to blue light and shows reddish orange broadband emission. The preparation, spectroscopic characterization, decay lifetime, and related LED device data are also presented.

----- Lunch -----

15:15 - 16:25

Room 302 B

PH1: Phosphors for General

Chair: J. Silver, Brunel Univ., UK

Co-Chair: T. Miyata, Kanazawa Inst. of Tech., Japan

PH1 - 1: *Invited* A New Luminescence Material for Displays and Sensing

15:15

W. Chen, L. Ma

Univ. of Texas at Arlington, USA

Cu-Cysteamine complex is a new material for displays and sensing technologies. In addition to its photoluminescence, the Cu-Cy emits intensive X-ray luminescence which is stronger than that of semiconductor quantum dots CdTe and ZnS:Mn as well as PVT/PPO organic scintillators. It has a good potential for lighting and radiation detection.

PH1 - 2: *Invited* Advanced Nanophosphors Synthesized by Microreaction Method and Their Application to Wavelength Conversion Layer

15:40

*H. Okura, K. Ohmi**

Merck, Japan

**Tottori Univ., Japan*

A novel solution combinatorial system based on microreaction method has been developed. The $\text{Bi}^{3+}, \text{Eu}^{3+}$ co-activated yttrium vanadate (YVO_4) red nanophosphor with high quantum efficiency has been synthesized using the microreactor. We have confirmed the improvement to the positive data by using the wavelength conversion layer for silicon solar cells.

PH1 - 3 **Synthesis of $\text{LaPO}_4:\text{Ce}^{3+},\text{Tb}^{3+}$ Phosphors by Solid Hydrate Thermal Processing**

16:05

S. W. Kim, T. Kaneko, K. Toda, K. Uematsu, T. Ishigaki, M. Sato, J. Koide, M. Toda*, Y. Kudo**

Niigata Univ., Japan

**N-Luminescence, Japan*

Green-emitting $\text{LaPO}_4:\text{Ce}^{3+},\text{Tb}^{3+}$ phosphors were synthesized by our original solid hydrate thermal processing. The Ce^{3+} and Tb^{3+} doped LaPO_4 phosphors with monoclinic structure were obtained in a single phase form. These phosphors exhibit green emission assigned to the energy transition from $^5\text{D}_4$ to $^7\text{F}_J$ ($J = 6, 5, 4, \text{ and } 3$) of Tb^{3+} .

----- Break -----

17:00 - 18:05

Room 302 B

PH2: Phosphor Applications

Chair: R.-J. Xie, NIMS, Japan

Co-Chair: K. Wani, TAZMO, Japan

PH2 - 1: ***Invited* Development of a UV Light Source Using Pr:LuAG Thin Film Target Pumped by Electron Beam**

17:00

N. Ichikawa, K. Ikeda, Y. Honda, H. Taketomi, K. Kawai, T. Suzuki

Hamamatsu Photonics, Japan

Pr:LuAG thin film was deposited by PLD. Pumping this film by electron beam, it was applied for UV light source with around 300 nm.

PH2 - 2 **Fabrication of Luminescent Thin Film for Electron Beam Excitation Assisted Optical Microscope**

17:25

T. Furukawa, S. Kanamori, M. Fukuta*, Y. Nawa, H. Kominami*, Y. Nakanishi*, A. Sugita*, W. Inami, Y. Kawata*

JST, Japan

**Shizuoka Univ., Japan*

We fabricated ZnO luminescent thin films for nanometric light spot of high spatial resolution optical microscopy based on electron beam excitation. The ZnO film annealed at 1000°C in N_2 had high cathodoluminescence intensity compared with as-deposited film, and the film provided nano-imaging beyond the diffraction limit using the microscopy.

PH2 - 3 **Growth, Structure, and Cathodoluminescence**
17:45 **Property of ZnO Nanorods Prepared with Low**
Temperature Reducing Annealing

C. Li, X. Li, S. Hou

Kochi Univ. of Tech., Japan

ZnO nanorods were fabricated in a novel reducing annealing methods at a low temperature process. The structural and cathodoluminescence properties of ZnO nanorods were investigated. The strong cathodoluminescence emission peak centered at 492 nm was obtained from well-aligned ZnO nanorods.

Author Interviews and Demonstrations

18:30 – 19:30

Friday, December 5

9:00 - 10:25

Room 302 A

PH3: Phosphors for Lighting Application
Special Topics of Interest on Lighting Technologies

Chair: W. Chen, Univ. of Texas at Arlington, USA

Co-Chair: K. Ohmi, Tottori Univ., Japan

PH3 - 1: *Invited* Quantum Rods Optical Film for Backlight
9:00

D. Glozman, E. Shaviv, H. Arbell, Y. Bonfil, U. Banin, S. Amir*

Qlight Nanotech, Israel

**Hebrew Univ. of Jerusalem, Israel*

Semiconductor quantum rods offer unique opportunities in the field of displays. Qlight is developing a film for LCD backlight enabling wide color gamut and the design of an energy-efficient polarized backlight. Another application being developed is QPixel, novel display technology based on electric field modulation of the quantum rods emission.

PH3 - 2 **Thermal Degradation of Green-Emitting**
9:25 **SrSi₂O₂N₂:Eu²⁺**

C. Wang, R.-J. Xie, T. Takeda*, T. Suehiro*, N. Hirosaki**

Univ. of S&T of China, China

**NIMS, Japan*

SrSi₂O₂N₂:Eu²⁺ is a very promising green phosphor for solid state lighting, which has a high quantum efficiency and small thermal quenching. However, this phosphor cannot be practically used because the degradation of white LEDs using it over time is not acceptable. In this work, we investigated the thermal degradation and its mechanism of SrSi₂O₂N₂:Eu²⁺.

**PH3 - 3 Wireless Power Transmission Method of a Powder
9:45 EL Sheet Device**

*K. Wani, T. Kanda, E. Hashimoto
TAZMO, Japan*

A thin and flexible EL lighting device was driven by a wireless power source. There is no other electrical component in the EL lighting unit except a planar secondary coil, which makes the lighting unit almost as thin as the EL sheet only.

Also presented in Innovative Demonstration Session (see p. 214)

**PH3 - 4 Studies of Electroluminescence from Individual
10:05 Phosphor Particles**

*J. Silver, P. G. Harris
Brunel Univ., UK*

Measurements of the radiance of powder a.c.electroluminescent devices have in the past been carried out on lamps containing large numbers of particles. In this work studies of individual ACEL particles of different sizes and in a variety of environments have been made to understand how they behave.

PH

Author Interviews and Demonstrations

16:45 – 17:45

Supporting Organizations:

Phosphor Research Society, The Electrochemical Society of Japan
The 125th Research Committee on Mutual Conversion between
Light and Electricity, Japan Society for Promotion of Science

EXHIBITION

12:40 – 18:00 Wednesday, Dec. 3, 2014

10:00 – 18:00 Thursday, Dec. 4, 2014

10:00 – 14:00 Friday, Dec. 5, 2014

Exhibition Hall B

TOKI MESSE Niigata Convention Center

Free admission with your registration name tag

Workshop on Field Emission Displays, CRTs and Plasma Displays

Friday, December 5

9:00 - 9:05

Room 302 B

Opening

Opening Remarks

9:00

H. Mimura, Shizuoka Univ., Japan

9:05 - 10:35

Room 302 B

FED1: Novel Devices and Applications

Chair: Y. Gotoh, Kyoto Univ., Japan

Co-Chair: F. Wakaya, Osaka Univ., Japan

FED1 - 1: *Invited* High Resolution Optical Imaging for Living 9:05 Cells with Electron Beam Excitation

Y. Kawata^{,**}, Y. Nawa^{*}, W. Inami^{*,**}*

^{}Shizuoka Univ., Japan*

*^{**}JST-CREST, Japan*

We present optical nanoimaging system and demonstrate the observation of biological specimens without any stained process. The electron-beam excited assisted (EXA) optical microscope has a few tens nanometer spatial resolution laterally and is possible to observe dynamic behaviors of specimens in various surroundings such as air or liquid.

FED1 - 2 **Electrostatic-Focusing Spindt-Type FEA with 9:35 Improved Electron-Beam Extraction Efficiency for FEA-HARP Image Sensor**

Y. Honda^{,**}, M. Nanba^{*}, K. Miyakawa^{*}, M. Kubota^{*},
M. Nagao^{***}, N. Egami^{****}*

^{}NHK, Japan*

*^{**}Shizuoka Univ., Japan*

*^{***}AIST, Japan*

*^{****}Kinki Univ., Japan*

A new electrostatic-focusing Spindt-type field emitter (FE) for a field emitter array high-gain avalanche rushing amorphous photoconductor image sensor was designed. Simulation results showed that the new electrostatic-focusing FE can improve electron-beam extraction efficiency.

**FED1 - 3
9:55** **A High-Sensitivity Photodetector Made of Amorphous Selenium and Nitrogen-Doped Diamond Cold Cathode**

T. Masuzawa, I. Saito^{}, M. Onishi^{*}, T. Ebisudani^{*},
J. Ochiai^{*}, T. Yamada^{**}, Y. Neo, H. Mimura,
D. H. C. Chua^{***}, K. Okano^{*}*

Shizuoka Univ., Japan

^{}Int. Christian Univ., Japan*

*^{**}AIST, Japan*

*^{***}Nat. Univ. of Singapore, Singapore*

We present a vacuum-tube type photodetector with extremely high sensitivity and potential imaging capability. A unique carrier multiplication effect and high resistivity of amorphous selenium has been utilized to enhance nominal quantum efficiency up to 10 times as large as theoretical absorption limit.

**FED1 - 4
10:15** **Photoassisted Field Emission from P-Type Silicon FEAs**

H. Shimawaki, M. Nagao^{}, T. Yoshida^{*}, Y. Neo^{**},
H. Mimura^{**}, F. Wakaya^{***}, M. Takai^{***}*

Hachinohe Inst. of Tech., Japan

^{}AIST, Japan*

*^{**}Shizuoka Univ., Japan*

*^{***}Osaka Univ., Japan*

We investigate the photoassisted electron emission from a p-type silicon FEA under illumination of laser lights. The increase of the emission current under light illumination is proportional to the emission current in the dark. The significant influence of the polarization in photoassisted emission for each wavelength was not observed.

----- Break -----

FED

10:45 - 11:45

Room 302 B

FED2: Fabrication Processes and New Materials

Chair: H. Mimura, Shizuoka Univ., Japan

Co-Chair: H. Shimawaki, Hachinohe Inst. of Tech., Japan

**FED2 - 1
10:45** **Fabrication and Emission Characteristics of Ni and Mo Spindt-Type FEAs with Volcano-Structured Focusing Electrode**

M. Nagao

AIST, Japan

We have proposed new fabrication of Spindt-type FEA with volcano-structured double-gate. Firstly, Ni was selected as an emitter material because of easy fabrication. Emission and focusing characteristics of the double gate Ni FEA were measured. Secondly, fabrication process was improved to make a Mo tip toward a higher reliability.

**FED2 - 2 Computer Simulation of Electron Beam Trajectories
11:05 in Double-Gated Spindt-Type FEAs**

*Y. Gotoh, H. Tsuji, M. Nagao**

Kyoto Univ., Japan

**AIST, Japan*

Computer simulations of the trajectories of the electron beams extracted from the double-gated Spindt-type FEAs were performed. The current density distribution of each beamlet was obtained, taking the estimated field value and the analytical relationship into consideration.

**FED2 - 3 Enhanced Field Emission of CuO Nanowire Arrays
11:25 by Coating of CNT Network Film**

H. Hu, D. Zhang, J. Lin, F. Li, T. Guo

Fuzhou Univ., China

Vertically aligned CuO nanowires were wrapped with CNT networks to improve the field emission properties. The effects of CuO morphology and CNT coverage on the FE characteristics were investigated. With the CNT-coating, the turn-on field of CuO array cathodes was dropped from 6.6 V/ μm to below 1.2 V/ μm .

FED2 - 4 Withdrawn

----- Lunch -----

13:30 - 14:50

Room 302 B

FED3: FE Mechanisms and PDP Protective Layers

Chair: M. Nagao, AIST, Japan

Co-Chair: H. Kajiyama, Tokushima Bunri Univ., Japan

**FED3 - 1 Observation of Fringelike Emission Pattern in
13:30 Magnetic Field**

Y. Yamada, S. Abo, K. Murakami, F. Wakaya, M. Abe,
M. Takai*

Osaka Univ., Japan

**Univ. of Tsukuba, Japan*

Experimentally observed shift distance of the emission pattern from the electron-beam-deposited Pt emitter by magnetic field was larger than expected one using Lorentz force, suggesting that the origin of the fringelike pattern was quantum mechanical interference.

FED3 - 2 **Work Function Measurements of Tungsten Surface Modified by Praseodymium Oxide by Using Field Emission Microscopy and Retarding Method**

13:50

*T. Kawakubo, K. Kanbara, T. Kitani, H. Nakane**

Kagawa Nat. College of Tech., Japan

**Muroran Inst. of Tech., Japan*

It is well known the work function of tungsten (100) surface is reduced after application of a very thin surface layer of transition metal and heating in an oxygen environment. We measured the work function of tungsten surface modified by Praseodymium oxide by using FEM and retarding method.

FED3 - 3 **High-Intensity Deep-UV Radiation and Exo-Electron Emission of MgO Powders for AC PDPs**

14:10

M. Sakai^{,**}, H. Asano^{*,**}, Y. Fukui^{*}, T. Tsujita^{*,**},
M. Nishitani^{*,**}, H. Kimiya^{*}, R. Murai^{*}, M. Kitagawa^{**}*

**Panasonic, Japan*

***Osaka Univ., Japan*

The electron emission mechanism of the MgO powders developed for the protective layer of the AC plasma display panels is investigated. The photoluminescence decay measurements show that their electron traps are very stable. The thermally stimulated exo-electron emission from the developed protective layer shows the improvement of the emission property.

FED3 - 4 **Electron Storage by Photochromic Transition of Oxide Nanoparticle**

14:30

H. Kajiyama, Y. Matsuura, M. Maekawa^{}, K. Uchino^{*},
K. Takata^{**}, S. Inoue^{***}*

Tokushima Bunri Univ., Japan

**Kyushu Univ., Japan*

***Kansai Univ., Japan*

****Hiroshima Univ., Japan*

A ZnSiO nanoparticle is synthesized using a VHF plasma assisted chemical vapor deposition apparatus. The nanoparticles with self-organized structure transform to photochromic (PC) states by UV irradiation. The PC transition by electron storage occurs in the ZnO part of nanoparticles. The stored electrons are thermally stable up to 550 K.

----- Break -----

15:15 - 16:50

Room 302 B

FED4: Summing Up of PDP History

Chair: L. Weber, Consult., USA

Co-Chair: T. Shiga, Univ. of Electro-Commun., Japan

FED4 - 1: Invited Summing Up of the PDP History and a Peek at Plasma Technologies Beyond Displays

15:15

*S. Mikoshiba**Univ. of Electro-Commun., Japan*

50 years of plasma display history, from the rise to the decline of the PDP business, will be analyzed, considering the intrinsic nature of gas discharges. The decline was due not to the technological maturity, but to business requirements. Also speculated are the future plasma technologies beyond displays.

FED4 - 2 A Flexible Luminous Array Film as a Radiation Area Selectable Hg-Free Ultra-Narrow Band UVB Light Source

15:55

*B. Guo, K. Awamoto, H. Hirakawa, T. Nishimoto***Plexie, Japan***Yumex, Japan*

A flexible Luminous Array Film as a radiation area selectable Hg-free ultra-narrow band UVB light source for skin treatment purpose is introduced. Compared with conventional mercury lamp and UV-LEDs, it has various merits, such as radiation area selectable, Hg-free, thin and flexible (~1 mm thickness) and ultra-narrow spectral bandwidth (~1 nm).

FED4 - 3 Photosynthesis Promotion by Pulsed Light from an AC-PDP Based Fluorescent Film

16:15

*H. Kajiyama, T. Ohata, I. Kanmai, S. Funai, T. Kono,**S. Nagahara, T. Matsuura**Tokushima Bunri Univ., Japan*

An ac-plasma based fluorescent film is used as a light source of plant photosynthesis. The effect of pulsed photoirradiation on the photosynthesis of a leaf vegetable is evaluated. It is confirmed that the stem growth rate per one photon increases by the pulsed photoirradiation with a lower frequency.

**FED4 - 4L Power Reduction Method for PDP Address Circuit
16:35 Using Address Data Smoothing Based on Visual
Masking Effect**

T. Shiga, M. Seki, M. Fujii

Univ. of Electro-Commun., Japan

An address power of PDPs is reduced while maintaining the image quality by choosing the smoothing area of address data based on the visual masking effect. The smoothing area is extracted using newly proposed index called the luminance-based segment. The estimated power reduction rate is about 50%.

Author Interviews and Demonstrations

16:45 – 17:45

Supporting Organizations:

JSPS 158th Committee on Vacuum Nanoelectronics
Plasma Display Technical Meeting

**Innovative Demonstration Session
by Oral and Poster Presenters**

Live demonstrations of emerging information
display technologies

16:45 – 19:30 Thursday, December 4, 2014

12:30 – 15:15 Friday, December 5, 2014

Exhibition Hall B

See Page 212 - 215 for details

RECEPTION

Wednesday, December 3, 2014

19:00 – 21:00

Room "Continental" (4F)

Hotel Okura Niigata

See page 12 for details

Workshop on OLED Displays and Related Technologies

Wednesday, December 3

14:00 - 15:20

Snow Hall B

OLED1: Advanced OLED Technologies (1)

Chair: T. Wakimoto, Merck, Japan

Co-Chair: T. Uchida, Tokyo Polytechnic Univ., Japan

OLED1 - 1 Flexibility and Reliability Improvement for Foldable OLED

14:00

S.-T. Yeh, G. Chen, C.-H. Tsai, Y.-H. Peng, J.-C. Ho, C.-C. Lee

ITRI, Taiwan

According to the stress simulation results, we developed the efficient passivation configurations to improve the bending ability of flexible AMOLED. This design equips our display with obvious bending performance even after the thousands times bending processes, and also provides the satisfied life time exhibition in flexible AMOLED panel.

OLED1 - 2 An Ultrathin AMOLED Integrated with On-Cell Touch Sensor for Flexible Displays

14:20

K.-T. Chen, S.-W. Chen, S.-A. Chen, P.-H. Wang, C.-C. Chang, S.-H. Lee, C.-W. Jung, M.-H. Yeh, K.-J. Chen, J.-Y. Yan, J.-C. Ho, C.-C. Lee

ITRI, Taiwan

This paper reveals a 6-in. flexible sensitive devices consisting of a capacitive touch sensor integrated on thin-film-encapsulated active-matrix organic light-emitting diodes (AMOLEDs). A folding test was performed repeatedly. The display survived the folding test (100,000 times) with a curvature radius of 7.5 mm.

OLED1 - 3 Black Screen for High Contrast Smart Window AMOLED Display

14:40

D. C. Choe, G. W. Kim, R. Lampande, J. H. Kwon

Kyung Hee Univ., Korea

We fabricated an ECD whose area of the ECD is 3 x 3 cm² and the fabricated ECD shows response time of less than 3 s. Absorbance of the ECD is 1.7 at 600 nm. We combined the ECD with red TOLED showing transmittance of 68% at 620 nm.

OLED1 - 4 High-Transparent 4.65-in. QHD AMOLED Display with 21% Transmittance
15:00

C.-T. Lee, Y.-Y. Huang, C.-C. Tsai, C.-C. Kuo, C.-H. Chiu, J.-H. Huang, S.-F. Liu, Y.-H. Cheng, C.-L. Chen, C.-T. Liang, W.-C. Yen, J.-S. Huang, Y.-W. Chiu, Y.-W. Liu
Chunghwa Picture Tubes, Taiwan

Display technology advances, from thin to "transparent" new forms of sustainable development. AMOLED panel cathode and anode use transparent materials. Furthermore, we demonstrate 4.65-in. AMOLED display, the module transparency of the AMOLED display is about 21% transmittance which can realize transparent and thinner portable device.

----- Break -----

15:45 - 17:00

Snow Hall B

OLED2: Advanced OLED Technologies (2)

Chair: Y. Kijima, Sony, Japan
 Co-Chair: S. Naka, Univ. of Toyama, Japan

OLED2 - 1 OLED on Silicon for Sensor Applications

15:45

M. Thomschke, M. Jahnel, B. Beyer, K. Fehse, U. Vogel
Fraunhofer COMEDD, Germany

We present two different approaches of OLED devices that are suitable for lab-on-a-chip applications. These include near UV electroluminescence (EL) and optically filtered green light to spectrally separate excitation from sample emission peaks. Both device architectures can be used for large-area deposition as well as integration onto Silicon-CMOS backplanes.

OLED2 - 2 Viewing Angle Spectral Analysis of OLED Display Light Emission Properties
16:05

P. M. Boher, T. Leroux, T. Bignon, V. Collomb-Patton
ELDIM, France

The angular emission of OLED displays is measured using a multispectral Fourier optics viewing angle system. The emission of red, green and blue states presents complex spectral changes versus angle. These changes probably related to interference fringes inside the OLED layered structure have small impact on color and luminance properties.

OLED2 - 3 Natural Stereoscopic Effect Achieved by High-Resolution OLED Display

16:25

*Y. Yanagisawa, H. Ikeda, D. Kubota, Y. Hirakata,
S. Yamazaki, M. Hirose*, M. Kasuga** ,****

Semiconductor Energy Lab., Japan

**Univ. of Tokyo, Japan*

***Sakushin Gakuin Univ., Japan*

****Utsunomiya Univ., Japan*

Statistical verifications reveal that organic light-emitting diode displays can more easily obtain a natural stereoscopic effect than liquid crystal displays. The use of curved flexible organic light-emitting diode displays and/or a frame placed in front of a display facilitates enhancement of the stereoscopic effect.

OLED2 - 4L Transparent Amorphous Oxide Semiconductors for Efficient and Stable Electron Transport Layers in Organic LEDs and Lightings

16:45

H. Hosono,***, E. Matsuzaki*,***, Y. Toda*,***, J. Kim*,
T. Kamiya*, S. Watanabe**,***, N. Nakamura**,
N. Miyakawa***

**Tokyo Inst. of Tech., Japan*

***Asahi Glass, Japan*

****Japan S&T Agency, Japan*

Proposed for OLEDs is an electron transport material, which is a transparent AOS and has a mobility of $\sim 1 \text{ cm}^2/\text{Vs}$ and a work function ϕ of 3.5 eV. The usage with a-C12A7:e⁻ ($\phi=3.0 \text{ eV}$) gives a higher injection efficiency than that of LiF/Al and is applicable also for inverted stacking.

Author Interviews and Demonstrations

17:15 – 18:15

IDW Best Paper Award**IDW Outstanding
Poster Paper Award**

These awards will go to the most outstanding papers selected from those presented at IDW '14.

The 2014 award winners will be announced on the IDW website: <http://www.idw.or.jp/award.html>

Thursday, December 4

9:00 - 10:25

Snow Hall B

OLED3: OLED Process Technologies
Special Topics of Interest on Printed Electronics

Chair: T. Shimizu, NHK, Japan

Co-Chair: T. Komatsu, Panasonic, Japan

OLED3 - 1: *Invited* OLED Device Fabrication by Ink-Jet Printing
9:00 Technology

*T. Sonoyama, M. Uchida, T. Sago, S. Watanabe,
 K. Ishida, M. Ito, M. Ishida, M. Yamada, Y. Okawa,
 S. Tanabe, H. Kiguchi*
Seiko Epson, Japan

Here we present the result of OLED device fabricated by Ink-jet method. We use a structure in which Red and Green EML are patterned by Ink-jet and Blue EML is formed by vapor deposition. We can make a good emission profile by improving uniformity of HIL and EML.

OLED3 - 2: *Invited* Important Technologies of Ink Jet System for
9:25 OLED Display Fabrication

T. Hayashi, K. Oshima, S. Takei, A. Shimamura,
 Y. Konta, S. Tanabe**
Tokyo Electron, Japan
**Seiko Epson, Japan*

We reported the advantages of ink jet printing (IJP) and the important technologies for MURA/Defect free panel fabrication by IJP. The swath-mura caused by IJ head variations, the ink mixed color issue in dry process and the oval-mura issue in baking process were already resolved by IJP equipment technologies.

OLED3 - 3 UV-Activated Transparent Desiccant for Practical
9:50 OLED Encapsulation Process

*H. Katsui, T. Miyasako, T. Arai, M. Takahashi,
 N. Onimaru, N. Takamatsu, T. Yamamura, K. Konno,
 K. Kuriyama*
JSR, Japan

We have developed a new-type desiccant material for practical OLED encapsulation process. Since a water absorbent function was activated via UV irradiation, we could handle the material in atmosphere until just before UV-sealing process. Such property would offer process simplicity and low equipment costs in OLED encapsulation process.

OLED3 - 4L Flexible AMOLED Display with Self-Aligned Top Gate Oxide TFTs and Novel Barrier Structures
10:10

*A. Kanegae, E. Kobayashi, Y. Honda, G. Sakamoto,
Y. Isaji, Y. Tsutsui, I. Ueno, T. Ukeda, K. Okada, Y. Izawa,
A. Kamitani, T. Mifune, K. Morita*
Panasonic, Japan

We have developed flexible AMOLED displays with self-aligned top gate oxide TFTs and novel barrier structures. Reactive sputtered aluminum oxide is used to lower the resistivity of IGZO. Newly developed moisture absorption barrier was also integrated. We could successfully demonstrate the 220-ppi full-color flexible AMOLED display for the first time.

----- Break -----

10:45 - 12:10

Snow Hall B

OLED4: OLED Materials (1)
Special Topics of Interest on Printed Electronics

Chair: K. Nakayama, Yamagata Univ., Japan
Co-Chair: K. Monzen, Nissan Chem. Inds., Japan

OLED4 - 1: *Invited* Blue Fluorescent OLEDs for Printed Display
10:45 **Applications**

*E. Böhm, C. Pflumm, H. Heil, S. Meyer, F. Knoch,
L.-I. Rodriguez, B. Burkhart, F. Eckes, K. Stegmaier,
H. Buchholz*
Merck KGaA, Germany

A solution processable host material for fluorescent blue OLEDs is presented. The contribution of triplet-triplet annihilation and emitter orientation to the external quantum efficiency for different OLEDs is investigated. Both effects enhance efficiency for devices manufactured by thermal evaporation. This is not the case for solution processed OLEDs.

OLED4 - 2: *Invited* Development and Manufacture of Solution-Processed White OLED Lighting Panel
11:10

T. Ogata
Mitsubishi Chem. Group S&T Res. Ctr., Japan

High-performance, solution-processable OLED materials have been developed. By the joint development with Pioneer Corporation, Mitsubishi Chemical Corporation started the mass production and shipment of OLED lighting panels with wet-processed platform and light emitting layers, which allow to reduce the manufacturing cost than conventional modules by vapor deposition process.

**OLED4 - 3 The Soluble Hole Injection Materials and the Inks
Applicable to OLED Devices**

11:35

*N. Otani, H. Koga, S. Moriyama, T. Endo, N. Nakaie,
K. Monzen**Nissan Chem. Inds., Japan*

We are developing the soluble hole injection materials and the ink, named ELsource that can be used as hole injection layer in OLED devices. Optimization of ink formulation applicable to wet coating process and new hole injection material with higher transmittance are reported.

**OLED4 - 4L Triplet-Energy Control of PAHs by BN Replacement
for Development of Ambipolar Host Materials for
PHOLEDs**

11:55

T. Hatakeyama, T. Ikuta, S. Hashimoto**, K. Shiren*,
S. Nakatsuka, J. Ni*, M. Nakamura****Kwansei Gakuin Univ., Japan***JNC PetroChem., Japan****Kyoto Univ., Japan*

The triplet-energy control of polycyclic aromatic hydrocarbons (PAHs) was achieved by replacing the CC unit with a BN unit. The PAH containing the BN unit, 4b-aza-12b-boradibenzo[g,p]chrysene, showed a large E_T value and ambipolar carrier-transport abilities and enable us to build phosphorescent organic light-emitting diodes of high performance.

----- Lunch -----

Author Interviews and Demonstrations

18:30 – 19:30

OLED

13:30 - 16:30

Exhibition Hall B

**Poster OLEDp1: OLED Poster
Special Topics of Interest on Lighting Technologies****OLEDp1 - 1 Flexible Hybrid White Light Emitting Diodes Based
on Small Molecules and Quantum Dots***W. Wu, F. Li, H. Hu, J. Lin, T. Guo**Fuzhou Univ., China*

A flexible hybrid white light emitting diode, in which the QDs acted as an orange emitter and organic small molecules as the blue emitter in a multilayered structure was fabricated. The device could produce white light emission and the current efficiency has a maximum of 0.97 cd/A.

OLEDp1 - 2 Novel Phosphorescent Host Material for Tunable Hybrid White OLED Devices

*H.-L. Huang, B. Balaganesan, H.-M. Kuo, B.-W. Xie
eRay Optoelect. Tech., Taiwan*

The novel phosphorescent host for phosphorescent yellow dopant was designed and prepared with easy scale-up reaction procedures. The hybrid WOLED can be tuned from warm white 30 lm/W@CIE(0.42, 0.49), 21 lm/W@CIE(0.39, 0.45) to cold white 15 lm/W@CIE(0.32, 0.39) under different thickness of the blue layer.

