ITE

SID
SOCIETY FOR INFORMATION DISPLAY

IDW/AD'12

The 19th International Display Workshops in conjunction with Asia Display 2012

Final Program

Kyoto International Conference Center
Kyoto, Japan
December 4(Tue) – 7(Fri), 2012

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PROGRAM HIGHLIGHTS

The 19th International Display Workshops in conjunction with Asia Display 2012 will be held as IDW/AD '12 for encouraging aggressive research and development of display technologies throughout the world and especially in the Asian region. IDW/AD '12 focuses on the following three special topics, which are extremely timely, as well as fifteen active workshops.

Special Topics of Interest on
- Oxide TFT
- Augmented Reality
- Lighting Technologies

Workshops on
- LC Science and Technologies
- Active Matrix Displays
- FPD Manufacturing, Materials and Components
- Plasma Displays
- EL Displays and Phosphors
- Field Emission Display and CRT
- 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 Displays
- Touch Panels and Input Technologies

The four-day conference will feature 552 papers, including four keynote addresses, 114 invited papers and 434 regular papers including 226 poster presentations. Following plenary session of keynote addresses in the Tuesday morning, presentations will begin and continue in 7 parallel oral sessions through Friday. Poster sessions and author interviews with demonstrations will enable participants to discuss topics in detail. IDW/AD '12 will also present "IDW Best Paper Award" and "IDW Outstanding Poster Paper Award" based on paper originality and technical significance to information displays. Exhibits by universities and display industry-related businesses will also be featured from Tuesday to Friday in parallel with workshops. IDW/AD '12 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 TFT

Oxide TFTs have a long history going back for almost a half century, but they have been intensively investigated since the first demonstration of amorphous oxide TFTs in 2004, and have now become one of the hottest topics in backplane technologies for active-matrix FPDs. We are glad to see and touch the first commercial LCD products using the oxide TFTs this year, however, there still remain many technical issues for further evolution toward higher resolution, speed, and reliability, lower fabrication temperature, and broader applications. In IDW/AD '12, the latest achievements involved in the brand-new challenges to these issues will be found in the papers marked Special Topics "Oxide TFT" in workshops for AMD, FMC, OLED, EP, FLX and their joint sessions. Neither should you miss the brilliant invited talks given by world-leading researchers in oxide TFTs such as Prof. T. Kamiya (Tokyo Inst. of Tech.), Prof. M. Furuta (Kochi Univ. of Tech.), Prof. K. Kobayashi (Shizuoka Univ.), Prof. K. Yasui

(Nagaoka Univ. of Tech.), Prof. H. J. Kim (Yonsei Univ.), Dr. J. Steiger (Evonik), Dr. S. Jeon and Dr. J. S. Park (SAIT), Dr. N. Gong (LG Display), Dr. C.-H. Chen (AU Optronics), Dr. K. Teramoto (Sony) and Dr. H. Yamaguchi (Toshiba).

Special Topics of Interest on Augmented Reality (AR)

In recent years, augmented reality applications have been making substantial progress with high-performance display devices and tracking methods. In the session organized by the Applied Vision and Human Factors Workshop, four papers on wide-angle and head-up display human factors are presented, including an invited talk on ultra-realistic dome images. In the session organized by the 3D/Hyper-Realistic Displays and Systems Workshop, there will be a presentation on the recent activities of archiving and virtually reproducing the Yamahoko Parade at the Kyoto Gion Festival, which has been registered on the list of the "Intangible Cultural Heritage of Humanity" by UNESCO. In the session organized by the Display Electronic Systems Workshop, activities in the industrial community toward commercialization of AR systems are first presented, followed by presentations on recent trends in visual tracking methods for AR. Regarding the AR topics related to the Touch Panels and Input Technologies Workshop, we highlight one presentation by Dr. Iseki. He will review the existing technologies for data collection and analysis during a surgery at a distance. He will then discuss the roles of user interface technologies envisioned for telemedicine in the future. The sessions are organized by the 3D, VHF, DES and INP workshops.

Special Topics of Interest on Lighting Technologies (LIT)

This Lighting Technologies of Special Topics of Interest will cover all aspects of science and technologies of lighting including LED lighting, OLED lighting, flexible lighting, manufacturing of lightings, lighting materials, device structures for lightings and internal or external efficiency enhancement technologies.

Workshop on LC Science and Technologies (LCT)

This workshop covers topics from fundamental studies to recent developments in LCD technologies and LC materials. New LCD technologies, such as blue phase LCDs, 3D-LCDs, polymer stabilized LCDs and photo-alignment LCDs are extensively discussed. Novel semiconductor LCs and special novel LCD evaluation techniques are also discussed.

Workshop on Active Matrix Displays (AMD)

The AMD workshop has devoted itself to the exchange of the scientific and technological knowledge for FPD applications, covering the various technologies of Si-TFT, Oxide TFT, Organic TFT, OLED integrated sensors, flexible devices and novel applications. AMD is recognized as one of the largest workshops in IDW. Recent paper presentations tend to focus on Oxide TFTs, which may be expected to play a role in the applications for higher-definition LCD, next-generation OLED and flexible displays. This year, we highlight the oxide TFT as a special topic of interest (STI). We devote three sessions to the oxide-TFT STI, three sessions to AMD alone, and three sessions for joint sessions, which cover a wide area from device/process to applications. The presentations also promise to achieve green and sustainable technologies.

Workshop on FPD Manufacturing, Materials and Components (FMC)

The FMC workshop covers the recent developments and achievements in the field of flat panel display technologies in manufacturing, materials, measurements and components. This year, three sessions are devoted to special topics of interests, Lighting and Oxide TFT, showing recent

trends. The joint session with the FLX workshop deals with the new manufacturing technologies including Roll to Roll fabrication technologies, etc. More than 50 interesting papers including 12 invited papers will be presented. The presentations are on organic semiconductors, color switching of one dimensional photonic crystals, transparent nanofiber papers, transparent conductive films with Ag nanowires and organic-inorganic hybrid materials, etc.

Workshop on Plasma Displays (PDP)

Presentations on SUPER Hi-VISION (Ultra High Definition Television) should not be missed. A debut of the 145-in.-diagonal, 8Kx4K-pixel plasma display has been made jointly by NHK and Panasonic, with a breathtakingly high picture quality. The system was installed at the International Broadcasting Center in London Olympic Park. The outline of SUPER Hi-VISION will be presented at the DES Workshop. Also stressed is an announcement of the world first introduction into the market of the (MgCa)O protective layer, which may replace the commonly used MgO with a significant reduction of sustain voltage.

Workshop on EL Displays and Phosphors (PH)

This workshop presents the latest achievements on devices and phosphors for emissive displays, general lighting and liquid-crystal backlighting. Invited talks will present emerging technologies such as efficient powder EL, luminance enhancement with nano particle plasmon, and new phosphor materials for white LED applications and emissive displays.

Workshop on Field Emission Display and CRT (FED)

Field emission display (FED) is a vacuum device similar to the cathode ray tube (CRT) and is one of most promising flat panel displays because of several features such as high picture quality, low power consumption and fast response time. This workshop covers the entire field of CRT and field emission display technologies. Recent progress in carbon nanotube (CNT) field emitter arrays for X-ray sources and displays are presented. New devices with field emission, such as X-ray image detectors and switching devices are also presented. Furthermore, fabrication processes, field emission characteristics and various field emitter materials, such as CNTs, TiO_2, and porous silicon, are also discussed.

Workshop on OLED Displays and Related Technologies (OLED)

The OLED workshop covers all aspects of 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 based on new full-color realizing methods are reported on, and technologies from micro display viewer to large size TV application. Material and device architecture for higher quantum efficiencies, supporting these device technologies are also presented. In addition, organic transistors for one of the optimal backplane technologies with OLEDs are also discussed.

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, two-view display, multi-view display, holography, new optical components, crosstalk, measurement, perception, standardization and so on for 3D/ hyper-reality display technologies. Invited talks in this workshop include topics from the forefront of 3D imaging technologies and recent research into advanced display systems such as multi-view

display, holography, and liquid crystal lens.

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 sessions and a poster session, include lively discussions on the latest topics ranging from fundamental theories to applications. This year, in addition to a session on the special topic of interest in augmented reality (VHF/AR session), there are eight oral sessions and a poster session, on color reproduction, 3D vision, human factors, image formats and ergonomic design of HDTV/UHDTV displays, and display measurement. Six distinguished invited talks will be given on the latest topics in ultra-realistic dome images, color differences for images, color rendering properties of artificial illuminants, guidelines for in-vehicle displays, the SUPER Hi-VISION (SHV) image format and its standardization, and ergonomic design guidelines for flat panel displays.

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

PRJ-WS covers all Projection technologies, devices and related applications. Ongoing Laser and High Reality technologies have contributed to the progress of Projectors. Papers on HUD (Head Up Display) and other displays for Automotive and Aircraft are going to be presented. Also, continuous improvements in the field of Solid State Lighting and display devices will be discussed.

Workshop on Electronic Paper (EP)

This workshop focuses on current topics in electronic paper including rewritable paper, paper-like displays and flexible displays. Developments of e-Paper technologies are now in great demand due to the emergence of applications such as the e-Book, e-Newspaper, Electronic shelf label, etc. Various novel technologies in electrophoretic, liquid crystal, electrowetting, electrochromic and twisting ball display systems will be reported. Challenging new approaches in e-Paper technologies will also be reported. Enthusiastic discussion is expected about systems, devices, materials, human factors, color evaluations and applications in this field.

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

The 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 horizons of display and imaging technologies into cutting-edge technologies. Research areas such as materials, basic physics and fabrication process 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. Authorities in this field are invited from top research institutions around the world. Invited speakers are from Univ. of Cambridge, Univ. of Stuttgart, Ecole Polytechnique, Kyung Hee Univ., Univ. of Oxford, Nat. Chiao Tung Univ. and Ritsumeikan Univ. Together with excellent contributed papers, this workshop invites participants who wish to open a new field of displays, imaging devices and emerging devices.

Workshop on Display Electronic Systems (DES)

This workshop covers all aspects of display systems in relation to electronics of video data processing, interface technologies, cooperative operations between display components such as cells and backlights, sensors, applications to the new arena such as 3D video and augmented

reality. We set up a new session, the SUPER Hi-VISION Public Viewing at the London 2012 Olympic Games. In addition, the wide and high dynamic range of color reproduction systems and low power consumption systems are focused on.

Workshop on Flexible Displays (FLX)

Recently, flexible display technologies are drawing much attention, and they are spread over a wide range of fields from materials science to practical applications. The hottest sessions cover all aspects of flexible device/material technologies including OLED, electronic paper, TFT fabrication, substrate, printing/roll-to-roll processes and evaluation.

Workshop on Touch Panels and Input Technologies (INP)

This workshop covers all aspects of input technologies on materials, devices and systems. We expect that INP will open up brand new fields by fusing the input and display technologies. In addition to the recent developments in the touch panel technologies, new user interface technologies and as well the most advanced 3D/2D image sensor technologies and systems are featured in this year's session.

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/AD '12. The award winners will be announced on the IDW website and given a plaque after the conference.

Exhibition

The IDW/AD '12 Exhibition, which will be held from December 4 through December 7, covers materials, components, manufacturing and measuring equipments, software systems and other related products for display devices. Please join in and enjoy discussions at exhibitors' booths (1F, Event Hall).

December 4: 12:40 – 18:20
December 5: 10:00 – 18:00
December 6: 10:00 – 18:00
December 7: 10:00 – 14:00

Evening Get-Together with Wine

Monday, December 3, 2012
18:00 – 20:00
at Restaurant "The Grill" (1F),
Kyoto International Conference Center
(Sponsored by Merck Ltd., Japan)
See page 12 for details

GENERAL INFORMATION

SPONSORSHIP
IDW/AD '12 is sponsored by the Institute of Image Information and Television Engineers (ITE) and the Society for Information Display (SID).

CONFERENCE SITE
Kyoto International Conference Center
Takaragaike, Sakyo-ku,
Kyoto 606-0001
Phone: +81-75-705-1234 Fax: +81-75-705-1100

ON-SITE SECRETARIAT
Telephone and fax machines for IDW/AD '12 use will be temporarily set up in the secretariat room (Room G) at the Kyoto International Conference Center (December 3-7). Phone/Fax: +81-75-705-2001

RECEPTION
A buffet style reception will be held on December 5 from 19:00 to 21:00 at the Sakura (1F) in the Kyoto International Conference Center. 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 3 from 18:00 to 20:00 at Restaurant Grill (1F) in the conference site. Wine (Sponsored by Merck Ltd. Japan) will be served to participants with a relaxed atmosphere for networking.

REGISTRATION
Registration is available in advance and also on-site. However, on-site registrants may not be able to obtain books, if there are an unexpectedly large number of on-site registrations. Advance registration is strongly recommended.

Registration Fees
The registration fee for IDW/AD '12 includes admission to the conference and CD-ROM of the proceedings. Additional ¥10,000 will be charged for those who prefer the proceedings in book format. Detailed information will be announced on the website.

	Paid by Nov. 2	After Nov. 2
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/AD '12 committee.
***Photocopy of student ID is required.

Please note that the reduced registration fee must be paid by November 2. The full fee will be charged for payments made later than November 2. 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 the registration desk. 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 sets of the proceedings (Books and CD-ROM)

At the conference site	¥ 11,000
Airmail after the conference	¥ 18,000
Domestic mail after the conference	¥ 13,000

Additional sets of Books and CD-ROM can be purchased only those who have completed payment by November 23.

Payment

Three ways are provided for registration.

(1) e-Registration

Access the following URL.

http://www.idw.ne.jp/regist.html

e-Registration will be accepted until November 23, 2012.

(2) Mail or Fax Registration

Complete the registration form (download from the website) and send it to the secretariat together with all necessary payments no later than November 23, 2012.

IDW/AD '12 Secretariat
c/o Bilingual Group Ltd.
3-3-6 Kudan Minami, Chiyoda-ku, Tokyo 102-0074, Japan
Phone: +81-3-3263-1345 Fax: +81-3-3263-1264
E-mail: idw@idw.ne.jp

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

1. Credit Card
2. Bank Transfer to:

Bank:	Bank of Tokyo-Mitsubishi UFJ (Swift Code: BOTKJPJT)
Branch:	Ichigaya Branch (Branch No. 14)
Account No.:	1474095 (Ordinary Account)
Account:	IDW

Please attach a copy of the bank receipt with the registration form to avoid any confusion. Please note that the remittance charge 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 be open:

December 3 (Mon.)	17:00 – 20:00
December 4 (Tue.)	8:00 – 18:00
December 5 (Wed.)	8:00 – 18:00
December 6 (Thu.)	8:00 – 18:00
December 7 (Fri.)	8:00 – 13:00

The on-site registration fee will be payable by:

1. Cash (JAPANESE YEN only)
2. Credit Card (VISA, MasterCard or Amex)

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

Cancellation Policy

Refunds for registration, reception, additional sets of proceedings etc. will be made upon receipt by IDW/AD '12 secretariat of written cancellation by **November 2**. For cancellations received after November 2 or no-shows, refunds will not be made. However, after IDW/AD '12 closes, a set of the proceedings will be sent to the registrants who have paid the registration fees. If it becomes difficult to hold IDW/AD '12 due to infectious disease and other unavoidable factors, we will substitute the IDW with the mail delivery of the IDW/AD '12 proceedings at a later date to all those who have registered and completed payment.

INQUIRIES

IDW/AD '12 Secretariat
c/o Bilingual Group Ltd.
3-3-6 Kudan Minami, Chiyoda-ku, Tokyo 102-0074, Japan
Phone:+81-3-3263-1345 Fax: +81-3-3263-1264
E-mail: idw@idw.ne.jp

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
- Japan Ergonomics Society
- The Japanese Liquid Crystal Society
- The Japan Society of Applied Physics
- The Virtual Reality Society of Japan
- The Society of Polymer Science, Japan

FUNDS

- Grant-in-Aid for Scientific Research (KAKENHI: 2464002) from MEXT
- The Asahi Glass Foundation
- The Telecommunications Advancement Foundation

For final updated information, please visit our website, http://www.idw.ne.jp/

SID Display Week 2013

May 19-24, 2013

Vancouver Convention Center

Vancouver, British Columbia, Canada

EuroDisplay 2013

September 16-19, 2013

Imperial College London

London, UK

TRAVEL INFORMATION

ACCOMMODATIONS
JTB Western Japan, Corp. will handle arrangements for your hotel reservations.

It will be very hard to book a hotel in Kyoto in December due to it being the peak tourist season. So we recommend you make reservations in advance at the hotels recommended by IDW.

Hotel reservations can be made at the IDW official website.
http://www.idw.ne.jp/accommodation.html

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

JTB Western Japan, Corp.
Communication Division, MICE Center, IDW/AD '12 Desk

Phone: +81-6-6252-2861 Fax: +81-6-6252-2862
Office Hours: 9:30-17:30 (Weekdays only)
E-mail: westec_op6@west.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 country. 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 official website for applications.
http://www.idw.ne.jp/visa.html

CLIMATE
The average temperature in Kyoto during the conference should be around 8°C(46°F) in the daytime and 4°C(39°F) at night.

EXHIBITION

12:40 – 18:20 Tuesday, Dec. 4, 2012
10:00 – 18:00 Wednesday, Dec. 5, 2012
10:00 – 18:00 Thursday, Dec. 6, 2012
10:00 – 14:00 Friday, Dec. 7, 2012

Event Hall, 1F
Kyoto International Conference Center

Free admission with your registration name tag

Kyoto - Ancient Capital

Kyoto has a population of 1.47 million, and is an ancient city with a history spanning over 1200 years. Kyoto served as Japan's capital and the emperor's residence from 794 until 1868.

Kyoto also preserves the beloved properties of its culture as testimonials of time. This is shown in the ancient temples and shrines built in styles unique to Kyoto, as well as private residences. Moreover, many festivals, ceremonies and traditional industries reveal the will of this city to transmit and maintain its 1200-year-old culture.

Kyoto's history and culture could, without exaggeration, be said to be the history and culture of Japan itself.

In addition, many tourists from all over Japan visit Kyoto in the fall to view the beautiful colored leaves. When the conference is being held, the Shimogamo and Kitano Tenmangu Shrines will be the best places to view the fall colors. Please enjoy the changing seasons in Japan.

http://www.kyoto.travel/shrines_temples/st_north/

Places of Interest

Kiyomizu-dera Temple

This is one of the most famous Buddhist temples. The name, which means "Temple of Pure Water" derives from the fact that there is a spring in the temple grounds. The expression "to jump off the stage at Kiyomizu" is the Japanese equivalent of the English expression "to take the plunge". Access: Kiyomizudera can be reached from Kyoto Station by city bus (Kyoto Transportation Bureau) number 100 or 206 (15 minutes, 220 yen). Get off at Kiyomizu-michi bus stop; from there it is a ten-minute uphill walk to the temple. Opening Hours: 6:00-18:00

Kinkaku-ji Temple

The name Kinkaku (Golden Pavilion) is derived from the gold leaf used to decorate the inside and outside of the second and third stories. It is the most widely-recognized image of Kyoto. Access: Kinkakuji can be accessed from Kyoto Station by direct Kyoto City Bus number 101 or 205 (about 40 minutes, 220 yen). Opening Hours: 9:00-17:00

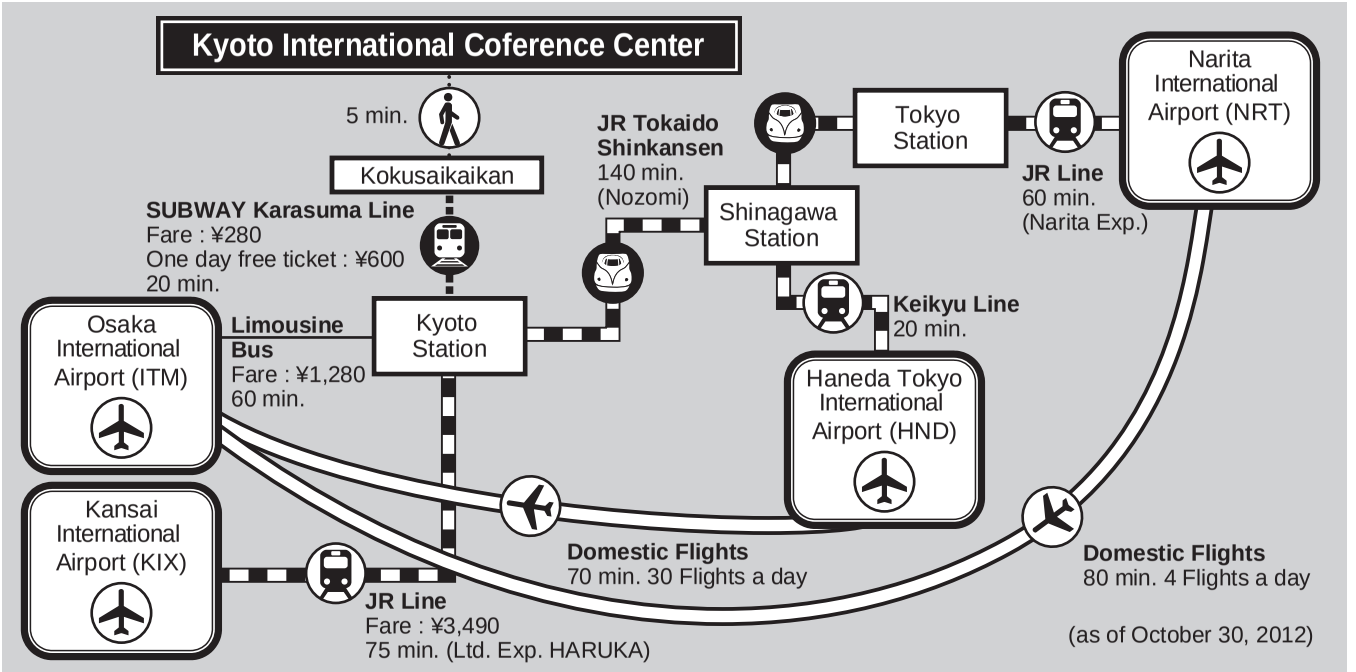
Gion

Kyoto's Gion district is famous for its traditional architecture and entertainment. Located around Shijo Avenue, and it attracts tourists with its high concentration of traditional wooden *machiya* merchant houses. Gion is filled with shops, restaurants and *ochaya* (teahouses), where *geiko* (Kyoto dialect for geisha) and *maiko* (*geiko* apprentices) entertain. Access: Gion can be reached by bus from Kyoto Station (about 20 minutes, 220 yen). Take number 100 and 206 and get off at Gion bus stop. The closest train stations are Gion Shijo Station on the Keihan Line and Kawaramachi Station on the Hankyu Line.

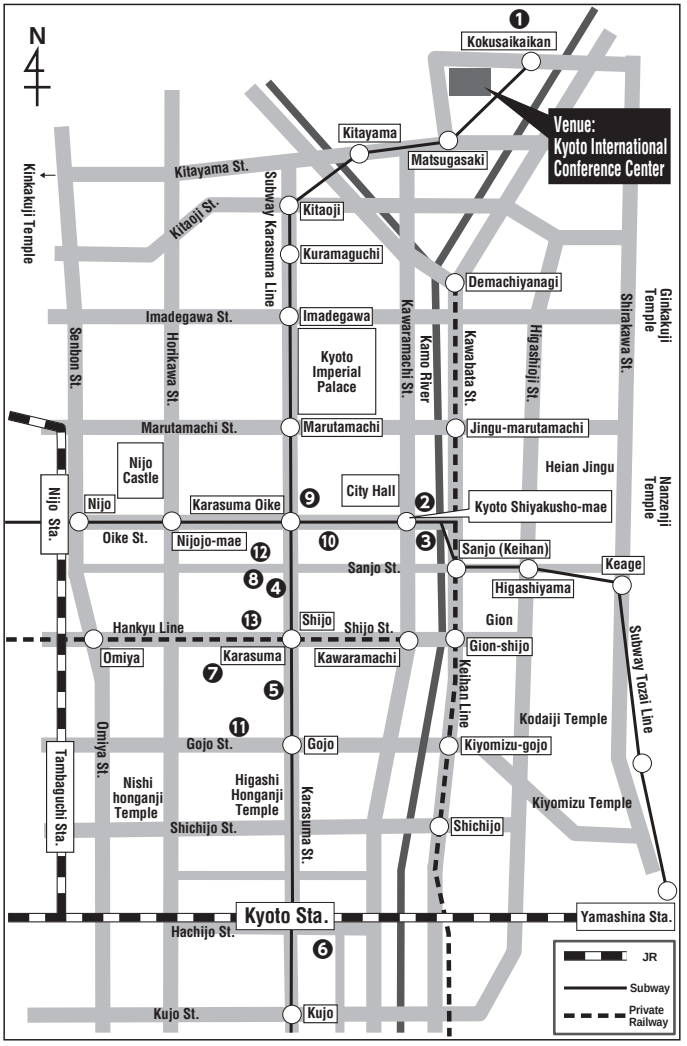
Further information

Kyoto Visitor's Guide	**http://www.kyotoguide.com/**
Kyoto Official Travel Guide	**http://www.kyoto.travel/**
Kyoto City Tourism Association	**http://www.kyoto-magonote.jp/en/**

Access to Conference Site



Hotel Map



❶ Grand Prince Hotel Kyoto
❷ Kyoto Hotel Okura
❸ Kyoto Royal Hotel & Spa
❹ Hotel Monterey Kyoto
❺ Karasuma Kyoto Hotel
❻ Hotel Keihan Kyoto
❼ Mitsui Garden Hotel Kyoto Shijo
❽ Mitsui Garden Hotel Kyoto Sanjo
❾ Hearton Hotel Kyoto
❿ Hotel Gimmond Kyoto
⓫ Aranvert Hotel Kyoto
⓬ Kyoto Garden Hotel
⓭ Via Inn Kyoto Shijomuromachi

Plenary Sessions

Tuesday, December 4

9:25 - 9:40 **Main Hall**

Opening

Master of Ceremony: H. Okumura, Executive Chair, Toshiba, Japan

Opening Remarks
9:25

N. Ibaraki, General Chair, AIST, Japan
M. Omodani, Program Chair, Tokai Univ., Japan

9:40 - 12:40 **Main Hall**

Keynote Addresses

Co-Chairs: M. Omodani, Program Chair, Tokai Univ., Japan
H. Okumura, Executive Chair, Toshiba, Japan

Keynote Address - 1 **Defy Gravity: Beyond Tangible Bits, Toward Radical Atoms**
9:40

H. Ishii

MIT Media Lab, USA

Looking back through the history of HCI, we believe that vision-driven design is critical in fostering quantum leaps, and it complements needs-driven and technology-driven design by looking beyond current-day limits. I will present my vision-driven research: Tangible Bits and Radical Atoms to seek new guiding principles and concepts to trail blaze a new realm in interaction design.

Keynote Address - 2 **Steps Toward a Giant Leap in Mixed and Augmented Reality**
10:20

H. Tamura

Ritsumeikan Univ., Japan

Augmented reality and/or mixed reality (AR/MR) is an attractive research field, where a variety of applications can be expected. Although steady steps have already been made toward its future success in technical aspect, the author believes a giant leap and a dramatic turn of diffusion in this area. In this invited talk, a historical progress and current state of AR/MR technology are overviewed, and a personal expectation of such a leap is presented from a point of view of display technology.

----- Break (11:00 - 11:20) -----

Co-Chairs: N. Ibaraki, General Chair, AIST, Japan
Y. Gotoh, Program Vice-Chair, Kyoto Univ., Japan

Keynote Address - 3 **A Crystal Ball View of Smart TV for 2013 and Beyond**
11:20

N. Murakami

Former VP of Google & Former President of Google Japan, Japan

Many people think “Smart TV” is a tangible hardware, but it is not. It is an eco-system which has multi-layer structure. Hardware is just one layer of its four layers such as Platform, Hardware, Application, and Content from the bottom to the top.

Keynote Address - 4 **How e-Readers and Tablets are Changing Books, Newspapers and Documents**
12:00

S. Nordqvist

WAN-IFRA, Germany

The introduction of mobile smart devices; mobiles, tablets, and e-readers, have enabled the next phase of digitalization of the media industry. In addition to devices and content the importance and effect of ecosystems are in focus when changing the face of services and products from media companies.

Special Topics of Interest on Oxide TFT

Tuesday, December 4

14:20 - 15:35 **Room B-1**

FMC1: Manufacturing Technologies (1)

Chair: M. Furuta, Kochi Univ. of Tech., Japan
Co-Chair: T. Tomono, Toppan Printing, Japan

FMC1 - 1: 14:20 ***Invited*** **Preparation of Amorphous p-Type $InGaZnO_4$ Films by Codoping of Al and N Atoms**

K. Kobayashi, X. Zhang, Y. Kohno, Y. Tomita, Y. Maeda
Shizuoka Univ., Japan

Codoped $InGaZnO_4$ films were prepared by sputtering of targets of $InGaZnO_4$ and AlN in an Ar atmosphere. The hole-conductivity is confirmed in films prepared from the target (7% AlN) at 2×10^{-2} Torr in 0.3-0.6% O_2 atmosphere. The rectification characteristic is obtained for a PN junction of $InGaZnO_4$ films.

FMC1 - 2: 14:40 ***Invited*** **Solution-Based Atmospheric Pressure Deposition Method for Oxide TFTs**

M. Furuta, T. Kawaharamura, D. Wang
Kochi Univ. of Tech., Japan

We fabricated a thin-film transistor (TFT) with an amorphous InGaZnO (a-IGZO) and aluminum oxide (AlOx) gate dielectric stack that was deposited by a solution-based atmospheric pressure chemical vapor deposition (APCVD). Field effect mobility of 4.1 $cm^2 \cdot V^{-1} \cdot s^{-1}$ and on/off current ratio of over 10^8 was obtained.

FMC1 - 3: 15:00 ***Invited*** **Zinc Oxide Film Growth Using High-Energy H_2O Generated by a Catalytic Reaction on Pt Nanoparticles**

K. Yasui, H. Miura, H. Nishiyama
Nagaoka Univ. of Tech., Japan

In this paper, a new CVD method of ZnO thin films using the reaction between zimethylzinc (DMZn) and high-energy H_2O, the latter is generated by the Pt-catalyzed exothermic H_2–O_2 reaction, is presented. Using this CVD method, ZnO thin films with excellent electrical and optical properties were grown.

FMC1 - 4L 15:20 **Large Area Sputtered Al_2O_3 Films for High Mobility AM-TFT Backplanes on PVD Array System PiVot 55kVi²**

A. Kloeppel, J. Liu, E. Scheer

Appl. Materials, Germany

In order to provide increased stability to AM-OLED backplanes using IGZO we demonstrate the production worthiness of sputtered Al_2O_3 buffer films on Gen 8.5 substrates using rotary targets on PVD array system PiVot. The achieved Al_2O_3 layer properties and uniformity underline the advantages of using rotary technology.

Author Interviews and Demonstrations
17:50 – 18:50

Wednesday, December 5

9:00 - 10:30 **Room A**

AMD3: Oxide TFT: Materials & Devices

Chair: H. J. Kim, Yonsei Univ., Korea
Co-Chair: N. Morosawa, Sony, Japan

AMD3 - 1: 9:00 ***Invited*** **Present Status, Knowledge and Issues of Oxide Semiconductor Technology**

T. Kamiya, K. Nomura, H. Hosono

Tokyo Inst. of Tech., Japan

Oxide semiconductors have been studied very intensively from late ’90, and the first commercial product of oxide TFT appeared in this March. This paper reviews the present status and new applications of oxide semiconductors with main focus on amorphous oxide semiconductor. Then, we will discuss clarified knowledges and remaining issues.

AMD3 - 2 9:25 **High Performance AOS-Based Offset TFTs for Kickback Voltage Reduction**

M. Mativenga, D. H. Kang, Y. S. Ahn, J. Jang

Kyung Hee Univ., Korea

This paper shows that amorphous-oxide-semiconductor (AOS)-based thin-film transistors (TFTs) with drain- and/or source-offsets perform much better compared to Si-based offset TFTs in literature. Attributes of AOS-based offset TFTs include improved stability, high on-currents, independence of threshold-voltage from offset-length, and possibility for kickback-voltage reduction in active-matrix display applications.

AMD3 - 3 9:45 **Effects of Multi-Gates on Performance and Stability of Self-Aligned Coplanar a-IGZO TFTs**

J. U. Han, D. H. Kang, J. Jang

Kyung Hee Univ., Korea

We studied the effects of multiple gates on the performance and stability of a-IGZO TFTs. The subthreshold region of transfer characteristics shift to negative gate voltage direction with increasing gate number, and the threshold voltage shift induced by positive gate bias stress decreases with increasing gate number.

AMD3 - 4: 10:05 ***Invited*** **High Mobility Zinc Oxynitride (ZnON) Based Thin-Film Transistors (TFTs) for Display Applications**

J. S. Park, H.-S. Kim, T. S. Kim, K. S. Son, J.-B. Seon, S.-J. Seo, S.-J. Kim, M. Ryu, S. Lee

Samsung Advanced Inst. of Tech., Korea

The fabrication of thin-film transistor devices incorporating active semiconductors based on zinc oxynitride (ZnON) compounds is presented. Devices with field effect mobility values exceeding 50 cm^2/Vs are routinely achieved, which makes them suitable as switching or driving elements in next generation flat panel displays.

----- Break -----

10:50 - 12:20 **Room A**

AMD4: Oxide TFT: Applications

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

AMD4 - 1: 10:50 ***Invited*** **Ultra Definition 240 Hz 55-in. LCD TV Driven by 1G1D with Oxide Semiconductor TFTs & Copper Signal Lines**

N. Gong, C. Park, J. Lee, I. Jeong, H. Han, J. Hwang, J. Park, U. Chung, K. Park, H. Jeong, Y. Ha, W. Shin, S. Yeo

LG Display, Korea

We have implemented a 240 Hz 55-in. ultra definition (UD, or 3840x2160) resolution TV panel using amorphous IGZO TFT. Among various data driving architectures, the data single 1G1D driving renders cost benefit, process competitiveness and design flexibility. So we suggest a-IGZO TFT and copper metallization technology as a solution.

AMD4 - 2: 11:15 ***Invited*** **Ultra High-Definition Amorphous-IGZO Liquid-Crystal Display**

B.-L. Yeh, C.-N. Lin, H.-K. Tseng, I.-P. Chien, C.-C. Wu, C. H. Huang, C.-M. Chang, W.-C. Tsai, C.-H. Chen

AU Optronics, Taiwan

ES type IGZO TFT with different IGZO back channel treatment was studied to improve TFT stability. A modified ES process flow was developed to improve IV uniformity. Ultra-high definition 3840x2160 65-in. liquid-crystal display with IGZO TFT was also fabricated and PNBTS < I3I V; Vth U% < 2 V was achieved.

AMD4 - 3: 11:40 ***Invited*** **Amorphous Oxide Semiconductor Thin Film Transistor for Novel Device Applications**

S. Jeon[,**], I. Song[*,**], S.-E. Ahn[*,**], C. I. Kim[*,**], U.-I. Chung[*,**]*

[*]Samsung Advanced Inst. of Tech., Korea
[**]Samsung Elect., Korea

Among various semiconductor devices, electronically active oxide thin film transistors (TFTs) have received considerable attention for a wide range of device applications. In this presentation, we review various device applications utilizing amorphous oxide semiconductor TFT, which include photo-sensor, image sensor and other device applications.

AMD4 - 4L 12:05 **Novel Fabrication Method for Self-Aligned Bottom-Gate Oxide TFTs**

M. Nakata, H. Tsuji, Y. Fujisaki, H. Sato, Y. Nakajima, T. Takei, T. Yamamoto

NHK, Japan

We have developed a novel fabrication method using excimer laser irradiation for self-aligned bottom-gate oxide thin-film transistors (TFTs). Irradiation from the back-side of the substrate using the gate electrode as a mask reduces resistance in InGaZnO (IGZO) films sufficiently for their application as source/drain regions in bottom-gate IGZO-TFTs.

9:20 - 12:20 **Event Hall**

Poster **FMCp: FPD Manufacturing, Materials & Components**

FMCp - 16 **Properties of Cu Doped NiO Transparent Oxide Thin Films by Sol-Gel Solution**

C. Takahashi, M. Kawamura, Y. Abe, K. H. Kim

Kitami Inst. of Tech., Japan

Wide band-gap oxide semiconductor nickel oxide thin films were prepared by sol-gel spin-coating under various annealing temperatures from 250 to 450˚C and Cu doping amounts from 0 to 20 at.%. The optical and structural properties of these films significantly depend on the temperature and the Cu doping amount.

FMCp - 17 **Low Temperature Fabrication and UV Treatment of Spin Coated ZnO Films Using Partial Hydrolyzate of Diethylzinc Based Solutions**

K. Haga, K. Inaba, K. Toyota, Y. Takemoto, K. Tokudome, M. Oshima[*]*, K. Yoshino*[*]

Tosoh Finechem, Japan
[*]*Univ. of Miyazaki, Japan*

Low temperature fabrication of ZnO films using partial hydrolyzate of diethylzinc based solution were investigated. UV treatment was effective to improve the electronic performance of ZnO films. Group 13 element metals (Ga and In) compounds were mixed to our precursor solution and transparent multi-metal oxide films were obtained.

9:20 - 12:20 **Event Hall**

Poster FLXp: Flexible Display Technologies

FLXp - 3 **Flexible Non-Volatile Memory Based on Indium-Gallium-Zinc-Oxide with Excellent Reliability and Flexibility**

Y.-S. Fan, C.-H. Hsu, C.-H. Chang, W.-H. Huang, M.-C. Yu[*]*, P.-T. Liu*

Nat. Chiao Tung Univ., Taiwan
[*]*WINTEK, Taiwan*

The memory characteristics of a-IGZO RRAM reveal excellent reliability including 1000 times DC sweep endurance, 10^4 pulse endurance, 10^4 s data retention with read disturb immunity. Furthermore, this work also demonstrated on flexible substrate, which shows the very potential flexibility applications.

----- Lunch -----

14:00 - 15:25 **Room A**

AMD5: Oxide TFT: Solution Process

Chair: J. S. Park, Samsung Advanced Inst. of Tech., Korea
Co-Chair: H. Hamada, Panasonic, Japan

AMD5 - 1: 14:00 ***Invited*** **New Approaches for High Performance and Multi-Functional Solution-Processed Oxide TFT Technologies**

H. J. Kim

Yonsei Univ., Korea

In this study, new approaches for high performance and multi-functional solution-processed amorphous oxide semiconductor (SAOS) thin-film transistors (TFTs) are presented: a multi-stacked active layer structure for highly stable SAOS TFT, a self-patternable SAOS TFT (both active layer and source/drain electrodes), and DNA detection using SAOS TFT.

AMD5 - 2
14:25

Solution-Processed Amorphous In_2O_3-Based TFT Performance Depending on the Semiconductor Film Morphology

S. Botnaraş[,**], D. Weber[*], D.-V. Pham[*], J. Steiger[*], R. Schmechel[**]*

[*]Evonik Inds., Germany
[**]Duisburg-Essen Univ., Germany

The morphology of solution-processed amorphous In_2O_3-based thin films annealed at 350˚C was investigated. The semiconductor solutions were provided by Evonik Industries AG. By increasing the smoothness of the semiconductor thin film it is possible to improve the fabricated TFTs, achieving mobilities above 15 cm²/Vs and higher gate bias stress stability.

AMD5 - 3
14:45

Effects of Zr Doping on the Performance of Solution-Processed InZnO Thin-Film Transistors

S.-Y. Liu, B.-Y. Su, P.-C. Kao[*], S.-Y. Chu

Nat. Cheng Kung Univ., Taiwan
[*]Nat. Chiayi Univ., Taiwan

Thin-film transistors with zirconium doping on the indium-zinc oxide as active layer by the solution-processed deposition method were fabricated and their TFT characteristics were examined. The solution-processed ZrInZnO films show high transmittance over 90% in the visible region and good electrical characteristic of I_{on} / I_{off} ratio current over 10^5.

AMD5 - 4
15:05

Effects of Solution-Processed Al_2O_3 Gate Insulator Thickness on IGZO TFTs

S.-M. Song, J.-S. Lee, D.-W. Kang, J.-Y. Kwon[*], M.-K. Han

Seoul Nat. Univ., Korea
[*]Yonsei Univ., Korea

We fabricated IGZO TFTs employing solution-processed Al_2O_3 gate insulator with various thicknesses. Leakage current density of Al_2O_3 films decreased exponentially and dielectric constant decreased with increasing insulator thickness. When the insulator thickness was 230 nm, the TFT showed 9.00 cm^2/Vs of saturation mobility and 3.4 V of the threshold voltage.

----- Break -----

15:50 - 17:25 **Room A**

FLX3: Flexible Oxide TFTs

Chair: M. Ito, Toppan Printing, Japan
Co-Chair: K. Uemura, Nippon Steel & Sumitomo Metal, Japan

FLX3 - 1: 15:50 ***Invited*** **Development of Low Temperature Solution-Processed Metal-Oxide TFT Materials**

J. Steiger, D.-V. Pham, M. Marinkovic, A. Hoppe, A. Neumann, A. Merkulov, R. Anselmann

Evonik Inds., Germany

We present recent developments at Evonik in regard to solution-based processing techniques of metal oxides for TFT applications. Specific tailored materials for different annealing temperatures are demonstrated and include mobilities above 2 cm²/Vs at temperatures of 160˚C, suitable for low cost flexible substrates.

FLX3 - 2 16:15 **Flexible AMOLED Display on Polyethylene Napthalate (PEN) Foil with Metal-Oxide TFT Backplane**

A. K. Tripathi, B. van der Putten, J.-L. van der Steen, K. Tempelaars, B. Cobb, M. Ameys, T. H. Ke*, K. Myny*, S. Steudel*, M. Nag*, S. Schols*, P. Vicca*, S. Smout*, J. Genoe*, P. Heremans*, I. Yakimets, G. Gelinck*

Holst Ctr./TNO, the Netherlands
**imec, Belgium*

We present a top emitting monochrome AMOLED display with 85 ppi resolution using an amorphous Indium-Gallium-Zinc-Oxide (IGZO) TFT backplane on PEN-foil. Maximum processing temperature was limited to 150°C in order to ensure an overlay accuracy < 3 μm on PEN foil.

FLX3 - 3 16:35 **Solution-Processed Low Temperature Amorphous Thin Films**

B. Singh, J. Jasieniak, C. D. Easton, L. Tozi, M. Bown

CSIRO Material Sci. & Eng., Australia

Oxidative treatment effectively reduces residual impurities in the thin films of metal oxide deposited via precursor route enabling reduced temperature of processing. Non-halide based precursors were found to be good candidate which shows that oxidative treatment significantly enhance the rate of bulk metal oxide formation resulting in high mobility transistors.

FLX3 - 4L
16:55

High Performance Indium Zinc Oxide Thin-Film Transistors Fabricated by Solution-Process at Low Temperature

L. Lu[*], Y. Osada[*], Y. Kawamura[*], T. Nishida[*], Y. Ishikawa[,**], Y. Uraoka[*,**]*

[*]Nara Inst. of S&T, Japan
[**]JST, Japan

Solution-processed InZnO thin film transistors showed a high field effect mobility of 19.5 $cm^2/V{\cdot}s$ at a low fabrication temperature of 300˚C by an aqueous solution. The on/off current ratio exceeded 10^9. Good bias stability was also obtained by the passivation of Al_2O_3 thin films.

FLX3 - 5L
17:10

Amorphous In-Ga-Zn-O Thin Film Transistors on Ultra-High-Tg Polycarbonate Films

T. Negishi, Y. Ikeda, T. Daidou, T. Shiro, K. Ikeda[*]

Teijin, Japan
[*]Teijin Chems., Japan

An ultra-high-Tg (264˚C) polycarbonate (UHT-PC) film is developed for use in high temperature processes for fabricating plastic electronic devices. This UHT-PC film can be used as a substrate in electronic devices that are annealed at temperatures over 200˚C. Amorphous In-Ga-Zn-O TFTs on the UHT-PC films are demonstrated.

Author Interviews and Demonstrations
17:30 – 18:30

Thursday, December 6

9:20 - 12:20 **Event Hall**

Poster **AMDp1: Oxide TFT**

AMDp1 - 1 **Withdrawn**

AMDp1 - 2 **A Study of Degradation Mechanism about Bias-Temperature-Illumination Instability in a-IGZO TFTs**

H. Choi, D. Y. Park, J. W. Baek, S. J. Yu, S. H. Jeon

LG Display, Korea

We have investigated the degradation mechanism of threshold voltage shift(ΔVth) of a-IGZO TFTs induced by bias-temperature-illumination stress. Under positive bias stress, charge trapping induced temperature is progressively the dominant mechanism. The ΔVth by negative bias stress is dependent on the thermal-induced / photo-generated hole trapping caused by temperature and illumination.

AMDp1 - 3 **The Effect of Annealing Temperature in Solution-Processed In-Ga-O Thin-Film Transistors**

D. H. Yoon, H. S. Lim, S. J. Kim, J. Jung, H. J. Kim

Yonsei Univ., Korea

As the annealing temperature increased from 200 to 300˚C, the In-Ga-O (IGO) thin-film transistors (TFTs) showed enhanced performances for switching devices. The annealing temperature above 350˚C caused the IGO TFT excessively conductive, and it was attributed to the crystallization of IGO thin-film.

AMDp1 - 4 **Investigation on Effects of Composition on Transparent Aluminum Zinc Tin Oxide Thin-Film Transistors**

C.-S. Fuh, L.-F. Teng, Y.-S. Fan, C.-H. Chang, P.-T. Liu

Nat. Chiao Tung Univ., Taiwan

We investigated on electrical performance of amorphous Al-Zn-Sn-O thin film transistor (AZTO TFT). The mobility enhanced while the concentration of Sn increased. The improved stability can be attributed to the increase of Sn concentration and enhancement of bonding energy of metal ion with the increase of O_2 gas flow rate.

AMDp1 - 5 **High Performance Inverter with a-IGZO-Based Resistor Load and Self-Aligned Coplanar a-IGZO Driving TFT**

D. Geng, D. H. Kang, M. J. Seok, M. Mativenga, J. Jang

Kyung Hee Univ., Korea

We demonstrate an inverter implemented with a coplanar amorphous-indium-gallium-zinc-oxide (a-IGZO) driving thin-film transistor (TFT) and an a-IGZO-based resistor load. The inverter has larger voltage gain and wider swing range compared to inverters employing enhancement mode TFTs as load, making it applicable to high speed logic gates and other simple circuits.

AMDp1 - 6 **New IGZO-Based Oxide Semiconducting Material for Back Channel Etch Type Thin Film Transistor**

*S. Morita, K. Hirose, A. Hino, H. Goto, T. Kugimiya, E. Kusumoto**

Kobe Steel, Japan
**Kobelco Res. Inst., Japan*

We have developed a new IGZO-based oxide semiconducting material for back channel etch (BCE) type thin film transistor. It is demonstrated that the TFTs using the new oxide semiconducting material with high chemical stability for conventional etchant possesses better performance compared with that of conventional IGZO TFT with BCE structures.

AMDp1 - 7 **Analysis of Electronic-Structural Change in a-InGaZnO by High Pressure Water Vapor Annealing**

Y. Ueoka, N. Maejima, H. Matsui, F. Matsui, M. Morita, S. Kitagawa, M. Fujita, K. Yasuda, H. Yamazaki, S. Urakawa, M. Horita, Y. Ishikawa, H. Daimon, Y. Uraoka

Nara Inst. of S&T, Japan

The effect of high pressure vapor annealing (HPV) for a-IGZO was investigated by angle-resolved XPS. We found that In HPV enable to oxidize In atoms and reduce Ga atoms. It is considered that high channel mobility and stability attribute these reactions.

AMDp1 - 8 **The Comparison of Lithium Doping Impact to Solution-Processed ZnO/InZnO Thin Film Transistors Characteristics**

Y. W. Wang, P. H. Fang, A. C. Cheng, W. C. Su, P. R. Lin

Nat. Changhua Univ. of Education, Taiwan

We report the impact of lithium doping to ZnO/InZnO thin film transistors' electrical and optical characteristics. A best device with mobility ~0.94 cm^2/Vs, and an on/off current ratio over 10^6 were achieved. Further, the high ionization energy of lithium (5.39 eV) led the transistor stabilizer than which without lithium doping.

AMDp1 - 9L **A Method to Increase the Reflectivity of Transflective LCDs**

S. Huo, W. Jiang

Shanghai Tianma Micro-Elect., China

We have provided a new transflective liquid crystal displays which has a novel structure to broaden the reflective area in one pixel. By making the reflector cover the interval area between the adjacent pixels, almost all of the pixel area is effective display part. So the reflectance is improved largely.

AMDp1 - 10L **Oxide TFT Wired MUX Circuit for Dual Mode Shift Register**

E.-J. Song, H. Nam

Kyung Hee Univ., Korea

This paper demonstrates a wired MUX circuit for an oxide TFT dual mode shift register which supports two scanning pulses of different timings and pulse widths at one gate line. This integrated MUX guarantees the rail-to-rail output voltage over the threshold voltage variation from –4 V to 5 V.

AMDp1 - 11L **Electrical Degradation Behavior of a-InGaZnO Thin-Film Transistors with Sm_2O_3 Gate Dielectrics**

F.-H. Chen, J.-H. Liu, S. Mondal, B.-L. Wu, T.-M. Pan

Chang Gung Univ., Taiwan

We investigate the electrical degradation behavior in amorphous-InGaZnO (a-IGZO) thin-film transistors (TFTs) with Sm_2O_3 gate dielectrics. The negative shift of threshold voltage in Sm_2O_3 a-IGZO TFTs can be attributed to the generation of extra electrons from oxygen vacancies in the a-IGZO channel.

----- Lunch -----

14:00 - 15:15 **Room A**

AMD7: Oxide TFT: Reliability

Chair: T. Kamiya, Tokyo Inst. of Tech., Japan
Co-Chair: M. Hiramatsu, Japan Display Central, Japan

AMD7 - 1
14:00 **Instability of Light Illumination Stress on Amorphous InGaZnO Thin Film Transistors**

S. Park, E. N. Cho, I. Yun

Yonsei Univ., Korea

In this paper, the effects of the different wavelengths of the light under both positive and negative V_{GS} stress on Amorphous InGaZnO Thin Film Transistors are investigated. The TFT instability depending on optical and electrical stresses can be explained by the charge trapping mechanism and the interface modification.

AMD7 - 2
14:20 **The Effects of Wavelength and Negative Bias on Light-Induced Hysteresis of In-Ga-Zn-O Thin-Film Transistors**

S.-H. Kuk, S.-Y. Lee, M.-K. Song, S. Kwon[*]*, S. C. Youn*[*]*, M.-K. Han*

Seoul Nat. Univ., Korea
[*]*LG Display, Korea*

We investigated the effects of wavelength and negative bias on light-induced hysteresis of In-Ga-Zn-O thin-film transistors. Transfer characteristics were measured under various wavelengths and sweep ranges. Hysteresis was observed under the 450 nm illumination, and was increased with wavelength decrease. And hysteresis was increased, as applied negative bias increased.

AMD7 - 3
14:40

The Influence of New SiN_x Gate Insulator in a-InGaZnO Thin Film Transistors

H. Yamazaki, Y. Ishikawa, Y. Ueoka, M. Fujiwara, E. Takahashi*, Y. Andoh*, Y. Uraoka*

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

We fabricated highly reliable amorphous In-Ga-Zn-O thin-film transistors (a-IGZO TFTs) with new silicon nitride (SiN_x) as a gate insulator. The SiN_x layer was formed with utilizing SiF_4/N_2 as source gases at a temperature as low as 150°C. We studied the influence of hydrogen and fluorine on the electrical characteristics.

AMD7 - 4 **Withdrawn**

AMD7 - 5L
15:00

The 4 Masks a-IGZO TFT Structure with High Uniformity and Electrical Stability

J. Y. Yan, W.-W. Tsai, C.-Y. Hung, H.-C. Yao, L.-H. Chen, H.-C. Lin, Y.-C. Lin

ITRI, Taiwan

This article provides the four masks structure and process for channel protection a-IGZO TFTs. The hybrid channel protection structure is development to replace the PECVD SiO_2 and improve the stability and manufacturing yield. TFT mobility is over 20 cm^2/Vs, and standard derivation of Vth is less than 0.03 V.

----- Break -----

15:50 - 17:15 **Room A**

AMD8/FLX7: Oxide TFT: Flexible Displays

Chair: C.-H. Cheng, AU Optronics, Taiwan
Co-Chair: M. Kimura, Nagaoka Univ. of Tech., Japan

AMD8/
FLX7 - 1:
15:50

Invited **Flexible AMOLED Displays Driven by a-IGZO TFTs and their Applications**

H. Yamaguchi, T. Ueda, K. Miura, N. Saito, S. Nakano, T. Sakano, K. Sugi, I. Amemiya

Toshiba, Japan

Reliability of a-IGZO TFTs on plastics against bias-temperature stress has been improved. We developed an 11.7-in. AMOLED display driven by a-IGZO TFTs on plastics. Using the panel, we demonstrated a prototype of flexible-display system integrated with a bend-input function that enables users to interact with the display by flexing it.

AMD8/ FLX7 - 2: 16:15 ***Invited*** **A 9.9-in. qHD Top-Emission Flexible OLED Display Driven by Oxide TFTs**

K. Teramoto, E. Fukumoto, T. Fukuda, K. Shimokawa, T. Saito, T. Tanikawa, M. Suzuki, G. Izumi, M. Noda, S. Kumon, T. Arai, T. Kamei, M. Kodate, S. No, T. Sasaoka, K. Nomoto

Sony, Japan

We have developed a direct fabrication method of oxide TFTs on a flexible substrate. We have also developed a flexible color filter array for white OLEDs. The oxide TFT is integrated on a flexible substrate. The fabricated display had a wide color gamut with over 100% NTSC in u'v' space.

AMD8/ FLX7 - 3 16:40 **Flexible Top-Gate Amorphous InGaZnO TFTs on a New Colorless Polyimide Substrate for Flexible Display Applications**

Y.-H. Yeh, C.-C. Cheng, M.-J. Yu, H.-C. Ku, B. C.-M. Lai, B.-Y. Chou, E. Horii[*], E. Kuribayashi[*], T. Iwamoto[*], M. Yamazaki[*], H. Inari[*], K. Kurimoto[*]

ITRI, Taiwan
[*]Kaneka, Japan

The flexible top-gate a-IGZO TFTs array was fabricated on a Kaneka's colorless polyimide (PI) substrate at 200°C. Our proposed PI substrate has high T_g (~350°C), high light transmittance (~87%), and low thermal coefficient (8 ppm/°C). Polymer resin (ILLUMIKA) was also applied to passivate the a-IGZO TFTs.

