



# IDW '11

## THE 18TH INTERNATIONAL DISPLAY WORKSHOPS

### Workshops on

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

### Topical Sessions on

- Lighting Technologies (LIT)
- Automotive Displays (AUTO)

***Final Program***

***Nagoya Congress Center  
Nagoya, Japan  
December 7(Wed) – 9(Fri), 2011***

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# PROGRAM HIGHLIGHTS

Scientific and technological advances in research and development on information displays can be found at the 18th International Display Workshops (IDW '11). Features of the IDW '11 include the integration of the following fifteen workshops as well as two topical sessions focusing on recent progress of lighting technologies and automotive displays.

## 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

## Topical Sessions on

- Lighting Technologies
- Automotive Displays

The three-day conference will feature 534 papers, including two keynote addresses, two invited addresses, 108 invited papers, 184 oral presentations, and 238 poster presentations. Following plenary session of keynote and invited addresses in the Wednesday morning, presentations will begin and continue in 8 parallel oral sessions through Friday. Poster sessions and author interviews with demonstrations will enable participants to discuss topics in detail. IDW '11 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 Wednesday to Friday in parallel with workshops. IDW '11 should be of interest to not only researchers and engineers, but also managers of companies and institutions in the display community.

## **Workshop on LC Science and Technologies (LCT)**

Recent advances in LCD technologies and LC materials are presented. The sessions cover from fundamental studies to recent development. New LCD modes, such as blue phase LCDs, three-dimensional LCDs, polymer stabilized LCDs and photo-alignment LCDs are extensively discussed. Novel LC materials, including biaxial nematic LC, special alignment materials and LC semiconductor materials, together with novel LCD evaluation techniques are discussed.

## **Workshop on Active Matrix Displays (AMD)**

The AMD workshop has devoted itself to the exchange of scientific and technological knowledge for the most advanced 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 workshop in IDW. Recent paper presentations trend to focus on Oxide TFTs, which may be expected to play a role in the applications of next-generation OLED and flexible displays. This year, we devote six to AMD alone, and two for joint

sessions, which cover a broader range of device/process applications. These presentations also promise to achieve green displays in the near future.

### **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 terms of manufacturing, materials, and components. The cutting-edge technologies of optical films, manufacturing technologies, FPD materials and measurement systems are highlighted. Recycling of FPD materials and environmental safety technologies are included as highlighted topics. In addition to display areas, these technologies will contribute to solar cell, battery systems and so on.

### **Workshop on Plasma Displays (PDP)**

Total sales of the PDP-TV sets are continuously increasing, partly because of the demand for 3D displays. Along with the business progress, technological advancements have been pursued and introduced at IDW '11. The main stream of the improvements is focused on low power consumption, especially with new protective layer materials. Detailed performance of the new protective layers will be introduced. Also applications of PDPs in digital signage displays will be highlighted.

### **Workshop on EL Displays and Phosphors (PH)**

This workshop presents the latest achievements on devices and phosphors for emissive displays, illumination and liquid-crystal backlighting. Invited talks will be delivered on emerging technologies such as full color quantum dot EL displays, submicron-sized phosphors for EL display, a new red LED of GaN:Eu<sup>3+</sup> 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 cathode ray tube (CRT) and 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 back-light units and X-ray sources is presented. The novel photo-cathode and vertical thin film field emitter arrays are also presented. Furthermore, field emission characteristics and various field emitter materials, such as CNTs, graphene, HfN, TiO<sub>2</sub> and porous silicon, are discussed.

### **Workshop on OLED Displays and Related Technologies (OLED)**

OLED workshop covers all aspects of the science and technologies of OLED and other organic devices, ranging from materials research, basic device physics to display including backplane technologies and other applications. OLED technologies based on new full-color realizing methods are reported on, technologies facilitating the use of OLED in mobile and TV applications. Material and device architecture for highly efficient emissions supporting these device technologies are also presented. In addition, organic transistors for optimal backplane technologies in display devices are discussed.

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

This workshop focuses on recent progress in 3D, hyper-realistic image system and related visual sciences. It also covers 3D acquisition, measurement, standardization, holography, and crosstalk. Invited talks



in this workshop include topics from the forefront of 3D imaging technologies and recent research into advanced display systems.

### **Workshop on Applied Vision and Human Factors (VHF)**

The VHF workshop covers all aspects of vision, human factors, and image quality relating to information displays. The sessions include lively discussions on the latest topics ranging from fundamental theories to applications. This year, the VHF workshop has eight oral sessions on display measurement, image quality, human factors, color, and 3D image quality. We present four sessions on color, including six invited talks and introducing the latest topics on color science, color reproduction, and human and color vision. A new measurement method for motion image quality will be introduced at an invited talk in the display measurement session. A session on 3D image quality and ergonomics introduces new knowledge on the relation between frame rate and 3D image quality, as an invited talk. In addition to our regular poster session on applied vision and human factors, we have an additional joint session relating to human factors in automobiles.

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

On going process in the field of solid states light, LED/Laser, and D-cinema will be discussed. Recent 3D technology contributes to projector progress. Continuous improvements in pico projectors will be high-lighted. The latest topics in unique holographic technology are covered.

### **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 eagerly wanted by emerging applications of e-Books, e-Newspapers, Electronic shelf labels, etc. Various novel technologies in electrophoretic, liquid crystal, electrowetting, electrochromic, liquid powder and toner display systems will be reported on. Challenging new approaches in e-Paper technologies will also be reported. Systems, devices, materials, human factors and applications in this field are expected to be eagerly discussed.

### **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 processes are included. Among all the MEMS and display conferences in the world, this is the only opportunity for MEMS and cutting-edge technology researchers to gather and discuss such devices. Authorities in this field are invited from top research institutions around the world. Invited speakers are from MIT, Univ. of Cambridge, Ecole Polytech., Kyung Hee Univ., CEA-LETI, Samsung Advanced Inst. of Tech., Keio Univ., Tohoku Univ. and Univ. of Tokyo. Together with the 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 the electronics of video data processing, interface technologies, cooperative operations between display components such as cells and backlights,

sensors, and applications in the new areas such as 3D video. We have set up a new session on augmented reality, visualization, and post-HDTV, which are emerging technologies for new applications. In addition, the systems for a wide and high dynamic range of color reproduction such as multi-primary color systems, high fidelity, high framerate, high resolution, and low power consumption systems, are focused on.

### **Workshop on Flexible Displays (FLX)**

Recently, there is much attention on flexible display technologies. The technologies are spread over a wide range of fields from materials science to practical applications. The hottest sessions cover all aspects of flexible display technologies including electronic paper, flexible flat panel displays, display materials, TFT and substrate technologies, which are related across AMD, FMC and EP workshops.

### **Workshop on Touch Panels and Input Technologies (INP)**

Touch panel technology continues to evolve. Camera systems are often employed in auto-stereoscopic displays. Sensing and displaying three-dimensional positions literally opens a new dimension for a truly intuitive human interface. This workshop covers all aspects of input technologies related to displays, ranging from material research and theoretical analysis to application systems.

### **Topical Session on Lighting Technologies (LIT)**

This topical session will cover all aspects of the science and technologies of lighting, ranging from LED lighting, OLED lighting, flexible lighting, manufacture of lightings, lighting materials, device structures for lightings and internal or external efficiency enhancement technologies.

### **Topical Session on Automotive Displays (AUTO)**

Since Nagoya is the center of the automotive industry in Japan, it is worth holding a special session in the IDW: "Topical Session on Automotive Displays". Car navigation displays have already become the interface for Intelligent Transport Systems and further advanced displays such as head-up displays to assist drivers are also being introduced. With the increasing significance of visual interface, studies on how to present information with less-fatigue and less-risk are also taking place. Aged vision and handicapped vision must be also studied in relation to new display devices. In our Topical Session, issues relating to driver's vision and cognition, human factors in connection with traffic accidents, and information displays to assist safe driving are presented by the invited speakers and regular paper contributors.

### **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 '11. The award winners will be announced on the IDW website and given a plaque after the conference.

### **Exhibition**

The IDW '11 Exhibition, which will be held from December 7 through December 9, 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 (2F, 3F Lobby, Bldg. 2).

December 7: 12:40 – 18:00

December 8: 10:00 – 18:00

December 9: 10:00 – 14:00

# GENERAL INFORMATION

## SPONSORSHIP

IDW '11 is sponsored by the Institute of Image Information and Television Engineers (ITE) and the Society for Information Display (SID).

## CONFERENCE SITE

Nagoya Congress Center

1-1, Atsuta-nishimachi, Atsuta-ku,

Nagoya 456-0036

Phone: +81-52-683-7711 Fax: +81-52-683-7777

## ON-SITE SECRETARIAT

Telephone and fax machines for IDW '11 use will be temporarily set up in the secretariat room (Room 221) at the Nagoya Congress Center (December 6-9). Phone/Fax: +81-52-682-9045

## BANQUET

A buffet-style banquet will be held on December 7 from 19:30 to 21:30 at the Shirotori Hall (1F) in the Nagoya Congress Center. As the number of tickets is limited, you are urged to make an advance reservation through the website.

## EVENING GET-TOGETHER WITH WINE

A get-together will be held on December 6 from 18:00 to 20:00 at Skyview Restaurant Pastel (7F) in the conference site. Wine (Sponsored by Merck Ltd., Japan) will be served to participants with a relaxed atmosphere for informal discussion.

## 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 '11 includes admission to the conference and CD-ROM of the proceedings. Additional ¥8,000 will be charged for those who prefer the proceedings in book format. For users who do not have CD drives on their computers, we will provide the data at the conference site. Detailed information will be announced on the website.

	Paid by Nov. 4	After Nov. 4
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
Banquet	¥ 7,000	¥ 10,000

\*ASO: Academic Supporting Organizations

(See p. 12 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 '11 committee.