OLEDp1 - 3L Synthesis Yellow and Green Color Iridium(III) Complexes Containing Thieno[3, 2-C]pyridine Functional Group for Organic Light Emitting Diode

*C. A. Wu, J. S. Lin, M. H. Chang, P. C. Liu, M. R. Tseng
ITRI, Taiwan*

Thieno[3, 2-C]pyridine based OLED dopants were successfully prepared by our research group. These phosphorescent dopants showed excellent device performances. The yellow and green color devices revealed the EQE of 21.02, 13.6% and current efficacy of 67.6, 48.8 cd/A and power efficacy of 38.6, 30.6 lm/W at 1000 nits.

OLEDp1 - 4L Blue Top-Emissive Organic Light-Emitting Diodes on Stainless Steel

*J. Shin, E. Jung, S. H. Lim, S. M. Cho
Sungkyunkwan Univ., Korea*

We have fabricated blue top-emissive organic light-emitting diodes using stainless steel substrate and investigated the characteristics of these OLEDs compared with glass-based OLEDs that have same structure. The angle dependency of OLEDs on stainless steel was found much less than that on glass.

OLEDp1 - 5L Highly-Efficient Solution-Processed Yellow Organic Light-Emitting Diodes

*H.-C. Yeh, T.-C. Chao, C.-H. Chou, J.-Y. Liao,
M.-R. Tseng
ITRI, Taiwan*

A small molecular yellow iridium complex, PO-08, is prepared and characterized. A solution-processed yellow emission OLED using PO-08 as dopant exhibits very high performance with a current efficacy of 45.2 cd/A and a power efficacy of 36.7 lm/W at 1,050 cd/m².

OLEDp1 - 6L The Viewing Angle Dependency of Diffuser Layer on the Organic Light Emitting Diode with Microcavity Structure

B. W. Lim, M. C. Suh

Kyung Hee Univ., Korea

We have developed randomly dispersed nano-scattering films having nano-hemispherical shapes and nano-concave structures by nanoimprinting or simple spin coating processes. Those films were utilized as a diffuser layer to obtain desirable emission pattern like Lambertian distribution.

13:30 - 16:30

Exhibition Hall B

**Poster OLEDp2: OLED Poster
Special Topics of Interest on Printed Electronics**

OLEDp2 - 1 High-Mobility Solution-Processed Organic Field-Effect Transistors with Channel Length of 5 μm

R. Nakamichi, T. Nagase, T. Kobayashi, Y. Sadamitsu,
H. Naito*

Osaka Pref. Univ., Japan

**Nippon Kayaku, Japan*

We have fabricated short-channel organic FETs with top-gate configurations by conventional spin-coating processes. The solution-processed organic FETs with a channel length of 5 μm exhibit high field-effect mobilities of $1 \text{ cm}^2\text{V}^{-1}\text{s}^{-1}$ in both the linear and saturation regions and show electrically stable operations against gate bias stress.

OLEDp2 - 2L A Novel Orange Emitter for Solution Processed White OLEDs

J.-Y. Liao, H.-C. Yeh, T.-C. Chao, J.-S. Lin, M.-R. Tseng

ITRI, Taiwan

A novel orange emitter, PO-10, is studied. The PO-10 dopant performs ultra-high efficacies of 44.3 lm/W and 45.8 cd/A in NPB host. Two-emitter white devices using PO-10, Flrpic and a tri-host system are also characterized. Efficacies of 24.8 lm/W and 39.5 cd/A are recorded at brightness of ca. 2000 nits.

OLED

IDW '15

The 22nd International Display Workshops

December 9 – 11, 2015

Otsu Prince Hotel

Otsu, Japan

<http://www.idw.or.jp>

13:30 - 16:30

Exhibition Hall B

Poster OLEDp3: OLED Poster**OLEDp3 - 1 Polyfluorenes Containing Partially Hydrolyzed Phosphonate Pendant Groups as Electron-Injection Layer for PLEDs**

Y. Chen, C.-Y. Chou, H.-A. Lu, C.-P. Chen, Y.-J. Lin, C.-S. Wu

Nat. Cheng Kung Univ., Taiwan

Polyfluorenes containing pendant phosphonate (PF-EP) or partially hydrolyzed phosphonate groups (PF-EPK) are successfully applied as electron-injection layer (EIL) in PLEDs. The device with PF-EP doped with 2.5% PF-EPK as EIL enhanced device performance to 12052 cd/m² and 3.62 cd/A, respectively, from 725 cd/m² and 0.16 cd/A of non-EIL device.

OLEDp3 - 2 Inverted Transparent Organic Light-Emitting Diodes (i-TOLEDs) Comprising Metal Oxide Compounds as Electron-Injection Layer without Alkali Metal

R. Tejima, M. Ichikawa, Y. Hoshi, T. Uchida

Tokyo Polytechnic Univ., Japan

Inverted transparent OLED (i-TOLEDs) were made using spray CVD and vacuum-deposition methods. Only oxide compounds were used for the EIL of the diodes and without alkali metals. Furthermore, these i-TOLEDs were made with a nanoscale metal/dielectric multilayered transparent anode. We evaluated the performance of i-TOLEDs with ZnO, ZrO₂, ZnO:ZrO₂.

OLEDp3 - 3 The Study of High Resolution Micro-Contact Printing Technology on 4-in. 441 ppi FHD OLED Display

J.-A. Cheng, P.-C. Lin, Q. Li, Z. Zhu*, D. An*, L.-N. Chien, C.-T. Lin, I.-W. Wu**, I.-M. Lu, S. Fan**

Yeh Hsin Tech. Consulting, Taiwan

**Tsinghua Univ., China*

***Century Tech., China*

A 4-in. FHD OLED was investigated by using micro-contact printing technology. Via micro-patterned PDMS stamps, the full-color sub-pixel arrays with pattern size of 6.2 μm, 6.3 μm and 10.2 μm for red, green and blue, respectively, at a resolution of 441 ppi were printed for demonstrating its ability for OLED display fabrication.

OLEDp3 - 4 Enhancement of Hole-Injection and Power Efficiency of Organic Light Emitting Devices Using an Ultra-Thin MnO-Doped ZnO Buffer Layer

H.-W. Lu, P.-C. Kao, S.-Y. Chu*

Nat. Cheng Kung Univ., Taiwan

**Nat. Chiayi Univ., Taiwan*

In this paper, the MnO-doped ZnO (MZO) layers with different thickness were prepared by thermal-evaporating the MnO-doped ZnO powders and then treated by ultraviolet (UV) ozone exposure. The luminance enhanced about 262% from 8230 cd/m² of non-doped to 21600 cd/m² of 1 nm MnO-doped ZnO at 8 V.

OLEDp3 - 5 Characterization of Metals/Pentacene Interfaces by Hard X-Ray Photoelectron Spectroscopy

I. Hirose, T. Watanabe, H. Oji, K. Tada, N. Yoshimoto**

JASRI, Japan

**Iwate Univ., Japan*

Electronic structures around interfaces between metals and pentacene were characterized by hard x-ray photoelectron spectroscopy. It was proved that electronic state of Ag-coated pentacene film was more sensitive to applied biases than that of Au-coated film.

OLEDp3 - 6 Surface-Light-Emitting Transistors Using a P-Type Metal-Base Organic Transistors

N. Kogasaka, H. Muto, K. Nakayama

Yamagata Univ., Japan

We demonstrated high performance light-emitting organic transistors using p-type metal-base organic transistors (MBOT) having a simple layered structure with fluorescent OLED materials. The p-type MBOT enables us to reduce energy barrier for the emitting layer, resulting in high luminous efficiency.

OLED

OLEDp3 - 7 A Characterization and Evaluation Method for a Gas Barrier Film and Polarizer to Predict Minimum Bending Diameter Allowed in a Flexible OLED Device

A. T. Huang, S.-T. Ho, S.-H. Hung, M.-T. Lee

AU Optronics, Taiwan

Here we propose an easy straining method for a preliminary screening of gas barrier film and polarizer for a flexible OLED device. Change of gas barrier property can be detected with calcium cell. Changes of optical properties of a polarizer can be measured with different optical measurement.

OLEDp3 - 8 Analysis of Exciton Quenching Dynamics of Ir(ppy)₃ with Hole Measured by Time-Resolved Luminescence Spectroscopy*S. Oyama, H. Sakai, H. Murata**JAIST, Japan*

The time-resolved luminescence spectroscopy is employed to clarify the exciton quenching dynamics in holes-only devices (HODs) based on tris(2-phenylpyridinato)iridium(III) (Ir(ppy)₃). The results indicate the reaction rate of exciton-hole quenching saturate at the hole current of 0.05 mA/cm². On the other hand, exciton-hole quenching area expands as increasing hole current.

OLEDp3 - 9 Detection of Charged Species in Operating Organic Devices Using Multiple Reflection Absorption Spectra*Y. Akagi, H. Sakai, H. Murata**JAIST, Japan*

We developed a multiple reflection technique to obtain the absorption spectra of charged species in operating devices. Absorption spectra of the hole only devices (HODs) were measured under the operation. We succeeded the high sensitive in-situ detection of dication of α -NPD in solid state for the first time.

OLEDp3 - 10 In Situ Characterization of the Charge Transport and Crystal Structural Properties in Organic Thin Film Transistor*T. Watanabe, T. Koganezawa, M. Kikuchi*, K. Nishida*, N. Yoshimoto*, I. Hirose**JASRI, Japan***Iwate Univ., Japan*

A new instrumentation was developed to study the in situ electrical and crystallographic properties of organic thin film transistor during vacuum deposition. In situ measurement during deposition show 2-5-bis[p-(hexylphenyl)vinyl]-thieno[3,2-b]thiophene (DH-DSTT) thin film is oriented polycrystalline film along surface normal and source-drain current elevated as film thickness increased.

OLEDp3 - 11 Mechanistic Analysis for Preferable Performances at High Temperature of the OLED Device with New Electron Transport Material*K. Nomura, T. Tanaka**TOSOH, Japan*

We demonstrated low voltage, high efficiency and long lifetime in organic light-emitting diode (OLED) devices using new electron transport material (ETM) at room temperature and high temperatures. And the origins of these preferable lifetime performances at high temperature were discussed in terms of carrier balance and thermal stability.

OLEDp3 - 12 High Efficiency Blue Phosphorescent Organic Light-Emitting Diodes with Various Host Materials

*S. H. Kim, Y. J. Kim, Y.H.Son, J.M.Lee, B.Y.Kang,
C.H.Noh, S.H.Kim*, J.H.Kwon*

*Kyung Hee Univ., Korea
Samsung Elect., Korea

We report high efficiency deep blue phosphorescent organic light-emitting diodes (PHOLEDs) by using well-known iridium(III)bis[(3,5-difluoro-4-cyanophenyl)-pyridinato-N,C']picolate (FCNlIpic) dopant with good host materials. A maximum external quantum efficiency (EQE) of 23.9% and power efficiency of 30.2 lm/W are achieved with CIE color coordinate of (0.14, 0.21).

OLEDp3 - 13 Improvement on Equivalent Circuit Model for OLED with Its Luminance Decay Characteristics

J. Wu, Z. Zou, Y. Tang, Y. Zheng

Southeast Univ., China

The fundamental electric characteristics and the luminance decay rules of OLED have been achieved. The luminance of OLED changes exponentially, and it is a function which initial luminance, decay time factor, the decay exponent are related. Based on these rules, an improved equivalent circuit mode of OLED has been proposed.

OLEDp3 - 14 Efficient Ionization Method of Atomized Droplet for Fabricating Multilayer Organic Light-Emitting Diode

A. Sato, T. Fukuda, N. Kamata, Z. Honda

Saitama Univ., Japan

We demonstrated an improved deposition rate of organic film by an efficient ionization method using a needle electrode, and it became 2.7 times faster by applying the high voltage. In addition, a maximum luminance of 4,240 cd/m² was achieved for a multilayer organic light-emitting diode with the electron blocking layer.

OLED

OLEDp3 - 15 A Fast Evaluation of Barrier Tapes for In-Plane Water Vapor Permeation in Conventional Ca Film Tests

S.-T. Ho, S.-H. Hung, W.-L. Hung, C.-L. Wang, M.-T. Lee

AU Optonics, Taiwan

The permeation of water vapor through barrier tapes on calcium film has been observed and the geometrical difference around Ca film for various permeations has been introduced. Moreover, the growth of Ca oxidation can be fitted to diffusion equations. Therefore, a fast evaluation of barrier tapes has been demonstrated.

OLEDp3 - 16 Blue Phosphorescence Light-Emitting Diode with a New CbzOXD Host

H.-J. Chen, T.-L. Chiu, Y.-H. Hsieh, M.-K. Leung*, J.-H. Lee**

Yuan Ze Univ., Taiwan

**Nat. Taiwan Univ., Taiwan*

A new organic material was synthesized by conjugating a hole transporting moiety carbazole with an electron transporting moiety oxadiazole (OXD) to achieve a bipolar molecule, which was employed to be the host of emitting layer doped with blue emitter Flrpic inside an efficient blue phosphorescence organic light-emitting diode.

OLEDp3 - 17 High Efficiency Blue Phosphorescence Light-Emitting Diode with Novel CbzTAZ Host

H.-J. Chen, T.-L. Chiu, P.-S. Wang, J.-H. Lee*, Y.-H. Hsieh*, M.-K. Leung**

Yuan Ze Univ., Taiwan

**Nat. Taiwan Univ., Taiwan*

A novel bipolar carbazol-triazole derivatives was synthesized by conjugating hole transporting moiety carbazole (Cbz) with electron transporting moiety triazole (TAZ) to achieve a bipolar molecule, which was employed as the host of emitting layer doped with blue emitter Flrpic inside an blue phosphorescence OLED with EQE of more than 24%.

OLEDp3 - 18 Enhancement of Polarization Ratio on Polarized Organic Light Emitting Diodes Using Anisotropic Micro Lens Arrays

D. M. Lee, Y. D. Kim, S. I. Jo, C.-J. Yu, J.-H. Kim

Hanyang Univ., Korea

In this paper, we proposed an anisotropic micro lens structure to compensate the polarization ratio of the polarized OLED. And also, we could improve an out coupling efficiency of the organic light-emitting diodes by optimization of the micro lens structure.

OLEDp3 - 19 Optical Modeling of V-Shaped Organic Solar Cells in Oblique Incidence of Sunlight

J. Yoon, K. Kang, J. Kim

Kyung Hee Univ., Korea

We theoretically investigate the effect of the oblique incidence of sunlight on V-shaped organic solar cells. The light absorbance at the active layer is calculated as a function of the incidence angle. In addition, we calculate the short-circuit current and the open-circuit voltage by taking into account the light absorbance.

OLEDp3 - 20 Solution Processed N-P Junction for High Performance Organic Light Emitting Diode

*J. Kim, H.-M. Kim, J. Jang
Kyung Hee Univ., Korea*

We have studied the OLED using solution processed n-p junction as HIL. It is found that n-p junction acting as electron-hole generation can be used in OLED instead of HIL of conventional OLED. Our device with n-p junction exhibits similar performance comparable to conventional OLED using HIL by thermal evaporation.

OLEDp3 - 21L Nano-Honeycomb Structured Organic Light-Emitting Diodes with Enhanced Light Out-Coupling Efficiency through the Effective Extraction of the Surface Plasmon-Polariton Loss Mode

*X.-B. Shi, M. Qian, D.-Y. Zhou, Y. Liu, J. Liang,
Z.-K. Wang, L.-S. Liao
Soochow Univ., China*

The performance of OLEDs based on the nano-honeycomb structures are systematically studied. There is good agreement between the numerically calculated and the experimentally measured dispersion relations for the nano-honeycomb structure OLEDs. As an application in red phosphorescent OLEDs, high enhancements greater than 2.0 and 2.3 fold are achieved for the current and power efficiency, respectively.

OLEDp3 - 22L Extremely Low Operating Voltage Green Phosphorescent Inverted Organic Light-Emitting Diodes on Large-Size Flexible Substrate

*L. Ding, Y. Q. Sun, M. Y. Xie, K. Z. Wang, S. L. Liao
Soochow Univ., China*

Green phosphorescent inverted organic light-emitting diodes (IOLEDs) with HAT-CN/Al/n-doped Bphen used as interlayer was demonstrated. The IOLED shows the lowest driving voltage of 4.5 V at 10000 cd/m² to data. For application in large-area OLEDs, a 120×120 mm² flexible IOLED was successfully fabricated based on this interlayer.

OLEDp3 - 23L Investigation of n-Type Doping Organic Light-Emitting Diodes with a Novel Electron-Injection Material

*M.-C. Li, P.-C. Kao, S.-Y. Chu
Nat. Cheng Kung Univ., Taiwan*

This letter demonstrated the OLED incorporating a novel n-doping transport layer composed of rubidium iodide (RbI) doped into the electron transport layer as electron injection material. The device with a 15 wt.% RbI-doped Alq₃ achieves maximum luminance of to 19500 cd/A and also shows a efficiency of to 4.291 cd/A.

OLEDp3 - 24L Multi-Channel Instrument of Water Vapor Transmission Rate Measurements Using Electrical Calcium Test

*W. Duan, H. Zhang, S. Li, Z. Zhang, J. Zhang
Shanghai Univ., China*

A multichannel instrument for measuring water vapor transmission rate of encapsulation thin films was developed based on the electrical calcium test. The UV seal by glass was measured as 1.16×10^{-4} g/m²day at 25°C and 80% RH. This system can measure an accurate permeation rate with a high sensitivity.

OLEDp3 - 25L Transparent Organic Light-Emitting Diodes with Top Electrode by Ion-Plating Method

*H. Sano, R. Ishida, T. Kura, S. Fujita, S. Naka, H. Okada,
T. Takai**
Univ. of Toyama, Japan
**Nachi-Fujikoshi, Japan*

Transparent organic light-emitting diodes (OLEDs) were deposited with top electrode of indium-tin-oxide (ITO) by ion-plating method. High transmittance of over 80% at 550 nm and bright emission of 1,500 and 830 cd/m², from bottom and top side at 100 mA/cm², respectively, were obtained.

Friday, December 5

9:00 - 10:25

Snow Hall A

OLED5: OLED Materials (2)

Chair: S. Aratani, Hitachi, Japan
Co-Chair: T. Ikuta, JNC Petrochem., Japan

OLED5 - 1: *Invited* Latest Status of Soluble-OLED Material Development

*T. Yamada, Y. Tsubata, D. Fukushima, K. Ohuchi,
N. Akino*
Sumitomo Chem., Japan

The basic guidelines of material design for higher efficiency and longer lifetime, and the recent progress of polymer organic light-emitting diode (p-OLED) are reported.

OLED5 - 2 Electrical Properties of Solution-Processed Hole Injection Layer Analyzed by Impedance Spectroscopy

9:25

*T. Endo, Y. Horiuchi, N. Otani, K. Monzen
Nissan Chem. Inds., Japan*

The electrical properties of our developing solution-processed hole injection layer (HIL) were investigated by impedance spectroscopy. By impedance analysis, we clarified that the hole carrier mobility of our HIL was insensitive to temperature and/or electric field and our HIL worked as an effective electron blocking layer in OLED devices.

OLED5 - 3 Design to Electron Injection Complex Using Molecular Energy Calculation for High Performance OLED

9:45

*J. H. Kong, G. H. Kim, M. J. Park, H. W. Bae, J. H. Kwon
Kyung Hee Univ., Korea*

We report two newly synthesized electron injection complexes, lithium 2-(2-pyridyl)pyridine-3-olate (LIPPy) and lithium 4-phenyl-2-(2-pyridyl)phenolate (LIPPP), which were designed with molecular simulation. The organic light emitting devices fabricated using new complexes exhibit high performance as compare to the commercially available electron injection complexes, lithium 8-quinolate (Liq) and lithium 2-(2-pyridyl)phenolate (LIPP).

OLED5 - 4 Iridium-Free OLED Solutions for the Whole Color Spectrum

10:05

*M. Mydlak, D. Volz, D. Zink, T. Baumann, H. Flügge,
C. Fléchon, J. Navarro
CYNORA, Germany*

We present Singlet Harvesting emitter materials which efficiently emit light in the whole color spectrum, even in the deep blue region. An overview of the material class will show the capabilities of our new material classes, that reach state-of-the-art efficiencies, like 73 lm/W in solution-processed green OLED devices.

----- Break -----

Author Interviews and Demonstrations

16:45 – 17:45

Supporting Organizations:

The Japanese Society of Printing Science and Technology
The Society of Photography and Imaging of Japan

Workshop on 3D/Hyper-Realistic Displays and Systems

Thursday, December 4

9:00 - 12:00

Exhibition Hall B

Poster 3Dp1: 3D/Hyper-Realistic Displays

3Dp1 - 1 **Design of Pixel Structure for Color Electronic Holography Using One-Dimensional Spatial Light Modulator**

*A. Ueno, K. Nitta, O. Matoba
Kobe Univ., Japan*

Pixel structure of one-dimensional spatial light modulator is designed in color electronic holography. The numerical results indicate that the optimization of pixel size in color electronic holography reduces the reconstruction error caused by the cross-talk noise due to diffraction broadening.

3Dp1 - 2 **Computer-Generated Hologram Using Range Sensors and Digital Cameras at Arbitrary Locations**

*K. Tai, Y. Sakamoto
Hokkaido Univ., Japan*

In this paper, we propose a method that creates computer-generated holograms (CGHs) from voxel models generated by range sensors and digital cameras. Proposed method expresses occlusion in generated CGHs because devices are arranged arbitrary locations in a wide range by camera calibration.

3Dp1 - 3 **Automatic Geometric Calibration in Full-Parallax 3D Display Using Holographic Screen**

*R. Higashida, M. Yamaguchi
Tokyo Inst. of Tech., Japan*

We propose an automatic geometric calibration technique for a dynamic 3D display using a holographic screen and a projector. The test patterns suitable for the geometric calibration of the holographic screen are projected and the reconstructed light-rays are captured by a camera. In the experiment, correct 3D image was reconstructed.

3Dp1 - 4 Volumetric 3D Display Using Rotating Screens

S. Suzuki, C. Fujikawa, M. Omodani
Tokai Univ., Japan

We have focused on volumetric 3D display which can produce real 3D images for universal view point. We have suggested and demonstrated a novel method of volumetric 3D display, in which multi layers of section images are projected by an LCD projector on rotating concentric screens.

Also presented in Innovative Demonstration Session (see p. 212)

3Dp1 - 5 Floating Depth-Fused 3D Image Using Multi-Focal Lens 3D System for Image Data Reduction

R. Tanimoto^{}, T. Kurokawa^{*}, H. Yamamoto^{*,**}, S. Suyama^{*}*
^{*}*Univ. of Tokushima, Japan*
^{**}*Utsunomiya Univ., Japan*

In order to reduce the number of layered 2D image data in volumetric 3D display, we adopt DFD (Depth-fused 3D) technology to multi-focal lens 3D system. Floating DFD image with appropriate perceived depth can be achieved by calibrating luminance appropriately.

3Dp1 - 6 Wide Viewing Zone by Dynamic Head Movement in Edge-Based DFD Display

T. Soumiya^{}, H. Kuribayashi^{**}, H. Yamamoto^{*,***}, S. Suyama^{*}*
^{*}*Univ. of Tokushima, Japan*
^{**}*Nikon, Japan*
^{***}*Utsunomiya Univ., Japan*

Wide viewing zone can be achieved in edge-based DFD (Depth-fused 3D) display by dynamic head movement. Statistically, the viewing zone is limited between both eyes in DFD display. On the other hand, by moving head dynamically, viewing zone can be widely expanded as compared with the static case.

3Dp1 - 7 Crossed-Mirror Array Converges Sound Wave in 3D Space

R. Kujime^{}, K. Miyamoto^{*}, S. Suyama^{*}, H. Yamamoto^{*,**}*
^{*}*Univ. of Tokushima, Japan*
^{**}*Utsunomiya Univ., Japan*

We have converged sound-wave by using crossed-mirror array (CMA), which was reported to converge light by reflection. As sound-wavelength is much longer than light-wavelength, large size CMA comparable to sound-wavelength is used for converging sound-wave. By measuring sound 3D distribution, sound intensity has a maximum value at theoretical converging point.

3Dp1 - 8 Perceived Depth Degradation by Delay Time and Discontinuous Image Flipping in Monocular Motion Parallax Display

S. Yamada^{}, I. Ishii^{**}, H. Yamamoto^{***}, S. Suyama^{*}*

^{}Univ. of Tokushima, Japan*

*^{**}Hiroshima Univ., Japan*

*^{***}Utsunomiya Univ., Japan*

Perceived depth in monocular motion parallax is degraded by increasing delay time between head and stimulus motion and by discontinuous image flipping. When delay time is 649 ms, range of perceived depth is degraded about 65%. When image flipping is 63 mm, range of perceived depth is degraded about 50%.

3Dp1 - 9 Elimination and Mechanism Study of Binocular Luminance Difference in a 240 Hz Shutter-Type 3D LCDs

Y. Tian, X. Zhang, J. Hsu, C. Chen, C. Dong, X. Lian

Shenzhen China Star Optoelect. Tech., China

An obvious binocular luminance difference was found in a 240 Hz 3D LCDs. A facile and low-cost technology has been successfully developed for solving this issue. Besides, the root cause of this phenomenon has been mastered, and the mechanism illustration is proposed. With this solution, the luminance difference can be eliminated.

3Dp1 - 10 Withdrawn

3Dp1 - 11 Crosstalk Suppression Based on Gray Couples Measurement

J. Wang, X. Li, Y. Zhang, Z. Xia, S. Li^{}, S. Huang^{*}*

Southeast Univ., China

^{}Hisense Electric, China*

A crosstalk suppression method for active glasses 3D LCD displays is proposed. Firstly, couples of luminance through left/right glass is detected simultaneously. Based on those measurement results, optimized substitution for each couple can be derived and comprises a lookup table together. Crosstalk can be suppressed significantly when applying the table.

3Dp1 - 12 Study of Image Performance Affected by Color Pixel Arrangements and Lenticular Lenses Configuration for Autostereoscopy

Z.-H. Jhong, Y.-W. Chen, C.-R. Sheu

Nat. Cheng Kung Univ., Taiwan

3D imaging performance with respect to color sub-pixel arrangements is investigated via an autostereoscopic display with non-slanted or slanted lenticular lenses. The better imaging performance is achieved by slanted lenticular lenses rather than by non-slanted one. Especially, no more color separation is occurred for vertical stripe sub-pixel arrangement.

3Dp1 - 13 KANSEI Multimedia Display System That Can Control Smell Discharge Direction and the Psychological Effects

*M. Tanaka, R. Shu, R. Shinohara, K. Tomono, A. Tomono
Tokai Univ., Japan*

In order to promote the realistic sensations of visuals, a display system, in which smell along with air was discharged through a bamboo-blind screen to a viewer, was invented. A subject questionnaire and a cerebral blood-flow meter were used for the analysis of the users' psychological impact.

3Dp1 - 14L Real-Time Time-Division Color Electroholography Using a Multi-GPU PC

H. Araki, H. Niwase, N. Takada, H. Nakayama,
A. Sugiyama**, T. Kakue**, T. Shimobaba**, T. Ito***

Kochi Univ., Japan

**Nat. Astronomical Observatory of Japan, Japan*

***Chiba Univ., Japan*

We proposed a real-time time-division color electroholography using parallel calculation on multi graphics processing unit (GPU) system. Finally, we succeeded to display a reconstructed color 3D object of around 4000 points per color in real-time.

3Dp1 - 15L Real-Time Spatiotemporal Division Multiplexing Electroholography Using Multi-GPU Cluster System

*H. Niwase, H. Araki, N. Takada, Y. Maeda, M. Fujiwara,
H. Nakayama*, A. Sugiyama**, T. Kakue**,
T. Shimobaba**, T. Ito***

Kochi Univ., Japan

**Nat. Astronomical Observatory of Japan, Japan*

***Chiba Univ., Japan*

We try to display the real-time reconstructed 3D image consisting of a large number of object points. We propose spatiotemporal division multiplexing electroholography using multi-GPU cluster system with InfiniBand network. Finally, the proposed method realized a real-time reconstructed movie of a 3D object composed of 44,647 points.

3Dp1 - 16L Implementation of Hologram Generation from Integral Photographic Image with Wide Viewing-Zone Angle on GPU

*T. Suzuki***, T. Hayashi***, N. Hirata***, Y. Ichihashi**,
K. Yamamoto**, T. Kakue*, T. Shimobaba*, T. Ito**

**Chiba Univ., Japan*

***NICT, Japan*

We implemented an algorithm for enlarging the viewing-zone angle of holographic images on GPU with the aim of speeding up the calculation. We achieved results showing that calculations on the GPU were 15 times faster than on the CPU.