AMD8/ FLX7 - 4L 17:00 **High-Performance Solution Processed Indium Oxide Thin Film s Transistors**

C. Avis, Y. G. Kim, H. R. Hwang, J. Jang

Kyung Hee Univ., Korea

We have developed a high performance solution processed indium oxide TFT (InO_x TFT). The spin-coated TFTs has saturation mobility, Vth, and gate swing of 57.3 cm^2/Vs, 0.4 V, and 149 mV/dec., respectively. Inverters based on InO_x TFTs were fabricated and showed a gain~27 at V_{DD}=3 V.

Author Interviews and Demonstrations
17:30 – 18:30

Special Topics of Interest on Augmented Reality

Wednesday, December 5

14:00 - 17:00 **Event Hall**

Poster **DESp1: Poster: Display Electronic Systems (AR)**†

†*Short Presentation (See p. 193)*

DESp1 - 1 **Image Synthesis from Illumination Estimation**

T.-H. Lin

Nat. Taiwan Univ. of S&T, Taiwan

Our proposed method synthesizes images with cast shadows and shading of 3D graphic models. We use a calibration board and a plastic gaze ball for illumination estimation. Then, 3D graphic models corresponding to the light directions and relative intensities are superimposed to induce photorealistic images.

Thursday, December 6

9:00 - 10:30 **Room B-1**

VHF6: Wide-Angle and Head-Up Display Human Factors

Chair: T. Kurita, NHK, Japan
Co-Chair: A. Yoshida, Sharp, Japan

VHF6 - 1: 9:00 ***Invited*** **Education for Disaster Prevention Using Ultra-Realistic Dome Images −Learning Through Images of the Great East Japan Earthquake−**

M. Okyudo

Wakayama Univ., Japan

On 11 March 2011, our country suffered an earthquake and a tsunami of unprecedented size. Streets and towns throughout a wide region were destroyed. We recorded these disaster areas in ultra-realistic dome images, presented them in a digital planetarium, and began to use them as disaster prevention education.

VHF6 - 2 9:30 **Development of Perceived Depth Position Control Method with a Preceding Obstacle for Monocular Head-Up Display Images**

A. Hotta, T. Sasaki, A. Moriya, H. Okumura

Toshiba, Japan

We developed novel depth perception control methods for the monocular HUD virtual image when there is a preceding obstacle. The results show that the perceived depth position of the HUD images can be controlled from 30 m to 120 m within an error of 30% which is further than the obstacle position.

VHF6 - 3
9:50 **Effect of a Head-Up Display on Reaction Time in a Skiing Simulation**

M. Lolic, R. Hoskinson, É. Naugle, H. Abdollahi

Recon Instrs., Canada

A computer simulation was created to monitor the reaction time of participants using a heads up display (HUD) while watching a first-person ski video. It was found on average that the reaction time increased by 0.19 seconds when users were asked to pay attention to notifications on a HUD.

VHF6 - 4
10:10 **A LC Lens Array Based Projection System for Near Eye Displays**

S. Valyukh, J. De Smet[,**], O. Slobodyanyuk[***], H. De Smet[*,**]*

Linköping Univ., Sweden
[*]imec, Belgium
[**]Ghent Univ., Belgium
[***]Taras Shevchenko Nat. Univ. of Kyiv, Ukraine

A projection optical system for hypothetic near eye displays that can be built into a contact lens or glasses is considered. The system parameters are evaluated. Aspects of practical usage of the displays and possible embodiments of the optical system are discussed.

----- Break -----

10:50 - 12:30 **Room B-1**

3D6: Digital Museum of Kyoto Gion Festival

Chair: M. Tsuchida, NTT, Japan
Co-Chair: K. Makita, AIST, Japan

3D6 - 1:
10:50 ***Invited*** **Digital Museum of Gion Festival within Virtual Kyoto**

K. Yano, T. Seto, D. Kawahara[*]

Ritsumeikan Univ., Japan
[*]CAD Ctr., Japan

Virtual Kyoto is a historical virtual geographic environment of the historical city of Kyoto, which aims at reconstruction and visualization of the city's historical landscapes. This paper introduces Digital Museum of Gion Festival which represents Kyoto's culture and tradition, based on Virtual Kyoto.

3D6 - 2: 11:15 ***Invited*** **A Virtual Tour of Gion Festival Yamahoko Parade**

L. Li, W. Choi[*]*, K. Hachimura, T. Nishiura, K. Yano*

Ritsumeikan Univ., Japan
[*]Gunma Nat. College of Tech., Japan

We tried to virtually reproduce Yamahoko Parade in Kyoto Gion Festival, which has been registered in the list of "Intangible Heritage of Humanity" by UNESCO. This work contributes to the research of digital museum and provides a platform that allows the users to virtually experience the atmosphere of the event.

3D6 - 3: 11:40 ***Invited*** **Particle-Based Translucent Visualization of Funeboko for the Gion Festival**

S. Tanaka, M. Uemura, M. Yamamoto, K. Hasegawa, S. Nakata

Ritsumeikan Univ., Japan

We translucently visualize laser-scanned 3D point data of the Funeboko float for the Gion Festival (Kyoto). We use the particle-based surface rendering, which we recently proposed, regarding the scanned points as particles. Our approach enables precise and comprehensible translucent visualization of the complex internal 3D structure of Funeboko.

3D6 - 4: 12:05 ***Invited*** **Digital Archiving and Large-Scale Visuo-Haptic Display of Large 3D Woven Cultural Artifacts**

W. Wakita, M. Tsuchida[*]*, J. Yamato*[*]*, H. T. Tanaka*

Ritsumeikan Univ., Japan
[*]NTT, Japan

We have measured large 3D woven cultural artifacts with rail-wheel 3D scanning system, and captured high-resolution images with a two-shot type 6-band image capturing system, and modeled woven cultural artifacts in 3D. This paper describes a digital archiving and large-scale visuo-haptic display of large 3D woven cultural artifacts.

----- Lunch -----

14:00 - 15:35 **Room B-1**

DES5: Recent Advances in Augmented Reality Applications

Chair: K. Makita, AIST, Japan
Co-Chair: M. Tsuchida, NTT, Japan

DES5 - 1: 14:00 ***Invited*** **SmartAR: Integrated Augmented Reality Technology for Novel Application Creation**

T. Yoshigahara
Sony, Japan

Sony has developed integrated Augmented Reality technology called as "SmartAR." Fast object recognition and dynamic 3D space recognition have enabled us to propose various novel applications. In this talk, we present an outline of the development of SmartAR and the various applications we created.

DES5 - 2: 14:25 ***Invited*** **Mixed Reality Applications of Design Engineering & Manufacturing**

T. Aso
Canon, Japan

Canon started Mixed Reality solution business this year. We are planning to develop this solution business from the design engineering & manufacturing field. It enables the intuitive evaluation of design data created by 3D-CAD. Canon is going to develop new business domain by Mixed Reality.

DES5 - 3: 14:50 ***Invited*** **Recent Trends on Visual Tracking for Augmented Reality**

H. Uchiyama
Toshiba, Japan

Computer vision technologies play an important role for estimating and tracking a camera pose in augmented reality. This paper reports state-of-the-art visual tracking technologies and classifies them into three categories: fiducial marker based augmented reality, object template based augmented reality and wide area augmented reality.

DES5 - 4 15:15 **Texture Significant Hash Function with Robust Occlusion Handling for Fast Inpainting the Virtualized-Reality Models**

K. Thangamani[,**], T. Ishikawa[**], K.Makita[**], T. Kurata[*,**]*
[*]Univ. of Tsukuba, Japan
[**]AIST, Japan

This paper discusses the texture significant hash table usage for speed up the inpainting process in the virtualized-reality indoor models. The proposed hash works are included in the Exemplar-Based inpainting and this revised method is tested in the virtualized-reality indoor models.

----- Break -----

15:50 - 17:35 **Room B-1**

INP6: AR Interactive Systems

Chair: H. Iseki, Tokyo Women's Medical Univ., Japan
Co-Chair: N. Hashimoto, Citizen Holdings, Japan

INP6 - 1: 15:50 ***Invited*** **SCOT (Smart Cyber Operating Theater) Project: Advanced Medical Information Analyzer for Guidance of the Surgical Procedures**

*H. Iseki, Y. Muragaki, M. Tamura, T. Suzuki, K. Yoshimitsu, S. Ikuta, J. Okamoto, M. Chernov, K. Izumi**

Tokyo Women's Medical Univ., Japan
**Univ. of Tokyo, Japan*

Computer-assisted advanced medical information analyzer is based on the constant monitoring, recording, co-registration and archiving of the various data. The system permits fast extraction of the required parameters from the database and significantly facilitates evaluation of the clinical procedures, which may result in significant increase of their safety and reliability.

INP6 - 2 16:15 **Laser Projection UI Robot System and Its Applications**

M. Ide, Y. Abe, T. Komiyama, S. Fukaya, T. Tamura, K. Arakawa, T. Nozaki

Citizen Holdings, Japan

We present a novel pan-tilt projection UI robot system using a laser light source with a MEMS scanner in combination with a hand tracking sensor. The UI robot system can detect and track a hand and then project a virtual remote controller (VRC) image onto the top of a palm.

INP6 - 3L: 16:35 ***Invited*** **Real-Time Rendering Method of Virtual Liquid in Mixed Reality Environment with Automatic Generation of Sound Effect**

M. Imura, Y. Kuroda, O. Oshiro

Osaka Univ., Japan

We propose a real-time rendering method of virtual liquids in mixed reality environment and an automatic generation method of sound effect of liquids based on a computational fluid dynamics simulation. Two cameras are adopted for capturing the images of real environment for appropriate rendering of transparent liquids.

INP6 - 4L: 16:55 ***Invited*** **Synchronized Visualization of Bone Cutting to Support Microendoscopic Discectomy**

M. Nakao, K. Imanishi[*], M. Kioka[**], M. Yoshida[**], K. Minato[***], T. Matsuda

Kyoto Univ., Japan
[*]e-Growth, Japan
[**]Wakayama Medical Univ., Japan
[***]Nara Inst. of S&T, Japan

This presentation introduces a new concept of augmented reality (AR) assisted bone cutting to support Microendoscopic Discectomy. The designed system dynamically updates volume rendered images of patient's CT data while synchronizing with intraoperative cutting procedures, and contributes to precise and rapid cutting as well as reducing perceptual difficulties in microendoscopic operation.

INP6 - 5L: 17:15 ***Invited*** **Contents-Rich Display for Medical Diagnostic and Surgical Aid**

K. Mori

Nagoya Univ., Japan

This paper presents recent advances of medical image processing techniques utilized in diagnostic and surgical assistance from the viewpoint of human anatomy exploration and its display. Interactive rendering of human anatomical structures is now widely utilized in the clinical filed. This presentation demonstrates contents-rich display based on medical image recognition.

Author Interviews and Demonstrations
17:30 – 18:30

EXHIBITION

12:40 – 18:20 Tuesday, Dec. 4, 2012
10:00 – 18:00 Wednesday, Dec. 5, 2012
10:00 – 18:00 Thursday, Dec. 6, 2012
10:00 – 14:00 Friday, Dec. 7, 2012

Event Hall, 1F
Kyoto International Conference Center

Free admission with your registration name tag

Special Topics of Interest on Lighting Technologies

Wednesday, December 5

9:20 - 12:20 **Event Hall**

Poster **FMCp:FPD Manufacturing, Materials & Components**

FMCp - 9 **An Analytical Model for Describing LED Pad Temperature in Backlight Unit**

K.-Y. Chang, C.-C. Hu, C. Xiong, W.-Y. Wei

Shenzhen China Star Optoelect. Tech., China

An Equivalent Thermal Resistance, ETR, is introduced in this paper to predict LED (light emitting diode) pad temperature while same thermal management is applying. A simplified experiment is conducted to find the behavior of ETR as different heat sink size is applied. Analytical solution, a power function, shows great match with the experiment data.

FMCp - 10 **The Study on Relation between Color Gamut and Luminous Efficiency Based on the Shift of Color Filter and LED Spectrum**

W. Zheng, C.-T. Kang

Shenzhen China Star Optoelect. Tech., China

The relation between color gamut and luminous efficiency basic on the shift of color filter and LED spectrum is proposed. The study is undergone by simulation and the simulation result shows that the two parameters we study in the paper usually change oppositely on the whole.

FMCp - 11 **Development of a Simulation Model to Analyze the Chromaticity Variation at the Place Lit by RYGB-White-LED**

K. Misono

Miyakonojo Nat. College of Tech., Japan

Although the RYGB-White-LED can provide a flexible control of photometric and colorimetric characteristics, the practical issue is to suppress the color variation on the lit-plane. By taking into account the spectral irradiance, we developed a ray tracing model that can evaluate the color uniformity on the lit-plane.

FMCp - 12 **Transmittance of LED Encapsulant Containing Quantum Dot with Various Types of Ligands**

C. S. Lee[,**], C. J. Han[**], S.-K. Hong[*]*

[*]Dongguk Univ., Korea
[**]KETI, Korea

In this study, transmittance and degree of cure of encapsulant was measured according to the number of purification of quantum dot, when quantum dot was used as LED phosphor. The changes in the degree of cure was checked along with the types of ligand in quantum dot.

FMCp - 13 **Conversion Efficiency of RGB Phosphor Array on the Lightguide**

H. J. Jeon, K. S. Lim, J. H. Kwon

Yeungnam Univ., Korea

The light power conversion efficiency of the RGB phosphors was measured in terms of the phosphor concentration. The excitation wavelength was 450 nm. The power conversion efficiency was almost doubled when the reflecting layer was placed behind the phosphor layer and was proportional to the phosphor concentration.

FMCp - 14 **Solution for Eliminating Support Pin Shadow Mura in Direct LED Backlight**

K.-Y. Chang, C.-C. Hu, Z. Su

Shenzhen China Star Optoelect. Tech., China

A simple method for eliminating support pin shadow mura in direct LED backlight for LCD-TV was proposed. Mechanism of support pin shadow mura was discussed. Simulation and experiment results confirmed that, by lower the height of support pin, shadow mura would effectively drop off. However, the supporting function remains.

FMCp - 15 **A Modified Color System for LED Chromaticity Ranking in a System**

C. Feng, K.-Y. Chang, C.-C. Hu, C. Ning

Shenzhen China Star Optoelect. Tech., China

A modified color system is proposed for light emitting diode (LED) chromaticity ranking. By directly giving the output chromaticity, it solves the problem of LED metamerism that results in output chromatic difference of lighting systems. It may also simplify the LED chromaticity control and increase the LED usage rate.

Thursday, December 6

9:00 - 10:00 **Room C-2**

PH4: Phosphors Late News

Chair: D. Y. Jeon, KAIST, Korea
Co-Chair: K. Hara, Shizuoka Univ., Japan

PH4 - 1L
9:00

A New Paradigm for Phosphor Discovery

*K.-S. Sohn, W. B. Park, M. Ibukiyama**

Sunchon Nat. Univ., Korea
**Denki Kagaku Kogyo, Japan*

We employed a non-dominated-sorting genetic algorithm (NSGA) for a preliminary screening of the multidimensional search space, and particle swarm optimization (PSO) for the ensuing fine-tuning. We also created a parameter designating the novelty of the phosphors, the so-called structural rank, and used it as an objective function in the NSGA.

PH4 - 2L
9:15

Selecting a White Point Using $(Y_{1-a}Gd_a)_3Al_5O_{12}:Ce^{3+}$ (Where a is in the Range 0.3 to 0.6) Phosphors on Screens and Two Blue LEDs

J. Silver, R. Withnall, P. Marsh

Brunel Univ., UK

$(Y_{1-a}Gd_a)_3Al_5O_{12}:Ce^{3+}$ (where a = 0.3-0.6) phosphors were synthesised, incorporated into inks and screen printed. The phosphors were used with blue LEDs to produce white light. The color point of the white light was fine tuned by varying parameters including the gadolinium concentration, phosphor layer thickness, and the LED emission wavelength.

PH4 - 3L
9:30

Luminescence Properties of Novel Nitride-Based Yellow Phosphor for White Light-Emitting Diodes

S. Takashina, A. Ohto

Mitsubishi Chem., Japan

We succeeded in synthesizing novel yellow phosphors with color coordinates from x = 0.417 to 0.475. We investigated the emission spectra of $La_3Si_6N_{11}$:Ce and its derivatives (LSN). We were able to create 9000 ~ 4000 K white light-emissions by combining various colored LSN and blue LEDs.

PH4 - 4L
9:45

New Shape White LEDs with Uniform Hue

H. Daicho, A. Nomura, K. Enomoto, Y. Shinomiya, S. Sugimori

Koito Manufacturing, Japan

We fabricated new shape white LEDs for general lighting. The white LEDs consist of a violet-chip and the thick phosphor layer, which contains blue and yellow emitting phosphors. The phosphor concentration of the phosphor layer is low. The excellent hue uniformity of our white LED will reduce color binning.

----- Break -----

14:00 - 17:00 **Event Hall**

***Poster* OLEDp: OLED Technologies**

OLEDp - 12 **Materials for Enhancing External Light Out-Coupling Efficiency of Organic Light-Emitting Diodes**

P.-C. Chien, I.-L. Kao, Y.-L. Hsu, P.-C. Chen

ITRI, Taiwan

The purpose of this study was to present a simple and low cost method which has a good balance between improvement of OLEDs light extraction efficiency and suppression of color shift at various viewing angle by attaching scattering films with porous particles.

OLEDp - 13 **Very-High Color Rendering Index OLEDs with Natural Light-Style Spectrum**

J.-H. Jou, J.-R. Tseng, F.-C. Yang, C.-T. Chen, H.-W. Liu, S.-P. Chen[*], H.-W. Hung[*], J.-Y. Li[*], M.-C. Liu[*]

Nat. Tsing Hua Univ., Taiwan
[*]ITRI, Taiwan

Natural light-style OLEDs with both color rendering index (CRI) and high sunlight spectrum resemblance (SSR) will be presented. The feasibility of fabricating quality light sources with very-high CRI and very-high SSR at any designated color temperature warrants OLED to be the ultimate lighting technique.

OLEDp - 14 **Novel Carbazole-Substituted Anthracene Derivatives for Non-Doped Blue Light Emitting Diodes**

R.-H. Lee, Y.-G. Chen, Y.-C. Chang, Y.-C. Chen[*], J.-T. Lin[*], R.-J. Jeng[**]

Nat. Chung Hsing Univ., Taiwan
[*]Academia Sinica, Taiwan
[**]Nat. Taiwan Univ., Taiwan

Three anthracene derivatives featuring carbazole moieties as side groups were synthesized for use in blue organic light emitting devices. The highest brightness (6821 cd/m^2) was that for the tCz^9PhAnt-based device; the greatest current efficiency (2.1 cd/A) was that for the tCz^9Ph_2Ant-based device.

OLEDp - 15 **Light Extraction Enhancing Buffer Layers for Organic Light-Emitting Diodes**

H. J. Cho, H.-N. Lee

Soonchunhyang Univ., Korea

Numerical simulations and experiments were conducted to study the light outcoupling enhancement effects based on electrode-buffer structures. Thin tungsten-oxide buffer and titanium-oxide buffer increased the outcoupling noticeably. However, thick buffers decreased the outcoupling. The combined effects of the constructive interference and the creation of additional bound modes explain these behaviors.

Friday, December 7

9:00 - 10:25 **Room A**

OLED3: OLED for Lighting Application

Chair: Y. Kijima, Sony, Japan
Co-Chair: T. Ikuta, JNC Petrochem., Japan

OLED3 - 1: 9:00 ***Invited*** **Design of Backplanes and Optical Enhancement Structure for Large-Area OLED Lighting Panels**

M.-H. Ho, C.-C. Lin, Y.-C. Chin, C.-C. Chen, M.-T. Lee, T.-Y. Cho, C.-W. Chen

AU Optronics, Taiwan

We demonstrate a novel design for large-area OLED lighting panels with low electrode resistance and short reduction to achieve high brightness uniformity with both low power efficiency loss and high production yield. In addition, efficiency of OLED lighting panels can be further enhanced by applying internal extraction layer between transparent electrodes and substrate.

OLED3 - 2 9:25 **Highly Efficient White OLEDs with Single Solution-Processed Emitting Layer Consisting of Three Kinds of Dopants**

H. Sakuma, S. Nobuki, S. Ishihara, S. Aratani, A. Sano, K. Kobayashi

Hitachi, Japan

We achieved a highly efficient white organic light emitting diode with a single emitting layer consisting of three kinds of dopants. The emitting layer was fabricated with a one-step solution coating process. A maximum power efficiency of 70 lm/W was obtained by applying high fluorescence quantum yield dopants and improving light extraction efficiency.

OLED3 - 3 9:45 **Improving the Performance of Solution-Processed Green Phosphorescent OLEDs Using EL Spectra Analysis**

T. Sugizaki, Y. Shinjo, A. Amano, T. Yonehara, Y. Mizuno, S. Enomoto, I. Amemiya

Toshiba, Japan

Emission regions in solution-processed green phosphorescent OLEDs have been estimated by analyzing their electroluminescent (EL) spectra. The performance of the OLEDs has been improved by optimization of device structure based on the analysis.

OLED3 - 4 10:05 **A New 2-Dimensional OLED Circuit Modeling for Obtaining Uniform Brightness in Large Area OLED Lighting Panels**

J.-H. Han, J. Moon, J. W. Huh, D.-H. Cho, J.-W. Shin, C. W. Joo, J. Hwang, B. J. Lee, S. K. Park, J.-T. Ahn, N. S. Cho, H. Y. Chu, J.-I. Lee

ETRI, Korea

We report on a new 2-dimensional OLED circuit modeling method for obtaining uniform brightness across large area OLED lighting panels. Our method is very useful in predicting the brightness distributions with different panel shapes and sizes. Our simulation results have been successfully applied to fabricate panel with high brightness uniformity.

----- Break -----

10:50 - 11:50 **Room B-2**

FMC9: LED Lighting Technologies

Chair: K. Käläntär, Global Optical Solutions, Japan
Co-Chair: K. Li, Wavien, USA

FMC9 - 1 10:50 **10,000 Nits Projection-Type Recycling LED Back-Light System for Outdoor LCDs**

K. Li

Wavien, USA

This paper describes a high brightness back-light system for LCD displays using Wavien's Recycling LED Technology (RLT). A 2 X 2 Micro Cube system comprising four 19-in. display video cubes has been demonstration with over 10,000 nits output brightness. A single 80-in. diagonal LCD display is being constructed.

FMC9 - 2 **11:10**

A Novel Design of LED Embedded Alexis Wound Retractor

Y. -C. Su[*], Y.-S. Chen[**], J.-W. Pan[,**], C.-Y. Wu[**]*

[*]Chi Mei Medical Ctr., Taiwan

[**]Nat. Chiao Tung Univ., Taiwan

The key design of this invention is the LED mounted on the inner ring of Alexis Wound Retractor. With this design, we could offer a much wide spreaded lightening comparing to the traditional shadowless lighting.

FMC9 - 3 **11:30**

"Square-Light" Technology as Novel Approach for Making Ultra-Slim LED Lighting Devices

J. Hou, Z.-W. Koh, W.-C. Ing

LuxingTek, Taiwan

The world thinnest "direct-lit" LED backlight module having a minimal number of LED light source will be presented. This revolutionary approach reveals the possibility of converting a strong LED "dot" light into a uniform surface light at 7 mm thickness with 50 mm LED pitch.

9:20 - 12:20 **Event Hall**

***Poster* PHp: Phosphors**

PHp - 16

Effects of Phosphor Distribution and Step-Index Remote Configuration on the Luminous Efficacy of Warm White Light-Emitting Diodes

H.-Y. Tsai, T.-H. Liu, H.-Y. Kuo, H.-Y. Lin, S.-Y. Chu

Nat. Cheng Kung Univ., Taiwan

This paper demonstrated that Y down / R up type is the preferable phosphor distribution for warm pc-WLEDs. Compared with common warm pc-WLEDs using silicone gel as the remote layer, a step-index remote configuration proposed herein exhibited a superior luminous efficacy at 67.4262 lm/W under 350 mA.

PHp - 17 **Withdrawn**

PHp - 18

Recent Progress in the Development of Ce^{3+}-Activated Fluorosulfide and Fluorooxysulfide Phosphors for LED Lighting

T.-M. Chen, Y.-C. Wu, C.-S. Lee, S.-N. Chen

Nat. Chiao Tung Univ., Taiwan

Several novel Ce^{3+}-activated $Y_2(Ca,Sr)F_4S_2$, α- and β-YSF, and $Y_3S_2OF_3$ fluorosulfide and fluorooxysulfide phosphors, have been synthesized and luminescence was investigated. Fluorosulfide-based phosphors can be excited by blue light and shows yellow-to-orange and red broadband emissions, respectively. Recent progress on the synthesis and structure-luminescence relationship of these phosphors is discussed.

PHp - 19 **Selecting a Red Point Using CaS:Eu^{2+} and SrS:Eu^{2+} Phosphors on Screens and One Blue LED**

J. Silver, R. Withnall, P. J. Marsh

Brunel Univ., UK

Screen printing inks containing various CaS:Eu^{2+}:SrS:Eu^{2+} ratios were prepared. The phosphors were printed on screens which were excited by blue LED light to produce red emission. The color point of the red light can be fine tuned by varying the CaS:Eu^{2+}:SrS:Eu^{2+} ratios, printed phosphor thickness, particle size and morphology.

----- Lunch -----

14:00 - 15:35 **Room B-2**

PRJ4: Solid State Lighting

Chair: F. Shevlin, Dyoptyka, Ireland
Co-Chair: M. Sakai, Ushio, Japan

PRJ4 - 1: 14:00 ***Invited*** **Recent Progress in Green and Blue InGaN Laser Diodes for Projection Display Applications**

J. W. Raring, M. C. Schmidt, C. Poblenz, H. Huang, C. Bai, P. Rudy, J. S. Speck, S. P. DenBaars, S. Nakamura

Soraa, USA

We report recent progress for InGaN-based lasers diodes fabricated on nonpolar/semipolar substrates. In the green, we demonstrate single-mode lasers operating with >3.5% wall-plug-efficiency and 190 mW output power. In the blue, we demonstrate single-mode lasers with >23% wall-plug-efficiency and high power lasers operating with >2.5 W of output power.

PRJ4 - 2: 14:25 ***Invited*** **Green-to-Yellow Spectral Region CW Operation of BeZnCdSe Quantum-Well Laser Diodes**

S. Tanaka, S. Fujisaki, J. Kasai, S. Tsuji, R. Akimoto[*]*, T. Hasama*[*]*, H. Ishikawa*[*]

Hitachi, Japan
[*]*AIST, Japan*

Continuous-wave operation in green-to-yellow spectral region was demonstrated with BeZnCdSe quantum-well laser diodes. The lasing wavelength of the fabricated yellow laser diode was 571 nm. Light output power of the green and yellow laser diode was as high as 50 mW with a low threshold current density.

PRJ4 - 3 14:50 **High Efficiency and Highly Reliable 638 nm Broad Stripe Laser Diode for Display Applications**

T. Yagi, N. Shimada, T. Nishida, H. Mitsuyama, M. Miyashita

Mitsubishi Elec., Japan

638 nm broad stripe laser LD was newly developed. The LD has the large optical confinement factor design for high WPE and the window-mirror structure for reliable operation. The LD shows WPE of 35% at 25˚C, 44 lm/W, and highly stable operation at 35˚C, 550 mW up to 8,000 hours.

PRJ4 - 4L: 15:10 ***Invited*** **High-Power, Long-Lifetime Green Laser Diodes with Wavelengths above 525 nm Grown on Semipolar {20-21} GaN Substrates**

K. Tasai, H. Nakajima, K. Naganuma, Y. Takiguchi, T. Hamaguchi, N. Futagawa, K. Yanashima, M. Ikeda, Y. Enya[*], S. Takagi[*], M. Adachi[*], T. Kyono[*], Y. Yoshizumi[*], T. Sumitomo[*], Y. Yamanaka, T. Kumano[*], S. Tokuyama[*], K. Sumiyoshi[*], N. Saga[*], M. Ueno[*], K. Katayama[*], T. Ikegami[*], T. Nakamura[*]

Sony, Japan
[*]Sumitomo Elec. Inds., Japan

GaInN-based green laser diodes (LDs) with wavelengths above 525 nm were fabricated on semipolar {20–21} GaN substrates. The LDs were estimated to have lifetimes of over 5000 h for an optical output power of 50 mW at a case temperature of 55˚C under continuous-wave operation.

----- Break -----

15:50 - 17:20 **Room B-2**

PH3: Phosphors for Lighting

Chair: T.-M. Chen, Nat. Chiao Tung Univ., Taiwan
Co-Chair: T. Hisamune, Mitsubishi Chem., Japan

PH3 - 1: 15:50 ***Invited*** **Progress in Developing High-Power InGaN LEDs for Illumination**

K. Bando

Nichia, Japan

High-power LEDs for general lightings are reviewed. Blue chip with high reflection structure is shown to have an excellent performance of 743 mW, EQE 77% at 350 mA. White chip exhibits 181 lm/W. New technology such as phosphor coating on the chip topside and improving CRI by multi-phosphor system are developed.

PH3 - 2
16:20

A Phosphor Sheet Providing Wider Color Gamut for LCDs

Y. Ito, T. Hori, H. Tani, T. Kusunoki, H. Kondo

Dexerials, Japan

A phosphor sheet in which thiogallate green and sulfide red phosphor are contained has been developed. Good color gamut performance of 90% NTSC-xy can be realized by a LCD with that. It has moisture barrier layers on the surface, which can reduce the reaction between these phosphors and moisture.

PH3 - 3
16:40

Improved Display Color Gamut by Using the β-SiAlON Green Phosphor with an Asymmetric Emission Spectrum

K. Yoshimura, K. Takahashi, H. Fukunaga, M. Harada, Y. Tomomura, R.-J. Xie[*]*, N. Hirosaki*[*]*, T. Takeda*[*]

Sharp, Japan
[*]*NIMS, Japan*

The effect of the emission spectrum shape of β-sialon($Si_{6-z}Al_zO_zN_{8-z}$):Eu^{2+} on the characteristics of liquid crystal display with LED backlight is analyzed. The asymmetric spectrum which enhanced in accordance with the decrease of z value is clarified to contribute largely to the improvement of display color gamut.

PH3 - 4
17:00

$Si^{4+}$and Si^{4+}-N^{3-} Incorporation into YAG:Ce^{3+} and Its Verification in Luminous Efficacy and Color Rendering Enhancement of Phosphor-Converted White Light-Emitting Diodes

T.-H. Liu, H.-Y. Kuo, H.-Y. Lin, S.-Y. Chu

Nat. Cheng Kung Univ., Taiwan

This paper demonstrated that the luminous efficacy of the YAG-based white light-emitting diode was improved from 74.3 to 83.7 lm/W with substitution of 0.1 mol Si^{4+} for Al^{3+} while the color rendering index was improved from 67.1 to 79.2 with substitution of 0.2 mol Al^{3+}-O^{2-} by Si^{4+}-N^{3-} under 350 mA.

Author Interviews and Demonstrations
17:30 – 18:30

RECEPTION

Wednesday, December 5, 2012
19:00 – 21:00
Sakura (1F)
Kyoto International Conference Center
See page 12 for details

Workshop on LC Science and Technologies

Tuesday, December 4

14:20 - 17:20 **Event Hall**

***Poster* LCTp1: LC Alignment**

LCTp1 - 1 **Substitute Effect of Fluorine-Containing Polyimides on Photo Alignment Characteristics as an Alignment Layer**

S. Sato, H. Ito, T. Mizunuma, K. Nagai, H. Matsumoto, S. Matsumoto

Meiji Univ., Japan

The substituent effect of fluorine-containing polyimides with 4,4-(hexafluoro-isopropylidene) diphthalic anhydride (6FDA) group on the photo alignment of the liquid crystal (LC) molecule and the effect of 254 nm linearly polarized ultraviolet (LPUV) irradiation on the chemical structure were systematically investigated.

LCTp1 - 2 **Study of the Adsorption of Isopropyl Alcohol Solution on Alignment Film Surface Using Real-Time in situ AFM**

M. Kwak, J. Jeon, S. An, K. Kim, Y. Yi, S. Choi, N. Kim, B. Kim, D. Kang, Y. Choi, S. Jeon

LG Display, Korea

In order to compare isopropyl alcohol (IPA) adsorption process on the surface of alignment film (AF), it was measured in real time inside of a solution using AFM. And, analysis was done with the use of calcite (10-14) face for the dissolving characteristics of liquid crystal (LC) component.

LCTp1 - 3 **Fast Response Time Patterned Vertical Alignment Mode Using Double Step UV Exposure**

D.-H. Kim, Y. Kim, J. H. Lee, Y.-J. Lee, C.-J. Yu, J.-H. Kim

Hanyang Univ., Korea

We propose an advanced patterned vertical alignment (PVA) mode with a fast response time through double ultraviolet (UV) exposure to UV curable reactive mesogen (RM) mixed in alignment layer. Polymerized RM by the double step UV using a photo-mask produces a modified pretilt angle and a high elastic deformation energy.

LCTp1 - 4 **Withdrawn**

LCTp1 - 5 **Alignment of Anisotropic Micro-Structures in LC Director Field**

G. Nakazawa[*], H. Yoshida[,**], K. Tagashira[*], M. Ozaki[*]*

[*]Osaka Univ., Japan
[**]JST PRESTO, Japan

We investigated the alignment of the anisotropic micro-structures fabricated by laser lithography in a uniformly-aligned photopolymerizable nematic liquid crystal. We observed the behavior of structures by a polarization microscope and found that the structures rotated spontaneously until the molecular alignment inside the structure matched to that of the surrounding.

LCTp1 - 6 **The Reverse Domain Issue in High PPI Panel**

S. L. Lee[*], J. H. Lu[,**], X. M. Jiang[*], Y. Q. Lee[*], C. T. Liao[*], Y. W. Chiu[*], T. C. Chung[*], T. S. Jen[*]*

[*]Infovision Optoelect., China
[**]Shanghai Jiao Tong Univ., China

A 3.97-in. WVGA (480 × 800) normally white (NW) TN-LCD panel has been developed. A display issue happened when the image changed from white to black. With the help of simulation tool, the root cause of the defect is reverse domain. Then some methods are proposed to cover this issue.

LCTp1 - 7 **Characterization of LC Alignment with Reactive Mesogen Doped in Polyimide**

C.-C. Hsieh, C.-Y. Chiu, S. Hao, Y. Song, F. Zhao

Shenzhen China Star Optoelect. Tech., China

Surface-controlled vertical alignment is an attractive technology. In our study, we use reactive mesogen mixed in polyimide and adopt UV exposure process to investigate the polymerization and pre-tilt formation of liquid crystal. The mechanism is explained by morphology analysis, and the optics and reliability performance are studied.

LCTp1 - 8 **Decrease The Reverse Domain in TN-LCD by Rubbing Process and PI-LC Matching**

C. Wang, Z. L. Chen, X. M. Jiang, Y. W. Chiu, C. T. Liao, D. C. Chung, A. Tsai, T. S. Jen

Infovision Optoelect., China

Contribution of rubbing process and material matching character to reduce reverse domains in twist nematic liquid crystal display (TN-LCD) have been investigated. Enhancement rubbing strength and selection polyamic acid (PAA) type polyimide (PI) can increase surface anchoring energy. Adjusting LC polymer components and doping new chiral molecule augmented LC elastic energy.

LCTp1 - 9 **Azimuthal LC Anchoring on Stacked Polyimide Layers with Overcoating Screening Layer**

S.-W. Oh, H. J. Lee, K.-I. Joo, M.-K. Park, K. H. Park, J.-H. Lee*, B. K. Kim*, H.-R. Kim*

Kyungpook Nat. Univ., Korea
**LG Display, Korea*

We investigated an azimuthal liquid crystal (LC) anchoring on stacked SiO_2 screening layer, where the underlying polyimide (PI) was rubbed but the stacked SiO_2 layer was not rubbed. As decreasing the thickness of the SiO_2 layer, the azimuthal LC anchoring was increased due to van-der-Waals interaction of the underlying PI.

LCTp1 - 10 **Formation of Alignment Films for N-LC with Controlled Pre-Tilt Angle by Using Novel Electro-Spray Deposition Method**

Y. Kudoh, T. Nakano, Y. Uchida, T. Takahashi

Kogakuin Univ., Japan

The Electro-spray Deposition (ESD) method is known as a film forming method. The ESD technique applied to the pre-tilt control for the LC cell was proposed by our previous report. In this study, some results, which were obtained from further investigation, were reported.

LCTp1 - 11L **Influence of Irradiation Condition on Photoalignment Layer with Polymer Bearing Photoreactive Side Chain**

J. H. Kang, S. Y. Yang, M. I. An, S. Y. Jeong, S. Lee, K. H. Choi, G. J. Shin

Korea Inst. of Ind. Tech., Korea

The retardation of prepared photoalignment films with different polarized UV exposure energy was evaluated for confirming $\lambda/4$ =125 nm at 500 nm. Retardation properties are very much dependent on the UV exposure energy. This result indicated the interchain [2+2] cycloaddition contributes to the enhancement of LC orientation on the photoalignment layer.

LCTp1 - 12L **High Performance Liquid Crystal Photo-Alignement with Polyimide Based Using Polarized UV**

J. Lim, W. Zhao, F. Yang, Y. Ko, H. Jung, J. Park

Chengdu BOE Optoelect. Tech., China

We studied that photo-alignment by photo activity polyimide with polarized UV using 4.46qHD. Through these experiments, we have found that photo-alignment has a lower pretilt angle, lower azimuth angle and higher rubbing density than rubbing process. These results bring to higher CR than traditional rubbing method.

LCTp1 - 13L **Porous PMMA Films Fabricated by Solution Casting for PDLC Type LC Devices**

T. Nose, T. Ito, H. Makka, R. Ito, M. Honma, T. Watanabe, K. Ito*, S. Yanagihara**

Akita Pref. Univ., Japan
**Yurikogyo, 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. However, there are serious shrinkage problem. Here, film fabrication method is investigated to attain extremely thick LC layer by stacking them.

14:20 - 17:20 **Event Hall**

Poster LCTp2: LC Evaluation

LCTp2 - 1 **Evaluation of Azimuthal Anchoring Energy for LC Device with Low and High Pretilt Angles Equipped with Color Filter**

K. Goda, M. Kimura, T. Akahane

Nagaoka Univ. of Tech., Japan

In this study, the azimuthal anchoring energies using the twisted nematic liquid crystal cells with low and high pretilt angles equipped with/without a color filter are evaluated. The result indicates almost the same azimuthal anchoring energy between the TN LC cells equipped with/without a color filter.

LCTp2 - 2 **Comparison of Correlation between Ion Density and VHR on Real TFT-LCD Panels**

M. Kwak, J. Jeon, S. An, K. Kim, Y. Yi, S. Choi, N. Kim, B. Kim, D. Kang, Y. Choi, S. Jeon

LG Display, Korea

Amount of moving ions in panel according to process conditions was measured using LCM-3 device which can measure Ion Density of real TFT-LCD Panel. When Ion Density and VHR were comparatively evaluated, Ion Density and VHR tendency were the same. Correlation of 0.72 showed a close relationship.

LCTp2 - 3 **Morphology Investigation of Spectrum and Temperature Effect on Polymer-Stabilized Alignment**

Y. Song, F. Zhao, S. Hao, H.-C. Lu, C.-C. Hsieh, C.-Y. Chiu

Shenzhen China Star Optoelect. Tech., China

We investigated the properties of liquid-crystal device made by polymer-stabilized method. The alignment uniformity and liquid crystal dynamics is analyzed with surface morphology. The relationship of polymerization process and environmental parameters is unveiled and the effect on LC molecules behavior caused by UV spectrum and temperature is explained.

LCTp2 - 4L **Reduction of Ion Density in Liquid Crystal-Silica Nanoparticle Dispersions by High-Voltage-Pulse Excitation**

S.-W. Liao, C.-T. Hsieh, C.-C. Kuo*, C.-Y. Huang**

Nat. Changhua Univ. of Education, Taiwan

We demonstrate an effective method of reducing ion density in the silica nanoparticle (SN)-doped LC cell by AC high-voltage-pulse excitation. The director distortion in LCs near the substrate creates a lifting force that traps the SNs and ions onto the substrates, markedly decreases ion density of the cell.

LCTp2 - 5L **Effect of Annealing on Rubbed Polyimide Surface Studied by Grazing-Incidence X-Ray Diffraction**

*I. Hirosawa, T. Koganezawa, H. Ishii**

JASRI, Japan
**Nissan Chem. Inds., Japan*

Experiment by grazing-incidence X-ray diffraction proved that ordering of surface polymers of rubbed polyimide film occurred by annealing at rather low temperature 373 K. In-plane orientation of surface polymers also became to be more ordered by annealing.

14:20 - 17:20 **Event Hall**

Poster LCTp3: Display Mode

LCTp3 - 1 **Study on Reducing the Light Leakage in Horizontal Viewing Angle**

B. Hai, C.-T. Kang, Y. Dai

Shenzhen China Star Optoelect. Tech., China

In this article, we study the light leakage appearance on dark state using single compensation film on our PS-VA cell, and we will provide some improvement methods to reduce the light leakage in horizontal viewing angle and make the light leakage near to the vertical viewing angle.

LCTp3 - 2 **High Transmittance with Less the Light Leakage Appearance Use Single Compensation Construction**

C.-T. Kang, B. Hai, X. Ye

Shenzhen China Star Optoelect. Tech., China

In this article, we study how to approach less the light leakage appearance with the construction use single side compensation film on our VA cell both have high transmittance, low module cost design and feasibility for mass production

LCTp3 - 3 **Withdrawn**

LCTp3 - 4 **Improvement of Gray Inversion in Electrically Controlled Birefringence Mode**

S. H. Yu, J. H. Kwon, J. S. Gwag

Yeungnam Univ., Korea

In order to improve low contrast ratio of normally white ECB mode and gray inversion of twist nematic mode, a normally black ECB mode is presented. It is characterized by λ/2 plate and two domain LC structure. Simulated results show the proposed mode can improve drastically the gray inversion.

LCTp3 - 5 **Characteristics on ECB Mode Designed for Phase Modulation Using New LC Materials**

M. Shin, S. Kim, M. Yoon, S. Lee, K. Lim

LG Display, Korea

We analyze response characteristics of new LC materials by using an ECB mode to realize phase-modulated display. 2π phase retardation can be induced from differently blended LC materials. We present current level of LC response speed and suggest the way of blending nematic LC materials in further research.

LCTp3 - 6 **A New Low Power and Wide-Viewing Angle OCB-LCD Compensated with A-Plate and C-Plate**

I. Fukuda, Y. Sakamoto, T. Ishinabe[*], T. Uchida[,**]*

Kanazawa Inst. of Tech., Japan
[*]Tohoku Univ., Japan
[**]Sendai Nat. College of Tech., Japan

A new low power and wide-viewing angle OCB-LCD compensated with A-plate and C-plate was developed to improve the difficulty of the manufacturing of transflective LCD compensated with discotic liquid crystal films. We clarified that wide viewing angle range over 160˚ was achieved by optimizing design parameters of the LCD.

LCTp3 - 7 **Withdrawn**

LCTp3 - 8 **Polarization-Dependence on Light Absorption in Dye-Doped Twisted Nematic LC Mode without Polarizers**

H. J. Lee, S.-W. Oh, M.-K. Park, K.-W. Park, J.-S. Park, H.-R. Kim

Kyungpook Nat. Univ., Korea

We investigate a liquid crystal (LC) mode without polarizers by using dye-doped twisted nematic LC (DDTNLC). As decreasing pitch length of the DDTNLC, the polarization-dependence in light absorption by the doped dyes can be effectively reduced due to mode coupling between the e-mode and the o-mode of an incident light.

LCTp3 - 9 **Polymer Stabilization of Reverse Twisted Nematic LCD with UV Curable LC Monomer**

M. Akimoto, N. Atomi, M. Nishitateno, M. Sannomiya, K. Takatoh, S. Kobayashi

Tokyo Univ. of Sci. Yamaguchi, Japan

To stabilize the unstable configuration of the Reverse Twisted Nematic LCD, we examine the polymer-stabilization method. It is found that the vertically-aligned polymer wall formed only nearby the cell edge stabilizes the RTN configuration successfully, without degrading the LCD performance.

LCTp3 - 10 **Fabrication of Coatable Polarizer Based on Lyotropic Chromonic LC for Flexible Display**

S. Yoon, Y. Jeong, H. Yang, M. Lee

Chonbuk Nat. Univ., Korea

Conventional polarizer has some problems such as the difficulty of durability improvement, the complexity on process and the thick film. For this reason, it is unsuitable for flexible display. Consequently, we need to develop alternative thin film polarizers. The best way to satisfy this objective is the coatable polarizer.

LCTp3 - 11 **Withdrawn**

LCTp3 - 12L **Optimized Materials to Improve Contrast Ratio of Fringe Field Switching Mode LCDs for Moving Applications**

X. Zuo, X. Xiang, Y. Feng, J. Zhang, J. Lim, Y. Ko, H. Jung, J. Park

Chengdu BOE Optoelect. Tech., China

Fringe Field Switching (FFS) mode LCDs is very sensitive to rubbing process, which makes the contrast ratio is not very high. In this paper, we develop optimized polyimide, rubbing cloth, liquid crystal, and color resin; such materials could improve the contrast ratio of FFS mode LCDs for moving applications.

LCTp3 - 13L **Color Shift Analysis for Optically Compensated IPS/ FFS Mode LCDs**

G. Qin, T. Suzuki, K. Kim, Y. Yang, M. Kashima, X. Gu, J. You

Tech. Ctr. BOE Tech. Group, China

A simulation analysis for the color shift in the dark state of the optically compensated IPS/FFS mode LCDs has been performed. The simulation results include a novel compensation scheme with our unique “Switch-Back” concept for depressing the dark state color shift in the diagonal directions.

LCTp3 - 14L **Effect of Photoreaction on Photoalignment of Polymaleimide with Cinnamate Groups**

S. Y. Yang, J. H. Kang, M. I. An, S. Y. Jeong, S. Lee, K. H. Choi, G. J. Shin

Korea Inst. of Ind. Tech., Korea

Different spacer length of polymaleimides containing cinnamate group were prepared and the controllability of LCs alignment with photoalign method were investigated. From DSC and TGA analysis, products were shown to have thermal stability. Pretilt angles of LCs on the exposured surfaces were 0~2˚, depending on the exposure energy and spacer length.

14:20 - 17:20 **Event Hall**

Poster LCTp4: LC Application

LCTp4 - 1 **Hybrid-Aligned Dual-Frequency LC Lenses**

*C.-H. Lin, R.-H. Chiang, C.-H. Chen, I.-M. Jiang, C.-T. Kuo, C.-Y. Huang**

Nat. Sun Yat-Sen Univ., Taiwan
**Nat. Changhua Univ. of Education, Taiwan*

This work proposes a liquid-crystal lens, which can be controlled between a positive lens and a negative lens. Additionally, a dielectric effect occurs between the DFLC and the SR dielectric under the frequency modulation, enabling the LC lens to exhibit a uniform response-time distribution than a conventional LC lens.

LCTp4 - 2 **Resolution and MTF of Imaging System with LC Lens as Focusing Element**

M. Ye, B. Wang, M. Uchida, S. Yanase, S. Takahashi, S. Sato

Akita Ind. Tech. Ctr., Japan

A liquid crystal lens is installed in front of a camera module as a focusing element. Images of an ISO12233 chart are analyzed. The LC lens works well bringing the chart into focus, and no obvious loss in image quality owing to the using of the LC lens is observed.

LCTp4 - 3 **The Applications of ASDDLC for Controlling the Diffraction of Laser Beam**

Y.-H. Huang, S.-W. Ko, A. Y.-G. Fuh

Nat. Cheng Kung Univ., Taiwan

This paper demonstrated the research of axially symmetric dye-doped liquid crystal (ASDDLC). Axially symmetric devices were widely used in symmetric optics, such as converting linear polarized light into axially, azimuthally or vortically light. The novel applications have been presented, such as polarization-independent liquid crystal lens and tunable donut beam.

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LCTp4 - 4L **Thermally Manageable Gratings Based on a Hybrid-Aligned Cholesteric Liquid Crystal**

C. H. Lin, R. H. Chiang, S. H. Liu

Nat. Sun Yat-Sen Univ., Taiwan

This work reports thermally manageable gratings based on a hybrid aligned cholesteric liquid crystal. The experiment reveals that the ordered stripe of the hybrid-aligned cholesteric grating only exists for the d/P ratio between 1.5 and 3. Using the hot stage, we then studied the rotating characteristic of the H-fingerprint grating.

Wednesday, December 5

9:00 - 10:20 **Room D**

LCT1: LC Semiconductors and Display Modes

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

LCT1 - 1: 9:00 ***Invited*** **High Carrier Mobility of np-Phthalocyanine LC Semiconductors**

Y. Miyake[,**], F. Nekelson[*,**], M. Yoneya[*], H. Monobe[*], H. Yoshida[**], A. Fujii[**], M. Ozaki[**], Y. Shimizu[*]*

[*]AIST, Japan
[**]Osaka Univ., Japan

Homologues of non-peripheral (np) -type phthalocyanine liquid crystals were studied on the carrier transport properties. These exhibit an ambipolar carrier transport with the mobility in the order of 10^{-1} cm^2 V^{-1} s^{-1} for the mesophase. Particularly, the hole mobility in the crystal reaches to 1.5 cm^2 V^{-1} s^{-1} at RT.

LCT1 - 2: 9:25 ***Invited*** **Molecular Design and Electronic Functions of Nanostructured LC Semiconductors**

M. Funahashi

Kagawa Univ., Japan

In this paper, we report a molecular design of LC electronic materials based on nanosegregation. Electrochromic LC molecules consisting of a p-conjugated system and a ionic moiety, high hole mobility of LC side chain polysiloxane bearing terthiophene groups, and LC perylene tetracarboxylic bisimide derivatives bearing oligosiloxane chains are discussed.

LCT1 - 3L 9:50 **Relative Luminance Efficiency of NTN-FSC-LCD With and Without Doping Nanoparticles**

S. Kobayashi, T. Miyama, H. Morita, H. Yoshida, Y. Shiraishi, H. Sawai, N. Toshima, M. Okita[*], K. Takeuchi[**], H. Takatsu[**]

Tokyo Univ. of Sci. Yamaguchi, Japan
[*]HDT, Japan
[**]DIC, Japan

We suggest an indicator called "Relative Luminance Efficiency (RLE)" for characterizing power consumption efficiency of FPD in relation to their Luminance. And it is shown that the value of RLE of our FSC-LCD is 4.12. This value may provide a good reference to the Energy Star Program.

LCT1 - 4L 10:05 **Field-Sequential Display Using Electrically Suppressed Helix Ferroelectric Liquid Crystal**

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

Hong Kong Univ. of S&T, Hong Kong

The frame frequency of 240 Hz has been demonstrated for the Field Sequential Color (FSC) based on Electrically Suppressed Helix Ferroelectric (ESHFLC) E-O mode. The proposed display, at the electric field of 3.33 V/μm, is characterized by the high contrast (10000:1), wide viewing angle and large color triangle (130% of NTSC).

----- Break -----

10:50 - 12:10 **Room D**

LCT2: New Functional LC Devices

Chair: Y. Shimizu, AIST, Japan
Co-Chair: T. Yamaguchi, JNC Petrochem., Japan

LCT2 - 1 10:50 **A Fast-Tuning of Bragg Reflection Band in Cholesteric LCs**

Y. Inoue[*], H. Yoshida[,**], H. Kubo[*], M. Ozaki[*]*

[*]Osaka Univ., Japan
[**]JST PRESTO, Japan

We propose a new tuning method of Bragg reflection band with a microsecond response in cholesteric liquid crystals (ChLCs). The ChLC device consisted of an anisotropic polymer matrix possessing helical order embedded with nanosized pores filled with a ChLC. The ChLC composite showed a decay time of 6 μs.

LCT2 - 2
11:10

Relationship Between Refractive Index Distribution and Electrode Structure in the LC Lens for 3D Displays

T. Naganuma, S. Oka, S. Komura

Japan Display East, Japan

Relationship between refractive index distribution and the cell parameters in the liquid crystal lens 3D displays is analyzed by using the liquid crystal alignment simulation. The optimum conditions of a cell gap, an electrode width and a width between electrodes are clarified.

LCT2 - 3
11:30

Index Distribution Analysis of LC Lens with Low Voltage Drive and Simple Structure Design for 3D Display Application

K.-T. Huang, Y.-W. Hong, R.-X. Fang, T.-C. Ou, Y.-T. Chao, C. Lee

HannStar Display, Taiwan

A liquid-crystal-lenticular-lens (LC-lens) with low voltage drive and simple structure design is proposed for auto-stereoscopic 3D display application. The LC-lens design parameter will be analyzed and perfect index distribution can be achieved through simple electrode design with desired electric field across the LC-layer, just likes the effects of GRIN-lens.

LCT2 - 4
11:50

Fast Switchable 2-D Structure Ferroelectric LC Grating

Y. Ma, Q. Guo, A. Srivastava, V. G. Chigrinov, H. S. Kwok

Hong Kong Univ. of S&T, Hong Kong

A method for fabrication of 2D Ferroelectric liquid crystal switchable grating based on photo-alignment technique has been proposed. The first order diffraction efficiency is 68% and response time is 69 μs. Grating can be tuned at the electric field of 1.33 V/μm.

----- Lunch -----

IDW Best Paper Award

IDW Outstanding Poster Paper Award

These awards will go to the most outstanding papers selected from those presented at IDW/AD '12.
The 2012 award winners will be announced on the IDW website: http://www.idw.ne.jp/award.html

14:00 - 15:25 **Room D**

LCT3: Blue Phase

Chair: M. Funahashi, Kagawa Univ., Japan
Co-Chair: M. Ozaki, Osaka Univ., Japan

LCT3 - 1: 14:00 ***Invited*** **Progress of Blue-Phase LC Applications**

D. Kubota, T. Ishitani, A. Yamashita, T. Nishi, K. Okazaki, M. Katayama*, H. Shishido, H. Miyake, J.Koyama, Y. Hirakata, S. Yamazaki*

Semiconductor Energy Lab., Japan
**Advanced Film Device, Japan*

To apply blue-phase liquid crystals to displays, we have widely studied materials and the like and achieved a saturation voltage of 23 V and a contrast ratio of 1000:1. Further, we have improved the yield and shortened the process time using blue-phase liquid crystals having a non-platelet-like texture and unclear boundary.