\*\*\*Photocopy of student ID is required.

Please note that the reduced registration fee must be paid by November 4. The full fee will be charged for payments made later than November 4. Also note that *the number of banquet tickets to register on site is limited.*

For additional sets of the proceedings (Books and CD-ROM)

At the conference site ¥ 9,000

Air mail after the conference ¥ 16,000

Domestic mail after the conference ¥ 11,000

Additional sets of Books and CD-ROM can be purchased only those who have completed payment by November 25.

## 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 25, 2011.

### (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 25, 2011.

IDW '11 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](mailto: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 6 (Tue.) 17:00 – 20:00

December 7 (Wed.) 8:00 – 18:00

December 8 (Thu.) 8:00 – 18:00

December 9 (Fri.) 8:00 – 13:00

The on-site registration fee will be payable by:

1. Cash (JAPANESE YEN only)

2. Credit Card (VISA or MasterCard only)

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

## Cancellation Policy

Refunds for registration, banquet, additional sets of proceedings etc. will be made upon receipt by IDW '11 secretariat of written cancellation by **November 4**. For cancellations received after November 4 or no-shows, refunds will not be made. However, after IDW '11 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 '11 due to infectious disease and other unavoidable factors, we will substitute the IDW with the mail delivery of the IDW '11 proceedings at a later date to all those who have registered and completed payment.

## **INQUIRIES**

IDW '11 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: 2364002) from MEXT
- The Asahi Glass Foundation

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

## **Evening Get-Together with Wine**

Tuesday, December 6, 2011

18:00 – 20:00

at Skyview Restaurant Pastel (7F),

Nagoya Congress Center

(Sponsored by Merck Ltd., Japan)

See page 10 for details

# TRAVEL INFORMATION

## ACCOMMODATIONS

JTB Business World Tokyo Corp. will handle arrangements for your hotel reservations.

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 Business World Tokyo Corp.  
Corporate Sales Yokohama Branch  
(Yokohama Convention Centre)

Phone: +81-45-316-4602 Fax: +81-45-316-5701  
Office Hours: 9:30-17:30 (Weekdays only)  
E-mail: [jtb\\_convention@bwt.jtb.jp](mailto:jtb_convention@bwt.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 ask the secretariat at least two months before the conference.

## CLIMATE

The average temperature in Nagoya during the period is around 11.4°C in the daytime and 2.6°C at night.

## IDW/AD '12

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

December 4-7, 2012

Kyoto International Conference Center  
Kyoto, Japan

<http://www.idw.ne.jp>

## **Nagoya**

Nagoya is located in the center of Honshu, the main island of Japan, with a population of 2.24 million. Thanks to the rich water resources of the Kisogawa, Nagaragawa and Ibigawa Rivers, the fertility of the land due to the blessings of the rivers, and other advantages such as good transportation links, the people of Nagoya have lived affluent lives since early days.

Nagoya has a long history and is the birthplace of three notable feudal lords, Oda Nobunaga, Toyotomi Hideyoshi and Tokugawa Ieyasu. In addition, traditional industries like ceramics and textiles, and today's key industries like automobiles, aviation and machine tools have developed, and Nagoya plays an important role in Japan's industrial society.

Chubu Centrair International Airport is the gateway of Central Japan to the sky, and has many international and domestic routes. Centrair is linked to Nagoya by an excellent transport network, taking 28 minutes by train or 30-40 minutes by car. Nagoya has good access to Tokyo, Kyoto, Osaka and all other areas in Japan. Participants can enjoy a diverse and exciting range of post-convention activities taking advantage of Nagoya's location.

## **Places of Interest**

### **Nagoya Castle**

This is a castle built in 1612 for the Owari Tokugawa Family. The current *donjon* was reconstructed in 1959. The 3rd floor through the 5th floor were remodeled in 1997 and are used to exhibit artifacts depicting the lives of the feudal lords and ordinary citizens of Nagoya in those days, as well as telling the story behind the golden Shachihoko. Access: a 5-minute walk from the Shiyakusho subway station.

### **The Tokugawa Art Museum**

The Tokugawa Art Museum is known for its collection of "Daimyo Dogu," the precious treasure of the Owari Tokugawa feudal lords. The collection includes over 10,000 items such as armors and swords belonging to Hideyoshi, Ieyasu and successive feudal lords of the Owari Tokugawa clan. Access: a 10-minute walk from the JR Ozone Station.

### **Port of Nagoya Public Aquarium**

This aquarium is conveniently located at the Nagoya Port Garden Pier. It offers a vivid exhibition of marine mammals. Visitors can see dolphins playing in the large world class pool through a large underwater window. Access: a 5-minute walk from the Nagoya Port Subway Station.

### **Toyota Commemorative Museum of Industry and Technology**

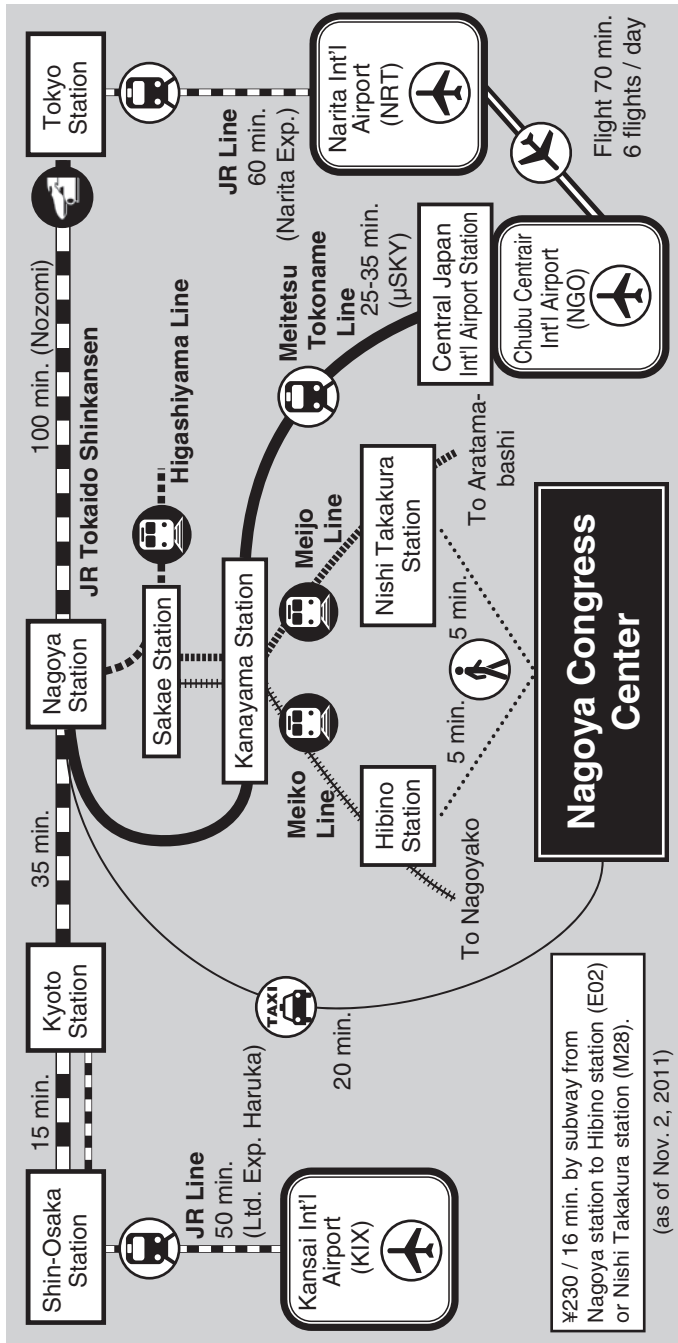
The Toyota Group established this museum to help people understand the importance and wonder of "making things" and the "originality and research" behind it, which have become harder to see as the high technology of industries has evolved in recent years. Traffic access: a 10-minute walk from the Kamejima Subway Station.

Please see the following websites for more information.

<http://www.ncvb.or.jp/en/contents/>

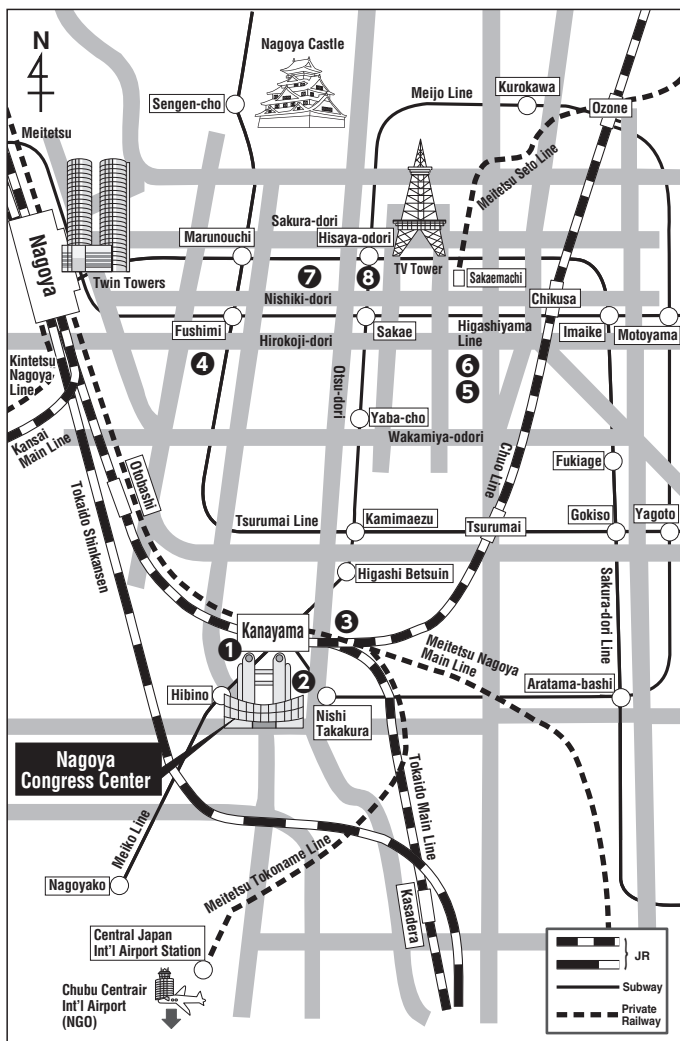
<http://www.nagoya-congress-center.jp/english/>