3Dp1 - 17L 3D Image Superposition for Flexible 3D Shape Measurements*S. Shinohara, Y. Takaki**Tokyo Univ. of A&T, Japan*

A new application for see-through three-dimensional (3D) displays is proposed where 3D object's shapes are measured using human depth perception. The shapes of reference 3D images superposed on 3D objects are interactively modified. The 3D shapes can be measured even when there are obstacles ahead of the objects.

3Dp1 - 18L Transparent Flat-Panel Integral Imaging Display*Y. Yamaguchi, Y. Takaki**Tokyo Univ. of A&T, Japan*

This paper proposes a transparent flat-panel 3D display based on integral imaging that enables to superpose 3D images on background scenes. Plural lens arrays are combined with a transparent flat-panel display to combine background rays with rays of 3D images. Preliminary experimental results describing the see-through feature are provided.

3Dp1 - 19L Integral 3D Display Using Computer-Generated Light Field Data*T. Iwane, M. Nakajima**Nikon, Japan*

We generated light field data in computer according to our light field theorem and applied this data to an integral 3D display. We report that 3D image can be displayed on a common cellular phone, placing a lens array plate without adjusting position.

Also presented in Innovative Demonstration Session (see p. 212)

3Dp1 - 20L Nanomaterials for 3D Imaging Screen*H. Aoki, A. Kuroda, S. Sato, K. Kodama, S. Maeda**Tokai Univ., Japan*

We have recently developed a calculation-free 2D-to-3D automatic conversion projection screen that uses the specific nanomaterials. The focus of this present work is to explore the nature of materials which are appropriate to the imaging screen.

SID Display Week 2015

May 31 – June 5, 2015

San Jose Convention Center

San Jose, California, U.S.A.

**3Dp1 - 21L In Cell Laminated Polarizer on Patterned Retarder
3D Display with Low Temperature Alignment
Material**

*J. Park, D. Lee, S. Kim, M. Yun, W. Jeong, K. Lim,
I. Kang, A. Muravsky*, A. Muravsky*, V. Agabekov**

*LG Display, Korea
NAS Belarus, Belarus

A low-temperature alignment material (LTAM) for an in-cell laminated polarizer on a patterned-retarder (ICL-PR) type 3D displays has been developed in order to enhance the vertical viewing-angle. The optical properties of LTAM were compared with the polyimide, and the vertical viewing-angle of the proposed 3D-panel with LTAM was measured.

**3Dp1 - 22L Imaging Studies of the Human Eye 3D Spatial
Frequency Identification**

C.-W. Lin, N.-W. Hsueh, Y.-C. Fang

Nat. Kaohsiung First Univ. of S&T, Taiwan

This study analyzes the human eyes identification of 2D and 3D images. Invited 80 students, when display appear images, they identify various the 2D and 3D identifications of the test. The experimental results showed that the two-dimensional image recognition rate 6.1% higher than the three-dimensional images.

3Dp1 - 23L Study of Realistic Color Painting for 3D Models

C.-C. Lan, H.-F. Wang, T.-H. Lin, P.-C. Hu, H.-S. Chen*

*Nat. Taiwan Univ. of S&T, Taiwan
Metal Inds. R&D Ctr., Taiwan

This paper discusses a practical solution of color texture mapping. In this paper, we try to map the high quality color texture, particularly from physical measurement, on the 3D teeth model in order to construct a realistic 3D teeth model. In the result, several realistic teeth models are compared to different RGB measurements.

----- Lunch -----

**The 50th Anniversary Speech of PDPs
“Summing Up of the PDP History
and a Peek at Plasma
Technologies Beyond Displays”
(FED4 – 1)**

Friday, December 5, 2014

15:15 - 15:55

Room 302B

See page 118 for detail

13:30 - 15:00

Room 302 A

3D1: Holography

Chair: H. Yamamoto, Utsunomiya Univ., Japan
 Co-Chair: M. Tsuchida, NTT, Japan

3D1 - 1: Invited Real-Time Pupil Tracking for Holographic Display
13:30

H.-G. Choo, K. A. Moon, J. Kim
ETRI, Korea

In this paper, we address a real-time pupil tracking method for holographic display. By using Kinect as auxiliary sensing, the complexity of stereo vision-based tracking can be reduced enough to locate the viewing window of the holographic display onto the observer's pupil.

3D1 - 2: Invited Color Holographic Display Based on Shifted and Scaled Fractional Fourier Transform
13:55

J. Xia, C. Chang, Y. Jiang, W. Lei, Y. Xie, M. Kang*, Q. Zhang**
Southeast Univ., China
**S&T Electro-Optic Control Lab., China*

We propose a method of calculating the color hologram for color holographic display. Three phase-only holograms of red, green and blue component are calculated by using the shifted and scaled fractional Fourier transform. Both of the chromatic aberration and zero order diffraction can be eliminated by our method.

3D1 - 3 3D Hologram Reconstruction in the Front of a Transmission Diffuser Screen
14:20

J.-F. Chang, W.-C. Su
Nat. Changhua Univ. of Education, Taiwan

In this article, based on the technique of optical phase conjugation, a technique of 3D hologram reconstruction in the front of the diffuser has been presented.

3D1 - 4 DMD as a Display Device for Holographic Displays
14:40

J.-Y. Son, B.-R. Lee, M.-C. Park**, O. Chernyshov*
Konyang Univ., Korea
**ETRI, Korea*
***KIST, Korea*

Properties of a DMD as being a display device for holographic displays and the condition of being a blazed grating are discussed. High speed, large separation between reconstructed image and reconstruction beam, a rhombic pixel arrangement and no 0th order beam for a specific wavelength are those desired for the displays.

----- Break -----

15:15 - 16:45

Room 301

3D2: Interactive 3D Display Technology
Special Topics of Interest on Augmented Reality and Virtual Reality

Chair: M. Tsuchida, NTT, Japan

Co-Chair: K. Yamamoto, NICT, Japan

3D2 - 1: 15:15 ***Invited* Interactive Display Technologies Using High-Speed Image Processing**

*M. Ishikawa**Univ. of Tokyo, Japan*

Design concepts for implementing low latency interface using high speed image processing and immersive interactive 2D/3D display systems such as commercial 3D display, emerging aerial display, dynamic projection mapping, high speed information environment, volume slicing display, and deformable workspace will be shown by using videos of those systems.

3D2 - 2: 16:00 ***Invited* Floating Digital Signage Based on Aerial Imaging Techniques**

H. Yamamoto^{,**}, S. Suyama^{***}**^{*}Utsunomiya Univ., Japan**^{**}JST-CREST, Japan**^{***}Univ. of Tokushima, Japan*

This paper reviews our floating digital signage techniques. After introducing design issues for floating LED signage, we introduce and show experimental results on two types of optical components: crossed-mirror array enables floating visual and thermal display; AIRR (aerial imaging by retro-reflection) forms floating LED screen with wide viewing angle.

Also presented in Innovative Demonstration Session (see p. 214)

3D2 - 3L 16:30 **Comparison of Material Combinations for Bright and Clear Floating Image by Retro-Reflective Re-imaging Technique**

Y. Tokuda, A. Hiyama, M. Hirose, T. Large^{}**Univ. of Tokyo, Japan**^{*}Microsoft Appl. Scis. Group, USA*

We investigate a solution to create clear and bright floating images from LCD display by comparing 16 different kinds of retro-reflectors and beam-splitters for a pseudo-phase-conjugation-effect. We found a reflective polarizer film can enhance the brightness and corner-cube array retro-reflectors can create clearer results than glass beads type for LCD.

Also presented in Innovative Demonstration Session (see p. 214)

----- Break -----

17:00 - 18:40

Room 301

3D3: Omnidirectional Hyper-Realistic System
Special Topics of Interest on Augmented Reality and Virtual Reality

Chair: K. Yamamoto, NICT, Japan

Co-Chair: M. Tsuchida, NTT, Japan

3D3 - 1: *Invited* Characteristic of the Ultra-Realistic Dome Images Estimated from Viewing Behavior

17:00

*M. Okyudo, C. Yoshizumi**Wakayama Univ., Japan*

The audience can feel realistic sensation by the dome images better than by the general flat images. We studied the characteristic of the dome images estimated from viewing behavior. As a result, the head's motion is raising the realistic. Then, we propose the dome viewing to watch Tokyo Olympic 2020.

3D3 - 2: *Invited* Development of Spherical Image Camera RICOH THETA

17:25

*M. Shohara**Ricoh, Japan*

A spherical image camera RICOH THETA is an emerging digital camera. The development of a spherical image camera is different from a conventional digital camera. We had to optimize the ways of the lens design, image processing and user interface. This paper explains the technical challenges during the development.

3D3 - 3: *Invited* Omnidirectional Video Streaming System with HMD

17:50

*D. Ochi**NTT, Japan*

An interactive video streaming technology that lets users view their favorite sections of events recorded with a 360° omnidirectional camera is proposed. This technology provides an immersive experience with an interactive view of any direction through an HMD following the user's head orientation within a reasonable amount of network bandwidth.

Also presented in Innovative Demonstration Session (see p. 214)

3D3 - 4: *Invited* Holographic HMD with Wide Visual Field

18:15

*Y. Sakamoto**Hokkaido Univ., Japan*

An electro-holographic display has a potential to be an ultimate three-dimensional (3D) display, however the visual field is narrow due to insufficient resolutions of the electronic devices. This paper reports our color electro-holographic head mounted display (HMD) with a wide visual field.

Author Interviews and Demonstrations

18:30 – 19:30

Friday, December 5

9:00 - 10:20

Room 301

3D4: 3D/Hyper-Realistic Displays (1)

Chair: H.-G. Choo, ETRI, Korea
 Co-Chair: K. Yamamoto, NICT, Japan

3D4 - 1 **Realization of Homogeneous Brightness for
 9:00** **Autostereoscopic Displays with Directional
 Backlights Composed of Convex Lens Arrays**

*S. Ishizuka, T. Mukai, H. Kakeya
 Univ. of Tsukuba, Japan*

We realize homogenous brightness of the autostereoscopic display with a directional backlight using a convex lens array by aligning the elemental lenses so that the phase of lens placement in each raw may differ from one another. The validity of the proposed optical design is confirmed by a prototype system.

Also presented in Innovative Demonstration Session (see p. 215)

3D4 - 2 **Floating Touch Display Based on a Heterogeneous
 9:20** **Imaging System**

*Y. Maeda, D. Miyazaki, S. Maekawa**
Osaka City Univ., Japan
**Parity Innovations, Japan*

An aerial imaging display with a sensor device is proposed as a floating touch display. The proposed imaging system based on retro reflection in a crosswise direction can be made at low cost without significant distortion. An observer can see and manipulate the aerial image naturally.

Also presented in Innovative Demonstration Session (see p. 215)

3D4 - 3 **A 2D-3D Display with a 120 Hz Hybrid Spatial-
 9:40** **Temporal Color LCD**

*Y. Weng, Y. Zhang, X. Li
 Southeast Univ., China*

A hybrid spatial-temporal color 2D/3D display is proposed. It uses a 120 Hz liquid crystal panel with two-color filters and a light emitting diode matrix backlight. Compared to the current commercial 3D LCD, this new configuration has a 1.5 times higher resolution and around 2 times higher light efficiency.

3D4 - 4 **True Color Optical Simulation of Integral Imaging 3D Display**
10:00

*J. Chen, B. Fang, D. Fan, Q. Liao, Q. Wei, C. Yang,
 C. Lee, C. Lo, A. Lien**

*Shenzhen China Star Optoelect. Tech., China
 TCL Corporate Res., China

A true color method was proposed to simulate integral imaging (II) 3D display of focused mode by adopting color filters in LightTools. The simulated Moiré pattern and perspective views were in good agreement with the measured ones in real setup.

----- Break -----

10:45 - 11:45

Room 301

3D5: 3D/Hyper-Realistic Displays (2)

Chair: J.-Y. Son, Konyang Univ., Korea

Co-Chair: M. Tsuchida, NTT, Japan

3D5 - 1 **3D Image Qualities for the 4K2K TVs**

10:45

*J.-Y. Huang, H.-S. Chen, P.-L. Sun, R. Luo**

*Nat. Taiwan Univ. of S&T, Taiwan
 Univ. of Leeds, UK

The aim of this study is to evaluate 3D image qualities of 65-in. 3D TVs with a maximum resolution of 4K2K. Two kinds of glasses-type 3D TVs are tested: one is active pattern retarder type and the other is passive shutter-glasses type. Two kinds of experiments of visual assessment are designed.

3D5 - 2 **Withdrawn**

3D5 - 3 **4D Floating Image Display Using Dual Off-Axis Parabolic Reflectors**
11:25

K. Li

Wavien, USA

This paper describes a reflector system with the 4th dimension added in which the 3D floating image moves from one location to another without the constraint of the focus in response to the movement of the object. Applications include theme-parks, fashion shows, security, etc., can be implemented using various configurations.

----- Lunch -----

13:30 - 14:55

Room 301

3D6: Optical Devices for 3D System

Chair: S. Yano, Shimane Univ., Japan

Co-Chair: M. Tsuchida, NTT, Japan

3D6 - 1: 13:30 Invited Expanding Depth Directional Stereoscopic Viewing Zone by Continuous Varying Optical Power Lens with Removing Structural Crosstalk in Auto-Stereoscopic 3D*K.-H. Lee**Korea Photonics Tech. Inst., Korea*

To expand the suitable stereoscopic viewing zone on depth directional and remove the structural crosstalk induced by the overlapped shape difference between unit-pixel and viewing zone forming optics as slanted lenslet, Segmented Lenticular lens having Continuous Varying Optical Power (SL-CVOP) is proposed.

3D6 - 2 13:55 A Novel Autostereoscopic Display Designed by Use of Wave Optics Simulation*A. Yuuki, T. Fujino, T. Satake, Y. Niwano, S. Nagano**Mitsubishi Elec., Japan*

We designed a novel autostereoscopic display by wave optics simulation. It is composed with a parallax barrier and a liquid crystal display. We formed distributions of transmission coefficient and refractive index in its light path, so that it has wide 3D viewing space where the luminance peak is very flat.

3D6 - 3 14:15 Analytical Solutions Finder (Moiré Solver) of the Parameters of 3D Auto-Stereoscopic Multi-View Display*F. Mukhtarov, S. D. Hwang**Samsung Elect., Korea*

In this paper we present our work introducing easy to use mathematic mechanism to suppress Moiré pattern for 3D displays. Mathematical engine was developed based on "Microsoft Office EXCEL" s/w. Results also confirmed by ray tracing simulations and Lenticular lens sample production for "Samsung Galaxy Note PRO".

3D

IDW '14 Tutorial in Japanese

Organized by SID Japan Chapter

Tuesday, December 2, 2014

Room 301, 3F

TOKI MESSE Niigata Convention Center

Detailed information is available on

<http://www.sid-japan.org>

3D6 - 4 **The Design of a Stereo Microscopic Eyepiece by Using a Biprism**
14:35

S.-W. Yang, T.-H. Lin^{}, C.-Y. Chen^{*}, K.-L. Huang^{**},
 P.-J. Wu^{***}*

Nat. Central Univ., Taiwan

^{}Nat. Yunlin Univ. of S&T, Taiwan*

*^{**}Ming Dao Univ., Taiwan*

*^{***}Nat. Chiao Tung Univ., Taiwan*

This study proposes a stereo microscopic eyepiece which is mounted in the stereo microscope. The eyepiece uses a biprism placed between the double gauss lens for obtaining an image pair with two view angles. It cannot only help the stereo microscopic to get 3D images but is easy to refit.

----- Break -----

15:15 - 16:20

Room 301

3D7/VHF7: Visual Perception for 3D System

Chair: K.-H. Lee, Korea Photonics Tech. Inst., Korea

Co-Chair: Y. Hisatake, Japan Display, Japan

3D7/ **Invited Towards the ISO Guideline for Image Safety**
VHF7 - 1: **during Stereoscopic Viewing**
15:15

T. Bando, A. Iijima^{}, S. Yano^{**}*

AIST, Japan

^{}Niigata Univ., Japan*

*^{**}Shimane Univ., Japan*

In accordance with the development of ICT technologies, stereoscopic 3D images have been commercially available. At the same time, biological influences have been reported, and a guideline to prevent undesirable influences is expected. In this review, the bases and efforts to establish such a guideline for image safety are discussed.

3D7/ **The Impact of Screen Size on 3D Flicker-Free**
VHF7 - 2 **Luminance**
15:40

P.-L. Sun, Y. P. Sie, H.-S. Chen, M. R. Luo^{}*

Nat. Taiwan Univ. of S&T, Taiwan

^{}Univ. of Leeds, UK*

3D flicker is one of the primary factors increasing visual discomfort especial for shutter-glasses type 3D TVs. The flicker-free luminance was estimated visually and the results show it's inversely proportional to the screen size. Besides, dimmable LED ambient lighting would generate strong flicker through the glasses.

3D7/
VHF7 - 3
16:00

**Measurement of Visual Fatigue Induced by
Stereoscopic Display Using an Oddball Based
Event-Related Potential Experiment**

*P. Ye, H. Liang, J. Wang, F. Chen, S. Yang, J. Chen,
X. Wu, D. Gao*

Nat. Sun Yat-Sen Univ., China

An oddball based event-related potential (ERP) experiment was designed to assess the visual fatigue induced by stereoscopic display. By using 3D stimuli without monocular cues, we controlled the subjects' disparity load and avoided fatigue induced by frequent changed disparity. ERP signals were obtained for characterizing 3D fatigue more accurately.

Author Interviews and Demonstrations

16:45 – 17:45

Supporting Organizations:

Technical Group on Three-Dimensional Image Technology, ITE
Holographic Display Artists and Engineers Club, The Japan Society of
Applied Physics

Evening Get-Together with Wine

Tuesday, December 2, 2014

18:00 – 20:00

Observation Deck (31F),

Hotel Nikko Niigata

(Sponsored by Merck Ltd., Japan)

See page 12 for details

EXHIBITION

12:40 – 18:00 Wednesday, Dec. 3, 2014

10:00 – 18:00 Thursday, Dec. 4, 2014

10:00 – 14:00 Friday, Dec. 5, 2014

Exhibition Hall B

TOKI MESSE Niigata Convention Center

Free admission with your registration name tag

Workshop on Applied Vision and Human Factors

Thursday, December 4

9:00 - 10:25

Room 302 A

VHF1: Optical Measurements

Chair: J. Bergquist, Nokia Techs., Japan

Co-Chair: Y. Hisatake, Japan Display, Japan

VHF1 - 1: *Invited* General FPD Mura Index under the IEC 9:00 Measurement Standard

S. Hasegawa^{ **}, S. Tomioka^{*}, K. Nagamine^{*}*

^{*}*Sony, Japan*

^{**}*JEITA, Japan*

We developed FPD's General Mura Index and submit to the IEC TC110 in order to provide the scale of Mura for proper evaluation method in the FPD industry instead of limit sample base method.

Also presented in Innovative Demonstration Session (see p. 212)

VHF1 - 2 Novel Evaluation Method of Sparkle for LCDs with 9:30 Different Anti-Glare Films

T.-W. Hsu, Y.-H. Chiang, C.-W. Chen

AU Optronics, Taiwan

We have presented a new method for sparkle evaluation. Unlike traditional methods, the proposed method separate and estimate sparkle in spatial-frequency domain, the analyzing process could be done automatically. The quantification factor calculated from analyzing process has good agreement with human perception test.

VHF1 - 3 Spectral Imaging Analysis of OLED Display Light 9:50 Emission Properties

P. M. Boher, T. Leroux, T. Bignon, V. Collomb-Patton

ELDIM, France

OLED displays are measured using innovative spectral imaging system. The homogeneity of red, green and blue states emission is evaluated on the entire display surface and at the sub pixel level. Color fluctuations above the human eye sensitivity are measured in both cases.

**VHF1 - 4L Color Mixing Assessing and Human Factor
10:10 Evaluating Under Large Viewing Angle in the Fringe-
Field Switching Mode**

*P. Y. Kuo, P. C. Yeh, H. C. Huang, C. S. Cheng, W. Huang
AU Optronics, Taiwan*

Color mixing assessing under large viewing angle can be carried out by NTSC measurement. However, there is no link between measurement and human vision experience. We verify color mixing by measurement and human vision experience and find the most optimized pixel structure which can improve image quality and color mixing.

VHF

----- Break -----

10:45 - 12:10

Room 302 A

VHF2: Color and OLEDs

Chair: S. Hasegawa, Sony, Japan
Co-Chair: K. Masaoka, NHK, Japan

**VHF2 - 1: *Invited* Visual Effects of Curved AMOLEDs
10:45**

*J. S. Kimmel
Nokia Techs., Finland*

Flexible AMOLEDs are becoming feasible display devices for consumer applications, with visual characteristics approaching glass-based AMOLEDs. Some visual effects become evident when the display is bent. Measurement results of an AMOLED device are presented, and the main AMOLED architectures are discussed, assessing the visual effects of bending the display.

**VHF2 - 2 A Monitor-Based System for Digital Quantification
11:15 of Deuteranomalous Vision**

*Y. Tsai, H. Chen, M. R. Luo**
Nat. Taiwan Univ. of S&T, Taiwan
**Univ. of Leeds, UK*

The aim of the present study is to further find a colour vision analytical strategy and predict the severities of deuteranomalous colour vision based on just-noticeable chromatic difference (JNCD). The monitor-based system was used to perform colour vision test on well-calibrated colour monitor.

**VHF2 - 3 Estimation of the Helmholtz-Kohlrausch Effect in
11:35 Natural Images Using Gaze Tracking Data**

T. Shizume, G. Ohashi, H. Takamatsu, Y. Shimodaira*

Shizuoka Univ., Japan

**NEC Display Solutions, Japan*

The purpose of this study is to derive and discuss the calculated and measured values of the Helmholtz-Kohlrausch effect in natural images. To improve the estimation accuracy, we apply gaze tracking data to derivation of the calculated values.

**VHF2 - 4L Study on Optimum Color Gamut of Mobile WCG
11:55 LCD**

*W. Seo, T. Kim, S. Lee, J. Jang, T.-Y. Park, J. Park,
M. Lim, J. Baek*

LG Display, Korea

This paper proposed an optimum color gamut to maximize color preference of mobile LCD. An experiment was carried out to find the optimized color gamut. The optimum color gamut from this study was evaluated at the same level using mobile LCD/OLEDs have color gamut larger than the optimum color gamut.

----- Lunch -----

13:30 - 16:30

Exhibition Hall B

Poster VHFp1: Applied Vision and Human Factors

**VHFp1 - 1 Evaluating and Simulating on Luminance
Discrepancy between Centre and Fringe of a Liquid
Crystal Display**

J. Wang, C. Wu, H. Liu, S. Lo

Shenzhen China Star Optoelect. Tech., China

The brightness in two lateral sides of a large-sized display is often higher than the central area. We provided specification values of luminance and pixel voltage discrepancy for future display design, and we gave a guiding principle for simulation to restrict the luminance discrepancy below the acceptable specification value.

**VHFp1 - 2 Object Images Quality Improvement for Transparent
Display**

Y.-H. Tsai, W.-D. Jeng, K.-L. Lo, T.-W. Huang,
O.-Y. Mang*

Nat. Chiao Tung Univ., Taiwan

**ITRI, Taiwan*

In this paper, we simulated the diffraction effect of transparent electrowetting display (EWD) and proposed a corresponding couple micro lens to reduce the diffraction effect. After optimizing the lens size, 92% diffraction width can be reduced.

VHFp1 - 3 Image Qualities of the Curved OLED Displays with Different Picture Setting Modes

*J.-Y. Huang, C.-W. Hsu, H.-S. Chen, P.-L. Sun,
M. R. Luo**

Nat. Taiwan Univ. of S&T, Taiwan

**Univ. of Leeds, UK*

This study is to evaluate subjective image qualities of curved OLED displays in standard mode and movie mode respectively. Five image quality indexes were designed to assess image qualities of RGB and RGBW OLED displays, including preference, naturalness, vivid, viewing angle and blackness.

VHF

VHFp1 - 4 Quantitative Visual Assessment of Moving Image Quality for 4K8K UHDTV Systems

I. Kawahara, H. Tabata

Keisoku Giken, Japan

A quantitative yet visual assessment on moving image quality and performance for 4K8K system was developed. Simple readability checks on dedicated patterns with well-designed motion, realized efficient and reliable evaluation for both display and CODEC. While making best use of human perception, display ergonomics, or visual comfort is highly considered.

Also presented in Innovative Demonstration Session (see p. 212)

VHFp1 - 5 Equivalent Spatial Resolution of RxGxBx Subpixel Arrangements

H.-C. Lin, C.-H. Wen, P.-L. Sun, S.-P. Wang*, K.-J. Hu*,
M.-C. Lo***

Nat. Taiwan Univ. of S&T, Taiwan

**ITRI, Taiwan*

***Shih Hsin Univ., Taiwan*

This paper approaches a set of subpixel arrangements with the corresponding subpixel rendering algorithms and demonstrates the simulated images on a 99% Adobe display. The perception experiments were conducted to the benchmark the spatial resolution performance of the subpixel arrangements against a real 423 ppi mobile display.

VHFp1 - 6 Comparison of Accommodation and Convergence among Real Object, 2D Display and 3D Display When a Target Moves along the Depth Direction

S. Mochizuki, Y. Yokoyama, H. Takahira, M. Yamada

Tokai Univ., Japan

We examined the mismatch of convergence and accommodation which were said to be one of the causes of image sickness. We found that the convergence and accommodation changed according to the depth movement of the real target faithfully, but the 2D and 3D image didn't change significantly.

VHFp1 - 7 Analysis of Fundamental Characteristics of Movement of Eye and Head When Indexing the Target by the Finger

K. Kikuchi, H. Takahira, R. Ishiro, Y. Tanaka, M. Endou, M. Yamada

Tokai Univ., Japan

We have developed a device to measure gaze and hand movements in a natural setting, and have been studying the fundamental characteristics of eye, head and hand coordination. Here, we analyzed the difference of head, eye, and hand coordination when gazing at a target with or without finger pointing.

VHFp1 - 8 Analysis of Accommodation and Convergence while Viewing 4K Images

H. Takahira, S. Mochizuki, Y. Yokoyama, M. Yamada

Tokai Univ., Japan

We analyzed the change of convergence eye movement and accommodation while viewing 4K, 2K and 1K images. The convergence eye movement occurred at all resolutions, but a difference among resolutions was seldom observed. Slight accommodation occurred, but no relation between convergence and accommodation was clearly shown.

VHFp1 - 9 Analysis of Convergence and Accommodation while Viewing 3D Movies

Y. Shiratori, M. Kitade, H. Takahira, S. Mochizuki, Y. Yokoyama, M. Yamada

Tokai Univ., Japan

When some individuals watch 3D movies, they experience discomfort that may be caused by a mismatch of convergence and accommodation. Here we simultaneously analyzed the convergence and accommodation of subjects watching 3D movies, focusing on the amount of disparity on the 3D image as a parameter.

VHFp1 - 10 Analysis of Accommodation and Convergence Eye Movement among Medium When a Target Moves along the Depth Direction

Y. Yokoyama, S. Mochizuki, H. Takahira, M. Yamada

Tokai Univ., Japan

We focused on the accuracy of accommodation and convergence while subjects viewed a display that was moving in the depth direction. We evaluated changes in accommodation and convergence angle during depth-direction movement with different kinds of display media, fonts and font sizes.

VHFp1 - 11L Studies of 3D Display of Non-Invasive Ophthalmoscopy for Diagnostic and Rehabilitation

P.-M. Lin, C.-H. Chu, Y.-C. Fang

Nat. Kaohsiung First Univ. of S&T, Taiwan

This research is proposed to study the examination of eyes via near infrared spectrum and a 3D ophthalmoscopy. The target captures 3D images as a non-invasive diagnosis via visible light and near-infrared light.

VHFp1 - 12L Examination of Blue Light Spectrum Emitted from OLED Displays

H. Isono, Y. Kuroda

Tokyo Denki Univ., Japan

We examined the blue region of the spectrum for an OLED display and an LCD. Since the OLED display has a sharp blue emission peak at about 458 nm, similar to that for the LCD, consideration needs to be given to health risks associated with blue light.

VHFp1 - 13L Color Conversion Method Overcoming Color Tracking and Imperfect Additive Color Mixture

M. Takaya, Y. Amano, Y. Shimodaira**

Nat. Inst. of Tech. Numazu College, Japan

**Shizuoka Univ., Japan*

Color conversion method for displays is proposed. It overcomes color differences caused by color tracking and imperfect additive color mixture. As a result of applying the method for displays, color difference of 1.9 is achieved. It's about 2.3 times accurate in comparison with the method of ICC-specified.

VHFp1 - 14L Evaluation on the Pixel Arrangement of Display

P. Dang, X. Zhang, X. Zhang, H. Zhu, X. Huang, X. Gao

Kunshan New Flat Panel Display Tech. Ctr., China

The differences in visual display quality among displays having different pixel arrangements were evaluated by Likert scale. The results indicated to show the quality was not only related to their PPIs, but also their pixel arrangements because of the pixel aperture and the distance between sub pixels.