LCT3 - 2 14:25 **Polymer-Network Blue Phase Device: Effects of Monomers**

C.-S. Chen, Y.-C. Hsieh, C.-K. Wu, K.- H. Chou, H.-Y. Chen

Feng Chia Univ., Taiwan

Influences of the structures of the polymer-network in blue phase on the thermal stability and the electro-optical response are studied. Surface morphology of the polymer network is record by SEM. Thermal stability of polymer-network blue phases is not affected by structure of the polymer network, but the electro-optical response is.

LCT3 - 3 14:45 **Relationship Between the Temperature Range and the Storage Modulus in Polymer-Stabilized Blue Phase**

M. Oiwa, S. Takeda, S. Komura*

Japan Display East, Japan
**Hitachi, Japan*

We present the relationship of temperature range and the storage modulus as factors of rigidity in polymer-stabilized blue phase (PSBP). The temperature range enlarges due to the increase in the storage modulus of PSBP regardless of the reactive monomer material or process conditions.

LCT3 - 4
15:05 **Unusual Electro-Optical Behavior of Wide-Temperature Blue Phase II Device**

N.-A. Chang, C.-H. Tseng, H.-Y. Chen
Feng Chia Univ., Taiwan

An electro-optical response of a wide-temperature blue phase II cell is demonstrated in this study. From the reflection spectra of the cell, the temperature range of BPII is about 6˚C. After applying an in-plan field, from the reflected spectrum, two phenomena are seen: wavelength shift and wider reflection band.

----- Break -----

15:50 - 17:10 **Room D**

LCT4: Wide Viewing Angle and Fast Switching

Chair: T. Ishinabe, Tohoku Univ., Japan
Co-Chair: M. Inoue, Apple, Japan

LCT4 - 1
15:50 **Room-Temperature Optical-Isotropic LCD without Polymer Network**

S.-F. Lu, Y.-C. Hsieh, H.-Y. Chen
Feng Chia Univ., Taiwan

Electrooptical characteristics of an optical-isotropic liquid crystal were demonstrated. Light transmission and responses at field is measured and contrast ratio, hysteresis phenomenon and residual birefringence is discussed. Responses do not vary with changing the electric field and do not depend on the temperature, and residual birefringence is not observed here.

LCT4 - 2
16:10 **Novel Pixel Structure in IPS-LCD to Improve Transmittance Using Wall Electrodes**

T. Hiratsuka, O. Itou, D. Sonoda, T. Ishigaki, S. Komura
Japan Display East, Japan

We propose a novel pixel structure in an in-plane switching (IPS) liquid crystal display (LCD) using wall electrodes whose height is equivalent to the liquid crystal (LC) layer. Based on simulations and experiments, we have achieved higher transmittance than conventional IPS-LCDs, using wall electrodes and pseudo wall electrodes.

LCT4 - 3
16:30 **Optimized Pixel Design and LC for Better Process Margin and Increasing Transmittance in FFS Technology**

W.-H. Chang, H.-W. Cheng, S.-C. F. Jiang, J.-J. Su
AU Optronics, Taiwan

In present paper, overcoming the inevitable process deviation and increasing the transmittance for FFS mode are investigated. We redesign a pixel electrode to minimize the optical deviation. Besides, the LC characteristics were also chosen for maximizing LC optical efficiency. In our result, the transmittance deviation issues are reduced.

LCT4 - 4
16:50

Fast LCD Modes

L. Komitov, G. Hegde[*]

Univ. of Gothenburg, Sweden
[*]Univ. of Malaysia, Malaysia

A sub-millisecond liquid crystal device driven by a fringe electric field is presented. Surface localized polymer network is created in the device in order to reduce the fall time. Double cell device with both rise and fall times controlled by the applied field is also presented.

Author Interviews and Demonstrations
17:30 – 18:30

Friday, December 7

10:50 - 12:15 **Room D**

LCT5: Emerging Display Mode

Chair: T. Koda, Yamagata Univ., Japan
Co-Chair: T. Nose, Akita Pref. Univ., Japan

LCT5 - 1:
10:50

Invited **Towards Guest-Host Displays Composed of LC Dispersions of Plasmonic Metal Nanoparticles**

Q. Liu[,**], M. Campbell[**], S. He[*], I. I. Smalyukh[**,***]*

[*]Zhejiang Univ., China
[**]Univ. of Colorado, USA
[***]RASEI, Univ. of Colorado & NREL, USA

We demonstrate the bulk self-alignment of dispersed gold nanorods in liquid crystals. This results in a switchable polarization-sensitive plasmon resonance exhibiting stark differences from that of the same nanorods in isotropic fluids. The devise-scale alignment and switching may enable plasmonic polarizers and guest-host displays that utilize nanoparticles instead of dyes.

LCT5 - 2
11:15

Transparent LC Panel by Dye Doped Liquid Crystal (DDLC) Gel

C.-S. Hsieh, J.-T. Lien, S.-M. Fu

Chunghwa Picture Tubes, Taiwan

In this paper, a polarizer-free dye doped liquid crystal gels in transmission mode are proposed. It has potential in transparent display. We demonstrate the low driving voltage ~8 V, good contrast ratio ~28:1 and fast response time ~9.8 ms in PDLC cell. Besides, the contrast ratio of DDLC gel is 13 with response time 20.6 ms.

LCT5 - 3 **A New Polymer Dispersed LC Applied in Active-Matrix TFT Transparent Display**
11:35

C.-W. Su, J.-T. Lien

Chunghwa Picture Tubes, Taiwan

We have developed a 10.1-in. transparent display based on new polymer dispersed liquid crystal. It has low driving voltage and it is satisfied with active-matrix TFT display. Besides, it applied in transparent display advantages polarizer free, backlight free, and the fabrication process don't need polyimide coating and rubbing.

LCT5 - 4 **Scattering Mode LC Light Shutter Based on Double-Side Poly(N-Vinyl Carbazole) Films**
11:55

K.-T. Cheng, Y.-D. Chen, A. Y.-G. Fuh

Nat. Cheng Kung Univ., Taiwan

The nematic LC device, fabricated by two substrates coated with uniform PVK films, is heated and then cooled, generating the rough PVK layers onto the surfaces of the substrates. The device having rough PVK layers, with high electro-optical performances, produces micron-sized, multiple domains of disordered LCs, and scatters light.

----- Lunch -----

14:00 - 15:15 **Room D**

LCT6: Photo Alignment

Chair: S. Ishihara, Osaka Inst. of Tech., Japan
Co-Chair: I. Hirosawa, JASRI, Japan

LCT6 - 1 **The World' s First Photo-Aligned IPS-LCDs for a TV Use**
14:00

H. Matsukawa, Y. Shimano, M. Suefuji, Y.Umeda, K. Mimura

Panasonic Liquid Crystal Display, Japan

We applied the photo alignment technology to the IPS mode LCD-TVs and launched them for the first time in the world. Here, we have investigated the relationship between UV irradiation conditions and alignment property of liquid crystal molecules and excellent black image quality and wide viewing angle characteristics were realized.

LCT6 - 2 **Withdrawn**

LCT6 - 4L 14:20 **Recent Developments in Photoalignment Technology: Alignment Properties of a Thiophene Based Bis-Hydrazone Derivative**

G. Hegde, S. Abhishek[*], A. V. Adhikari[**], K. Vishnumurthy[**], M. M. Yusoff, V. G. Chigrinov[*], H. S. Kwok[*]

Univ. Malaysia Pahang, Malaysia
[*]Hong Kong Univ. of S&T, Hong Kong
[**]Nat. Inst. of Tech. Karnataka, India

Liquid crystal photoalignment on bis-hydrazones derived from thiophene derivatives is reviewed. Proposed material shows excellent alignment properties which is highly promisable for future applications. This photoalignment is based on reorientation phenomena attributed to thiophenes.

LCT6 - 3 14:40 **The New Analysis Method of Photo-Alignment Layers via Reflection Spectrometry**

C. Huang, T.-C. Lin, M.-D. Lai, Y.-L. Chen

Chunghwa Picture Tubes, Taiwan

Photo-alignment is an advanced aligning technique for LCD, but the analysis for its coating layer is not easy to do due to no obvious physical change on the surface. We develop a new reflection spectrometer for analyzing the optical axis orientation of the photo-alignment layer and its degree of photo-aligning.

LCT6 - 5L 15:00 **Electro-Optical Properties in Polymer Stabilized Reverse Mode LCD**

R. Yamaguchi, K. Goto, X.-J. Chang

Akita Univ., Japan

A polymer stabilizing effect has been investigated in reverse mode liquid crystal cells containing a reactive mesogen (RM). When a voltage was applied during polymerization of RM, a reverse mode driving voltage reduced. Moreover, a normal mode electro-optical property can be obtained by polymerizing with high voltage application.

----- Break -----

RECEPTION

Wednesday, December 5, 2012
19:00 – 21:00
Sakura (1F)
Kyoto International Conference Center
See page 12 for details

15:50 - 17:10 **Room D**

LCT7: LC Alignment Technology

Chair: I. Smalyukh, Univ. of Colorado, USA
Co-Chair: S. Shibahara, Sony, Japan

LCT7 - 1: 15:50 ***Invited*** **Polyimide-Less Alignment by Dendrimers Dissolved in LC**

T. Sakuma, N. Funakoshi, Y. Takahashi, M. Uchida, T. Koda, O. Haba, K. Yonetake, M. Kwak, Y. Momoi*, J. Jeon*, S. An*, D. Choi*, D. Kang*, Y. Choi*, S. Jeon**

Yamagata Univ., Japan
**LG Display, Korea*

We use dendrimers in combination with liquid crystal display as surfactant agent to induce homeotropic alignment modify. This is done without special technique, but we should only mix small amount of dendrimers to conventional liquid crystals. We call this alignment technique liquid crystal dendrimer alignment (LCDA).

LCT7 - 2 16:15 **Study of Polymer Bumps Formation and Influence in PS-VA LCD**

X. Zhong, H. J. Huang, X. Ma, C.-S. Li, W. Yu, S.-W. Yeh, K.-C. Lee

Shenzhen China Star Optoelect. Tech., China

Two different reactive mesogens (RMs) were introduced into polymer-stabilized vertical alignment LCD. It is found that the sizes and uniformity of polymer bumps formed by photo-polymerization are strongly dependent on the initial RMs composition in LC mixture. This provides us an effective way to control the optical performance of PS-VA LCD.

LCT7 - 3 16:35 **Study of LC Ripple Caused by Tactile Force Acting on Display**

Y. J. Lee, T. S. Liu, M.-H. Lin, K.-F. Huang**

Nat. Chiao Tung Univ., Taiwan
**Chimei-Innolux, Taiwan*

Liquid crystal display (LCD) panels subjected to tactile force will show ripple propagation on screens. The Ericksen-Leslie theory is used to investigate ripple propagation that results from liquid crystal molecule tilt. Tactile-force effects are taken into account to derive the molecule equation of motion for liquid crystals.

LCT7 - 4L 16:55 **Optimal Method to Improve Pressure Resistant Characteristic for 2-Domain Fringe-Field-Switching Display**

N. Jiang, F. Yang, J. Lim, J. Zhang, Z. Chen, Y. Feng

Chengdu BOE Optoelect. Tech., China

In this paper, we improved pressure resistant characteristic of 2-domain FFS by optimizing 2nd ITO structure and controlling process. Larger middle corner length and corner angle of 2nd ITO can improve pressure resistant characteristic of 2-domain FFS, and the distance of 1st ITO edge to 2nd ITO is also important.

Author Interviews and Demonstrations
17:30 – 18:30

Supporting Organization:
The Japanese Liquid Crystal Society (JLCS)

Workshop on Active Matrix Displays

Tuesday, December 4

14:20 - 15:45 **Room A**

AMD1: Organic & Carbon TFT

Chair: M. Kimura, Ryukoku Univ., Japan
Co-Chair: Y. Fujisaki, NHK, Japan

AMD1 - 1: 14:20 ***Invited*** **Inkjet Printing of Single Crystal Films for Organic TFTs**

H. Minemawari, Y. Noda, T. Yamada, T. Hasegawa

AIST, Japan

We developed "double-shot inkjet printing" that combines the technique of antisolvent crystallization with the microfluidic inkjet printing processes. We found that the sequential deposition of an antisolvent and a semiconductor solution can trigger the controlled formation of exceptionally uniform thin films, yielding organic thin-film transistors with high carrier mobilities.

AMD1 - 2: 14:45 ***Invited*** **New Generation of Flexible GHz Graphene Transistor**

H. Happy[*], C. Sire, F. Ardiaca, S. Lepilliet[*], J.-W. T. Seo[**], M. C. Hersam[**], G. Dambrine[*], V. Derycke

IRAMIS, France
[*]IEMN, France
[**]Northwestern Univ., USA

Flexible electronics mostly relies on organic semiconductors. But the limited carrier velocity in molecular films prevents their use at frequencies above a few megahertz. In this work, we conducted the first study of solution-based graphene transistors, with current gain cutoff frequencies of 2.2 GHz.

AMD1 - 3 15:10 **Quantitative Extraction of Contact Resistance at Organic Semiconductor − Metal Electrode Interface and Impact of Treatment on the Contact Resistance**

K. Sasai, Y. Okumoto, A. Miyamoto, K. Morita, Y. Fujisaki[*], T. Yamamoto[*]

Panasonic, Japan
[*]NHK, Japan

Contact resistance at the organic semiconductor (OSC) – metal electrode interface has been successfully estimated by transmission line method and AFM potentiometry. We have found that contact resistance of source edge was drastically reduced by surface treatment of UV/ozone or thiol self-assembled monolayer (SAM) before OSC fabrication at the first time.

AMD1 - 4L 15:30 **Integrated Potentiostat Using TFTs with Electrochemical Cell - Optimization of Detection Parameters -**

Y. Sagawa, K. Setsu, Y. Ito, Y. Ono, M. Kimura

Ryukoku Univ., Japan

We have developed an integrated potentiostat using TFTs with an electrochemical cell and optimized detection parameters. The waiting time is optimized to 2 min, and the sweep speed is optimized to 0.2 mV/s. Using these detection parameters, it was confirmed that the integrated potentiostat can detect a glucose concentration as low as 2 mM.

----- Break -----

16:15 - 17:35 **Room A**

FLX1/AMD2: Flexible Active Matrix Devices

Chair: H. Maeda, DNP, Japan
Co-Chair: H. Happy, IEMN, France

FLX1/ AMD2 - 1: 16:15 ***Invited*** **Transfer Printing Nanowire Electronic Devices on Non-Si Substrates**

C. H. Lee, X. Zheng

Stanford Univ., USA

I will discuss various transfer printing methods that can fabricate electronic devices onto diverse nonconventional substrates, such as paper, plastics, tapes, glasses, polydimethylsiloxane, Al foils, and polymer substrates. These flexible, transparent, ultrathin, or biocompatible devices will impact many technologies, such as flexible displays, solar cells, and biosensors.

FLX1/ AMD2 - 2 16:40 **Solution-Processed and Low-Temperature ZnO-Based N-Channel TFTs on Polyethylene Naphthalate Foil, Suited for Hybrid Complementary Circuitry**

M. Rockelé[,**], M. Nag[*,**], T. H. Ke[*], S. Botnaraş[***], D. Weber[***], D.-V. Pham[***], J. Steiger[***], S. Steudel[*], K. Myny[*,**], S. Schols[*], B. van der Putten[****], J. Genoe[*], P. Heremans[*]*

[*]imec, Belgium
[**]Katholieke Univ. Leuven, Belgium
[***]Evonik Inds., Germany
[****]Holst Ctr., the Netherlands

State-of-the-art solution-processed ZnO-based n-TFTs (μ_{sat}~ 0.6-1.1 cm²/Vs and I_{on}/I_{off}~10^7) at 160°C are realized on polyethylene naphthalate (PEN) foil, demonstrating promising uniformity and bias-stress results (ΔV_{th}~0.8 V after 10^4 s). The threshold voltage of 3 V makes the technology favorable for hybrid complementary line-drive circuitry at the borders of flexible AMOLED displays.

FLX1/ AMD2 - 3 17:00 **Formation of Polycrystalline Silicon Films on Plastic Films by Underwater Laser Annealing at Super Low-Temperature**

E. Machida[*], M. Horita[,**], Y. Ishikawa[*,**], Y. Uraoka[*,**], T. Okuyama[***], H. Ikenoue[****]*

[*]Nara Inst. of S&T, Japan
[**]JST, Japan
[***]TOYOBO, Japan
[****]Kyushu Univ., Japan

We succeeded in the super low-temperature crystallization to high-quality poly-Si films on plastic substrates by underwater laser annealing (WLA). WLA enhances the energy margin twice as high as that in laser annealing in air (LA). Moreover, the crystallinity of WLA poly-Si was much better than that of LA poly-Si.

FLX1/ AMD2 - 4L 17:20 **Solution-Processed Organic Thin-Film Transistors on a Very Thin Transparent Paper Substrate**

Y. Fujisaki, H. Koga[*], Y. Nakajima, M. Nakata, H. Tsuji, M. Nogi[*], T. Yamamoto

NHK, Japan
[*]Osaka Univ, Japan

We fabricated solution-processed organic thin-film transistors (TFTs) on a transparent paper. A 20-nm thick cellulose nanofibers film was used as the novel flexible substrate. The TFT showed the mobility up to 1 cm^2/Vs. These results showed possibility toward the realization of paper electronics & display with low-cost and low environmental burden.

Author Interviews and Demonstrations
17:50 – 18:50

Wednesday, December 5

9:00 - 10:30 **Room A**

AMD3: Oxide TFT: Materials & Devices
Special Topics of Interest on Oxide TFT

Chair: H. J. Kim, Yonsei Univ., Korea
Co-Chair: N. Morosawa, Sony, Japan

AMD3 - 1: 9:00 ***Invited*** **Present Status, Knowledge and Issues of Oxide Semiconductor Technology**

T. Kamiya, K. Nomura, H. Hosono

Tokyo Inst. of Tech., Japan

Oxide semiconductors have been studied very intensively from late ’90, and the first commercial product of oxide TFT appeared in this March. This paper reviews the present status and new applications of oxide semiconductors with main focus on amorphous oxide semiconductor. Then, we will discuss clarified knowledges and remaining issues.

AMD3 - 2 9:25 **High Performance AOS-Based Offset TFTs for Kickback Voltage Reduction**

M. Mativenga, D. H. Kang, Y. S. Ahn, J. Jang

Kyung Hee Univ., Korea

This paper shows that amorphous-oxide-semiconductor (AOS)-based thin-film transistors (TFTs) with drain- and/or source-offsets perform much better compared to Si-based offset TFTs in literature. Attributes of AOS-based offset TFTs include improved stability, high on-currents, independence of threshold-voltage from offset-length, and possibility for kickback-voltage reduction in active-matrix display applications.

AMD3 - 3 9:45 **Effects of Multi-Gates on Performance and Stability of Self-Aligned Coplanar a-IGZO TFTs**

J. U. Han, D. H. Kang, J. Jang

Kyung Hee Univ., Korea

We studied the effects of multiple gates on the performance and stability of a-IGZO TFTs. The subthreshold region of transfer characteristics shift to negative gate voltage direction with increasing gate number, and the threshold voltage shift induced by positive gate bias stress decreases with increasing gate number.

AMD3 - 4: 10:05 ***Invited*** **High Mobility Zinc Oxynitride (ZnON) Based Thin-Film Transistors (TFTs) for Display Applications**

J. S. Park, H.-S. Kim, T. S. Kim, K. S. Son, J.-B. Seon, S.-J. Seo, S.-J. Kim, M. Ryu, S. Lee

Samsung Advanced Inst. of Tech., Korea

The fabrication of thin-film transistor devices incorporating active semiconductors based on zinc oxynitride (ZnON) compounds is presented. Devices with field effect mobility values exceeding 50 cm^2/Vs are routinely achieved, which makes them suitable as switching or driving elements in next generation flat panel displays.

----- Break -----

10:50 - 12:20 **Room A**

AMD4: Oxide TFT: Applications
Special Topics of Interest on Oxide TFT

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

AMD4 - 1: 10:50 ***Invited*** **Ultra Definition 240 Hz 55-in. LCD TV Driven by 1G1D with Oxide Semiconductor TFTs & Copper Signal Lines**

N. Gong, C. Park, J. Lee, I. Jeong, H. Han, J. Hwang, J. Park, U. Chung, K. Park, H. Jeong, Y. Ha, W. Shin, S. Yeo

LG Display, Korea

We have implemented a 240 Hz 55-in. ultra definition (UD, or 3840x2160) resolution TV panel using amorphous IGZO TFT. Among various data driving architectures, the data single 1G1D driving renders cost benefit, process competitiveness and design flexibility. So we suggest a-IGZO TFT and copper metallization technology as a solution.

AMD4 - 2: 11:15 ***Invited*** **Ultra High-Definition Amorphous-IGZO Liquid-Crystal Display**

B.-L. Yeh, C.-N. Lin, H.-K. Tseng, I.-P. Chien, C.-C. Wu, C. H. Huang, C.-M. Chang, W.-C. Tsai, C.-H. Chen

AU Optronics, Taiwan

ES type IGZO TFT with different IGZO back channel treatment was studied to improve TFT stability. A modified ES process flow was developed to improve IV uniformity. Ultra-high definition 3840x2160 65-in. liquid-crystal display with IGZO TFT was also fabricated and PNBTS < I3I V; Vth U% < 2 V was achieved.

AMD4 - 3: 11:40 ***Invited*** **Amorphous Oxide Semiconductor Thin Film Transistor for Novel Device Applications**

S. Jeon[*,**]*, I. Song*[*,**]*, S.-E. Ahn*[*,**]*, C. I. Kim*[*,**]*, U.-I. Chung*[*,**]

[*]*Samsung Advanced Inst. of Tech., Korea*
[**]*Samsung Elect., Korea*

Among various semiconductor devices, electronically active oxide thin film transistors (TFTs) have received considerable attention for a wide range of device applications. In this presentation, we review various device applications utilizing amorphous oxide semiconductor TFT, which include photo-sensor, image sensor and other device applications.

AMD4 - 4L 12:05 **Novel Fabrication Method for Self-Aligned Bottom-Gate Oxide TFTs**

M. Nakata, H. Tsuji, Y. Fujisaki, H. Sato, Y. Nakajima, T. Takei, T. Yamamoto

NHK, Japan

We have developed a novel fabrication method using excimer laser irradiation for self-aligned bottom-gate oxide thin-film transistors (TFTs). Irradiation from the back-side of the substrate using the gate electrode as a mask reduces resistance in InGaZnO (IGZO) films sufficiently for their application as source/drain regions in bottom-gate IGZO-TFTs.

----- Lunch -----

14:00 - 15:25 **Room A**

AMD5: Oxide TFT: Solution Process
Special Topics of Interest on Oxide TFT

Chair: J. S. Park, Samsung Advanced Inst. of Tech., Korea
Co-Chair: H. Hamada, Panasonic, Japan

AMD5 - 1: 14:00 ***Invited*** **New Approaches for High Performance and Multi-Functional Solution-Processed Oxide TFT Technologies**

H. J. Kim

Yonsei Univ., Korea

In this study, new approaches for high performance and multi-functional solution-processed amorphous oxide semiconductor (SAOS) thin-film transistors (TFTs) are presented: a multi-stacked active layer structure for highly stable SAOS TFT, a self-patternable SAOS TFT (both active layer and source/drain electrodes), and DNA detection using SAOS TFT.

AMD5 - 2 14:25 **Solution-Processed Amorphous In_2O_3-Based TFT Performance Depending on the Semiconductor Film Morphology**

S. Botnaraş[,**], D. Weber[*], D.-V. Pham[*], J. Steiger[*], R. Schmechel[**]*

[*]Evonik Inds., Germany
[**]Duisburg-Essen Univ., Germany

The morphology of solution-processed amorphous In_2O_3-based thin films annealed at 350˚C was investigated. The semiconductor solutions were provided by Evonik Industries AG. By increasing the smoothness of the semiconductor thin film it is possible to improve the fabricated TFTs, achieving mobilities above 15 cm²/Vs and higher gate bias stress stability.

AMD5 - 3 14:45 **Effects of Zr Doping on the Performance of Solution-Processed InZnO Thin-Film Transistors**

S.-Y. Liu, B.-Y. Su, P.-C. Kao[*], S.-Y. Chu

Nat. Cheng Kung Univ., Taiwan
[*]Nat. Chiayi Univ., Taiwan

Thin-film transistors with zirconium doping on the indium-zinc oxide as active layer by the solution-processed deposition method were fabricated and their TFT characteristics were examined. The solution-processed ZrInZnO films show high transmittance over 90% in the visible region and good electrical characteristic of I_{on} / I_{off} ratio current over 10^5.

AMD5 - 4
15:05

Effects of Solution-Processed Al_2O_3 Gate Insulator Thickness on IGZO TFTs

S.-M. Song, J.-S. Lee, D.-W. Kang, J.-Y. Kwon, M.-K. Han*

Seoul Nat. Univ., Korea
**Yonsei Univ., Korea*

We fabricated IGZO TFTs employing solution-processed Al_2O_3 gate insulator with various thicknesses. Leakage current density of Al_2O_3 films decreased exponentially and dielectric constant decreased with increasing insulator thickness. When the insulator thickness was 230 nm, the TFT showed 9.00 cm^2/Vs of saturation mobility and 3.4 V of the threshold voltage.

----- Break -----

15:50 - 17:20 **Room E**

INP3/AMD6: Touch Panel (2)

Chair: T. Nakamura, Japan Display Central, Japan
Co-Chair: H. Katoh, Sharp, Japan

INP3/
AMD6 - 1:
15:50

Invited **Newly Developed In-Cell Capacitive Touch Panel Technology in a Wide Viewing Angle IPS-Mode Display**

K. Noguchi, Y. Kida, K. Ishizaki, K. Azumi, H. Mizuhasi

Japan Display West, Japan

This paper is a presentation of a 4.0-in. qHD (960×540) IPS-mode LTPS display with a newly developed In-cell mutual capacitive touch technology. The panel has higher touch scanning speed of 120 Hz and newly developed touch scanning circuit for narrow dead band on a LCD glass.

INP3/
AMD6 - 2
16:15

A Novel Design of Capacitive In-Cell Touch Sensor Circuit Using a-Si TFT

C.-T. Hsieh, S.-K. Hsu

Chimei-Innolux, Taiwan

This paper proposes an In-cell touch sensor circuit with the threshold voltage compensated method for active matrix displays by using the a-Si TFT. According to the simulation results, the novel touch sensor circuit is effectively against the variation of threshold voltage and improved the reliability of in-cell touch sensor circuit.

INP3/ AMD6 - 3: 16:35 ***Invited*** **In-Cell Projected Capacitive Touch Panel Technology**

Y. Sugita, K. Kida, S. Yamagishi

Sharp, Japan

We describe an In-Cell Projected Capacitive Touch Panel in a display using IGZO TFT technology. The prototype demonstrates high signal-to-noise ratio (SNR) and pen input operation. The possibility of enlarging the display size beyond current limits makes this a highly promising approach for In-Cell Capacitive touch panels.

INP3/ AMD6 - 4 17:00 **Active Photo-Sensing Array of Thin Film Transistor with Threshold Voltage Compensation**

L.-S. Chou, H. M. Chen, B.-C. Chen, J.-Y. Zhang, Y.-H. Tai, I. Chan[*]*, M.-H. Yeh*[*]

Nat. Chiao Tung Univ., Taiwan

[*]*ITRI, Taiwan*

In this paper, an active photo-sensing amplifier pixel circuit with compensation function of device variation is proposed, which has high aperture ratio since only 3 TFTs are used. The compensation function of the circuit obviously improves the sensing error resulted from device variation from 80% to 6%.

Author Interviews and Demonstrations
17:30 – 18:30

Thursday, December 6

9:20 - 12:20 **Event Hall**

Poster **AMDp1: Oxide TFT**
Special Topics of Interest on Oxide TFT

AMDp1 - 1 **Withdrawn**

AMDp1 - 2 **A Study of Degradation Mechanism about Bias-Temperature-Illumination Instability in a-IGZO TFTs**

H. Choi, D. Y. Park, J. W. Baek, S. J. Yu, S. H. Jeon

LG Display, Korea

We have investigated the degradation mechanism of threshold voltage shift(ΔVth) of a-IGZO TFTs induced by bias-temperature-illumination stress. Under positive bias stress, charge trapping induced temperature is progressively the dominant mechanism. The ΔVth by negative bias stress is dependent on the thermal-induced / photo-generated hole trapping caused by temperature and illumination.

AMDp1 - 3 **The Effect of Annealing Temperature in Solution-Processed In-Ga-O Thin-Film Transistors**

D. H. Yoon, H. S. Lim, S. J. Kim, J. Jung, H. J. Kim

Yonsei Univ., Korea

As the annealing temperature increased from 200 to 300˚C, the In-Ga-O (IGO) thin-film transistors (TFTs) showed enhanced performances for switching devices. The annealing temperature above 350˚C caused the IGO TFT excessively conductive, and it was attributed to the crystallization of IGO thin-film.

AMDp1 - 4 **Investigation on Effects of Composition on Transparent Aluminum Zinc Tin Oxide Thin-Film Transistors**

C.-S. Fuh, L.-F. Teng, Y.-S. Fan, C.-H. Chang, P.-T. Liu

Nat. Chiao Tung Univ., Taiwan

We investigated on electrical performance of amorphous Al-Zn-Sn-O thin film transistor (AZTO TFT). The mobility enhanced while the concentration of Sn increased. The improved stability can be attributed to the increase of Sn concentration and enhancement of bonding energy of metal ion with the increase of O_2 gas flow rate.

AMDp1 - 5 **High Performance Inverter with a-IGZO-Based Resistor Load and Self-Aligned Coplanar a-IGZO Driving TFT**

D. Geng, D. H. Kang, M. J. Seok, M. Mativenga, J. Jang

Kyung Hee Univ., Korea

We demonstrate an inverter implemented with a coplanar amorphous-indium-gallium-zinc-oxide (a-IGZO) driving thin-film transistor (TFT) and an a-IGZO-based resistor load. The inverter has larger voltage gain and wider swing range compared to inverters employing enhancement mode TFTs as load, making it applicable to high speed logic gates and other simple circuits.

AMDp1 - 6 **New IGZO-Based Oxide Semiconducting Material for Back Channel Etch Type Thin Film Transistor**

*S. Morita, K. Hirose, A. Hino, H. Goto, T. Kugimiya, E. Kusumoto**

Kobe Steel, Japan
**Kobelco Res. Inst., Japan*

We have developed a new IGZO-based oxide semiconducting material for back channel etch (BCE) type thin film transistor. It is demonstrated that the TFTs using the new oxide semiconducting material with high chemical stability for conventional etchant possesses better performance compared with that of conventional IGZO TFT with BCE structures.

AMDp1 - 7 **Analysis of Electronic-Structural Change in a-InGaZnO by High Pressure Water Vapor Annealing**

Y. Ueoka, N. Maejima, H. Matsui, F. Matsui, M. Morita, S. Kitagawa, M. Fujita, K. Yasuda, H. Yamazaki, S. Urakawa, M. Horita, Y. Ishikawa, H. Daimon, Y. Uraoka

Nara Inst. of S&T, Japan

The effect of high pressure vapor annealing (HPV) for a-IGZO was investigated by angle-resolved XPS. We found that In HPV enable to oxidize In atoms and reduce Ga atoms. It is considered that high channel mobility and stability attribute these reactions.

AMDp1 - 8 **The Comparison of Lithium Doping Impact to Solution-Processed ZnO/InZnO Thin Film Transistors Characteristics**

Y. W. Wang, P. H. Fang, A. C. Cheng, W. C. Su, P. R. Lin

Nat. Changhua Univ. of Education, Taiwan

We report the impact of lithium doping to ZnO/InZnO thin film transistors' electrical and optical characteristics. A best device with mobility ~0.94 cm^2/Vs, and an on/off current ratio over 10^6 were achieved. Further, the high ionization energy of lithium (5.39 eV) led the transistor stabilizer than which without lithium doping.

AMDp1 - 9L **A Method to Increase the Reflectivity of Transflective LCDs**

S. Huo, W. Jiang

Shanghai Tianma Micro-Elect., China

We have provided a new transflective liquid crystal displays which has a novel structure to broaden the reflective area in one pixel. By making the reflector cover the interval area between the adjacent pixels, almost all of the pixel area is effective display part. So the reflectance is improved largely.

AMDp1 - 10L **Oxide TFT Wired MUX Circuit for Dual Mode Shift Register**

E.-J. Song, H. Nam

Kyung Hee Univ., Korea

This paper demonstrates a wired MUX circuit for an oxide TFT dual mode shift register which supports two scanning pulses of different timings and pulse widths at one gate line. This integrated MUX guarantees the rail-to-rail output voltage over the threshold voltage variation from –4 V to 5 V.

AMDp1 - 11L **Electrical Degradation Behavior of a-InGaZnO Thin-Film Transistors with Sm_2O_3 Gate Dielectrics**

F.-H. Chen, J.-H. Liu, S. Mondal, B.-L. Wu, T.-M. Pan

Chang Gung Univ., Taiwan

We investigate the electrical degradation behavior in amorphous-InGaZnO (a-IGZO) thin-film transistors (TFTs) with Sm_2O_3 gate dielectrics. The negative shift of threshold voltage in Sm_2O_3 a-IGZO TFTs can be attributed to the generation of extra electrons from oxygen vacancies in the a-IGZO channel.

9:20 - 12:20 **Event Hall**

Poster AMDp2: Active-Matrix Devices

AMDp2 - 1 **Device Performance of Benzothienobenzothiophene-Based Top-Gate Organic Field-Effect Transistors with Embedded Electrodes**

*Y. Kimura, F. Mochizuki, T. Nagase, T. Kobayashi, K. Takimiya[*], M. Ikeda[**,***], H. Naito*

Osaka Pref. Univ., Japan
[*]Hiroshima Univ., Japan
[**]Nippon Kayaku, Japan
[***]Kyushu Univ., Japan

We have fabricated 2,7-dioctyl[1]benzothieno [3,2-b][1]benzothiophene (C_8-BTBT)-based top- gate organic FETs with embedded source-drain electrodes and investigated the effect of the planarization of C_8-BTBT layers. Top-gate C_8-BTBT FETs with embedded electrodes show better electrical performance and smaller device-to-device variation in characteristics as compared to top-gate FETs with a conventional electrode configuration.

AMDp2 - 2 **Charge Transport in S olution-Processed Top-Gate Organic Thin-Film Transistors with Different Gate Insulators**

K. Takagi[,**], T. Nagase[*,**], T. Kobayashi[*,**], H. Naito[*,**]*

[*]Osaka Pref. Univ., Japan
[**]Res. Inst. for Molecular Elect. Devices, Japan

Charge transport in top-gate OTFTs using solution-processable polycrystalline and amorphous semiconductors with different polymer gate insulators is investigated. Unlike amorphous OTFTs, polycrystalline OTFTs exhibit high field-effect mobility irrespective of the dielectric constant of gate insulators, due to the suppression of dipole disorder. Electrical stability under gate-bias stress is also studied.

AMDp2 - 3 **Temperature Sensor Employing 1-Transistor 1-Capacitor Circuit Consisting of p-Type Poly-Si Thin-Film Transistor**

T. Mukuda[*], J. Taya[*], A. Nakashima[*], M. Kimura [,**,***]*

[*]Ryukoku Univ., Japan
[**]Joint Res. Ctr. for S&T, Japan
[***]High-Tech Res. Ctr., Japan

We propose a temperature sensor employing a 1T1C circuit consisting of a p-type poly-Si TFT. The temperature detection using the temperature dependence of the subthreshold current of the TFT is confirmed. The temperature more than from –10˚C to 100˚C can be detected using the temperature sensor.

AMDp2 - 4 **Suppression of Atom-Migration Effect and Recovery by SR Soft X-Ray Irradiation**

T. Fukuoka, A. Heya, N. Matsuo, Y. Haruyama, K. Kanda, T. Noguchi[*]

Univ. of Hyogo, Japan
[*]Univ. of the Ryukyus, Japan

The low-temperature activation and the suppression of anomalous diffused B by using SR soft X-ray were investigated for ultra shallow junction. The transient enhanced diffusion due to the interstitial B clusters can be suppressed by using soft X-ray.

AMDp2 - 5 **High-Performance and Low-Temperature-Compatible Solid Phase Crystallized Polycrystalline Silicon Thin Film Transistors Using Thermal Oxide Buffered Aluminum Oxide as Gate Dielectric**

M. Zhang, W. Zhou, R. Chen, J. Ho, M. Wong, H.-S. Kwok

Hong Kong Univ. of S&T, Hong Kong

High-performance and low-temperature-compatible solid phase crystallized polycrystalline silicon thin film transistors using thermal oxide buffered aluminum oxide (Al_2O_3) as gate dielectric are demonstrated. By growing a thermal oxide buffer layer using two-step annealing method, the interface quality is greatly improved, resulting in excellent device performance.

AMDp2 - 6 **Design of Vcom Driver Circuit with Poly-Si Technology for TFT-LCD Applications**

C.-C. Hung, M.-H. Cheng, C.-D. Tu, C.-L. Lin

Nat. Cheng Kung Univ., Taiwan

This paper presents a Vcom driver circuit with a gate driver circuit which can provide a constant voltage swing and improve the power consumption for TFT-LCDs. The output waveform of gate driver circuit is stable and the maximum error of storage voltage in pixel is 0.22 V.

AMDp2 - 7 **Electrical Characterization of Nitrogen-Excess SiNx Films Deposited by Surface Wave Plasma Chemical Vapor Deposition**

K. Yagi, T. Okada, T. Noguchi, K. Azuma[*]

Univ. of the Ryukyus, Japan
[*]Shimadzu, Japan

SiN_x film with excess-nitrogen was formed using the newly designed SWP-CVD at low temperature on Si-wafer. Low leakage of 1.25×10^{-9} A/cm^2 was comparable with that of a thermal oxidation film. The nitrogen-excess SiN_x film is expected to be applied as an improved gate insulator in high performance Si-TFTs on panel.

AMDp2 - 8 **Proposal of μ-Poly Si Film Structure with High Photo-Sensitive PIN-Diode for Advanced FPD**

K. Sugihara, S. Chinen, H. Goga[*]*, K. Shirai, T. Okada, T. Noguchi*

Univ. of the Ryukyus, Japan
[*]Okinawa Scale Inspection Office, Japan

A new structure for PIN-diode using μ-poly Si film is proposed. After hydrogenation of μ-poly Si film formed by BLDA, remarkable photo-conductivity appeared. By optimizing the layer structure, the photo-conductivity in red region was enhanced. The newly proposed micro-grain structure is expected to be applied to AM-OLED on flexible panel.

AMDp2 - 9 **The Latest IPS Pixel Structure Suitable for High Resolution LCDs**

K. Ono, I. Hiyama

Panasonic Liquid Crystal Display, Japan

A pixel structure named IPS-Pro-Next which realizing drastic reduction of power consumption has been proposed. The structure has a function of the transparent common electrode covering the TFT wirings via an insulating film. The superiority has been confirmed by developing 20-in. diagonal LCDs with a resolution of 4K2K.

AMDp2 - 10 **The Impact of Polarity Inversion on Interlace Image Sticking at ADS-Mode**

Y. T. Yang, H. Z. Liang, D. Q. Zhang, Y. B. Lee, G. Y. Tian, Y. B. Xu, S. K. Lee

Hefei BOE Optoelect. Tech., China

This paper introduces a kind of image sticking caused by interlace scanning in the television system at ADS Mode. The relation between the line image sticking and polarity inversion has been studied. The results indicate that special polarity inversion have good characteristic for interlace image sticking.

AMDp2 - 11 **A Novel Coupled Charge-Shared Structure on Polymer Sustained Alignment Mode**

T.-L. Ting, Y.-C. Wu, K.-C. Tien, C.-H. Liao, W.-H. Hsu, J.-J. Su

AU Optronics, Taiwan

We propose a novel LCD mode with the coupled charge-shared polymer sustained alignment mode (CCS PSA). CCS PSA controls the sub-pixel voltages by a combination of the capacitance-coupled method and the charge-shared method. This novel mode has the features of low color washout and small pixel-to-pixel parasitic capacitances.

AMDp2 - 12 **An Application of New TFT Driving Method for 47-in. Diagonal IPS LCDs with Resolutions of QFHD and FHD**

R. Oke, T. Nakai, G. Toshima, D. Kajita, J. Maruyama, Y. Ooishi, T. Kobayashi, I. Mori, I. Hiyama

Panasonic Liquid Crystal Display, Japan

A driving to improve charging performance of LCDs driven by a-Si TFTs has been developed. The charging time was divided into two periods, and the voltage in the first period was adjusted. The effect was successfully confirmed by observing images of a QFHD IPS LCD driven at 240 Hz.

AMDp2 - 13 **Development of 5 µm-Pixel Pitch Active-Matrix for Transmissive LCD Picoprojector**

F. Templier, U. Rossini, J. S.-Puchades, L. Clerc, T. Flahaut, D. Sarrasin, V. Larrey, H. W.-Alause[*]*, J. Marty*[*]

CEA LETI, France
[*]*STMicroelect., France*

Development of transparent active-matrix for picoprojector with 5 µm color-pixel pitch has been shown. Transfer on glass of pre-processed SOI wafer, followed by silicon grinding and post-process on glass has been achieved. This process seems to be very suitable for the fabrication of high-resolution picoprojectors with transmissive LCDs.

AMDp2 - 14 **A Low Power Consumption Level Shifter Using LTPS-TFT**

M. Yamashita, M. Yoshida

Tokai Univ., Japan

In this paper, we propose a low power consumption level shifter using LTPS-TFT. By simulation results, it is verified that the power consumption of the proposed level shifter can be reduced up to 54%, compared to that of the previously reported capacitive coupling type level shifter.

AMDp2 - 15L **Magnetic Area Sensor Using Poly-Si Micro Hall Devices - Working Confirmation of Actual Operation -**

Y. Yamaguchi[*], D. Tadokoro[*], T. Segawa[*], H. Hashimoto[*], M. Kimura[,**,***]*

[*]Ryukoku Univ., Japan
[**]Joint Res. Ctr. for S&T, Japan
[***]High-Tech Res. Ctr., Japan

We have developed a magnetic area sensor using poly-Si micro Hall devices and confirmed the actual operation. We put the magnetic area sensor on a neodymium magnet and succeeded in finding the location of the neodymium magnet. This result indicates that the magnetic area sensor is available for practical use.

AMDp2 - 16L **A Model for Photo-Induced Threshold Voltage Shift in a Transistor Based on a BTBT Derivative**

I. Fujieda, T. Hoshino, T. Hanasaki

Ritsumeikan Univ., Japan

Light irradiation on a p-type transistor based on a [1]benzothieno[3,2-b] benzothiophene (BTBT) derivative resulted in a positive threshold voltage shift. The shift was slowly reversed when the device was stored under dark. This behavior is fit by a model assuming meta-stable states with two decay constants.

----- Lunch -----

14:00 - 15:15 **Room A**

AMD7: Oxide TFT: Reliability
Special Topics of Interest on Oxide TFT

Chair: T. Kamiya, Tokyo Inst. of Tech., Japan
Co-Chair: M. Hiramatsu, Japan Display Central, Japan

AMD7 - 1 **Instability of Light Illumination Stress on**
14:00 **Amorphous InGaZnO Thin Film Transistors**

S. Park, E. N. Cho, I. Yun

Yonsei Univ., Korea

In this paper, the effects of the different wavelengths of the light under both positive and negative V_{GS} stress on Amorphous InGaZnO Thin Film Transistors are investigated. The TFT instability depending on optical and electrical stresses can be explained by the charge trapping mechanism and the interface modification.

AMD7 - 2
14:20

The Effects of Wavelength and Negative Bias on Light-Induced Hysteresis of In-Ga-Zn-O Thin-Film Transistors

S.-H. Kuk, S.-Y. Lee, M.-K. Song, S. Kwon, S. C. Youn*, M.-K. Han*

Seoul Nat. Univ., Korea
**LG Display, Korea*

We investigated the effects of wavelength and negative bias on light-induced hysteresis of In-Ga-Zn-O thin-film transistors. Transfer characteristics were measured under various wavelengths and sweep ranges. Hysteresis was observed under the 450 nm illumination, and was increased with wavelength decrease. And hysteresis was increased, as applied negative bias increased.

AMD7 - 3
14:40

The Influence of New SiN_x Gate Insulator in a-InGaZnO Thin Film Transistors

H. Yamazaki, Y. Ishikawa, Y. Ueoka, M. Fujiwara, E. Takahashi*, Y. Andoh*, Y. Uraoka*

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

We fabricated highly reliable amorphous In-Ga-Zn-O thin-film transistors (a-IGZO TFTs) with new silicon nitride (SiN_x) as a gate insulator. The SiN_x layer was formed with utilizing SiF_4/N_2 as source gases at a temperature as low as 150°C. We studied the influence of hydrogen and fluorine on the electrical characteristics.

AMD7 - 4 **Withdrawn**

AMD7 - 5L
15:00

The 4 Masks A-IGZO TFT Structure with High Uniformity and Electrical Stability

J. Y. Yan, W.-W. Tsai, C.-Y. Hung, H.-C. Yao, L.-H. Chen, H.-C. Lin, Y.-C. Lin

ITRI, Taiwan

This article provides the four masks structure and process for channel protection a-IGZO TFTs. The hybrid channel protection structure is development to replace the PECVD SiO_2 and improve the stability and manufacturing yield. TFT mobility is over 20 cm^2/Vs, and standard derivation of Vth is less than 0.03 V.

----- Break -----

15:50 - 17:15 **Room A**

AMD8/FLX7: Oxide TFT: Flexible Displays
Special Topics of Interest on Oxide TFT

Chair: C.-H. Cheng, AU Optronics, Taiwan
Co-Chair: M. Kimura, Nagaoka Univ. of Tech., Japan

AMD8/FLX7 - 1: 15:50 ***Invited*** **Flexible AMOLED Displays Driven by a-IGZO TFTs and their Applications**

H. Yamaguchi, T. Ueda, K. Miura, N. Saito, S. Nakano, T. Sakano, K. Sugi, I. Amemiya

Toshiba, Japan

Reliability of a-IGZO TFTs on plastics against bias-temperature stress has been improved. We developed an 11.7-in. AMOLED display driven by a-IGZO TFTs on plastics. Using the panel, we demonstrated a prototype of flexible-display system integrated with a bend-input function that enables users to interact with the display by flexing it.

AMD8/FLX7 - 2: 16:15 ***Invited*** **A 9.9-in. qHD Top-Emission Flexible OLED Display Driven by Oxide TFTs**

K. Teramoto, E. Fukumoto, T. Fukuda, K. Shimokawa, T. Saito, T. Tanikawa, M. Suzuki, G. Izumi, M. Noda, S. Kumon, T. Arai, T. Kamei, M. Kodate, S. No, T. Sasaoka, K. Nomoto

Sony, Japan

We have developed a direct fabrication method of oxide TFTs on a flexible substrate. We have also developed a flexible color filter array for white OLEDs. The oxide TFT is integrated on a flexible substrate. The fabricated display had a wide color gamut with over 100% NTSC in u'v' space.

AMD8/FLX7 - 3 16:40 **Flexible Top-Gate Amorphous InGaZnO TFTs on a New Colorless Polyimide Substrate for Flexible Display Applications**

Y.-H. Yeh, C.-C. Cheng, M.-J. Yu, H.-C. Ku, B. C.-M. Lai, B.-Y. Chou, E. Horii[*]*, E. Kuribayashi*[*]*, T. Iwamoto*[*]*, M. Yamazaki*[*]*, H. Inari*[*]*, K. Kurimoto*[*]

ITRI, Taiwan
[*]*Kaneka, Japan*

The flexible top-gate a-IGZO TFTs array was fabricated on a Kaneka's colorless polyimide (PI) substrate at 200°C. Our proposed PI substrate has high T_g (~350°C), high light transmittance (~87%), and low thermal coefficient (8 ppm/°C). Polymer resin (ILLUMIKA) was also applied to passivate the a-IGZO TFTs.

AMD8/ FLX7 - 4L 17:00 **High-Performance Solution Processed Indium Oxide Thin Films Transistors**

C. Avis, Y. G. Kim, H. R. Hwang, J. Jang

Kyung Hee Univ., Korea

We have developed a high performance solution processed indium oxide TFT (InO_x TFT). The spin-coated TFTs has saturation mobility, Vth, and gate swing of 57.3 cm^2/Vs, 0.4 V, and 149 mV/dec., respectively. Inverters based on InO_x TFTs were fabricated and showed a gain~27 at V_{DD}=3 V.

Author Interviews and Demonstrations
17:30 – 18:30

Friday, December 7

14:00 - 15:35 **Room B-1**

AMD9: Active-Matrix Circuits

Chair: S. Jeon, Samsung Advanced Inst. of Tech., Korea
Co-Chair: M. Inoue, Chimei Innolux, Japan

AMD9 - 1 14:00 **New Pixel Circuit Based on a-IGZO TFTs Compensating OLED Degradation for 3D AMOLED Displays**

W.-Y. Chang, P.-Y. Kuo, C.-C. Hung, C.-L. Lin

Nat. Cheng Kung Univ., Taiwan

This work presents a new pixel circuit using amorphous indium gallium zinc oxide TFTs that compensates for the degradation of TFTs and the OLED for 3D active-matrix organic light-emitting diode displays. According to the simulation results, the proposed driving scheme successfully compensates for the luminance drop when the OLED degrades.

AMD9 - 2 14:20 **Highly Reliable Gate Driver Circuit with Modulated Gate Bias for Threshold Voltage Amelioration**

M. H. Cheng, C. D. Tu, C. L. Lin

Nat. Cheng Kung Univ., Taiwan

This work introduces an a-Si:H gate driver combining an AC-driving method with modulated V_{GS} of pull-down TFTs to further improve the V_{TH} shift for long-term operation. The experimental results indicate the V_{TH} shift of a TFT with the proposed scheme is reduced by 58.33% compared to that of DC-bias stress.

AMD9 - 3
14:40

A Novel Design Methodology for On-Glass Integrated Shift Register Circuits Using Hydrogenated Amorphous-Si Thin Film Transistors

H. Bang, J.-S. Kang, D.-S. Jung, S.-B. Kim, L.-Y. Kim, H. Koo, K.-H. Lee

LG Display, Korea

A concept for design methodology for on-glass shift register circuits which includes BTS effect is introduced. Based on the Vth of each TFTs predicted by an empirical formula, the clamping voltages were estimated through the SPICE circuit simulation and proven to match well with the measured on-going reliability test values.

AMD9 - 4
15:00

High Resolution Active Photo-Sensing Circuit Using Dual-Scan Compensation

L.-S. Chou, H. M. Chen, C.-T. Yang, Y.-H. Yang, Y.-H. Tai, M.-H. Yeh[*]

Nat. Chiao Tung Univ., Taiwan
[*]ITRI, Taiwan

The simplest 2T1C sensing circuit has high aperture ratio in pixel, while it suffers from a severe error owing to the voltage drop on scan bus. In order to solve this issue, a dual-scanning active amplifier sensing circuit is proposed, which can correct the sensing error from 38.5% to 5.7%.

AMD9 - 5L
15:20

Multi-Bit Dynamic Self-Refreshing Memory-in-Pixel Circuit for Ultra Low Power LTPS TFT-LCD

K. Yamashita, M. Yoshiga, S. Kawata, Y. Matsui, Y. Haruyama, N. Sumi, H.-Y. Liang[*]*, T.-Y. Cheng*[*]

Chimei-Innolux, Japan
[*]Chimei-Innolux, Taiwan

A 2-bit ultra low power dynamic Self-Refreshing-Pixel Memory in Pixel (SRP-MIP) circuit is successfully integrated into a 6.0-in. qHD (540x900) reflective LTPS TFT-LCD. Measured power consumption in MIP mode is 2 mW and high reflectance of 21% is achieved. The prototype is compatible with 60 Hz movie mode with excellent LC response time.

Author Interviews and Demonstrations
17:30 – 18:30

Supporting Organization:
Thin Film Materials & Devices Meeting

Workshop on FPD Manufacturing, Materials and Components

Tuesday, December 4

14:20 - 15:35 **Room B-1**

FMC1: Manufacturing Technologies (1)
Special Topics of Interest on Oxide TFT

Chair: M. Furuta, Kochi Univ. of Tech., Japan
Co-Chair: T. Tomono, Toppan Printing, Japan

FMC1 - 1: 14:20 ***Invited*** **Preparation of Amorphous p-Type $InGaZnO_4$ Films by Codoping of Al and N Atoms**

K. Kobayashi, X. Zhang, Y. Kohno, Y. Tomita, Y. Maeda
Shizuoka Univ., Japan

Codoped $InGaZnO_4$ films were prepared by sputtering of targets of $InGaZnO_4$ and AlN in an Ar atmosphere. The hole-conductivity is confirmed in films prepared from the target (7% AlN) at 2×10^{-2} Torr in 0.3-0.6% O_2 atmosphere. The rectification characteristic is obtained for a PN junction of $InGaZnO_4$ films.

FMC1 - 2: 14:40 ***Invited*** **Solution-Based Atmospheric Pressure Deposition Method for Oxide TFTs**

M. Furuta, T. Kawaharamura, D. Wang
Kochi Univ. of Tech., Japan

We fabricated a thin-film transistor (TFT) with an amorphous InGaZnO (a-IGZO) and aluminum oxide (AlOx) gate dielectric stack that was deposited by a solution-based atmospheric pressure chemical vapor deposition (APCVD). Field effect mobility of 4.1 $cm^2 \cdot V^{-1} \cdot s^{-1}$ and on/off current ratio of over 10^8 was obtained.

FMC1 - 3: 15:00 ***Invited*** **Zinc Oxide Film Growth Using High-Energy H_2O Generated by a Catalytic Reaction on Pt Nanoparticles**

K. Yasui, H. Miura, H. Nishiyama
Nagaoka Univ. of Tech., Japan

In this paper, a new CVD method of ZnO thin films using the reaction between zimethylzinc (DMZn) and high-energy H_2O, the latter is generated by the Pt-catalyzed exothermic H_2–O_2 reaction, is presented. Using this CVD method, ZnO thin films with excellent electrical and optical properties were grown.

FMC1 - 4L 15:20 **Large Area Sputtered Al_2O_3 Films for High Mobility AM-TFT Backplanes on PVD Array System PiVot 55kVi[2]**

A. Kloeppel, J. Liu, E. Scheer

Appl. Materials, Germany

In order to provide increased stability to AM-OLED backplanes using IGZO we demonstrate the production worthiness of sputtered Al_2O_3 buffer films on Gen 8.5 substrates using rotary targets on PVD array system PiVot. The achieved Al_2O_3 layer properties and uniformity underline the advantages of using rotary technology.