## Access to Conference Site





# Hotel Map



- |   |                        |
|---|------------------------|
| ① ANA Crowne Plaza Hotel Grand Court Nagoya | Phone: +81-52-683-4111 |
| ② Cypress Garden Hotel                      | Phone: +81-52-679-1661 |
| ③ Nagoya Kanayama Washington Hotel Plaza    | Phone: +81-52-322-1111 |
| ④ Hilton Nagoya                             | Phone: +81-52-212-1111 |
| ⑤ Nagoya Tokyu Hotel                        | Phone: +81-52-251-2411 |
| ⑥ Hotel Precede Nagoya                      | Phone: +81-52-263-3411 |
| ⑦ Tokyo Dai-ichi Hotel Nishiki              | Phone: +81-52-955-1001 |
| ⑧ APA Hotel Nagoya Nishiki Excellent        | Phone: +81-52-953-5111 |

## **SID 2012**

International Symposium, Seminar and Exhibition

June 3-8, 2012

Boston, Massachusetts, U.S.A.

Call for Papers

## **Special Section on Electronic Displays**

**IEICE Transactions on Electronics**

Submission Deadline: Feb. 24, 2012

<http://ny7084.rie.shizuoka.ac.jp/eid/top-e.htm>

## **IDW Tutorial in Japanese**

Tuesday, December 6, 2011

Room 131, Bldg.1

Nagoya Congress Center

Detailed information is available on

<http://www.sidchapters.org/japan/>

## **IDW Outstanding Poster Paper Award**

This award will go to the most outstanding paper  
selected from those presented at IDW '11  
poster presentation.

The 2011 award winners will be announced on the  
IDW website: <http://www.idw.ne.jp/award.html>

# Plenary Sessions

Wednesday, December 7

9:30 - 9:40

Shirotori Hall

## Opening

Master of Ceremony: T. Komaki, Executive Chair, Panasonic, Japan

### Opening Remarks

9:30

*N. Ibaraki, General Chair, AIST, Japan*

*M. Kimura, Program Chair, Ryukoku Univ., Japan*

9:40 - 11:00

Shirotori Hall

## Keynote Addresses

Co-Chair: M. Kimura, Program Chair, Ryukoku Univ., Japan  
N. Ibaraki, General Chair, AIST, Japan

### Keynote Address - 1 Technological Strategy for Picture Quality of Future Displays

9:40

*T. Kamitake*

*Toshiba, Japan*

Realism, the most important issue concerning high image quality, is established by reconstructing image clarity, texture and depth feel. We have been developing technologies, including super-resolution, glasses-free 3D display, 2D3D image conversion and texture creation, which reconstruct the three components, and incorporated them into our TV products.

### Keynote Address - 2 Current Status and Future Trend of Information Display

10:20

*K. Y. Choi*

*LG Elect., Korea*

Current market and technologies of 3D display is reviewed and future technology is also investigated. Film patterned retarder type has been commercialized. For 3D display without glasses, lenticular lens and parallax barrier has been studied. Large screen and interactive board has been required for the commercial display. Alternate light source of projector such as LD and LED has been also investigated.

----- Break -----

11:20 - 12:40

Shirotori Hall

**Invited Addresses**

Co-Chair: M. Kimura, Program Chair, Ryukoku Univ., Japan  
M. Date, Program Vice-Chair, NTT COMWARE, Japan

**Invited Address - 1      Oxide Electronics for Display Backplanes**  
**11:20**

*J. F. Wager, R. L. Hoffman<sup>\*</sup>, D. A. Mourey<sup>\*</sup>*  
*Oregon State Univ., USA*  
*<sup>\*</sup>Hewlett-Packard, USA*

Oxide electronics is emerging as an enabling display backplane technology. The objective of this work is to (i) briefly review the origins and evolution of oxide electronics, (ii) outline the main process attributes of indium gallium zinc oxide (IGZO) based thin-film transistors (TFTs), (iii) critically compare this technology to its competitors, and (iv) assess where oxide electronics is likely to have an impact in future display applications.

**Invited Address - 2      Graphene in Electronics: Current Status**  
**12:00                      and Future Outlook**

*M. Suemitsu<sup>\*,\*\*</sup>*  
*<sup>\*</sup>Tohoku Univ., Japan*  
*<sup>\*\*</sup>JST-CREST, Japan*

With the quasi-relativistic unique electronic structure, graphene presents outstanding electrical and optical properties. Graphene layer can be formed by various methods, which include CVD for transparent conductive films and graphene-on-silicon (GOS) method for FET applications. Despite numerous issues to be solved before industrialization, graphene is doubtlessly a driver for electronics.

# Workshop on LC Science and Technologies

Wednesday, December 7

14:00 - 15:25

Reception Hall 2

## LCT1: Blue Phase

Chair: T. Ishinabe, Tohoku Univ., Japan  
Co-Chair: M. Ozaki, Osaka Univ., Japan

### LCT1 - 1: *Invited* The Dawn of Blue-Phase LCDs

14:00 H.-C. Cheng, J. Yan, L. Rao, T. Ishinabe, S.-T. Wu  
Univ. of Central Florida, USA

A hysteresis-free blue-phase LCD with low operation voltage, high contrast ratio, and submillisecond response time is demonstrated using a vertical field switching cell. Some remaining challenges, such as wider blue-phase temperature range, lower operation voltage, and higher voltage holding ratio remain to be overcome before widespread applications can be realized.

### LCT1 - 2 Evaluation of the Electric Properties of PSBP by Network Structure and Temperature Conditions

14:25 M. Kwak, J. Jeon, K. Kim, Y. Yi, D. Choi, Y. Choi,  
K. Jeong  
LG Display, Korea

A polymer network structure of polymer-stabilized blue phase (PSBP) was analyzed using isopropyl alcohol cleaning liquid. The changes of VHR of PSBP were evaluated by heating conditions. VHR increased when heating temperature was 120°C, and reached highest point at 140°C, and the value showed dependency on heating time as well.

### LCT1 - 3 Fast Electric-Field Response in LC BPIII Device

14:45 J.-L. Lai, C.-C. Chan, H.-Y. Chen  
Feng Chia Univ., Taiwan

Electric-field response in blue phase III was investigated. When an electric field is applied on BPIII, reflected intensity of BPIII rapidly increases or decreases. Response time to switch the reflected intensity in BPIII is a few milliseconds. Moreover, the rise time of BPIII reduced with increasing the strength of electric field, and the decay time is constant.

**LCT1 - 4      Effects of Monomers on Blue Phase LCs**

**15:05**

*X. Xiao, P. Yang*

*AU Optronics Trade, China*

Effects of monomers on electro-optic and stability of blue phase liquid crystal (BPLC) were investigated through experiments. The results indicate that the saturation voltage increases with enhancing the amount of monomers and extending the multi-functional group monomers ratio.

----- Break -----

**15:40 - 16:40**

**Reception Hall 2**

**LCT2: LC Alignment Technology**

Chair:

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

Co-Chair:

S. Komura, Hitachi Displays, Japan

**LCT2 - 1**

**15:40**

**Transition-Free OCB LCD by Polymerization Process**

*C.-S. Hsieh, J.-T. Lien, H.-Y. Wu*

*Chunghwa Picture Tubes, Taiwan*

In this paper, we expand a method to fabricate a liquid crystal display which eliminates transition in pi-cell. The LC alignment can be stabilized by adding monomers in pi-cell to form polymer network. We successfully demonstrated the pi cell in bend or twist state. The response time is about 6ms.

**LCT2 - 2**

**16:00**

**Photo-Aligned RGBW Transflective ECB LCD**

*H.-Y. Wu, C.-S. Hsieh, P.-L. Hsieh, J.-T. Lien*

*Chunghwa Picture Tubes, Taiwan*

We proposed a high color gamut and brightness transflective LCD (TRLCD) with a novel pixel design. The novel pixel design with white sub-pixel increased the brightness in transmissive mode. We select the suitable ratio of the color filter to get high chromaticity and high transmittance in the novel pixel design.

**LCT2 - 3**

**16:20**

**Study of Key Parameters in PS-VA UV Curing Process**

*C.-T. Kang, S.-F. Chen, X. Zhang*

*Shenzhen China STAR Optoelect. Tech., China*

In this article, the relationship between UV curing conditions and generated tilt angle in PS-VA process was studied. The article also explored how the optical performance, voltage holding ratio, and residual monomer vary with UV light wavelength.

**LCT2 - 4**

**Withdrawn**

----- Break -----

LCT

17:20 - 18:00

Reception Hall 2

**LCT3: LCD Characterizations**

Chair: M. Inoue, Apple, Japan

Co-Chair: I. Hirosawa, JASRI, Japan

**LCT3 - 1      An Analytical LC Cell Model for Gravity Mura Analysis****17:20***L.-Y. Ding, J.-C. Li, W.-P. Shih, M.-S. Lin<sup>\*</sup>, Y.-C. Hu<sup>\*\*</sup>,  
P.-Z. Chang**Nat. Taiwan Univ., Taiwan**<sup>\*</sup>Chimei Innolux, Taiwan**<sup>\*\*</sup>Nat. Ilan Univ., Taiwan*

Gravity Mura due to the improper deformation of color filter glass is a defect in large-sized LCDs. This investigation presents an analytical model of LC cell to prevent gravity Mura. The analytical model can be used to establish instant design criteria for LC cell without considerable simulation and experimental data.