----- Break -----

17:00 - 18:00

Room 302 A

VHF3: Moving Image Quality

Chair: T. Kurita, NHK Media Tech., Japan

Co-Chair: Y. Nakamura, Mitsubishi Elec., Japan

VHF3 - 1 Manual Pursuit Camera and a Method of Verifying Pursuit Accuracy

17:00

M. Rejhon, J. Bergquist, E. F. Kelley**, P. A. Boynton*****Rejhon Techs., Canada***Nokia Techs., Japan****KELTEK, USA*****NIST, USA*

In order to verify the accuracy of pursuit cameras in tracking moving objects on a display, we employ cascading synchronous markers that move below a moving box at the same pixel interval per frame. Under appropriate conditions, the markers can verify a velocity uncertainty of less than one percent.

VHF3 - 2 A Method of Image Quality Evaluation for Adaptive Temporal Aperture Control with Hold-Type Displays

17:20

*T. Usui, H. Sato, Y. Takano, T. Yamamoto, K. Ishii**NHK, Japan*

An adaptive technique of temporal aperture controlling in OLEDs is advantageous in improving motion image quality and suppressing degradation of lifetimes. We therefore propose the method and confirmed it to be effective using system for evaluating the method with an OLED of 25% temporal aperture and videos simulated motion blur.

Also presented in Innovative Demonstration Session (see p. 215)

VHF3 - 3 Image Quality Metrics for Color Breakup Based on Perceived Image Simulation

17:40

K. Hirai, N. Torige, T. Horiuchi, S. Tominaga, T. Shibuya, F. Hasegawa*, M. Nose***Chiba Univ., Japan***Ricoh, Japan*

This paper presents image quality metrics for evaluating color breakups of field-sequential color displays (FSCDs). We developed a perceived image simulator of FSCDs. The color breakup criteria are calculated from the simulated perceived images. Our metrics evaluated color breakups due to both smooth pursuit eye-tracking and saccades.

Author Interviews and Demonstrations

18:30 – 19:30

Friday, December 5

9:00 - 10:00

Room 201

VHF4: Display Legibility

Chair: Y. Shimodaira, Shizuoka Univ., Japan
 Co-Chair: N. Hiruma, NHK, Japan

**VHF4 - 1 Model for Flicker Analysis in Reflective LCD in Low
 9:00 Frequency Driving**

*Y. Kubota, R. Hatsumi, S. Fukai, D. Kubota, Y. Hirakata,
 S. Yamazaki, M. Hirose^{*}, M. Kasuga^{**},^{***}*

Semiconductor Energy Lab., Japan

^{}Univ. of Tokyo, Japan*

*^{**}Sakushin Gakuin Univ., Japan*

*^{***}Utsunomiya Univ., Japan*

Low-frequency driving of liquid crystal displays has attracted attention as low-power-consumption technology. We propose an analytical model that can verify whether data rewrite operations are perceived as flicker. The validity of the proposed model is verified by comparing the results of the analysis and sensory evaluation.

**VHF4 - 2 Effect of Font Types and Pixel Density of Electronic
 9:20 Displays on the Legibility of Japanese Characters**

Y. Hisatake, T. Kawamorita^{}, Y. Kanno, S. Takahashi^{**},
 M. Ito^{**}, H. Takahashi^{**}*

Japan Display, Japan

^{}Kitasato Univ., Japan*

*^{**}DNP, Japan*

Investigated was the readability of Japanese characters with different font-types and pixel-density on Electronic Displays, where the higher pixel density resulted in the faster reading-speed. The difference is obvious in small font size, while the reading-speed also depends on the font-types.

Also presented in Innovative Demonstration Session (see p. 212)

**VHF4 - 3 Psychological Derivation of Optimal Line Space for
 9:40 Legible Japanese Documents Based on Scheffe's
 Method of Paired Comparison**

Y. Yonezu, T. Tokui, N. Ishikawa, T. Matsui

Gunma Univ., Japan

The optimal line space lengths to make Japanese documents most legible are derived by using Scheffe's method of paired comparison to examine the cause of the quantitative difference between the conventional psychological and theoretical results. The experimentally-derived optimal line space lengths are located between the two kinds of conventional results.

----- Break -----

10:45 - 12:30

Room 201

DES3/VHF5: System Design and Evaluation in Augmented Reality
Special Topics of Interest on Augmented Reality and Virtual Reality

Chair: K. Morita, Nat. Traffic Safety & Environment Lab., Japan

Co-Chair: K. Sakamoto, Panasonic, Japan

DES3/ VHF5 - 1: *Invited* Simulation of Traffic Accident Scenarios with an Augmented Reality Vehicle

10:45

N. Uchida, T. Tagawa, K. Sato

Japan Automobile Res. Inst., Japan

Observing drivers' behaviours by reproducing traffic accidents and conflict situations is important for developing advanced driver assistant systems. For the purpose, an instrumented vehicle, named the JARI-ARV (Japan Automobile Research Institute - Augmented Reality Vehicle), was developed to reproduce realistic traffic accident and conflict scenarios without endangering the driver.

DES3/ VHF5 - 2: *Invited* The Realistic 3D Image Display Using Direct Light Scanning Method

11:10

H. Horimai, K. Hattori, T. Umezaki*

3Dragons LLC, Japan

**Chubu Univ., Japan*

The realistic 3D image displays using Direct Light Scanning Method, so-called Holo-Table/Holo-Deck have become available. The features of these displays are not only large number views but also high density of views. Because of these features, users can see a 3D scene from any directions with smooth motion parallax.

Also presented in Innovative Demonstration Session (see p. 215)

DES3/ VHF5 - 3: Fast Calculation Algorithm Based on Point-Based Method for CGHs Using Polygon Model

11:35

Y. Ogihara, Y. Sakamoto

Hokkaido Univ., Japan

Computer-generated holograms (CGHs), which are made by simulating light propagation using a computer, are able to represent virtual objects. However, an enormous amount of calculation time is needed to make CGHs. We propose the fast calculation algorithm with point-based method to make CGHs of the polygon model.

**DES3/
VHF5 - 4
11:55** **The Superiority of Widespread Monocular
Augmented Reality Presentation in a Manual Tracing
Task**

A. Kitamura, H. Naito, T. Kimura, K. Shinohara,
T. Sasaki**, H. Okumura***

Osaka Univ., Japan

**Kansai Univ. of Welfare Scis., Japan*

***Toshiba, Japan*

We conducted two experiments involving a tracing task with augmented reality image presentation covering a visual field observed in monocular or binocular mode. Performance on the tracing task was better in monocular mode relative to binocular mode, demonstrating the superiority of monocular AR presentation for performance of a manual task.

**DES3/
VHF5 - 5L
12:15** **A Fundamental Study of an Augmented Reality
System for Road Maintenance Services**

*K. Makita, C.-T. Chang, R. Ichikari, T. Okuma, T. Kurata
AIST, Japan*

In this paper, a fundamental study of an augmented reality system for supporting road maintenance is described. For realizing efficient road maintenance, we implemented a prototype augmented reality system using a camera fixed in the environment and a hand held device to visualize degenerate parts of the roads.

----- Lunch -----

13:30 - 14:45

Room 302 A

VHF6: Mobile Human Factors and 'Kansei' Evaluation

Chair: J. S. Kimmel, Nokia Techs., Finland
Co-Chair: T. Nakatsue, Sony, Japan

**VHF6 - 1
13:30** **Required Performances of Electronic Displays for
Smartphones Revealed by the Survey Results**

Y. Hisatake, M. Takemoto, S. Kubota***

Japan Display, Japan

**Seikei Univ., Japan*

***Ergo Design Lab., Japan*

Based on survey results on smart phones, including comparison with feature phones investigated in six-years ago, we studied the required performances of electronic displays for the smartphones.

**VHF6 - 2 An Overall Image Quality Model for Mobile Displays
13:50 under Different Lighting Conditions***R. Gong, H. Xu, M. R. Luo***Zhejiang Univ., China***Univ. of Leeds, UK*

An image quality model was proposed, applicable to various mobile displays and different lighting conditions. Large-scale psychophysical experiments were carried out to visually evaluate seven perceptual attributes of image quality. Based on interactions among these attributes, the overall image quality was predicted by its constituent attributes via multiple linear regression.

**VHF6 - 3 Emotion Prediction Model of Museum Lighting
14:10***C.-J. Chou, H.-W. Luo, H.-S. Chen, M. R. Luo***Nat. Taiwan Univ. of S&T, Taiwan***Univ. of Leeds, UK*

The aim of this paper is to establish an emotion model of indoor lighting for museums. Two experiments were conducted under different settings of CCT and illuminance in a large-scale museum and a small-scale laboratory, respectively. The emotion models were derived according to the CCT values and illuminance levels of lighting conditions in this experiment.

**VHF6 - 4L Super Hi-Vision (8K) Produces Stronger Depth
14:30 Sensation than 4K and Hi-Vision (2K).***Y. Tsushima, K. Komine, Y. Sawahata, T. Morita,
N. Hiruma**NHK, Japan*

People who experience Super Hi-Vision (8K) display often report stronger depth sensation than Hi-Vision (2K). Here, we psychophysically compared depth sensation of composite stimuli with 2K, 4K, and 8K. The results clearly show that higher resolution facilitates depth sensation. This indicates that SHV provides the audiences with unparalleled depth sensation.

----- Break -----

IDW '15

The 22nd International Display Workshops

December 9 – 11, 2015

Otsu Prince Hotel
Otsu, Japan<http://www.idw.or.jp>

15:15 - 16:20

Room 301

3D7/VHF7: Visual Perception for 3D System

Chair: K.-H. Lee, Korea Photonics Tech. Inst., Korea

Co-Chair: Y. Hisatake, Japan Display, Japan

**3D7/
VHF7 - 1: Invited Towards the ISO Guideline for Image Safety
during Stereoscopic Viewing**

15:15

T. Bando, A. Iijima, S. Yano****AIST, Japan***Niigata Univ. Japan****Shimane Univ., Japan*

VHF

In accordance with the development of ICT technologies, stereoscopic 3D images have been commercially available. At the same time, biological influences have been reported, and a guideline to prevent undesirable influences is expected. In this review, the bases and efforts to establish such a guideline for image safety are discussed.

**3D7/
VHF7 - 2 The Impact of Screen Size on 3D Flicker-Free
Luminance**

15:40

*P.-L. Sun, Y.-P. Sie, H.-S. Chen, M. R. Luo***Nat. Taiwan Univ. of S&T, Taiwan***Univ. of Leeds, UK*

3D flicker is one of the primary factors increasing visual discomfort especial for shutter-glasses type 3D TVs. The flicker-free luminance was estimated visually and the results show it's inversely proportional to the screen size. Besides, dimmable LED ambient lighting would generate strong flicker through the glasses.

**3D7/
VHF7 - 3 Measurement of Visual Fatigue Induced by
Stereoscopic Display Using an Oddball Based
Event-Related Potential Experiment**

16:00

*P. Ye, H. Liang, J. Wang, F. Chen, S. Yang, J. Chen,
X. Wu, D. Gao**Nat. Sun Yat-Sen Univ., China*

An oddball based event-related potential (ERP) experiment was designed to assess the visual fatigue induced by stereoscopic display. By using 3D stimuli without monocular cues, we controlled the subjects' disparity load and avoided fatigue induced by frequent changed disparity. ERP signals were obtained for characterizing 3D fatigue more accurately.

Author Interviews and Demonstrations

16:45 – 17:45

Supporting Organizations:

Technical Committee on Electronic Information Displays, Electronics Society, IEICE

Technical Group on Information Display, ITE

Workshop on Projection and Large-Area Displays and Their Components

Wednesday, December 3

14:00 - 14:05

Room 201

Opening

Opening Remarks

14:00

S. Ouchi, Hitachi, Japan

14:05 - 15:30

Room 201

PRJ1: Solid-State Light Source Technologies for Projector

Chair: P. Hickl, Barco Control Rooms, Germany

Co-Chair: H. Nakano, Barco, Japan

PRJ1 - 1: *Invited* SiC Light Emitting Diode and Its Polarization Control Using a Dressed Photon

14:05

T. Kawazoe, K. Nishioka, M. Ohtsu

Univ. of Tokyo, Japan

An optically polarized SiC light emitting diode was demonstrated. To fabricate this device, it was annealed by Joule heating brought about by a forward bias current under laser irradiation (dressed-photon-phonon (DPP) annealing). The emission peak wavelength and polarization both corresponded to those of the laser light irradiated during annealing.

PRJ1 - 2 High Power AlGaInP Red Laser Diode for Display Applications

14:30

K. Kuramoto, T. Nishida, S. Abe, M. Miyashita, K. Mori, T. Yagi

Mitsubishi Elec., Japan

The broad stripe red LD for one chip projector, which is operated under the pulse condition, was newly developed. The LD had a three-stripe configuration and was assembled on the 9 mm TO. The LD showed the maximum peak power exceeding 5 W under duty of 33%, 25°C.

**PRJ1 - 3 A New Technology for Stabilization of Chromaticity
14:50 in Laser Projectors**

*Y. Ogi, Y. Seo, S. Ouchi
Hitachi, Japan*

We have developed a technology for stabilization of chromaticity in laser scan type projectors. The technology using correction functions ($f_R(T), f_G(T), f_B(T)$) improves an instability of laser diode output in the wide temperature range. We have achieved the chromaticity accuracy within ± 0.015 in the temperature range (0 – 50°C).

**PRJ1 - 4 Lighting Technology for Automotive Headlamps
15:10**

*T. Masuda, H. Tanaka, Y. Shibata, M. Hayakawa,
S. Yamamura
Koito Manufacturing, Japan*

We are studying lamps that attract pedestrians' attention by displaying information on the road surface. In this study, we calculated the lamp brightness required to draw signals on the road surface, and confirmed that flashing the road surface signal at a specific frequency makes it more visible to pedestrians.

----- Break -----

PRJ

15:45 - 17:15	Room 201
PRJ2: Vehicle Display	

Chair: J. Thompson, Texas Instrs., USA
Co-Chair: K. Ohara, Texas Instrs. Japan, Japan

**PRJ2 - 1: Invited Projection Technology Will Take Automotive
15:45 Head-Up Display to the Next Level**

*C. Kusaka, J. Kimura
Techno Syss. Res., Japan*

With the increasing awareness of safety driving, various information is obtained by vehicles. For providing these information to the driver, HUD is suitable and Pico Projection technology has attracted to provide an advanced HUD. This paper covers the market expectations and the potential of Pico Projection technology for automotive HUD.

**PRJ2 - 2: Invited DLP Technology: Enabling the Next
16:10 Generation of Automotive Head-Up Display Systems**

*G. Pettitt, J. Ferri, J. Thompson
Texas Instrs., USA*

Texas Instruments has developed key technology for the next generation HUD for Automobiles. Car OEMs desire very large field of view, bright, colorful, HUD systems with augmented reality. DLP technology facilitates far virtual image distances, high brightness, mechanical packaging, and use of solid state light sources for next generation HUD.

PRJ2 - 3 Intelligent Head-Up-Display for Driver Assistance

16:35

*S.-W. Cheng, C.-Y. Shih, J.-T. Hsu**Automotive Res. & Testing Ctr., Taiwan*

We developed an intelligent heads-up display system in this study. That displays integrated car warning information on 2.5 meters in front of windshield. Large Area of the image (26-in.) is realized by combining a laser projector, a screen and a concaved half mirror. Semi-transparent display system is implemented in the car.

PRJ2 - 4 Development of Car Display System with Free-Form Screen

16:55

*S. Okagaki, J. Kondo, H. Sakamoto, S. Nakahara, M. Kuwata, A. Heishi, H. Yoshii, K. Nakamura, K. Kojima, M. Uno**Mitsubishi Elec., Japan*

Mitsubishi Electric has developed a car display system with a free-form screen, and the details of the system are described. The system's free-form screen responds flexibly to the increasing use of curves and other design features in car interiors, and its easy visibility helps to promote driving safety.

Author Interviews and Demonstrations

17:15 – 18:15

Thursday, December 4

9:00 - 10:25

Room 301

PRJ3: Projection Technologies

Chair: D. Cuypers, imec, Belgium

Co-Chair: H. Kikuchi, NHK, Japan

PRJ3 - 1: Invited Speckle Reduction by Current-Induced Magneto-Optical Effect Using P-type ZnO Device

9:00

*N. Tate, T. Kawazoe, M. Ohtsu**Univ. of Tokyo, Japan*

We experimentally demonstrated giant optical phase modulation using a p-type ZnO device fabricated using a technique that we developed. We achieved a sufficient reduction in the speckle noise of laser light by utilizing this effect to decrease the contrast of time-averaged speckle patterns.

**PRJ3 - 2 Speckle Measurement of Laser Display by Means of
9:25 Simulating to Human Eye Perception**

*T. Fukui, K. Suzuki, S. Kubota
Oxide, Japan*

In order to verify the speckle measurement by simulating to the human eye perception, the experiment with changing the pinhole diameter of the observation was performed. The results were quite consistent with the speckle theory and the designing of optical system was discussed for appropriate and repeatable speckle measurement.

**PRJ3 - 3 Speckle Reduction by Optimizing Pulse Width of
9:45 Drive Current for Red Laser Diodes**

T. Nishida^{,**}, T. Yagi^{*}, H. Murata^{**}, A. Koizumi^{**},
Y. Fujiwara^{**}, M. Takemi^{*}
^{*}Mitsubishi Elec., Japan
^{**}Osaka Univ., Japan*

Speckle contrast reduction method is newly proposed. The method is based on the active layer temperature control by optimizing the pulse width of the laser diode drive current. The speckle contrast shows minimum at the pulse width around 2-3 ms, which is suitable width for one spatial light modulator projector.

**PRJ3 - 4L Difference in Speckle Reduction by Wavelength
10:05 Diversity between Two Types of Screen**

*H. Yamada, K. Moriyasu, H. Sato, H. Hatanaka
Ushio, Japan*

Speckle reduction by using multiple wavelength lasers were measured at two types of screen: matte screen and silver screen. Significant differences in degrees of speckle reduction were seen between two screens. The result was analyzed theoretically.

----- Break -----

PRJ

10:45 - 11:50

Room 301

PRJ4: Wearable Display
Special Topics of Interest on Augmented Reality and Virtual Reality

Chair: S. Shikama, Setsunan Univ., Japan
Co-Chair: S. Ouchi, Hitachi, Japan

**PRJ4 - 1: Invited Laser Light Field Display Based on a Retinal
10:45 Scanning Array**

*M. Ide, K. Yoda, S. Kato
Citizen Holdings, Japan*

We present a near-to-eye laser light field display system using a MEMS scanner in combination with a microlens array. The system functions as a high-resolution tiled retinal-scanning array and creates multiple projection images on the retina. This gives the system a refocusing feature that can be applied to near-to-eye displays.

Also presented in Innovative Demonstration Session (see p. 212)

PRJ4 - 2 Compact Optical Engine for SmartGlass

11:10

*H. Baba, T. Totani, T. Hashizume**Seiko Epson, Japan*

After commercializing SmartGlass "MOVERIO-BT100" in Nov. 2011, EPSON has commercialized compact and lighter weight SmartGlass "MOVERIO-BT200" in June this year. New design of compact projection lens and light-guide, and finer micro display is discussed and summarized.

Also presented in Innovative Demonstration Session (see p. 213)

PRJ4 - 3 Light-Guide Optical Element Utilizing Notch Filters for See-Through Glasses

11:30

*X. Xiao, X. Lin, X. Tan**Beijing Inst. of Tech., China*

Eyewear display is a new type of portable mobile devices. A new way to achieve see-through glasses is proposed. Light-guide with an array of notch filters designed to partially reflect special narrow bands of the spectrum are used to coupling light from the microdisplay to the eye of the viewer.

----- Lunch -----

13:30 - 14:50

Room 302 B

PRJ5: Projection Applications

Chair: F. Shevlin, DYOPTYKA, Ireland

Co-Chair: Y. Asakura, Nittoh Kogaku, Japan

PRJ5 - 1 Ultra-Short-Throw 4K Projector with Solid-State

13:30

Light Source*T. Mochizuki, Y. Sato, J. Nishikawa, R. Miyao, H. Kikuchi**Sony, Japan*

Sony has developed the world's first ultra-short-throw 4K projector for home-use. This projector carries a zooming 4K projection lens with shifting-lens function and new solid-state light source consisted of blue laser diodes and a reflective phosphor wheel. The specification of the projector and technologies stated above are described in this paper.

PRJ5 - 2 Stable Optical Projection Screen for Near Seamless Display Walls

13:50

*P. Hickl**Barco Control Rooms, Germany*

Screens used in tiled rear projection display walls are environmentally unstable and require an air gap between the tiles. These problems are solved by using screens out of stable transparent base materials with integrated optical functionalities, so that the wall appears like a stable single screen with no mechanical gap.

**PRJ5 - 3 Inorganic Alignment Layers for Liquid Crystal
14:10 Grating Devices***D. Cuypers^{*,**}, H. D. Smet^{*,**}, J. D. Smet^{*,**}, P. Joshi^{*,**},
X. Shang^{*,**}***imec, Belgium****Ghent Univ., Belgium*

The possibility of producing tunable liquid crystal alignments using only inorganic obliquely evaporated alignment layers is explored and used for realizing proof-of-principle liquid crystal diffraction gratings, as such gratings promise to be very stable under high light fluxes.

**PRJ5 - 4L A Compact, Low Cost, Phase Randomizing Device
14:30 for Laser Illuminated Displays***F. Shevlin**DYOPTYKA, Ireland*

A compact, low cost version of our phase randomizing deformable mirror for use in mass produced laser illuminated microdisplay-type picoprojectors is described. Its speckle reduction performance is similar to our other more complex designs.

Also presented in Innovative Demonstration Session (see p. 215)

PRJ

14:50 - 15:02**Room 302 B****Short Presentation PRJp1: Projection**

All authors of poster papers for the PRJp1 session will give a brief, 3-minute oral presentations with no discussion time in advance.

Author Interviews and Demonstrations

18:30 – 19:30

Friday, December 5**9:00 - 12:00****Exhibition Hall B****Poster PRJp1: Projection****PRJp1 - 1 A Wide Laser Head-Up Display with the Complex
Refractive Elements***J.-H. Wu, I.-K. Hsu, P.-J. Wu^{*}, C.-Y. Chen**Nat. Yunlin Univ. of S & T, Taiwan**^{*}Nat. Chiao Tung Univ., Taiwan*

A laser Head-Up Display (HUD) with the wide-view effect is proposed to improve traffic safety for drivers. By using complex refractive elements, we can make the original image (14 mm×14 mm) become a wide image (32.6 mm×5 mm). Then, the virtual and magnifying wide-image is projected on the windshield.

PRJp1 - 2 A Study of Optical Design of Laser Projector*W.-T. Li, K.-D. Huang**Nat. Kaohsiung First Univ. of S&T, Taiwan*

In this study, we propose a newly designed laser projector with local dimming technique, including optical design of the structure adopted to the telecentric beam path of telecentric relay optics. Using micro lens array on the chip, we might improve contrast of image dramatically and even and better uniformity.

PRJp1 - 3 Development of Column-Parallel LED Screen with Flexible Shape*K. Sato^{*}, A. Tsuji^{*}, S. Suyama^{*}, H. Yamamoto^{*,**,*}**^{*}Univ. of Tokushima, Japan**^{**}JST-CREST, Japan**^{***}Utsunomiya Univ., Japan*

We have developed a high-frame-rate and flexible LED screen. Our LED screen employs column-parallel architecture, where every LED line is controlled by a micro-controller and runs in parallel. Therefore, latency is dependent of the number of lines. Furthermore, the LED lines are separated and can be installed in 3D shape.

PRJp1 - 4 Image Dispersion Compensation Based on Spatial-Multiplexed Holographic Optical Elements*H.-T. Lin, H.-S. Syu, W.-C. Su**Nat. Changhua Univ. of Education, Taiwan*

Holographic optical elements (HOEs) are important components for optical system. However, for display application, HOE will generate image dispersion. In order to solve dispersion, we use spatial-multiplexed of HOEs to correct the diffraction angle of different light wavelength.

15:15 - 16:35**Marine Hall****PRJ6: Wearable Display and Application**Chair: *K. Li, Wavien, USA*Co-Chair: *O. Akimoto, Sony, Japan***PRJ6 - 1L Small and Lightweight Optical Module for HMD****15:15***J. Iwai, K. Suzuki**Telepathy Japan, Japan*

We developed small, lightweight, high efficiency and low power consumption display module for HMD. Our optical design with reflective LCD made small sized display module applicable to HMD with minimal cover on the wearers' face.

Also presented in Innovative Demonstration Session (see p. 213)

PRJ6 - 2L High Efficiency Optical System Using Small Light Integrator for Head Mounted Display

15:35

T. Kawamura, T. Takaiwa, D. Sakai*, Y. Kawakami*, S. Ouchi**Hitachi, Japan***Hitachi Chem., Japan*

A light integrator in optical system for Head Mounted Display(HMD) was developed to enhance optical efficiency. The integrator is a light confinement rod containing fine particles for RGB light mixing. A HMD using the integrator was achieved with luminance of 8,300 cd/m² at the LED power of 45 mW.

PRJ6 - 3L Calculation-Free 2D-to-3D Projection Screen Using Nanomaterials

15:55

*A. Kuroda, S. Sato, K. Kodama, H. Aoki, S. Maeda**Tokai Univ., Japan*

3D projection screens are now in common use. In general, 3D imaging techniques require high computing power, specific software, and heavy large-scale hardware. In contrast, we have developed a calculation-free 2D-to-3D automatic conversion projection screen that uses the nature of specific nanomaterials.

PRJ6 - 4L Liquid-Cooled Laser Phosphor for Digital Projection

16:15

*K. Li**Wavien, USA*

This paper describes a laser excited phosphor suspended in a circulating liquid allowing high power and high efficiency operations suitable for screen brightness of over 30,000 lumens. Experiments are being performed using fiber-coupled laser with 10 W laser output powers from a 0.4 mm diameter fiber optic with 0.22 NA.

Author Interviews and Demonstrations

16:45 – 17:45

Supporting Organizations:

Laser Display Technology Research Group, Optical Society of Japan
 Technical Group on Information Display, ITE

Workshop on Electronic Paper

Wednesday, December 3

14:00 - 15:25

Room 302 A

EP1: Electrophoretic Displays

Chair: G. Zhou, South China Normal Univ., China
 Co-Chair: M. Tsuchiya, Innova Dynamics, Japan

EP1 - 1: *Invited* Three Particle Microencapsulated 14:00 Electrophoretic Display

*M. Wang, C. Lin, H. Du, H. Zang, M. McCreary
 E-Ink, USA*

E Ink Spectra displays utilize black, white and red engineered particles in a colorless solvent to achieve red plus B/W independent optical states without a color filter array. The technology, performance, and applications of Spectra will be described.

EP1 - 2: *Invited* Biprimary Dual-Particle Electrokinetic 14:25 Displays with 70% Reflectance and Greatly Improved Color Saturation

S. Mukherjee, J. Heikenfeld, N. Smith, M. Goulding*,
 C. Topping*, S. Norman*, Q. Liu**, L. Kramer**
 Univ. of Cincinnati, USA
 *Merck Chems., UK
 **Hewlett Packard Res. Lab., USA*

We demonstrate the "Biprimary" color system with dual-particle dispersions in a 3-electrode in-plane electrophoretic cell and a more advanced electrokinetic device structure to generate 4 color states. Preliminary contrast ratio reaches 10:1. The newly improved electrokinetic structure improves the color saturation greatly and the white state reflectance now reaches 70%.

EP1 - 3L: *Invited* TFT Free Active Matrix Addressable 14:50 Electronic Paper Display

M. Hong, H. W. Yoon, K. H. Yang, S. Han, B. Bae*,
 J. Lee*, S.-W. Lee**, M. Kim**, J. Kim**
 Korea Univ., Korea
 *Hoseo Univ., Korea
 **Kyung Hee Univ., Korea*

We have developed a simple metal-insulator-metal (MIM) structure for fast-moving ball actuator (FMBA) based on technology. In order to clarify the operation mechanism of FMBA, fundamental physics was investigated. Simplified and optimized driving scheme showed that FMBA was active matrix addressable without assistance of thin film transistors, additional storage capacitors.

**EP1 - 4L Stretchable and Flexible Electrophoretic Image
15:10 Display**

T. Kitamura, T. Nakamura, N. Kobayashi, T. Sawada,
T. Abe*, S. Yoshioka**

Chiba Univ., Japan

**Panasonic, Japan*

The stretchable and flexible electrophoretic image display device using the stretchable polymer film coated with the electrically conductive layer was produced. The stretchable polymer film was composed primarily of epoxy resin and used carbon nanotube for an electrically conductive layer.

----- Break -----

15:45 - 17:20

Room 302 A

EP2: Various Technologies for e-Paper

Chair: M. Omodani, Tokai Univ., Japan

Co-Chair: N.-S. Roh, Samsung Display, Korea

**EP2 - 1: Invited Review of Paper-Like Display Technologies
15:45**

Z. Yi, L. Wang*, P. Bai***, B. Tang***, D. Yuan***,
M. Jin***, L. Shui***, R. A. Hayes***, G. Zhou****

**South China Normal Univ., China*

***Guohua Optoelect., China*

Paper-like displays have received much attention after electrophoretic-based electronic paper displays were commercialized in 2004 for their excellent reading experience and ultra-low power consumption. In this paper, we give an overview on various paper-like display technologies with emphasis on the electrofluidic displays.