----- Break -----

16:10 - 17:30 **Room B-1**

FMC2: Manufacturing Technologies (2)

Chair: J. Hanna, Tokyo Inst. of. Tech., Japan
Co-Chair: T. Miyashita, Tohoku Inst. of. Tech., Japan

FMC2 - 1: 16:10 ***Invited*** **Solution-Crystallized High-Mobility Organic Active Matrices and Display Panels**

J. Takeya[,**], T. Uemura[*], M. Uno[***], Y. Kanaoka[***]*

[*]Osaka Univ., Japan
[**]Ctr. for High-End Molecular Semiconductors, Japan
[***]TRI Osaka, Japan

High-mobility organic active matrices are developed with solution-crystallized TFTs of various small molecular compounds. A patterning process is found to fabricate the crystalline TFT arrays homogeneously, so that active-matrix panels are constructed with the average mobility more than 3 cm^2/Vs. Operation of LCDs is successfully demonstrated using the printable backplanes.

FMC2 - 2: 16:30 ***Invited*** **High Thermal Stability and High Performance in OFETs Fabricated with Smectic LC Materials**

J. Hanna, H. Iino

Tokyo Inst. of Tech., Japan

The liquid crystallinity, which often appears in soluble organic field effect transistor (OFET) materials, has been hardly recognized to be available for fabrication of OFETs. We discuss and demonstrate its availability in fabricating molecularly flat and uniform films in large-area, improving thermal stability of the films, and high FET performance.

FMC2 - 3: 16:50 ***Invited*** **Development of Novel Piezo Inkjet Print Head Utilizing MEMS Technology for Printed Electronics Applications**

Y. Nishi, S. Sakai, K. Higashino[*]*, Y. Machida, K. Yoshida*

Konica Minolta IJ Techs., Japan
[*]*Konica Minolta Tech. Ctr., Japan*

We are trying to develop a new inkjet printing head with the use of MEMS technology for the Printed Electronics applications. We investigated an ink channel design and highly-accurate silicone nozzle plate, and finally achieved to eject small droplets accurately through all of the nozzles without creating a satellite.

FMC2 - 4 17:10 **Optimization of the Surface Treatment on Cover Glass for Automotive TFT-LCDs**

T. Kiyohara, Y. Morii, M. Kawano, K. Itoga, A. Yuki, T. Satake

Mitsubishi Elec., Japan

We have established the surface treatment optimizing method of the cover glass for automotive TFT-LCDs by using angular scattering light characteristics. We can obtain excellent image quality under the various sun light conditions with the cover glass which surface treatment optimized by this method.

Author Interviews and Demonstrations
17:50 – 18:50

Wednesday, December 5

9:20 - 12:20 **Event Hall**

Poster **FMCp: FPD Manufacturing, Materials & Components**

FMCp - 1 **Wet Etching and Striper Characterization for H_2O_2 and Non-H_2O_2 Etchant and Amine and Non-Amine Stripper of Cu-Based TFT Application**

H. Kou, C. Zhang, Y. Chen, X. Zhong, G. Li

Shenzhen China Star Optoelect. Tech., China

For Cu-base TFT application, the key effect factors about different H_2O_2 contents and shelf-life were investigated. It is found etching performances are influenced on changeable and nonlinear etching rate of main and sub oxidizer. And the novel striper of ester-base exhibits better performances than conventional amine-base striper.

FMCp - 2 **Research on Thinning Technology with Wing Pattern**

D. Shi, G. Jian, C. Xu, X. Jiang, L. Qu, D. Yang, T. Wu, T. Min

BOE Optoelect. Tech., China

To realize higher resolution, narrow frame, lower power consumption, subject to the condition of equipment, it is difficult to get narrow spacing. In this paper, we change normal line to wing line in mask, and realize further narrow space in the existing condition.

FMCp - 3 **Fabrication of Multi Nozzle Dispenser for RGB Phosphor Light Source**

G. Lim, H. J. Jeon, J. S. Gwag, G. Park[*]*, J. H. Kwon*

Yeungnam Univ., Korea
[*]Sunlin Univ., Korea

The RGB linear light source array that consisted of the RGB phosphors was fabricated by using the multinozzle dispenser. The multinozzle was made on the silicon wafer by etching the multinozzle photoresist pattern in the DRIE equipment. The width and spacing between the nozzles were 100 μm and 541.5 μm.

FMCp - 4 **Low Power Consumption TFT-LCD Using Si-C Resin as Passivation Layer**

C. Yan, Z. Xie, J. Guo, X. Chen, T. Min, X. Chen, Q. Shen, W. Zhang, T. Li, S. Xu, K. Lu, X. Hou, X. Jiang, T. Wu, S. Su, J. Wang

BOE Optoelect. Tech., China

By using Si-C resin, we succeeded in prototyping a high definition LCD panel, retina display as 300 pixels per inch, which improves the RC delay of signal effectively and decreases nearly 40% in the logic power consumption compared to the exiting panel with SiN_x passivation layer.

FMCp - 5 **Study on Photo Process for Low-k Non-Photoactive Acrylic Resin TFT-LCD**

X. Hou, J. Guo, X. Chen, T. Wu, Q. Shen, K. Lu, T. Min

BOE Optoelect. Tech., China

In this paper, we studied on the effects of photo process parameters to PR profile, which can improve the low-k non-photoactive acrylic resin etching profile. By optimizing PR profile, the resin etching structure profile is good for overlap of next layers had obtained.

FMCp - 6 **Cellulose Ether Polymers as Optical Compensation Films for LCDs - High Birefringence and Tunable Optics**

Z. Wang, J. Folkenroth[*], W. Zhou[**], Y. Zhang, S. Xiuqin

Dow Chem., China
[*]Dow Wolff Cellulosics, USA
[**]Dow Materials Sci., USA

ETHOCEL ethylcellulose from Dow Chemical provides an alternative material to tri-acetyl-cellulose for LCD retardation films to increase viewing angle through its unique birefringence optics and excellent optical transparency. Recently, a new ETHOCEL-based polymer system has been developed with new optical properties such as tunable birefringence and flat wavelength dispersion.

FMCp - 7 **TFT Characteristics Improvement by Using Single Slit Mask**

L. Qu, J. Guo, X. Chen, Z. Xie, W. Zhang, M. Taeyup, T. Wu

BOE Optoelect. Tech., China

As an effective TFT channel design technique, single slit mask can improve the TFT characteristics greatly. This article makes the theoretical and experimental analysis on the characteristics of TFT by using single slit mask. Compared to the mass production, I_{on} has improved by 29%.

FMCp - 8 **An Inspection System for Transparent Circuits with the Use of a PDLC/ITO Film**

C.-H. Chan[,**], Y.-T. Zou[**], C.-T. Chen[**], T.-K. Liu[**], C.-H. Chen[**], H.-W. Wang[**], S.-C. Lin[*]*

[*]Nat. Tsing Hua Univ., Taiwan
[**]ITRI, Taiwan

An inspection system for transparent circuits to locate faulty shut/open circuits has been developed. With power on, the liquid crystals line up, re-orientate themselves and the film covering the conducting area turns clear while the liquid crystals covering the non-conducting area are randomly scattered and diffuse light in all directions.

FMCp - 9 **An Analytical Model for Describing LED Pad Temperature in Backlight Unit**

K.-Y. Chang, C.-C. Hu, C. Xiong, W.-Y. Wei

Shenzhen China Star Optoelect. Tech., China

An Equivalent Thermal Resistance, ETR, is introduced in this paper to predict LED (light emitting diode) pad temperature while same thermal management is applying. A simplified experiment is conducted to find the behavior of ETR as different heat sink size is applied. Analytical solution, a power function, shows great match with the experiment data.

FMCp - 10 **The Study on Relation between Color Gamut and Luminous Efficiency Based on the Shift of Color Filter and LED Spectrum**

W. Zheng, C.-T. Kang

Shenzhen China Star Optoelect. Tech., China

The relation between color gamut and luminous efficiency basic on the shift of color filter and LED spectrum is proposed. The study is undergone by simulation and the simulation result shows that the two parameters we study in the paper usually change oppositely on the whole.

FMCp - 11 **Development of a Simulation Model to Analyze the Chromaticity Variation at the Place Lit by RYGB-White-LED**

K. Misono

Miyakonojo Nat. College of Tech., Japan

Although the RYGB-White-LED can provide a flexible control of photometric and colorimetric characteristics, the practical issue is to suppress the color variation on the lit-plane. By taking into account the spectral irradiance, we developed a ray tracing model that can evaluate the color uniformity on the lit-plane.

FMCp - 12 **Transmittance of LED Encapsulant Containing Quantum Dot with Various Types of Ligands**

C. S. Lee[,**], C. J. Han[**], S.-K. Hong[*]*

[*]Dongguk Univ., Korea
[**]KETI, Korea

In this study, transmittance and degree of cure of encapsulant was measured according to the number of purification of quantum dot, when quantum dot was used as LED phosphor. The changes in the degree of cure was checked along with the types of ligand in quantum dot.

FMCp - 13 **Conversion Efficiency of RGB Phosphor Array on the Lightguide**

H. J. Jeon, K. S. Lim, J. H. Kwon

Yeungnam Univ., Korea

The light power conversion efficiency of the RGB phosphors was measured in terms of the phosphor concentration. The excitation wavelength was 450 nm. The power conversion efficiency was almost doubled when the reflecting layer was placed behind the phosphor layer and was proportional to the phosphor concentration.

FMCp - 14 **Solution for Eliminating Support Pin Shadow Mura in Direct LED Backlight**

K.-Y. Chang, C.-C. Hu, Z. Su

Shenzhen China Star Optoelect. Tech., China

A simple method for eliminating support pin shadow mura in direct LED backlight for LCD-TV was proposed. Mechanism of support pin shadow mura was discussed. Simulation and experiment results confirmed that, by lower the height of support pin, shadow mura would effectively drop off. However, the supporting function remains.

FMCp - 15 **A Modified Color System for LED Chromaticity Ranking in a System**

C. Feng, K.-Y. Chang, C.-C. Hu, C. Ning

Shenzhen China Star Optoelect. Tech., China

A modified color system is proposed for light emitting diode (LED) chromaticity ranking. By directly giving the output chromaticity, it solves the problem of LED metamerism that results in output chromatic difference of lighting systems. It may also simplify the LED chromaticity control and increase the LED usage rate.

FMCp - 16 **Properties of Cu Doped NiO Transparent Oxide Thin Films by Sol-Gel Solution**

C. Takahashi, M. Kawamura, Y. Abe, K. H. Kim

Kitami Inst. of Tech., Japan

Wide band-gap oxide semiconductor nickel oxide thin films were prepared by sol-gel spin-coating under various annealing temperatures from 250 to 450°C and Cu doping amounts from 0 to 20 at.%. The optical and structural properties of these films significantly depend on the temperature and the Cu doping amount.

FMCp - 17 **Low Temperature Fabrication and UV Treatment of Spin Coated ZnO Films Using Partial Hydrolyzate of Diethylzinc Based Solutions**

K. Haga, K. Inaba, K. Toyota, Y. Takemoto, K. Tokudome, M. Oshima[*]*, K. Yoshino*[*]

Tosoh Finechem, Japan
[*]*Univ. of Miyazaki, Japan*

Low temperature fabrication of ZnO films using partial hydrolyzate of diethylzinc based solution were investigated. UV treatment was effective to improve the electronic performance of ZnO films. Group 13 element metals (Ga and In) compounds were mixed to our precursor solution and transparent multi-metal oxide films were obtained.

FMCp - 18L **Strain Gage Studies to Understand the Impact of Ring Radius in Ring on Ring Test**

A. N. Subramanian, P. R. Samala, S. H. Carley

Corning, USA

This paper investigates the impact of ring radius in the Ring on Ring (ROR) test specific to stress development in thin glasses by strain gage studies. 0.6 mm thick ion exchanged Corning Gorilla Glass was used for this study. Two ring geometries with different minor radius were considered.

FMCp - 19L **Effect of Birefringence to Fiber Polarizers Utilizing a New Ray Tracing Simulation Tool**

*R. Iwasaki, H. Imamura, Y. Yokote, H. Kim**

Samsung Yokohama Res. Inst., Japan
**Samsung Elect., Korea*

We have developed a new ray tracing simulation tool which directly took birefringent effect into the models to investigate the effect of fiber polarizers. Simulated result showed the same tendency as that of the article in the past.

FMCp - 20L **Improvement of Surface Strength for Cover Glasses**

H. Ohkawa, H. Saiki, A. Nakagawa, M. Fukawa, N. Ishimaru

Asahi Glass, Japan

Recently, thinner cover glass is required therefore the glass strength is more important. It was found that surface polishing after chemical strengthening improved surface strength. In chemical strengthening process hydrogen enters the glass surface and creates chemical defects. Surface strength is improved by removing them.

FMCp - 21L **Comparison of Micro Poly-Si Grains Formed by Blue Multi Laser Diode Annealing (BLDA) and Plasma Enhanced Chemical Vapor Deposition (PE-CVD)**

*K. Shirai, S. Chinen, T. Okada, T. Noguchi, D. Daineka**, *Y. Bonnassieux**

Univ. of the Ryukyus, Japan
**Ecole Polytechnique, France*

Characteristics of micro poly-Si grains formed by BLDA and PE-CVD were compared. Randomly oriented small grains were obtained by PE-CVD. Uniform micro poly-Si grains with preferred crystal orientation of (111) face were obtained by controlling the irradiation condition of BLDA.

FMCp - 22L **Novel Diffusion Sheet Using Nano Fibers**

T. Kim, S. Kim, M. S. Lee, D. Y. Lim**, S.-W. Choi*

Kyung Hee Univ., Korea
**Chonnam Nat. Univ., Korea*
***Korea Inst. of Ind. Tech., Korea*

We fabricate a novel diffusion sheet using nano fibers. The diffusion sheet is consisted of a blended isotropic polymer matrix and nano fibers with distinct ordinary (n_o) and extraordinary refractive index (n_e). The diffusion sheet designed and fabricated here exhibits uniform distribution of brightness.

FMCp - 23L **ESR Evaluation of Damages Induced in $InGaZnO_4$ with Plasma**

T. Matsuda, D. Nishimoto, K. Takahashi, T. Ueno, M. Kimura

Ryukoku Univ., Japan

Damage induced in IGZO by plasma was evaluated by ES. The ESR signal was newly found at g-factor of 1.939, and width with 0.97 mT, respectively. Another ESR signal was weakly observed at g-factor at 2.0030. These ESR signal would be related to the oxygen vacancy in IGZO material.

FMCp - 24L **Uniform IGZO Layers by Large Area Sputter Deposition from Rotary Targets**

E. Scheer, D. K. Yim, Y. Ye**

Appl. Materials, Germany
**Appl. Materials, USA*

To enable metal oxide technology for AM-OLED backplanes uniform IGZO layers are needed on large area substrates. The control of oxygen ion bombardment exposure during layer growth is essential for reactive sputter processes. Using rotary targets for IGZO deposition achieves both uniform electronic properties as well as suitable TFT distribution.

----- Lunch -----

RECEPTION

Wednesday, December 5, 2012
19:00 – 21:00
Sakura (1F)
Kyoto International Conference Center
See page 12 for details

14:00 - 15:00 **Room B-2**

FMC3: Materials (1)

Chair: K. Suganuma, Osaka Univ., Japan
Co-Chair: T. Hotta, DNP, Japan

FMC3 - 1: 14:00 ***Invited*** **Fabrication of Transparent Conductive Films with Ag Nanowires on Plastic Films**

K. Suganuma, T. Tokuno, T. Araki, J. Jiu, T. Sugahara, M. Nogi, H. Uchida[*]*, K. Shinozuka*[*]

Osaka Univ., Japan
[*]*Showa Denko, Japan*

Transparent conductive films with Ag nanowires were successfully fabricated at low temperature on plastic films. Random networks of Ag nanowires exhibit high electrical conductivity, optical transparency, and flexibility. Mechanical pressing or light sintering was found to be effective to achieve the excellent performance of the transparent conductive films.

FMC3 - 2: 14:20 ***Invited*** **Optically Transparent Nanofiber Papers for Printed Electronics**

M. Nogi, H. Koga, M. Karawaka, K. Suganuma

Osaka Univ., Japan

Recently, we have invited an optically transparent paper using cellulose nanofibers of 15 nm wide. The nanofiber paper has higher thermal stability than plastics and optical transparency of glass, maintaining high foldability of conventional paper. In this presentation, we introduce their characteristics and applications in the electronic devices.

FMC3 - 3 14:40 **Development of Dielectric Materials and Cu Inks for a Fine Pitch Wiring in Printing Process**

M. Ito, K. Tsuruoka, M. Fukuda, Y. Kuwana, Y. Nagai, S. Kashiwabara

Asahi Glass, Japan

We developed a surface energy controllable dielectrics and a low temperature curable Cu ink. A fine pitch wiring which is important technology for printing process was achieved by forming electrode patterns using Cu ink inkjet printing onto the high surface energy area of dielectrics.

----- Break -----

15:50 - 17:10 **Room B-2**

FMC4: Materials (2)

Chair: R. Yamaguchi, Akita Univ., Japan
Co-Chair: S. Kurihara, Kumamoto Univ., Japan

FMC4 - 1: 15:50 ***Invited*** **History and Future of FPD' s and Semiconductors**

Y. Todokoro[,**], S. Imai[*], T. Matsumoto[*], T. Unate[***]*

[*]Osaka Univ., Japan
[**]Nara Inst. of S&T, Japan
[***]UNATE, Japan

History of semiconductors has been reviewed in miniaturization, increasing wafer size, introduction of new materials, and integration of new functions. History of FPD's has been reviewed in frontplane and backplane. Feedbacks from the history of semiconductors to FPD's have been discussed.

FMC4 - 2: 16:10 ***Invited*** **Color Switching of One Dimensional Photonic Crystals Consisting of Azobenzene-Functionalized Polymer LCs and Polyvinylalcohol**

S. Kurihara[,**], Y. Kuwahara[*], T. Ogata[*], M. Moritsugu[***]*

[*]Kumamoto Univ., Japan
[**]Kumamoto Inst. for Photo-Electro Organics, Japan
[***]Kinki Univ., Japan

Photo-responsive multi-bilayered films consisting of azobenzene polymer liquid crystals (PAzo) and polyvinylalcohol (PVA) were prepared on a glass substrate by spin coating of the polymer solutions alternately. The reflectivity of the multi-bilayered films disappeared and appeared again by annealing at 80˚C and UV irradiation, respectively.

FMC4 - 3: 16:30 ***Invited*** **A Novel Mechanism to Give Photosensitivity to Engineering Plastics: Reaction Development Patterning**

T. Oyama

Yokohama Nat. Univ., Japan

Reaction development patterning (RDP) is a novel method to give photosensitivity to engineering plastics including commercially available polyimides, polycarbonates and polyesters. RDP-based pattern formation is realized by changing solubility of a polymer by reaction with nucleophiles in a developer during development process.

FMC4 - 4
16:50

A Frame Work of New Design for Bending Test to the Non-Planar Glass

C.-Y. Chiu, K.-C. Chang, Y.-C. Liu

G-tech Optoelect., Taiwan

Balls-on-Balls (BOB) bending test is a new design for non-planar glass flexure strength measuring. The correlations among loading force, bending span, thickness, and width of glass fit in with the calculation of flexure stress ($\sigma \propto PL/wt^2$). It is practicable to measure the flexure stress for non-planar glass.

Author Interviews and Demonstrations
17:30 – 18:30

Thursday, December 6

10:50 - 12:05 **Room E**

FLX5/FMC5: Flexible Materials and Fabrication Processes

Chair: Y. Mishima, FUJIFILM, Japan
Co-Chair: A. Fujita, JNC, Japan

FLX5/
FMC5 - 1
10:50

Roll-to-Roll Deposition of ITO Film on a Flexible Glass Substrate

Y. Ikari, H. Tamagaki

Kobe Steel, Japan

The roll-to-roll deposition of ITO film on a flexible glass roll, 50 μm thick, 300 mm wide and 10 m long, was made successfully by magnetron sputtering at elevated substrate temperature. The ITO film shows a sheet resistance of 7.5 ΩSq at 190 nm, and the resistivity is calculated as 143 μΩcm.

FLX5/
FMC5 - 2
11:10

Ultra Thin Glass for Flexible Display

C. C. Kuo, Y. C. Chen, B. S. Chiou, J. Y. Chiou, Y. T. Lee, Y. Y. Huang

Chunghwa Picture Tubes, Taiwan

Nowadays, glass is attractive as a substrate in flexible electronic and display. We have developed complete SH-to-SH type TFT backplane process flow. Moreover we have succeeded demonstrate a flexible EPD using 0.1 mm glass as TFT backplane substrate. In this paper, we will describe fabrication procedures and realize in a 6-in. EPD module.

FLX5/ FMC5 - 3 11:30 **Flexible LCD Fabricated with a Slit Coater**

M. Kimura, K. Ohtsuka, Y. Nagataki, T. N. Oo, M. Mori[*]*, H. Hirata*[*]*, T. Akahane*

Nagaoka Univ. of Tech., Japan
[*]Toray Eng., Japan

Homogeneously aligned liquid crystal layer on substrate film on which there is no necessity of forming alignment film can be assembled by a slit coater. TN and IPS type flexible LCDs were demonstrated. It is expected that production time can be shortened several ten minutes because of unnecessity of alignment film.

FLX5/ FMC5 - 4L 11:50 **Development of a Single Substrate Flexible LCD Using Microencapsulation Technology**

S.-H. Han, Y.-S. Kang, H.-G. Kim, S. S. G. Kang, H.-H. Hwang

Image Lab, Korea

A Single substrate flexible LCD is developed using Ch-LC microencapsulation and printing method. Unlike conventional PIPS method, combining LC microencapsulation with printing process enabled us to dispense with an upper substrate, resulting in a much simplified manufacturing of flexible LCDs. Good electro-optic performances and low reset voltage are achieved.

----- Lunch -----

14:00 - 15:00 **Room B-2**

FMC6: Materials (3)

Chair: K. Matsukawa, Osaka Municipal Tech. Res. Inst., Japan
Co-Chair: T. Unate, UNATE, Japan

FMC6 - 1: 14:00 ***Invited*** **High Refractive Index Thin Film Prepared from Organic-Inorganic Hybrid Materials**

K. Matsukawa, Y. Minami[*]*, S. Watase*

Osaka Municipal Tech. Res. Inst., Japan
[*]Solar, Japan

The organic-inorganic hybrid thin films are optically transparent, so they are useful optical materials and good candidates of refractive index controllable materials. We have been investigating several types of organic-inorganic hybrid materials with high refractive index by containing sulfur elements, zirconia nano-particles.

FMC6 - 2
14:20

High Reliability of Oxide TFT Using Solution-Processed Photosensitive Passivation Layer

A. Tanabe, T. Kojiri, M. Hanmura

ZEON, Japan

A solution-processed photosensitive passivation layer (PPL) has been developed for an a-IGZO TFT. By optimizing the component, we have achieved high reliability performance of an a-IGZO TFT. Because the PPL is coated by a solution process, the CVD process can be skipped. The PPL will reduce manufacturing cost of LCD panels and OLED.

FMC6 - 3
14:40

Spatial Distribution of Properties of a-IGZO Films Deposited by Rotation Magnet Sputtering Incorporating Dual Target Structure

T. Goto, S. Sugawa, T. Ohmi

Tohoku Univ., Japan

A new magnetron sputtering equipment called rotation magnet sputtering incorporating dual planar target structure was developed to obtain high target utilization and wide high-quality-film-deposition region by moving multiple plasma loops. This new system was applied to a-IGZO film depositions. Spatial distributions of film properties were investigated.

----- Break -----

15:50 - 16:50 **Room B-2**

FMC7: Backlight

Chair: S. Banerjee, Sumitomo Chem., Japan
Co-Chair: K. Käläntär, Global Optical Solutions, Japan

FMC7 - 1
15:50

Slim Block Backlight System with Local Dimming

S. Yamamoto, J. Yokoyama, M. Nagayoshi, S. Ouchi

Hitachi, Japan

We have developed the new Slim Block Backlight which realizes low profile with the lowest power consumption, and high contrast ratio. A new side-view LED, diffusion structures and a shielding pattern are newly developed for this new backlight system.

FMC7 - 2
16:10

The Design of Novel Wedge Structure with High Efficiency LGP

Y.-W. Chang, S. Liao, H.-P. Kuo

AU Optronics, Taiwan

We propose a novel wedge structure to improve the efficiency of wedge type LGP. With our design, we could improve wedge type LGP efficiency 13% up and decrease light naturally lost in shorter mixing distance. As the LGP thickness decrease, the benefit is more distinct.

FMC7 - 3
16:30

Multilayer Wavelength-Selective Reflector Films for LCD Applications

S. Banerjee

Sumitomo Chem., Japan

We designed multilayer wavelength-selective reflector films by stacking thin-films of transparent polymer. The optimum structure of the multilayer is determined using a combination of characteristic matrix method and a version of genetic algorithm. Such multilayer films can be used in LCD devices to enhance the color saturation of the display.

Author Interviews and Demonstrations
17:30 – 18:30

Friday, December 7

9:00 - 10:20 **Room B-2**

FMC8: Manufacturing Technologies (3)

Chair: Y. Iimura, Tokyo Univ. of A&T, Japan
Co-Chair: T. Nonaka, AZ Elec. Materials, Japan

FMC8 - 1
9:00

Barrier Properties of Ultra High Barrier Coating Prepared by Roll to Roll PECVD Process and Analysis of Gas Leakage Mechanism

H. Tamagaki, T. Okimoto

Kobe Steel, Japan

SiO_x transparent ultra high barrier coating up to 1000 nm was prepared by roll-to-roll PECVD system on Planelized PEN substrate, and its barrier(WVTR) was measured as $1.7x10^{-5}$ g/m^2/day by calcium test. A cross-sectional TEM observation of the point of water leakage revealed a localized crack in the SiO_x coating.

FMC8 - 2
9:20

Low Temperature Crystallization Technology of Extremely Thin TCO for Next Generation Panels

T. Yukawa, M. Takei, Y. Oono, A. Ota, M. Arai, J. Kiyota, S. Ishibashi, K. Saito

ULVAC, Japan

Recently, realization of high-performance transparent conductive oxide (TCO) film is required, due to the trend of high-performance small and middle size panel (mainly represented by smart phone and tablet PC). We hereby report the crystallization technology of extremely thin TCO that realized high transmittance and low resistance through low-temperature deposition.

FMC8 - 3
9:40

Optical Properties of Nanostructured ZnO Films Influenced by Different Gas Ratio Deposition with Radio Frequency Magnetron Sputtering

C. Li, X. Li, D. Wang, T. Kawaharamura, M. Furuta, A. Hatta

Kochi Univ. of Tech., Japan

ZnO nanostructures fabricated on the as-deposited ZnO films which were prepared with different gas ratio during a magnetron radio frequency sputtering. It was found that Zn rich thin film contributed to form much density ZnO nanostructures as well as exhibited higher intensity blue-green emission.

FMC8 - 4
10:00

Rotary Sintered Ceramic ITO Sputtering Targets for the Flat Panel Display Industry

T. Miyata, P. Lippens[*]*, D. Chiu*[**]

Umicore Japan, Japan
[*]*Umicore Thin Film Prods., Liechtenstein*
[**]*Umicore Thin Film Prods., Taiwan*

The sintered ceramic ITO sputtering targets achieve much higher target utilization up to 90% and give rise to much lower coating costs. At the same time, they realize quasi nodule free sputtering even at high power loads. That results in higher process stability and a better product yield.

----- Break -----

10:50 - 11:50 **Room B-2**

FMC9: LED Lighting Technologies
Special Topics of Interest on Lighting Technologies

Chair: K. Käläntär, Global Optical Solutions, Japan
Co-Chair: K. Li, Wavien, USA

FMC9 - 1
10:50

10,000 Nits Projection-Type Recycling LED Back-Light System for Outdoor LCDs

K. Li

Wavien, USA

This paper describes a high brightness back-light system for LCD displays using Wavien's Recycling LED Technology (RLT). A 2 X 2 Micro Cube system comprising four 19-in. display video cubes has been demonstration with over 10,000 nits output brightness. A single 80-in. diagonal LCD display is being constructed.

FMC9 - 2 11:10 **A Novel Design of LED Embedded Alexis Wound Retractor**

Y. -C. Su[*], Y.-S. Chen[**], J.-W. Pan[,**], C.-Y. Wu[**]*

[*]Chi Mei Medical Ctr., Taiwan
[**]Nat. Chiao Tung Univ., Taiwan

The key design of this invention is the LED mounted on the inner ring of Alexis Wound Retractor. With this design, we could offer a much wide spreaded lightening comparing to the traditional shadowless lighting.

FMC9 - 3 11:30 **"Square-Light" Technology as Novel Approach for Making Ultra-Slim LED Lighting Devices**

J. Hou, Z.-W. Koh, W.-C. Ing

LuxingTek, Taiwan

The world thinnest "direct-lit" LED backlight module having a minimal number of LED light source will be presented. This revolutionary approach reveals the possibility of converting a strong LED "dot" light into a uniform surface light at 7 mm thickness with 50 mm LED pitch.

Author Interviews and Demonstrations
17:30 – 18:30

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

IDW Best Paper Award

IDW Outstanding Poster Paper Award

These awards will go to the most outstanding papers selected from those presented at IDW/AD '12.
The 2012 award winners will be announced on the IDW website: http://www.idw.ne.jp/award.html

Workshop on Plasma Displays

Wednesday, December 5

14:00 - 17:00 **Event Hall**

***Poster* PDPp: PDP**

PDPp - 1 **Study on Seamless and Large-Cell PDPs**

T. J. Kweon, J. N. Kim, H. H. Kim, D. H. Choe
Samsung SDI, Korea

In this paper, we have studied a promising device for seamless and large cell flat panel display using PDP discharge. Finally, we developed not only seamless but also large cell plasma display panel using bus electrode on film material and chemical etching method of thin glass.

PDPp - 2 **Characteristics of High Efficient Two Level Sustain Waveforms in AC PDPs**

J.-Y. Jeong, J.-S. Park, J.-W. Kang
Dankook Univ., Korea

In order to improve the luminance of ac-PDP, four different types of sustain pulses were proposed and examined. IR emission, luminance and current were measured and then compared with those properties of conventional pulse. The proposed waveform showed 25% higher luminance and 47.3% higher efficiency than the conventional.

PDPp - 3 **Characteristics of a Gas Type X-Ray Detector Based on Plasma Display Technology**

H.-H. Park, S.-H. Eom, J.-W. Kang, H.-J. Lee[*], *K.-S. Lee*[*]
Dankook Univ., Korea
[*]*Korea Univ., Korea*

A gas type detector based on plasma display technology was investigated as a candidate for the flat-panel radiation detector. The sensitivity of Xe 100% detector was 0.20 nC/mR•cm^2 at the electric field of 0.36 V/μm and it is about a tenth lower compared to that of a-Se detector at 10 V/μm.

PDPp - 4L **Crystal Growth of MgO Thin Films with Co Nanoparticles Deposited Using Arc Plasma Gun**

H. Kosuga, H. Yoshioka[*], *S. Yamamoto*
Ryukoku Univ., Japan
[*]*Hyogo Pref. Inst. of Tech., Japan*

The MgO thin film on Co nanoparticles deposited using the APG with 500 pulses of arc discharge exhibited improved crystallinity and a photoelectron emission that was at least threefold higher than that of the MgO thin film without Co nanoparticles.

PDPp - 5L **New 3D Experimental AC-PDP Cell with Grooved Structure**

*T. Sakai, K. Tachibana**

Display Res. Labs., Japan
**Osaka Electro-Commun. Univ., Japan*

High efficiency PDP is still required commercially. Its solutions depend on the effective uses of positive column and metastable Xe atoms in the region. We made a new 3D experimental panel toward these aims.

Thursday, December 6

10:50 - 11:50 **Room C-2**

PDP1: Driving

Chair: Q. Yan, COC Display Device, China
Co-Chair: R. Murai, Panasonic, Japan

PDP1 - 1 10:50 **High Speed, Low Voltage Write Addressing of PDPs by Use of Extremely Weak Discharge for Priming**

M. Yoshita, T. Shiga

Univ. of Electro-Commun., Japan

Extremely weak discharge ignited just before the scan pulse provides priming effect to the addressing. The address discharge delay is reduced to less than half and the data voltage is reduced to 17 V when the scan voltage margin is 10 V. There is no increase in the background luminance.

PDP1 - 2 11:10 **Adaptive Subfield Data Optimization for Low Address Power in PDPs**

F. Han, X. Zhang, Z. Tu, W. Wang, Z. Liang

Xi' an Jiaotong Univ., China

Based on visual perception characteristics to image at different brightness level, adaptive subfield data optimization method for lower address power is proposed. The experimental results with IEC standard video displayed on 50-in. PDP show that the maximum and average address power are reduced by 25.8 W and 8.16%, respectively.

PDP1 - 3 11:30 **Effect of Transparent Electrode with High Resistance on PDP Luminance and Efficacy**

S. Nagano

Samsung SDI, Korea

The transparent electrode with ultra-high resistance could help high luminance and high luminous efficacy without boosting up the discharge voltage. Presumably the mechanism is that it restricts the peak current to accordingly promote moderate and long persistent discharge. The sheet resistance should be investigated around 10 k - 1 MΩ.

----- Lunch -----

14:00 - 15:15 **Room C-2**

PDP2: Ultra HDTV

Chair: Y.-S. Kim, Hongik Univ., Korea
Co-Chair: H. Kajiyama, Tokushima Bunri Univ., Japan

PDP2 - 1: 14:00 ***Invited*** **Development of 145-in. Diagonal SUPER Hi-VISION PDPs**

R. Murai, H. Abe, T. Oue, K. Ishii, Y. Murakami*, N. Shimidzu**

Panasonic, Japan
**NHK, Japan*

We have developed prototype full-resolution SUPER Hi-VISION (SHV) plasma display panel (PDPs) which has 4,320 scanning lines and over 33 million pixels with 0.417-mm pixel pitch by driving method. This SHV PDP was exhibited to the public at the International Broadcasting Center in the London during the 2012 Olympic Games.

PDP2 - 2: 14:20 ***Invited*** **Image Quality of 145-in. Diagonal SUPER Hi-VISION PDPs**

T. Usui, K. Ishii, N. Saito, T. Yamashita, N. Nakamura*, K. Nishimura**

NHK, Japan
**Panasonic, Japan*

We have developed a prototype full-resolution SUPER Hi-VISION (SHV) Plasma Display Panel (PDP) with 4,320 scanning lines and over 33 million pixels. Highly realistic SHV programs were reproduced successfully on a 145-in. diagonal PDP with a 0.417 mm pixel pitch using a new panel driving method.

PDP2 - 3 14:40 **Driving Characteristics of Ultrahigh Resolution PDPs with Twin-Path Coplanar Discharge Cells**

K. Ishii, Y. Hirano, T. Usui, T. Shiga, Y. Murakami*

NHK, Japan
**Univ. of Electro-Commun., Japan*

Write- and erase-address panel driving characteristics were investigated for a twin-path-type ultrahigh-resolution plasma display panel. The common scanning electrode structure increases the minimum addressing voltage. When the common electrode area is decreased, the decrease in the write-addressing voltage margin is notable compared with that of erase-addressing.

PDP2 - 4L 15:00 **Reduction of Address Period in 120-Hz Frame Rate PDP by Mixing Single-Line and Multi-Line Scanning**

C. Suzuki, T. Shiga

Univ. of Electro-Commun., Japan

Pixels are alternately scanned by single-line and multi-line scanning technique every frame. Errors caused by multi-line scanning are compensated with the help of summation property of human eye. The method shortens 25% address period when two lines are scanned simultaneously. PSNR of the images with the proposed method exceeds 40 dB.

----- Break -----

15:50 - 17:10 **Room C-2**

PDP3: Protective Layer

Chair: L. F. Weber, Consultant, USA
Co-Chair: K. Ishii, NHK, Japan

PDP3 - 1: 15:50 ***Invited*** **Mechanism of Seed Electron Emission from MgO Nano-Powders for AC PDPs**

J.-K. Kim, Y.-S. Kim[*]*, L. F. Weber*[**]

Seoul Nat. Univ. of S&T, Korea
[*]*Hongik Univ., Korea*
[**]*Consultant, USA*

Seed electron currents emitted by voltage pulses were measured using a highly-sensitive and fast-responding measuring apparatus. A short burst of seed electrons was emitted from MgO nano-powders upon voltage pulse application and its current density was ~4 orders of magnitude larger compared with that of exo-electron emission.

PDP3 - 2: 16:10 ***Invited*** **Manufacture Issues of Implementing $Ca_xMg_{1-x}O$ Protecting Layer for High Efficiency AC PDPs**

Q. Yan

COC Display Device, China

$Ca_xMg_{1-x}O$(CMO) has a merit of generating high secondary electron emission in high Xe content which results in high luminous efficacy PDP. The easy formation of $CaCO_3$ and $MgCO_3$ in manufacture process is a big challenge to mass production. Both technique and cost issues associated to this technology is discussed.

PDP3 - 3
16:30

Effect of Space between Rib and MgO Film on Temporal Image Sticking

S. Nagano

Samsung SDI, Korea

Space between ribs and the discharge surface relaxes the bright temporal image sticking caused by the residual charge that has been accumulated through prior sustain discharge. Effective reset of the charge around the longitudinal ribs could explain the phenomenon.

PDP3 - 4
16:50

Electron Trap Formation with UV Irradiation

H. Kajiyama[*], H. Tanaka[,**], T. Matsuura[*], A. Otomo[**], S. Inoue[**]*

[*]Tokushima Bunri Univ., Japan
[**]Hiroshima Univ., Japan

The control of trapped electrons in a protective layers is crucial to optimize the exoelectron emission in ac-PDPs. This paper studies the electron traps created by ultraviolet (UV) irradiation in the case of MgSnO films. It is shown the activation energy and electron aggregation states depend on UV dose.

Author Interviews and Demonstrations
17:30 – 18:30

Sponsor:
Plasma Display Technical Meeting

Workshop on EL Displays and Phosphors

Thursday, December 6

9:00 - 10:00 **Room C-2**

PH4: Phosphors Late News

Special Topics of Interest on Lighting Technologies

Chair: D. Y. Jeon, KAIST, Korea
Co-Chair: K. Hara, Shizuoka Univ., Japan

PH4 - 1L
9:00

A New Paradigm for Phosphor Discovery

*K.-S. Sohn, W. B. Park, M. Ibukiyama**

Sunchon Nat. Univ., Korea
**Denki Kagaku Kogyo, Japan*

We employed a non-dominated-sorting genetic algorithm (NSGA) for a preliminary screening of the multidimensional search space, and particle swarm optimization (PSO) for the ensuing fine-tuning. We also created a parameter designating the novelty of the phosphors, the so-called structural rank, and used it as an objective function in the NSGA.

PH4 - 2L
9:15

Selecting a White Point Using $(Y_{1-a}Gd_a)_3Al_5O_{12}:Ce^{3+}$ (Where a is in the Range 0.3 to 0.6) Phosphors on Screens and Two Blue LEDs

J. Silver, R. Withnall, P. Marsh

Brunel Univ., UK

$(Y_{1-a}Gd_a)_3Al_5O_{12}:Ce^{3+}$ (where a = 0.3 - 0.6) phosphors were synthesised, incorporated into inks and screen printed. The phosphors were used with blue LEDs to produce white light. The color point of the white light was fine tuned by varying parameters including the gadolinium concentration, phosphor layer thickness, and the LED emission wavelength.

PH4 - 3L
9:30

Luminescence Properties of Novel Nitride-Based Yellow Phosphor for White Light-Emitting Diodes

S. Takashina, A. Ohto

Mitsubishi Chem., Japan

We succeeded in synthesizing novel yellow phosphors with color coordinates from x = 0.417 to 0.475. We investigated the emission spectra of $La_3Si_6N_{11}$:Ce and its derivatives (LSN). We were able to create 9000 ~ 4000 K white light-emissions by combining various colored LSN and blue LEDs.

PH4 - 4L 9:45 **New Shape White LEDs with Uniform Hue**

H. Daicho, A. Nomura, K. Enomoto, Y. Shinomiya, S. Sugimori

Koito Manufacturing, Japan

We fabricated new shape white LEDs for general lighting. The white LEDs consist of a violet-chip and the thick phosphor layer, which contains blue and yellow emitting phosphors. The phosphor concentration of the phosphor layer is low. The excellent hue uniformity of our white LED will reduce color binning.

----- Break -----

14:00 - 15:20 **Room C-1**

PH1: Phosphors in EL

Chair: J. Silver, Brunel Univ., UK
Co-Chair: K. Ohmi, Tottori Univ., Japan

PH1 - 1: 14:00 ***Invited*** **Potential of SiC as a Rare-Earth-Free Fluorescent Material**

S. Kamiyama

Meijo Univ., Japan

Donor-acceptor-pair recombination mechanism in fluorescent-SiC doped with N and B were investigated. The control of C/Si ratio in the growth ambient was found to be important to suppress the non-radiative recombination and light absorption losses. The maximum internal quantum efficiency of 40% was obtained, despite of no surface passivation.

PH1 - 2: 14:30 ***Invited*** **Design Considerations of Phosphor Layer for a High Efficacy AC Powder EL**

K. Wani, T. Kanda, E. Hashimoto

TAZMO, Japan

An AC powder EL that demonstrates high efficacy of >20 lm/W using original design method for the phosphor layer will be discussed. Newly developed phosphor layer consists of organic-inorganic hybrid binder. The design parameters and the performance of the experimental device will be presented in detail.

PH1 - 3 15:00 **Eco-Friendly AC Electroluminescent Lamps**

R. Withnall, J. Silver, P. G. Harris

Brunel Univ., UK

AC electroluminescent lamps have been fabricated on biodegradable substrates in order to investigate possibilities of minimising the waste resulting from opto-electronic devices at the end of life. The performance characteristics of these eco-friendly ACEL lamps have been investigated.

----- Break -----

15:50 - 17:30 **Room C-1**

PH2: Phosphors in General

Chair: K.-S. Sohn, Sunchon Nat. Univ., Korea
Co-Chair: R. J. Xie, NIMS, Japan

PH2 - 1: 15:50 ***Invited*** **Phosphors for High Quality LED Lighting**

H. Winkler, A. Benker, C. Hampel, R. Petry, A. Zych
Merck KGaA, Germany

In this paper we discuss the impact of dichromatic versus trichromatic white LEDs on color rendition. Trichromatic LEDs offer a larger flexibility in color temperature alignment and much better color rendition. In addition the color consistency of the LEDs is studied.

PH2 - 2: 16:20 ***Invited*** **Novel Plasmonic Hybrid Phosphor for White Light Emitting Diodes**

K. C. Choi, S. M. Lee, M. Kim
KAIST, Korea

We demonstrated a plasmonic enhancement function of Au nanoparticles for highly efficient phosphor-converted white light emitting diodes. Au nanoparticles selectively improved the luminescence intensity from visible lighting phosphors by spectral overlap with localized surface plasmon resonance. The optimal concentration of Au nanoparticles on yellow phosphors was estimated through photoluminescence measurement.

PH2 - 3 16:50 **Suppression of $SrGa_2S_4$:Eu Phosphor Degradation by Glass Coating and Adding ZnO Nanosize Particles**

M. Daimon, T. Yamasuge, T. Kusunoki
Dexerials, Japan

$SrGa_2S_4$:Eu phosphor has excellent optical properties. However, it undergoes decomposition while releasing H_2S that corrodes the electrodes under hygrothermal conditions. Consequently, we attempted to reduce its exposure to moisture by glass coating using the sol-gel method and avoid to releasing H_2S from the phosphor by adding ZnO as adsorbent particles.

PH2 - 4 17:10 **Synthesis and Luminescent Properties of Eu^{2+}-Doped $La_2Si_6O_3N_8$ Phosphors Prepared by Spark Plasma Sintering**

B. Kim, E.-H. Kang, S.-H. Hong
Seoul Nat. Univ., Korea

A new phosphor, bluish green emitting $La_2Si_6O_3N_8:Eu^{2+}$ was successfully prepared by SPS. The phase, morphology, and luminescence properties were investigated. The obtained $La_2Si_6O_3N_8:Eu^{2+}$ phosphors were excited at near UV region, and showed a bluish green emission band centered at 485 nm. Also, the temperature dependence of photoluminescence was measured.

Author Interviews and Demonstrations
17:30 – 18:30

Friday, December 7

9:20 - 12:20 **Event Hall**

Poster **PHp: Phosphors**

PHp - 1 **Novel Oxynitride Phosphors; $La_{4-x}Ca_xSi_{12}O_{3+x}N_{18-x}:Eu^{2+}$ and $Ce_{4-x}Ca_xSi_{12}O_{3+x}N_{18-x}:Eu^{2+}$**

W. B. Park, Y. Jeong, K.-S. Sohn

Sunchon Nat. Univ., Korea

The performance of the $La_{4-x}Ca_xSi_{12}O_{3+x}N_{18-x}:Eu^{2+}$ and $Ce_{4-x}Ca_xSi_{12}O_{3+x}N_{18-x}:Eu^{2+}$ phosphors was brilliant in terms of PL intensity and color chromaticity at blue and UV excitations. The PL intensity and color chromaticity of the $La_{4-x}Ca_xSi_{12}O_{3+x}N_{18-x}:Eu^{2+}$ and $Ce_{4-x}Ca_xSi_{12}O_{3+x}N_{18-x}:Eu^{2+}$ phosphors were comparable to commercially available yellow phosphors for use in LED applications.

PHp - 2 **Solid-State Combinatorial Screening of (Sr, Ba, Ca) (Y, La, Lu)$Si_4N_7:Eu^{2+}$ Phosphors**

Y. Jeong, W. B. Park, K. H. Son, K.-S. Sohn

Sunchon Nat. Univ., Korea

$ARSi_4N_7:Eu^{2+}$ (A = Sr, Ca, Ba; R = Y, La, Lu), so as to obtain a quantitative structure and property relationship (QSPR) in a systematic manner. Most of the samples constituting the double-ternary combi-chem library turned out to have $ARSi_4N_7$ structures with a $P6_3mc$ space group.

PHp - 3 **Particle Swarm Optimization-Assisted Discovery of a Novel Oxynitride Phosphor for Use in Light Emitting Diodes and Its Structural Determination**

Y. Song, K. H. Son, W. B. Park, K.-S. Sohn

Sunchon Nat. Univ., Korea

We discovered a novel oxynitride phosphor in the SrO-BaO-CaO-Si_3N_4 quaternary composition search space, and identified it as a monoclinic structure in the C2/m space group. The exact structure and stoichiometry is now being determined, using direct method and ensuing Rietvelt refinement based on synchrotron X-ray diffraction data.

PHp - 4 **Withdrawn**

PHp - 5 **Synthesis of $SrGa_2S_4$:Eu Phosphors by Solvothermal Sulfurization Method**

K. Taniguchi, Y. Nishikata, A. Kato

Nagaoka Univ. of Tech., Japan

$SrGa_2S_4$:Eu fine particles were obtained by sulfurizing $SrGa_2O_4$:Eu nanoparticles synthesized by solvothermal method (solvothermal sulfurization method). The ratio of residual oxygen is successfully suppressed to the same level of solid state reaction. These $SrGa_2S_4$:Eu fine particles are expected to be utilized for inorganic electroluminescent devices.

PHp - 6 **Preparation of $SrGa_2S_4$:Eu Films by Spray Pyrolysis Sulfurization Method**

Y. Tani, A. Kato

Nagaoka Univ. of Tech., Japan

$SrGa_2S_4$:Eu films were obtained by sulfurizing films prepared by spray pyrolysis method. The films are identified to be $SrGa_2S_4$:Eu by powder X-ray diffraction analyses and exhibit a broad emission around 530 nm due to 5d-4f transition in Eu^{2+}. These $SrGa_2S_4$:Eu films are expected to be utilized for inorganic electroluminescent devices.

PHp - 7 **Coating Method of ZnS Layer for InP Quantum Dot by Solvothermal Method**

S. Akiyama, N. Funaki, T. Kurabayashi, T. Fukuda, N. Kamata, Y. Ishimaru

Saitama Univ., Japan

A ZnS layer was coated around InP quantum dot (QD) by a solvothermal process. The photoluminescence (PL) quantum yield was improved by optimizing the annealing temperature, and the highest value was 42.2%. In addition, emission peak was changed from 532 nm to 629 nm by a size-sorting process.

PHp - 8 **Temperature Dependence of PL Excitation Spectra of $BaMgAl_{10}O_{17}$:Eu in VUV Region**

K. Nakamura, T. Kunimoto[*], T. Honma[**], K. Ohmi

Tottori Univ., Japan
[*]Tokushima Bunri Univ., Japan
[**]JASRI, Japan

A temperature dependence of photoluminescence excitation spectra in vacuum-UV (VUV) region has been investigated to clarify the de-excitation mechanism in $BaMgAl_{10}O_{17}$:Eu. The internal quantum efficiency of the raw sample under VUV excitation is above 84%. Contrary, that of the degraded sample baked at 700˚C is mere 32%.

PHp - 9 **Synthesis and Luminescence Properties of Stoichiometry-Controlled YAGG:Ce Phosphors under Vacuum UV Excitation**

M. Wu, S. Choi, H.-K. Jung

Korea Res. Inst. of Chem. Tech., Korea

Ce-doped yttrium aluminum gallium garnet ($Y_3(Al,Ga)_5O_{12}:Ce^{3+}$, YAGG:Ce) phosphors with the control of stoichiometry were synthesized by solid-state method. Photoluminescence properties of stoichiometry-controlled YAGG:Ce phosphors were investigated under vacuum UV excitation of 147 nm. The luminance of YAGG:Ce phosphors with non-stoichiometric compositions were higher than that of stoichiometric phosphor.

PHp - 10 **Problem-Solving Methods of Design and Research of the Thin Film Electroluminescent Element in Indicator Devices**

D. A. Evsevichev, O. V. Maksimova, S. M. Maksimov, M. K. Samokhvalov

Ulyanovsk State Tech. Univ., Russia

Thin-film electroluminescent display is one of the most promising indicator devices. This article describes main charcteristics of those displays and relations between them. The result of this research work is the development of the computer-aided design system of the thin film electroluminescent element that solves design and research problems.

PHp - 11 **Thin Film Perovskite Electroluminescence with Ferroelectric $BaTiO_3$ Films as Insulating Layers**

*H. Takashima, N. Miura**

AIST, Japan

**Meiji Univ., Japan*

Electroluminescence with $BaTiO_3$(BTO) / $((Ca_{0.6}Sr_{0.4})_{0.997}Pr_{0.002})TiO_3$ (PSCTO) / BTO thin films at 1 kHz ac source was obtained with the driving voltages around 8 V by visual estimation. With further increasing driving voltages, intensity of electroluminescence dramatically increased.

PHp - 12 **Preparation and PL/EL Property of Rare-Earth Doped Perovskite Metal Oxide Nano Crystals Using Supercritical Water Method**

Y. Hakuta, K. Minami, M. Aoki, M. Ohara, K. Sue, Y. Takebayashi, S. Yoda, H. Takashima

AIST, Japan

We report that preparation and PL/EL property of Pr doped Perovskite type metal oxide nanoparticles via supercritical hydrothermal synthesis method. The particles obtained under supercritical water condition were highly crystalline nanoparticles with Perovekite structure. These particles showed bright red emission induced by both UV irradiation and applying electric field.

PHp - 13 **High Flexibility ACEL Lamps Printed Directly onto Cloths**

R. Withnall, J. Silver, P. G. Harris

Brunel Univ., UK

ACEL lamps have been printed directly onto certain types of coated cloths. These ACEL lamps exhibit high flexibility and impressive brightness and can be incorporated into clothing.

PHp - 14 **Utilising Wavelength Converting Phosphor Nanoparticles for Applications in Solar Cells**

J. Silver, R. Withnall, T. G. Ireland, P. W. Reip[*]*, S. Subbiah*[*]

Brunel Univ., UK
[*]*Intrinsiq Materials, UK*

Nanometre sized phosphor particles have been produced on an industrial scale. The phosphors can be used as wavelength convertors in solar cells, and because they downconvert UV and blue light they protect the solar cells polymers from degradation thereby prolonging cell life as well as increasing efficiency.

PHp - 15 **Accelerated Ageing Studies of CaS:Eu^{2+} and SrS:Eu^{2+} Phosphors**

R. Withnall, J. Silver, M. Ghazli, C. Catherall, J. J. Ojeda

Brunel Univ., UK

The stabilities of CaS:Eu^{2+} and SrS:Eu^{2+} phosphors have been studied when they are subjected to accelerated ageing under conditions of 80% relative humidity and temperatures in the range of 50-80°C. The stability of the CaS:Eu^{2+} phosphor with an ALD coating of Al_2O_3 is also investigated.

PHp - 16 **Effects of Phosphor Distribution and Step-Index Remote Configuration on the Luminous Efficacy of Warm White Light-Emitting Diodes**

H.-Y. Tsai, T.-H. Liu, H.-Y. Kuo, H.-Y. Lin, S.-Y. Chu

Nat. Cheng Kung Univ., Taiwan

This paper demonstrated that Y down / R up type is the preferable phosphor distribution for warm pc-WLEDs. Compared with common warm pc-WLEDs using silicone gel as the remote layer, a step-index remote configuration proposed herein exhibited a superior luminous efficacy at 67.4262 lm/W under 350 mA.

PHp - 17 **Withdrawn**

PHp - 18 **Recent Progress in the Development of Ce^{3+}-Activated Fluorosulfide and Fluorooxysulfide Phosphors for LED Lighting**

T.-M. Chen, Y.-C. Wu, C.-S. Lee, S.-N. Chen

Nat. Chiao Tung Univ., Taiwan

Several novel Ce^{3+}-activated $Y_2(Ca,Sr)F_4S_2$, α- and β-YSF, and $Y_3S_2OF_3$ fluorosulfide and fluorooxysulfide phosphors, have been synthesized and luminescence was investigated. Fluorosulfide-based phosphors can be excited by blue light and shows yellow-to-orange and red broadband emissions, respectively. Recent progress on the synthesis and structure-luminescence relationship of these phosphors is discussed.

PHp - 19 **Selecting a Red Point Using CaS:Eu^{2+} and SrS:Eu^{2+} Phosphors on Screens and One Blue LED**

J. Silver, R. Withnall, P. J. Marsh

Brunel Univ., UK

Screen printing inks containing various CaS:Eu^{2+}:SrS:Eu^{2+} ratios were prepared. The phosphors were printed on screens which were excited by blue LED light to produce red emission. The color point of the red light can be fine tuned by varying the CaS:Eu^{2+}:SrS:Eu^{2+} ratios, printed phosphor thickness, particle size and morphology.