**LCT3 - 2      A Novel Technique for Evaluating LCD Characteristics by Microscopic Determination of the Pretilt Angle****17:40***A. Ikemura, M. Miyashita, M. Kitamura, M. Nakamura<sup>\*</sup>,  
M. Miyakawa<sup>\*</sup>, S. Suwa<sup>\*</sup>, T. Isozaki<sup>\*</sup>**Shintech, Japan**<sup>\*</sup>Sony, Japan*

A new evaluation technique for LCD by means of microscopic polarimetry is proposed. The implementation method using a polarimeter designed specially for our study is presented. The result from application of this technique to FPA and PSA LC cells is shown as a confirmation of necessity and validity of it.

**Author Interviews and Demonstrations**

18:40 – 19:30

**IDW/AD '12****The 19th International Display Workshops  
in conjunction with Asia Display 2012**

December 4-7, 2012

Kyoto International Conference Center

Kyoto, Japan

<http://www.idw.ne.jp>

## Thursday, December 8

9:00 - 10:25

Reception Hall 2

**LCT4: 3D & New Functional LCDs**

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

Co-Chair: H. Wakemoto, Toshiba Mobile Display, Japan

**LCT4 - 1: Invited One-Dimensional Integral Imaging 3D Display Systems**

9:00

*Y. Hirayama**Toshiba, Japan*

We have developed autostereoscopic display systems using one-dimensional integral imaging method. They reproduce light beams similar of those produced by a real object. Therefore natural 3D scenes can be observed with continuous motion parallax. The 2D/3D switchable displays and time division multiplexing 3D displays have been also developed.

LCT

**LCT4 - 2 Multi-View Privacy Mode LCD by Image Data Modification**

9:25

*B. Broughton, P. Gass, H. Walton, T. Wynne-Powell, M. Esashi**Sharp Labs. of Europe, UK*

A privacy effect for mobile LCD devices: "Colour Veil View", has been developed which allows reconfigurable colour side images to be displayed, obscuring the main image content for off-axis viewers. The effect requires image data modification only, so is switchable and causes no image quality reduction in the public mode.

**LCT4 - 3 New MVA Design Having High Transmittance and Fast GTG RT for Mobile Applications**

9:45

*C.-M. Chen, Y.-P. Kuo, S.-C. F. Jiang, C.-H. Shih, W.-M. Huang**AU Optronics, Taiwan*

We have developed a novel advanced multi-domains vertical alignment (AMVA-mobile 2) LCD for mobile applications. AMVA-mobile 2 technology is protrusion-less structure and specific ITO design. This technology can reach higher transmittance. We also introduce lower  $\gamma$  1 LC to achieve fast GTG RT.

**IDW Best Paper Award**

This award will go to the most outstanding paper selected from those presented at IDW '11.

The 2011 award winners will be announced on the IDW website: <http://www.idw.ne.jp/award.html>



**LCT4 - 4      High Contrast Ratio Transflective LCD with In-Cell Retarder**  
**10:05**

*C.-Y. Lee, Y.-P. Kuo, C.-H. Shih, W.-M. Huang*

*AU Optronics, Taiwan*

We propose a high contrast ratio transflective LCD with in-cell retarder. In our prototype, we produced a dual gap structure transflective LCD with linear polarizer and inserted a retarder layer at reflective area to promote the contrast ratio. The contrast ratio of the transflective LCD can reach 2200:1.

----- Break -----

**10:40 - 11:40**

**Reception Hall 2**

**LCT5: LCD Materials**

Chair: S.-T. Wu, Univ. of Central Florida, USA

Co-Chair: M. Suzuki, Merck, Japan

**LCT5 - 1      New Generation of VA Materials for LCDs**

**10:40**

*L. Komitov<sup>\*</sup>, B. Helgee<sup>\*</sup>, N. Olsson<sup>\*</sup>, G. Hegde<sup>\*,\*\*\*</sup>,  
I. Dahl<sup>\*</sup>, H. Fukuro<sup>\*\*</sup>, H. Endo<sup>\*\*</sup>, D. Sahade<sup>\*\*</sup>,  
H. Matsumoto<sup>\*\*</sup>*

*<sup>\*</sup>Univ. of Gothenburg, Sweden*

*<sup>\*\*</sup>Nissan Chem., Japan*

*<sup>\*\*\*</sup>Univ. Malaysia Pahang, Malaysia*

A new series of side-chain polymers for alignment layers in liquid crystal displays (LCD) promoting a stable vertical alignment (VA) is presented. These materials are easy to process (no curing required), easy to be stored and transported. They are appropriate especially for LCDs with plastic substrates.

**LCT5 - 2      Synthesis of New Biaxial Nematic LCs and Their Properties**  
**11:00**

*S. Yoshida, S. Yoshida, T. Kitamura<sup>\*</sup>, A. Kakuta*

*Chitose Inst. of S&T, Japan*

*<sup>\*</sup>Kyushu Nanotec Optics, Japan*

New banana-shaped molecules were synthesized to produce a biaxial nematic liquid-crystal mesophase. The molecules had a planar naphthalene-core structure, in contrast to conventional single-core molecules, and the products exhibited liquid crystalline phases. Preliminary results of biaxial discotic molecules are also presented.

**LCT5 - 3      Liquid-Crystalline Perylene and Phthalocyanine  
11:20      Derivatives Bearing Oligosiloxane Chains**

*M. Funahashi, N. Takeuchi, N. Tomita, T. Ishii,  
A. Sonoda\**

*Kagawa Univ., Japan*

*\*AIST, Japan*

New n-type perylene tetracarboxylic bisimide (PTCBI) and p-type phthalocyanine derivatives bearing oligosiloxane chains exhibit columnar phases at r.t. They exhibit the high solubility in organic solvents and their thin films can be produced by a spin-coating method. Liquid-crystalline PTCBI exhibits high electron mobility in the columnar phase at room temperature.

----- Lunch -----

**13:20 - 14:20**

**Reception Hall 2**

**LCT6: Ferroelectric LCs & New LCD Modes**

Chair: L. Komitov, Gothenburg Univ., Sweden

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

**LCT6 - 1      Novel Photoaligned Fast Ferroelectric LCD**

**13:20**

*V. Chigrinov, Q. Guo, A. Lastochkin, E. Pozhidaev,  
F. Fan, H. S. Kwok, A. Srivastava, Y. Ma*

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

The development of novel photoaligned fast ferroelectric LCD based on Deformed Helix Ferroelectric (DHFLC) mode is discussed. A high quality dark state of DHF FLC has been obtained as well as V-shape switching with a high frequency. The applications in Field Sequential Color (FSC) and 3D LCD are envisaged.

**LCT6 - 2      Ferroelectric LC Binary Phase Grating Based on  
13:40      Striped Electrodes**

*C.-W. Lin, H.-M. P. Chen*

*Nat. Chiao Tung Univ., Taiwan*

Using the asymmetric alignment technique, based on double-side striped electrodes, the electrically tunable ferroelectric LC grating, approaching calculated diffraction efficiency is demonstrated. The width of thin striped electrodes is designed smaller than half of the grating pitch to compensate for the fringe field effect and thus improve the diffraction efficiency.

**LCT6 - 3L**      **Improvement of the Crosstalk in Autostereoscopic 3D Display Using LC GRIN Lens with High Resolution LCD**

14:00

*S. Oka, T. Sugita, T. Naganuma, T. Saito, S. Komura, T. Miyazawa*

*Hitachi Displays, Japan*

We investigate a 3D display using an LC Gradient Refractive Index (LC GRIN) lens. We optimized the structure of the LC GRIN lens and the parameters of the LC to obtain ideal refractive index dispersion. A crosstalk value of 2.5% for 2 views is achieved using the LC GRIN lens.

**Author Interviews and Demonstrations**

18:00 – 18:50

**Friday, December 9**

9:00 - 12:00

Room 222-224

**Poster LCTp1: LC Materials**

**LCTp1 - 1      Synthesis and Properties of New Dipeptide LCs that Self-Assemble into Helical Pores**

*J. Oh, K.-U. Jeong, S. W. Kang, M.-H. Lee*

*Chonbuk Nat. Univ., Korea*

The synthesis and structural analysis of a liquid crystal is reported. Three dipeptide liquid crystals containing as nonpolar amino acids self-assemble into helical porous columns through hydrogen bonding.

**LCTp1 - 2      Synthesis and Properties of Quaterylene-Based Lyotropic Chromonic LC for Coatable Polarizer**

*H.-J. Yang, Y.-J. Bae, S.-H. Shin\*, K.-U. Jeong, M.-H. Lee*

*Chonbuk Nat. Univ., Korea*

*\*Korea Inst. of Ind. Tech., Korea*

Previously, we reported a new fabrication method of coatable polarizer by using perylene-based lyotropic chromonic LCs dissolved in photocurable ionic monomer solution. However, since the perylene-based chromonic dyes only cover the red-color region, synthesis of another chromonic dye having a blue is required.

**LCTp1 - 3      Synthesis and Characterizations of Liquid Crystalline Epoxy Monomers with Different Reactive End-Functional Groups**

*J. Oh, S.-M. Kim, H. S. Kang, H. J. Seong, M.-H. Lee*

*Chonbuk Nat. Univ., Korea*

The influence of the curing position containing different reactive groups and the liquid crystalline phase of liquid crystalline epoxy resins (LCERs) was investigated. Three LCERs with different epoxy rings were synthesized for this purpose.