**EP2 - 2: Invited The Progress of Electrowetting Display and
16:10 Its Applications**

*L.-C. Chen, J.-W. Shiu, W.-Y. Cheng, K.-L. Lo,
R.-L. Chang*

ITRI, Taiwan

Electrowetting utilized interfacial tension of polar liquid/non-polar liquid and electromechanical force. Owing to its high aperture ratio, fast switching speed and low power consumption characteristics, this technology is very promising for reflective, transmission and transparent display applications. In this article, the development progress of electrowetting display in ITRI was introduced.

**EP2 - 3: Invited Frontlighting Technologies for Reflective
16:35 Displays: e-Papers, MEMS, MEOMS, LCDs**

K. Kälantär

Global Optical Solutions, Japan

Frontlighting reflective displays such as e-Papers, MEMS, MEOMS, LCDs, using edge-lit frontlight unit (FLU) is a unique method to modulate the displayed images and recover the optical characteristics under the dim environment. In this paper the concept of frontlighting and the recent developments of FLU are reported.

EP2 - 4L: *Invited* Electrochromic Smart Windows –The Power to Change

17:00

*J.-C. Giron**SAGE, USA*

Inefficient windows are responsible for over 30% of building energy consumption. But such problem is solvable with electrochromic (EC) glass that actively controls the daylight and solar heat. We will present why and how such technology is critical for more efficient and sustainable buildings through the example of commercialized SageGlass.

Author Interviews and Demonstrations

17:15 – 18:15

Thursday, December 4**9:00 - 10:05****Marine Hall****EP3: Chromic Displays**

Chair: N. Kobayashi, Chiba Univ., Japan

Co-Chair: M. Higuchi, NIMS, Japan

EP3 - 1: *Invited* Thermo-Switchable Imaging Media with Dual Emissive and Reflective Modes

9:00

*K. Nakamura, K. Ogasawara, Y. Kobayashi,
K. Kanazawa, N. Kobayashi**Chiba Univ., Japan*

Multi-functional composite films showing thermoresponsive switching of its absorption and emission were demonstrated by using thermochromic leuco dyes, developer and luminescent molecules. The composite films enabled control of the coloration and emission by thermal stimuli, resulting in RGB multicolor dual mode representation.

EP3 - 2 Improvement of Coloration Properties of Electrochromic Cell by Immobilizing Organic Electrochromic Molecules on the Electrode

9:25

*N. Ura, K. Nakamura, N. Kobayashi**Chiba Univ., Japan*

Electrochromism (EC) is known as electrochemical reaction exhibiting coloration, and is applicable to a new imaging device. In this paper, we report EC molecule-modified electrode using phthalate derivatives. The EC molecule-modified electrode showed vivid magenta color by reduction reaction, better EC properties than solution based EC cell.

**EP3 - 3 Design and Preparation of Metallo-Supramolecular
9:45 Polymers with Improved Electrochromic Properties**

M. Higuchi^{,**}*

^{}NIMS, Japan*

*^{**}JST-CREST, Japan*

Metallo-supramolecular polymers were synthesized by the complexation of various metal ions with ditopic ligands. They showed electrochromic properties with different colors or multi-colors. Metallo-supramolecular polymers with 3-D structures were also prepared using a tritopic ligand. They exhibited better electrochromic properties than the linear polymers due to the porous film structure.

10:05 - 10:38

Marine Hall

Short Presentation EPp1: Electronic Paper

All authors of poster papers for the EPp1 session will give a brief, 3-minute oral presentations with no discussion time in advance.

----- Break -----

Author Interviews and Demonstrations

18:30 – 19:30

13:30 - 16:30

Exhibition Hall B

Poster EPp1: Electronic Paper

**EPp1 - 1 Improvement of Response of an Electrophoretic
Display by Controlling Liquid Flow**

K. Sato, M. Omodani

Tokai Univ., Japan

We have focused on the liquid flow generated by particle movement in a display cell. We have tried to control the liquid flow by introducing guide blocks in the cell. We have suggested that appropriate arrangements of display cell structure can effectively improve the response time of electrophoretic displays.

**EPp1 - 2 Development of Twisting Balls for e-Paper by a
Microchannel Device**

H. Akita, Y. Awatsu, Y. Takizawa

Soken Chem. & Eng., Japan

We successfully mass-produced twisting ball display by utilizing the original fine particle creation technology used microchannel device. We can offer display materials that match the trend of the times and meet the needs of customers, such as clock, message board and variable display poster.

EPp1 - 3L Power-Saving Bar Indicator for Applied Voltage Utilizing Twisting Ball Technology

Y. Komazaki, T. Torii

Univ. of Tokyo, Japan

We fabricated a twisting ball display whose two facing pair electrodes were not parallel and the gap between two electrodes varied gradually with location. This display could indicate the strength of applied voltage as the length of the colored region.

EPp1 - 4L Polyaniline-Silica Nanocomposite Particles as Display Elements for Electronic Paper Sheets

T. Sugiura, T. Syoji, S. Maeda

Tokai Univ., Japan

We have prepared organic conducting particles which utilize polyaniline as conducting parts and silica as dispersants. The particles of polyaniline and silica represent a potentially useful processable form of polyaniline. We demonstrated the polyaniline-silica particles can be utilized as display elements in electrophoretic display due to their high colloid stabilities.

EPp1 - 5L Reflective Electrochromic Display (ECD) Having Memory Effect Utilizing Electrodes Modified by Electrochromic and Redox Polymer

T. Nakamura, T. Kitamura, N. Kobayashi

Chiba Univ., Japan

We developed a reflective electrochromic display (ECD) having memory effect utilizing a pair of electrodes modified by electrochromic and redox polymer. At first, the ECD is in colorless state, but by applying appropriate negative voltage, colorless state is changed into color state, which is maintained without applying additional voltage.

EPp1 - 6L Reversible Change of Primary Colors CMYK, RB and Green on Silver Nanoparticles by Pulse Width Modulation via Localized Surface Plasmon Resonance

M. Ichikawa, R. Tejima, T. Tani, T. Uchida*

Tokyo Polytechnic Univ., Japan

**The Society of Photography & Imaging of Japan, Japan*

A novel electro-chromic device achieved reversible change of primary colors-cyan, magenta, yellow, and black (CMYK). The device can also red, blue and green by pulse width modulation (PWM). The green color was achieved by low voltage PWM which forms uniform large nano particles with a coupling plasmon resonance.

EPp1 - 7L Niobium Films as Rewritable Imaging Media for Electronic Paper

*H. Aoki, I. Komatsu, K. Matsunaka, S. Maeda
Tokai Univ., Japan*

We are studying an easy method for preparing colored Nb by anode oxidation. The focus of this paper is to explore the possibility of this color Nb as rewritable media for use in electronic paper. We found that our Nb can be used as rewritable media by controlling preparation conditions.

EPp1 - 8L Study of Rewritable Paper Utilizing Kapok Fibers Containing Thermo-sensitive Inks

*M. Yukawa, K. Noda, A. Kuroda, S. Maeda
Tokai Univ., Japan*

The focus of this work is to develop a novel paper sheet which integrating Kapok fibers containing thermo-sensitive inks inside. The Kapok fiber is natural half-transparent hollow tube whose inner and outer diameters are 18 and 20 μm respectively. We think this technology can be utilized to rewritable paper.

EPp1 - 9L Proposing a Baseline Setup for Readability Using a Visual Analog Scale

T. Koizuka, Y. Ishii, T. Kojima, N. Ishio, P. R. Lege,
M. Miyao
Nagoya Univ., Japan
Chubu Gakuin Univ., Japan

We investigated in the readability of the e-paper display devices. We conducted subjective evaluations using a Visual Analog Scale, and the subjects reading efficiency. According to the results, we propose a baseline setup for readability of these devices from the analysis of the association between subjective evaluation and reading efficiency.

EPp1 - 10L Difference in Readability of the Contrast Ratio of Mobile Devices

*K. Iwata, Y. Ishii, T. Koizuka, S. Matsunami, N. Ishio,
P. R. Lege, T. Kojima*, M. Miyao
Nagoya Univ., Japan
Chubu Gakuin Univ., Japan

We carried out an experiment to evaluate the readability of e-books and ordinary paper text. In the experiments, we conducted subjective evaluations and measured the readability of each device with different contrast ratios. This study found a dependency between readability and the contrast ratio of the text of each device.

EPp1 - 11L Contribution of Character Sizes to the Readability of Mobile Devices

*Y. Ishii, T. Koizuka, K. Iwata, N. Ishio, S. Matsunami,
P. R. Lege, T. Kojima*, M. Miyao*

Nagoya Univ., Japan

**Chubu Gakuin Univ., Japan*

We carried out an experiment to evaluate the readability of e-books backlit LCD, and ordinary paper text. In the experiments, we conducted subjective evaluations, measured the subjects reading time, and calculated their percentage of correct answers. This study found a dependency between readability and the character sizes of each device.

IDW Best Paper Award

IDW Outstanding Poster Paper Award

These awards will go to the most outstanding papers selected from those presented at IDW '14.

The 2014 award winners will be announced on the IDW website: <http://www.idw.or.jp/award.html>

Innovative Demonstration Session by Oral and Poster Presenters

Live demonstrations of emerging information display technologies

16:45 – 19:30 Thursday, December 4, 2014

12:30 – 15:15 Friday, December 5, 2014

Exhibition Hall B

See Page 212 - 215 for details

Workshop on MEMS and Emerging Technologies for Future Displays and Devices

Thursday, December 4

9:00 - 9:10

Room 201

Opening

Opening Remarks **10th Anniversary Opening Remarks**
9:00

M. Nakamoto
Shizuoka Univ., Japan

9:10 - 10:30

Room 201

MEET1: Emerging Quantum Dots and Nanotechnologies

Chair: W. Milne, Univ. of Cambridge, UK
Co-Chair: Y. Bonnassieux, Ecole Polytechnique, France

MEET1 - 1: *Invited* Images and Cathodoluminescent Spectra of Red and Green Quantum Dots
9:10

J. Silver, G. R. Fern, T. G. Ireland, S. Coe-Sullivan, J. S. Steckel**
Brunel Univ., UK
**QD Vision, USA*

MEET

Cathodoluminescent imaging of the visible light emitted from green and red quantum dots is reported. The shape and uniformity of individual particles is observed in the electron image and this can have the image created from the visible light emitted from the particle by cathodoluminescence simultaneously superimposed on it.

MEET1 - 2: *Invited* Progress in Quantum Dots for Liquid Crystal Displays
9:30

S. Coe-Sullivan
QD Vision, USA

Products and product announcements currently place QDs in TVs, monitors, notebooks and tablet PCs, and they will continue to proliferate and gain market share in these and other display market segments. However, there are many important trends, in product performance and standards that continue to drive this market adoption.

**MEET1 - 3: *Invited* Red Quantum Rods under the Electron
9:50 Microscope**

G. R. Fern, J. Silver, T. Jochum^{}, J. S. Niehaus^{*},
F. Schröder-Oeynhausen^{*}, H. Weller^{*}*

Brunel Univ., UK

^{}CAN, Germany*

Cathodoluminescent (CL) imaging of the visible light emitted from quantum dot in rods (DRs) is reported. Their shape and uniformity is observed in the images and the image of the particles created from their visible light collected simultaneously is shown. The CL emission spectrum collected from the DRs is reported.

**MEET1 - 4: *Invited* Advancements in On-Chip Quantum Dots for
10:10 LED Backlights in Wide Color Gamut LCD Displays**

J. Osinski

Opticalogic Advisors LLC, USA

The implications of integrating quantum dots into an LCD display by placing them directly into an LED backlight package are described. This approach allows drop-in replacement of existing phosphor-based LEDs without requiring a system redesign, thereby providing cost, color gamut, and efficiency benefits simultaneously.

----- Break -----

10:45 - 12:45

Room 201

MEET2: Fundamental Components and Process Technologies

Chair: D. Pribat, Sungkyukwan Univ., Korea

Co-Chair: F. Templier, CEA-LETI, France

**MEET2 - 1: *Invited* CNTs and Graphene for X-ray Systems and
10:45 Other Applications**

W. I. Milne^{,**}, R. J. Parmee^{*,**}, J. Cameron^{**}, C. Li^{***},
W. Lei^{***}, B. Wang^{***}, M. T. Cole^{*,**}*

^{}Univ. of Cambridge, UK*

*^{**}Cambridge X-ray Syss., UK*

*^{***}Southeast Univ., China*

Carbon based materials have been investigated as possible field emission sources for a plethora of applications. This paper will describe our recent work on the design, growth and optimisation of CNTs for application in pulsed X-ray sources and end with our recent work on the use of graphene.

MEET2 - 2: *Invited* Fabrication of Lighting Lamp with Carbon Nanotube Emitters Beam (C-beam)

11:05

J. S. Kang, H. R. Lee, K. C. Park

Kyung Hee Univ., Korea

High brightness lighting lamp with carbon nanotube based electron beam (C-beam) were fabricated. The brightness of the lamp shows more than 30,000 cd/m² with lower driving power less than 5 W. The fabrication and performance of the vacuum lamp will be presented.

MEET2 - 3 Sub-Micron Transparent Metal Mesh Conductor for Touch Screen Displays

11:25

B. Kobrin, I. McMackin, J. Geddes, O. Seitz, M. Aryal, J. Wassei

Rolith, USA

Rolith, Inc. reports on superior performance of NanoWeb: sub-micron transparent metal mesh conductor for touch screen displays with high transmission (~ 96%), low sheet resistance (~ 4 Ohm/sq), absolute invisibility of metal mesh to the human eye, and complete elimination of Moiré fringes, fabricated on glass and PET film.

MEET2 - 4: *Invited* Gaussian Density-of-States Model for Organic Devices

11:45

Y. Bonnassieux, S. Jung, C. H. Kim, G. Horowitz

Ecole Polytechnique, France

In this presentation, we systematically study the effect of electronic structure on the charge carrier injection and transport as well as the low voltage current-voltage characteristics of organic rectifying diodes based on Gaussian disorder model.

MEET2 - 5 Crystallization Technique with Carbon Nanotube Electron Beam (C-beam) Exposure Technique

12:05

H. T. Park, J. S. Kang, J. H. Hong, H. Lee, W. J. Kim, K. C. Park

Kyung Hee Univ., Korea

In this study, we propose a novel crystallization process that is called carbon nanotube electron beam (C-beam) exposed crystallization technique. When C-beam is exposed on a-Si:H films, exposed area is crystallized to poly-Si. Poly-Si thin films has higher crystalline properties with lower hydrogen contents.

MEET2 - 6 Cathodoluminescence Properties of Silicon Thin Films with Carbon Nanotube Electron Beam (C-beam) Exposure Technique

12:25

W. J. Kim, J. S. Kang, H. R. Lee, J. H. Hong, H. T. Park, K. C. Park

Kyung Hee Univ., Korea

In this study, we investigated the cathodoluminescence (CL) properties of silicon thin films with carbon nanotube electron beam (C-beam) exposure technique. An intensive CL emission spectrum is observed in the visible range of 300 ~ 800 nm and the origin of the CL were studied for silicon optoelectronic devices.

----- Lunch -----

13:30 - 15:05

Room 201

MEET3: EL Quantum Dots Technologies

Chair: S. Coe-Sullivan, QD Vision, USA

Co-Chair: J. Silver, Brunel Univ., UK

MEET3 - 1: *Invited* All Solution Processed QLED

13:30

J. Jang, J. E. Lee

Kyung Hee Univ., Korea

This paper reviews inverted quantum-dot light emitting diodes (QLEDs) using all solution process. To improve the device performances, the inverted QLED is designed with stacked electron transporting layer (ETL). The stacked ETL and doped HTL reduced electron and hole transport barriers to QDs, respectively, and could improve the device efficiency.

MEET3 - 2: *Invited* Efficient Quantum Dot Light-Emitting Diodes by Improving Charge Carrier Balance

13:50

J. Kwak, M. Park, H. Jung*, J. Lim**, W. Bae***, K. Char*, S. Lee*, C. Lee**

Dong-A Univ., Korea

**Seoul Nat. Univ., Korea*

***Los Alamos Nat. Lab., USA*

****KIST, Korea*

We demonstrate efficient full-color quantum dot (QD) based light-emitting diodes by employing an inverted device structure with zinc oxide (ZnO) electron injection layer. Charge carrier balance is improved by inserting a thin charge blocking layer between the ZnO layer and QD layer, resulting in high efficiency and reduced efficiency roll-off.

MEET3 - 3: Invited Quantum Dot Light-Emitting Diodes for Efficient, Solution-Processed Flat Panel Displays
14:10

J. R. Manders^{}, Y. Zheng^{*}, L. Qian^{*}, Y. Yang^{*}, A. Titov^{*},
J. Hyvonen^{*}, J. Tokarz-Scott^{*}, W. Cao^{**}, J. Xue^{**},
C. Morton^{*}, P. H. Holloway^{*,**}*

^{}NanoPhotonica, USA*

*^{**}Univ. of Florida, USA*

Colloidal quantum-dot, solution-processed hybrid light-emitting diodes (S-QLEDs) that exhibit current efficiencies of 15, 61, and 4.4 cd/A, power efficiencies of 18, 63, and 2.4 lm/W, and external quantum efficiencies up to 12%, 14%, and 10.7% for red, green, and deep blue emitting QLEDs are reported.

MEET3 - 4 Enhanced Efficiency of Quantum Dot Light-Emitting Diodes by Modifying Sol-Gel Based Metal-Doped ZnO Electron Transport Layer
14:30

H. Jung, M. Thambidurai, J. Lim, K. Char, S. Lee, C. Lee

Seoul Nat. Univ., Korea

We studied the effect of electron mobility of an electron transport layer varied by the annealing temperature of sol-gel processed gallium-doped zinc oxide thin films on the electrical and optical properties of inverted quantum dot based light-emitting diodes.

MEET3 - 5L Magneto-Optical Spatial Light Modulator Driven by Si Based MOS-FET Backplane for Holography Display
14:50

*K. Aoshima, H. Kinjo, K. Machida, D. Kato, K. Kuga,
H. Kikuchi, N. Shimidzu*

NHK, Japan

We have developed a magneto-optical spatial light modulator (the spin SLM) controlled by a transistor backplane which plays a crucial role for extending large scale display. It has 10×5-pixels with their size of 0.5 μm. We have successfully confirmed its contrast change by magnetization switching in light modulation elements.

----- Break -----

**The 50th Anniversary Speech of PDPs
“Summing Up of the PDP History
and a Peek at Plasma
Technologies Beyond Displays”
(FED4 – 1)**

Friday, December 5, 2014

15:15 - 15:55

Room 302B

See page 118 for detail

15:15 - 16:55

Room 201

MEET4: Novel Materials and Components

Chair: K. C. Park, Kyung Hee Univ., Korea

Co-Chair: G. R. Fern, Brunel Univ., UK

MEET4 - 1: Invited Graphene-Silicon Composites for Improved Solar Cells

15:15

*E. Moyer, J. Jo, G.-D. Kwon, Y. W. Kim, Y. Lee, D. Pribat
Sungkyunkwan Univ., Korea*

We propose an unconventional approach for solar cell fabrication, based on semiconductor wires (or nanoparticles) sandwiched between graphene sheets. Typically, the wires are grown separately, harvested and then spread and sandwiched between respectively n- and p-type doped graphene sheets, thus forming horizontal, flexible p-n arrays.

MEET4 - 2 Conducting Graphene Thin Film on Glass with Electron Beam Irradiation

15:35

*G. C. Lim, J. S. Kang, J. S. Ahn, K. C. Park
Kyung Hee Univ., Korea*

We fabricate the transparent graphene film on glass using spin coating method, and irradiate the electron beam on the film. From microscopic structural analysis, enhanced grain size and flatter of grain were confirmed. The resistance decreases from $> 100 \text{ M}\Omega$ to $10 \text{ k}\Omega$, resulting transparent graphene electrode formation.

MEET4 - 3: Invited High Target Utilization Sputtering of Thin Film Metal Oxides for Large-Area Electronics

15:55

*A. J. Flewitt
Univ. of Cambridge, UK*

High target utilization sputtering is reviewed. A remote, inductively-coupled plasma generator is used to produce a sputtering plasma, which is then confined by electromagnets and guided onto a metallic target, which is itself subjected to a dc voltage bias. This allows very high quality metal oxides to be deposited.

MEET4 - 4 Super Smart Window-its Energy Design and Some Early Research

16:15

*H. Morita, H. Yoshida
Tokyo Univ. of Sci., Yamaguchi, Japan*

We designed the window light-shielding system by using the electric energy generated by the built-in transparent solar cell. In our system of combined solar cell and electrochromic light absorption control layers, the energy creation and its effective consumption can be carried out on the same glass window plain.

**MEET4 - 5 Resonator-Type Infrared Detector Released by
16:35 Plasmaless Sacrificial Si Etching**

J.-H. Jeong, S. Kumagai, S. Tajima^{}, T. Hayashi^{*},
K. Yamakawa^{**}, M. Sasaki*

Toyota Tech. Inst., Japan

^{}Nagoya Univ., Japan*

*^{**}Katagiri Eng., Japan*

Resonator-type infrared detector is fabricated from thin SiO₂ and Cr films. New technique of the plasmaless sacrificial Si etching is applied for releasing the resonator without the plasma-related damage. The resonator shows the large ratio of the resonant frequency shift -580 ppm/K against the substrate temperature indicating the high sensitivity.

----- Break -----

17:00 - 18:40

Room 201

MEET5: Nanotechnology Display and Imaging

Chair: J. Jang, Kyung Hee Univ., Korea

Co-Chair: A. J. Flewitt, Univ. of Cambridge, UK

**MEET5 - 1: *Invited* High-Brightness GaN LED Arrays Hybridized
17:00 on Silicon Interconnect at a Pixel-Pitch of 10 μm**

*F. Templier, H. Bono, J.-M. Bethoux, F. Marion,
I.-C. Robin, M.-A. di Forte-Poisson^{*}*

CEA-LETI, France

^{}3-5 Lab, France*

We have developed high-brightness GaN LED arrays hybridized on Silicon interconnect at a pixel pitch of 10 μm. The GaN LED arrays has been developed and hybridized on silicon interconnect using the microtube technology. The devices provide high optical power and brightness over 1 x 10⁷ cd/m².

**MEET5 - 2: *Invited* Mechanical Strengthening of Silicon Torsion
17:20 Bar of Scanning Micro Mirror by Hydrogen Anneal**

S. Yoshida, S. Tanaka, M. Esashi

Tohoku Univ., Japan

We report on hydrogen anneal to enhance the torsional fracture strength of dry-etched single crystal silicon (SCS) microstructures. For the SCS-wafer-based device, the dry-etched surface irregularity were smoothed out, and the fracture strength of the torsion bar was successfully improved by a factor of 3 by 120 min. hydrogen anneal.

MEET5 - 3: *Invited* Formation of Conductive AlN by a New Spontaneous Via Holes Technique and Development of Vertical Deep Ultra-Violet Light Emitting Device (RefV-LED)

17:40

N. Kurose, Y. Aoyagi

Ritsumeikan Univ., Japan

We developed a new type vertical ultra-violet light emitting device using a new spontaneous via holes formation technique in AlN epitaxial layer grown on n⁺Si substrate, which makes insulating AlN to be conductive. We have succeeded in fabricating and operating substrate removal free vertical DUV-LED (RefV-LED) using the technique.

MEET5 - 4: *Invited* High Brightness Microdisplays by Monolithic Integration of III-V LEDs and Thin Film Silicon Transistors

18:00

V. W. Lee

Lumiodo, USA

There is increasing demand for see-through, glasses-like displays, but a major technological barrier is the brightness of microdisplays currently available. To overcome this challenge, we integrate thin film polycrystalline silicon transistors with III-V LED materials for a combination of an efficient light source and high mobility drive transistors.

MEET5 - 5: *Invited* Quantum Photonic Imager (QPI): A New Display Technology and Its Applications

18:20

H. S. El-Ghoroury, Z. Y. Alpaslan

Ostendo Techs., USA

QPI is an emissive spatial light modulator (SLM) that combines the light generation and modulation together at the pixel level, eliminating the waste in most existing SLMs in which light is separately generated, collimated then modulated. This paper explains the QPI architecture and examples of QPI's applications in various areas.

Author Interviews and Demonstrations

18:30 – 19:30

IDW '14 Tutorial in Japanese

Organized by SID Japan Chapter

Tuesday, December 2, 2014

Room 301, 3F

TOKI MESSE Niigata Convention Center

Detailed information is available on

<http://www.sid-japan.org>

Workshop on Display Electronic Systems

Thursday, December 4

9:00 - 10:35

Room 302 B

DES1: Display Technologies in Augmented Reality *Special Topics of Interest on Augmented Reality and Virtual Reality*

Chair: K. Kiyokawa, Osaka Univ., Japan

Co-Chair: K. Makita, AIST, Japan

DES1 - 1: *Invited* Diminished Reality Based on Image 9:00 Inpainting for Visually Removing Real Objects in Real Time

N. Kawai

Nara Inst. of S&T, Japan

We introduce our diminished reality method that removes real objects from video images in real time. The proposed method achieves generation of high-quality background textures and temporal coherence of textures for 3D scenes by analyzing the background geometry using a Visual-SLAM method.

Also presented in Innovative Demonstration Session (see p. 213)

DES1 - 2: *Invited* HMD Technologies for AR

9:25

K. Kiyokawa

Osaka Univ., Japan

This article introduces technology trends and future visions of head mounted displays (HMDs) for augmented reality. Specifically, recent research on wide field-of-view head mounted visual displays, and multi-focal head mounted displays will be introduced, and future challenges and visions will be discussed.

Also presented in Innovative Demonstration Session (see p. 213)

DES1 - 3: *Invited* Fog Display as a Co-creative Expression 9:50 Media

Y. Miwa, S. Itai, Y. Terada

Waseda Univ., Japan

In our view, fog displays are characterized by the lack of any clear distinction between the image and actual spaces. That is, fog displays are essentially borderless. The development of the embodied media and support of co-creative expression are demonstrated in the "Massive fog display" and "Fog box" systems, respectively.

Also presented in Innovative Demonstration Session (see p. 213)

DES1 - 4 Security Door

10:15

H.-F. Wang, C.-C. Lan, J.-Y. Huang, T.-H. Lin, H.-S. Chen
Nat. Taiwan Univ. of S&T, Taiwan

This paper presents a practical "security door" to create an illusion of seeing outdoor view through the indoor. This illusion is achieved by transferring information from two cameras which are disposed at outdoor area, and then their images are cast on the indoor by a display.

----- Break -----

10:45 - 12:20

Room 302 B

DES2: Image Processing

Chair: A. Ninan, Dolby Labs., USA

Co-Chair: A. Sakaigawa, Japan Display, Japan

DES2 - 1: Invited Evolution of Displays through Advances in Next Generation Video

10:45

A. Ninan, S. Daly
Dolby Labs., USA

In pursuing pleasing lifelike images, display systems have been chasing after resolution. One aspect overlooked is dynamic range and color. The factors driving toward this dimension of improvement as the next stage of display evolution are presented. The Dolby Vision format and HDR displays demonstrate the bridge towards this goal.

Also presented in Innovative Demonstration Session (see p. 213)

DES2 - 2: Invited Pursuit of Visually Lossless Compression and Practical Tradeoffs in Display Systems

11:10

D. F. Stoltzka
Samsung Display, USA

Visually lossless compression for display streaming is a reality in commercial products. Compressing display streams is a practical way to deliver a high-end product to users while gaining system performance benefits including low bill-of-materials cost and low power consumption without sacrificing picture quality. This paper outlines important tradeoffs to integrators.

DES2 - 3 Study of Low Color Shift Design with a WRGB LCD Panel

11:35

L.-X. Chen, C.-T. Kang
Shenzhen China Star Optoelect. Tech., China

We simulate a 2-data & 1-gate lines low color shift design under WRGB panels and propose some suggestions of how to improve view angle performance. Both ways of gamma settings and look up tables are discussed.

DES2 - 4L: Invited Fixed-Rate Compression for Frame Buffer Application

11:55

*N. Jacobson, A. Teng, M. Dai, I. Ikizyan, S. Saeed, M. Aleksic**Qualcomm, USA*

As market demand for high resolution displays on mobile devices increases, frame compression must be leveraged to compensate for display interface transmission limits. Compression encoding is performed on the SoC and decoding on the DDIC. We describe a fixed-rate compression scheme designed for 2:1 and 3:1 compression for frame-buffer application.

Also presented in Innovative Demonstration Session (see p. 213)

----- Lunch -----

Author Interviews and Demonstrations

18:30 – 19:30

13:30 - 16:30

Exhibition Hall B

Poster DESp1: Display Electronic Systems**DESp1 - 1 Design of Human Face Recognition Application on Wide Viewing Angle Near-Eye See-Through Display***Z. Song, Z. Hu, L. Wang, Y. Tang**Southeast Univ., China*

An augmented reality system design based on embedded system is presented, which can realize human recognition and personal information display. Using face recognition algorithm, the system obtains the corresponding human information like name, birthday, etc, from embedded database. A wide-viewing-angle see-through display prototype is built to display personal information interface.