PHp - 20L **Photo-Luminescence of Carbon Nitride Films for Application to White Light Emitting Device**

M. Satake, J. Sawahata, K. Itoh*, K. Takarabe**, K. Fukui***, S. Yamamoto*

Ryukoku Univ., Japan
**Tsuyama Nat. College of Tech., Japan*
***Okayama Univ. of Sci., Japan*
****Univ. of Fukui, Japan*

We fabricated amorphous carbon nitride by radio-frequency sputtering method. The results of PL have shown that the spectrum of the sample grown in only N_2 gas atmosphere has 400 nm – 650 nm wavelength, while that of the sample grown in the mixture of N_2, Ar, and CH_4 gas has 450 nm – 750 nm wavelength.

PHp - 21L **Evaluation of Distributed Inorganic Electroluminescence (EL) Devices with Comb Electrodes**

T. Nonaka, Y. Uraoka, N. Taguchi**, S. Yamamoto*

Ryukoku Univ., Japan
**NAIST, Japan*
***Image Tech, Japan*

It may be possible to produce a display that does not require transparent electrodes by using the phosphor layer side of a device with comb electrodes made of metals, such as Au, for the front side of the display.

PHp - 22L **Luminescence Properties of $Na_{0.34}Ca_{0.66}Al_{1.66}Si_{2.34}O_8:Eu^{2+}$ Phosphor Synthesized by Sol-Gel Method**

G.-Y. Lee, J. Y. Han, W. B. Im, S. H. Cheong, A. Kirakosyan, D. Y. Jeon*

KAIST, Korea
**Chonnam Nat. Univ., Korea*

A blue-emitting $Na_xCa_{1-x}Al_{2-x}Si_{2+x}O_8:Eu^{2+}$ (x = 0.34) (NCASO:Eu^{2+}) phosphor was developed by a sol-gel method. The phosphor shows a bright blue emission peaking at 440nm under UV excitation. In addition, the shape of PL changed and red-shifted due to energy transfer among four Eu sites as Eu^{2+} contents was increased.

PHp - 23L **Photoluminescent Properties of Mn-Doped Deep Red Emitting Phosphors under Blue and UV Excitations**

H. Kominami, T. Ishinaga, Y. Nakanishi, K. Hara

Shizuoka Univ., Japan

Photoluminescent properties of $Mg_2(Ti_{0.99-x-y},Ge_x,Si_y)O_4$:Mn phosphor for white-LED was studied. The powders showed deep-red emission under blue-light excitation. The PL intensity depended on the ratio of IV atoms. It was found that the multinary compounds showed higher luminescence. It indicates that the deflection of the composition has influence on the emission.

PHp - 24L **Shape Evolution of $CuInS_2$/ZnS Core/Shell Nanocrystals during the Growth of ZnS Shell: The Effect of Temperature and Zn Amount**

Y. Kim, H. Kim, E.-S. Kim, T. Lee, D. Y. Jeon*

KAIST., Korea
**Samsung Advanced Inst. of Tech., Korea*

The evolution of morphology and luminescence of $CuInS_2$/ZnS core/shell nanocrystals (NCs) during ZnS shell passivation were studied. The reaction temperature was shown to directly determine the morphology of NCs from tetrahedron to cube, and the emission peak of NCs was predominantly controlled by the amount of Zn.

----- Lunch -----

15:50 - 17:20 **Room B-2**

PH3: Phosphors for Lighting
Special Topics of Interest on Lighting Technologies

Chair: T.-M. Chen, Nat. Chiao Tung Univ., Taiwan
Co-Chair: T. Hisamune, Mitsubishi Chem., Japan

PH3 - 1: 15:50 ***Invited*** **Progress in Developing High-Power InGaN LEDs for Illumination**

K. Bando

Nichia, Japan

High-power LEDs for general lightings are reviewed. Blue chip with high reflection structure is shown to have an excellent performance of 743 mW, EQE 77% at 350 mA. White chip exhibits 181 lm/W. New technology such as phosphor coating on the chip topside and improving CRI by multi-phosphor system are developed.

PH3 - 2 16:20 **A Phosphor Sheet Providing Wider Color Gamut for LCDs**

Y. Ito, T. Hori, H. Tani, T. Kusunoki, H. Kondo

Dexerials, Japan

A phosphor sheet in which thiogallate green and sulfide red phosphor are contained has been developed. Good color gamut performance of 90% NTSC-xy can be realized by a LCD with that. It has moisture barrier layers on the surface, which can reduce the reaction between these phosphors and moisture.

PH3 - 3 16:40 **Improved Display Color Gamut by Using the β-SiAlON Green Phosphor with an Asymmetric Emission Spectrum**

K. Yoshimura, K. Takahashi, H. Fukunaga, M. Harada, Y. Tomomura, R.-J. Xie[*], N. Hirosaki[*], T. Takeda[*]

Sharp, Japan
[*]NIMS, Japan

The effect of the emission spectrum shape of β-sialon($Si_{6-z}Al_zO_zN_{8-z}$): Eu^{2+} on the characteristics of liquid crystal display with LED backlight is analyzed. The asymmetric spectrum which enhanced in accordance with the decrease of z value is clarified to contribute largely to the improvement of display color gamut.

PH3 - 4 17:00 **$Si^{4+}$and Si^{4+}-N^{3-} Incorporation into YAG:Ce^{3+} and Its Verification in Luminous Efficacy and Color Rendering Enhancement of Phosphor-Converted White Light-Emitting Diodes**

T.-H. Liu, H.-Y. Kuo, H.-Y. Lin, S.-Y. Chu

Nat. Cheng Kung Univ., Taiwan

This paper demonstrated that the luminous efficacy of the YAG-based white light-emitting diode was improved from 74.3 to 83.7 lm/W with substitution of 0.1 mol Si^{4+} for Al^{3+} while the color rendering index was improved from 67.1 to 79.2 with substitution of 0.2 mol Al^{3+}-O^{2-} by Si^{4+}-N^{3-} under 350 mA.

Author Interviews and Demonstrations
17:30 – 18:30

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

Workshop on Field Emission Display and CRT

Friday, December 7

9:00 - 9:10 **Room C-1**

Opening

Opening Remarks
9:00

M. Takai, Osaka Univ., Japan

9:10 - 10:40 **Room C-1**

FED1: CNT Emitters & Applications

Chair: H. Mimura, Shizuoka Univ., Japan
Co-Chair: H. Shimawaki, Hachinohe Inst. of Tech., Japan

FED1 - 1: 9:10 ***Invited*** **High Performance Field Emission from CNT Based Point Emitters**

D. H. Shin, Y. N. Song, Y. Sun, Y. M. Hwang, S. Y. Lee, K.-N. Yun, J. H. Shin, C. J. Lee

Korea Univ., Korea

CNT based point emitters are considered as a powerful candidate for high performance X-ray tube or electron beam source applications. Because CNT point X-ray tube can promise high speed response time, a small electron beam spot and long lifetime. Here, we evaluate their field emission properties and field emission stability.

FED1 - 2 9:40 **Evaluations for Processed Graphite Field Emitters and Its Applications**

*Y. Iwai, A. Jyouzuka, T. Koike, Y. Hayama, T. Nakamura, Y. Onizuka, H. Mimura**

Onizuka Glass, Japan
**Shizuoka Univ., Japan*

The characteristics of processed graphite field emitters named graphite nanospines (GNS) and graphite field emitter inflamed at high temperature (GFEIHT) have been investigated. Those emitters can emit a relatively larger current of 2 mA. We also report X-ray tubes using those emitters and its applications.

FED1 - 3
10:00

Field Emission Property of Carbon Nanotube Electron Source Using Side-Gate Electrode

S. Nitta, S. Abo, F. Wakaya, M. Takai

Osaka Univ., Japan

A Carbon nanotube (CNT) electron source using side-gate electrodes solves the issues of the gate metal structure in a gated CNT electron source. In this study, CNT electron sources using side-gate electrodes are fabricated and their field emission characteristics are evaluated in a triode configuration.

FED1 - 4
10:20

Enhanced Field Emission Display with Carbon Nanotube Emitters Grown by Resist-Assisted Patterning Process

S. W. Lee, Y. J. Eom, C. Y. Kim[*]*, C.-R. Lee*[*]*, J. Jang, K. C. Park*

Kyung Hee Univ., Korea
[*]*SNDisplay, Korea*

Field emission display (FED) was fabricated with carbon nanotube (CNT) emitters grown by resist-assisted patterning (RAP) process. Electron emission current uniformity was strongly improved by homogenizing process with silicon-on glass (SOG). We fabricated 3-in. FED with 32 μm sub-pixel size with the CNT emitters.

----- Break -----

10:50 - 12:10 **Room C-1**

FED2: Applications & New Materials

Chair: M. Sasaki, Univ. of Tsukuba, Japan
Co-Chair: F. Wakaya, Osaka Univ., Japan

FED2 - 1
10:50

X-Ray Imaging Using an Electron Beam

Y. Neo, R. Suzuki, T. Aoki, H. Mimura

Shizuoka Univ., Japan

We present the results on X-ray imaging that consists of a CdTe Schottky diode and a SEM. We investigated two methods for reading out. The output current varied linearly and nonlinearly with intensity and the energy, respectively. In addition, an X-ray transmission image of a 200-μm stainless-steel mesh was obtained.

FED2 - 2
11:10

Vacuum Switch with Negative Electron Affinity of Diamond p-i-n Electron Emitter

D. Takeuchi[,***,****], S. Koizumi[**,****], T. Makino[*,***,****], H. Kato[*,***,****], M. Ogura[*,***,****], H. Okushi[*,***,****], H. Ohashi[*,***,****], S. Yamasaki[*,***,****]*

[*]*AIST, Japan*
[**]*NIMS, Japan*
[***]*JST-ALCA, Japan*
[****]*JST-CREST, Japan*

This paper presents experimental results of a vacuum switch with negative electron affinity of diamond p-i-n electron emitter with 10 kV off and 13 V on-voltages at RT. A model for the vacuum switch proves a principle of vacuum switches over 100 kV with an efficiency beyond 99.9%.

FED2 - 3
11:30

Observation of Cathodoluminescence of Germanium-Implanted Quartz Glass Excited by Low-Energy Electrons Emitted from Silicon Field Emitter Array

H. Tsuji, A. Sakata, G. Miyagawa, Y. Yasutomo, Y. Gotoh

Kyoto Univ., Japan

Cathodoluminescence of germanium implanted quartz glass was investigated. An electron beam emitted from a silicon field emitter array was used to excite the sample. Violet-blue luminescence was observed at the electron energy of 240 eV.

FED2 - 4
11:50

Cathodoluminescence in $((Ca_{0.6}Sr_{0.4})_{0.997}Pr_{0.002})TiO_3$ Perovskite Films

H. Takashima, M. Nagao

AIST, Japan

Thin-film cathodoluminescence has been successfully obtained in the chemically stable perovskite oxide $((Ca_{0.6}Sr_{0.4})_{0.997}Pr_{0.002})TiO_3$ thin films. By using the field emitter with a gate electrode for the source of electrons, high-quality red color and whole-surface intense cathodoluminescence (CL) was observed.

----- Lunch -----

14:00 - 15:20 **Room C-1**

FED3: Fabrication Processes

Chair: C. J. Lee, Korea Univ., Korea
Co-Chair: Y. Gotoh, Kyoto Univ., Japan

FED3 - 1
14:00

Vertical Thin Film FEA for Large-Sized Applications

T. Yoshida, T. Nishi, M. Nagao

AIST, Japan

We have proposed simple fabrication of field emitter array based on conventional thin film process. In our method, a bending thin film that is bent up by ion-beam irradiation is used as an emitter tip. The advantage of our process is having high compatibility with MOS and TFT processes.

FED3 - 2
14:20

Spindt-Emitter Fabrication without E-Beam Deposition

*T. Yoshida, M. Nagao, T. Nishi, N. Koda, T. Nakano**

AIST, Japan
**Seikei Univ., Japan*

A new fabrication method of Spindt-type emitters will be presented. In our method, a double-layered photoresist is used as a parting layer, and high-power impulse magnetron sputtering is used instead of e-beam evaporator for emitter-cone formation. The etch-back method is adopted to form the multi-gate electrodes on each emitter cone.

FED3 - 3
14:40

Selective-Area Growth and Field Emission Properties of Titanium-Oxide Nanowires on Glass Substrate

T. Nakatani, F. Wakaya, S. Abo, M. Takai

Osaka Univ., Japan

A two-dimensional array of a 10-μm-diameter Ti/Au disk with a pitch of 50 μm was prepared on a glass substrate by electron-beam lithography. Titanium-oxide nanostructures were fabricated by oxidation and annealing of the array. Field-emission current was observed at an applied electric field over approximately 10 V/μm.

FED3 - 4
15:00

Effect of H_2SO_4 Concentration on Nano-Porous Silicon Morphology and Electron Emission Characteristic

X. Duan, X. Zhang, W. Wang, C. Liu,

Xi 'an Jiaotong Univ., China

Increasing the concentration of H_2SO_4 in ECO, oxide film in porous silicon becomes thicker. Crevices appear on the surface when concentration is not less than 1.5 mol/L. Samples without crevices have stable electron emission and good consistency. The maximum emission current density and efficiency are 27.2 $\mu A/cm^2$ and 5.9‰, respectively.

----- Break -----

15:50 - 16:50 **Room C-1**

FED4: Fundamental Mechanisms

Chair: M. Takai, Osaka Univ., Japan
Co-Chair: Y. Neo, Shizuoka Univ., Japan

FED4 - 1
15:50

Work Function Measurements of W(100) Surface Modified by Scandium Oxide by Using Photoemission Electron Microscopy and Field Emission Microscopy

T. Kawakubo, H. Takeda[*]*, H. Nakane*[*]

Kagawa Nat. College of Tech., Japan
[*]*Muroran Inst. of Tech., Japan*

It is well known that the work function of w(100) surface is reduced after application of a very thin surface layer of transition metal and heating in an oxygen environment. In this research, we measured the work function of W(100) surface modified by Sc oxide by using PEEM and FEM.

FED4 - 2
16:10

Field Emission from the Arc-Prepared Carbon Films

S. Horie, T. Endo, T. Higuchi, Y. Yamada, M. Sasaki

Univ. of Tsukuba, Japan

We have found that the threshold field for FE from a blunt W tip is much reduced by coating it with the arc-prepared carbon film. The FEM, however, shows a featureless image, indicating no nano-protrusions. The mechanism will be discussed on the basis of the FIM/FIM and STM observations.

FED4 - 3
16:30

Photoassisted Electron Emission from MOS Cathodes Based on Nanocrystalline Silicon

H. Shimawaki, Y. Neo[*]*, H. Mimura*[*]*, F. Wakaya*[**]*, M. Takai*[**]

Hachinohe Inst. of Tech., Japan
[*]*Shizuoka Univ., Japan*
[**]*Osaka Univ., Japan*

We have investigated the photoresponse of electron emission from metal-oxide-semiconductor (MOS) cathodes based on nanocrystalline silicon (nc-Si) induced by blue diode laser pulses. The rise and fall times of photoresponse were confirmed at least less than 4 μs.

Author Interviews and Demonstrations
17:30 – 18:30

Sponsor:
JSPS 158th Committee on Vacuum Nanoelectronics

Workshop on OLED Displays and Related Technologies

Thursday, December 6

9:00 - 10:00 **Room A**

OLED1: Keynote and Future Trend

Chair: S. Naka, Univ. of Toyama, Japan
Co-Chair: T. Komatsu, Panasonic, Japan

OLED1 - 1: 9:00 ***Invited*** **OLED Display Market: What Is the Killer Application?**

J. Masuda

IHS-iSuppli, Japan

Small OLED (AMOLED) displays have become a popular choice in mobile devices. The market requires thinner lighter weight, improved durability and reduced power. AMOLED is well positioned to satisfy each of these requirements. For larger AMOLED TV displays the "killer" specifications could be improved power efficiency with excellent image quality.

OLED1 - 2 **Withdrawn**

OLED1 - 3: 9:30 ***Invited*** **Light Extraction from OLEDs with Plasmonic Structures**

T. Okamoto

RIKEN, Japan

Three kinds of plasmonic structures for effectively extracting the light energy trapped as surface plasmons at the cathode surface of organic light emitting diodes are proposed. The employed plasmonic structures are a plasmonic crystal, a metal-insulator-metal layer, and a plasmonic crystal combined with donor and acceptor layers.

----- Break -----

10:50 - 12:25 **Room A**

OLED2: Micro OLED Display

Chair: K. Monzen, Nissan Chem., Japan
Co-Chair: Y. Kijima, Sony, Japan

OLED2 - 1: *Invited* High-Brightness and High Resolution AMOLED Microdisplay
10:50

A. Ghosh, I. Wacyk, T. Ali, I. Khayrullin, O. Prache, S. Zeismer

eMagin, USA

eMagin's new generation AMOLED microdisplays, including a full color 9.6 μm pixel pitch WUXGA (1920x1200), 9.6 μm pixel pitch SXGA-096 (1280x1024) high brightness (>27,000 cd/m^2) green microdisplay and an 8.1 μm pixel pitch SXGA test device is presented. These developments are aimed at next-generation "see-through" and daylight imaging HMDs.

OLED2 - 2: *Invited* High Resolution OLED Microdisplays for Electronic Vision Systems
11:15

G. Haas, E. Marcellin-Dibon

MICROOLED, France

We discuss some of the technical challenges related to OLED microdisplay design and manufacturing, and present results obtained on our 0.38-in. diagonal WVGA display with 1.7 millions independent subpixels as well as on our 0.61-in. diagonal SXGA microdisplay with 5.4 millions of independent subpixels.

OLED2 - 3 Organic Microdisplays for Interactive Head-Mounted Applications
11:40

K. Fehse, C. Schmidt, M. Thomschke, R. Herold, B. Richter, U. Vogel

Fraunhofer IPMS, Germany

This paper deals with the development of an OLED microdisplay that provides integrated photodiodes within the CMOS backplane. By using electrically doped charge transport layer as well as a white emitter system with color filter, the VGA microdisplay achieves several orders of luminance with RGBW sub pixel concept.

OLED2 - 4L: *Invited* 0.5-In. XGA Micro-OLED Display on a Silicon Backplane with High Definition and High Performance
12:00

J. Yamada, Y. Onoyama, E. Kambe, J. Yamashita, H. Kitagawa, E. Hasegawa, A. Makita, S. Yokoyama, R. Asaki, M. Nakamura, T. Nishimura, K. Uchino, S. Makimura, Y. Shiraishi, T. Urabe

Sony, Japan

We have developed a high-definition (0.5-in. XGA) Micro-OLED display that employs a new pixel driving circuit and a new high-efficient and stable top-emitting white OLED. These technologies were incorporated in the world's first XGA OLED electronic viewfinder for digital single-lens cameras and HD-personal 3D viewer with two 720p Micro-OLED displays.

----- Lunch -----

14:00 - 17:00 **Event Hall**

***Poster* OLEDp: OLED Technologies**

OLEDp - 1 **The Effect of Inorganic/Organic Hybrid Quantum-Well Structure on Efficient White Organic Light Emitting Devices**

Y.-C. Chen, M.-H. Wu, S.-Y. Chu, P.-C. Kao[*]

Nat. Cheng Kung Univ., Taiwan
[*]Nat. Chiayi Univ., Taiwan

In this study, the effect of MQW structures adopting inorganic material (sodium fluoride) has been demonstrated. Brightness, current efficiency was significantly enhanced with a NaF/NPB MQW structure being inserted. The admittance spectroscopy was measured to explain the different mechanism of reducing hole between organic/organic inorganic/organic MQW structures.

OLEDp - 2 **Ultra Violet OLED with Organic Fluorescent Down-Conversion Layer: Fabrication of White OLED**

H.-W. Lu, P.-C. Kuo[*], S.-Y. Chu

Nat. Cheng Kung Univ., Taiwan
[*]Nat. Chiayi Univ., Taiwan

WOLEDs have been considered as a promising candidate of solid-state lighting for two decades. The UV-OLEDs have been studied, and adopted fluorescent materials as down-conversion layer on the back side of the ITO substrate. A wide area of the WOLEDs has been demonstrated and the CIE coordinates achieves (0.28,0.33).

OLEDp - 3 **High Efficiency and Low Efficiency Roll-Off White Phosphorescent Organic Light-Emitting Devices with Double Emissive Layers**

B. Y. Lin, Y. H. Lan[*], T.-L. Chiu[**], C.-F. Lin[*], J. H. Lee

Nat. Taiwan Univ., Taiwan
[*]Nat. United Univ., Taiwan
[**]Yuan Ze Univ., Taiwan

We reported a high efficiency and low efficiency roll-off white phosphorescent organic light-emitting device (WPHOLED) with double emitting layer (DEML) as base. The white OLED exhibited a peak current efficiency of 45.37 cd/A, power efficiency of 35.64 lm/W, and external quantum efficiency (EQE) of 17.06%, respectively.

OLEDp - 4 **TRZ-Based Material as the Host of Blue Phosphorescent Organic Light-Emitting Device**

T. Y. Hung, Y. H. Lan[*], B. Y. Lin, P. Yin, T. L. Chiu[**], M. K. Leung, C. F. Lin[*], J. H. Lee

Nat. Taiwan Univ., Taiwan
[*]Nat. United Univ., Taiwan
[**]Yuan Ze Univ., Taiwan

We fabricated organic light emitting devices (OLED) with 2,4,6-triphenyl-1,3,5-triazne (TRZ) as the host of the emitting layer (EML). In this paper we will discuss the performance of TRZ devices on difference concentrations.

OLEDp - 5 **Durable Ag Alloy Reflective Anode Electrodes for Top Emission Organic Light-Emitting Diodes**

H. Goto, Y. Shida, Y. Iwanari, Y. Tauchi, E. Kusumoto[*], T. Kugimiya

Kobe Steel, Japan
[*]Kobelco Res. Inst., Japan

We have developed highly reflective and oxidation resistive Ag-Zn alloy reflective anode electrodes for top emission organic light-emitting diodes (OLEDs). The reflectivity of the stacked ITO/Ag-Zn/ITO electrode was virtually unchanged after UV irradiation due to ZnO barrier layer formation against oxygen diffusion.

OLEDp - 6 **Study of Luminance and Thermal Distribution in OLEDs**

M. Shibasaki, T. Tamura, M. Inui, Y. Azuma, T. Satoh, T. Uchida

Tokyo Polytechnic Univ., Japan

We studied the luminance and thermal distributions in organic light-emitting diodes (OLEDs) and examined their relationship. In transparent OLEDs, luminance degradation at the cathode was remarkable and an area of high thermal distribution was observed. We have demonstrated that a full cover sealing OLEDs have better thermal distribution characteristics.

OLEDp - 7 **Comparison among Various Hole-Injection Layers in Blue Organic Light Emitting Diode**

Y.-T. Chuang, T.-L. Chiu, P.-Y. Lee, C.-F. Lin[*], J.-H. Lee[**]

Yuan Ze Univ., Taiwan
[*]Nat. United Univ. Taiwan
[**]Nat. Taiwan Univ., Taiwan

The MoO_3, WO_3, and mCP doped with them MoO_3:mCP; WO_3:mCP were employed as hole injection layers to probe the hole injection behavior and pursue the better electro-optical performance of blue organic light-emitting diodes. The optimized thickness of hole injection layer benefits the reduction in operational voltage and significantly enhancement in efficiency.

OLEDp - 8 **Luminance Enhancements in OLEDs Using a TiO_2 Electron Injection Buffer**

T. Matsuzaki, Y. Seki, Y. Yasuda, Y. Sawada, Y. Hoshi, T. Uchida

Tokyo Polytechnic Univ., Japan

We studied the luminance enhancement in OLEDs with TiO_2-coated ITO, in terms of the energy band diagram and surface morphology around the cathode, and reported the electron-injection enhancement in electron-only devices. When using TiO_2-coated ITO as the electron-injection material, the electrode work function varied from 4.7 to 4.4 eV.

OLEDp - 9 **Deposition of Thin Film of Benzene or Naphthalene by Plasma Polymerization and Application to Organic Light Emitting Devices**

Y. Takahashi, H. Kanai, Y. Sato, S. Yoshikado

Doshisha Univ., Japan

Thin films applicable to organic light emitting devices were deposited by plasma polymerization of benzene or naphthalene monomers by radio frequency discharge. The effects of the monomer gas pressure and species on the properties of the polymerized film were investigated. Electroluminescence of blue color from naphthalene thin film was observed.

OLEDp - 10 **Design of Insulator Material for Stable Operation of Organic Field Effect Transistors**

K. Suemori, T. Kamata

AIST, Japan

Stability of an organic field-effect transistor with respect to its gate bias stress is degraded by the roughness, long-chain chemical species, and dipoles of the insulator surface. We found that the surface of a polystyrene thin film fabricated on a SiO_2 insulator does not have these instability factors.

OLEDp - 11 **Effect of MoO_3 Hole-Injection Layers on the Performance of Top-Gate Organic Transistors Based on Soluble Benzothienobenzothiophene Derivatives**

*F. Mochizuki, Y. Miyata, T. Nagase, T. Kobayashi, K. Takimiya[*], M. Ikeda[**,***], H. Naito*

Osaka Pref. Univ., Japan
[*]Hiroshima Univ., Japan
[**]Nippon Kayaku, Japan
[***]Kyusyu Univ., Japan

Effect of MoO_3 hole-injection layers on the electrical characteristics of top-gate C_8-BTBT OFETs has been investigated. The field-effect mobility of short-channel devices is improved by inserting 1-nm-thick MoO_3 layers, as a result of the decrease in contact resistance. The dependence of the electrical characteristics on MoO_3 thickness is also investigated.

OLEDp - 12 **Materials for Enhancing External Light Out-Coupling Efficiency of Organic Light-Emitting Diodes**

P.-C. Chien, I.-L. Kao, Y.-L. Hsu, P.-C. Chen

ITRI, Taiwan

The purpose of this study was to present a simple and low cost method which has a good balance between improvement of OLEDs light extraction efficiency and suppression of color shift at various viewing angle by attaching scattering films with porous particles.

OLEDp - 13 **Very-High Color Rendering Index OLEDs with Natural Light-Style Spectrum**

J.-H. Jou, J.-R. Tseng, F.-C. Yang, C.-T. Chen, H.-W. Liu, S.-P. Chen[*], H.-W. Hung[*], J.-Y. Li[*], M.-C. Liu[*]

Nat. Tsing Hua Univ., Taiwan
[*]ITRI, Taiwan

Natural light-style OLEDs with both color rendering index (CRI) and high sunlight spectrum resemblance (SSR) will be presented. The feasibility of fabricating quality light sources with very-high CRI and very-high SSR at any designated color temperature warrants OLED to be the ultimate lighting technique.

OLEDp - 14 **Novel Carbazole-Substituted Anthracene Derivatives for Non-Doped Blue Light Emitting Diodes**

R.-H. Lee, Y.-G. Chen, Y.-C. Chang, Y.-C. Chen[*], J.-T. Lin[*], R.-J. Jeng[**]

Nat. Chung Hsing Univ., Taiwan
[*]Academia Sinica, Taiwan
[**]Nat. Taiwan Univ., Taiwan

Three anthracene derivatives featuring carbazole moieties as side groups were synthesized for use in blue organic light emitting devices. The highest brightness (6821 cd/m^2) was that for the tCz^9PhAnt-based device; the greatest current efficiency (2.1 cd/A) was that for the tCz^9Ph_2Ant-based device.

OLEDp - 15 **Light Extraction Enhancing Buffer Layers for Organic Light-Emitting Diodes**

H. J. Cho, H.-N. Lee

Soonchunhyang Univ., Korea

Numerical simulations and experiments were conducted to study the light outcoupling enhancement effects based on electrode-buffer structures. Thin tungsten-oxide buffer and titanium-oxide buffer increased the outcoupling noticeably. However, thick buffers decreased the outcoupling. The combined effects of the constructive interference and the creation of additional bound modes explain these behaviors.

OLEDp - 16L **Highly Efficient Polymer Light-Emitting Diodes with Conjugated Polyelectrolyte Electron Injection Layers Using Combined Solution Processing Techniques**

H. Chang[*], M. Suh[*], S. W. Kim[*], J.-S. Kim[,**], D. Y. Jeon[*]*

[*]KAIST, Korea
[**]Imperial College London, UK

Herein, highly efficient PLEDs with CPE EILs were demonstrated by combining two different solution processing techniques. Upon annealing of F8BT active layer, the surface contrast was reduced by 40%. Consequent reduction produces 1.6 times higher luminous efficiency (9.30 Cd/A at 3.6 V) compared to the device without thermal treatment.

OLEDp - 17L **Achieve White Light by Utilizing Interface Defects on Simplified Ultraviolet Organic Light Emitting Diodes**

H.-L. Weng, S.-Y. Chu, P.-C. Kao[*], Y.-C. Chen

Nat. Cheng Kung Univ., Taiwan
[*]Nat. Chiayi Univ., Taiwan

A simplified bilayer ultraviolet organic light emitting diode(UV-OLED) with broadband spectrum has been demonstrated. This device achieved a near-white light at high voltages. The recombination zone has been known by inserting ultrathin film of Rubrene. The electroluminescence spectra was measured to elucidate the recombination zone shift by voltage increasing.

OLEDp - 18L **Highly Efficient Green Phosphorescent Iridium Complex Based on Thieno[3,2-c]Pyridine Ligand**

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

ITRI, Taiwan

A series of novel green phosphorescent dopants containing thieno[3,2-c]pyridine-based ligands were synthesized and characterized. Green devices with efficacies of 56 cd/A and 39 lm/W were reported with the brightness of 1447 nits. When double emitting layers were adopted, the efficacy was improved to 63 cd/A and 44 lm/W@1257 nits.

Author Interviews and Demonstrations
17:30 – 18:30

Friday, December 7

9:00 - 10:25 **Room A**

OLED3: OLED for Lighting Application
(Special Topics of Interest on Lighting Technologies)

Chair: Y. Kijima, Sony, Japan
Co-Chair: T. Ikuta, JNC Petrochem., Japan

OLED3 - 1: *Invited* **Design of Backplanes and Optical Enhancement Structure for Large-Area OLED Lighting Panels**
9:00

M.-H. Ho, C.-C. Lin, Y.-C. Chin, C.-C. Chen, M.-T. Lee, T.-Y. Cho, C.-W. Chen

AU Optronics, Taiwan

We demonstrate a novel design for large-area OLED lighting panels with low electrode resistance and short reduction to achieve high brightness uniformity with both low power efficiency loss and high production yield. In addition, efficiency of OLED lighting panels can be further enhanced by applying internal extraction layer between transparent electrodes and substrate.

OLED3 - 2 **Highly Efficient White OLEDs with Single Solution-Processed Emitting Layer Consisting of Three Kinds of Dopants**
9:25

H. Sakuma, S. Nobuki, S. Ishihara, S. Aratani, A. Sano, K. Kobayashi

Hitachi, Japan

We achieved a highly efficient white organic light emitting diode with a single emitting layer consisting of three kinds of dopants. The emitting layer was fabricated with a one-step solution coating process. A maximum power efficiency of 70 lm/W was obtained by applying high fluorescence quantum yield dopants and improving light extraction efficiency.

OLED3 - 3 **Improving the Performance of Solution-Processed Green Phosphorescent OLEDs Using EL Spectra Analysis**
9:45

T. Sugizaki, Y. Shinjo, A. Amano, T. Yonehara, Y. Mizuno, S. Enomoto, I. Amemiya

Toshiba, Japan

Emission regions in solution-processed green phosphorescent OLEDs have been estimated by analyzing their electroluminescent (EL) spectra. The performance of the OLEDs has been improved by optimization of device structure based on the analysis.

OLED3 - 4 **A New 2-Dimensional OLED Circuit Modeling for Obtaining Uniform Brightness in Large Area OLED Lighting Panels**
10:05

J.-H. Han, J. Moon, J. W. Huh, D.-H. Cho, J.-W. Shin, C. W. Joo, J. Hwang, B. J. Lee, S. K. Park, J.-T. Ahn, N. S. Cho, H. Y. Chu, J.-I. Lee

ETRI, Korea

We report on a new 2-dimensional OLED circuit modeling method for obtaining uniform brightness across large area OLED lighting panels. Our method is very useful in predicting the brightness distributions with different panel shapes and sizes. Our simulation results have been successfully applied to fabricate panel with high brightness uniformity.

----- Break -----

10:50 - 12:15 **Room A**

OLED4: Materials and Devices

Chair: T. Wakimoto, Merck, Japan
Co-Chair: H. Kuma, Idemitsu Kosan, Japan

OLED4 - 1: *Invited* **Recent Progress on Polymer LED Materials**
10:50

T. Yamada, Y. Tsubata, K. Ohuchi, D. Fukushima, N. Akino, R. Wilson, M. Roberts*, I. Grizzi**

Sumitomo Chem., Japan
**Cambridge Display Tech., UK*

Through intense studies of device physics and chemistry including triplet dynamics in polymer system, we established commercial-use-ready p-OLED material which is well suitable for printing fabrication of OLED display. We also established the p-OLED printing technology based on precise micro-cavity design through ink-jet printing.

OLED4 - 2 **New Hole Transport Materials for Solution Processing and Vacuum Deposition**
11:15

J. Birnstock, M. Zöllner, T. Canzler, Z. Wang, U. Denker, K. Lederer

Novaled AG, Germany

Latest results in the development of hole transport layer materials for OLEDs are presented. For both types of deposition techniques new materials will be introduced: For solution processing techniques such as slot-dye coating or ink-jet printing and for vacuum deposition techniques such as thermal evaporation or organic vapor phase deposition.

OLED4 - 3 **Mixed Host Concepts in Triplet Green Applications**
11:35

A. Jatsch, C. Pflumm, J. Kröber, A. Parham, P. Stößel, J. Kaiser, T. Eberle, E. Böhm, H. Buchholz

Merck KGaA, Germany

Two different mixed host concepts are discussed for triplet green applications. Addition of a wide-bandgap or hole-transporting co-host to an electron-transporting host material leads to a remarkable improvement on performance data, especially in external quantum efficiency, roll-off and lifetime.

OLED4 - 4 11:55 **Oxadiazole Derivatives for Blue Phosphorescent Organic Light-Emitting Diode by Partially Doping Techniques**

Y. H. Liu, Y. H. Lan[*], W. H. Yang[**], M. K. Leung[**], M. K. Wei, T. L. Chiu[***], C. F. Lin[*], J. H. Lee[**]

Nat. Dong Hwa Univ., Taiwan
[*]Nat. United Univ., Taiwan
[**]Nat. Taiwan Univ., Taiwan
[***]Yuan Ze Univ., Taiwan

In this paper, we fabricated high efficiency blue phosphorescent OLED using greenish-blue emitter iridium(III)bis[4,6-di-fluorophenyl-pyridinato-N, C2]picolinate (FIrpic) and oxadiazole derivatives (OXD) as host with good electron-transporting properties. High current efficiency of 40.05 cd/A was reached by partially doped EML, improving charge balance of device.

----- Lunch -----

14:00 - 15:05 **Room A**

OLED5: Display Technologies (1)

Chair: K. Nakayama, Yamagata Univ., Japan
Co-Chair: T. Uchida, Tokyo Polytechnic Univ., Japan

OLED5 - 1: 14:00 ***Invited*** **Crystalline Organic TFTs for Active-Matrix Display Panels**

J. Takeya[,**], T. Uemura[*], M. Uno[***], Y. Kanaoka[***]*

[*]Osaka Univ., Japan
[**]Ctr. for High-End Molecular Semiconductors, Japan
[***]TRI Osaka, Japan

This presentation focuses on development of organic single-crystal transistors which have realized high charge carrier mobility exceeding 10 cm^2/Vs. Materials, solution-patterning processes, and the mechanism of charge carrier transport are discussed so that the new class of organic semiconductors offers practical high-performance devices in flexible and printed electronics industries.

OLED5 - 2 14:25 **Electrical Modeling of a Full Stack Fluorescent Dual Emitter White PIN OLED**

K. Bouzid, H. Doyeux, H. Kanaan

CEA LETI, France

Electrical modeling of a full stack fluorescent dual emitter (blue + yellow) emitter white PIN OLED is performed using a commercial software and a set of material parameters obtained by extraction from single carrier devices JV curves. Simulation outputs show JV characteristics matching experimental JV curves and a consistent behavior.

OLED5 - 3 **Detection of a Space-Charge Region in an Organic**
14:45 **Photoconductive Sensor**

*W. Woestenborghs, P. D. Visschere, F. Beunis, K. Neyts, A. Vetsuypens**

Ghent Univ., Belgium
**Barco, Belgium*

In our contribution we will present a transparent photoconductive sensor based on organic materials. The performance of the photoconductive sensor will be demonstrated by electrical and spectral response measurements. The existence of a high-field space charge region near the cathode will be shown by means of local illumination measurements.

----- Break -----

15:50 - 17:15 **Room A**

OLDE6: Display Technologies (2)

Chair: S. Enomoto, Toshiba, Japan
Co-Chair: T. Shimizu, NHK, Japan

OLED6 - 1: ***Invited*** **TFT Backplane Technologies with Low**
15:50 **Temperature Process for Flexible AMOLED**

H.-H. Hsieh, C.-S. Yang, C.-J. Liu, C.-H. Tsai, C.-H. Fang, C.-S. Chuang

AU Optronics, Taiwan

In this presentation, two TFT backplane technologies with low temperature process will be introduced. Firstly, the Oxide TFTs based on ITZO channel layer with high mobility (>20 cm^2/Vs) and good stability will be discussed. Secondly, the ultra-low-temperature poly-crystalline silicon TFTs and a 4.0-in. flexible AMOLED will be investigated.

OLED6 - 2 **Withdrawn**

OLED6 - 5L **Electron Injection-Properties of RT-Deposited**
16:15 **Amorphous $12CaO{\cdot}7Al_2O_3$ Electride Thin Film for OLED**

S. Watanabe, T. Watanabe, K. Ito, N. Miyakawa, S. Ito, Y. Toda*, H. Hosono**

Asahi Glass, Japan
**Tokyo Inst. of Tech., Japan*

RT deposited thin films of amorphous $12CaO{\cdot}7Al_2O_3$ electride were found to possess a small work function of ~3.1 eV by directly observing ultraviolet photoelectrons. The resulting films were transparent, chemically inert and workable as an electron injection layer to Alq3 with a Schottky barrier height of ~0.9 eV.

OLED6 - 3
16:35

Low Power Consumption of OLED Displays with Highly Efficient Sky Blue

Y. Kim, H. Kim, J. Yoo, K. Lee, J. Lee, B. Lee, S. Yoon, I. Kang

LG Display, Korea

We present a 4 color pixel structure incorporating a red, green, deep blue(B) and sky blue(b) and a related driving scheme sharing a sky blue and deep blue within neighboring pixels. An addition of the highly efficient sky blue into a conventional RGB structure could reduce the power consumption of AMOLEDs dramatically.

OLED6 - 4
16:55

OLED Based 3D Eyetracking See-Through Data-Glasses

R. Herold, J. Baumgarten, K. Fehse, U. Vogel, S. Weber[*]*, U. Heinrich*[*]

Fraunhofer IPMS, Germany
[*]*Interactive Minds, Germany*

This paper describes the conceptual design and a possible application of OLED based 3D eyetracking see-through data-glasses. This lightweight system enables the user to see virtual 3D objects and to interact with these objects in 3D. For example, to touch, move and zoom a virtual building by using the eyes.

Author Interviews and Demonstrations
17:30 – 18:30

IDW Best Paper Award

IDW Outstanding Poster Paper Award

These awards will go to the most outstanding papers selected from those presented at IDW/AD '12.
The 2012 award winners will be announced on the IDW website: http://www.idw.ne.jp/award.html

Workshop on 3D/Hyper-Realistic Displays and Systems

Tuesday, December 4

14:20 - 15:50 **Room B-2**

3D1: Ray-Space Analysis

Chair: Y. Takaki, Tokyo Univ. of A&T, Japan
Co-Chair: M. Tsuchida, NTT, Japan

3D1 - 1: 14:20 ***Invited*** **Light Field Analysis of Autostereoscopic Three-Dimensional Displays**

J.-H. Park

Chungbuk Nat. Univ., Korea

Light field reconstruction characteristics of various autostereoscopic three-dimensional displays are analyzed. Quality of the displayed three-dimensional images including resolution and depth range can be addressed based on the light field analysis.

3D1 - 2 14:50 **Stereoscopic Viewing Space Analysis Based on Interocular Differences in Contrast**

T. Horikoshi, S. Kimura

NTT DoCoMo, Japan

We use the interocular differences in contrast to propose a new index “Stereo Contrast”. This index is simple and permits direct comparison of different types of 3D displays. Based on this index, we design a 7-view type 3D display for mobile use.

3D1 - 3 15:10 **Viewing Space Diagrams to Evaluate Auto-Stereoscopic 3D Displays**

K. Nakao, T. Higano, N. Kanda, H. Wakemoto

Japan Display Central, Japan

The mechanism of 3D perception has been clarified using pattern matching method. We have proposed Categorized Viewing Space Diagram for 3D perception based on the method. In this paper some viewing space diagrams are proposed to evaluate 3D displays. These viewing space diagrams show overall properties of auto-stereoscopic displays.

3D1 - 4
15:30 **Depth Resolution in 3-D Image**

J.-Y. Son, M.-C. Park[*], C.-H. Lee[**], O. O. Chernyshov, W.-H. Son[***]

Konyang Univ., Korea
[*]KIST, Korea
[**]Joongbu Univ., Korea
[***]Elect. & Telecommun. Res. Inst., Korea

The depth resolution in 3-dimensional images is analyzed. The resolution depends mainly on the camera distance and input pupil diameter of each camera. The periodic line arrays aligned in depth direction informs that the experimentally defined resolution values match well with those predicted theoretically.

----- Break -----

16:10 - 17:50 **Room B-2**

3D2: Holography

Chair: J.-Y. Son, Konyang Univ., Korea
Co-Chair: M. Tsuboi, NTT DoCoMo, Japan

3D2 - 1:
16:10 ***Invited*** **Holographic Display Module Using 4k2k-SLM**

Y. Takaki

Tokyo Univ. of A&T, Japan

A holographic display module with a viewing zone angle and screen size of 10.5˚ and 2.0 inches, respectively, was developed using a 4k2k-SLM. Resolution redistribution technique was employed. Moreover, the module has a frameless screen, so that multiple modules can be arranged seamlessly to increase the screen size.

3D2 - 2:
16:40 ***Invited*** **Fully Updatable Three-Dimensional Holographic Display Device Using Photorefractive Compounds**

N. Tsutsumi, K. Kinashi, W. Sakai

Kyoto Inst. of Tech., Japan

We will present quickly updatable real-time holographic imaging using photorefractive polymer composite device. Photorefractive polymer composite device can be easily fabricated and is easily handling with flexibility. Real object and object image on special light modulator was recorded in the photorefractive polymer device and simultaneously reconstructed and over-recorded.

3D2 - 3
17:10

Wavefront-Type 3D Display with 8k × 8k Binary Phase Distribution from CG Data

O. Matoba, N. Ueda, K. Nitta, K. Fukue[*], M. Sasada[*], K. Ueta[*]

Kobe Univ., Japan
[*]Dainippon Screen Mfg., Japan

Binary phase distribution with 8k x 8k pixels is calculated from computer graphics data for wavefront-type 3D display. We evaluate numerically the quality of reconstructed 3D objects by using binary phase distribution.

3D2 - 4
17:30

Complex Modulation Using a Phase Only SLM

G.Y. Sung, H. Song, S. Choi[*], K. Won, H. Kim[*], H.-S. Lee

Samsung Advanced Inst. of Tech., Korea
[*]Korea Univ., Korea

In this paper, a novel complex SLM architecture using two-phase encoding technique is proposed. The complex SLM consists of single phase SLM and a pair of cylindrical lens with phase grating. Two pixels of a phase SLM can be coupled via phase grating to modulate the amplitude and phase simultaneously.

Author Interviews and Demonstrations
17:50 – 18:50

Wednesday, December 5

9:00 - 10:20 **Room B-1**

3D3/VHF3: 3D Crosstalk Evaluation

Chair: J.-H. Park, Chungbuk Nat. Univ., Korea
Co-Chair: T. Kurita, NHK, Japan

3D3/ VHF3 - 1
9:00

Perceptual Correspondence of Gray-to-Gray Crosstalk Equations for Stereoscopic Displays

Z. Xia, X. Li, Y. Cui, L. Chen, K. Teunissen[*]

Southeast Univ., China
[*]TP Vision, the Netherlands

Although several crosstalk definitions have been proposed to indicate the level of crosstalk in stereoscopic displays, they do not necessarily correlate with perceived crosstalk. Based on perception experiments, we studied the correlation between ten objective crosstalk equations and perceived crosstalk for four glasses-based stereoscopic displays while using several gray-to-gray transitions.

3D3/ VHF3 - 2 9:20

Visibility Thresholds for Crosstalk on Stereoscopic Displays

Y.-Y. Ko, Y.-L. Chen, Y.-J. Chang, C.-W. Chen, R.-L. Rong

AU Optronics, Taiwan

Crosstalk is one of the critical factors determining the viewing quality and comfort in stereoscopic displays. This study tried to find out the relationship between crosstalk and related factors, like parallax angle and spatial frequency, and proposed psychophysics and ergonomic method to obtain the crosstalk threshold trend of human eyes.

3D3/ VHF3 - 3 9:40

Camera-Based Cross-Talk and Uniformity Measurement of Multi-View Autostereoscopic 3D Display

C.-F. Hung, F.-C. Tsai, C.-P. Ho

AU Optronics, Taiwan

This paper presents a camera-based approach with a uniformity measurement function to quantify the uniformity and the crosstalk characteristic of a multi-view autostereoscopic 3D display. The results show that the proposed method can efficiently and accurately measure both the global and local uniformity characteristic of the 3D display.

3D3/ VHF3 - 4 10:00

A Novel Method to Evaluate the 3D Crosstalk of Stereoscopic 3D Display

H.-T. Lin, S.-C. Lin, C.-C. Chiu

Chunghwa Picture Tubes, Taiwan

In this paper, we proposed a method to evaluate the quality of 3D display by using gray-to-gray crosstalk, through the formula convert the brightness of crosstalk into human perceptual response, and we also proposed some check patterns to make observer to evaluate the gray-to-gray 3D crosstalk easily and efficiently.

----- Break -----

10:50 - 12:05 **Room B-1**

3D4/VHF4: 3D Image Quality (1)

Chair: T. Horikoshi, NTT DoCoMo, Japan
Co-Chair: A. Yoshida, Sharp, Japan

3D4/ VHF4 - 1 10:50

Quality Control of Active Glass 3D Displays Using Temporal Measurements

*P. Boher, T. Leroux, T. Bignon, P. Blanc**

ELDIM, France

**Labs. d' Essais de la FNAC, France*

Quality control of active glasses 3D TVs is performed using high accuracy and high temporal resolution luminance measurements versus time. The two main parasitic effects on such displays, crosstalk and flicker are derived for different couples of gray levels applied. Quality criteria for ghost effect and flicker visibility are derived.

3D4/ VHF4 - 2 11:10 **New Crosstalk Index of Shutter Glasses 3D Display**

C. W. Chen, Q. Liao, C. C. Hsiao
Shenzen China Star Optoelect. Tech., China

A concept of universal crosstalk index for stereoscopic 3D display was proposed. Conventional crosstalk of shutter glasses 3D could be transferred to the new crosstalk index that could be comparable with the crosstalk index of patterned retarder 3D. The new crosstalk index was also investigated by human perceptive experiment.

3D4/ VHF4 - 3 11:30 **The Use of a Small-Sized Autostereoscopic Display: Context Influence on User Experiences**

M. Pölönen, M. Salmimaa
Nokia, Finland

92 participants viewed stereoscopic content on a small-sized autostereoscopic display in four different environments. The results indicate that the context of use did not influence user experiences, particularly with regard to eyestrain or motion-induced sickness levels, but context of use had some influence on image quality.

3D4/ VHF4 - 4L 11:50 **High Resolution Multi-View 3D Display Based on Active Optical Device**

K. Choi, Y. Choi, Y. Kim, Y. Kwon, J. Bae
Samsung Elect., Korea

This paper review system architectures for displaying a 3-dimensional image, based on a time multiplexing scheme. More particularly, an apparatus for displaying a 3D image, capable of providing a natural 3D display with a simple structure using an active optical device (or active optical element) capable of changing a path of light.

----- Lunch -----

15:50 - 17:10 **Room B-1**

VHF5/3D5: 3D Image Quality (2)

Chair: N. Hiruma, NHK, Japan
Co-Chair: K. Yamamoto, NICT, Japan

VHF5/ 3D5 - 1 15:50 **Stereo-Resolution Analysis Based on Reading Performance**

Y.-Y. Lai, S.-F. Y. Mao
ITRI, Taiwan

The reading performance is used to analyze the stereo-resolution in the stereoscopic display. In this paper, static and dynamic experimental designs were proposed to detect the stereo-resolution of stereoscopic display. From the results, reading performance could be a method to assess the property of stereo-resolution.

VHF5/ 3D5 - 2 16:10 **The Quantization of 3D Resolution Based on Human Perception**

Y.-L. Chen, C.-W. Chen, R.-L. Dong

AU Optronics, Taiwan

This is a novel study tried to quantify 3D resolution based on human perceptual judgment. Take resolution-related font size changes as stimuli, we found the reduced resolution in 3D would deteriorate perceptual clarity. The perceptual 3D resolution and better resolution design of 3D display were proposed.

VHF5/ 3D5 - 3 16:30 **3D Depth Detection in Multi-View Displays**

S.-F. Yang-Mao, Y.-T. Lin, T.-M. Wang, C.-H. Ho, H.-W. Chen, C.-S. Wu

ITRI, Taiwan

We propose a new design of testing for stereoscopic performance estimation between multi-view displays. Testing results show that parallel multi-view display has lower depth JND than convergent multi-view display; in other words, more depth details can be perceived in multi-view display with parallel optical beam on configuration of 36-rays.

VHF5/ 3D5 - 4 16:50 **Accommodation Response of Super Multi-View Display Using Directional Light in Monocular Condition**

J.-H. Jung, J. Kim, S.-G. Park, S. Y. Choi[*]*, D. Nam*[*]*, B. Lee*

Seoul Nat. Univ., Korea
[*]*Samsung Advanced Inst. of Tech., Korea*

Accommodation responses in a monocular condition are measured in a super multi-view display composed of telecentric lens, spatial light modulator and relay optics. The ideal case of super multi-view display is implemented and its induction of accommodation response in monocular eye is verified by the accommodation measurement using autorefractometer.

Author Interviews and Demonstrations
17:30 – 18:30

Thursday, December 6

10:50 - 12:30 **Room B-1**

3D6: Digital Museum of Kyoto Gion Festival
Special Topics of Interest on Augmented Reality

Chair: M. Tsuchida, NTT, Japan
Co-Chair: K. Makita, AIST, Japan

3D6 - 1: 10:50 ***Invited*** **Digital Museum of Gion Festival within Virtual Kyoto**

K. Yano, T. Seto, D. Kawahara[*]

Ritsumeikan Univ., Japan
[*]CAD Ctr., Japan

Virtual Kyoto is a historical virtual geographic environment of the historical city of Kyoto, which aims at reconstruction and visualization of the city's historical landscapes. This paper introduces Digital Museum of Gion Festival which represents Kyoto's culture and tradition, based on Virtual Kyoto.

3D6 - 2: 11:15 ***Invited*** **A Virtual Tour of Gion Festival Yamahoko Parade**

L. Li, W. Choi[*], K. Hachimura, T. Nishiura, K. Yano

Ritsumeikan Univ., Japan
[*]Gunma Nat. College of Tech., Japan

We tried to virtually reproduce Yamahoko Parade in Kyoto Gion Festival, which has been registered in the list of "Intangible Heritage of Humanity" by UNESCO. This work contributes to the research of digital museum and provides a platform that allows the users to virtually experience the atmosphere of the event.

3D6 - 3: 11:40 ***Invited*** **Particle-Based Translucent Visualization of Funeboko for the Gion Festival**

S. Tanaka, M. Uemura, M. Yamamoto, K. Hasegawa, S. Nakata

Ritsumeikan Univ., Japan

We translucently visualize laser-scanned 3D point data of the Funeboko float for the Gion Festival (Kyoto). We use the particle-based surface rendering, which we recently proposed, regarding the scanned points as particles. Our approach enables precise and comprehensible translucent visualization of the complex internal 3D structure of Funeboko.

3D6 - 4: 12:05 ***Invited*** **Digital Archiving and Large-Scale Visuo-Haptic Display of Large 3D Woven Cultural Artifacts**

W. Wakita, M. Tsuchida[*], J. Yamato[*], H. T. Tanaka

Ritsumeikan Univ., Japan
[*]NTT, Japan

We have measured large 3D woven cultural artifacts with rail-wheel 3D scanning system, and captured high-resolution images with a two-shot type 6-band image capturing system, and modeled woven cultural artifacts in 3D. This paper describes a digital archiving and large-scale visuo-haptic display of large 3D woven cultural artifacts.

----- Lunch -----

14:00 - 17:00 **Event Hall**

Poster 3Dp: 3D/Hyper-Realistic Displays and Systems

3Dp - 1 **Perceived Depth Change of Depth-Fused 3D Display by Changing Distance between Front and Rear Plane**

A. Tsunakawa, T. Soumiya, Y. Horikawa, H. Yamamoto, S. Suyama

Univ. of Tokushima, Japan

We estimated the dependence of the perceived depth by increasing distance between front and rear plane. When the distance was large, perceived depth was near front plane at 0~40% of rear luminance, and perceived depth was near rear plane at 60~100% of rear luminance.

3Dp - 2 **Interference Experiment for 3D and 2D Discernment**

J.-H. Gu, J.-K. Liau, J.-W. Huang, Y.-L. Wang, H.-Y. Chen

Nat. Kaohsiung First Univ. of S&T, Taiwan

3D image recognition is higher than the 2D image, the main reason is that human eye obtain image depth of space recognition about object by 3D. It not infected with light source to change and background environment, conform feature of the human visual. So improve disadvantage of recognizable on 2D image.

3Dp - 3 **Withdrawn**

3Dp - 4 **To Reduce the Flicker and Crosstalk by Outputting the Data Frame Rate of 130 Hz on the Shutter-Type 3D Display**

L. Liao, P. Lin, Y. Chen

Shenzhen China Star Optoelect. Tech., China

The flicker caused by room light is now still an important issue at shutter-type 3D LCD. Therefore, we propose a 130 Hz system including 2 frames memories and one over-driving LUT to reduce the flicker and 3D crosstalk effectively.