**LCTp1 - 4      Synthesis and Characterization of LC Retardation Film by Cyclopolymerization of Heptadiene Monomers**

*H. S. Kang, Y. Wu, S. M. Kim, H. J. Seong, M. H. Lee  
Chonbuk Nat. Univ., Korea*

In this research, a series of novel reactive mesogens have designed and synthesized, which employ completely different polymerization mode named as diene photopolymerization. These RMs will be photopolymerized after aligning to prepare an optically anisotropic film such as  $\lambda/4$  plate. Kinetics of diene photopolymerization have also investigated.

**LCTp1 - 5L      Electrochromic Optical Element Based on Nanostructured Materials**

*O. I. Aksimentyeva, Z. M. Mykytyuk\*, A. V. Fechan\*,  
O. J. Sushynskyy\*, V. S. Petryshak\*  
Ivan Franko Nat. Univ. of L'viv, Ukraine  
\*L'viv Polytechnic Nat. Univ., Ukraine*

The electrochromic optical element with small on/off time and a wide range of voltage control is elaborated. The type of electrochromic polymer layer will determine the color changing in this optical element. The on/off time of such electrochromic optical element are investigated.

LCT

9:00 - 12:00

Room 222-224

**Poster LCTp2: LC Alignment**

**LCTp2 - 1      New Vertical Alignment Technique-Advanced Hybrid Photo-Alignment**

*W.-J. Chang, K.-H. Wu, M.-S. Chen, W.-M. Huang  
AU Optronics, Taiwan*

In this paper, we describe the concept and experiment results of our new design, advanced hybrid photo-alignment. It is a protrusion-less technology with photo-sensitive polyimide coating. This technology can achieve fast response time and high contrast ratio at the same time.

**LCTp2 - 2      Vertical Alignment of a Nematic LC by Composite Material Containing Perfluorinated and Siloxane Units**

*R. A. Alla\*, G. Hegde\*, \*\*, E. Chiellini\*\*\*, A. Morelli\*\*\*,  
G. Galli\*\*\*, L. Komitov\*  
\*Gothenburg Univ., Sweden  
\*\*Univ. Malaysia Pahang, Malaysia  
\*\*\*Univ. of Pisa, Italy*

Here we report on the study of vertical alignment of a nematic liquid crystal due to the segregation between perfluorinated and the polysiloxane groups of a multi-component composite alignment material. The measured surface anchoring energy was found to depend on the relative amount of polysiloxane matrix in the composite material.

**LCTp2 - 3     Inverse Twisted Nematic Mode Using Photo-Alignment Method**

*S. G. Lee, S. I. Jo, C.-J. Yu, J.-H. Kim*  
*Hanyang Univ., Korea*

We propose an inverse twisted nematic mode using photo-alignment method with two stacked alignment layers. By stacking the planar and vertical alignment layers, we can increase the azimuthal surface anchoring energy, and thus the stable twist structure is obtained under an electric field.

**LCTp2 - 4L     Switching Behavior of Bistable Liquid Crystal Cells Fabricated by Microrubbing**

*M. Honma, T. Nose*  
*Akita Pref. Univ., Japan*

A microrubbing cell with a spatially distributed twist angle is proposed for bistable LC optical devices. One state is generated by heating the cell up to the clearing point and then cooling. Another state is induced by a sufficiently high voltage application. These two states are switched repeatedly at will.

**LCTp2 - 5L     Preferred Crystalline Orientation of Rubbed Polyimide Film**

*I. Hirose, T. Koganezawa, H. Ishii\**  
*Japan Synchrotron Radiation Res. Inst., Japan*  
*\*Nissan Chem. Inds., Japan*

Grazing incidence X-ray diffraction experiment proved that the a- and c-axes of PMDA-ODA crystals at the annealed films preferentially aligned in normal and parallel directions to rubbing, and that surface polymer chains aligned in rubbing direction.

<b>9:00 - 12:00</b>	<b>Room 222-224</b>
<b>Poster LCTp3: LC Evaluation</b>	

**LCTp3 - 1     Analysis the Interlace Image Sticking at FFS-Mode**

*Y. B. Lee, H. Z. Liang, K. H. Park, Y. T. Yang, J. L. Liu,*  
*S. K. Lee*  
*BOEHF, China*

This paper introduced a kind of image sticking caused by interlace scanning in the television system at FFS Mode. The relation between the image sticking and polyimide materials has been studied. The results indicated that the low resistivity polyimide have good characteristic for interlace image sticking.

**LCTp3 - 2      Dynamic Analysis of LCD**

*A. Kunii, H. Seki*

*Hachinohe Inst. of Tech., Japan*

Field sequential color liquid crystal display (FSC-LCD) has merits of low power consumption and high resolution. The evaluation method of a dynamic characteristic of the FSC-LCD is developed. The method is based on a slit scan method. The display image is developed to two dimensional image data with time-space.

**LCTp3 - 3      Surface Analysis of Polyimide-Less LC Alignment by Dissolving Dendrimer**

*Y. Momoi, K. Furuta, M. Kwak<sup>\*</sup>, T. Koda<sup>\*\*</sup>, O. Haba<sup>\*\*</sup>, K. Yonetake<sup>\*\*</sup>*

*LG Display, Japan*

*<sup>\*</sup>LG Display, Korea*

*<sup>\*\*</sup>Yamagata Univ., Japan*

LCT

It has been proposed that liquid crystal (LC) was aligned vertically by dissolving dendrimer without polyimide (PI). We tried to analyze the alignment by dendrimer with TOF-SIMS and SEM observation. We found that dendrimer molecules are adsorbed on the glass surface uniformly and the layer thickness was less than 30 Å.

**LCTp3 - 4      Analysis of the Surface of Alignment Film within IPA Solution Using AFM**

*M. Kwak, J. Jeon, K. Kim, Y. Yi, D. Choi, Y. Choi, K. Jeong*

*LG Display, Korea*

In order to compare isopropyl alcohol adsorption on the alignment film, it was measured inside of a solution using AFM. There was no change on surface in pure water but the surface form was created high in isopropyl alcohol caused by alcohol, and it was measured in real time.

**LCTp3 - 5      A Method for Measuring Leslie Viscosity Coefficients and Dielectric Anisotropy of n-type Nematic LCs from Transient Current Using a Genetic Algorithm**

*M. Oka, Y. Iwata, H. Naito, M. Inoue<sup>\*</sup>, H. Ichinose<sup>\*\*</sup>, M. Klasen-Memmer<sup>\*\*\*</sup>, K. Tarumi<sup>\*\*\*</sup>*

*Osaka Pref. Univ., Japan*

*<sup>\*</sup>TOYO, Japan*

*<sup>\*\*</sup>Merck, Japan*

*<sup>\*\*\*</sup>Merck, Germany*

We have measured the Leslie viscosity coefficients and dielectric anisotropy by fitting the analytical expressions for transient current to the experimental data using a newly developed algorithm. This algorithm is based on a genetic algorithm, Levenberg-Marquardt method and golden section method.

**LCTp3 - 6 High Precision Measurement of Twist Elastic Constant  $K_{22}$  of LC Materials Based on New Ellipsometry Analysis**

*T. Ishinabe, Y. Morita, Y. Ohno, T. Miyashita\*, T. Uchida\*\**

*Tohoku Univ., Japan*

*\*Tohoku Inst. of Tech., Japan*

*\*\*Sendai Nat. College of Tech., Japan*

A simple and accurate method for measuring the twist elastic constant  $K_{22}$  of LC materials was devised. We proposed a novel technique, based on ellipsometry analysis, to determine the director profile of TN cell in the on-state, and successfully obtained the value of  $K_{22}$  with a high degree of accuracy.

9:00 - 12:00

Room 222-224

**Poster LCTp4: Display Mode**

**LCTp4 - 1 Comparison of the Process Margin between FFS and IPS Mode**

*K. H. Park, Y. B. Lee, R. Zhang, Z. H. Zhang, X. B. Yin, S. Wang, S. K. Lee*

*BOEHF, China*

ITO CD, rubbing angle and polarizer angle dependent characteristics in the FFS mode have been studied by using LC simulator (TechWizLCD 2D). We confirmed that the FFS Mode's process margin is better than IPS mode.

**LCTp4 - 2 The Novel Design for Improved Off-Axis Gamma Curve in Vertically Aligned LC Cell**

*D. E. Lim, W. S. Kang, B. J. Mun, S. Y. Hur, G. D. Lee*

*Dong-A Univ., Korea*

We propose a novel optical compensation structure, which shows eliminating light leakage in the dark-state for wide viewing angle, as well as featuring that it can control the middle gray level transmittance so that it decreases off-axis gamma distortion in the vertically aligned (VA) liquid crystal (LC) cell.

**LCTp4 - 3 Electro-Optic Response of a Nematic Bent Core LC**

*O. Elamain\*, G. Hegde\*, \*\*, K. Fodor-Csorba\*\*\*, L. Komitov\**

*\*Gothenburg Univ., Sweden*

*\*\*Univ. Malaysia Pahang, Malaysia*

*\*\*\*Hungarian Ac. of Sci., Hungary*

Electro-optic effect exhibited by a bent core liquid crystal (BCLC) under an applied dc electric field where molecules of the material under study are aligned parallel to the rubbing direction of the alignment layer is reported. Very high quality dark state was found with small cell gap (about 2  $\mu\text{m}$ .)

**LCTp4 - 4      Effect of Stacked Alignment Layer to the Response Time of Vertical Aligned LC Mode**

*S. I. Jo, Y.-J. Lee, J. H. Park\*, H. Lee\*, S.-T. Shin\*,  
C.-J. Yu, J.-H. Kim*

*Hanyang Univ., Korea*

*\*Samsung Elect., Korea*

We studied about the effect stacked alignment layer to the response time of vertical alignment (VA) mode. The response time characteristic of the rubbed VA mode is dramatically improved by adopting the stacked alignment system in high field region due to the enhanced azimuthal anchoring energy.