DES

DESp1 - 2 A Study of Optical Design of Automotive Head-Up Display*Y.-H. Chang, B.-R. Hsueh*, Y.-C. Fang**Nat. Kaohsiung First Univ. of S&T, Taiwan***Kao Yuan Univ. of S&T, Taiwan*

We present a virtual-reflection head-up display (HUD) design for automotive application. A special LCD is employed as light source. 3X zoom optics play the role at various head up display application. Distortion is averagely lower than 3%.

DESp1 - 3 Amorphous Silicon Integrated Gate Driver Circuits for High Resolution and Narrow Bezel Panel Application

G.-T. Zheng, P.-T. Liu^{}, C.-H. Chang^{*}, S.-H. Hung^{*},
W.-C. Wang^{**}, Y.-H. Chang^{**}, W.-C. Wang^{**}, W.-L. Sung^{**}*

Nat. Tsing Hua Univ., Taiwan

^{}Nat. Chiao Tung Univ., Taiwan*

*^{**}Chunghwa Picture Tubes, Taiwan*

This paper presents integrated amorphous silicon thin film transistor (a-Si) gate driver circuit which is composed of two pairs of independent clock signals (CLK1, CLK1B, CLK2, and CLK2B). By overlapping 50% of CK1 and CK2 signal in time domain, high resolution display panel can be achieved.

DESp1 - 4 Proposal of a Negative Level Shifter for a Negative High Voltage Generator

*M. Fukuhara, A. Ueda, M. Urakami, S. Hayakawa,
M. Yoshida*

Tokai Univ., Japan

This paper proposes a new level shifter to generate a negative voltage using LTPS-TFT. The proposed level shifter converts input clocks to an output signal which has a level difference from $-2V_{DD}$ to 0. The range of application of the level shifter is examined in detail by Smart Spice.

DESp1 - 5 Withdrawn

DESp1 - 6 Introduction of a Liquid Crystal Driving Circuit

*X. Xu, Z. Song, J. Chang, C. Gang, A. Jian, R. Lung,
X. Chen, B. Liao*

Shenzhen China Star Optoelect. Tech., China

This paper introduces an array substrate driving circuit, including a plurality of GoA driving units used to drive a plurality of gate lines, and a plurality of Com driving units used to drive a plurality of common electrode lines.

DESp1 - 7 Reducing Influence of Bias Stress on AMOLED Displays by Driving in Linear Regime: a Sensitivity Perspective

F. D. Roose^{,**}, K. Myny^{**}, J. Genoe^{*,**}, P. Heremans^{*,**},
W. Dehaene^{*}*

^{}KU Leuven, Belgium*

*^{**}imec, Belgium*

We present analytical equations to calculate the sensitivity of AMOLED displays to degradation of the electric characteristics of both the transistor and OLED. These equations can be applied to any technology using 2T1C pixels. They show that digital driving is less sensitive to bias stress.

DESp1 - 8 TFT V_{TH} Detecting System for AMOLED Displays*W.-C. Chiu, C.-C. Tsou, P.-S. Chen, C.-L. Lin**Nat. Cheng Kung Univ., Taiwan*

This paper presents a new method that compensates for the threshold voltage shift of amorphous-indium-gallium-zinc-oxide (a-IGZO) thin-film transistors (TFTs) and organic light-emitting diode (OLED) degradation by the external circuit with field-programmable gate array (FPGA), and still retains the merits of the simplest structure of AMOLED driving circuit.

DESp1 - 9 Withdrawn**DESp1 - 10 Super-Resolution Based on Edge Detection and Sub-Regional Interpolation***H.-L. Hu, H. Li, L.-W. Chu, P.-S. Kuo, C. Li, C.-C. Lo**Shenzhen China Star Optoelect. Tech., China*

A novel method of super-resolution based on edge detection and sub-regional interpolation was proposed. The method can enhance images clarity and get smooth edge. This method only needs fewer pixel data in the input to obtain enhanced edge, so it can save more hardware resource and get better image quality.

Friday, December 5**10:45 - 12:30****Room 201****DES3/VHF5: System Design and Evaluation in Augmented Reality
Special Topics of Interest on Augmented Reality and Virtual Reality**

Chair: K. Morita, Nat. Traffic Safety & Environment Lab., Japan

Co-Chair: K. Sakamoto, Panasonic, Japan

**DES3/
VHF5 - 1: Invited Simulation of Traffic Accident Scenarios with
an Augmented Reality Vehicle****10:45***N. Uchida, T. Tagawa, K. Sato**Japan Automobile Res. Inst., Japan*

Observing drivers' behaviours by reproducing traffic accidents and conflict situations is important for developing advanced driver assistant systems. For the purpose, an instrumented vehicle, named the JARI-ARV (Japan Automobile Research Institute - Augmented Reality Vehicle), was developed to reproduce realistic traffic accident and conflict scenarios without endangering the driver.

- DES3/
VHF5 - 2:
11:10** **Invited The Realistic 3D Image Display Using Direct Light Scanning Method**
H. Horimai, K. Hattori, T. Umezaki*
3Dragons, Japan
**Chubu Univ., Japan*

The realistic 3D image displays using Direct Light Scanning Method, so-called Holo-Table/Holo-Deck have become available. The features of these displays are not only large number views but also high density of views. Because of these features, users can see a 3D scene from any directions with smooth motion parallax.

Also presented in Innovative Demonstration Session (see p. 215)

- DES3/
VHF5 - 3
11:35** **Fast Calculation Algorithm Based on Point-Based Method for CGHs Using Polygon Model**
Y. Ogihara, Y. Sakamoto
Hokkaido Univ., Japan

Computer-generated holograms (CGHs), which are made by simulating light propagation using a computer, are able to represent virtual objects. However, an enormous amount of calculation time is needed to make CGHs. We propose the fast calculation algorithm with point-based method to make CGHs of the polygon model.

- DES3/
VHF5 - 4
11:55** **The Superiority of Widespread Monocular Augmented Reality Presentation in a Manual Tracing Task**
A. Kitamura, H. Naito, T. Kimura, K. Shinohara, T. Sasaki**, H. Okumura***
Osaka Univ., Japan
**Kansai Univ. of Welfare Scis., Japan*
***Toshiba, Japan*

We conducted two experiments involving a tracing task with augmented reality image presentation covering a visual field observed in monocular or binocular mode. Performance on the tracing task was better in monocular mode relative to binocular mode, demonstrating the superiority of monocular AR presentation for performance of a manual task.

- DES3/
VHF5 - 5L
12:15** **A Fundamental Study of an Augmented Reality System for Road Maintenance Services**
K. Makita, C.-T. Chang, R. Ichikari, T. Okuma, T. Kurata
AIST, Japan

In this paper, a fundamental study of an augmented reality system for supporting road maintenance is described. For realizing efficient road maintenance, we implemented a prototype augmented reality system using a camera fixed in the environment and a hand held device to visualize degenerate parts of the roads.

----- Lunch -----

13:30 - 14:30

Room 201

DES4: Display Driving Technologies

Chair: A. Sakaigawa, Japan Display, Japan

Co-Chair: T. Yamamoto, NHK, Japan

DES4 - 1 Low Power Liquid Crystal Driving Technique Based on Capacitors for 1-Pixel Displays

13:30

H. Manabe, M. Date^{}, H. Takada^{*}, H. Inamura**NTT DOCOMO, Japan**^{*}NTT, Japan*

A technique that reduces the power to drive LCDs is proposed. It harvests charges on the LCD and stores them in an additional capacitor for reuse when the polarity changes. A simulation shows it reduces the charge by up to 50% and a 30% reduction was achieved in an experiment.

Also presented in Innovative Demonstration Session (see p. 213)

DES4 - 2 Ultra Low Power LCD TV Using RGBW System

13:50

*C. G. Jung, Y. F. Chu, Z. D. Lai, X. X. Zhao, Y. L. Han,**K. M. Kim, L. L. Zhang, J. M. Jun**BOE Tech. Group, China*

We developed Ultra Low Power ADS LCD Module which is using RGBW pixel structure. We could increase panel transmittance by adding white pixel, could keep the image quality by using newly developed white color generation algorithm and driving method.

DES4 - 3 Pixel Circuit with Fast Charging Capability Using Charge-Sharing Method for Blue-Phase Liquid Crystal Displays

14:10

P.-C. Lai, M.-H. Cheng, P.-C. Lai, N. Sugiura^{}, C.-H. Lin^{*},**C.-L. Lin**Nat. Cheng Kung Univ., Taiwan**^{*}AU Optronics, Taiwan*

A new pixel circuit for BPLCDs is presented to deal with large capacitance of BPLCs, a charge-sharing-reset method is developed to improve the insufficient charging capability of the conventional 1T2C pixel circuit. Simulations indicate the average voltage error rate under 120-Hz frame rate through the proposed circuit is about 3%.

----- Break -----

15:15 - 16:15

Room 201

DES5: Display Interface and Driving Technologies

Chair: H. Okumura, Toshiba, Japan

Co-Chair: T. Yamamoto, NHK, Japan

**DES5 - 1
15:15 An Automatic DC Self-Adjusting Encoder of 5Gbps/
Lane Intra-Panel Interface for High Speed
Transmission***L.-W. Chang, Y.-C. Wu, Y.-C. Kang, W.-T. Chen, C.-P. Ho,
C.-H. Yang, H.-D. Lin, H.-C. Wang**AU Optronics, Taiwan*

An automatic DC self-adjusting encoder is presented based on the iSP+ [2]. The proposed encoder can effectively control the run length and provide the perfect DC balance data without LUT. Moreover, this encoder is highly flexible to adjust the overhead for attaining either better high speed performance or bandwidth.

**DES5 - 2
15:35 A Novel Method to Reduce the Loss of the Data in
High Resolution LCD***S.-Y. Wu, Y.-L. Ho, Y.-C. Chen, H.-H. Chen, H.-M. Su,
W.-Z. Zeng**Chunghwa Picture Tubes, Taiwan*

In this paper, first we define the parameters about trace width or space etc. in layout design to decrease the loss of signal and having better signal integrity. Second, we follow the rule that we had defined to design the FPCA and simulating the trace impedance to make sure the differential impedance can near 100 ohm. At the final, we simulate the eye-diagram of signal to confirm the signal integrity is satisfied the MIPI standard. And the result shows the performance being optimized obviously after follow the layout rule that we defined.

**DES5 - 3
15:55 A P-Type LTPS TFT Compensation Pixel Circuit for
Self-Emission Displays with GOA***Y.-T. Lin, H.-Y. Hsieh, C.-H. Chen, Y.-C. Lai, M.-Y. Lu,
C.-C. Kuo, C.-T. Chuang, Y.-S. Huang, C.-N. Yeh,
N. Sugiura**AU Optronics, Taiwan*

This study reports a novel driving architecture that uses only P-type low-temperature poly silicon (poly-Si) thin-film transistors (LTPS-TFTs) to simplify the fabrication process of 4.3-in. qHD (960×540) self-emission displays. This reliable shift register circuit will contribute to the lower cost and slim bezel flat panel display with high picture quality.

Author Interviews and Demonstrations

16:45 – 17:45

Supporting Organizations:

Shin-etsu Section, IEEE

Special Interest Group on Mixed Reality, The Virtual Reality Society of Japan

Technical Committee on Electronic, Information Displays, Electronics Society IEICE

Technical Group on Information Display, ITE

Technical Group on Information Sensing Technologies, ITE

Technical Committee on Image Engineering, Systems Society, IEICE

Workshop on Flexible Electronics

Wednesday, December 3

14:00 - 14:05

Snow Hall A

Opening

Opening Remarks

14:00

T. Sekitani, Osaka Univ., Japan

14:05 - 15:40

Snow Hall A

FLX1: Flexible Backplane

Chair: T. Kamata, AIST, Japan

Co-Chair: T. Sekitani, Osaka Univ., Japan

FLX1 - 1: *Invited* Oxide Thin Film Transistors for Flexible Display

14:05

Y. Uraoka, M. Fujii, M. Horita, Y. Ishikawa

Nara Inst. of S&T, Japan

Oxide semiconductor TFTs were investigated for flexible device. Solution-processed oxide thin film transistors showed a high field effect mobility of $19.5 \text{ cm}^2/\text{V}\cdot\text{s}$ at a low fabrication temperature of 300°C by an aqueous solution. Fluorinated SiN gate insulator greatly improved the reliability of oxide TFT under gate bias stress.

FLX1 - 2: *Invited* Improvement in the Field-Effect Mobility of Metal Oxide TFTs by Advanced Stack Channel Structure and Defect Control for the Next-Generation High-End Active-Matrix Displays

14:30

J. K. Jeong, H. Ji, A. Y. Hwang, P. S. Yun, J. U. Bae*, K.-S. Park**

Inha Univ., Korea

**LG Display, Korea*

In this paper, two kinds of approaches including the double channel structure and metal reaction method are introduced to improve substantially the field effect mobility of metal oxide TFTs. By optimization, the high mobility exceeding $60.0 \text{ cm}^2/\text{Vs}$ can be achievable in the resulting metal oxide TFTs.

FLX1 - 3: Withdrawn

**FLX1 - 4 Flexibility Improvement of LTPS-TFT for Foldable
15:20 AMOLED**

*J.-Y. Yan, W.-W. Tsai, B.-Y. Su, C.-W. Su, H.-C. Yao,
T.-J. Wang, W.-C. Kao, Y.-C. Lin, C.-Y. Hung, W.-H. Chen,
M.-J. Yang, C.-Y. Chiang, K.-L. Chuang, W.-T. Wang,
C.-C. Lee*

ITRI, Taiwan

High reliability & flexibility p-type LTPS-TFT by FlexUP technology was achieved. The mobility of flexible P-type LTPS is over 70 cm²/Vs. The process temperature is limited at 400°C. After mechanical de-bonding, the mobility does not change. This result indicated the p-type LTPS fabricated on FlexUP is feasible for foldable AMOLED application.

----- Break -----

15:45 - 16:40

Snow Hall A

FLX2: Flexible Displays and Devices

Chair: K. Uemura, Nippon Steel & Sumitomo Metal, Japan

Co-Chair: H. Maeda, DNP, Japan

**FLX2 - 1 Bezel-Less PMOLED Modules with Flexible
15:45 Substrates for Scalable Display System**

*H. Iijima, M. Izuchi, H. Makino, T. Wakabayashi, K. Sasai,
Y. Okumoto, A. Miyamoto, K. Morita*

Panasonic, Japan

We have successfully demonstrated a bezel-less scalable display system by arraying bezel-less PMOLED modules. Each has a lifetime of 40,000 hours life, 250 μm encapsulation width, 1 mm pixel pitch and a flexible substrate. They were realized by SiN/SiN edge encapsulation and the adoption of a slide bending structure.

**FLX2 - 2 A Flexible Display Panel, a Flexible Battery, and a
16:05 Flexible Printed Circuit for Wearable Display**

*T. Miwa, R. Tajima, Y. Goto, Y. Saito, T. Oguni, H. Miyake,
A. Hitotsuyanagi, J. Goto, H. Katagiri, S. Okano,
M. Kaneyasu, M. Hiroki, M. Takahashi, S. Yamazaki*

Semiconductor Energy Lab., Japan

To fabricate a genuinely flexible and wearable display with a flexible battery together with a flexible OLED panel and a flexible printed circuit, a flexible lithium ion battery has been developed, and a prototype of a wrist-wearable display has been fabricated.

FLX2 - 3L Flexible AMOLED on Transparent Polyimide Substrate

16:25

*C.-C. Kuo, J.-Y. Chiou, E. Syu, S.-F. Liu, C.-H. Chiou, M.-C. Chen, C.-T. Li**Chunghwa Picture Tubes, Taiwan*

We succeeded in demonstrating the flexible AMOLED combined with transparent PI substrate, and the device can achieve the curvature radius of 3.5 cm, and the module thickness of AMOLED display is about only 0.2 mm which can realize rollable and portable widget device

Author Interviews and Demonstrations

17:15 – 18:15

Thursday, December 4

9:00 - 12:00

Exhibition Hall B

Poster FLXp1: Flexible Electronics**FLXp1 - 1 A 4.6-in. Flexible AMOLED Encapsulated by Sputtered Thin Film and Laminated High Barrier Film***L. Lin, L. Deng, P. Dang, C. Zhao, X. Gao, X. Huang
Kunshan New Flat Panel Display Tech. Ctr., China*

AMOLED devices encapsulated with a method combining alternative Al_2O_3 /polyacrylate multilayer thin-film encapsulation (TFE) and high barrier film lamination have been demonstrated. With an additional high barrier film layer, the organic/inorganic stacking TFE layer has been successfully simplified from 4.5 dyad to 2.5 dyad, and the yield of encapsulation has been greatly improved.

FLXp1 - 2 Ultra-High Gas Barrier Film Deposition Using a Novel Precursor, TG-4E, by PECVD for OLED Devices*H. Chiba, M. Shimizu, D. Hara, K. Tokuhisa
TOSOH, Japan*

We have developed a novel precursor, TG-4E, for ultra-high gas barrier film deposition by PECVD. Colorless, transparent, and flexible gas barrier films were obtained, and furthermore, the water vapor transmission rate (WVTR) of the three-layer coated film achieved 5.7×10^{-5} g/m²/day under 40°C, 90% RH condition.

FLXp1 - 3 Flexible Dye Sensitized Solar Cells for Device Power Applications

*J. Silver, T. G. Ireland, G. R. Fern, M. Spratt**

Brunel Univ., UK

**G24 Power, UK*

Described herein is how a dye sensitised solar cell is constructed; these devices can be manufactured roll to roll producing highly flexible modules. These cells harvest incident light converting it into electrical energy in both low and high light environments. These modules can be easily integrated into modern electrical devices.

FLXp1 - 4 Withdrawn**FLXp1 - 5 The Study on Electrical Characteristics Variation of Flexible Pentacene Based Thin Film Transistors on PET Substrate with/without Surface Treatments**

J. J. Shivan, J. C. Ming, L. W. Lun, W. Y. Wu

Nat. Changhua Univ. of Education, Taiwan

We report the characteristics variation of flexible pentacene based thin film transistors (OTFTs) which were operated at a very low voltage under 3 Volt through utilizing a high dielectric gate insulator on PET substrate. The results denote good device performance with mobility $0.8 \text{ cm}^2/\text{Vs}$ and sub-threshold slope 0.23 V/dec .

FLXp1 - 6 Structure Design of IGZO TFTs with Stress Analysis for Flexible Applications Using Finite Element Method

M. H. Lee, S.-M. Hsu, C. Liu, J.-D. Shen*

Nat. Taiwan Normal Univ., Taiwan

**Nat. Taiwan Univ., Taiwan*

The stress analysis in flexible IGZO TFTs structures with ITO electrode and rolling curvatures using finite element method was proposed. The stress at mid-channel with four structures was compared and obtained the top-gate structure with small stress variation for mechanical rolling. The feasibility of oxide TFT was optimized the structures.

FLXp1 - 7 Flexible Polymer Dispersed LC Materials for Holographic Recording

K.-T. Kuo, W.-C. Su

Nat. Changhua Univ. of Education, Taiwan

This paper presented the flexible holograms in polymer dispersed liquid crystal films. We use the polymethylmethacrylate instead of glass substrate to fabricate the liquid crystal films which can be bended. And we observe the image change before and after bending the polymer dispersed liquid crystal films.

FLXp1 - 8 Study of Polymer Stabilized Blue Phase LC on Flexible Substrate*N. Endo, T. Matsumoto, H. Kikuchi*, M. Kimura**Nagaoka Univ. of Tech., Japan***Kyushu Univ., Japan*

Polymer stabilized blue phase (PSBP) has a potential to realize a flexible LCD. In this study, flexible PSBP LCD fabricated on a plastic and/or glass substrate are demonstrated and whose electro-optical properties are evaluated.

FLXp1 - 9 Fabrication of Conductive Electrode on Flexible Substrate Using Ag Nanoparticle Ink by Transfer Printing Method*J.-C. Choi, J.-S. Park, G. T. Park, J.-H. Kim, M.-K. Park,**I. Mahmud, J.-H. Bae, H.-R. Kim**Kyungpook Nat. Univ., Korea*

We fabricated highly conductive electrode on flexible substrate using metal nanoparticle ink by thermal sintering and transfer printing method. To enhance transfer printing, etching process was introduced. Furthermore, an adhesion layer was used to improve bending stability.

FLXp1 - 10 Pretilt Angle and Surface Anchoring Energy of LCD Fabricated by Slit Coater*T. Yamamoto, M. Kimura**Nagaoka Univ. of Tech., Japan*

Pretilt angle and polar anchoring energy fabricated by slit coater method will be demonstrated under the several fabrication conditions. LC layer coated by slit coater will be made with pattern alignment by expose UV light through a simple photo-mask. Furthermore, the alignment control with polarized UV is studied.

FLXp1 - 11 A Non-Contact Resistance Measurement of Flexible Substrates for Repeating Bending Test by Using a Terahertz Time Domain Spectroscopy*B.-J. Wen, T.-A. Liu, S.-W. Hsu, T.-Y. Chung**ITRI, Taiwan*

The study utilizes a terahertz time domain spectroscopy to measure electrical properties of flexible polyethylene terephthalate/ ITO substrates up to 20,000 bending times. According to the measurement results, the values show a reasonable agreement with contact-mode four-point probe measurements.

FLXp1 - 12 The Enhanced Thin Glass with an Ultra-High Bending Strength by a Laser Peeling Technology

C.-H. Li, C.-J. Huang, K.-T. Chen, M.-C. Lin
ITRI, Taiwan

The laser physical enhancement technology can fully remove cracks of ultra-thin glass edges according to the temperature gradient provided by laser energy can induce a tensile stress larger than the tensile strength of ultra-thin glass. The laser peeling technology can be applied to the flexible touched panel and display.

FLXp1 - 13L Fabrication of Organic-Inorganic Hybrid Moisture-Barrier Film for OLEDs

S. H. Lim, S.-W. Seo, J. Shin, S. M. Cho
Sungkyunkwan Univ., Korea

We fabricated moisture-barrier films using ALD and plasma enhanced CVD method for OLED encapsulation. The ZrO_2 inorganic layer was deposited on PEN substrate using TEMAZ (tetrakis(ethylmethylamino) zirconium) precursor. The organic layer was grown with n-hexane precursor. The moisture-barrier property and flexibility were measured by Ca test and bending test.

FLXp1 - 14L Fabrication and Evaluation of IPS-mode Flexible LCDs Using Uniaxial Polycarbonate Substrates

A. Sato, T. Ishinabe, H. Fujikake
Tohoku Univ., Japan

Optical compensation of flexible IPS-mode LCDs using uniaxial polycarbonate substrates was achieved for wide viewing angle. We clarified that the slow axis of plastic substrate must be parallel to the alignment direction of IPS-mode LC. We suppressed light leakage in the dark state by fabricated device using uniaxial polycarbonate substrates.

FLXp1 - 15L Synthesis and Application of Silver Nanowire for Transparent Electrodes Applied Touch Screen Panel

M. Y. Lee, W. S. Cho, G. S. Kwak, S. Y. Park
Kyungpook Nat. Univ., Korea

Silver nanowires (AgNWs) were synthesized using silver nitrate and ethylene glycol. At this work, using polyvinylpyrrolidone (PVP) as template and sodium dodecylsulfate (SDS) as surfactant at once, it were observed reaction rates and forms of AgNWs. Synthesized AgNWs was spray-coating on polyethylene terephthalate (PET) films and they were evaluated properties of electrical and optical.

----- Lunch -----

13:30 - 15:00

Snow Hall B

FLX3: Advanced Printing Technologies
Special Topics of Interest on Printed Electronics

Chair: M. Ito, Toppan Printing, Japan

Co-Chair: H. Hirata, Toray Eng., Japan

**FLX3 - 1: *Invited* Novel Roll-to-Roll Screen Printing Machine
 13:30 for Flexible Devices**

D. Kobayashi, N. Naoi, T. Suzuki*, T. Sasaki*,
 T. Furukawa***

Tokai Shoji, Japan

**Tokai Seiki, Japan*

***Yamagata Univ., Japan*

Novel roll-to-roll screen printing machine was developed for printing on flexible substrates. By this machine, technical problems of the conventional screen printing machines have been solved, such as the problems of “distortion of the image” and “stability in the condition of peeling-off of the printing stencil mask from the substrate.”

**FLX3 - 2: *Invited* Technologies for Fully Integrated Printed
 13:55 Displays**

*N. Fruehauf, D. Benzel, M. Strecker
 Univ. of Stuttgart, Germany*

Ultra low cost applications such as packaging demand the use of low cost technologies, which create previously not addressed challenges, even if their lower optical performance is acceptable. These include low voltage printed organic thin film transistors, low cost encapsulation processes and redundant circuit design for printed electronics based systems.

**FLX3 - 3: *Invited* Flexible Transparent Conductive Films Based
 14:20 on Metal Mesh Technology**

Z. Cui

Chinese Ac. of Sci., China

A new technique for making flexible transparent conductive substrates based on metal mesh structures is presented. The metal mesh structures are made by embedding silver nanoparticles inks into imprinted grooves on a flexible transparent substrate. The new technology has been successfully implemented in high volume manufacturing of touch panel sensors for displays.

FLX3 - 4L 14:45 Patterned ITO Film by Roll-to-Roll Process on Ultra-Thin Glass

T. Furukawa, K. Mitsugi, S. Akiyama*, H. Itoh**,
D. Kobayashi***, T. Suzuki****, H. Kuroiwa*****,
M. Sakakibara*****, K. Tanaka*****, N. Kawamura,
M. Kodon*

Yamagata Univ, Japan

**Nippon Elec. Glass, Japan*

***Teijin, Japan*

****Tokai Syoji, Japan*

*****Tokai Seiki, Japan*

******FEBACS, Japan*

******DNP, Japan*

******Kobe Steel, Japan*

We have recently succeeded in patterning ITO film for OLED lighting on 50- μ m ultra-thin glass by 'Roll-to-Roll' process and confirming luminescence of OLED on the substrate. 'Roll-to-Roll' wet cleaning equipment, 'Roll-to-Roll' deposition equipment, and the new type of 'Roll-to-Roll' screen printing equipment were used for this study.

----- Break -----

15:15 - 16:45

Snow Hall B

FLX4: Printed TFT Technologies
Special Topics of Interest on Printed Electronics

Chair: Y. Uraoka, Nara Inst. of S&T, Japan

Co-Chair: T. Furukawa, Yamagata Univ., Japan

FLX4 - 1: 15:15 Invited Fully Printed Flexible TFT Array for Electronic Paper

*M. Ito, H. Chujo, K. Murata, M. Nishizawa, N. Ikeda,
K. Hatta, M. Yokoo, R. Matsubara, O. Kina, S. Akao,
M. Takei, M. Kumagai, M. Ishizaki, K. Morosawa,
M. Matsumura*

Toppan Printing, Japan

Flexible organic TFT arrays are fabricated by fully printed method for electronic paper. Taking advantage of flexible feature, electronic paper with extraordinary laterally elongated shape, whose size is 15 mm by 900 mm is demonstrated. This novel electronic paper can be applied to rail-type ESL (Electronic Shelf Label).

FLX4 - 2: 15:40 Invited Fully-Printed Organic TFTs and Circuits on Ultra-Flexible Substrates

K. Fukuda, Y. Takeda, S. Tokito

Yamagata Univ., Japan

In this paper, we report on fully-printed organic thin-film transistor (TFT) devices fabricated on ultra-flexible films in large area with good electrical performances. The resulting devices were extremely light and exhibited excellent mechanical stability. The devices remained operational even under 50% compressive strain, without significant changes in their performances.

FLX4 - 3 Flexible Electronics on Backmolded Plastic Foils

16:05

P. Gaucci, N. Fruehauf, A. Ilchmann, B. Polzinger*,
W. Eberhardt*, H. Kück***Univ. of Stuttgart, Germany
HSG-IMAT, Germany

Inkjet-printed organic thin film transistors and unipolar inverters with different combination of channel length and channel width have been fabricated on plastic foil, which was afterwards implemented for the first time on the 3D curved surface of an injection molded plastic object by back-injection molding.

FLX4 - 4L: Invited Automated Continuously-Manufacturing Line of All-Printed Organic TFT Array Flexible Film

16:25

S. Nishi,**, T. Kamata',******JAPERA, Japan
**Konica Minolta, Japan
***AIST, Japan*

We have constructed a sheet-to-sheet (S2S) manufacturing line in order to prove the possibility and reality of production technologies and integrated processes of all-printed electronics devices. We acquired an organic TFT array on a flexible film of G1 size in a reasonable high yield, whose electrical properties were highly uniform.