3Dp - 5 **While Viewing 3D Video-Clips, Accommodative Focus and Convergence are in Harmony with Virtual Image Position**

M. Miyao, T. Shiomi, T. Kojima, K. Uemoto, H. Ishio[*], H. Takada[**]

Nagoya Univ., Japan
[*]Fukuyama City Univ., Japan
[**]Univ. of Fukui, Japan

We carried out the experiments to compare fixation distances between accommodation and convergence in young and middle-aged subjects while they viewed 2D and 3D video clips. When subjects are young, accommodative power for 3D images is similar to the distance of convergence and virtual positions.

3Dp - 6 **Evaluate Visual Comfort of 2D/3D Mixing Contents on 3D Glasses-Free Panel**

Y.-J. Li, H.-S. Chen, C.-W. Chen[*], Y.-L. Chen[*], R.-L. Dong[*]

Nat. Taiwan Univ. of S&T, Taiwan
[*]AU Optronics, Taiwan

The 2D/3D mixing mode on 3D glasses-free panel will allow us to create more potential contents. To evaluate the comfortable disparity range in 2D text and 3D picture mixing content on 3D glasses-free panel, there are two approaches designed in this paper.

3Dp - 7 **A Study of Visual Fatigue When Viewing 3D Images with Pseudoscopic Vision**

H. Isono

Tokyo Denki Univ., Japan

The present study examined visual fatigue when viewing 3D images with pseudoscopic and normal stereoscopic vision through objective assessment of changes in time required to accommodate the eyes and subjective assessment using the SD method. We also measured changes in cerebral blood flow when viewing 3D images using NIRS apparatus.

3Dp - 8 **Withdrawn**

3Dp - 9 **Color Analysis for Lens Type 3D Display**

C.-T. Chang, W.-L. Chen, C.-H. Shih, W.-M. Huang

AU Optronics, Taiwan

The intensity distribution of a lens type 3D display is the most important property characterizing the 3D performance and is highly discussed in most papers. In this paper, we qualitatively and quantitatively discuss the color distribution of lens type 3D displays to more completely describe and further improve its performance.

3Dp - 10 **New Applications of Viewing Angle Polarization Analysis for Characterization of Displays**

P. M. Boher, T. Leroux, T. Bignon, V. Collomb-Patton

ELDIM, France

ELDIM proposes viewing angle and imaging instruments capable to measure the polarization state of the light in addition to luminance, color or radiance. We use these instruments hereafter to characterize auto-stereoscopic and passive 3D displays to understand better the limits and the defects of each type of technology.

3Dp - 11 **Full Screen 3D Visual Uniformity Design for the Multi-View Slant LC Barrierautostereoscopic Display**

C. Pan, H. Cui, B. Li, D. Li, J. Wang, T.-C. Chung, T. S. Jen

Infovision Optoelect., China

We propose an approach for optimizing the slant barrier parameters of multi-view autostereoscopic displays to achieve a high quality 3D image. The slant barrier parameter optimization method is discussed. A 3-D display, 9-view 55-inch model of 3840 x 2160pixel was designed, the effect of the multi-view barrier system is ideal.

3Dp - 12 **Still Gamma and Single Eye Overdrive for Eliminating Crosstalk in Shutter-Type 3D Display**

Y. Chen

Shenzhen China Star Optoelect. Tech., China

To drive the LC to 240 Hz frame rate and separate the BLU into a lot of scanning regions don't completely solve the crosstalk issue. Therefore, we propose a new structure including several mapping LUTs and single eye overdrive to create the low crosstalk on low cost flash BLU system.

3Dp - 13 **An Integrated Back-End System Design for Autostereoscopic Display**

M.-C. Weng, Y.-C. Chen, H.-H. Chen, H.-M. Su

Chunghwa Picture Tubes, Taiwan

Chunghwa Picture Tubes has successfully developed the 7-in. 3D lenticular lens panel. In addition, the single-chip 3D controller that integrates T-CON and 3D converter functions will develop as soon as possible. It can make lower total system hardware cost and better ability of lower power states in advance.

3Dp - 14 **Lighting Position Dependence and Observation Angle Dependence of Perceived Depth in Arc 3-D Display**

N. Yamada, C. Maeda, S. Suyama, H. Yamamoto

Univ. of Tokushima, Japan

The perceived depth is increased as lighting angle decreases. When an observer effectively moves to right and left, the perceived depth is decreased as the angle increases. Our theoretical depth and position coincide with the measured values, even when the light and observer are positioned at center or not.

3Dp - 15 **Active Retarder 3D Display Technology**

C.-W. Li, C.-H. Hsu, C.-Y. Fang, C.-H. Yeh, W.-T. Liao, W.-J. Tsai, F.-C. Wu, W.-C. Wang, L.-H. Tsai

WINTEK, Taiwan

Active Retarder is a novel glasses type 3D technology that uses polarized glasses with light weight and has full resolution 3D image. In this paper, we present a novel electrode design of Active Retarder to improve the cross-talk issue.

3Dp - 16 **Dynamic Wavefront Changes by a Liquid-Crystal Prism**

F. Kimura, T. Yamamoto, S. Toyama, S. Suyama, I. Ishii[*]*, H. Yamamoto*

Univ. of Tokushima, Japan
[*]*Hiroshima Univ., Japan*

We have fabricated a liquid-crystal (LC) prism based on a new LC motion for a fast optical deflector. In order to investigate distribution of effective index difference, in this paper, we observe dynamic wavefront changes of transmitted light through an LC deflector by use of a high speed camera.

3Dp - 17 **Withdrawn**

3Dp - 18 **Full Resolution Auto-Stereoscopic Active Barrier 3D Liquid Crystal Display**

H.-C. Tseng, M.-K. Kang, I.-F. Wang, K.-C. Lee, C.-H. Yu

HannStar Display, Taiwan

In order to break through current technical predicament so we provide more additional values for the photo electricity industry. This plan proposes a kind of full resolution auto-stereoscopic 3D display. This technology possesses not only spatial-multiplexed but also time-multiplexed characteristic.

3Dp - 19 **Withdrawn**

3Dp - 20 **Experimental Estimation of the Dihedral Corner Reflector Array for Floating Imaging**

K. Nitta, K. Ogawa, T. Akashi, O. Matoba, S. Maekawa[*]

Kobe Univ., Japan
[*]NICT, Japan

Imaging characteristics of the dihedral corner reflector array are estimated with experiments and simulations. An optical system for experimental estimations is constructed. From results, it is shown that these results are not similar. Then, we discuss on a fabrication errors as a factor to blur the point image.

3Dp - 21 **Thermal and Visual 3D Display by Use of Crossed-Mirror Array**

R. Kujime, S. Suyama, H. Yamamoto

Univ. of Tokushima, Japan

We utilize a crossed-mirror array (CMA) for a 3D display of heat and light. Our developed CMA composed of hollow apertures and converge visible light and infrared radiation to the image position. The proposed 3D display shows an aerial visual image that makes us feel warmth when it is touched.

3Dp - 22 **Volumetric Display Based on Three-Dimensional Optical Scanning of an Inclined Image Plane Using an Image Rotator**

Y. Maeda, D. Miyazaki, T. Mukai

Osaka City Univ., Japan

We propose to use a rotational scanning method for a volumetric three-dimensional (3D) display based on optical scanning of an inclined image plane. A 3D image is created from a stack of an image plane moved by an image rotator. The size of the 3D displayable space was 1400 cm^3.

3Dp - 23 **Autostereoscopic 3D Pictures on Optically Rewritable Electronic Paper**

X. Wang, L. Wang, J. Sun, A. Srivastava, V. G. Chigrinov, H.-S. Kwok

Hong Kong Univ. of S&T, Hong Kong

Autostereoscopic 3D image was obtained in our lab by means of bonding the lenticular lenses array to the optically rewritable (ORW) electronic paper (E-paper). The two different but related images can be simultaneously seen by right eye and left eye respectively, thus forming the 3D image in one's mind.

3Dp - 24 **3D Display by Wavefront Reconstruction Using 1D Binary Spatial Light Modulator with Rectangle-Shape Pixel**

A. Ueno, K. Kobayashi, K. Nitta, O. Matoba, K. Fukue[*], M. Sasada[*], K. Ueta[*]

Kobe Univ., Japan
[*]Dainippon Screen Mfg., Japan

Reconstruction quality of 3D display by wavefront reconstruction using 1D spatial light modulator with rectangle-shape pixel is evaluated. Scanning along the vertical direction is required for constructing a 3D display system. The broadening by diffraction along the vertical direction is evaluated by changing the size of rectangle-shaped pixel.

3Dp - 25 **Holographic Collimator for Reconstruction of Display Holograms**

H. T. Lin, W.-C. Su, Y.-W. Wang

Nat. Changhua Univ. of Education, Taiwan

A compact holographic collimator is presented for the reconstruction of display holograms. Diffracted 3D image from a display hologram can be observed through the illumination of it. A compact active holographic display can be achieved by switching the internal light source of it to control diffraction of the 3D image.

3Dp - 26 **Special-Purpose Computer HORN-7 with FPGA Technology for Phase Modulation Type Electro-Holography**

N. Okada, D. Hirai, Y. Ichihashi[*], A. Shiraki [**], T. Kakue , T. Shimobaba, N. Masuda, T. Ito

Chiba Univ., Japan
[*]NICT, Japan
[**]Kisarazu Nat. College of Tech., Japan

An electro holography is one of the techniques for achieving three-dimensional television. We developed special-purpose computer HORN-7 for kinoform, which records the phase information of an object light. The HORN-7 can create a 2M pixels hologram of 16,000 object points in 0.4 sec.

3Dp - 27 **Accelerating Computational Time of Image Reconstruction Process of Parallel Phase-Shifting Digital Holography by GPU with CUDA**

T. Kakue, T. Shimobaba, N. Masuda, T. Ito

Chiba Univ., Japan

We succeeded in accelerating computational time of image reconstruction process of parallel phase-shifting digital holography. A GPU with CUDA can achieve 12× and 14× faster computational times of phase-shifting interferometry and angular spectrum method in the process than a CPU, respectively.

3Dp - 28 **Stereo Video Rectification by Using Interpolated Homography Matrixes**

T.-H. Lin

Nat. Taiwan Univ. of S&T, Taiwan

This paper addresses a rectification method for stereo videos which are captured with varying physical parameters. Our method linearly interpolates homography matrixes by decomposition of the rectification matrixes of key frames. The result shows our method can rectify stereo videos and has smoother transition effects than the traditional methods.

3Dp - 29 **Augmented Reality Head-Up-Display**

S.-W. Cheng, C.-B. Chiang, Y.-F. Su, J.-T. Hsu

Automotive Res. & Testing Ctr., Taiwan

We developed an augmented reality heads-up display system in this study. That displays integrated messages including overlapped image of lane marking and information of preceding vehicles on 5 meters in front of windshield. The system will also be verified for its feasibility through software simulation and prototype production.

3Dp - 30 **Fatige-Proof Intelligent Shoot-Right 3D Video Recording System-AUOSOME-3D**

C. P. Chen, C. P. Lin, T. Y. Wu, C. C. Yu, H. Lee, Y. H. Chen, J. L. Tung[*], C. W. Chen[*], N. W. Chang[*], I. L. Chen[*], C. H. Wen[**], P. L. Sun[**], H. H. Chen[**]

Nat. Taiwan Univ., Taiwan
[*]AU Optronics, Taiwan
[**]Nat. Taiwan Univ. of S&T, Taiwan

AUOSOME is an automatic 3D stereo filming system solving problems encountered in 3D filming process, making captured video right and comfortable to view. We performed an automatic camera positioning system ensure disparities be in comfort zone and real-time stereo image correction process, including color correction, horizontal alignment and rotation calibration.

3Dp - 31L **Fast Parallel Computation of Computer-Generated Hologram Using a Multi-GPU Environmental PC**

N. Takada, T. Shimobaba[*], A. Sugiyama[*], N. Okada[*], H. Nakayama[**], A. Shiraki[***], N. Masuda[*], T. Ito[*]

Kochi Univ., Japan
[*]Chiba Univ., Japan
[**]VASA Entertainment, Japan
[***]Kisarazu Nat. College of Tech., Japan

Electroholography using a computer-generated hologram (CGH) is the ultimate technique for realizing 3-D television. We implemented an optimized CGH computation in our multi-GPU environmental PC with four GPUs. In the case of 3D object composed of 10,240 points, our system is 215 times faster than a CPU.

3Dp - 32L **Three Dimensional Display Incorporated with Active Retarder Using 90° Twisted Alignment and Horizontal Electric Field**

S. Kim, T. Kim, S.-W. Choi

Kyung Hee Univ., Korea

We propose a three dimensional (3D) display incorporated with active retarder (AR) using 90˚ twisted alignment and horizontal electric field. From the results of simulation, our AR-3D display exhibited relatively better performance than the previously proposed AR-3D display using horizontal electric field.

3Dp - 33L **Study of Autostereoscopic Imaging Performance with Respect to Specifications of Lens Arrays and Polarization Light in the Integral Photography System**

C.-H. Yang[*], W.-Y. Lu[*], Y.-H. Hsu[*], C.-J. Hsu[*], C.-R. Sheu[,**]*

[*]Nat. Cheng Kung Univ., Taiwan

We investigate imaging performance of integral photography (IP) system with two types of lens arrays with hexagonal and square units, respectively. Simultaneously, we also experimentally observe effects of polarization light used in pickup and reconstruction to discuss the possible issues if the LC lens arrays are used to process IP.

3Dp - 34L **Quantitative Verification of Its Spatial Frequency when Enlarging the Image Captured with an IP Camera**

Y. Ichihashi, H. Sasaki, T. Senoh, K. Yamamoto

NICT, Japan

In this paper, we describe effects on a spatial frequency of a reconstructed image when enlarging an image captured with an IP (integral photography) camera. We conducted experiments in IP images to enlarge with two different methods. In the results, there is a slight difference between the two reconstructed images.

3Dp - 35L **Accommodation and Distance Perception for Floating LED Image Formed by a Crossed-Mirror Array**

Y. Horikawa, T. Ogura, T. Soumiya, R. Kujime, H. Yamamoto, S. Suyama

Univ. of Tokushima, Japan

We have fabricated a crossed-mirror array (CMA) for imaging of an LED panel. Accommodation responses and perceived distance for the floating LED image formed by the CMA have been investigated experimentally. We report that accommodation and perceived distance fluctuate between the CMA and the optically formed image position.

Author Interviews and Demonstrations
17:30 – 18:30

Friday, December 7

9:00 - 10:20 **Room E**

3D7: Novel 3D Approach

Chair: Y.-P. Huang, Nat. Chiao Tung Univ., Taiwan
Co-Chair: Y. Ichihashi, NICT, Japan

3D7 - 1
9:00

A Moiré Display

V. Saveljev, S.-K. Kim

KIST, Korea

A display technique is proposed with a useful visual image created by moiré patterns. The methods to control the visual image using the affine transformations of gratings are proposed and confirmed experimentally. The extension of the current two-dimensional display to a three dimensional one is also suggested.

3D7 - 2
9:20

Reconstruction of Dynamic Digital Holographic Image Using Modified Gerchberg-Saxton Algorithm

G.-S. Huang, Q.-L. Deng[*], H.-T. Chang, H.-E. Hwang[**], C.-Y. Chen

Nat. Yunlin Univ. of S&T, Taiwan
[*]Nat. Chiao Tung Univ., Taiwan
[**]Chung Chou Univ. of S&T, Taiwan

The display system of dynamic grayscale holographic movie was projected by using Modified Gerchberg-Saxton Algorithm with the original three-dimensional images. After the analysis of image quality, the output image of visibility was about 0.91 in visual area, the diffraction efficiency was about 54% and the speckle contrast was about 10%.

3D7 - 3
9:40

Analysis on the Characteristics of Multi-View Display System and Eye Detection-Based Crosstalk Reduction

J. Park, D. Nam

Samsung Advanced Inst. of Tech., Korea

To eliminate inter-view crosstalk in multi-view displays, we have suggested an eye detection-based algorithm. It is very effective in reducing the crosstalk, but it can cause color inconsistency along the viewing direction. In this paper, we analyze causes for the artifacts and propose a solution to this problem.

3D7 - 4
10:00 **EEG Measurement of 3D Cognitive Fatigue Caused by Viewing Mobile 3D Content**

S. Mun[,***], M.-C. Park[*,***], S. Cho[**,***], S. Yano[****]*

[*]Univ. of S&T, Korea
[**]Korea Univ., Korea
[***]KIST, Korea
[****]Shimane Univ., Japan

3D visual fatigue has been evaluated to ensure 3D image safety. However, it has seldom been tested on 3D mobile displays. This study was aimed at investigating changes of evoked-potentials in the pre- and post-mobile 3D viewing conditions and determining association between 3D visual fatigue and perceived immersion.

----- Break -----

10:50 - 12:20 **Room E**

3D8: Device and Approach for 3D Display

Chair: S. Iwasawa, NICT, Japan
Co-Chair: H. Yamamoto, Tokushima Univ., Japan

3D8 - 1:
10:50 ***Invited*** **Development of Time-Multiplexed Backlight on Auto-Stereoscopic LCD for Multi-User and Wide-Viewing Angle Function**

Y.-P. Huang, C.-H. Ting, C.-Y. Hsu, C.-H. Yang

Nat. Chiao Tung Univ., Taiwan

A multi-user 3D film was proposed to add in front of the directional sequential backlight system and make the display for three users. Furthermore, a high resolution time-multiplexed backlight with tracking system for multi-user applicable wide-viewing auto-stereoscopic LCD was proposed.

3D8 - 2
11:20 **A High Resolution Multi-View 3D Display Using Switchable Liquid Crystal Lens**

Y. Yang, T. Koito, N. Takasaki

Japan Display West, Japan

We have developed a six view 3D display of high 3D resolution above 170 ppi. A liquid crystal lens with strong optical focal strength has been developed. By using the liquid crystal lens, low crosstalk multi view 3D display has been realized.

3D8 - 3
11:40 **Study on Crosstalk Improvement of TN-LC Parallax Barrier Type Autostereoscopic Display**

C.-Y. Chen, B.-S. Lin[*], Q.-L. Deng[*], J.-K. Siao, H.-W. Lin

Nat. Yunlin Univ. of S&T, Taiwan
[*]Nat. Chiao Tung Univ., Taiwan

The twisted nematic liquid crystal to replace the conventional grating on an autostereoscopic panel. This study analyzes the crosstalk effect with different widths of slit pitch of grating at different viewing distances from 30 cm to 150 cm. From the simulation results, the crosstalk reduces down to 3.5% at each position.

3D8 - 4
12:00 **A Method of Improving the Flicker in Low Frequency Time-Sequential 3D Display**

C. Ye, C.-K. Chang, B. Fang, J. Qiu, C.-C. Lin

Shenzhen China Star Optoelect. Tech., China

We decrease the frequency of display, to improve the crosstalk. However, lower display frequency will make the flicker be observed by human eyes more easily. Hence a method of improving flicker is required. The result shows that the flicker and crosstalk are both improved by adding on additional backlight pulse.

----- Lunch -----

14:00 - 15:30 **Room E**

3D9: Ray-Based Realistic 3D Display

Chair: M.-C. Park, KIST, Korea
Co-Chair: T. Koike, Hitachi, Japan

3D9 - 1:
14:00 ***Invited*** **Behind the Screen of NICT's 200-in. Automultiscopic Display**

S. Iwasawa, M. Kawakita

NICT, Japan

NICT developed the automultiscopic display technology whose prototype has a 200-in. large screen with a significant number of viewpoints or horizontal parallax images. The observed images of the prototype display are practically flipping-free despite the existence of tightly packed multiple viewpoints.

3D9 - 2
14:30 **Autostereoscopic Display with Parallel Light Rays Using Multi-Projectors and Lenticular Screen**

C.-Y. Chen, C.-J. Chou, S.-C. Cheng, C.-S. Wu, Y.-H. Chen, Y.-H. Chou, C.-H. Tsai

ITRI, Taiwan

This paper proposed a projection-type auto-stereoscopic display. The screen which the key component converts the diverged light rays from each projector to parallel light rays of different direction. The intersections of the light rays form the points of object to be displayed.

3D9 - 3
14:50 **Reduction of Moiré in Multilayer Integral Imaging Display**

Y. Ueda, H. Kakeya

Univ. of Tsukuba, Japan

This paper proposes moiré reduction method for multilayer integral imaging display. Moiré pattern, which is distinct in conventional multilayer integral imaging, can be obscured by adding another layer of convex lens array with short focal length just in front of the layered display panels.

3D9 - 4
15:10

Hybrid Full-Resolution 3D Display Using Time-Sequential 8.0-in. WVGA OCB-LCD

H. Miki, D. Suzuki, N. Kanda, S. Araki, E. Higano, K. Nishiyama, K. Nakao

Japan Display Central, Japan

We have developed hybrid 3D display; autostereoscopic and glasses mode are in one system, using time-sequential OCB and directional backlight. Both modes can show full-resolution 3D image, especially with glasses we can see 3D crosstalk-free images. Furthermore, we have got the prospect for reducing 3D crosstalk of autostereoscopy.

----- Break -----

15:50 - 16:25 **Room E**

3D10: Quality Evaluation

Chair: C.-Y. Chen, ITRI, Taiwan
Co-Chair: T. Mishina, NHK, Japan

3D10 - 1
15:50

Empirical Investigation Based on Depth Cues for 2D-to-3D Conversion Evaluations

C.-H. Wen, Y.-H. Li, S.-L. Tsai, Y.-L. Chen[*]*, C.-W. Chen*[*]*, R.-L.Dong*[*]

Nat. Taiwan Univ. of S&T, Taiwan
[*]*AU Optronics, Taiwan*

This paper computes disparity distributions of 2D-to-3D converted images and proposes a checklist based on depth cues for subjective assessment of stereo-displays. Experiments were conducted to investigate visual comforts on both 23-in. and 65-in. displays. There were different visual experiences on both displays even if the parameter settings were fixed.

3D10 - 4L
16:10

Color Three-Dimensional Image Generation Using Viewing-Zone Scanning-Type Super Multi-View Display

T. Ueda, Y. Toda, Y. Takaki

Tokyo Univ. of A&T, Japan

A viewing-zone scanning-type super multi-view display can generate numerous viewing points. This study introduced the time-multiplexing technique to produce three-dimensional color images. The prototype display generates 55 viewing points at an interval of 3.3 mm for each R, G, and B color with a refresh rate of 48.5 Hz.

3D10 - 2 **Withdrawn**

3D10 - 3 **Withdrawn**

Author Interviews and Demonstrations
17:30 – 18:30

Supporting Organizations:
3-D Image Technology Research Group, ITE
Holographic Display Artists and Engineers Club

Workshop on Applied Vision and Human Factors

Tuesday, December 4

14:20 - 15:50 **Room C-1**

VHF1: Color (1)

Chair: N. Ohta, Rochester Inst. of Tech., USA
Co-Chair: T. Matsumoto, Sony, Japan

VHF1 - 1: 14:20 ***Invited*** **Assessing Colour Difference for Images**

M. R. Luo

Univ. of Leeds, UK

This paper provides an overview of the development of colour difference formulae and uniform colour spaces. It will then extended for evaluating images. The work under CIE TC8-02 Colour Difference Evaluation in Images will be introduced together with more recent works will be introduced.

VHF1 - 2 14:50 **Image Enhancement Based on Perceptual Correlates of Lightness/Chroma in CIECAM02 Color Space**

M.-C. Lo, J.-L. Lin, W.-B. Li

Shih Hsin Univ., Taiwan

In this paper, four types of image enhancement algorithms (IEAs) were developed, and used for improving display image quality factors, such as details and dynamic range or spatio- frequency-temporal image artifacts. The IEAs derived consist of Fourier transform (including both highpass and lowpass), unsharp masking (USM), bilateral filtering, and Gaussian pyramid.

VHF1 - 3 15:10 **Possible Color Reproduction Methods to Obtain High Luminance and Wide Gamut on Reflective Displays**

M. Kanazawa

NHK-ES, Japan

The relationship of the luminance and the color gamut for reflective type displays is investigated. It is shown that methods based on the human visual system other than the current RGB sub-pixel can have better luminance and color gamut.

VHF1 - 4
15:30 **An Analytical Strategy for Colour Vision Deficiency Using a Digital Colour Vision Test Plate**

*Y.-C. Tsai, H.-S. Chen, M. R. Luo**

Nat. Taiwan Univ. of S&T, Taiwan
**Univ. of Leeds, UK*

An analytical strategy for colour vision deficiency to examine the degrees of deuteranomalous vision based on just-noticeable chromatic difference was developed. The developed computer software named Digital Colour Vision Test Plate (DCVTP) was used. The accuracy of DCVTP will be compared with Farnsworth-Munsell Dichotomous D-15 and Heidelberger Multi Colour Anomaloscope.

----- Break -----

16:10 - 17:30 **Room C-1**

DES2/VHF2: Color (2)

Chair: M. R. Luo, Univ. of Leeds, UK
Co-Chair: T. Fujine, Sharp, Japan

DES2/
VHF2 - 1:
16:10 ***Invited*** **Measuring Light and Color: Defining Color Rendering Property of Artificial Illuminants**

N. Ohta

Rochester Inst. of Tech., USA

The basis of the CIE standard colorimetric system was established as early as in 1931. After that, varieties of applications have been developed. Among them, I will today explain the method widely applied in the industrial field for evaluating the color rendering of light sources.

DES2/
VHF2 - 2:
16:40 ***Invited*** **Development of Laser Backlighting LCD Television**

E. Niikura, R. Murase, S. Kagawa, N. Nakano, A. Nagase, H. Sakamoto, T. Sasagawa, K. Minami, H. Sugiura, K. Shimizu, M. Hanai

Mitsubishi Elec., Japan

We have developed a laser backlighting LCD television using a LD for one of the light sources. The backlighting system of this TV uses two kinds of light source. One is a red LD and the other is a cyan LED. We realized a wide color gamut from this TV.

DES2/ VHF2 - 3 17:10 **The Effect of Lightness Component on Preferred Skin Color Reproduction of a Display**

S.-H. Chen, H.-S. Chen, N. Ohta[*], R. Luo[**], N.-C. Hu

Nat. Taiwan Univ. of S&T, Taiwan
[*]Rochester Inst. of Tech., USA
[**]Univ. of Leeds, UK

It is important to understand preferred skin color reproduction in display industry. The aim of this study is to examine the relationship between the brightness of skin color and perceived preference. The experiments are conducted to determine the preferred skin color ranges on chromatic components and lightness component on display.

Author Interviews and Demonstrations
17:50 – 18:50

Wednesday, December 5

9:00 - 10:20 **Room B-1**

3D3/VHF3: 3D Crosstalk Evaluation

Chair: J.-H. Park, Chungbuk Nat. Univ., Korea
Co-Chair: T. Kurita, NHK, Japan

3D3/ VHF3 - 1 9:00 **Perceptual Correspondence of Gray-to-Gray Crosstalk Equations for Stereoscopic Displays**

Z. Xia, X. Li, Y. Cui, L. Chen, K. Teunissen[*]

Southeast Univ., China
[*]TP Vision, the Netherlands

Although several crosstalk definitions have been proposed to indicate the level of crosstalk in stereoscopic displays, they do not necessarily correlate with perceived crosstalk. Based on perception experiments, we studied the correlation between ten objective crosstalk equations and perceived crosstalk for four glasses-based stereoscopic displays while using several gray-to-gray transitions.

3D3/ VHF3 - 2 9:20 **Visibility Thresholds for Crosstalk on Stereoscopic Displays**

Y.-Y. Ko, Y.-L. Chen, Y.-J. Chang, C.-W. Chen, R.-L. Rong

AU Optronics, Taiwan

Crosstalk is one of the critical factors determining the viewing quality and comfort in stereoscopic displays. This study tried to find out the relationship between crosstalk and related factors, like parallax angle and spatial frequency, and proposed psychophysics and ergonomic method to obtain the crosstalk threshold trend of human eyes.

3D3/ VHF3 - 3 9:40 **Camera-Based Cross-Talk and Uniformity Measurement of Multi-View Autostereoscopic 3D Display**

C.-F. Hung, F.-C. Tsai, C.-P. Ho

AU Optronics, Taiwan

This paper presents a camera-based approach with a uniformity measurement function to quantify the uniformity and the crosstalk characteristic of a multi-view autostereoscopic 3D display. The results show that the proposed method can efficiently and accurately measure both the global and local uniformity characteristic of the 3D display.

3D3/ VHF3 - 4 10:00 **A Novel Method to Evaluate the 3D Crosstalk of Stereoscopic 3D Display**

H.-T. Lin, S.-C. Lin, C.-C. Chiu

Chunghwa Picture Tubes, Taiwan

In this paper, we proposed a method to evaluate the quality of 3D display by using gray-to-gray crosstalk, through the formula convert the brightness of crosstalk into human perceptual response, and we also proposed some check patterns to make observer to evaluate the gray-to-gray 3D crosstalk easily and efficiently.

----- Break -----

10:50 - 12:05 **Room B-1**

3D4/VHF4: 3D Image Quality (1)

Chair: T. Horikoshi, NTT DoCoMo, Japan
Co-Chair: A. Yoshida, Sharp, Japan

3D4/ VHF4 - 1 10:50 **Quality Control of Active Glass 3D Displays Using Temporal Measurements**

*P. Boher, T. Leroux, T. Bignon, P. Blanc**

ELDIM, France

**Labs. d' Essais de la FNAC, France*

Quality control of active glasses 3D TVs is performed using high accuracy and high temporal resolution luminance measurements versus time. The two main parasitic effects on such displays, crosstalk and flicker are derived for different couples of gray levels applied. Quality criteria for ghost effect and flicker visibility are derived.

3D4/ VHF4 - 2 11:10 **New Crosstalk Index of Shutter Glasses 3D Display**

C. W. Chen, Q. Liao, C. C. Hsiao

Shenzen China Star Optoelect. Tech., China

A concept of universal crosstalk index for stereoscopic 3D display was proposed. Conventional crosstalk of shutter glasses 3D could be transferred to the new crosstalk index that could be comparable with the crosstalk index of patterned retarder 3D. The new crosstalk index was also investigated by human perceptive experiment.

3D4/ VHF4 - 3 11:30 **The Use of a Small-Sized Autostereoscopic Display: Context Influence on User Experiences**

M. Pölönen, M. Salmimaa

Nokia, Finland

92 participants viewed stereoscopic content on a small-sized autostereoscopic display in four different environments. The results indicate that the context of use did not influence user experiences, particularly with regard to eyestrain or motion-induced sickness levels, but context of use had some influence on image quality.

3D4/ VHF4 - 4L 11:50 **High Resolution Multi-View 3D Display Based on Active Optical Device**

K. Choi, Y. Choi, Y. Kim, Y. Kwon, J. Bae

Samsung Elect., Korea

This paper review system architectures for displaying a 3-dimensional image, based on a time multiplexing scheme. More particularly, an apparatus for displaying a 3D image, capable of providing a natural 3D display with a simple structure using an active optical device (or active optical element) capable of changing a path of light.

----- Lunch -----

15:50 - 17:10 **Room B-1**

VHF5/3D5: 3D Image Quality (2)

Chair: N. Hiruma, NHK, Japan
Co-Chair: K. Yamamoto, NICT, Japan

VHF5/ 3D5 - 1 15:50 **Stereo-Resolution Analysis Based on Reading Performance**

Y.-Y. Lai, S.-F. Y. Mao

ITRI, Taiwan

The reading performance is used to analyze the stereo-resolution in the stereoscopic display. In this paper, static and dynamic experimental designs were proposed to detect the stereo-resolution of stereoscopic display. From the results, reading performance could be a method to assess the property of stereo-resolution.

VHF5/ 3D5 - 2 16:10 **The Quantization of 3D Resolution Based on Human Perception**

Y.-L. Chen, C.-W. Chen, R.-L. Dong

AU Optronics, Taiwan

This is a novel study tried to quantify 3D resolution based on human perceptual judgment. Take resolution-related font size changes as stimuli, we found the reduced resolution in 3D would deteriorate perceptual clarity. The perceptual 3D resolution and better resolution design of 3D display were proposed.

VHF5/ 3D5 - 3 16:30 **3D Depth Detection in Multi-View Displays**

S.-F. Yang-Mao, Y.-T. Lin, T.-M. Wang, C.-H. Ho, H.-W. Chen, C.-S. Wu

ITRI, Taiwan

We propose a new design of testing for stereoscopic performance estimation between multi-view displays. Testing results show that parallel multi-view display has lower depth JND than convergent multi-view display; in other words, more depth details can be perceived in multi-view display with parallel optical beam on configuration of 36-rays.

VHF5/ 3D5 - 4 16:50 **Accommodation Response of Super Multi-View Display Using Directional Light in Monocular Condition**

J.-H. Jung, J. Kim, S.-G. Park, S. Y. Choi[*]*, D. Nam*[*]*, B. Lee*

Seoul Nat. Univ., Korea
[*]*Samsung Advanced Inst. of Tech., Korea*

Accommodation responses in a monocular condition are measured in a super multi-view display composed of telecentric lens, spatial light modulator and relay optics. The ideal case of super multi-view display is implemented and its induction of accommodation response in monocular eye is verified by the accommodation measurement using autorefractometer.

Author Interviews and Demonstrations
17:30 – 18:30

Thursday, December 6

9:00 - 10:30 **Room B-1**

VHF6: Wide-Angle and Head-Up Display Human Factors
Special Topics of Interest on Augmented Reality

Chair: T. Kurita, NHK, Japan
Co-Chair: A. Yoshida, Sharp, Japan

VHF6 - 1: 9:00 ***Invited*** **Education for Disaster Prevention Using Ultra-Realistic Dome Images −Learning Through Images of the Great East Japan Earthquake−**

M. Okyudo

Wakayama Univ., Japan

On 11 March 2011, our country suffered an earthquake and a tsunami of unprecedented size. Streets and towns throughout a wide region were destroyed. We recorded these disaster areas in ultra-realistic dome images, presented them in a digital planetarium, and began to use them as disaster prevention education.

VHF6 - 2 9:30 **Development of Perceived Depth Position Control Method with a Preceding Obstacle for Monocular Head-Up Display Images**

A. Hotta, T. Sasaki, A. Moriya, H. Okumura

Toshiba, Japan

We developed novel depth perception control methods for the monocular HUD virtual image when there is a preceding obstacle. The results show that the perceived depth position of the HUD images can be controlled from 30 m to 120 m within an error of 30% which is further than the obstacle position.

VHF6 - 3 9:50 **Effect of a Head-Up Display on Reaction Time in a Skiing Simulation**

M. Lolic, R. Hoskinson, É. Naugle, H. Abdollahi

Recon Instrs., Canada

A computer simulation was created to monitor the reaction time of participants using a heads up display (HUD) while watching a first-person ski video. It was found on average that the reaction time increased by 0.19 seconds when users were asked to pay attention to notifications on a HUD.

VHF6 - 4 10:10 **A LC Lens Array Based Projection System for Near Eye Displays**

S. Valyukh, J. De Smet[,**], O. Slobodyanyuk[***], H. De Smet[*,**]*

Linköping Univ., Sweden
[*]imec, Belgium
[**]Ghent Univ., Belgium
[***]Taras Shevchenko Nat. Univ. of Kyiv, Ukraine

A projection optical system for hypothetic near eye displays that can be built into a contact lens or glasses is considered. The system parameters are evaluated. Aspects of practical usage of the displays and possible embodiments of the optical system are discussed.

----- Break -----

14:00 - 17:00 **Event Hall**

***Poster* VHFp: Applied Vision and Human Factors**

VHFp - 1 **Detection of Analog Meter Indicator Using Combinational Hough Transform Based on Features of Indicator**

J. Mizutani, F. Saitoh

Gifu Univ., Japan

We propose a method to detect indicator of analog meter in an objective image using the combinational Hough transform and features of indicator. The experimental results show that the indicators of various analog meters are detected by the proposed method.

VHFp - 2 **Fast Detection Method for Perceptive Curves**

T. Takagi, F. Saitoh

Gifu Univ., Japan

In the previous conference, we have proposed the high-precision method to detect perceptive continuous curves from a binary image. This time we propose the fast detection method without additional parameters and accuracy deterioration. Experimental results show that this method would be 50 times faster than pre-reported method.

VHFp - 3 **Reliable Image Template Matching Using Adaptive Block Separation**

A. Hirosawa, F. Saitoh

Gifu Univ., Japan

This paper proposes a more reliable method for template matching that builds the algorithm that automatically divides blocks into conventional method. In each block, to calculate the degree of similarity among contiguous block. Their blocks are connected depending on the results. Template matching is performed by using foregoing blocks.

VHFp - 4 **High-Speed Image Matching Using Templates with Detection History Learning**

S. Nakamura, F. Saitoh

Gifu Univ., Japan

Template matching has the method of improving performance by machine learning. However, those methods require time for making data learn. Moreover, preparation of the data for machine learning is not easy. Therefore, the method of optimizing a template image by learning simultaneously with detection is proposed.

VHFp - 5 **Correspondence between Subjective Assessment and Objective Computational Metric for Viewing Angle**

Y.-Y. Lin, C.-H. Wen, P.-C. Huang[*]*, T.-W. Hsu*[*]*, K.-C. Chang*[*]

Nat. Taiwan Univ. of S&T, Taiwan

[*]*AU Optronics, Taiwan*

A new metric to identify the image quality of viewing angles is proposed to correspond with human subjective evaluations. Experiments were conducted to verify the feasibility of the metric using three displays. The advantages include the capability of dealing with color image quality of viewing angles through current metrology.

VHFp - 6 **Three-Layered Secure Display Based on Polarization Modulation**

K. Uchida, S. Suyama, H. Yamamoto

Univ. of Tokushima, Japan

We have realized a new secure display by three liquid-crystal display (LCD) panels. A special code set for optical encryption has been constructed in order to suppress color change caused by higher-order birefringence. Use of three-layered LCD panels strictly limits the viewing position and increases complexity of keys.

VHFp - 7 **Analysis of Drop Mura in Fringe Field Switching Liquid Crystal Display**

W. Zhang, S. H. Song, X. Chen, T. Y. Min

BOE Optoelect. Tech., China

Drop Mura, one of the most frequent defects in themanufacture of Fringe-Field Switching LCD, was thoroughly analyzed in this paper. It's believed that Drop Mura is caused by too weak anchoring to LC molecules. Provably, three feasible approaches to improve it were supplied.

VHFp - 8 **Plural Image Areas Searching by Immune System Type Genetic Algorithm with Two Memory Mechanisms**

Y. Shimohira, F. Saitoh

Gifu Univ., Japan

This paper proposed a method that extracts plural target image areas with free locations, inclination and scale that are similar to template image by immune system type genetic algorithm with two memory mechanisms. The experimental results show the proposed method can search more plural local solutions than conventional methods.

VHFp - 9 **Curved Mirror Detection Using Edge Pre-Processing Based on Curvature**

T. Kawamoto, F. Saitoh

Gifu Univ., Japan

We propose a method to detect only the curved mirror using Least Square Method and Hough Transform from the image of urban area. The experimental results also show the effectiveness of the pre-processing proposed in this paper.

VHFp - 10 **Withdrawn**

VHFp - 11 **The Comfort Zone and Fusion Limit of a Foreground Object with Its Background on a Large Format 3D Display**

P.-L. Sun, T.-H. Tseng, Y.-L. Chen, C.-W. Chen*, R.-L. Dong**

Nat. Taiwan Univ. of S&T, Taiwan
**AU Optronics, Taiwan*

Unlike previous studies which ignored the background of an image, the comfort zone and fusion limit of a foreground object with its background were investigated. The results show the fusion limit is nearly a constant for different vergence distance. Besides, blur the background slightly would extend the comfort zone.

VHFp - 12L **Gamut Extension Algorithm in Laser Display**

*B. Na, W. Wang, W. Lu**

East China Normal Univ., China
**Chinese Ac. of Scis., China*

The paper proposed a new gamut mapping system, the system is applied based on the image contents. The images reproduced by the new system are more flaming and more beautiful than usual without the problem of making the viewers fell fatigue.

Author Interviews and Demonstrations
17:30 – 18:30

Friday, December 7

10:50 - 12:35 **Room C-2**

VHF7: Human Factors and Visual Cognition

Chair: S. Clippingdale, NHK, Japan
Co-Chair: K. Sakamoto, Panasonic, Japan

VHF7 - 1: 10:50 ***Invited*** **JAMA Guidelines for In-Vehicle Display Systems**

Y. Nakamura

Honda R&D, Japan

JAMA executed the road tests to analyze driver's workload of various operations to the navigation systems. As a result, the JAMA guidelines regulated the world's first numerical criterion for display operations while driving. The paper describes the grounds of the criterion.

VHF7 - 2 **Study on User Interface for Flexible Displays**
11:20
S.-P. Wang, M.-Y. Lu, S.-H. Wu, C.-C. Liang
ITRI, Taiwan

In order to find out the most intuitive user interface methods on flexible displays, series of human factor experiments were executed to understand the natural operating behaviors of users. Gestures and false signals judgment algorithms were found out by keeping track of users' gestures.

VHF7 - 3 **Visual Comfort for Older People Reading on a Tablet**
11:40 **Computer under Dark Conditions**
H.-P. Huang, Y.-H. Bai, L.-C. Ou
Nat. Taiwan Univ. of S&T, Taiwan

We studied visual comfort of 20 young and 20 older observers viewing text-background combinations presented on an iPad 2. As a result, older observers tended to prefer higher lightness difference for text-background combinations, while visual comfort for young observers tended not to increase for lightness difference higher than 80.

VHF7 - 4 **The Influence of Recognition of Illumination upon**
12:00 **Depth Perception**
K. Oba, K. Nagai, H. Kaji, T. Ishikawa, M. Ayama
Univ. of Utsunomiya, Japan

We investigated the quantitative relation between the shadow on an object's surface and the perceptual evaluation of its depth using primary and secondary objects. The luminance gradient causing protrusive perception of the secondary object depended on whether it was perceived to be in front of or behind the primary object.

VHF7 - 5L **Luminance-Contrast Smoothness as a Depth Cue**
12:20
Y. Tsushima, K. Komine, N. Hiruma
NHK, Japan

It is known that luminance-contrast change is one of depth cues, however, little is known about the relationship between depth perception and display resolution. Here we examine how luminance-contrast smoothness correlates with depth perception. The results show that contrast smoothness can be used as one of depth cues.

----- Lunch -----

14:00 - 15:35 **Room C-2**

VHF8: Image Format and Ergonomic Design of HD/UHDTV

Chair: Y. Shimodaira, Shizuoka Univ., Japan
Co-Chair: K. Masaoka, NHK, Japan

VHF8 - 1: 14:00 ***Invited*** **SUPER Hi-VISION Image Format and Its Standardization**

M. Sugawara, K. Masaoka, M. Emoto, Y. Nishida, Y. Shishikui

NHK, Japan

A series of studies on the parameter values for SUPER Hi-VISION image format were carried out from the viewpoint of human factors. A set of selected parameter values was proposed to ITU-R. Recommendation ITU-R BT.2020 was established in August 2012 after four years of standardization activities.

VHF8 - 2: 14:30 ***Invited*** **Summary and Impact of the Ergonomic Design Guidelines for Flat Panel Display Televisions Issued by the Japan Ergonomics Society**

*Y. Hisatake, S. Kubota**

Japan Display Central, Japan
**Seikei Univ., Japan*

This paper summarizes the Ergonomic Design Guidelines for Flat Panel Display Televisions issued by the Japan Ergonomics Society, reviewing the required luminance contrast ratio. We concluded that the contrast ratio of the display should be 6700 or more under actual normal television-viewing conditions.

VHF8 - 3 15:00 **Size Effect Revisited : Subjective Image Quality of HDTV Images as a Function of Visual Angle and Display Size**

T. Kanda, T. Fujine, M. Sugino

Sharp, Japan

In this research, we investigated size effect for image quality on reproducing HDTV images. We confirmed that sense of presence increased along with larger screen size, and realness increased along with higher angular resolution but had no size effect. Finally, we discussed about display for the next generation.

VHF8 - 4L 15:20 **Resolution Limits for Smartphone Displays**

L. Spencer, M. Jakobsen, S. Shah, G. Cairns, H. Washio, H. Nishishiba**

Sharp Labs. of Europe, UK
**Sharp, Japan*

This study determines an upper discernible limit for display resolution. A range of resolutions varying from 254-1016 PPI were evaluated by 49 subjects at 300 mm. Results of the study conclusively show users can discriminate between 339 and 508 PPI and in many cases between 508 and 1016 PPI.

----- Break -----

15:50 - 17:20 **Room C-2**

VHF9: Display Measurement

Chair: Y. Hisatake, Japan Display Central, Japan
Co-Chair: J. Bergquist, Nokia Japan, Japan

VHF9 - 1
15:50
Image Quality Evaluation for LCD by Employing Local Dimming Backlight

M.-H. Yang, S.-Y. Pan, K.-C. Chang, C.-Y. Lee
AU Optronics, Taiwan

We proposed new methods for evaluation of consistency of contrast, luminance, and uniformity of LCD with local dimming backlight by implementing checkerboards, box patterns and complex pictures. And evaluation of power consumption reduction ability of LCD with local dimming backlight, specified patterns of ISO and IEC standards are used.

VHF9 - 2 **Withdrawn**

VHF9 - 4L
16:10
A Quantitative Mura Evaluation Method that Depends on Viewing Distance

K. Nagamine, S. Tomioka
Sony, Japan

We developed a quantitative mura evaluation method that depends on viewing distance. In the present paper, we report the results of an analysis of the dependence of the mura edge appearance on viewing distance. We propose a new definition of the threshold for edge detection that considers human vision.

VHF9 - 3
16:30
Improved Picture Quality on Multi-Domain Polymer Sustained Alignment LCD Technology

K.-C. Tien, C.-H. Liao, M.-H. Wu, S.-M. Gong, J.-Y. Chung, W.-H. Hsu, J.-J. Su
AU Optronics, Taiwan

Design parameters, area ratio and voltage ratio, of multi-domain polymer sustained alignment (PSA) LCDs and their effects for picture quality are studied. By the optimized individual RGB sub-pixel design, we improve color-washout without suffering yellowish color-shift effect.

VHF9 - 5L 16:50 **Perceived and Acceptable Limit Level of Color Gamut Reduction**

J.-U. Kwon, S.-J. Bang, M.-C. Byun, H.-I. Baek, M. Lim, H.-H. Shin

LG Display, Korea

Perceived limit level (PLL) and acceptable limit level (ALL) were suggested in case the color gamut is reduced from 100% to 55%. When reference images were within 100% or 83% of BT.709 gamut, PLL was 88~89% and 74%, respectively. ALL was 69% and 60~61%, respectively.

VHF9 - 6L 17:05 **Saliency-Based Color Accessibility: Theory into Practice**

S. Tajima, K. Komine

NHK, Japan

We propose a novel methodology to analyze the universality of images, taking into account the diversity of color perception. It quantifies and visualizes expected information loss according to the notion of visual saliency. Psychophysical experiments indicated relationships between the model's predictions and subjective visual clarity.

Author Interviews and Demonstrations
17:30 – 18:30

Supporting Organizations:
Information Display Research Committee, ITE
Technical Committee on Electronic Information Displays, Electronics Society, IEICE

IDW Best Paper Award

IDW Outstanding Poster Paper Award

These awards will go to the most outstanding papers selected from those presented at IDW/AD '12.
The 2012 award winners will be announced on the IDW website: http://www.idw.ne.jp/award.html

Workshop on Projection and Large-Area Displays and Their Components

Thursday, December 6

9:00 - 10:35 **Room B-2**

PRJ1: High Reality

Chair: Y. W. Li, Himax Display, Taiwan
Co-Chair: T. Suzuki, JVC KENWOOD, Japan

PRJ1 - 1: 9:00 ***Invited*** **New Markets for Projection System and Ongoing Breakthrough Technology**

J. Kimura, M. Takaso
Techno Syss. Res., Japan

Projection display's main applications are presentation usage at education scenes, cinema, large venue, embedded, small and pocket projectors. Head Up Displays (HUDs), Head Mounted Displays (HMDs) have started to take off with the latest projection technology. Current challenges and the market expectation for solid state light source are noted.

PRJ1 - 2: 9:25 ***Invited*** **Realistic Image Display Based on High-Fidelity and Wide-Gamut Color Reproduction**

M. Yamaguchi
Tokyo Inst. of Tech., Japan

Technologies for realistic image display based on high-fidelity and wide-gamut color reproduction are presented. The system can be implemented with multiprimary color displays or laser projection displays, along with spectrum-based image acquisition and encoding. For improved material perception, techniques for gloss and high-luminance texture reproduction are also investigated.

PRJ1 - 3: 9:50 ***Invited*** **Autostereoscopic AR Display Based on Overlaid Multi-Projection 3D Display**

T. Koike, K. Utsugi, M. Oikawa, M. Yamasaki
Hitachi, Japan

We developed 3D aerial image by using a 3D display and a plane glass. The 3D display consists of 24 projectors and is based on a principle of overlaid multi-projection integral imaging. This technology realizes 3D augmented reality in real space by 3D aerial image superimposed on the real object.

PRJ1 - 4
10:15

Ultra-High Native Contrast 4K LCOS Projector Using e-Shift Technology

Y. Kojima, T. Aizaki, K. Maeno, T. Furukawa, T. Saiki, M. Furuya, M. Sato

JVC KENWOOD, Japan

A 4K projector for consumers has been developed. By combination of LCOS device and e-Shift technology that were developed for 8000 scan lines display, 4K projector became the home theater projector. Furthermore, by the evolution of the Wire-grid optical engine, it got ultra-high native contrast 120,000:1.

----- Break -----

10:50 - 11:20 **Room B-2**

Short Presentation PRJp: Projection and Optics

Chair: H. Kanayama, Panasonic, Japan
Co-Chair: H. Sugiura, Mitsubishi, Japan

All authors of poster papers for the PRJp session will give brief oral presentations of 3 minutes in advance.

----- Lunch -----

14:00 - 17:00 **Event Hall**

Poster PRJp: Projection and Optics

PRJp - 1

Compact Liquid Crystal Circular Polarization Switch for 3D Laser Pico-Projectors

S. Kato, T. Takeishi, T. Nozaki, M. Ide

Citizen Holdings, Japan

Crosstalk is one of the most important attributes of image quality of polarization switching 3D pico-projectors and the chromatic dispersion of a polarization switch causes crosstalk. We propose a novel compact polarization switch using an FLC in-plane switch and an NLC retarder with a polymer retardation film.

PRJp - 2

Integrated Waveguide-Type Red-Green-Blue Beam Combiners for Compact Projection-Type Displays

Y. Kato, Y. Kakinoki, R. Morimoto, T. Katsuyama

Univ. of Fukui, Japan

We studied the red-green-blue combiners with optical waveguides to obtain compact projection-type displays. Three combiners based on whispering-gallery mode, multi-mode interference and directional-coupler were designed. In these combiners, we concluded that the combiner based on the directional-coupler is the best candidate, giving 96% efficiency and the size of 0.06×6 mm^2.

PRJp - 3 **Withdrawn**

PRJp - 4 **Liquid Cooled Recycling LED Array for Digital Projectors**

K. Li

Wavien, USA

This paper presents an array of RLT-LEDs mounted in a heat sink with refrigerated liquid cooling. With the white LEDs operating at 280 W, an output of over 700 lumens is expected and with over 1,000 lumens after further optimization, using a DLP projector with a 0.65-in. WXGA imager.

PRJp - 5 **Zoomable Color Holographic Projection Method without a Zoom Lens**

T. Shimobaba, T. Kakue, N. Masuda, T. Ito

Chiba Univ., Japan

Holographic projection has the merits of being aberration-free, producing high contrast images. We have already proposed a zoomable monochrome holographic projection without using a zoom lens. In this paper, we advance the zoomable monochrome holographic projection to color one.

PRJp - 6 **Optical Lens Design for a Virtual Image Projector in a Helmet**

H. T. Lin, W.-C. Su, P.-K. Chang, Y.-W. Wang

Nat. Changhua Univ. of Education, Taiwan

A projection lens design for a virtual image projector in a helmet is presented. The designed projection lens system shows that optical modulation transfer function (MTF) is 0.55 at the spatial frequency of 40 lp/mm and field of view (FOV) is 8°.

PRJp - 7 **Optics-Based Dielectrophoretic Technology for Cells Manipulating**

H.-H. Chen, H.-H. Lo, C.-C. Lin, J.-C. Chen

ITRI, Taiwan

We propose a special designed lens to project the entire image to the optically-induced dielectrophoretic (ODEP) chip to achieve high light efficiency and large manipulating area. The ODEP chip combines two ITO glasses and spacer, and one ITO glass was coated with a photoconductive thin film.

PRJp - 8L **A Study of Optical Design of Laser Projector with High Contrast**

C.-H. Chu, Y.-C. Fang, W.-T. Li

Nat. Kaohsiung First Univ. of S&T, Taiwan

The research focuses on prospect module of laser projector with high contrast and efficiency. This is a completely new design which takes advantage of less heat interference and system whose performance and contrast of new developed projector have been further improved.

PRJp - 9L **Increase Brightness of Pico-Projectors with RGGB LEDs Using DPR Recycling Collars**

K. Li

Wavien, USA

A new LED recycling collar using Dual Parabolic Reflector (DPR) is being developed to increase the brightness of multi-colored LED package with RGGB LEDs. The output from each LED is recycled back into itself on the same location, thus increases the brightness of each LED independently.

PRJp - 10L **Analysis of Light Emitting Diode Reflector by Factor Analysis**

C.-J. Ou, C.-H. Lin, S.-L. Young

Hsiuping Univ. of S&T, Taiwan

This report discusses the important features of the three geometric factors and the two performance metric response (uniformity and collected energy) for the designing of the LED reflector. Shape factors for the LED reflectors are proposed, and the methodology for designing the optimal shape is discussed.

PRJp - 11L **Application of LED for Generalized Cell Illuminating Experiment System**

C.-J. Ou, S. R. Yeh[*]*, B.-W. Lee, C.-J. Huang, C.-H. Lin*

Hsiuping Univ. of S&T, Taiwan
[*]Nat. Tsing Hua Univ., Taiwan

Novel tissue engineering required the using of the light source produce a small light spot close to the cells. In order to investigate the LED factors (wavelength, polarization and spatial intensity distribution), we demonstrate a LED based portable cell illuminating system, and report the feasibilities of the present design.

Author Interviews and Demonstrations
17:30 – 18:30

Friday, December 7

9:00 - 10:25 **Room B-1**

PRJ2: Vehicle Displays

Chair: D. Cuypers, imec, Belgium
Co-Chair: K. Ohara, Texas Instrs., Japan

PRJ2 - 1: 9:00 ***Invited*** **Development of a Rear Projection Free-Form Display**

S. Nakahara, M. Kuwata, T. Kumagai, W. Yamazaki, T. Yagisawa, T. Matsubara, K. Kojima, A. Michimori, K. Minami, H. Sugiura

Mitsubishi Elec., Japan

On-board displays need a design which matches the interior design of the car, in addition to providing the driver with information. We have developed a free-form rear projection display. The rear projection display shows image information on three-dimensional curved surfaces. We propose a free-form cockpit using the rear projection display.