**LCTp4 - 5      Chiral Hybrid In-Plane Switching LC Mode with the Stable Domain by the Alignment Layers Mixed with Reactive Mesogen**

*Y. E. Kang, K. S. Bae, Y. J. Lee, J. H. Kim, K. H. Kim\*,  
J. W. Heo\*, C. J. Yu*

*Hanyang Univ., Korea*

*\*Samsung Elect., Korea*

We report an advanced chiral hybrid in-plane switching (CH-IPS) liquid crystal mode using the mixed vertical alignment layer with ultraviolet curable reactive mesogen (RM). The stable CH-IPS mode was obtained by the improved azimuthal anchoring energy due to the polymerized RM on the layer.

**LCTp4 - 6      3D LCD with Single Polarizer and Patterned Retarder Structure**

*J.-H. Jeong, K.-S. Bae, J.-H. Kim, C.-J. Yu*

*Hanyang Univ., Korea*

We present a three dimensional (3D) liquid crystal display (LCD) in a stereoscopic type using the single-polarizer LCD and in-cell patterned retarder. To construct 3D images in single-polarizer LCD with the microlens array, the micro-patterned retarder embedded the LCD generates two orthogonal polarizations.

**LCTp4 - 7      Withdrawn**

**LCTp4 - 8      Bistable Reflective Cholesteric-Blue Phase LCD**

*T.-H. Lin, C.-T. Wang, H.-C. Jau*

*Nat. Sun Yat-sen Univ., Taiwan*

The study investigates the thermal hysteresis in the phase transition between the cholesteric liquid crystal and the blue phase of liquid crystal. Both the CLC phase and the blue phase can stably exist at room temperature and be switched to each other using temperature-controlled processes.



**LCTp4 - 9 Improvement of TN-LCD  $\tau_{\text{off}}$  Value by Using Ultra Short Pitch (USP) LC Materials**

*K. Takatoh, A. Harima, Y. Kodama, Y. Kaname,  
M. Akimoto*

*Tokyo Univ. of Sci. Yamaguchi, Japan*

The new method to fabricate fast TN-LCDs by making LC material pitch length shorter than twice of the cell width was found. TN-LCDs could not have been fabricated in this condition because of STN formation. By our method, TN-LCDs with short pitch length could be formed.

**LCTp4 - 10 Withdrawn**

**LCTp4 - 11 Different p/d Ratios Lead to Different Twisted LC Configurations in Reverse Twisted Nematic LCD**

*M. Akimoto, S. Minami, M. Sannomiya, S. Kobayashi,  
K. Takatoh*

*Tokyo Univ. of Sci. Yamaguchi, Japan*

It is found that different twisted LC configurations of director are realized by applying an ac electric voltage to a 90 degree splayed twist nematic LCD, as varying the chiral pitch-to-cell gap (p/d) ratio. At sufficiently large p/d, the RTN-LCD is obtained, whereas smaller p/d leads to a STN-LCD.

**LCTp4 - 12 Fabrication of Monostable PS-V-FLC Photocured in Sma Phase**

*M. Tamura, M. Amano, S. Oka\*, S. Komura\*,  
S. Kobayashi\*\*, H. Furue*

*Tokyo Univ. of Sci., Japan*

*\*Hitachi Displays, Japan*

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

Polymer-stabilized ferroelectric liquid crystals photocured in Sma phase can show monostable V-shaped electrooptical characteristics. In this study, we have researched the dependence of the electrooptical characteristics on materials, polymer concentration and etc. As a result, it is found that the degradation of the bistability strongly depends on their conditions.

**LCTp4 - 13L High Transmittance Multi-Domain VA LCD**

*E.-Y. Jeon, K.-H. Kim, B. W. Park, D. H. Song, J.-H. Lee,  
G. S. Lee\*, K.-C. Shin\*, H. S. Kim\*, T.-H. Yoon*

*Pusan Nat. Univ., Korea*

*\*Samsung Elect., Korea*

We propose a multi-domain vertical alignment liquid crystal display with high optical efficiency. We form a protrusion on the top substrate to reduce the width of disclination lines at domain boundaries and confirm that the transmittance can be increased from 22.9% to 25.3%.

**LCTp4 - 14L Wide Viewing Angle LCD with Low Cost and Low Power Consumption**

*Y. Haruyama, M. Yoshiga, M. Shibazaki  
Chimei Innolux, Japan*

We have optimized all LCD components, such as backlight system, LC driving condition and optical foils, in order to realize wide viewing angle LCD with low cost and low power consumption. We confirmed that small color shift, small gamma shift and high contrast ratio could be achieved.

**LCTp4 - 15L Wide Viewing Angle VA LCD Using Dichroic Dyes**

*H. Jin, K.-H. Kim, J.-H. Lee, T.-H. Yoon  
Pusan Nat. Univ., Korea*

By mixing dichroic dyes with LCs, the obliquely incident light is absorbed in our device, by which we can reduce the off-axis light leakage at the dark state with little loss of the on-axis brightness. We expect that the proposed device can be used widely.

**LCTp4 - 16L Bistable LCD of Twisted Direction Switching Mode by Using Prism-Shaped Periodic Micro Grating Structure Surface**

*Y. Ohike, Y. Toko\*, T. Takahashi  
Kogakuin Univ., Japan  
\*Stanley Elec., Japan*

This LCD mode was required the high pretilt angle under some conditions. A novel method to obtain the high pretilt angle was proposed by using the periodic micro prism-shaped structure. A good contrast ratio and the improvement of viewing angle characteristic were obtained in our bistable LCD cell.

**LCTp4 - 17L Vertically-Aligned Bistable Nematic LCD Device**

*M.-G. Jo, J. H. Lee\*, D. H. Song, T.-H. Yoon  
Pusan Nat. Univ., Korea  
\*LG Display, Korea*

We propose a chiral-doped vertically aligned bistable nematic LCD device, which can be switched between the vertically aligned state and the  $2\pi$  homeotropic-focal conic state. Switching between the two stable states can be performed by applying an in-plane electric field and vertical electric field.

**LCTp4 - 18L Optical Design for Reflective Dual Mode Liquid Crystal Display with Infinite Memory Time and High Contrast Ratio**

*T. Kim, J. H. Lee<sup>\*</sup>, S. Kim, T.-H. Yoon<sup>\*\*</sup>, S.-W. Choi*

*Kyung Hee Univ., Korea*

*<sup>\*</sup>LG Display, Korea*

*<sup>\*\*</sup>Pusan Nat. Univ., Korea*

We propose an optical design for reflective dual mode liquid crystal display that has infinite memory time and high contrast ratio.  $-\pi$  twist state is used as a common dark state in both memory and dynamic mode. In simulation, it shows good contrast ratio over 900:1.

**LCTp4 - 19L Rewritable Long-Pitch Cholesteric LC Device**

*Z.-G. Shen, K.-H. Kim, J.-H. Lee, T.-H. Yoon*

*Pusan Nat. Univ., Korea*

We propose a cholesteric liquid crystal (ChLC) device that reflects infrared light in the planar state by long-pitch structure. We can write text messages on the proposed ChLC device by applying an external pressure locally to switch it from the focal conic state to the planar state.

**LCTp4 - 20L Multi-Color Cholesteric Liquid Crystal Displays Using Continuous Air-Extracting Cell Filling Technique**

*M.-C. Liu, C. M. Hsu, W.-T. Wu*

*Southern Taiwan Univ., Taiwan*

Red, green and blue cholesteric liquid crystals have been successfully filled into individual cells using a continuous air-extracting (CAE) technique. The cells can operate at normal by-stable states with a highest contrast ratio of 9. Results suggest full color cell filling for roll-to-roll processing is possible with the CAE technique.

**LCTp4 - 21L Fabrication of Porous Polymer Films for PDLC Type of Liquid Crystal Devices**

*T. Ito, Y. Ito, R. Ito, M. Honma, T. Watanabe<sup>\*</sup>, K. Ito<sup>\*</sup>,  
S. Yanagihara<sup>\*</sup>, T. Nose*

*Akita Pref. Univ., Japan*

*<sup>\*</sup>Yurikogyo, Japan*

Porous polymer films are prepared by spin coating PMMA/ethanol/water solution to attain large scale of LC devices for MMW/THz control. LC-porous polymer film components like PDLC can be obtained by impregnating with LC materials to the films and change of transmittance is observed by applying voltage.

**LCTp4 - 22L Study on Polymer-Stabilized Twisted Nematic LCD for Shutter Glasses Application**

*S. Ogiri, M. Kanai, H. Ichinose, H. Numata  
Merck, Japan*

For twisted nematic-LCD, lower driving voltage or shorter response time was realized by optimization of a UV curable reactive mesogen monomer and applied voltage during polymer-stabilized process. This technique can be applicable to shutter glasses for 3D LCD.

**LCTp4 - 23L Patterned Liquid Crystal Alignment Based on Nanoparticle-Doped Polymer Films**

*K.-T. Cheng, A. Y.-G. Fuh, C.-K. Liu, Y.-D. Chen  
Nat. Cheng Kung Univ., Taiwan*

This experimental results indicate that illuminating a nanoparticle-doped pre-polymer film, coated onto a substrate having a homogeneous alignment layer, with unpolarized UV light through a photomask causes the polymerization of pre-polymer, ultimately generating homogeneous and vertical alignment layers in unpolymerized and polymerized regions, respectively.