Author Interviews and Demonstrations

18:30 – 19:30

**Evening Get-Together
with Wine**

Tuesday, December 2, 2014

18:00 – 20:00

Observation Deck (31F),

Hotel Nikko Niigata

(Sponsored by Merck Ltd., Japan)

See page 12 for details

Friday, December 5

10:45 - 11:50

Snow Hall A

FLX5: Flexible Substrates

Chair: T. Shiro, Teijin, Japan
 Co-Chair: T. Eguchi, Sumitomo Bakelite, Japan

**FLX5 - 1: Invited Flexible Paper Electronics Based on
 10:45 Cellulose Nanofiber Paper**

*H. Koga, M. Nogi, K. Suganuma
 Osaka Univ., Japan*

Transparent conductive networks embedded in the surface of cellulose nanofiber paper are prepared by simple filtration coating. As-prepared transparent conductive paper showed sheet resistance of $12 \Omega\text{sq.}^{-1}$ with specular transmittance of 88% and was folded with negligible changes in electrical conductivity, opening new doors for future foldable electronics.

**FLX5 - 2 Resent Approach to High Throughput Barrier
 11:10 Coating on Plastic Substrate**

*T. Okimoto, Y. Kurokawa, T. Segawa, H. Tamagaki
 Kobe Steel, Japan*

By using a new magnet layout for generating plasma, high barrier coating of WVTR below $5 \times 10^{-4} \text{ g/m}^2/\text{day}$ was obtained at high dynamic deposition rate of 250 nm-m/min. And excellent coating uniformity was achieved on 1.3 m width substrate by using production scale equipment.

**FLX5 - 3 Development of Transparent Cellulose Nano Fiber
 11:30 Film for Flexible Displays**

*G. Banzashi, H. Fushimi, S. Iwai, M. Tsunoda, E. Mikami
 Oji Holdings, Japan*

Cellulose nano fiber (CNF) is nano size cellulose fiber which is produced by fibrillation of pulp. We have developed a continuous transparent CNF film. The CNF films exhibit high transmittance (>90%), high Young's modulus (>11 GPa), low coefficient of thermal expansion (<10 ppm/°C), tolerability to organic solvent and flexibility.

----- Lunch -----

SID Display Week 2015

May 31 – June 5, 2015

San Jose Convention Center

San Jose, California, U.S.A.

13:30 - 14:50

Snow Hall A

FLX6/FMC6: Flexible Materials and Devices

Chair: Y. Mishima, FUJIFILM, Japan
 Co-Chair: T. Tomono, Toppan Printing, Japan

FLX6/ FMC6 - 1: Invited Flexible Substrates and Alternative Electrodes of ITO for OLED Lighting

13:30

*M. Koden, H. Kobayashi, T. Moriya, N. Kawamura,
 T. Furukawa, H. Nakada
 Yamagata Univ., Japan*

"Flexible substrates with alternative electrode of ITO for organic electronics" is being developed in the "Yamagata University Organic Thin Film Device Consortium", in which 21 companies participate. The current status and some of the developmental results on flexible substrates and alternative electrodes of ITO for OLED lighting are reviewed.

Also presented in Innovative Demonstration Session (see p. 213)

FLX6/ FMC6 - 2: An Analysis Method of Shock Test for Flexible Displays by Using an Image Luminance Measurement Device

13:55

*J.-M. Hsu, S.-W. Hsu, B.-J. Wen, T.-Y. Chung
 ITRI, Taiwan*

The objective of this study is to put forward a new analysis method of shock test for flexible displays. The study utilized an image luminance measurement device to inspect optical properties of flexible organic light emitting diodes before and after shock test.

FLX6/ FMC6 - 3: Plastic Substrate Technology for Flexible LCD

14:15

*Z.-H. Chen, T.-H. Huang, J.-K. Lu, N. Sugiura
 AU Optronics, Taiwan*

Materials and handling method of plastic substrate are the key factor for flexible liquid crystal display (LCD). Different flexible substrate materials and fabrication process will be discussed in this article. Furthermore, 3.5-in. flexible LCD was demonstrated using optical clear fiber-reinforced-plastic substrate and film lamination followed via mechanical peeling process.

FLX

IDW '15

The 22nd International Display Workshops

December 9 – 11, 2015

Otsu Prince Hotel
 Otsu, Japan

<http://www.idw.or.jp>

**FLX6/
FMC6 - 4L Roll-to-Roll Planarized Stainless Steel Foil for OLED
Substrate**

14:35

N. Yamada, H. Kobayashi, S. Yamaguchi,
J. Nakatsuka**, K. Nose, K. Uemura, M. Koden*,
H. Nakada**

Nippon Steel & Sumitomo Metal, Japan

**Yamagata Univ., Japan*

***Nippon Steel & Sumikin Materials, Japan*

Roll samples of planarized stainless steel foil were produced by continuously forming inorganic-organic hybrid layer. The planarization layer endowed both surface flatness and electric insulation to the stainless steel foil, resulting in successful fabrication of OLED prototypes on the roll-to-roll planarized stainless steel foil.

Author Interviews and Demonstrations

16:45 – 17:45

Supporting Organizations:

Technical Committee on Electronic Information Displays, Electronics Society, IEICE

Technical Group on Information Display, ITE

IDW Best Paper Award

IDW Outstanding Poster Paper Award

These awards will go to the most outstanding papers selected from those presented at IDW '14.

The 2014 award winners will be announced on the IDW website: <http://www.idw.or.jp/award.html>

EXHIBITION

12:40 – 18:00 Wednesday, Dec. 3, 2014

10:00 – 18:00 Thursday, Dec. 4, 2014

10:00 – 14:00 Friday, Dec. 5, 2014

Exhibition Hall B

TOKI MESSE Niigata Convention Center

Free admission with your registration name tag

Workshop on Touch Panels and Input Technologies

Wednesday, December 3

INP

14:00 - 14:05

Room 302 B

Opening

Opening Remarks

14:00

N. Hashimoto, Citizen Holdings, Japan

14:05 - 15:30

Room 302 B

INP1: Touch Panel (1)

Chair: H. S. Koo, Minghsin Univ. of S&T, Taiwan

Co-Chair: K. Nakatani, Touchpanel Labs., Japan

INP1 - 1: *Invited* Technological Development of Touch Panel Industry in Taiwan

14:05

H. S. Koo, M. Chen

Minghsin Univ. of S&T, Taiwan

With technological development of computing, commercial, communication, and internet, various types of human-machine interface (HMI) and interactive devices are subsequently being designed, developed and applied to the desktop-, laptop-, portable, flexible and wearable ICT-based commodities. The touch-panel-based interactive interface input technology is one of the human-machine interface devices.

INP1 - 2: New AI-Based Metal Mesh Electrode for a Touch Screen Panel

14:30

M. Ochi, Y. Shida, H. Goto, T. Kugimiya, H. Okuno, M. Kanamaru**

Kobe Steel, Japan

**Kobelco Res. Inst., Japan*

We have developed an AI-based triple-layered metal mesh electrode including an Al-N based layer for optical adjustment. The electrode exhibits excellent reflective properties along with wet etching property that facilitates its micro-fabrication. The metal mesh electrode is useful for a touch-sensitive panel in ultra-high-resolution displays of the next generation.

INP1 - 3 **Low Reflectance Metal Layers for New Touch Panel Solutions**
14:50

J. L. Grillmayer, H. C. Ko, M. Bender, K. Witting**

Appl. Materials, Taiwan

**Appl. Materials, Germany*

To optimizing the OGS manufacturing, targeting new metal mesh and on-cell TP solutions new deposition technologies were developed. Low surface reflectance and resistivity were demonstrated for different black metal layers. Applied Materials is continues optimizing their PVD production equipment allowing cost efficient, high volume manufacturing of these TP devices.

INP1 - 4 **A Novel Metal Mesh Single Layer Touch Sensor Design to Achieve Preeminent Touch and Visual Performance**
15:10

R.-H. Fu, J. Qiu, J.-K. Zhang, C.-L. Ye, Y.-L. Lin,

*C.-Y. Lee, C.-C. Luo, A. Lien**

Shenzhen China Star Optoelect. Tech., China

**TCL Corporate Res., China*

Using single layer metal mesh to design a multi-touch projected capacitive touch (PCT) panel is proposed in this paper. Through fully utilization of metal owing low impedance, the dead zone of PCT can be greatly reduced. With the proposed design, there is a great improvement in touch linearity and visual performance.

----- Break -----

15:45 - 17:15

Room 302 B

INP2: Touch Panel (2) and Haptics

Chair: T. Hoshi, Nagoya Inst. of Tech., Japan

Co-Chair: H. Haga, NLT Techs., Japan

INP2 - 1: ***Invited* Electrostatic Tactile Display for Stimulus Localization**
15:45

H. Haga, K. Yoshinaga, J. Yanase, D. Sugimoto,

K. Takatori, H. Asada

NLT Techs., Japan

We present an electrostatic tactile display for stimulus localization. The 240-Hz electrostatic force was generated by the beat phenomenon in a region where excited X electrodes cross excited Y electrodes, which presents localized tactile sensation out of the entire surface. A 10.4-in. visual-tactile integrated display was successfully demonstrated.

**INP2 - 2: Invited Noncontact Tactile Display Using Airborne
16:10 Ultrasound***T. Hoshi**Nagoya Inst. of Tech., Japan*

A tactile display that provides tactile stimulation from a distance is studied. Hundreds of ultrasonic transducers cooperate to make a focal point of ultrasound based on phased-array focusing technique. It provides tactile feedback to floating images and natural user interfaces. It also tactually delivers characters, symbols, drawings, etc. to users.

**INP2 - 3 Touchless Architecture for Small and Medium Size
16:35 Panel Application***D.-C. Yu, J.-S. Liao, H.-H. Chen, H.-M. Su, W.-T. Tseng**Chunghwa Picture Tubes, Taiwan*

In recent year, the touchless application is more and more popular. Therefore, we will discuss and analyze the different type of touchless technologies applied to smart handheld devices and we will conclude the touchless technology which was more fit to smart handheld devices.

**INP2 - 4 A Novel Embedded Touch Display with Integrated
16:55 Chip Solution***C.-Y. Hsu, Y.-C. Li, C.-C. Chang, W.-J. Yang, H.-H. Chen,
H.-M. Su, W.-T. Tseng**Chunghwa Picture Tubes, Taiwan*

Chunghwa picture tubes, Ltd. has been successive to develop 5.0-in. HD (720×1280) FFS-mode a-Si display with a newly developed Hybrid Type capacitive touch In-cell which was driven by the TDDI (Touch Display Driver Integrate) IC. We proposed Hybrid structure of touch in cell that solve noise problem and get high SNR.

Author Interviews and Demonstrations

17:15 – 18:15

Innovative Demonstration Session by Oral and Poster Presenters

Live demonstrations of emerging information
display technologies

16:45 – 19:30 Thursday, December 4, 2014

12:30 – 15:15 Friday, December 5, 2014

Exhibition Hall B

See Page 212 - 215 for details

Thursday, December 4

9:00 - 12:00

Exhibition Hall B

Poster INPp1: Touch Panel**INPp1 - 1** **Withdrawn****INPp1 - 2** **Invisible Patterned Method for Silver Nano-Wires
Conductive Film***Y.-P. Chang, M.-H. Yang, W.-T. Chen, C.-Y. Chiu,
Y.-Z. Lee**ITRI, Taiwan*

We provided a novel invisible patterning method for silver nanowires conductive film. A photoresist pattern as the protector kept away the effect of patterned treatments, such as heat treatment and plasma treatment. The conductive nano-structure mesh film includes a first region and a second region adjacent to the first region.

INPp1 - 3 **Reduced Non-Uniformity Moiré in Metal Mesh Touch
Display Using View Angle Compensation***C.-Y. Chen, J.-L. Chen, S.-Y. Huang**General Interface Solution, Taiwan*

Metal mesh technology offers another alternative to ITO as low resistance. But metal mesh may appear moiré due to interference with TFT-LCD. We describe simulation result of moiré in the right and left side of TFT-LCD. Then we compensate this phenomenon via special metal mesh design.

INPp1 - 4 **Capacitive Touch Sensing Circuit on Flexible
Substrate Using Back-Channel-Etch a-IGZO TFTs***Y. Chen, D. Geng, J. Jang**Kyung Hee Univ., Korea*

We designed and fabricated a novel capacitive touch sensing circuit on flexible substrate with back channel etched a-IGZO TFTs. The circuit embedded with output buffer has large output voltage swing and load drivability, which make it suitable for flexible large-area touch sensing application.

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INPp1 - 5L Touchscreen Manufacturing Technology Using Inkjet Printing*Y. Fukushima, K. Asai, A. Kiura**Toray Eng., Japan*

Direct printing technology using inkjet technique for forming insulation layer and jumper lines, which is applicable to touchscreens with X and Y electrode on one layer, has been developed. The technology outperforms photolithography in efficiency of material usage, unnecessary of expensive exposure and developer, and reduction of manufacturing cost.

----- Lunch -----

INP

13:30 - 14:45**Room 301**

INP3: AR Interactive Systems
Special Topics of Interest on Augmented Reality and Virtual Reality

Chair: N. Hashimoto, Citizen Holdings, Japan

Co-Chair: K. Berkner, Ricoh Innovations, USA

INP3 - 1: *Invited* System Design Considerations for Personal Light Field Displays for the Mobile Information Gateway

13:30*W. Wu, N. Balram, I. Tošić, K. Berkner**Ricoh Innovations, USA*

Existing mobile devices are fundamentally limited with their small screen sizes. A promising direction in the quest for next generation human interfaces is the development of personal near-eye light field displays. We present a review of existing techniques in this field and discuss their system design considerations and tradeoffs.

INP3 - 2: *Invited* Further Analysis of the R-V Dynamics Illusion on Sense of Weight

13:55*S. Hashiguchi, Y. Kataoka, F. Shibata, A. Kimura**Ritsumeikan Univ., Japan*

In mixed reality space, we can change appearances of a real object (R) and virtual object (V). In this study, we visually change movements of the real and virtual objects and observe the influences of the virtual object's dynamics on the sense of the weight of the real object.

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INP3 - 3L: *Invited* Interactive Technologies with Applied Perception
14:20

J. Watanabe, S. Hirabara^{}, T. Maeda^{*}, H. Ando^{*}*
NTT, Japan
^{*}*Osaka Univ., Japan*

When we develop display technologies, the features of human action and perception are potential resources of information presentation. We introduce information displays that work on the basis of the characteristics of the human perceptual system.

Also presented in Innovative Demonstration Session (see p. 215)

----- Break -----

15:15 - 16:45

Room 302 A

INP4: Sensor and Applications

Chair: M. Kimura, Ryukoku Univ., Japan

Co-Chair: J. Ohta, NAIST, Japan

INP4 - 1: *Invited* Sensor Applications Using Thin-Film Devices
15:15 **Derived from Display Technologies - Flatpanel Imager, Artificial Retina, Temperature Sensor, Magnetic-Field Sensor, etc. -**

M. Kimura, T. Matsuda, S. Noguchi, T. Sakamoto^{},
 T. Ozawa^{**}, K. Aoki^{**}, C.-C. Kuo^{**}*
Ryukoku Univ., Japan
^{*}*AIST, Japan*
^{**}*AU Optronics, Japan*

We have been proceeding research and development of sensor applications using thin-film devices derived from display technologies. In this presentation, we will propose some examples of these sensor applications, such as flatpanel imager, artificial retina, temperature sensor, magnetic-field sensor. Shall we consider the next killer applications for TFTs ?

Also presented in Innovative Demonstration Session (see p. 215)

INP4 - 2: *Invited* CMOS Image Sensor Technologies in Biomedical Applications
15:40

J. Ohta
Nara Inst. of S&T, Japan

CMOS image sensor technology has been advanced and recently applied to various fields. This talk reviews recent applications of CMOS image sensors technology to biomedical fields focusing on implantable devices of a retinal prosthetic device and a brain-implantable imaging device.

**INP4 - 3: *Invited* Next Generation Natural User Interface, Tobii
16:05 Eye Tracking -Eye Experience-**

K. Hachisu

Tobii Tech., Japan

Tobii works with developers and manufactures to create mind-blowing user experiences with computers, games and other devices. We create an intuitive interface that uses your natural eye movements.

Also presented in Innovative Demonstration Session (see p. 215)

**INP4 - 4L An Electric Hum Signal Readout Circuit for Touch
16:30 Screen Panel Applications**

P.-Y. L. Li, C.-W. Lu

Nat. Tsing Hua Univ., Taiwan

This study presents a readout circuit, which senses the coupled electric hum signal through fingers, for touch screen panel applications. A 16-channel readout prototype was implemented by using 0.18- μm CMOS technology. The experimental results show that the proposed readout circuit can recognize the touched-position by sensing the electric hum signal.

Author Interviews and Demonstrations

18:30 – 19:30

Supporting Organizations:

Human Interface Society

The Forum for Advancement of Stereoscopic Three Dimensional Image Technology and Arts

Holographic Display Artists and Engineers Club, The Japan Society of Applied Physics

Technical Group on Information Sensing Technologies, ITE

**The 50th Anniversary Speech of PDPs
“Summing Up of the PDP History
and a Peek at Plasma
Technologies Beyond Displays”
(FED4 – 1)**

Friday, December 5, 2014

15:15 - 15:55

Room 302B

See page 118 for detail

Innovative Demonstration Session

Thursday, December 4

16:45-19:30

Exhibition Hall B

Innovative Demonstration Session (1)

- LCT2 - 3 Polarizer-Free Imaging of LC Lens Using Reference Image**
C. Cui, R. Bao, S. Yu, X. Gong, M. Ye
SuperD, China
- 3Dp1 - 4 Volumetric 3D Display Using Rotating Screens**
S. Suzuki, C. Fujikawa, M. Omodani
Tokai Univ., Japan
- 3Dp1 - 19L Integral 3D Display Using Computer-Generated Light Field Data**
T. Iwane, M. Nakajima
Nikon, Japan
- VHF1 - 1 General FPD Mura Index under the IEC Measurement Standard**
S. Hasegawa^{ **}, S. Tomioka^{*}, K. Nagamine^{*}*
^{*}*Sony, Japan*
^{**}*JEITA, Japan*
- VHF4 - 2 Effect of Font Types and Pixel Density of Electronic Displays on the Legibility of Japanese Characters**
Y. Hisatake, T. Kawamorita^{}, Y. Kanno, S. Takahashi^{**}, M. Ito^{**}, H. Takahashi^{**}*
Japan Display, Japan
^{*}*Kitasato Univ., Japan*
^{**}*DNP, Japan*
- VHFp1 - 4 Quantitative Visual Assessment of Moving Image Quality for 4K8K UHDTV Systems**
I. Kawahara, H. Tabata
Keisoku Giken, Japan
- PRJ4 - 1 Laser Light Field Display Based on a Retinal Scanning Array**
M. Ide, K. Yoda, S. Kato
Citizen Holdings, Japan

- PRJ4 - 2 Compact Optical Engine for SmartGlass**
H. Baba, T. Totani, T. Hashizume
Seiko Epson, Japan
- PRJ6 - 1L Small and Lightweight Optical Module for HMD**
J. Iwai, K. Suzuki
Telepathy Japan, Japan
- DES1 - 1 Diminished Reality Based on Image Inpainting for Visually Removing Real Objects in Real Time**
N. Kawai
Nara Inst. of S&T, Japan
- DES1 - 2 HMD Technologies for AR**
K. Kiyokawa
Osaka Univ., Japan
- DES1 - 3 Fog Display as a Co-creative Expression Media**
Y. Miwa, S. Itai, Y. Terada
Waseda Univ., Japan
- DES2 - 1 Evolution of Displays through Advances in Next Generation Video**
A. Ninan, S. Daly
Dolby Labs., USA
- DES2 - 4L Fixed-Rate Compression for Frame Buffer Application**
N. Jacobson, A. Teng, M. Dai, I. Ikizyan, S. Saeed, M. Aleksic
Qualcomm, USA
- DES4 - 1 Low Power Liquid Crystal Driving Technique Based on Capacitors for 1-Pixel Display**
H. Manabe, M. Date, H. Takada*, H. Inamura*
NTT DOCOMO, Japan
**NTT, Japan*
- FLX6/
FMC6 - 1 Flexible Substrates and Alternative Electrodes of ITO for OLED Lighting**
M. Koden, H. Kobayashi, T. Moriya, N. Kawamura, T. Furukawa, H. Nakada
Yamagata Univ., Japan

Friday, December 5

12:30-15:15

Exhibition Hall B

Innovative Demonstration Session (2)

- FMC4 - 1** **Wide Field of View Optical Combiner for Augmented Reality Head-Up Displays**
H. Okumura, A. Hotta, T. Sasaki, K. Horiuchi, N. Okada
Toshiba, Japan
- FMC4 - 3** **Fabrication of Special Glass-Beads Retroreflector for Aerial Imaging by Retro-Reflection**
Y. Tomiyama^{}, S. Suyama^{*}, H. Yamamoto^{*, **, ***}*
^{*}*Univ. of Tokushima, Japan*
^{**}*JST-CREST, Japan*
^{***}*Utsunomiya Univ., Japan*
- FMC5 - 1** **Light Guide Plate Illumination with Blue Laser and Quantum Dot Emission**
F. Shevlin
DYOPTYKA, Ireland
- PH3 - 3** **Wireless Power Transmission Method of a Powder EL Sheet Device**
K. Wani, T. Kanda, E. Hashimoto
TAZMO, Japan
- 3D2 - 2** **Floating Digital Signage Based on Aerial Imaging Techniques**
H. Yamamoto^{, **, ***}, S. Suyama^{***}*
^{*}*Utsunomiya Univ., Japan*
^{**}*JST-CREST, Japan*
^{***}*Univ. of Tokushima, Japan*
- 3D2 - 3L** **Comparison of Material Combinations for Bright and Clear Floating Image by Retro-Reflective Re-imaging Technique**
Y. Tokuda, A. Hiyama, M. Hirose, T. Large^{}*
^{*}*Univ. of Tokyo, Japan*
^{*}*Microsoft Appl. Scis. Group, USA*
- 3D3 - 3** **Omnidirectional Video Streaming System with HMD**
D. Ochi
NTT, Japan

- 3D4 - 1** **Realization of Homogeneous Brightness for Autostereoscopic Displays with Directional Backlights Composed of Convex Lens Arrays**
S. Ishizuka, T. Mukai, H. Kakeya
Univ. of Tsukuba, Japan
- 3D4 - 2** **Floating Touch Display Based on a Heterogeneous Imaging System**
*Y. Maeda, D. Miyazaki, S. Maekawa**
Osaka City Univ., Japan
**Parity Innovations, Japan*
- VHF3 - 2** **A Method of Image Quality Evaluation for Adaptive Temporal Aperture Control with Hold-Type Displays**
T. Usui, H. Sato, Y. Takano, T. Yamamoto, K. Ishii
NHK, Japan
- PRJ5 - 4L** **A Compact, Low Cost, Phase Randomizing Device for Laser Illuminated Displays**
F. Shevlin
DYOPTYKA, Ireland
- DES3/
VHF5 - 2** **The Realistic 3D Image Display Using Direct Light Scanning Method**
H. Horimai, K. Hattori, T. Umezaki*
3Dragons, Japan
**Chubu Univ., Japan*
- INP3 - 3L** **Interactive Technologies with Applied Perception**
J. Watanabe, S. Hirabara, T. Maeda*, A. Hideyuki**
NTT, Japan
**Osaka Univ., Japan*
- INP4 - 1** **Sensor Applications Using Thin-Film Devices Derived from Display Technologies - Flatpanel Imager, Artificial Retina, Temperature Sensor, Magnetic-Field Sensor, etc. -**
M. Kimura, T. Matsuda, S. Noguchi, T. Sakamoto, T. Ozawa**, K. Aoki**, C.-C. Kuo***
Ryukoku Univ., Japan
**AIST, Japan*
***AU Optronics, Japan*
- INP4 - 3** **Next Generation Natural User Interface, Tobii Eye Tracking -Eye Experience-**
K. Hachisu
Tobii Tech., Japan

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Program Chair:	A. Mikami	Kanazawa Inst. of Tech.
Program Vice-Chair:	Y. Gotoh	Kyoto Univ.
	M. Kimura	Ryukoku Univ.
	Y. Nakai	Toshiba
Program Secretary:	O. Akimoto	Sony
	M. Date	NTT

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H. Hirata	Toray Eng.
Y. Hisatake	Japan Display
K. Ishikawa	Tokyo Inst. of Tech.
H. Kato	Sharp
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K. Makita	AIST
M. Shinohara	Omron

Committee:

LCT	S. Ishihara	Osaka Inst. of Tech.
AMD	H. Kumomi	Tokyo Inst. of Tech.
FMC	T. Tomono	Toppa Printing
PH	N. Miura	Meiji Univ.
FED	H. Shimawaki	Hachinohe Inst. of Tech.
OLED	K. Monzen	Nissan Chem. Inds.
3D	M. Tsuchida	NTT
VHF	K. Masaoka	NHK
PRJ	K. Ohara	Texas Instr. Japan
EP	T. Fujisawa	DIC
MEET	Y. Nakai	Toshiba
DES	K. Makita	AIST
FLX	T. Sekitani	Osaka Univ.
INP	T. Nakamura	Japan Display

Workshop on LC Science and Technologies

Workshop Chair:	T. Ishinabe	Tohoku Univ.
Program Chair:	S. Ishihara	Osaka Inst. of Tech.
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	M. Nishikawa	JSR
	T. Nose	Akita Pref. Univ.
	H. Okada	Univ. of Toyama
	M. Ozaki	Osaka Univ.
	M. Suzuki	Merck
	T. Takahashi	Kogakuin Univ.
	S. Takanori	JNC Petrochem.

Workshop on Active Matrix Displays

Workshop Chair:	Y. Fujisaki	NHK
Program Chair:	H. Kumomi	Tokyo Inst. of Tech.
Program Vice-Chair:	M. Inoue	Huawei Techs. Japan
General Secretary:	H. Minemawari	AIST
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	K. Azuma	Shimadzu
	E. Fortunato	New Univ. of Lisbon
	H. Hamada	Kinki Univ.
	M. Hiramatsu	Japan Display
	S. Horita	JAIST

H. J. Kim	Yonsei Univ.
M. Kimura	Ryukoku Univ.
N. Morosawa	Sony
T. Noguchi	Univ. of the Ryukyus
T. Ozawa	AU Optronics
M. Shibazaki	Innolux
K. Suga	Sharp
K. Takatori	NLT Techs.
Y.-H. Yeh	ITRI

Workshop on FPD Manufacturing, Materials and Components

Workshop Chair:	T. Miyashita	Tohoku Inst. of Tech.
Program Chair:	T. Tomono	Toppan Printing
General Secretary:	R. Yamaguchi	Akita Univ.
Program Vice-Chair:	M. Shinohara	Omron
Program Committee:	I. Amimori	A51 Tech.
	T. Arikado	Tokyo Electron
	K. Dantani	ATMI Japan
	A. Fujita	JNC Petrochem.
	Y. Iimura	Tokyo Univ. of A&T
	Y. Inoue	Corning Holding Japan
	K. Käläntär	Global Optical Solutions
	T. Katoh	ZEON
	C. C. Lee	ITRI
	D. Matsuura	Dai Nippon Printing
	T. Mori	Nitto Denko
	Y. Murata	ULVAC
	S. Namekawa	Nippon Steel & Sumikin Chemical
	T. Nonaka	AZ Elec. Materials
	Y. Saitoh	FUJIFILM
	H. Sakurai	Asahi Glass
	S. Takahashi	Sumitomo Bakelite
	T. Takeda	Nagase ChemteX
	Y. Ukai	UDDI
	T. Unate	UNATE
	Y. Yang	Japan Display

Workshop on EL Displays and Phosphors

Workshop Chair:	Y. Nakanishi	Shizuoka Univ.
Program Chair:	N. Miura	Meiji Univ.
General Secretary:	N. Matsuda	Toshiba Materials
Program Committee:	K. Hara	Shizuoka Univ.
	T. Hisamune	Mitsubishi Chem.
	S. Itoh	Futaba
	D. Jeon	KAIST
	H. Kobayashi	Tottori Univ.
	T. Kunimoto	Tokushima Bunri Univ.
	T. Kusunoki	Dexerials
	T. Miyata	Kanazawa Inst. of Tech.
	T. Mukai	Nichia Chem.
	K. Ohmi	Tottori Univ.
	D. Poelman	Gent Univ.
	M. Shiiki	Hitachi Chem.
	K. Wani	TAZMO
	R. Xie	NIMS

Workshop on Field Emission Displays, CRTs and Plasma Displays

Workshop Chair:	H. Mimura	Shizuoka Univ.
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Program Chair:	H. Shimawaki	Hachinohe Inst.of Tech.
General Secretary:	M. Nanba	NHK
Program Committee:	Y. Gotoh	Kyoto Univ.
	J. Ishikawa	Chubu Univ.
	H. Kajiyama	Tokushima Bunri Univ.
	S. Mikoshihira	Univ. of Electro-Commun.
	M. Nagao	AIST
	M. Nakamoto	Shizuoka Univ.
	S. Okuda	Okuda
	T. Shiga	Univ. of Electro-Commun.
	M. Takai	Osaka Univ.
	F. Wakaya	Osaka Univ.