PRJ2 - 2 9:25 **Development of Full-Color Laser Head-Up Display**

Y. Tanahashi, O. Kasono, T. Yanagisawa, T. Nomoto, I. Kikuchi, T. Ezuka, K. Nakamura, H. Takahashi, Y. Imasaka, Y. Tsuchida, T. Shimizu

Pioneer, Japan

A compact head-up display (HUD) system, which can be attached on a car's ceiling, is developed. Wider field of view (FOV, 17.1˚ x 5.7˚) is achieved in combination with a laser projector, a micro-lens array screen and a concaved half mirror. Optical see-through AR navigation can be realized with it.

PRJ2 - 3 9:45 **Combiner for Head-up Displays Using Partial Transparent Fresnel Reflecter**

K. Horiuchi, S. Shimakawa, M. Inomoto, N. Okada, T. Sasaki, H. Okumura

Toshiba, Japan

A combiner for wide-view head-up displays using Fresnel reflector that acts both as a concave mirror for reflected light and a flat plate for transmitted light has been developed. Ghost image is eliminated by decentered Fresnel pattern with variable pitch sandwiched by the materials with the same refraction index.

PRJ2 - 4 10:05 **Projection Technology for Future Airplane Cockpits**

*D. Cuypers[*], H. D. Smet[**,*], A. Monté[*], X. Hugel[***], G. Dubroca[***]*

[*]imec, Belgium
[**]Ghent Univ., Belgium
[***]Optinvent, France

A large single interactive display designed for the cockpits of future airplanes, as it was developed during the European Project ODICIS is presented. It is based on an array of several short throw wide angle projectors resulting in a seamlessly tiled display. The project results are discussed in this contribution.

----- Break -----

10:50 - 12:15 **Room B-1**

PRJ3: Components

Chair: P. Rudy, Soraa, USA
Co-Chair: S. Shikama, Setsunan Univ., Japan

PRJ3 - 1: 10:50 ***Invited*** **New Progress of LCOS Using a Fringe-Field Color Filter**

Y. W. Li, K.-H. Fanchiang, H.-C. Kuo, H.-C. Tsai

Himax Display, Taiwan

The color performance of LCOS can be improved by Fringe Field Color Filter technology. Besides the color performance improvement, it also allows pixel size shrinkage. In this paper, we demonstrate that even 40% pixel size is reduced; the color performance still can be kept at the same level.

PRJ3 - 2 11:15 **Speckle Contrast as Low as LED for High Luminance Phosphor-Converted Lamp Excited by InGaN/GaN Blue Laser Diodes**

J. Kinoshita, Y. Ikeda, Y. Takeda, Y. Kawasaki, M. Ueno, Y. Matsuba, A. Heike

Toshiba Lighting & Tech., Japan

A white lamp with a spectrum consisting of blue output from InGaN/GaN laser diodes and yellow phosphor emission has achieved a luminance as high as 140 Mcd/m^2. Despite using the lasers, this lamp is suitable for various lighting applications because of its completely speckle-free PWM dimming performance.

PRJ3 - 3 11:35 **Speckle Reduction Within a Single One Microsecond Laser Pulse**

F. Shevlin

Dyoptyka, Ireland

Pulsed operation of lasers has a variety of advantages in projection displays. DYOPTYKA's innovative solution for the reduction of speckle noise, using a phase randomizing deformable mirror, is shown to achieve good performance both within a single one microsecond pulse duration and through sequences of such short pulses.

PRJ3 - 4 11:55 **Single and Dual Lamp System Using DPR for Digital Cinema Projectors**

K. Li

Wavien, USA

A multi-kilowatt single and dual xenon lamp based illumination systems for digital projectors are being developed using the Dual Paraboloid Reflectors (DPR) with polarization recycling system for LCOS and 3LCD imagers, and without recycling for DLP imagers. The DPR system allows higher efficiency operations compared to standard elliptical reflector system.

----- Lunch -----

14:00 - 15:35 **Room B-2**

PRJ4: Solid State Lighting
Special Topics of Interest on Lighting Technologies

Chair: F. Shevlin, Dyoptyka, Ireland
Co-Chair: M. Sakai, Ushio, Japan

PRJ4 - 1: 14:00 ***Invited*** **Recent Progress in Green and Blue InGaN Laser Diodes for Projection Display Applications**

J. W. Raring, M. C. Schmidt, C. Poblenz, H. Huang, C. Bai, P. Rudy, J. S. Speck, S. P. DenBaars, S. Nakamura

Soraa, USA

We report recent progress for InGaN-based lasers diodes fabricated on nonpolar/semipolar substrates. In the green, we demonstrate single-mode lasers operating with >3.5% wall-plug-efficiency and 190 mW output power. In the blue, we demonstrate single-mode lasers with >23% wall-plug-efficiency and high power lasers operating with >2.5 W of output power.

PRJ4 - 2: 14:25 ***Invited*** **Green-to-Yellow Spectral Region CW Operation of BeZnCdSe Quantum-Well Laser Diodes**

S. Tanaka, S. Fujisaki, J. Kasai, S. Tsuji, R. Akimoto, T. Hasama*, H. Ishikawa**

Hitachi, Japan
**AIST, Japan*

Continuous-wave operation in green-to-yellow spectral region was demonstrated with BeZnCdSe quantum-well laser diodes. The lasing wavelength of the fabricated yellow laser diode was 571 nm. Light output power of the green and yellow laser diode was as high as 50 mW with a low threshold current density.

PRJ4 - 3 14:50 **High Efficiency and Highly Reliable 638 nm Broad Stripe Laser Diode for Display Applications**

T. Yagi, N. Shimada, T. Nishida, H. Mitsuyama, M. Miyashita

Mitsubishi Elec., Japan

638 nm broad stripe laser LD was newly developed. The LD has the large optical confinement factor design for high WPE and the window-mirror structure for reliable operation. The LD shows WPE of 35% at 25˚C, 44 lm/W, and highly stable operation at 35˚C, 550 mW up to 8,000 hours.

PRJ4 - 4L: 15:10 ***Invited*** **High-Power, Long-Lifetime Green Laser Diodes with Wavelengths above 525 nm Grown on Semipolar {20-21} GaN Substrates**

K. Tasai, H. Nakajima, K. Naganuma, Y. Takiguchi, T. Hamaguchi, N. Futagawa, K. Yanashima, M. Ikeda, Y. Enya, S. Takagi*, M. Adachi*, T. Kyono*, Y. Yoshizumi*, T. Sumitomo*, Y. Yamanaka, T. Kumano*, S. Tokuyama*, K. Sumiyoshi*, N. Saga*, M. Ueno*, K. Katayama*, T. Ikegami*, T. Nakamura**

Sony, Japan
**Sumitomo Elec. Inds., Japan*

GaInN-based green laser diodes (LDs) with wavelengths above 525 nm were fabricated on semipolar {20–21} GaN substrates. The LDs were estimated to have lifetimes of over 5000 h for an optical output power of 50 mW at a case temperature of 55˚C under continuous-wave operation.

Author Interviews and Demonstrations
17:30 – 18:30

Supporting Organizations:
Information Display Research Committee, ITE
Laser Display Technology Research Group, Optical Society of Japan

IDW/AD '12 Tutorial in Japanese

Organized by SID Japan Chapter

Monday, December 3, 2012
Room B-2, 2F
Kyoto International Conference Center

Detailed information is available on
http://www.sidchapters.org/japan/

EXHIBITION

12:40 – 18:20 Tuesday, Dec. 4, 2012
10:00 – 18:00 Wednesday, Dec. 5, 2012
10:00 – 18:00 Thursday, Dec. 6, 2012
10:00 – 14:00 Friday, Dec. 7, 2012

Event Hall, 1F
Kyoto International Conference Center

Free admission with your registration name tag

Workshop on Electronic Paper

Tuesday, December 4

14:20 - 15:55 **Room D**

EP1: Electrophoretic Displays

Chair: T. Kitamura, Chiba Univ., Japan
Co-Chair: M. Tsuchiya, E-ink, Japan

EP1 - 1: 14:20 ***Invited*** **Color Electrophoretic e-Paper Using Independently Movable Colored Particles**

*N. Hiji, Y. Machida, Y. Yamamoto, K. Shigemura**

Fuji Xerox, Japan
**NLT Techs., Japan*

We have developed a novel color-filter free color electrophoretic e-Paper based on a IMCP (independently movable colored particles) technology using plural particles with different colors and threshold fields. The e-paper is a promising technology that has a feasibility to enable a print level color quality.

EP1 - 2: 14:45 ***Invited*** **Bright e-Skin Technology and Applications**

K.-M. H. Lenssen

Philips Res., the Netherlands

The most promising technologies for bright e-Skin, with a highly transparent state, are based on movement of colored particles. The ultra-low power consumption enables zero-energy e-Skin, which was demonstrated for in-plane electrophoretic and electrokinetic panels. The state-of-the-art of e-Skin technology as well as an overview of application areas are presented.

EP1 - 3: 15:10 ***Invited*** **High Performance Particle Materials and Fluids for Colour Filter Free, Colour Electrophoretic Displays**

M. Goulding, L. Farrand, A. Smith, H. Wilson, R. Kemp, T. Schwalm, E. Thomas, C. Topping, C. Berger, M.Hesselbach, M. Koch*, N. Greinert*, T. Bauer**

Merck Chems., UK
**Merck KGaA, Germany*

Colour reflective displays with “printed paper” luminance and moderate response times remain a challenging target for display designers. As an alternative to colour filter over monochrome electrophoretic (EPD) fluid, intrinsic colour EPD fluids are demonstrated. This paper presents recent developments in printable colour reflective and transmissive EPD fluids.

EP1 - 4 15:35 **150 to 225 ppi Large Area Flexible OTFT Backplanes for Monochrome and Colour Electrophoretic Displays**

P. A. Cain, S. Norval, J. D. Watts, M. Haugwitz[*]

Plastic Logic, UK
[*]*Plastic Logic, Germany*

We present a new device architecture and process that enables higher resolution flexible oTFT displays, and demonstrate this in a 2.8 million pixel display. Secondly, we present flexible colour reflective displays made with this architecture, and show the performance consistency achieved with this qualified manufacturing process.

----- Break -----

16:10 - 17:20 **Room D**

EP2: Reflective Displays and Evaluations

Chair: N.-S. Roh, Samusung Display, Korea
Co-Chair: A. Suzuki, Chiba Univ., Japan

EP2 - 1: 16:10 ***Invited*** **Ambient Light Reflectivity and Readability of Flat and Curved (Reflective) Displays**

K. Blankenbach, A. Sycev

Pforzheim Univ., Germany

The optical performance of reflective and flexible displays is essential for readability. We measured reflectance and contrast ratio characteristics of flat and curved displays, the latter especially tends to “capture” specular light sources. An improved and easy-to-use measurement set-up for angular reflection distribution was engineered and successfully evaluated.

EP2 - 2: 16:35 ***Invited*** **Driving Colorants for Print-Like Color – Beyond Electrophoresis**

J.-S. Yeo

Yonsei Univ., Korea

Approaches generally adopted for transmissive displays prove to be inefficient for reflective color so the stack architecture with layered colorants is considered a path for print-like color. Effective layering requires driving of colorants beyond electrophoresis to optimize all the electrokinetic forces in electronic ink along with electrode and encapsulant configurations.

EP2 - 3 17:00 **Advanced Driving Techniques in Electrowetting Display**

Y. J. Jang, N. G. Choi, J. W. Jeong, G. J. Park, H. S. Hwang, C. W. Park, B. H. You

Samsung Display, Korea

Electric field of electrowetting should be disturbed periodically to prevent the oil backflow. High voltage called "reset" is used for this scheme though it reduces the performance of display. In this paper, we propose a dynamic output control driving to get the improved contrast ratio (>26.7) and color gamut (>34.8%).

Author Interviews and Demonstrations
17:50 – 18:50

Wednesday, December 5

9:00 - 10:05 **Room B-2**

EP3: Electrochromic Displays and Others (1)

Chair: H. Higuchi, NIMS, Japan
Co-Chair: S. Maeda, Tokai Univ., Japan

EP3 - 1: 9:00 ***Invited*** **Electrochromism and Electrochemiluminescence as Novel Display Technology**

N. Kobayashi

Chiba Univ., Japan

We are studying novel electronic paper technology with electrochemical reaction. Our phthalate-based electrochromic (EC) cells were suitable for full-color e-paper. Also we invented dual-mode display (DMD) cell which shows EC as reflective-mode and electrochemiluminescence (ECL) as emissive-mode. In this paper, we reported phthalate-based full-color EC system and our DMD cell.

EP3 - 2 9:25 **High Resolution Technology for Multi-Layered Electrochromic Display**

Y. Okada, T. Yashiro, Y. Naijoh, S. Hirano, S. Kim, K. Tsuji, H. Takahashi, K. Fujimura, H. Kondoh

Ricoh, Japan

Multi-Layered Electrochromic Display (mECD) we have demonstrated is superior in terms of brightness and color reproducibility to the conventional full-color reflective electronic papers. By utilizing a nematic liquid crystalline (LC) electrolyte, we have obtained high resolution images of mECD without any fine patterning in the front-plane.

EP3 - 3
9:45

Multicolor Electrochromic Device with Electrochemically Size-Controlled Silver Nanoparticles

A. Tsuboi, K. Nakamura, N. Kobayashi

Chiba Univ., Japan

Novel multicolor electrochromic (EC) device with on electrochemical silver deposition mechanism was successfully demonstrated. The novel EC device enabled reversible color change between transparent, red and blue color in a single cell by using voltage step method which controlled the size of deposited Ag nanoparticles.

----- Break -----

10:50 - 11:30 **Room B-2**

EP4: Electrochromic Displays and Others (2)

Chair: N. Kobayashi, Chiba Univ., Japan
Co-Chair: Y. Toko, Stanley Elec., Japan

EP4 - 1
10:50

New Paper Displays Using Electrochromic / Vapoluminescent Organic-Metallic Hybrid Polymer Films

M. Higuchi[,**], J. Zhang[*,**], T. Sato[*,**]*

[*]NIMS, Japan
[**]JST-CREST, Japan

We revealed organic-metallic hybrid polymers show different properties by changing the metal ions: the polymers including Fe, Ru, Cu, and Co ions have excellent electrochromic properties, and the polymer bearing Eu ions exhibits unique vapoluminescence. We herein report the electrochromic printing technique and the vapoluminescent display.

EP4 - 2
11:10

Novel Image Displaying Medium Enabling Thermo-Switchable Emission and Coloration by Using Lanthanide(III) Complex and Leuco Dye

K. Nakamura, Y. Kobayashi, K. Kanazawa, N. Kobayashi

Chiba Univ., Japan

Multi-functional composite film showing thermoresponsive absorption and emission was demonstrated by using thermochromic leuco dye, developer and luminescent Europium(III) complex; the coloration and bleaching of the leuco dye enabled control of the photoluminescence of the Eu(III) complex by thermal stimuli.

11:30 - 12:20 **Room B-2**

Short Presentation EPp: Electronic Paper

All authors of poster papers for the EPp session will give brief oral presentations of 3 minutes in advance.

----- Lunch -----

14:00 - 17:00 **Event Hall**

Poster EPp: Electronic Paper

EPp - 1 **Molecular Design of Particles for Electrophoretic Displays by Using I/O Value**

R. Nakazawa, T. Suzuki, S. Maeda

Tokai Univ., Japan

The key technology in obtaining successful electrophoretic displays is utilizing appropriate surfactants for dispersing these particles. To reduce the R&D time and cost, finding useful parameters for applicable suitable surfactants is necessary. We demonstrate that I/O value is one of useful parameters in order to find such surfactants.

EPp - 2 **Monte Carlo Simulation of Coloration by Mixture of Pigment Particles**

Y. Kurimoto, T. Koda, A. Nishioka, K. Miyata

Yamagata Univ., Japan

We propose Monte Carlo simulation using hard repulsive models for development of new color electronic paper which contains four color pigments per pixel. Simulation results are analyzed in two dimensional chromaticity coordinate. We examine possibility of full coloration by a type of electric paint.

EPp - 3 **Principal Component Analysis of Multi-Pigments Transposition in Full-Color Electrophoretic Display**

Y.-H. Lu, Y.-H. Chiu, C.-H. Tien

Nat. Chiao Tung Univ., Taiwan

A methodology is introduced to characterize colorimetric performance of full-color EPD. The concept of PCA benefited simplifying complicated system through spectral eigenvectors. Proposed model was validated to predict chromatic feature with high accuracy. Due to its simplicity, proposed technique will has a promising impact on color characterization in emerging displays.

EPp - 4 **Black and White Particles Movement in Electrophoretic Image Display by Low Driving Voltage**

Y. Yagi, T.Shimogata, N. Kuranai, S. Nakamura, T. Kitamura

Chiba Univ., Japan

The fundamental display characteristics such as gap distance and electrophoretic particle concentration in an electrophoretic image display (EPID) were examined. An applied electric-field intensity dependence of the display characteristics in an electrophoretic display cell was measured. Movements of black and white particles in the very narrow gap and in high particle concentration were discussed.

EPp - 5 **A Novel Imaging Process for Modified Encapsulated Ch LCD**

M. H. Yang, W.-T. Chen, C.-Y. Wu

ITRI, Taiwan

A novel water-addressing process for the modified encapsulated ChLCD without any electrode is demonstrated in this paper. The reflectance of the planar state and focal conic state is 22.52% and 4.85%, respectively. This discovery creates opportunities for signage boards, applications, etc.

EPp - 6 **The Relationship between Manufacturing Process and Optical Performance in Polymer-Stabilized Cholesteric Texture**

Y.-S. Tsai, H.-Y. Tseng[*]*, T.-H. Lin*[*]*, K.-T. Chen, W.-W. Chiu, C.-C. Lai, P.-W. Liu, Y.-J. Chao*

ITRI, Taiwan
[*]*Nat. Sun Yat-Sen Univ., Taiwan*

In this article, we controlled the manufacturing process with different exposure time and exposure power of UV light on polymer stabilized cholesteric texture (PSCT). Evidences showed that with increasing exposure energy, the viewing angle of PSCT was increased while the reflectivity was decreased in the 0-degree viewing angle.

EPp - 7 **Thermal Stability of Gray-Scale Levels on Optical Rewritable Electronic Paper**

J. Sun, Y. Ma, X. Wang, V. G. Chigrinov

Hong Kong Univ. of S&T, Hong Kong

In this paper, the thermal stability of the gray-scale levels on the optical rewritable (ORW) electronic paper is checked by heating the 10 μm-gap cell with different temperatures at 80˚C, 100˚C, 120˚C, 140˚C and 160˚C for 3 minutes, respectively. It shows that the gray-scale levels on ORW will return to the previous state after the above mentioned cell temperatures cool down to room temperature, which shows a memory effect.

EPp - 8 **Improvement of Pixel Structure in Electrowetting Display for Display Memory**

T. Saito, K. Funatsuki, T. Takahashi, Y. Toko[*]

Kogakuin Univ., Japan
[*]*Stanley Elec., Japan*

The electrowetting display has good performances, however, it is difficult to provide a display memory. It is one of the important functions for the electronic paper. A novel pixel structure with the barrier structure was proposed. And the memory switching by the applied voltage was attempted in the novel pixel.

EPp - 9 **Model Experiment Intended to Lower Driving Voltage of Twisting Ball Electronic Paper**

K. Yamazaki, S. Maeda

Tokai Univ., Japan

We report the theoretical study for and the model experiment system on twisting ball displays for lowering their driving voltage toward the application of digital signage. We found that antimony sulfide is quite effective to lower the driving voltage of twisting ball displays using the model of experimental system.

EPp - 10 **Immobilization of Phthalate Derivatives on ITO Electrode Prepared by Using Silane Coupling Agent and Their Electrochromic Properties**

N. Ura, K. Nakamura, N. Kobayashi

Chiba Univ., Japan

Electrochromism is known as electrochemical reaction exhibiting coloration, and is applicable to a new imaging device. In this paper, we prepared novel modified electrode using Si coupling agent on ITO deposit. Novel modified electrode achieved better memory effect and lower coloration potential in comparison with previous modified electrode using TiO_2.

EPp - 11 **The Effect of Illuminance on Visibility during Reading e-books by Age Groups**

S. Sano, T. Kojima, M. Miyao

Nagoya Univ., Japan

We carried out experiments to evaluate the visibility of reading tablet devices and e-papers under conditions of staged illuminance. In the experiments, we measured reading time and conducted subjective evaluations. This study found a dependency between visibility and illuminance of each device by age groups.

EPp - 12 **Batteryless Electronic Paper Using Wireless Power Transfer with Resonant Capacitive Coupling**

T. Takahashi, R. Hattori, A. Watanabe[*]*, H. Ishinishi*[*]

Kyushu Univ., Japan
[*]*Network Appl. Eng. Labs., Japan*

The capacitively-coupled wireless power transfer system embedded in the e-Paper device was demonstrated. This system realizes a batteryless e-Paper with a wide power-supply position. 13.56 MHz power transfer frequency was employed and the frequency was modulated to keep the resonant conditions.

EPp - 13L **Comparison of Eye Fatigue between LCD Smart-Phone and Paper Book**

S. Mori, M. Omodani

Tokai Univ., Japan

We have measured eye fatigue of reading on a paper book and LCD smart-phone during 90 minutes of reading with a hand-holding condition of the media. Subjective answer of readers indicated that reading on an LCD smart-phone was slightly more fatiguing than that on a paper book.

EPp - 14L **Psychological and Physiological Reactions When Reading E-book Readers with Sound Effects**

H. Isono

Tokyo Denki Univ., Japan

We measured psychological and physiological reactions when reading e-book content with and without sound effects. Adding sound effects that match the content of the e-book can create a new reading experience that is not possible with paper books.

EPp - 15L **Comparison of Comprehension Performance of Readings on a Display with Full Page View and Scrolling Partial View**

J. Inada, M. Omodani

Tokai Univ., Japan

We have measured reading speed and comprehension rate on display with the two displaying conditions. The partial page showing condition indicated a longer reading time and lower correct answer rate. The frequent interruption brought by frequent operation of scrolling might cause the longer reading time and the lower comprehension level.

EPp - 16L **Rough and Smooth ITO Films Fabricated by Spray CVD for Transparent-Mirror-Black Three-Way Electrochemical Smart Window**

R. Onodera, Y. Seki[*]*, S. Seki, K. Yamada*[*]*, Y. Sawada*[*]*, T. Uchida*[*]

Sendai Nat. College of Tech., Japan
[*]*Tokyo Polytechnic Univ., Japan*

A novel electrochemical smart window with three-way reversible states between transparent, mirror and black was successfully fabricated by depositing a pair of transparent conducting electrodes, the surfaces of which are rough and smooth, respectively. Both ITO transparent conducting films prepared by spray CVD process to reduce the production cost.

Author Interviews and Demonstrations
17:30 – 18:30

Supporting Organization:
The Imaging Society of Japan

Workshop on MEMS and Emerging Technologies for Future Displays and Devices

Thursday, December 6

9:00 - 9:05 **Room D**

Opening

Opening Remarks
9:00

M. Nakamoto, Shizuoka Univ., Japan

9:05 - 10:40 **Room D**

MEET1: MEMS Imaging and Sensing

Chair: D. Pribat, Sungkyunkwan Univ., Korea
Co-Chair: N. Fruehauf, Univ. of Stuttgart, Germany

MEET1 - 1: ***Invited*** **Nanotechnology Convergence for**
9:05 **Electronics Applications**

J. M. Kim

Univ. of Oxford, UK

We present the current and future nanotechnology, especially focusing on the convergence of nano with electronics, and photonics. Nano-electronics will cover the graphene and carbon nanotubes, and their applications in flexible and transparent electrodes, and transistors. Nano-photonics will include quantum-dot displays and other applications.

MEET1 - 2: ***Invited*** **MEMS-Based Uncooled Infrared Sensors**
9:30

M. Kimata

Ritsumeikan Univ., Japan

Uncooled infrared sensors are among the most successful integrated microelectromechanical systems (MEMS) devices. This paper describes the role of MEMS technology in uncooled infrared sensor development and advances in high-performance uncooled infrared focal plane arrays. Recent trends in small-format infrared array sensors are also analyzed.

MEET1 - 3: 9:55 ***Invited*** **Design of a Novel Integrated Light Guiding Plate without the Reflective Sheet for Backlight Module Application**

Y.-W. Hu[*], B.-T. Chen[*], J.-W. Pan[,**]*

[*]Nat. Chiao Tung Univ., Taiwan
[**]Chi Mei Medical Ctr., Taiwan

We design a backlight system, which consists of a novel light guide plate (LGP) and one diffuser. Comparing with a conventional backlight module, the on-axis luminance can be improved up to 6.1-times and the half-luminance angle decreased to 10 degrees in the vertical direction.

MEET1 - 4 10:20 **Micro-Oscillator for Non-Contact Voltage Sensing**

S. Hasegawa, S. Kumagai, M. Sasaki

Toyota Tech. Inst., Japan

Non-contact voltage sensor which can keep the electrical isolation is realized using the phenomenon that the resonator is influenced in its resonant frequency by the electrical field from the high voltage. The experimental results are well explained by the theory indicating the feasibility of the non-contact voltage sensor.

----- Break -----

10:50 - 12:20 **Room D**

MEET2: Fundamental Components and Process Technologies

Chair: Y. Aoyagi, Ritsumeikan Univ., Japan
Co-Chair: Y. Bonnassieux, Ecole Polytechnique, France

MEET2 - 1: 10:50 ***Invited*** **CNT and Graphene for Field Emission Applications**

W. I. Milne, S. Iacobucci[*], M. Fratini[*], Y. Zhang[*], L. Wei[**], C. Li, M. Cole[*]

Univ. of Cambridge, UK
[*]Univ. Roma, Italy
[**]Southeast Univ., China

This paper details the use of carbon nanotubes and graphene for key field emission applications. We describe the growth of nanotubes and their optimization for use in electron microscopes, field emission displays and x-ray sources. We also present a novel edge-emitting graphene based structure for large area electron emission displays.

MEET2 - 2: *Invited* Fabrication of Stable CNT Emitters for Lighting Devices
11:15

K. C. Park, Y. J. Eom, S. W. Lee, H. N. Won, J. S. Kang, J. Jang

Kyung Hee Univ., Korea

The high current density and long life electron emitter with carbon nanotubes were studied for lighting device application. CNT emitters with triode structure show high brightness for general lighting and x-ray sources. Detail of electron emission properties of CNT emitters and their lighting device performance will be discussed.

MEET2 - 3 Vacuum Sealed X-Ray Tubes with Nano Emitter and Built-in Control Circuit for Stable Emission Current
11:40

J.-W. Jeong[*], S. Choi[*], J.-T. Kang[*], J.-W. Kim[,**], Y.-H. Song[*,**]*

[*]ETRI, Korea
[**]Univ. of S&T, Korea

Vacuum sealed X-ray tubes with carbon nano-tube (CNT) emitter were successfully developed. The good vacuum level of sealed tube was indirectly verified from the steady field emission current. More stable field emission current was attained from the simple built-in circuit.

MEET2 - 4 Fabrication of Small Area CNT Emitters for High Current Density X-Ray Source
12:00

Y. J. Eom, S. W. Lee, H. N. Won, J. S. Kang, J. Jang, K. C. Park

Kyung Hee Univ., Korea

We report on the stabilized high current emission of carbon nanotubes (CNTs). The CNTs can endure a high current and stable in long time operation. The electron emission current strongly depends on the growth conditions. By using this CNT emitter, we can make the high resolution X-ray source.

----- Lunch -----

14:00 - 15:15 **Room D**

MEET3: Emerging Technologies

Chair: W. I. Milne, Univ. of Cambridge, UK
Co-Chair: J. M. Kim, Univ. of Oxford, UK

MEET3 - 1: ***Invited*** **Si and Al Nanostructures for Advanced**
14:00 **Li-Ion Battery Anodes**

D. Pribat, T. H. Nguyen

Sungkyunkwan Univ., Korea

Aluminum is an interesting material for alloying with lithium in anodes of Li-ion batteries. However, anodes based on Al degrade rapidly upon charge-discharge cycling, hampering commercial developments. We have used Al, in core-shell nanostructures. We report impressive anode stability, manifested by 100,000 charge-discharge cycles at high rate (120˚C).

MEET3 - 2: ***Invited*** **Large Area Micro-Plasma Excited AlGaN Deep**
14:25 **Ultraviolet Light Emitter**

Y. Aoyagi, N. Kurose

Ritsumeikan Univ., Japan

DUV light emitter using micro-plasma excitation is successfully fabricated for the first time. Size of the device is 2-in. and operation wavelengths from 229 nm to 400 nm were confirmed. This new DUV light emitter makes possible to enlarge the size to more than 1 m x 2 m just like PDP display.

MEET3 - 3: ***Invited*** **Metal Oxide for Large Area Electronics**
14:50

J. Jang, C. Avis, H. M. Kim, A. R. B. M. Yusoff, H. P. Kim, S. H. Kim

Kyung Hee Univ., Korea

Metal oxide semiconductors can be applied not only to anode and cathode buffer layers of OLED and OPV, but also to active layer and gate insulator of TFTs for displays and sensors. The applications to TFT, OPV, OLED and QLED will be reviewed on the basis of our results.

MEET3 - 4 **Withdrawn**

----- Break -----

15:50 - 17:10 **Room D**

MEET4: Display and Imaging

Chair: J. Jang, Kyung Hee Univ., Korea
Co-Chair: M. Kimata, Ritsumeikan Univ., Japan

MEET4 - 2: ***Invited*** **Pentacene OTFT, Device Contacts Geometry**
15:50 **and Insulator Choice**

Y. Bonnassieux, C.-H. Kim, G. Horowitz

Ecole Polytechnique, France

Organic thin-film transistors are getting much attention due to the recent rapid advances in their performances. In this paper, we present organic thin-film transistors driven OLED and its fabrication method, performance and applications. We also propose a complete process to make a full organic pixel for AMOLED displays.

MEET4 - 3 **Withdrawn**

MEET4 - 4 **Tunable Color Device of Cellulose Aqueous**
16:15 **Solution**

Y. Kimbara, K. Sano, S. Ishihara, S. Uto
Osaka Inst. of Tech., Japan

Hydroxypropyl cellulose (HPC) aqueous solution forms cholesteric liquid crystal phase which has selective reflection ability. The reflection color can be changed by applied voltage. In this study, we are trying to make a color tunable display device of HPC. The color of the device was changed by applied voltage successfully.

MEET4 - 5 **Enhancing the Reliability of Electro-Wetting Display**
16:35 **by Improving the Structure and Materials**

K.-W. Lan, Y.-S. Ku, K.-L. Lo, S.-W. Kuo, Y.-H. Tsai, K.-C. Lee, P.-P. Cheng, C.-Y. Wu, J.-L. Chen, W.-Y. Cheng
ITRI, Taiwan

Electro-wetting display (EWD) is one of the potential technologies because of its higher transparence, colorful choosing, and faster response time. This paper described how to enhance the performance and reliability of transparent electro-wetting display (EWD) by using two-layer hydrophilic rib structure and development of pigment based ink.

MEET4 - 6L **Key Challenges to Affordable See Through Wearable**
16:55 **Displays: The Missing Link for Mobile AR Mass Deployment**

K. Mirza, K. Sarayeddine
Optinvent, France

Low cost see-through technologies for wearable AR displays have been an elusive key element to enable the market for consumer oriented mobile AR. This paper will explore the various available technologies and the key challenges to develop a platform that will enable affordable wearable displays for the consumer market.

Author Interviews and Demonstrations
17:30 – 18:30

Workshop on Display Electronic Systems

Tuesday, December 4

14:15 - 14:20 **Room C-2**

Opening

Opening Remarks
14:15

T. Fujine, Sharp, Japan

14:20 - 15:55 **Room C-2**

DES1: SUPER Hi-VISION Public Viewing

Chair: T. Yamamoto, NHK, Japan
Co-Chair: S. Ono, Panasonic, Japan

DES1 - 1: ***Invited*** **SUPER Hi-VISION Public Viewing at London 2012 Olympic Games**
14:20

K. Ishii, M. Sugawara, Y. Shishikui, T. Ito

NHK, Japan

SUPER Hi-VISION (SHV) broadcast technology can transmit such realistic images and sounds that the viewers feel as if they are actually there. We have developed the broadcasting equipment necessary for the SHV system. We introduce an outline of an SHV public viewing using the latest technology of the London 2012 Olympic Games.

DES1 - 2: ***Invited*** **The 8K LCD for SUPER Hi-VISION**
14:40

T. Kumakura, M. Shiomi, K. Shirai, M. Takahashi, M. Onoue, N. Hojo, A. Inoue, S. Horino, Y. Yoshida

Sharp, Japan

We have successfully developed an 85-in. 8Kx4K LCD for SUPER Hi-VISION. This LCD has a panel of 7680 by 4320 pixels and the single pixel size measures 0.245 mm. And the input and internal interface have been upgraded to the optical fiber system which is useful in Public Viewing.

DES1 - 3: ***Invited*** **Public viewing of 145-in. Diagonal SUPER Hi-VISION PDPs**
15:05

R. Murai, H. Nakahigashi, I. Horiuchi, K. Ishii[*], N. Shimidzu[*], T. Usui[*]

Panasonic, Japan
[*]NHK, Japan

We developed a prototype 145-in. full resolution SUPER Hi-VISION PDPs. (SHV-PDPs) We received a very favorable reception at the public viewing we staged at the 2012 London Olympics. We also exhibited our SHV PDPs at the IFA Consumer Electronics Show 2012 in Berlin, Germany.

DES1 - 4: 15:30 ***Invited*** **SUPER Hi-VISION Projectors Used in Public Viewing of London 2012 Olympic Games**

Y. Kusakabe, Y. Nishida

NHK, Japan

NHK hosted SUPER Hi-VISION (SHV) public viewings of the London 2012 Olympics in Japan, the United Kingdom, and the United States in cooperation with the Olympic Broadcasting Services (OBS) and the British Broadcasting Corporation (BBC). The outline of public viewing and features of the SHV projectors will be presented.

----- Break -----

16:10 - 17:30 **Room C-1**

DES2/VHF2: Color (2)

Chair: M. R. Luo, Univ. of Leeds, UK
Co-Chair: T. Fujine, Sharp, Japan

DES2/ VHF2 - 1: 16:10 ***Invited*** **Measuring Light and Color: Defining Color Rendering Property of Artificial Illuminants**

N. Ohta

Rochester Inst. of Tech., USA

The basis of the CIE standard colorimetric system was established as early as in 1931. After that, varieties of applications have been developed. Among them, I will today explain the method widely applied in the industrial field for evaluating the color rendering of light sources.

DES2/ VHF2 - 2: 16:40 ***Invited*** **Development of Laser Backlighting LCD Television**

E. Niikura, R. Murase, S. Kagawa, N. Nakano, A. Nagase, H. Sakamoto, T. Sasagawa, K. Minami, H. Sugiura, K. Shimizu, M. Hanai

Mitsubishi Elec., Japan

We have developed a laser backlighting LCD television using a LD for one of the light sources. The backlighting system of this TV uses two kinds of light source. One is a red LD and the other is a cyan LED. We realized a wide color gamut from this TV.

DES2/ VHF2 - 3 17:10 **The Effect of Lightness Component on Preferred Skin Color Reproduction of a Display**

S.-H. Chen, H.-S. Chen, N. Ohta[*], R. Luo[**], N.-C. Hu

Nat. Taiwan Univ. of S&T, Taiwan
[*]Rochester Inst. of Tech., USA
[**]Univ. of Leeds, UK

It is important to understand preferred skin color reproduction in display industry. The aim of this study is to examine the relationship between the brightness of skin color and perceived preference. The experiments are conducted to determine the preferred skin color ranges on chromatic components and lightness component on display.

Author Interviews and Demonstrations
17:50 – 18:50

Wednesday, December 5

9:00 - 10:10 **Room C-2**

DES3: Low Power Consumption

Chair: S. Takamura, NTT, Japan
Co-Chair: H. Okumura, Toshiba, Japan

DES3 - 1: 9:00 ***Invited*** **Low Power Consumption Technology for Ultra-High Resolution Mobile Display by Using RGBW System**

A. Sakaigawa, M. Kabe, T. Harada, F. Goto, N. Takasaki, M. Mitsui, T. Nakahara, K. Ikeda, K. Seki, T. Nagatsuma, A. Higashi

Japan Display West, Japan

In this paper, the basic concept and performance of a new RGBW technology is described, such as low power consumption, color image reproducibility and outdoor visibility. In addition, a newly developed 4.38-in. Full HD (1920 x 1080) 503 ppi prototype LCD utilizing this new RGBW technology is described.

DES3 - 2 9:30 **High-Efficiency and Low-Cost Passive Matrix Cholesteric ESL Prototype System**

C.-C. Hsu, C.-H. Wu, H.-Y. Hsieh, C.-J. Chen, Y.-S. Chang, C.-C. Wu, T.-H. Yu, K.-T. Chen, Y.-J. Cho, H.-S. Hsu[*]

ITRI, Taiwan
[*]GiantPlus Tech., Taiwan

A high-efficiency and low-cost ESL prototype system for multi-color cholesteric LCDs has been developed. It contains a highly-integrated timing controller, high-efficiency circuits and temperature compensated circuits, showing thin and light-weight features. The prototype has been successfully verified on ITRI's cholesteric LCDs which exhibit high contrast and good image quality.

DES3 - 3
9:50 **A Novel Power Control by Modulated Power Algorithm (MPA) for AM-OLED Application**

C.-C. Chiu, S.-M. Chang
Chunghwa Picture Tubes, Taiwan

We proposed a modulated power algorithm (MPA) for AMOLED panel to monitor power consumption. The duty ratio of emission control pin of pixel circuit is regulated and its duty ratio is calculated by MPA. Consequently, the constant power consumption is achieved and OLED lifetime and image quality are improvements.

----- Break -----

10:50 - 11:30 **Room C-2**

DES4: Display Electronic Systems

Chair: A. Sakaigawa, Japan Display West, Japan
Co-Chair: A. Nagase, Mitsubishi Elec., Japan

DES4 - 1
10:50 **Image Denoising Method Based on Non-Local Means Filter and Noise Estimation**

J. S. Lim, S. I. Cho, Y. H. Kim
Pohang Univ. of S&T, Korea

This paper proposes a denoising method based on a non-local (NL) means. The NL-means algorithm is effective to remove a Gaussian noise, but the denoising parameter should be controlled depending on the noise for proper noise elimination. The proposed method gives the optimal denoising parameter according to the noise levels.

DES4 - 2
11:10 **Integrated 3D System with Multi-Touch**

C.-L. Li, J.-S. Liao, H.-H. Chen, D.-W. Kuo, H.-M. Su
Chunghwa Picture Tubes, Taiwan

Chunghwa Picture Tubes, LTD. (CPT) sets up an integrated multi touch 3D system that not only supports 3D picture display in both portrait and landscape but also provides suitable multi-touch gestures automatically for 2D and 3D mode separately.

11:30 - 11:40 **Room C-2**

Short Presentation DESp: Display Electronic Systems

All authors of poster papers for the DESp session will give brief oral presentations of 3 minutes in advance.

----- Lunch -----

14:00 - 17:00 **Event Hall**

Poster DESp1: Poster: Display Electronic Systems (AR)
Special Topics of Interest on Augmented Reality

DESp1 - 1 **Image Synthesis from Illumination Estimation**

T.-H. Lin

Nat. Taiwan Univ. of S&T, Taiwan

Our proposed method synthesizes images with cast shadows and shading of 3D graphic models. We use a calibration board and a plastic gaze ball for illumination estimation. Then, 3D graphic models corresponding to the light directions and relative intensities are superimposed to induce photorealistic images.

14:00 - 17:00 **Event Hall**

Poster **DESp2: Poster: Display Electronic Systems**

DESp2 - 1 **TFT-LCD Auto-Adjust Gamma Curve System**

S.-S. Syu, Y.-Y.Chen

Shenzhen China Star Optoelect. Tech., China

Due to the variety of LCD manufacturing and materials, the gamma curve of displays would be different. This study presents a system structure and algorithms to implement an auto-adjust gamma system for quickly adjusting the flick and gamma curve of TFT-LCD on the production line.

DESp2 - 2 **An Image Quality Model for Optimizing Color Performance of Display System**

H.-T. Yang, P.-L. Sun, R. M. Luo

Nat. Taiwan Univ. of S&T, Taiwan

An image quality model based on contrast, naturalness, hue accuracy and vividness measurements was derived from a series psycho-visual experiment. Optimal color performance of a display system could be achieved by maximizing the image quality scores via tuning its tone curves iteratively.

Author Interviews and Demonstrations
17:30 – 18:30

Thursday, December 6

14:00 - 15:35 **Room B-1**

DES5: Recent Advances in Augmented Reality Applications
Special Topics of Interest on Augmented Reality

Chair: K. Makita, AIST, Japan
Co-Chair: M. Tsuchida, NTT, Japan

DES5 - 1: 14:00 ***Invited*** **SmartAR: Integrated Augmented Reality Technology for Novel Application Creation**

T. Yoshigahara

Sony, Japan

Sony has developed integrated Augmented Reality technology called as "SmartAR." Fast object recognition and dynamic 3D space recognition have enabled us to propose various novel applications. In this talk, we present an outline of the development of SmartAR and the various applications we created.

DES5 - 2: 14:25 ***Invited*** **Mixed Reality Applications of Design Engineering & Manufacturing**

T. Aso

Canon, Japan

Canon started Mixed Reality solution business this year. We are planning to develop this solution business from the design engineering & manufacturing field. It enables the intuitive evaluation of design data created by 3D-CAD. Canon is going to develop new business domain by Mixed Reality.

DES5 - 3: 14:50 ***Invited*** **Recent Trends on Visual Tracking for Augmented Reality**

H. Uchiyama

Toshiba, Japan

Computer vision technologies play an important role for estimating and tracking a camera pose in augmented reality. This paper reports state-of-the-art visual tracking technologies and classifies them into three categories: fiducial marker based augmented reality, object template based augmented reality and wide area augmented reality.

DES5 - 4 15:15 **Texture Significant Hash Function with Robust Occlusion Handling for Fast Inpainting the Virtualized-Reality Models**

K. Thangamani[,**], T. Ishikawa[**], K.Makita[**], T. Kurata[*,**]*

[*]Univ. of Tsukuba, Japan
[**]AIST, Japan

This paper discusses the texture significant hash table usage for speed up the inpainting process in the virtualized-reality indoor models. The proposed hash works are included in the Exemplar-Based inpainting and this revised method is tested in the virtualized-reality indoor models.

Author Interviews and Demonstrations
17:30 – 18:30

Supporting Organizations:
Information Display Research Committee, ITE
Information Sensing Research Committee, ITE
Special Interest Group on Mixed Reality, The Virtual Reality Society of Japan
Technical Committee on Electronic Information Displays, Electronics Society, IEICE
Technical Committee on Image Engineering, Information and Systems Society, IEICE

Workshop on Flexible Displays

Tuesday, December 4

16:10 - 16:05 **Room A**

Opening

Opening Remarks
16:10

M. Ito, Toppan Printing, Japan

16:15 - 17:35 **Room A**

FLX1/AMD2: Flexible Active Matrix Devices

Chair: H. Maeda, DNP, Japan
Co-Chair: H. Happy, IEMN, France

FLX1/ AMD2 - 1: 16:15 ***Invited*** **Transfer Printing Nanowire Electronic Devices on Non-Si Substrates**

C. H. Lee, X. Zheng

Stanford Univ., USA

I will discuss various transfer printing methods that can fabricate electronic devices onto diverse nonconventional substrates, such as paper, plastics, tapes, glasses, polydimethylsiloxane, Al foils, and polymer substrates. These flexible, transparent, ultrathin, or biocompatible devices will impact many technologies, such as flexible displays, solar cells, and biosensors.

FLX1/ AMD2 - 2 16:40 **Solution-Processed and Low-Temperature ZnO-Based N-Channel TFTs on Polyethylene Naphthalate Foil, Suited for Hybrid Complementary Circuitry**

M. Rockelé[,**], M. Nag[*,**], T. H. Ke[*], S. Botnaraş[***], D. Weber[***], D.-V. Pham[***], J. Steiger[***], S. Steudel[*], K. Myny[*,**], S. Schols[*], B. van der Putten[****], J. Genoe[*], P. Heremans[*]*

[*]imec, Belgium
[**]Katholieke Univ. Leuven, Belgium
[***]Evonik Inds., Germany
[****]Holst Ctr., the Netherlands

State-of-the-art solution-processed ZnO-based n-TFTs (μ_{sat}~ 0.6-1.1 cm²/Vs and I_{on}/I_{off}~10^7) at 160°C are realized on polyethylene naphthalate (PEN) foil, demonstrating promising uniformity and bias-stress results (ΔV_{th}~0.8 V after 10^4 s). The threshold voltage of 3 V makes the technology favorable for hybrid complementary line-drive circuitry at the borders of flexible AMOLED displays.

FLX1/ AMD2 - 3 17:00 **Formation of Polycrystalline Silicon Films on Plastic Films by Underwater Laser Annealing at Super Low-Temperature**

E. Machida[*], M. Horita[,**], Y. Ishikawa[*,**], Y. Uraoka[*,**], T. Okuyama[***], H. Ikenoue[****]*

[*]Nara Inst. of S&T, Japan
[**]JST, Japan
[***]TOYOBO, Japan
[****]Kyushu Univ., Japan

We succeeded in the super low-temperature crystallization to high-quality poly-Si films on plastic substrates by underwater laser annealing (WLA). WLA enhances the energy margin twice as high as that in laser annealing in air (LA). Moreover, the crystallinity of WLA poly-Si was much better than that of LA poly-Si.

FLX1/ AMD2 - 4L 17:20 **Solution-Processed Organic Thin-Film Transistors on a Very Thin Transparent Paper Substrate**

Y. Fujisaki, H. Koga[*], Y. Nakajima, M. Nakata, H. Tsuji, M. Nogi[*], T. Yamamoto

NHK, Japan
[*]Osaka Univ, Japan

We fabricated solution-processed organic thin-film transistors (TFTs) on a transparent paper. A 20-nm thick cellulose nanofibers film was used as the novel flexible substrate. The TFT showed the mobility up to 1 cm^2/Vs. These results showed possibility toward the realization of paper electronics & display with low-cost and low environmental burden.

Author Interviews and Demonstrations
17:50 – 18:50

Wednesday, December 5

9:20 - 12:20 **Event Hall**

Poster FLXp: Flexible Display Technologies

FLXp - 1 **Electro-Optical Properties of LCD Fabricated by Slit Coater**

K. Ohtsuka, Y. Nagataki, K. Miyashita[*], H. Hirata[*], T. N. Oo, M. Kimura, T. Akahane

Nagaoka Univ. of Tech., Japan
[*]Toray Eng., Japan

We recently reported a method utilizing a slit coater for printable liquid crystal (LC) devices. In this study, we proposed two ultraviolet (UV) irradiation techniques and investigated the electro-optical characteristics and azimuthal anchoring energy of LC sample cells performed by the two proposed techniques.

FLXp - 2 **The Dielectrophoresis Aligment of Silver Nanowire for Application in Electrode Conductivity Enhancement**

*C. Wei, H.-C. Chang, K.-W. Lai, W.-H. Sun**

Tatung Univ., Taiwan
**ITRI, Taiwan*

The silver nanowires fabricated by polyol process were deposited as electrodes to replace the ITO. For successful implementation, the purification of nanowires is critical for large scale fabrication. The dielectrophoresis was implemented to purify the silver nanowires and to implement the silver nanowires electrode.

FLXp - 3 **Flexible Non-Volatile Memory Based on Indium-Gallium-Zinc-Oxide with Excellent Reliability and Flexibility**

Y.-S. Fan, C.-H. Hsu, C.-H. Chang, W.-H. Huang, M.-C. Yu, P.-T. Liu*

Nat. Chiao Tung Univ., Taiwan
**WINTEK, Taiwan*

The memory characteristics of a-IGZO RRAM reveal excellent reliability including 1000 times DC sweep endurance, 10^4 pulse endurance, 10^4 s data retention with read disturb immunity. Furthermore, this work also demonstrated on flexible substrate, which shows the very potential flexibility applications.

FLXp - 4L **Novel Dielectric Metal Foil Substrates Using Anodic Aluminum Oxide for Flexible Electronics**

S. Yuuya, R. Kaito, K. Sato, K. Yamane

FUJIFILM, Japan

Novel flexible substrates having thermal stability over 500˚C and dielectric voltage over 500 V are developed. Aluminum or aluminum-steel clad are used for the core metal. The CTE of substrates are 5 or 10 ppm/K, respectively. Sheet-to-sheet process with a carrier glass and high temperature web handling in “Flexible-Electronics” is expected.

FLXp - 5L **All-Organic Self-Aligned Field-Effect Transistors**

T. Muramoto, S. Naka, H. Okada

Univ. of Toyama, Japan

All-organic self-aligned field-effect transistors were investigated. Using the back-surface exposure method, source and drain electrodes were self-aligned to gate electrode. Overlapping length of the gate-source and -drain electrodes was less than 1 μm. Transistor operation was confirmed and evaluated field effect mobility was 0.028 cm^2/Vs.

FLXp - 6L **Fabrication Energy Considerations of Flexible TFTs: Comparison between O-TFT and LTPS TFT**

*N. Yamauchi, T. Noguchi**

Waseda Univ., Japan
**Univ. of the Ryukyus, Japan*

In this paper, we compare the organic TFTs and LTPS in terms of fabrication energy. The fabrication energy of organic TFT and LTPS are evaluated based on the fabrication process.

----- Lunch -----

14:00 - 15:35 **Room B-1**

FLX2: Organic TFTs and Related Materials

Chair: T. Sekitani, Univ. of Tokyo, Japan
Co-Chair: H. Fujikake, Tohoku Univ., Japan

FLX2 - 1: 14:00 ***Invited*** **High-Mobility Organic Active Matrices Based on Solution-Crystallized TFT Arrays**

T. Uemura, M. Uno*,**, Y. Kanaoka**, J. Takeya**

**Osaka Univ., Japan*
***TRI Osaka, Japan*

High-mobility organic active matrices based on solution-crystallized TFT arrays are developed with 2,9-dialkyl-dinaphtho[2,3-b:2',3'-f] thieno[3,2-b]thiophene (C_{10}-DNTT). We have developed patterning processes of solution-crystallized films to fabricate high-mobility TFT arrays. The average mobility was over 3 cm^2/Vs. In this paper, we demonstrate the operation of LCDs with developed high-mobility active-matrix backplanes.

FLX2 - 2: 14:25 ***Invited*** **Low Voltage High Mobility Organic Semiconductors for Flexible Display Applications**

K. L. McCall, S. D. Ogier, B. A. Brown, S. R. Rutter, M. Palumbo, Y. U. Lee, L. A. Evans, T. J. Pease

Ctr. for Process Innovation, UK

Presented is the performance of novel organic semiconductor formulations with charge mobility of ~4 cm^2/Vs and on/off ratios of >10^8. OTFTs for end-use applications, such as OLED display backplanes are discussed. Material and device stability is demonstrated, in combination with excellent standard deviation (<5%) across the substrate.

FLX2 - 3 14:50 **Solution Processable Organic Semiconductor with a Wide Process Margin for TFT Devices**

C. J. Newsome, K. Zalewski, J. H. Burroughes

Cambridge Display Tech., UK

We have developed a high mobility solution processable organic semiconductor material for thin film transistor applications that exhibits low variance in device mobility with respect to the semiconductor film drying conditions. The material is stable to processing in air and devices exhibit a mobility of more than 1 $cm^2V^{-1}s^{-1}$.

FLX2 - 4: 15:10 ***Invited*** **Gas Barrier Testing Methods of Higher-Barrier Films for Flexible Electronics Devices**

K. Nagai

Meiji Univ., Japan

This paper presents a method for testing the barrier property of water vapor in higher-barrier films used in flexible electronics devices such as organic light-emitting diodes and solar cells and a topic of its international standardization.

----- Break -----

15:50 - 17:25 **Room A**

FLX3: Flexible Oxide TFTs
Special Topics of Interest on Oxide TFT

Chair: M. Ito, Toppan Printing, Japan
Co-Chair: K. Uemura, Nippon Steel & Sumitomo Metal, Japan

FLX3 - 1: 15:50 ***Invited*** **Development of Low Temperature Solution-Processed Metal-Oxide TFT Materials**

J. Steiger, D.-V. Pham, M. Marinkovic, A. Hoppe, A. Neumann, A. Merkulov, R. Anselmann

Evonik Inds., Germany

We present recent developments at Evonik in regard to solution-based processing techniques of metal oxides for TFT applications. Specific tailored materials for different annealing temperatures are demonstrated and include mobilities above 2 cm²/Vs at temperatures of 160˚C, suitable for low cost flexible substrates.

FLX3 - 2
16:15
Flexible AMOLED Display on Polyethylene Napthalate (PEN) Foil with Metal-Oxide TFT Backplane

A. K. Tripathi, B. van der Putten, J.-L. van der Steen, K. Tempelaars, B. Cobb, M. Ameys, T. H. Ke*, K. Myny*, S. Steudel*, M. Nag*, S. Schols*, P. Vicca*, S. Smout*, J. Genoe*, P. Heremans*, I. Yakimets, G. Gelinck*

Holst Ctr./TNO, the Netherlands
**imec, Belgium*

We present a top emitting monochrome AMOLED display with 85 ppi resolution using an amorphous Indium-Gallium-Zinc-Oxide (IGZO) TFT backplane on PEN-foil. Maximum processing temperature was limited to 150°C in order to ensure an overlay accuracy < 3 μm on PEN foil.

FLX3 - 3
16:35
Solution-Processed Low Temperature Amorphous Thin Films

B. Singh, J. Jasieniak, C. D. Easton, L. Tozi, M. Bown

CSIRO Material Sci. & Eng., Australia

Oxidative treatment effectively reduces residual impurities in the thin films of metal oxide deposited via precursor route enabling reduced temperature of processing. Non-halide based precursors were found to be good candidate which shows that oxidative treatment significantly enhance the rate of bulk metal oxide formation resulting in high mobility transistors.