**LCTp4 - 24L Silica Nanoparticle-Doped Twisted Pi Cell**

*C.-W. Chang, C.-C. Kuo, C.-Y. Huang, H.-C. Song  
Nat. Changhua Univ. of Education, Taiwan*

We fabricate a silica nanoparticle-doped twisted pi cell. With AC high voltage, the LCs near the substrates are distorted and create a lifting force, which accumulates the silica nanoparticles on the substrate. After turning off the AC voltage, the accumulated nanoparticles support the LCs in the twisted pi state.

**LCTp4 - 25L Fast Switching Mechanism of the Silica Nanoparticle-Doped Liquid Crystal Devices**

*C.-Y. Huang, M.-H. Wu, C.-C. Kuo, W.-C. Chien,  
C.-T. Hsieh  
Nat. Changhua Univ. of Education, Taiwan*

We investigate switching mechanisms of the silica nanoparticle-doped (SND) liquid crystal (LC) cell. The doped silica nanoparticles introduce disorder to LCs, decreasing the order parameter of the LCs. The decreased order parameter decreases the rotational viscosity of the LCs, decreasing the response time of SND HAN cell.

**LCTp4 - 26L Thermal Stability of Gray-Scale Levels on Optical Rewritable Electronic Paper**

*L. Wang, J. Sun, A. Srivastava, V. Chigrinov  
Hong Kong Univ. of S&T, Hong Kong*

The thermal stability of the gray-scale levels on the optical rewritable (ORW) electronic paper is checked by heating the cell with different temperatures for 3 minutes respectively. It shows that the gray-scale levels on ORW after being heated will return to the previous state, which shows a memory effect.

**9:00 - 12:00**

**Room 222-224**

**Poster LCTp5: LC Application**

**LCTp5 - 1 A Study of Compensation Method of LC Optics Applied to Blue Ray Disc Optics**

*C.-T. Yen, J.-H. Hsu, Y.-C. Fang\*, C.-M. Tsai, G.-Y. Huang  
Nat. Formosa Univ., Taiwan  
\*Kun Shan Univ., Taiwan*

A new optical design and compensation method of Blu-ray pick up head system with liquid crystal (LC) lens was proposed. LC optics delivers fast compensation through optical design when errors occur. The simulation results show that aberrations are eliminated up to 46% compared to traditional ones.

**LCTp5 - 2 Determination of Amplitudes and Frequency of Driving Voltages for LC Lens**

*M. Ye, B. Wang, M. Uchida, S. Yanase, H. Kunitsuka,  
S. Takahashi, S. Sato  
Akita Ind. Tech. Ctr., Japan*

The properties of the liquid crystal lens proposed recently by the authors depend on not only the amplitudes but also the frequency of the applied voltages. The optical aberrations of the lens are analyzed, and appropriate amplitudes and frequency to ensure low aberrations and wide focus range are determined.

**Supporting Organization:**

The Japanese Liquid Crystal Society (JLCS)

**SID 2012**

International Symposium, Seminar and Exhibition

June 3-8, 2012

Boston, Massachusetts, U.S.A.

# Workshop on Active Matrix Displays

Wednesday, December 7

14:00 - 17:00

Room 222-224

## Poster AMDp: Active-Matrix Devices

### AMDp - 1 Magnetic-Field Area Sensor Using Poly-Si Hall Devices: Static and Real-Time Area Sensing

Y. Yamaguchi<sup>\*</sup>, H. Hashimoto<sup>\*</sup>, T. Segawa<sup>\*</sup>, D. Tadokoro<sup>\*</sup>,  
M. Kimura<sup>\*,\*\*</sup>

<sup>\*</sup>Ryukoku Univ., Japan

<sup>\*\*</sup>Joint Res. Ctr. for S&T, Japan

We have developed a magnetic-field area sensor using poly-Si Hall devices. Hall effect in these devices has been evaluated to apply to our sensor. We have succeeded real-time area sensing of the magnetic-field varying with time using our devices connected to the multi-plexer measurement unit and lap-top computer.

### AMDp - 2 Extraction Technique of Trap Densities in Thin Films and at Insulator Interfaces of Thin-Film Transistors

M. Kimura<sup>\*,\*\*,\*\*\*</sup>

<sup>\*</sup>Ryukoku Univ., Japan

<sup>\*\*</sup>Joint Res. Ctr. for S&T, Japan

<sup>\*\*\*</sup>High-Tech. Res. Ctr., Japan

We have developed an extraction technique of trap densities in thin films and at insulator interfaces of TFTs. They are separated from C-V and I-V characteristics by numerically calculating physical equations. Those in the entire band gap are extracted from n- and p-type TFTs. Actual ones are extracted for HTPS-TFTs.

### AMDp - 3 High Hole Mobility Exceeding 4 cm<sup>2</sup>/Vs in Top-Gate C<sub>8</sub>-BTBT Field-Effect Transistors Processed by Spin Coating

F. Mochizuki<sup>\*</sup>, T. Endo<sup>\*</sup>, T. Nagase<sup>\*,\*\*</sup>, T. Kobayashi<sup>\*,\*\*</sup>,  
K. Takimiya<sup>\*\*\*</sup>, M. Ikeda<sup>\*\*\*\*,\*\*\*\*\*</sup>, H. Naito<sup>\*\*\*</sup>

<sup>\*</sup>Osaka Pref. Univ., Japan

<sup>\*\*</sup>RIMED, Japan

<sup>\*\*\*</sup>Hiroshima Univ., Japan

<sup>\*\*\*\*</sup>Nippon Kayaku, Japan

<sup>\*\*\*\*\*</sup>Kyusyu Univ., Japan

We have fabricated 2,7-dioctyl[1]benzothieno [3,2-b][1]benzothiophene (C<sub>8</sub>-BTBT)-based organic field-effect transistors (OFETs) with top-gate configurations having fluoropolymer gate insulators by spin-coating processes. Top-gate OFETs with spin-coated polycrystalline C<sub>8</sub>-BTBT films exhibit high maximum field-effect mobility of 4.1 cm<sup>2</sup>/Vs and low average threshold voltage of -7.0 V.

**AMDp - 4      Stability of Offset-Biased Integrated Gate Driver Circuit Using a-IGZO TFT for 240Hz 18.5-in. FHD TFT-LCD**

*Y. H. Jang, S. C. Choi, W. S. Choi, J. Y. You, T. W. Moon, J. H. Kim, H. N. Cho, C. K. Lee, S. B. Ryu, K.-S. Park, C.-D. Kim, M. Jun, Y. K. Hwang*

*LG Display, Korea*

The stability of offset-biased a-IGZO TFT gate driver integrated in 240 Hz FHD LCD was investigated. The circuit has separate ground nodes with different low level voltages and can be operated in DC/AC mode selectively. The effect of bias offset and driving mode on the stability during 60°C operation is presented.

**AMDp - 5      Withdrawn****AMDp - 6      Withdrawn****AMDp - 7      Effects of Gate Dielectrics on the Performance and Stability of Non-Implanted LTPS TFTs**

*S.-P. Weng, C.-C. Kao, H.-H. Hsieh, C.-S. Chuang, J. Wu, Y. Lin*

*AU Optronics, Taiwan*

LTPS TFTs with top-gate structures were fabricated without traditional implantation processes. The effects of gate dielectrics on the performance and stability of these devices were specifically investigated. It was found that the insertion of silicon nitride in the gate dielectrics significantly benefits the overall device characteristics.

**AMDp - 8      A High-K  $\text{Er}_2\text{Ti}_2\text{O}_7$  Gate Dielectric for Amorphous InGaZnO TFT Applications**

*F.-H. Chen, S. Mondal, Y.-H. Shao, K.-S. Wang, T.-M. Pan*

*Chang Gung Univ., Taiwan*

We developed a high-k  $\text{Er}_2\text{Ti}_2\text{O}_7$  gate dielectric for amorphous indium-gallium-zinc oxide thin-film transistor ( $\alpha$ -IGZO TFT) at various annealing temperatures. The high-k  $\text{Er}_2\text{Ti}_2\text{O}_7$   $\alpha$ -IGZO TFT device annealed at 400°C exhibited better electrical characteristics in terms of a large effective carrier mobility, high-driving current, low-threshold voltage, and high  $I_{\text{on/off}}$  ratio.

## SID 2012

International Symposium, Seminar and Exhibition

June 3-8, 2012

Boston, Massachusetts, U.S.A.

### AMDp - 9 Effects of Argon Plasma Irradiation on Amorphous In-Ga-Zn-O Film Evaluated by Microwave Photoconductivity Decay Method

S. Yasuno<sup>\*,\*\*</sup>, T. Kita<sup>\*\*</sup>, S. Morita<sup>\*\*\*</sup>, K. Hayashi<sup>\*\*\*</sup>,  
T. Kugimiya<sup>\*\*\*</sup>, S. Sumie<sup>\*</sup>

<sup>\*</sup>Kobelco Res. Inst., Japan

<sup>\*\*</sup>Kobe Univ., Japan

<sup>\*\*\*</sup>Kobe Steel, Japan

Microwave photoconductivity decay method was applied to evaluate the effects of Ar<sup>+</sup> plasma irradiation on a-In-Ga-Zn-O films. The peak reflectivities of photoconductivity response obtained after various Ar<sup>+</sup> plasma exposure time were correlated with transistor characteristics. With Ar<sup>+</sup> plasma irradiation, the peak reflectivity decreases in accordance with degradation of transistor characteristics.

### AMDp - 10 The Effect of the Adsorbed Water Molecules on the Soluble Processed Zinc Tin Oxide Thin Film Transistors

D. H. Kim, S. B. Yoon, Y. T. Jeong<sup>\*</sup>, Y. M. Kim<sup>\*</sup>, B. S. Kim<sup>\*</sup>,  
M. P. Hong

Korea Univ., Korea

<sup>\*</sup>Samsung Elect., Korea

AMD

We investigated the electrical performance of soluble zinc tin oxide thin film transistors when their channel layer is exposed to air, oxygen and moisture. In this research, we observed that adsorption of H<sub>2</sub>O on the back-channel surface can act as electron trap or/and donor, depending on the amount of H<sub>2</sub>O.