Workshop on OLED Displays and Related Technologies

Workshop Chair:	T. Wakimoto	Merck
Program Chair:	K. Monzen	Nissan Chem. Inds.
Program Vice-Chair:	T. Ikuta	JNC Petrochem.
General Secretary:	T. Uchida	Tokyo Polytechnic Univ.
Program Committee:	C. Adachi	Kyushu Univ.
	S. Aratani	Hitachi
	S. Enomoto	Toshiba Lighting & Tech.
	T. Fukuda	Saitama Univ.
	R. Hattori	Kyushu Univ.
	T. Inoue	TDK
	Y. Kijima	Sony
	T. Komatsu	Panasonic
	H. Kuma	Idemitsu Kosan
	A. Mikami	Kanazawa Inst.of Tech.
	H. Murata	JAIST
	S. Naka	Univ. of Toyama
	K. Nakayama	Yamagata Univ.
	Y. Sakai	MCRC
	T. Shimizu	NHK
	S. Tokito	Yamagata Univ.
	T. Tsuji	Pioneer

Workshop on 3D/Hyper-Realistic Displays and Systems

Workshop Chair:	S. Yano	Shimane Univ.
Program Chair:	M. Tsuchida	NTT
General Secretary:	K. Yamamoto	NICT
Program Committee:	T. Fujii	Nagoya Univ.
	T. Koike	Hosei Univ.
	T. Mishina	NHK
	J.-Y. Son	Konyang Univ.
	C.-H. Tsai	ITRI
	M. Tsuboi	NTT DoCoMo
	H. Yamamoto	Univ. of Utsunomiya

Workshop on Applied Vision and Human Factors

Workshop Chair:	T. Kurita	NHK Media Tech.
Program Chair:	K. Masaoka	NHK
General Secretary:	A. Yoshida	Sharp
Program Committee:	J. Bergquist	Nokia
	S. Clippingdale	NHK
	N. Hiruma	NHK
	Y. Hisatake	Japan Display
	M. Idesawa	Univ. of Electro-Commun.
	H. Isono	Tokyo Denki Univ.
	A. Morishita	Toshiba

Y. Nakamura	Mitsubishi Elec.
T. Nakatsue	Sony
G. Ohashi	Shizuoka Univ.
K. Sakamoto	Panasonic
Y. Shimodaira	Shizuoka Univ.
J. Someya	Mitsubishi Elec.
T. Tamura	Tokyo Polytech. Univ.
R. Yoshitake	Shibaura Inst. of Tech.

Workshop on Projection and Large-Area Displays and Their Components

Workshop Chair:	S. Ouchi	Hitachi
Program Chair:	K. Ohara	Texas Instr. Japan
Vice-Secretary:	O. Akimoto	Sony
Program Vice-Chair:	S. Shikama	Setsunan Univ.
General Secretary:	T. Suzuki	JVC KENWOOD
Program Committee:	Y. Asakura	Nittoh Kogaku
	K. Goto	Ushio
	H. Kikuchi	NHK
	H. Nakano	Barco
	H. Sugiura	Mitsubishi Elec.
	M. Takaso	Telepathy Japan
	C. Kusaka	Techno Sys. Res
	T. Hashizume	Seiko Epson
	S. Koike	

Workshop on Electronic Paper

Workshop Chair:	H. Arisawa	Fuji Xerox
Program Chair:	T. Fujisawa	DIC
Program Vice-Chair:	N. Kobayashi	Chiba Univ.
General Secretary:	Y. Toko	Stanley Elec.
Program Committee:	M. Higuchi	NIMS
	Y. Hotta	Ricoh
	S. Maeda	Tokai Univ.
	M. Omodani	Tokai Univ.
	N.-S. Roh	Samsung Display
	A. Suzuki	Chiba Univ.
	M. Tsuchiya	Innova Dynamics
	G. Zhou	South China Normal Univ.

Workshop on MEMS and Emerging Technologies for Future Displays and Devices

Workshop Chair:	M. Nakamoto	Shizuoka Univ.
Program Chair:	Y. Nakai	Toshiba
General Secretary:	T. Komoda	Panasonic
Program Committee:	T. Akinwande	MIT
	G. Barbastathis	MIT
	M. Esashi	Tohoku Univ.
	H. Fujita	Univ. of Tokyo
	J. Jang	Kyung Hee Univ.
	H. Kikuchi	NHK
	J. Kim	Univ. of Oxford
	K. Matsumoto	Olympus
	W. Milne	Univ. of Cambridge
	S. Sugiyama	Ritsumeikan Univ.
	H. Tuller	MIT
	S. Uchikoga	Toshiba
	J.-B. Yoon	KAIST
	Y. Yoshida	Mitsubishi Elec.

Workshop on Display Electronic Systems

Workshop Chair:	H. Okumura	Toshiba
Workshop Vice-Chair:	T. Yamamoto	NHK
Program Chair:	K. Makita	AIST
General Secretary:	S. Takamura	NTT
Program Committee:	R. Hattori	Kyushu Univ.
	T. Fujine	Sharp
	K. Kagawa	Shizuoka Univ.
	K. Käläntär	Global Optical Solutions
	L. Kerofsky	Sharp Labs. of America
	H.-S. Koo	Minghsin Univ. of S&T
	H. Nam	Kyung Hee Univ.
	O.-K. Kwon	Hanyang Univ.
	T. Mitasaki	NTT
	K. Morita	Nat. Traffic Safety & Environment Lab.
	A. Nagase	Mitsubishi Elec.
	H. Nitta	Japan Display
	S. Ono	Panasonic
	A. Sakaigawa	Japan Display
	K. Sekiya	Kanagawa Inst. of Tech.

Workshop on Flexible Electronics

Workshop Chair:	H. Fujikake	Tohoku Univ.
Program Chair:	T. Sekitani	Osaka Univ.
General Secretary:	H. Maeda	DNP
Program Committee:	K. Akamatsu	Sony
	T. Eguchi	Sumitomo Bakelite
	H. Endo	NEC HV
	M. Funahashi	Kagawa Univ.
	T. Furukawa	Yamagata Univ.
	H. Hirata	Toray Eng.
	M. Ito	Toppan Printing
	T. Kamata	AIST
	M. Kimura	Nagaoka Univ. of Tech.
	Y. Mishima	FUJIFILM
	A. Miyamoto	Panasonic
	M. Nakata	NHK
	T. Shiro	Teijin
	K. Takimiya	RIKEN
	T. Tomono	Toppan Printing
	K. Uemura	Nippon Steel & Sumitomo Metal
	Y. Uraoka	Nara Inst. of S&T

Workshop on Touch Panels and Input Technologies

Workshop Chair:	N. Hashimoto	Citizen Holdings
Program Chair:	T. Nakamura	Japan Display
General Secretary:	H. Haga	NLT Techs.
Program Committee:	I. Fujieda	Ritsumeikan Univ.
	K. Imoto	Toshiba
	M. Inoue	Huawei Technologies Japan
	K. Kagawa	Shizuoka Univ.
	H. Kato	Sharp
	F. Koo	Minghsin Univ. of S&T
	I. Mihara	Toshiba
	K. Nakatani	Touchpanel Labs.
	H. Noma	Ritsumeikan Univ.
	H. Okumura	Toshiba
	Y. Sasaki	Mitsubishi Elec.

K. Yamazaki Corning Holding Japan
J. Watanabe NTT

Special Topics of Interest on Oxide-Semiconductor TFT

Facilitator: M. Kimura Ryukoku Univ.

Program Committee:

AMD H. Kumomi Tokyo Inst. of Tech.
FMC R. Yamaguchi Akita Univ.
FLX M. Nakata NHK

Special Topics of Interest on Augmented Reality and Virtual Reality

Facilitator: K. Makita AIST

Program Committee:

FMC M. Shinohara Omron
3D M. Tsuchida NTT
PRJ O. Akimoto Sony
DES K. Makita AIST
INP N. Hashimoto Citizen Holdings
VHF A. Yoshida Sharp
DES H. Okumura Toshiba

Special Topics of Interest on Lighting Technologies

Facilitator: Y. Kijima Sony

Program Committee

FMC M. Shinohara Omron
PH K. Hara Shizuoka Univ.
OLED T. Ikuta JNC Petrochem.

Special Topics of Interest on Printed Electronics

Facilitator: H. Hirata Toray Eng.

Program Committee:

LCT K. Ishikawa Tokyo Inst. of Tech.
AMD H. Minemawari AIST
FMC T. Tomono Toppan Printing
OLED K. Monzen Nissan Chem. Inds.
DES R. Hattori Kyushu Univ.
FLX H. Hirata Toray Eng.

FINANCIAL SUPPORTING ORGANIZATIONS (as of November 1, 2014)

ADEKA corporation
Applied Materials, Inc.
ASAHI GLASS CO., LTD.
Japan Display Inc.
JSR Corporation
Nichia Corporation
Semiconductor Energy Laboratory Co., Ltd.
SHARP CORPORATION
TOKYO ELECTRON LIMITED
ZEON CORPORATION

SUPPORTING MEMBERS (as of November 1, 2014)

EIZO Corporation
JAPAN BROADCASTING CORPORATION
JNC Corporation
Merck Ltd. Japan
NLT Technologies, Ltd.
Panasonic Corporation
Toshiba Corporation
ULVAC, Inc.

COMPANIES LIST OF EXHIBITORS (as of November 1, 2014)

FRAUNHOFER FEP
KONICA MINOLTA, INC.
Kyoei Engineering Co., Ltd.
NAGASE & CO., LTD.
Prolinx Corporation
Silvaco Japan Co., Ltd.
Toray Research Center, Inc.
TOYO Corporation
Ube Industries, Ltd.
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Electron Device Engineering Labs., Univ. of Toyama
Faculty of Engineering, Univ. of the Ryukyus
Fujieda Lab., Ritsumeikan Univ.
Iimura Lab., Tokyo Univ. of A & T
Maeda Lab., Tokai Univ.
Mutsu Matsu Lab./Ryukoku Extension Center, Ryukoku Univ.
Nakamoto Lab., Shizuoka Univ.
Suyama Lab. (Univ. of Tokushima) & Yamamoto Lab. (Utsunomiya Univ.)

IDW '15

The 22nd International Display Workshops

December 9 – 11, 2015

Otsu Prince Hotel

Otsu, Japan

<http://www.idw.or.jp>

SID Display Week 2015

May 31 – June 5, 2015

San Jose Convention Center

San Jose, California, U.S.A.

Innovative Demonstration Session *by Oral and Poster Presenters*

Live demonstrations of emerging information
display technologies

16:45 – 19:30 Thursday, December 4, 2014

12:30 – 15:15 Friday, December 5, 2014

Exhibition Hall B

See Page 212 - 215 for details

IDW '14 Tutorial in Japanese

Organized by SID Japan Chapter

Tuesday, December 2, 2014

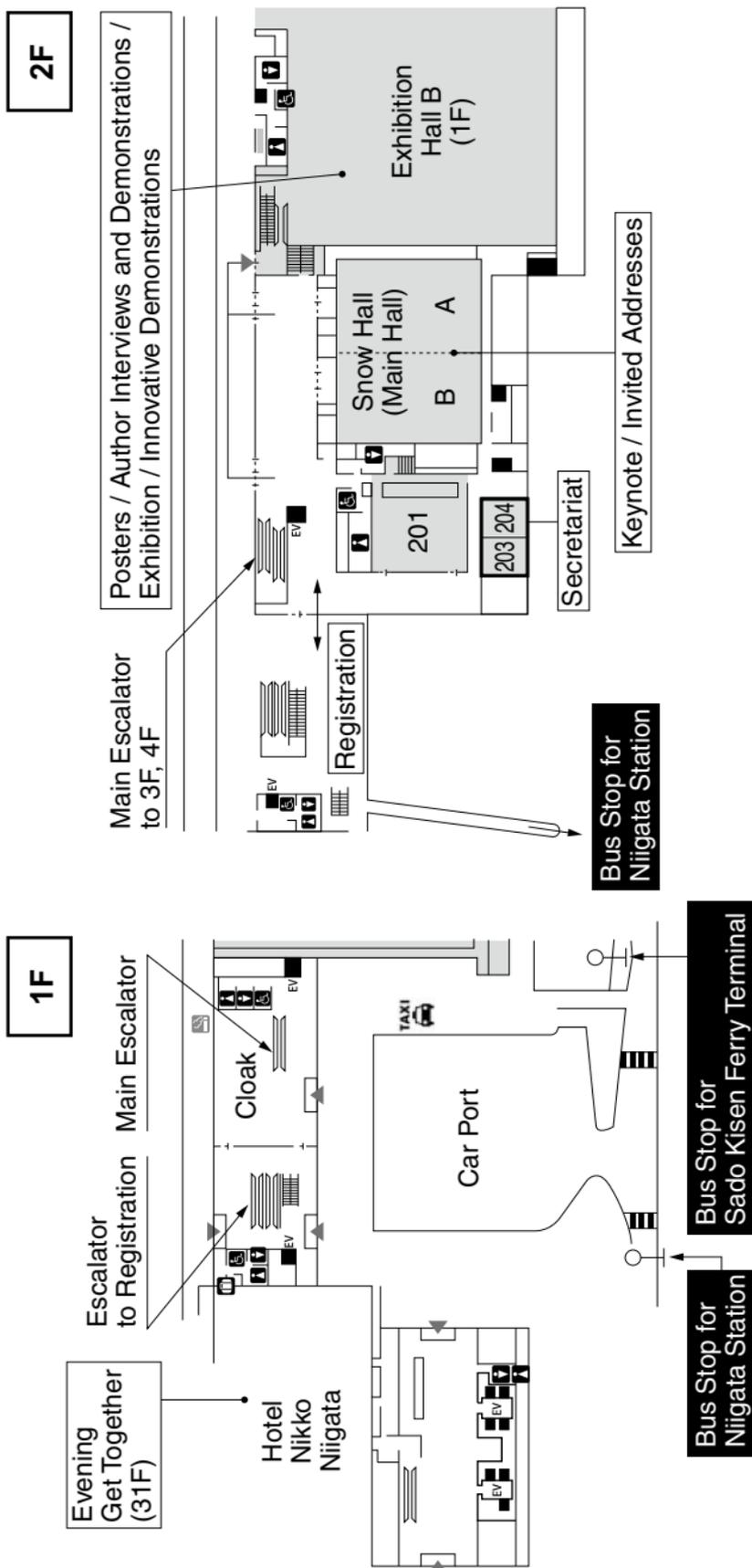
Room 301, 3F

TOKI MESSE Niigata Convention Center

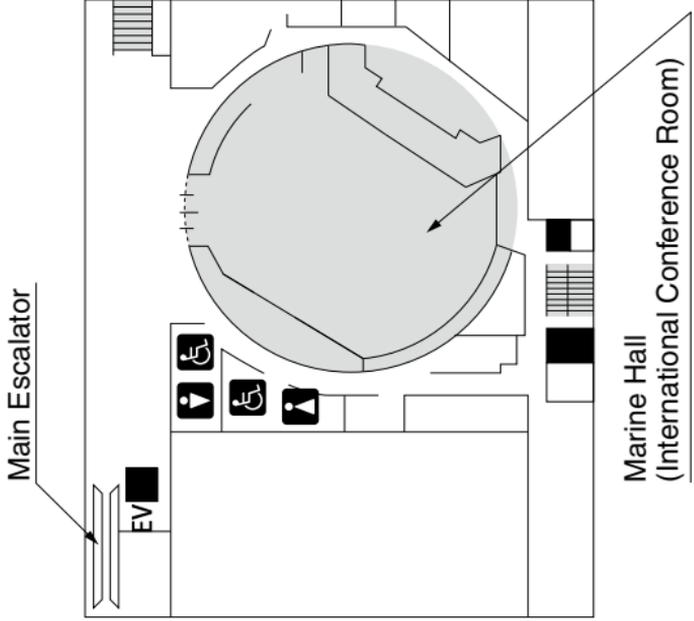
Detailed information is available on

<http://www.sid-japan.org>

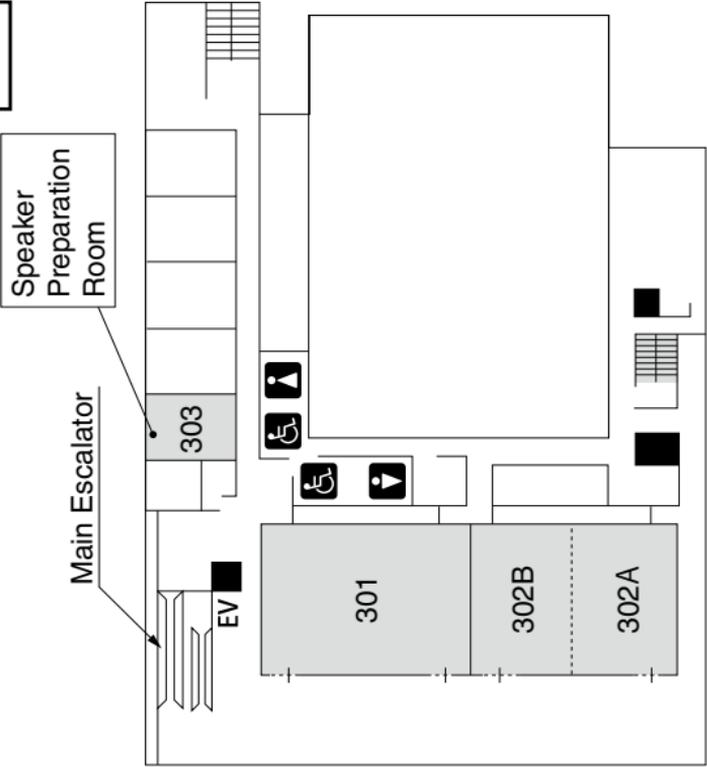
FLOOR MAP



4F



3F



MEMO

IDW '14 Workshop Timetable

Date	2F Lobby	Snow Hall A	Snow Hall B	Marine Hall	Room 301	Room 302 A	Room 302 B	Room 201	Exhibition Hall B	
Tue., Dec. 2	Registration 17:00 - 20:00	Evening Get-Together at Observation Deck (31F) in Hotel Nikko Niigata 18:00 - 20:00								
Wednesday, December 3	Registration 8:00 - 18:00	Opening, Keynote & Invited Addresses 9:30 - 12:30			Lunch				AMDp 14:00 - 17:00	Exhibition 12:40 - 18:00
		FLX1 14:00 - 15:40	OLED1 14:00 - 15:20	FMC1 14:00 - 15:20	LCT1 14:00 - 15:20	EP1 14:00 - 15:25	INP1 14:00 - 15:30	PRJ1 14:00 - 15:30		
		Break								
		FLX2 15:45 - 16:40	OLED2 15:45 - 17:00	FMC2 15:45 - 16:45	LCT2 15:45 - 17:10	EP2 15:45 - 17:20	INP2 15:45 - 17:15	PRJ2 15:45 - 17:15		
		Author Interviews & Demonstrations 17:15 - 18:15								
Reception at the Room "Continental" (4F) in Hotel Okura Niigata 19:00 - 21:00										
Thursday, December 4	Registration 8:00 - 18:00	AMD1 9:00 - 10:15	OLED3 9:00 - 10:25	EP3 [†] 9:00 - 10:38	PRJ3 9:00 - 10:25	VHF1 9:00 - 10:25	DES1 9:00 - 10:35	MEET1 9:00 - 10:30	FMCp, PHp, 3Dp, FLXp, INPp 9:00 - 12:00	Exhibition 10:00 - 18:00
		Break								
		AMD2 10:45 - 12:20	OLED4 10:45 - 12:10	LCT3 10:45 - 11:50	PRJ4 10:45 - 11:50	VHF2 10:45 - 12:10	DES2 10:45 - 12:20	MEET2 10:45 - 12:45		
		Lunch								
		AMD3 13:30 - 14:55	FLX3 13:30 - 15:00	LCT4 13:30 - 14:50	INP3 13:30 - 14:45	3D1 13:30 - 15:00	PRJ5 [†] 13:30 - 15:02	MEET3 13:30 - 15:05	OLEDp, VHFp, EPp, DESp 13:30 - 16:30	
		Break								
		AMD4 15:15 - 16:45	FLX4 15:15 - 16:45	LCT5 15:15 - 16:35	3D2 15:15 - 16:45	INP4 15:15 - 16:45	PH1 15:15 - 16:25	MEET4 15:15 - 16:55		
Break										
AMD5 17:00 - 18:30	FMC3 17:00 - 18:00		3D3 17:00 - 18:40	VHF3 17:00 - 18:00	PH2 17:00 - 18:05	MEET5 17:00 - 18:40	Author Interviews & Demonstrations 18:30 - 19:30	Innovative Demonstration Session (1) 16:45 - 19:30		
Friday, December 5	Registration 8:00 - 13:00	OLED5 9:00 - 10:25	FMC4 9:00 - 10:00	AMD6 9:00 - 10:15	3D4 9:00 - 10:20	PH3 9:00 - 10:25	FED1 9:00 - 10:35	VHF4 9:00 - 10:00	LCTp, PRJp 9:00 - 12:00	Exhibition 10:00 - 14:00
		Break								
		FLX5 10:45 - 11:50	FMC5 10:45 - 12:05	AMD7 10:45 - 11:45	3D5 10:45 - 11:45		FED2 10:45 - 11:45	DES3/VHF5 10:45 - 12:30		
		Lunch								
		FLX6/FMC6 13:30 - 14:50		AMD8 13:30 - 14:15	3D6 13:30 - 14:55	VHF6 13:30 - 14:45	FED3 13:30 - 14:50	DES4 13:30 - 14:30	Author Interviews & Demonstrations 16:45 - 17:45	
Break										
		PRJ6 15:15 - 16:35	3D7/VHF7 15:15 - 16:20		FED4 15:15 - 16:50	DES5 15:15 - 16:15				

[†]Including Short Presentations

Fri., Dec. 5	Thu., Dec. 4	Wed., Dec. 3
AM	PM	AM
AMD7: Back-Channel Etched Oxide TFT 10:45 - 11:45	AMD4: Higher Performance Oxide TFT 15:15 - 16:45	AMD1: High Resolution Displays on Oxide TFTs 9:00 - 10:15
AMD6: Chemistry of Oxide Semiconductors & TFT 9:00 - 10:15	AMD3: Stability of Oxide TFTs 13:30 - 14:55	AMD2: Physics of Oxide Semiconductors 10:45 - 12:20
		FMC4: Paper 9:00 - 12:00
		AMDp1: Poster 14:00 - 17:00
FMC4: Augmented Reality & Virtual Reality 9:00 - 10:00		
	3D3: Omnidirectional Hyper-Realistic System 17:00 - 18:40	
	3D2: Interactive 3D Display Technology 15:15 - 16:45	
	INP3: AR Interactive Systems 13:30 - 14:45	
	PRJ4: Wearable Display 10:45 - 11:50	
		DES1: Display Technologies in Augmented Reality 9:00 - 10:35
DES3/VHF5: System Design & Augmented Reality 10:45 - 12:30		
FMC5: Lighting Technology 10:45 - 12:05		
PH3: Phosphors for Lighting 9:00 - 10:25		
	OLEDp1: Poster 15:30 - 16:30	
		FMCp3, PHp2: Poster 9:00 - 12:00
	AMD5: Printed Electronics 17:00 - 18:30	
	FLX3: Advanced Printing Technologies 13:30 - 15:00	
	FLX4: Printed TFT Technologies 15:15 - 16:45	
	OLEDp2: Poster 15:30 - 16:30	
		OLED3: OLED Process Technologies 9:00 - 10:25
		OLED4: OLED Materials (1) 10:45 - 12:10

IDW '14 Special Topics of Interest Navigator

Snow Hall A	Marine Hall	Exhibition Hall B	Snow Hall B	Room 301	Room 302 B	Room 201	Snow Hall B	Room 302 A	Exhibition Hall B	Snow Hall A	Snow Hall B	Exhibition Hall B
Oxide-Semiconductor TFT			Augmented Reality and Virtual Reality			Lighting Technologies			Printed Electronics			

IDW '14 Session Navigator

	Wednesday, December 3			Thursday, December 4					Friday, December 5					
	PM		17:15-18:15	AM		PM			18:30-19:30	AM		PM		16:45-17:45
Active-Matrix Displays	Exhibition Hall B			Snow Hall A					Exhibition Hall B	Marine Hall				
	Posters			High Resolution Displays Using LTPS & Oxide TFTs	Physics of Oxide Semiconductors	Stability of Oxide TFT	Higher Performance Oxide TFT	Printed Electronics	A.I.	Chemistry of Oxide Semiconductors & TFT	Back-Channel Etched Oxide TFT	Advanced Si Technology		
Display Electronic Systems				Room 302 B		Exhibition Hall B			Exhibition Hall B	Room 201			Exhibition Hall B	
				Display Technologies in Augmented Reality	Image Processing		Posters		A.I.		System Design & Evaluation in Augmented Reality*	Display Driving Technologies	Display Interface & Driving Technologies	A.I.
Emissive Technologies	Room 201			Exhibition Hall B			Room 302 B		Exhibition Hall B	Room 302 B				Exhibition Hall B
	Solid-State Light Source Technologies for Projector			Posters			Phosphor for General	Phosphor Applications	A.I.	Novel Devices & Applications	Fabrication Processes & New Materials	FE Mechanisms & PDP Protective Layers	Summing Up of PDP History	A.I.
											Room 302 A	Snow Hall B		
e-Paper	Room 302 A		Exhibition Hall B	Marine Hall		Exhibition Hall B			Exhibition Hall B					
	Electrophoretic Displays	Various Technologies for e-Paper	A.I.	Chromic Displays	Posters		A.I.							
Flexible Electronics	Snow Hall A		Exhibition Hall B	Exhibition Hall B		Snow Hall B			Exhibition Hall B	Snow Hall A			Exhibition Hall B	
	Flexible Backplane	Flexible Displays & Devices	A.I.	Posters		Advanced Printing Technologies	Printed TFT Technologies		A.I.		Flexible Substrates		Flexible Materials & Devices*	A.I.
Image Quality Evaluation & Human Factor	Snow Hall A		Exhibition Hall B	Room 302 A		Exhibition Hall B		Room 302 A	Exhibition Hall B	Room 201		Room 302 A	Room 301	Exhibition Hall B
				Optical Measurements	Color & OLEDs	Posters		Moving Image Quality	A.I.	Display Legibility	System Design & Evaluation in Augmented Reality*	Mobile Human Factors & 'Kansei' Evaluation	Visual Perception for 3D System*	A.I.
Liquid-Crystal Technologies	Room 301		Exhibition Hall B	Marine Hall				Exhibition Hall B	Exhibition Hall B					
	Fast Switching LCD	Novel Optics for LCD	A.I.	Photo Alignment	LC Materials	LC Evaluation		A.I.	Posters					
Manufacturing, Process & Equipment	Marine Hall		Exhibition Hall B	Exhibition Hall B										
	Manufacturing Technologies		A.I.	Posters										
Materials & Components	Marine Hall		Exhibition Hall B	Exhibition Hall B			Snow Hall B	Exhibition Hall B	Snow Hall B		Snow Hall A		Exhibition Hall B	
	Materials & Components		A.I.	Posters			Optical Films	A.I.	Augmented Reality & Virtual Reality	Lighting Technologies	Flexible Materials & Devices*		A.I.	
MEMS & Nanotechnologies				Room 201				Exhibition Hall B						
				Emerging Quantum Dots & Nanotechnologies	Fundamental Components & Process Technologies	EL Quantum Dots Technologies	Novel Materials & Components	Nanotechnology Display & Imaging	A.I.					
Organic Light-Emitting Displays & Organic Devices	Snow Hall B		Exhibition Hall B	Snow Hall B		Exhibition Hall B			Exhibition Hall B	Snow Hall A			Exhibition Hall B	
	Advanced OLED Technologies (1)	Advanced OLED Technologies (2)	A.I.	OLED Process Technologies	OLED Materials (1)	Posters			A.I.	OLED Materials (2)			A.I.	
Projection & Large Area Displays	Room 201		Exhibition Hall B	Room 301		Room 302 B		Exhibition Hall B	Exhibition Hall B			Marine Hall	Exhibition Hall B	
	Solid-State Light Source Technologies for Projector	Vehicle Display	A.I.	Projection Technologies	Wearable Display	Projection Applications		A.I.	Posters			Wearable Display & Application	A.I.	
Touch & Interactive Technologies	Room 302 B		Exhibition Hall B	Exhibition Hall B		Room 301	Room 302 A		Exhibition Hall B					
	Touch Panel (1)	Touch Panel (2) & Haptics	A.I.	Posters		AR Interactive Systems	Sensor & Applications		A.I.					
3D/Hyper-Realistic Displays				Exhibition Hall B		Room 302 A	Room 301		Exhibition Hall B	Room 301			Exhibition Hall B	
				Posters		Holography	Interactive 3D Display Technology	Omni-directional Hyper-Realistic System	A.I.	3D/Hyper-Realistic Displays (1)	3D/Hyper-Realistic Displays (2)	Optical Devices for 3D System	Visual Perception for 3D System*	A.I.

A.I. Author Interviews & Demonstrations
* Joint Session

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