FLX3 - 4L
16:55
High Performance Indium Zinc Oxide Thin-Film Transistors Fabricated by Solution-Process at Low Temperature

L. Lu, Y. Osada*, Y. Kawamura*, T. Nishida*, Y. Ishikawa*,**, Y. Uraoka*,**

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

Solution-processed InZnO thin film transistors showed a high field effect mobility of 19.5 $cm^2/V{\cdot}s$ at a low fabrication temperature of 300°C by an aqueous solution. The on/off current ratio exceeded 10^9. Good bias stability was also obtained by the passivation of Al_2O_3 thin films.

FLX3 - 5L
17:10
Amorphous In-Ga-Zn-O Thin Film Transistors on Ultra-High-Tg Polycarbonate Films

*T. Negishi, Y. Ikeda, T. Daidou, T. Shiro, K. Ikeda**

Teijin, Japan
**Teijin Chems., Japan*

An ultra-high-Tg (264°C) polycarbonate (UHT-PC) film is developed for use in high temperature processes for fabricating plastic electronic devices. This UHT-PC film can be used as a substrate in electronic devices that are annealed at temperatures over 200°C. Amorphous In-Ga-Zn-O TFTs on the UHT-PC films are demonstrated.

Author Interviews and Demonstrations
17:30 – 18:30

Thursday, December 6

9:00 - 9:55 **Room E**

FLX4: Materials and Evaluation for Flexible Devices

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

FLX4 - 1
9:00
Display Aspect Computation Using Viewing Angle Measurements: Application to the Flexible Displays

P. M. Boher, T. Leroux, T. Bignon, V. Collomb-Patton
ELDIM, France

Fourier optics viewing angle measurements are used to predict what will be the practical performances of flexible displays. The display surface is rolled up around one axis of variable direction with a given curvature and the apparent luminance, contrast and color of the display surface is predicted for an observer.

FLX4 - 2L
9:25
Inspection Method of Hydrophilic Pattern on Hydrophobic Resin for Printed Electronics

M. Mori, Y. Mizutani, K. Yamamoto, S. Izumida, H. Hirata
Toray Eng., Japan

A unique fluorescence inspection method of using visible light has been developed to make distinction between hydrophilic and hydrophobic areas. This enables us to rapidly and on noncontact basis inspect micro hydrophilic pattern on hydrophobic resin, which inspection has been unattainable by the wettability test with conventional contact angle meter.

FLX4 - 3L
9:40
Stretching-Assembled Nanowires for Organic-Based Thin Film Transistors

G.-W. Hsieh, K. Ogata[*], K.-Y. Cheng, J.-Y. Wu, W. I. Milne[*]
Nat. Chiao Tung Univ., Taiwan
[*]Univ. of Cambridge, UK

We demonstrate a stretched contact-printing technique to assemble one-dimensional nanostructures with controlled density and orientation. Over 90% nanowires are highly aligned along the primary stretching direction. Specifically, The hybrid inorganic-organic TFTs based on a parallel-aligned nanowire network and a semiconducting polymer reveal a significant positive enhancement in transistor performance and air-stability.

----- Break -----

10:50 - 12:05 **Room E**

FLX5/FMC5: Flexible Materials and Fabrication Processes

Chair: Y. Mishima, FUJIFILM, Japan
Co-Chair: A. Fujita, JNC, Japan

FLX5/ FMC5 - 1 10:50 **Roll-to-Roll Deposition of ITO Film on a Flexible Glass Substrate**

Y. Ikari, H. Tamagaki

Kobe Steel, Japan

The roll-to-roll deposition of ITO film on a flexible glass roll, 50 μm thick, 300 mm wide and 10 m long, was made successfully by magnetron sputtering at elevated substrate temperature. The ITO film shows a sheet resistance of 7.5 ΩSq at 190 nm, and the resistivity is calculated as 143 μΩcm.

FLX5/ FMC5 - 2 11:10 **Ultra Thin Glass for Flexible Display**

C. C. Kuo, Y. C. Chen, B. S. Chiou, J. Y. Chiou, Y. T. Lee, Y. Y. Huang

Chunghwa Picture Tubes, Taiwan

Nowadays, glass is attractive as a substrate in flexible electronic and display. We have developed complete SH-to-SH type TFT backplane process flow. Moreover we have succeeded demonstrate a flexible EPD using 0.1 mm glass as TFT backplane substrate. In this paper, we will describe fabrication procedures and realize in a 6-in. EPD module.

FLX5/ FMC5 - 3 11:30 **Flexible LCD Fabricated with a Slit Coater**

M. Kimura, K. Ohtsuka, Y. Nagataki, T. N. Oo, M. Mori[*]*, H. Hirata*[*]*, T. Akahane*

Nagaoka Univ. of Tech., Japan
[*]*Toray Eng., Japan*

Homogeneously aligned liquid crystal layer on substrate film on which there is no necessity of forming alignment film can be assembled by a slit coater. TN and IPS type flexible LCDs were demonstrated. It is expected that production time can be shortened several ten minutes because of unnecessity of alignment film.

FLX5/ FMC5 - 4L 11:50 **Development of a Single Substrate Flexible LCD Using Microencapsulation Technology**

S.-H. Han, Y.-S. Kang, H.-G. Kim, S. S. G. Kang, H.-H. Hwang

Image Lab, Korea

A Single substrate flexible LCD is developed using Ch-LC microencapsulation and printing method. Unlike conventional PIPS method, combining LC microencapsulation with printing process enabled us to dispense with an upper substrate, resulting in a much simplified manufacturing of flexible LCDs. Good electro-optic performances and low reset voltage are achieved.

----- Lunch -----

14:00 - 15:15 **Room E**

FLX6: Fabrication for Flexible Devices

Chair: H. Hirata, Toray Eng., Japan
Co-Chair: K. Akamatsu, Sony, Japan

FLX6 - 1: 14:00 ***Invited*** **Printed Memory for Printed System Electronics**

J. Kasahara[*,**]

[*]*Thin Film Elect., Norway*
[**]*Hokkaido Univ., Japan*

Re-writable non-volatile memory is successfully commercialized with roll-to-roll printing technology. Leveraging the experience in the practical market, development on printed system electronics is underway. Integration of memory with printed transistor and other components like sensor will open up new market with printed electronics.

FLX6 - 2 14:25 **Self-Aligned Manufacturing Process of the Electrode and Bank Pattern for Flexible ChLC Panels**

P.-W. Liu, J.-P. Lu, K.-T. Chen, Y.-S. Tsai

ITRI, Taiwan

We propose a novel self-aligned manufacturing process for flexible cholesteric liquid crystal (ChLC) panels. We used photolithography or laser etching to make the light-shielding layer on the back of plastic substrates, then forming the ITO pattern and bank structures on the other side of the plastic substrate by self-aligned process.

FLX6 - 3L 14:45 **Solution-Processed Organic Field Effect Transistors from a Soluble Di-n-decyldinaphthothienothiophene Precursor**

A. Hamaguchi, Y. Ikeda, T. Daido, T. Shiro, M. Hamada[*], *S. Shinamura*[*]

Teijin, Japan
[*]*Nihon Kayaku, Japan*

A soluble C_{10}-DNTT precursor is developed for printed OFETs. The precursor is annealed to produce C_{10}-DNTT. XRD pattern of the film after annealing the precursor matched that of the vapor-deposited C_{10}-DNTT film. OFETs using the precursor are fabricated on silicon and plastic substrates by drop-casting followed by thermal annealing.

FLX6 - 4L 15:00 **Key Components for Flexible Display with Integrated Gate Driver**

C.-C. Chiu, M.-H. Lee, C.-T. Peng, W.-M. Huang

AU Optronics, Taiwan

We have demonstrated a high flexibility electrophoretic display with gate driver circuits integrated on array process (GOA). By studying the essential components such as TFTs, resistors and capacitors, GOA-embedded display can withstand 10,000 rolling cycles of 20 mm radius without any line defect.

----- Break -----

15:50 - 17:15 **Room A**

AMD8/FLX7: Oxide TFT: Flexible Displays
Special Topics of Interest on Oxide TFT

Chair: C.-H. Cheng, AU Optronics, Taiwan
Co-Chair: M. Kimura, Nagaoka Univ. of Tech., Japan

AMD8/ FLX7 - 1: 15:50 ***Invited*** **Flexible AMOLED Displays Driven by a-IGZO TFTs and their Applications**

H. Yamaguchi, T. Ueda, K. Miura, N. Saito, S. Nakano, T. Sakano, K. Sugi, I. Amemiya

Toshiba, Japan

Reliability of a-IGZO TFTs on plastics against bias-temperature stress has been improved. We developed an 11.7-in. AMOLED display driven by a-IGZO TFTs on plastics. Using the panel, we demonstrated a prototype of flexible-display system integrated with a bend-input function that enables users to interact with the display by flexing it.

AMD8/ FLX7 - 2: 16:15 ***Invited*** **A 9.9-in. qHD Top-Emission Flexible OLED Display Driven by Oxide TFTs**

K. Teramoto, E. Fukumoto, T. Fukuda, K. Shimokawa, T. Saito, T. Tanikawa, M. Suzuki, G. Izumi, M. Noda, S. Kumon, T. Arai, T. Kamei, M. Kodate, S. No, T. Sasaoka, K. Nomoto

Sony, Japan

We have developed a direct fabrication method of oxide TFTs on a flexible substrate. We have also developed a flexible color filter array for white OLEDs. The oxide TFT is integrated on a flexible substrate. The fabricated display had a wide color gamut with over 100% NTSC in u'v' space.

AMD8/ FLX7 - 3 16:40 **Flexible Top-Gate Amorphous InGaZnO TFTs on a New Colorless Polyimide Substrate for Flexible Display Applications**

Y.-H. Yeh, C.-C. Cheng, M.-J. Yu, H.-C. Ku, B. C.-M. Lai, B.-Y. Chou, E. Horii[*], E. Kuribayashi[*], T. Iwamoto[*], M. Yamazaki[*], H. Inari[*], K. Kurimoto[*]

ITRI, Taiwan
[*]Kaneka, Japan

The flexible top-gate a-IGZO TFTs array was fabricated on a Kaneka's colorless polyimide (PI) substrate at 200°C. Our proposed PI substrate has high T_g (~350°C), high light transmittance (~87%), and low thermal coefficient (8 ppm/°C). Polymer resin (ILLUMIKA) was also applied to passivate the a-IGZO TFTs.

AMD8/ FLX7 - 4L 17:00 **High-Performance Solution Processed Indium Oxide Thin Film s Transistors**

C. Avis, Y. G. Kim, H. R. Hwang, J. Jang

Kyung Hee Univ., Korea

We have developed a high performance solution processed indium oxide TFT (InO_x TFT). The spin-coated TFTs has saturation mobility, Vth, and gate swing of 57.3 cm^2/Vs, 0.4 V, and 149 mV/dec., respectively. Inverters based on InO_x TFTs were fabricated and showed a gain~27 at V_{DD}=3 V.

Author Interviews and Demonstrations
17:30 – 18:30

Supporting Organizations:
Information Display Research Committee, ITE
Technical Committee on Electronic Information Displays, IEICE

Workshop on Touch Panels and Input Technologies

Tuesday, December 4

14:20 - 17:20 **Event Hall**

***Poster* INPp: Touch Panels & Input Technologies**

INPp - 1 **Position Smoothing with Algorithm for Capacitive Touch Panels**

Y.-M. Chang, C.-S. Li, C.-L. Lin

Nat. Cheng Kung Univ., Taiwan

A fuzzy Kalman filter algorithm is proposed for applying in capacitive touch panel that can provide smooth tracks thereby eliminating noise and obtaining the accurate estimated position while touching. Based on the simulation and experiment results, the proposed method can reduce the unavoidable noise and provide a timely accurate position.

INPp - 2 **Improvement of Detection Linearity on the Capacitive Touch Panel Using Transient Electrical Response**

K. Kyoung, R. Hattori

Kyushu Univ., Japan

A new capacitive sensing method using the difference of transient response was proposed. In this method, the linearity of touch detection on an electrode was improved by using two reference voltages in relaxation oscillator circuits. We verified the improved circuits by SPICE simulations and an evaluation kit.

INPp - 3 **Withdrawn**

INPp - 4 **High Efficient Anti-Noise System for Embedded Advanced Touch On-Cell Display**

S.-Z. Peng, Y.-C. Li, C.-C. Chang, S.-H. Huang, H.-H. Chen

Chunghwa Picture Tubes, Taiwan

Chunghwa Picture Tubes (CPT) has successfully solved the major issue of interference from ToC display which showed the high SNR and widely used at any image pattern. We have successfully developed in ToC 3.5-in. with SDD type and ToC 4.3-in. with SDD in BAST (Brilliant Advanced Super TFT) LCD.

INPp - 5 **Discussion and Improvement of Signal to Noise Ratio on Projected Capacitive Touch Screen**

S. Yang, C.-W. Wu[*]*, H. Wang, X. Dong*

BOE Optoelect. Tech., China
[*]*BOE Tech. Group, China*

In this paper, the signal to noise ratio (SNR) of projected capacitive (pro-cap) touch screen and pattern designs to affect the SNR are discussed. Meanwhile, we simulate influence of the resistance and capacitance on SNR. Results verify that Clothes Pattern is better than Diamond Pattern on improvement of SNR.

INPp - 6 **The Proposal for Improving the Image Quality of LCD with Touch Panel for Outdoor Use**

H. Ohtsuki, T. Imamura, S. Mori, T. Nakamura, M. Hayashi[*]

Mitsubishi Elec., Japan
[*]*Melco Display Tech., Japan*

The image quality of LCD with TP outdoors becomes worse because of the washout. One of the factors is a diffuse reflection, additionally a specular reflection influences washout. We compare the observation results with the measurement results of the reflectances. We propose a target value of the both reflectance.

INPp - 7 **Force Sensor Touch Technology**

H.-H. Liao, T.-Y. Chang, C.-H. Hsu, Y.-C. Fang, K.-W. Li, C.-F. Hsu, W.-C. Wang

WINTEK, Taiwan

This paper proposes a structure of force sensor touch panel. It provides users adopt conductive or non-conductive mediums as an input device. We present a 4.3-in. TFT-LCD with this FST module. It has multi-touch function, and could accept non-conductive medium, such as glove, or insulated pen, and so on.

INPp - 8 **A Study of Performance Measurement of Digital Imaging System**

S.-Y. Tseng, Z.- W. Huang[*]*, Z.-Z. Xue*[*]*, X.-H. Ma*[*]*, Y.-C. Fang*[*]*, N.-W. Hsueh*[*]

Nat. Kaohsiung First Univ. of S&T, Taiwan
[*]*Kun Shan Univ., Taiwan*

This study propose a new method for evaluation of digital Imaging system, using the three sections of camera: transfer function of camera lens, transfer function of CCD/CMOS, and ratio of signal to noise. We try to define a new standard of performance evaluation of digital image system.

INPp - 9 **Index Matching of ITO-PET Film and ITO Glass by Organic Coating and Performance**

S. J. Park, H. H. Kim, E. H. Kim, S. M. Lee, L. S. Park

Kyungpook Nat. Univ., Korea

The visibility of patterned ITO layer on ITO-PET film or ITO glass is a cumbersome process in fabrication of projective capacitive touch panel. In this work we developed an index matching process utilizing organic coating materials. The design, simulation and measurement of the index matching process and performances are discussed.

Wednesday, December 5

10:50 - 12:25 **Room E**

INP1: Interaction

Chair: M. Doi, Toshiba, Japan
Co-Chair: I. E. Yairi, Sophia Univ., Japan

INP1 - 1: 10:50 ***Invited*** **Displaying Contents, Knowledge and Experiences**

M. Doi

Toshiba, Japan

The fundamental function of display has not changed. Consumer's lifestyle has changed. Consumers not only select and enjoy contents but also get things and knowledge on displays via online shopping and so on. Displays have changed into sensor probes for consumers. Consumers' experiences are shared on surrounding and wearing displays.

INP1 - 2: 11:15 ***Invited*** **Touch Panel Interaction for Visually Impaired People : Toward the Universal Design of Interactive Contents**

I. E. Yairi

Sophia Univ., Japan

This paper introduces our research project about the universal designed interactive contents for visually impaired people's touch panel interaction. As an instance, we proposed "One Octave Scale Interface (abbr. OOSI) as the graphical representation. This paper reports the evaluation of shape recognition puzzle contents by visually impaired people.

INP1 - 3: 11:40 ***Invited*** **Rapid Development of EAP Haptics Using a Mobile Device Simulator**

S. J. Biggs, R. N. Hitchcock, K. Kakinuma[*]

Artificial Muscle, USA
[*]*Bayer MaterialSci., Japan*

To rapidly develop electroactive polymer (EAP) modules for gaming, a mobile device simulator was used. The dynamics of candidate systems were modeled, and the simulated "feel" was rated by users. The approach supported development of a game-enhancing iPod case driven by an EAP actuator for commercial use called "ViviTouch".

INP1 - 4 12:05 **A Hybrid Interaction for Touchable Flexible AMOLED**

M.-Y. Lu, H.-Y. Chen, S.-P. Wang, S.-H. Wu, C.-C. Liang

ITRI, Taiwan

An improved user interface was proposed to increase the convenience and interest in manipulating them, including simultaneously beating, multi-level bending, and bending connected with touching, where sensors were integrated and designed into a flexible 6-in. AMOLED. The performance of the sensor-integrated AMOLED validated the developed user interface.

----- Lunch -----

14:00 - 15:10 **Room E**

INP2: Touch Panel (1)

Chair: N. Nakatani, Touch Panel Labs., Japan
Co-Chair: F. Soilihi, Nanomade Concept, France

INP2 - 1: 14:00 ***Invited*** **New Technology Trends in Touch Panel Sensing**

K. Nakatani

Touch Panel Labs., Japan

For a large size touch panel, there are some material issues such as high resistance of ITO film and increase of wiring area. To solve these issues, we developed new touch panels. It enables large size panel not only to produce by the roll-to-roll method but also to make new applications.

INP2 - 2 14:25 **Design of a Projected-Capacitive Touch Controller for Environment Noise Suppression**

B. Li, T. Wei, X. Wei, S. Zhan

Northwestern Polytech. Univ., China

A strategy of sensing the voltage difference of the adjacent sense electrodes with two complementary drive pulses is proposed for projected-capacitive touch controller. To verify the strategy, a prototype chip is designed and tested. The test results indicate the proposed sensing strategy is efficient for environment noise suppression.

INP2 - 3: 14:45 ***Invited*** **Flexible Touch Panel Based on Nanoparticle Strain Gauges**

F. Soilihi, N. Decorde, L. Ressier, B. Viallet**

Nanomade Concept, France
**Univ. de Toulouse, France*

We introduce an innovative patented multi-touch force sensing technology destined to flexible displays. Relying on nanoparticle-based strain gauges, this low-cost technology offers a unique set of features (full flexibility, multipoint force sensing and bend sensitivity), which offers ways of interacting with a display.

----- Break -----

15:50 - 17:20 **Room E**

INP3/AMD6: Touch Panel (2)

Chair: T. Nakamura, Japan Display Central, Japan
Co-Chair: H. Katoh, Sharp, Japan

INP3/ AMD6 - 1: 15:50 ***Invited*** **Newly Developed In-Cell Capacitive Touch Panel Technology in a Wide Viewing Angle IPS-Mode Display**

K. Noguchi, Y. Kida, K. Ishizaki, K. Azumi, H. Mizuhasi

Japan Display West, Japan

This paper is a presentation of a 4.0-in. qHD (960×540) IPS-mode LTPS display with a newly developed In-cell mutual capacitive touch technology. The panel has higher touch scanning speed of 120 Hz and newly developed touch scanning circuit for narrow dead band on a LCD glass.

INP3/ AMD6 - 2 16:15 **A Novel Design of Capacitive In-Cell Touch Sensor Circuit Using a-Si TFT**

C.-T. Hsieh, S.-K. Hsu

Chimei-Innolux, Taiwan

This paper proposes an In-cell touch sensor circuit with the threshold voltage compensated method for active matrix displays by using the a-Si TFT. According to the simulation results, the novel touch sensor circuit is effectively against the variation of threshold voltage and improved the reliability of in-cell touch sensor circuit.

INP3/ AMD6 - 3: 16:35 ***Invited*** **In-Cell Projected Capacitive Touch Panel Technology**

Y. Sugita, K. Kida, S. Yamagishi

Sharp, Japan

We describe an In-Cell Projected Capacitive Touch Panel in a display using IGZO TFT technology. The prototype demonstrates high signal-to-noise ratio (SNR) and pen input operation. The possibility of enlarging the display size beyond current limits makes this a highly promising approach for In-Cell Capacitive touch panels.

INP3/ AMD6 - 4 17:00 **Active Photo-Sensing Array of Thin Film Transistor with Threshold Voltage Compensation**

L.-S. Chou, H. M. Chen, B.-C. Chen, J.-Y. Zhang, Y.-H. Tai, I. Chan[*], M.-H. Yeh[*]

Nat. Chiao Tung Univ., Taiwan
[*]ITRI, Taiwan

In this paper, an active photo-sensing amplifier pixel circuit with compensation function of device variation is proposed, which has high aperture ratio since only 3 TFTs are used. The compensation function of the circuit obviously improves the sensing error resulted from device variation from 80% to 6%.

Author Interviews and Demonstrations
17:30 – 18:30

Thursday, December 6

9:00 - 10:10 **Room C-1**

INP4: 3D/2D Imaging Systems (1)

Chair: H. Watanabe, Panasonic, Japan
Co-Chair: K. Kagawa, Shizuoka Univ., Japan

INP4 - 1: 9:00 ***Invited*** **A 1.5 Mpixel RGBZ CMOS Image Sensor for User Interface and 3D Image Capture**

W. Kim, J. Yun, S.-H. Lee, Y. Wang[*], I. Ovsiannikov[*], Y. Park, C. Chung

Samsung Elect., Korea
[*]Samsung Semiconductor, USA

A 1.5 Mpixel RGBZ image sensor to capture color (RGB) and depth (Z) at the same time is presented. Time-Of-Flight (TOF) method is used for depth. Color pixels and depth pixels are placed together in pixel array with specially designed RGBZ pattern. It demonstrates excellent depth performance and full color image.

INP4 - 2: 9:25 ***Invited*** **Evolution of Eyes and Image Sensors**

H. Watanabe

Panasonic, Japan

The evolution of the eye and image sensors was overviewed. The possible disadvantage of the inverted structures of human eyes and FSI image sensors was solved with the use of the lightpipe function. A novel “SmartFSI” image sensor with stacked lightpipe structure demonstrated a high performance.

INP4 - 3 9:50 **Low Noise Readout Circuits Interface Using a Capacitive-Feedback Frontend Amplifier for High Output Impedance Sensors**

K. Mars, S. Kawahito

Shizuoka Univ., Japan

In this paper a low-noise high-gain readout circuit interface for high output impedance sensors is presented. Theoretical noise analysis and simulation results shows that by using a high-gain switched capacitor amplifier, the thermal noise is greatly reduced if the dominant reset noise component at the charge summing node is canceled.

----- Break -----

10:50 - 12:20 **Room C-1**

INP5: 3D/2D Imaging Systems (2)

Chair: J. D. K. Kim, Samsung Advanced Inst. of Tech., Korea
Co-Chair: C.-C. Hsieh, Nat. Tsing Hua Univ., Taiwan

INP5 - 1: 10:50 ***Invited*** **A Full-HD CMOS Image Sensor with Time-Multiplexed 2D/3D Image Acquisition**

S.-J. Kim, J. Shin, J. D. K. Kim, B. Kang, K. Lee

Samsung Advanced Inst. of Tech., Korea

We present a 1920x1080 pixel array to provide high-resolution 2D color images and high-accuracy 3D depth maps in a time-multiplexed manner. The prototype chip demonstrates the demodulation of 20 MHz time-of-flight signal with the contrast of 52.8%, achieving less than 38 mm depth error between the distance of 0.75 m and 4.5 m.

INP5 - 2: 11:15 ***Invited*** **An Ultra-Low Voltage CMOS Imager with Novel Pulse-Width-Modulation Readout**

C.-C. Hsieh, M.-T. Chung

Nat. Tsing Hua Univ., Taiwan

A 0.5 V PWM CMOS Imager chip with threshold variation cancelling and programmable threshold control scheme was implemented. It achieves 0.055% pixel FPN, 0.65 LSBrms random noise at dark, and 82 dB dynamic range at 11.8 fps. The chip consumes 4.95 μW at 11.8 fps; results in a iFOM as 163.9 pW/f-p.

INP5 - 3 11:40 **Discussing Pixel Circuits for Hybrid Sensor and Display Pixel Arrays**

N. Papadopoulos, M. Yang, M. Esmaeili-Rad, M. Sachdev, W. S. Wong

Univ. of Waterloo, Canada

The hybrid sensor and display pixel proposed consists of: light sensor and integrated display onto the backplane. Phototransistors incorporating both sensing and switching on the same device was used. The backplane was implemented using a driving TFT and an OLED. The grey scale is generated by pulse-height and width voltage modulation.

INP5 - 4
12:00 **Color Image Reconstruction from a Depth-Aware LCD Display Based on Coded Aperture Imaging**

S. Suh, C. Choi, D. Park, C. Kim

Samsung Advanced Inst. of Tech., Korea

This paper describes a novel color image reconstruction method based on coded aperture imaging. By sequentially displaying invisible coded aperture patterns in each LCD sub-pixel of red, green and blue colors, color multi-view images are reconstructed by decoding coded images in each color primary.

----- Lunch -----

15:50 - 17:35 **Room B-1**

INP6: AR Interactive Systems
Special Topics of Interest on Augmented Reality

Chair: H. Iseki, Tokyo Women's Medical Univ., Japan
Co-Chair: N. Hashimoto, Citizen Holdings, Japan

INP6 - 1:
15:50 ***Invited*** **SCOT (Smart Cyber Operating Theater) Project: Advanced Medical Information Analyzer for Guidance of the Surgical Procedures**

*H. Iseki, Y. Muragaki, M. Tamura, T. Suzuki, K. Yoshimitsu, S. Ikuta, J. Okamoto, M. Chernov, K. Izumi**

Tokyo Women's Medical Univ., Japan
**Univ. of Tokyo, Japan*

Computer-assisted advanced medical information analyzer is based on the constant monitoring, recording, co-registration and archiving of the various data. The system permits fast extraction of the required parameters from the database and significantly facilitates evaluation of the clinical procedures, which may result in significant increase of their safety and reliability.

INP6 - 2
16:15 **Laser Projection UI Robot System and Its Applications**

M. Ide, Y. Abe, T. Komiyama, S. Fukaya, T. Tamura, K. Arakawa, T. Nozaki

Citizen Holdings, Japan

We present a novel pan-tilt projection UI robot system using a laser light source with a MEMS scanner in combination with a hand tracking sensor. The UI robot system can detect and track a hand and then project a virtual remote controller (VRC) image onto the top of a palm.

INP6 - 3L: 16:35 ***Invited*** **Real-Time Rendering Method of Virtual Liquid in Mixed Reality Environment with Automatic Generation of Sound Effect**

M. Imura, Y. Kuroda, O. Oshiro

Osaka Univ., Japan

We propose a real-time rendering method of virtual liquids in mixed reality environment and an automatic generation method of sound effect of liquids based on a computational fluid dynamics simulation. Two cameras are adopted for capturing the images of real environment for appropriate rendering of transparent liquids.

INP6 - 4L: 16:55 ***Invited*** **Synchronized Visualization of Bone Cutting to Support Microendoscopic Discectomy**

M. Nakao, K. Imanishi[*], M. Kioka[**], M. Yoshida[**], K. Minato[***], T. Matsuda

Kyoto Univ., Japan
[*]e-Growth, Japan
[**]Wakayama Medical Univ., Japan
[***]Nara Inst. of S&T, Japan

This presentation introduces a new concept of augmented reality (AR) assisted bone cutting to support Microendoscopic Discectomy. The designed system dynamically updates volume rendered images of patient's CT data while synchronizing with intraoperative cutting procedures, and contributes to precise and rapid cutting as well as reducing perceptual difficulties in microendoscopic operation.

INP6 - 5L: 17:15 ***Invited*** **Contents-Rich Display for Medical Diagnostic and Surgical Aid**

K. Mori

Nagoya Univ., Japan

This paper presents recent advances of medical image processing techniques utilized in diagnostic and surgical assistance from the viewpoint of human anatomy exploration and its display. Interactive rendering of human anatomical structures is now widely utilized in the clinical filed. This presentation demonstrates contents-rich display based on medical image recognition.

Author Interviews and Demonstrations
17:30 – 18:30

Supporting Organizations:
Human Interface Society
Information Sensing Research Committee, ITE

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	Y. Ukai	UDDI
	T. Unate	UNATE
	T. Yanagimoto	Nippon Steel & Sumikin Chem.
	Y. Yang	Japan Display

Workshop on Plasma Displays

Workshop Chair:	H. Kajiyama	Tokushima Bunri Univ.
Program Chair:	R. Murai	Panasonic
General Secretary:	T. Shiga	Univ. of Electro-Commun.
Program Committee:	K. Ishii	NHK
	S. Mikoshiba	Univ. of Electro-Commun.
	T. Nagatomi	Osaka Univ.
	Y. Nakao	Asahi Glass
	T. Shinoda	Shinoda Plasma
	M. Uchidoi	Sichuan COC Display Device

Workshop on EL Displays and Phosphors

Workshop Chair:	Y. Nakanishi	Shizuoka Univ.
Program Chair:	N. Miura	Meiji Univ.
General Secretary:	N. Matsuda	Toshiba
Program Committee:	K. Hara	Shizuoka Univ.
	T. Hisamune	Mitsubishi Chem.
	S. Itoh	Futaba

	D. Jeon	KAIST
	M. Katayama	Denso
	H. Kobayashi	Tottori Univ.
	T. Kusunoki	Dexerials
	T. Miyata	Kanazawa Inst. of Tech.
	M. Niboshi	Sharp
	K. Ohmi	Tottori Univ.
	D. Poelman	Ghent Univ.
	M. Shiiki	Hitachi
	M. Sumitomo	Nichia Chem. Ind.
	K. Wani	TAZMO
	R. Xie	NIMS
	A. Yamamoto	Tokyo Univ. of Tech.

Workshop on Field Emission Display and CRT

Workshop Chair:	M. Takai	Osaka Univ.
Program Chair:	H. Mimura	Shizuoka Univ.
General Secretary:	M. Namba	NHK-ES
Program Committee:	T. Asano	Kyusyu Univ.
	Y. Gotoh	Kyoto Univ.
	J. Ishikawa	Chubu Univ.
	K. Koga	Panasonic Healthcare
	M. Nagao	AIST
	M. Nakamoto	Shizuoka Univ.
	S. Okuda	Okuda Ind.

Workshop on OLED Displays and Related Technologies

Workshop Chair:	S. Naka	Univ. of Toyama
Program Chair:	T. Wakimoto	Merck
Program Vice-Chair:	K. Monzen	Nissan Chem. Inds.
General Secretary:	N. Takada	AIST
Vice-Secretary:	T. Ikuta	JNC Petrochem.
Program Committee:	C. Adachi	Kyushu Univ.
	S. Aratani	Hitachi
	S. Enomoto	Toshiba
	Y. Fujita	Sharp
	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. Miyazaki	Kyushu Univ.
	H. Murata	JAIST
	K. Nakayama	Yamagata Univ.
	Y. Sato	Mitsubishi Chem.
	T. Shimizu	NHK
	S. Tokito	Yamagata Univ.
	T. Tsuji	Pioneer
	T. Uchida	Tokyo Polytechnic Univ.

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	Hitachi
	T. Mishina	NHK

	S. Ohtsuka	Kagoshima Univ.
	J.-Y. Son	Konyang Univ.
	C.-H. Tsai	ITRI
	M. Tsuboi	NTT DoCoMo
	H. Yamamoto	Univ. of Tokushima

Workshop on Applied Vision and Human Factors

Workshop Chair:	T. Kurita	NHK
Program Chair:	K. Masaoka	NHK
General Secretary:	T. Matsumoto	Sony
Program Committee:	J. Bergquist	Nokia
	S. Clippingdale	NHK
	N. Hiruma	NHK
	M. Idesawa	Univ. of Electro-Commun.
	H. Isono	Tokyo Denki Univ.
	A. Morishita	Toshiba
	K. Sakamoto	Panasonic
	Y. Shimodaira	Shizuoka Univ.
	J. Someya	Mitsubishi Elec.
	T. Tamura	Tokyo Polytech. Univ
	A. Yoshida	Sharp
	R. Yoshitake	IBM Japan

Workshop on Projection and Large-Area Displays and Their Components

Workshop Chair:	H. Kanayama	Panasonic
Program Chair:	T. Hayashi	3M
Program Vice-Chair:	J. Park	AIST
	S. Shikama	Setsunan Univ.
General Secretary:	T. Suzuki	JVC KENWOOD
Program Committee:	O. Akimoto	Sony
	Y. Asakura	Nittoh Kogaku
	H. Kikuchi	NHK
	S. Koike	Seiko Epson
	H. Nakano	Barco
	T. Ogura	Shincron
	K. Ohara	Texas Instr. Japan
	S. Ouchi	Hitachi
	M. Sakai	Ushio
	H. Sugiura	Mitsubishi Elec.
	Z. Tajima	Mobara Atecs
	M. Takaso	Techno Sys. Res.
	K. Takeda	

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
	T. Kitamura	Chiba Univ.
	S. Maeda	Tokai Univ.
	Y. Masuda	Bridgestone
	M. Omodani	Tokai Univ.
	N.-S. Roh	Samsung Display
	A. Suzuki	Chiba Univ.
	M. Tsuchiya	E-ink
	G. Zhou	Philips Res.

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
	T. Ooasa	Tokyo Electron
	S. Sugiyama	Ritsumeikan Univ.
	H. Tuller	MIT
	S. Uchikoga	Toshiba
	J.-B. Yoon	KAIST
	Y. Yoshida	BEANS Lab.

Workshop on Display Electronic Systems

Workshop Chair:	T. Fujine	Sharp
Program Chair:	T. Yamamoto	NHK
General Secretary:	S. Takamura	NTT
Program Committee:	K. Kagawa	Shizuoka Univ.
	K. Käläntär	Global Optical Solutions
	L. Kerofsky	Sharp Lab. of America
	T. Kim	Apple
	H.-S. Koo	Ming-Hsing Univ. of S&T
	O.-K. Kwon	Hanyang Univ.
	K. Makita	AIST
	K. Morita	National Traffic Safety and Environment Lab.
	A. Nagase	Mitsubishi Elec.
	H. Nitta	Hitachi
	H. Okumura	Toshiba
	S. Ono	Panasonic
	A. Sakaigawa	Japan Display
	H. Sasaki	Toshiba Semiconductor & Storage Prod.
	K. Sekiya	

Workshop on Flexible Displays

Workshop Chair:	H. Fujikake	Tohoku Univ.
Program Chair:	M. Ito	Toppan Printing
General Secretary:	T. Shiro	Teijin
Program Committee:	K. Akamatsu	Sony
	M. Funahashi	Kagawa Univ.
	T. Furukawa	Yamagata Univ.
	H. Hirata	Toray Eng.
	T. Kamata	AIST
	M. Kimura	Nagaoka Univ. of Tech.
	H. Maeda	DNP
	Y. Masuda	Bridgestone
	Y. Mishima	FUJIFILM
	T. Sekitani	Univ. of Tokyo
	K. Takimiya	Hiroshima Univ.
	T. Tomono	Toppan Printing
	K. Uemura	Nippon Steel & Sumitomo Metal

Workshop on Touch Panels and Input Technologies

Workshop Chair:	I. Fujieda	Ritsumeikan Univ.
Program Committee:	K. Nakatani	Touchpanel Labs.
General Secretary:	I. Mihara	Toshiba
Program Committee:	H. Haga	NLT Techs.
	N. Hashimoto	Citizen Holdings
	K. Kagawa	Shizuoka Univ.
	H. Kato	Sharp
	Y. Mizushima	Corning Holding Japan
	T. Nakamura	Japan Display
	Y. Nakatani	Ritsumeikan Univ.
	H. Noma	ATR Intelligent Robotics and Commu. Labs.
	H. Okumura	Toshiba
	Y. Sasaki	Mitsubishi Elec.
	K. Takatori	NLT Techs.

Special Topics of Interest on Oxide TFT

Facilitator:	K. Takatori	NLT Techs.
Program Committee:		
AMD:	H. Kumomi	Tokyo Inst. of Tech.
FMC:	R. Yamaguchi	Akita Univ.
OLED:	T. Uchida	Tokyo Polytechnic Univ.
EP:	Y. Toko	Stanley Elec.
FLX:	T. Sekitani	Univ. of Tokyo

Special Topics of Interest on Augmented Reality

Facilitator:	M. Date	NTT
Program Committee:		
3D:	M. Tsuchida	NTT
VHF:	T. Matsumoto	Sony
DES:	K. Makita	AIST
INP:	I. Mihara	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.
PRJ:	M. Sakai	Ushio

FINANCIAL SUPPORTING ORGANIZATIONS (as of October 30, 2012)

ADEKA Corporation
Applied Materials Inc.
ASAHI GLASS CO., LTD.
Corning Holding Japan G.K. Corning Technology Center
Dai Nippon Printing Co., Ltd.
JNC CORPORATION
JSR Corporation
Nichia Corporation
Semiconductor Energy Laboratory Co., Ltd.
SHARP CORPORATION
TOKYO ELECTRON LIMITED
Ube Material Industries, Ltd.

SUPPORTING MEMBERS (as of October 30, 2012)

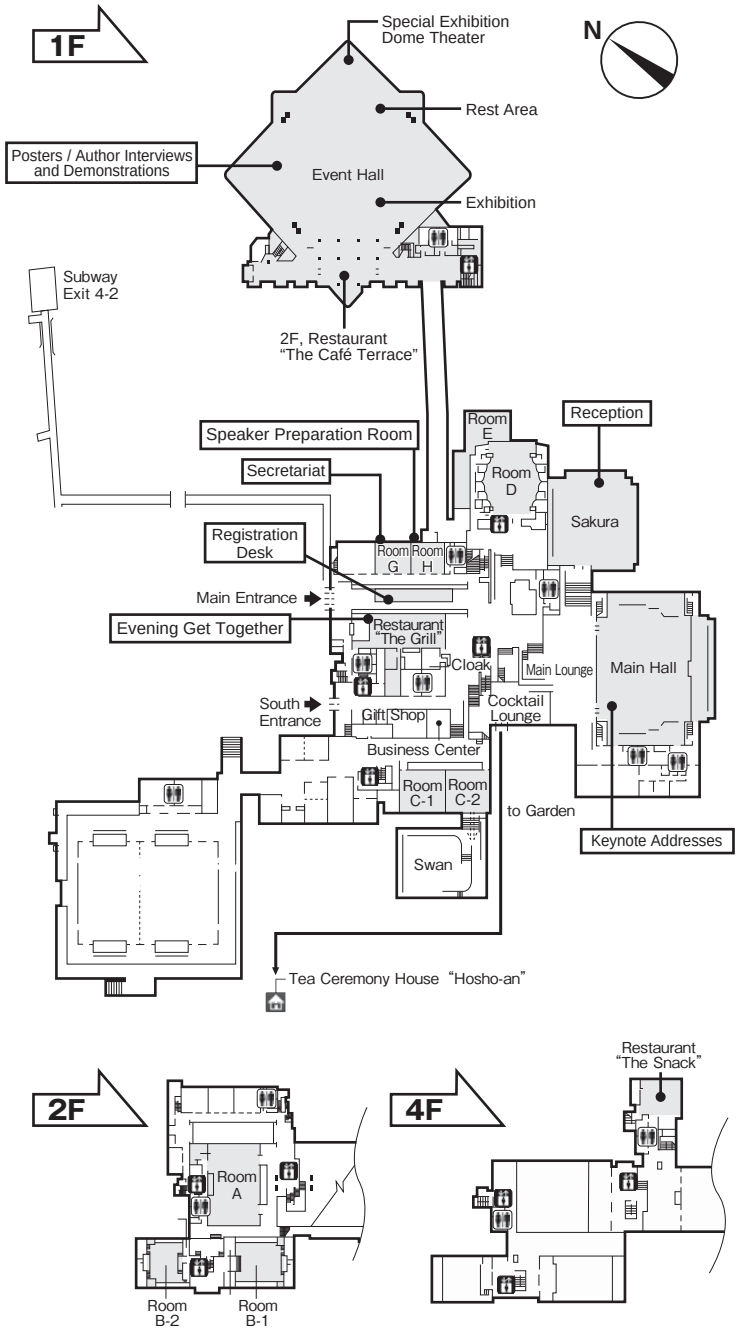
Eizo Nanao Corporation
Merck Ltd. Japan
NHK (JAPAN BROADCASTING CORPORATION)
NLT Technologies, Ltd.

SHIMADZU CORPORATION
Toshiba Corporation
ULVAC, Inc.
ZEON CORPORATION

COMPANIES LIST OF EXHIBITORS (as of October 30, 2012)
Fraunhofer COMEDD
Grand Seiko Co., Ltd.
KEISOKU GIKEN Co., Ltd.
Konica Minolta Optics, INC.
PTT Company Limited
Shintech, Inc.
SILVACO Japan, Ltd.
TOYO Corporation
Wexx Co., Ltd

UNIVERSITIES LIST OF EXHIBITORS (as of October 30, 2012)
Fujieda and Hanasaki Lab., Ritsumeikan Univ.
Graduate School of Eng. Sci., Osaka Univ.
Hideo Saito Lab., Keio Univ.
Hirose-Tanikawa Lab., the Univ. of Tokyo
Kyushu Univ.
Maeda Lab., Tokai Univ.
Mutsu and Matsu Lab./Ryukoku Extension Ctr., Ryukoku Univ.
Nagaoka Univ. of Tech.
Nakamoto Lab., Shizuoka Univ.
Nara Inst. of S&T
Omodani Lab., Tokai Univ.
Reality Media Lab. and Mobile Computing Lab., Ritsumeikan Univ.
Suyama and Yamamoto Lab., the Univ. of Tokushima
Takemura Lab. Cybermedia Ctr., Osaka Univ.
Univ. of Hyogo
Univ. of the Ryukyus
Univ. of Toyama
Univ. of Tsukuba

FLOOR MAP


1F
Special Exhibition Dome Theater
N
Rest Area
Posters / Author Interviews and Demonstrations
Event Hall
Exhibition
Subway Exit 4-2
2F, Restaurant "The Café Terrace"
Reception
Speaker Preparation Room
Room E
Room D
Secretariat
Sakura
Registration Desk
Room G
Room H
Main Entrance
Evening Get Together
Restaurant "The Grill"
Cloak
Main Lounge
Main Hall
South Entrance
Gift Shop
Cocktail Lounge
Business Center
Room C-1
Room C-2
to Garden
Keynote Addresses
Swan
Tea Ceremony House "Hosho-an"
2F
Room A
Room B-2
Room B-1
4F
Restaurant "The Snack"

MEMO

IDW/AD '12 Timetable

Date	Main Entrance	1F					2F			1F	
		Main Hall	Room C-1	Room C-2	Room D	Room E	Room A	Room B-1	Room B-2	Event Hall	
Mon., Dec. 3	Registration 17:00-20:00	Evening Get-Together at Restaurant "The Grill" (1F) 18:00-20:00									
Tuesday, December 4	Registration 8:00-18:00	Opening, Keynote Addresses 9:25-12:40									
		Lunch									
			VHF1 14:20-15:50	DES1 14:15-15:55	EP1 14:20-15:55		AMD1 14:20-15:45	FMC1 14:20-15:35	3D1 14:20-15:50	LCTp, INPp 14:20-17:20	Exhibition 12:40-18:20
		Break									
			DES2/VHF2 16:10-17:30		EP2 16:10-17:20		FLX1/AMD2 16:10-17:35	FMC2 16:10-17:30	3D2 16:10-17:50		
										Author Interviews & Demonstrations 17:50-18:50	
Wednesday, December 5	Registration 8:00-18:00			DES3 9:00-10:10	LCT1 9:00-10:20		AMD3 9:00-10:30	3D3/VHF3 9:00-10:20	EP3 9:00-10:05	FMCp, FLXp 9:20-12:20	
		Break									
				DES4/DESp† 10:50-11:40	LCT2 10:50-12:10	INP1 10:50-12:25	AMD4 10:50-12:20	3D4/VHF4 10:50-12:05	EP4/EPp† 10:50-12:20		Exhibition 10:00-18:00
		Lunch									
					LCT3 14:00-15:25	INP2 14:00-15:10	AMD5 14:00-15:25	FLX2 14:00-15:35	FMC3 14:00-15:00	PDPp, EPp, DESp 14:00-17:00	
		Break									
					LCT4 15:50-17:10	INP3/AMD6 15:50-17:20	FLX3 15:50-17:25	VHF5/3D5 15:50-17:10	FMC4 15:50-17:10		
										Author Interviews & Demonstrations 17:30-18:30	
		Reception at Sakura (1F) 19:00-21:00									
Thursday, December 6	Registration 8:00-18:00		INP4 9:00-10:10	PH4 9:00-10:00	MEET1 9:00-10:40	FLX4 9:00-9:55	OLED1 9:00-10:00	VHF6 9:00-10:30	PRJ1 9:00-10:35	AMDp 9:20-12:20	
		Break									
			INP5 10:50-12:20	PDP1 10:50-11:50	MEET2 10:50-12:20	FLX5/FMC5 10:50-12:05	OLED2 10:50-12:25	3D6 10:50-12:30	PRJp† 10:50-11:20		Exhibition 10:00-18:00
		Lunch									
			PH1 14:00-15:20	PDP2 14:00-15:15	MEET3 14:00-15:15	FLX6 14:00-15:15	AMD7 14:00-15:15	DES5 14:00-15:35	FMC6 14:00-15:00	OLEDp, 3Dp, VHFp, PRJp 14:00-17:00	
		Break									
			PH2 15:50-17:30	PDP3 15:50-17:10	MEET4 15:50-17:10		AMD8/FLX7 15:50-17:15	INP6 15:50-17:35	FMC7 15:50-16:50		
										Author Interviews & Demonstrations 17:30-18:30	
Friday, December 7	Registration 8:00-13:00		FED1 9:00-10:40			3D7 9:00-10:20	OLED3 9:00-10:25	PRJ2 9:00-10:25	FMC8 9:00-10:20	PHp 9:20-12:20	
		Break									
			FED2 10:50-12:10	VHF7 10:50-12:35	LCT5 10:50-12:15	3D8 10:50-12:20	OLED4 10:50-12:15	PRJ3 10:50-12:15	FMC9 10:50-11:50		Exhibition 10:00-14:00
		Lunch									
			FED3 14:00-15:20	VHF8 14:00-15:35	LCT6 14:00-15:15	3D9 14:00-15:30	OLED5 14:00-15:05	AMD9 14:00-15:35	PRJ4 14:00-15:35		
		Break									
			FED4 15:50-16:50	VHF9 15:50-17:20	LCT7 15:50-17:10	3D10 15:50-16:25	OLED6 15:50-17:15		PH3 15:50-17:20		
										Author Interviews & Demonstrations 17:30-18:30	

†Short Presentations

IDW/AD '12 Special Topics of Interest Navigator

	Oxide TFT			Augmented Reality (AR)		Lighting Technologies (LIT)			
Date	Room A	Room B-1	Event Hall	Room B-1	Event Hall	Room A	Room B-2	Room C-2	Event Hall
Tue., Dec. 4		FMC1: Manufacturing Technologies (1) 14:20-15:35							
Wednesday, December 5	AMD3: Oxide TFT: Materials & Devices 9:00-10:30		FMCp, FLXp: Poster 9:20-12:20		DESp† Room C-2 11:30-11:40				FMCp: Poster 9:20-12:20
	AMD4: Oxide TFT: Applications 10:50-12:20								
	AMD5: Oxide TFT: Solution Process 14:00-15:25				DESp1: Poster 14:00-17:00				
	FLX3: Flexible Oxide TFTs 15:50-17:25								
Thursday, December 6			AMDp1: Poster 9:20-12:20	VHF6: Wide-Angle and Head-Up Display Human Factors 9:00-10:30				PH4: Phosphors Late News 9:00-10:00	
				3D6: Digital Museum of Kyoto Gion Festival 10:50-12:30					
	AMD7: Oxide TFT: Reliability 14:00-15:15			DES5: Recent Advances in Augmented Reality Applications 14:00-15:35					OLEDp: Poster 14:00-17:00
	AMD8/FLX7: Oxide TFT: Flexible Displays 15:50-17:15			INP6: AR Interactive Systems 15:50-17:35					
Friday, December 7						OLED3: OLED for Lighting Application 9:00-10:25			PHp: Poster 9:20-12:20
							FMC9: LED Lighting Technologies 10:50-11:50		
							PRJ4: Solid State Lighting 14:00-15:35		
							PH3: Phosphors for Lighting 15:50-17:20		

IDW/AD '12 Session Navigator

	Tuesday, Dec. 4				Wednesday, Dec. 5					Thursday, Dec. 6					Friday, Dec. 7				
	9:25-12:40	PM		17:50-18:50	AM		PM		17:30-18:30	AM		PM		17:30-18:30	AM		PM		17:30-18:30
	Main Hall																		
Keynote	Opening, Keynote Addresses																		
LCT		Event Hall			Room D				Event Hall							Room D			Event Hall
		Posters			LC Semiconductors & Display Modes	New Functional LC Devices	Blue Phase	Wide Viewing Angle & Fast Switching	A.I.							Emerging Display Mode	Photo Alignment	LC Alignment Technology	A.I.
AMD		Room A		Event Hall	Room A			Room E	Event Hall	Event Hall		Room A		Event Hall			Room B-1		Event Hall
		Organic & Carbon TFT	Flexible Active Matrix Devices*	A.I.	Oxide TFT: Materials & Devices	Oxide TFT: Applications	Oxide TFT: Solution Process	Touch Panel (2)*	A.I.	Posters		Oxide TFT: Reliability	Oxide TFT: Flexible Displays*	A.I.			Active-Matrix Circuits		A.I.
FMC		Room B-1		Event Hall	Event Hall		Room B-2		Event Hall		Room E	Room B-2		Event Hall	Room B-2				Event Hall
		Manufacturing Technologies (1)	Manufacturing Technologies (2)	A.I.	Posters		Materials (1)	Materials (2)	A.I.		Flexible Materials & Fabrication Processes*	Materials (3)	Backlight	A.I.	Manufacturing Technologies (3)	LED Lighting Technologies			A.I.
PDP							Event Hall				Room C-2			Event Hall					
							Posters				Driving	Ultra HDTV	Protective Layer	A.I.					
PH										Room C-2		Room C-1		Event Hall	Event Hall			Room B-2	Event Hall
										Phosphors Late News		Phosphors in EL	Phosphors in General	A.I.	Posters			Phosphors for Lighting	A.I.
FED															Room C-1				Event Hall
															CNT Emitters & Applications	Applications & New Materials	Fabrication Processes	Fundamental Mechanisms	A.I.
OLED										Room A		Event Hall			Room A				Event Hall
										Keynote & Future Trend	Micro OLED Display	Posters		A.I.	OLED for Lighting Application	Materials & Devices	Display Technologies (1)	Display Technologies (2)	A.I.
3D		Room B-2		Event Hall	Room B-1			Room B-1	Event Hall		Room B-1	Event Hall			Room E				Event Hall
		Ray-Space Analysis	Holography	A.I.	3D Crosstalk Evaluation*	3D Image Quality (1)*		3D Image Quality (2)*	A.I.		Digital Museum of Kyoto Gion Festival	Posters		A.I.	Novel 3D Approach	Device & Approach for 3D Display	Ray-Based Realistic 3D Display	Quality Evaluation	A.I.
VHF		Room C-1		Event Hall	Room B-1			Room B-1	Event Hall	Room B-1		Event Hall				Room C-2			Event Hall
		Color (1)	Color (2)*	A.I.	3D Crosstalk Evaluation*	3D Image Quality (1)*		3D Image Quality (2)*	A.I.	Wide-Angle & Head-Up Display Human Factors		Posters		A.I.		Human Factors & Visual Cognition	Image Format & Ergonomic Design of HD/ UHDTV	Display Measurement	A.I.
PRJ										Room B-2		Event Hall			Room B-1		Room B-2		Event Hall
										High Reality	*Short Presentation*	Posters		A.I.	Vehicle Displays	Components	Solid State Lighting		A.I.
EP		Room D		Event Hall	Room B-2		Event Hall												
		Electrophoretic Displays	Reflective Displays & Evaluations	A.I.	Electrochromic Displays & Others (1)	Electrochromic Displays & Others (2) + *Short Presentation*	Posters		A.I.										
MEET										Room D				Event Hall					
										MEMS Imaging & Sensing	Fundamental Components & Process Technologies	Emerging Technologies	Display & Imaging	A.I.					
DES		Room C-2	Room C-1	Event Hall	Room C-2		Event Hall					Room B-1		Event Hall					
		SUPER Hi-VISION Public Viewing	Color (2)*	A.I.	Low Power Consumption	Display Electronic Systems + *Short Presentation*	Posters		A.I.			Recent Advances in Augmented Reality Applications		A.I.					
FLX			Room A	Event Hall	Event Hall		Room B-1	Room A	Event Hall	Room E			Room A	Event Hall					
			Flexible Active Matrix Devices*	A.I.	Posters		Organic TFTs & Related Materials	Flexible Oxide TFTs	A.I.	Materials & Evaluation for Flexible Devices	Flexible Materials & Fabrication Processes*	Fabrication for Flexible Devices	Oxide TFT: Flexible Displays*	A.I.					
INP		Event Hall				Room E			Event Hall	Room C-1			Room B-1	Event Hall					
		Posters				Interaction	Touch Panel (1)	Touch Panel (2)*	A.I.	3D/2D Imaging Systems (1)	3D/2D Imaging Systems (2)		AR Interactive Systems	A.I.					

LCT: Workshop on LC Science & Technologies
AMD: Workshop on Active Matrix Displays
FMC: Workshop on FPD Manufacturing, Materials & Components
PDP: Workshop on Plasma Displays
PH: Workshop on EL Displays & Phosphors
FED: Workshop on Field Emission Display & CRT
OLED: Workshop on OLED Displays & Related Technologies
3D: Workshop on 3D/Hyper-Realistic Displays & Systems

VHF: Workshop on Applied Vision & Human Factors
PRJ: Workshop on Projection & Large-Area Displays & Their Components
EP: Workshop on Electronic Paper
MEET: Workshop on MEMS & Emerging Technologies for Future Displays & Devices
DES: Workshop on Display Electronic Systems
FLX: Workshop on Flexible Displays
INP: Workshop on Touch Panels & Input Technologies

A.I.: Author Interviews & Demonstrations
*: Joint Session

IDW/AD '12 Secretariat:
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IDW/AD '12
FINAL PROGRAM
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TOKYO ELECTRON

UBE MATERIAL INDUSTRIES, LTD.