### AMDp - 11 5-in. AMOLED Driven by High Stability In-Zn-Oxide Thin-Film Transistors

M. Xu<sup>\*,\*\*</sup>, J. Zou<sup>\*,\*\*</sup>, D. Luo<sup>\*,\*\*</sup>, M. Li<sup>\*,\*\*</sup>, H. Xu<sup>\*,\*\*</sup>,  
L. Lan<sup>\*,\*\*</sup>, W. Wu<sup>\*,\*\*</sup>, H. Tao<sup>\*,\*\*</sup>, R. Xu<sup>\*,\*\*</sup>, J. Peng<sup>\*,\*\*</sup>,  
L. Wang<sup>\*,\*\*</sup>

<sup>\*</sup>South China Univ. of Tech., China

<sup>\*\*</sup>Guangzhou New Vision Opto-Elect. Tech., China

In-Zn-Oxide TFTs backplane, with amorphous AlO<sub>x</sub> as gate insulator, Mo-Al-Mo as SD electrodes, SiO<sub>2</sub> as passivation layer, is presented. The TFT backplane shows good electrical performance and high stability of V<sub>th</sub> under negative/positive bias stress. A 5-in. bottom emission AMOLED driven by this kind of TFT panel is demonstrated.



**AMDp - 12      Electrical Performance and Photo-Responses Enhancement by In-Situ Nitrogen Incorporation to Amorphous InGaZnO Thin-Film Transistors**

*L.-F. Teng, P.-T. Liu, C.-S. Fuh, Y.-T. Chou, F.-H. Li, C.-H. Chang, H.-P. D. Shieh*

*Nat. Chiao Tung Univ., Taiwan*

We studied wavelength dependent photo-responses in amorphous nitrogenated InGaZnO thin-film transistors (a-IGZO:N TFTs). The a-IGZO:N active layer was deposited by dc reactive sputter with a nitrogen and argon gas mixture at room temperature and performed the superior characteristics while comparing with the intrinsic IGZO TFTs.

**AMDp - 13      Fabrication and Electrical Properties of Chemical Bath Deposited CdS-Based Transparent Thin-Film-Transistors**

*J.-H. Kwon, J.-S. Ahn, H. Yang*

*Hongik Univ., Korea*

Using CdS film synthesized by a chemical bath deposition, transparent thin-film-transistors were fabricated with a bottom-gate scheme of glass/ITO/SiN<sub>x</sub>/CdS/Al. After annealing as-grown CdS at 350°C, fabricated transparent TFT exhibited a saturated field effect mobility of 0.7 cm<sup>2</sup>/V·s, a threshold voltage of 11.3 V and an on/off ratio of ~10<sup>7</sup>.

**AMDp - 14      Negative High Voltage Generator Using a Level Shifter with Booster Functions for TFT-LCD**

*K. Hayasida, M. Yoshida*

*Tokai Univ., Japan*

In this paper, a negative high voltage generator using a level shifter with booster functions for TFT-LCD is proposed. To verify electrical characteristics of the proposed circuit, the circuit analysis is carried out. The power efficiency of the proposed circuit is about 61%.

**AMDp - 15      Enhancement of Charge Mobility in Solution-Processed Organic Field-Effect Transistors Using Top-Gate Configurations**

*T. Nagase, K. Takagi, T. Kobayashi, T. Kushida\*, H. Naito*

*Osaka Pref. Univ., Japan*

*\*Teijin, Japan*

We have investigated charge transport in poly(3-hexylthiophene) (P3HT)-based OFETs using top-gate, bottom-gate, and double-gate configurations. Top-gate P3HT OFETs exhibit high field-effect mobilities, which are almost independent of the type of gate insulators and the surface energy of substrates, demonstrating that the performance of solution-processed OFETs is enhanced using top-gate configurations.

**AMDp - 16     A 12-bit Segmented DAC with a Serial Voltage Adder for AMLCD Column Drivers**

*J.-S. Lee, J.-Y. Bae, S.-K. Han, S.-G. Lee  
KAIST, Korea*

A 12-bit linear segmented type DAC for application to AMLCD column drivers is presented. The proposed DAC includes a global resistor string, six 2-bit sub-DACs, and a serial voltage adder. The serial voltage adder can generate final voltage in only three cycles through use of the charge subtraction concept.

**AMDp - 17     A Study of Novel Simulation Technology about Shift Resister Circuit in AMLCD Panel**

*H. Choi, S.-K. Han, J.-Y. Kim, S.-W. Jeong, K.-H. Moon,  
Y.-S. Choi, K.-D. Jeong  
LG Display, Korea*

We have been developed a novel simulation technology about shift resister circuit in AMLCD panel. It was first proposed in attempts to meet the rising the prediction of circuit operating characteristics. The proposed simulation technology could be realized not only full circuit simulation but also prediction accuracy of circuit characteristics.

**AMDp - 18     Withdrawn**

**AMDp - 19     Excellent Behavior of Nanocrystalline Silicon Thin Film Transistors for AMOLED Display Application**

*H.-C. Lin, K.-Y. Ho, H.-S. Dai, H.-Y. Chuang, C.-C. Hsu,  
C.-W. Lin, B.-C. Kung, J.-Y. Yan  
ITRI, Taiwan*

Nanocrystalline silicon thin film transistors with a negative threshold voltage and a high off current are a big issue for AMOLED display application. This issue can be solved and the reason is proved in this study. One 6-in. AMOLED display with nc-Si TFT arrays is also demonstrated.

**AMDp - 20     Effect of the Vacuum Seasoning Process on Poly 4-Vinyl Phenols (PVPs) as Organic Gate Dielectric in All Solution-Processed Organic Thin-Film Transistors**

*D. W. Kim, H. J. Kim, H. W. So, M. P. Hong  
Korea Univ., Korea*

We have evaluated to eliminate the polar component on the interface of organic gate insulator using a vacuum seasoning. The soluble OTFT processed by as a vacuum seasoning process presented much improved electrical characteristics as lower threshold voltage shifts, stiffer sub-threshold swing of few mV and near zero voltage turning-on.

**AMDp - 21    An Advanced a-Si TFT Gate Driver for Three Level Driving Application**

*J. H. Lu, H. L. Zheng, C.-T. Liao, T.-C. Chung, T.-S. Jen  
Infovision Optoelect., China*

A novel circuit with high reliability which was implemented to GIA for reducing the cost of TFT-LCD was proposed. It could output the three-level waveform. By implementation of this driving scheme with GIA circuit integrated into TFT array, high reliability, low cost and high aperture ratio could be achieved simultaneously.

**AMDp - 22    Electrical Properties of a-IGZO Thin Film Transistors with Tetraethylorthosilicate (TEOS) Based SiO<sub>2</sub> Gate Insulator Layer**

*Y. H. Choi, S. M. Lee, C. I. Ryoo, J. W. Park, J. S. Han,  
K. Y. Yun, K. H. Seo, D. W. Kim, Y. Y. Kim, I. K. Kang,  
Y. J. Koh, D. M. Han, H. S. Seo, B. C. Kim, S. Y. Cha  
LG Display, Korea*

We investigated the influence of TEOS based SiO<sub>2</sub> gate insulator layer on the characteristics of a-IGZO thin film transistors (TFTs). The device characteristics were found to be sensitive to deposition conditions of gate insulator layer such as gas flow rate, temperature, and pressure. We have reduced threshold voltage shift of a-IGZO TFTs under positive bias temperature stress.

**AMDp - 23    Investigation of the Degradation Mechanism in 5-Mask Polycrystalline Silicon TFTs**

*M.-Y. Chen, M.-H. Lee, C.-Y. Huang, P.-M. Chen,  
C.-T. Peng, W.-M. Huang  
AU Optronics, Taiwan*

The device degradation of 5-mask polycrystalline silicon thin-film transistors operates in diode-mode was investigated. Trap states create near gate-source junction when the device works under high reverse electric field condition. Treatment at the GI/poly-Si interface is proven as an effective way to improve the device reliability.

**AMDp - 24    Solution-Processed Zinc Tin Oxide Thin Film Transistor with Metallic Interlayer**

*J. S. Lee, W. J. Chung, M.-J. Cha, J.-M. Hong, Y. J. Lee,  
Y.-J. Kwack, W.-S. Choi  
Hoseo Univ., Korea*

The effect of metallic interlayer, MoO<sub>3</sub>, for the source and drain metal in inkjet processed zinc tin oxide (ZTO) thin-film transistor was investigated. The improved electrical properties were obtained. The hysteresis behavior and bias stability with interlayer was also investigated and compared with the spin-coated ZTO TFT.

**AMDp - 25 Improvement of the Field Effect Mobility by the Nano-Scale Structure on Organic Thin Film Transistor**

*H. Jung, S. I. Jo, J. S. Choi\*, C.-J. Yu, J.-H. Kim*

*Hanyang Univ., Korea*

*\*Hongik Univ., Korea*

We investigate an effect of nano-scale structures onto an insulating layer in organic thin-film transistor (OTFT). The electrical performance of OTFT could be improved by using source/drain nano-scale structures. The nano-scale structure reduces the contact resistance and thus improves the device performances.

**AMDp - 26 A Method to Reduce Self-Heating Effect in a-Si TFT Circuit Applications**

*C.-Y. Yang, S.-C. Huang, C.-Y. Lin, H.-L. Chiu,  
C.-H. Chen*

*AU Optronics, Taiwan*

In this paper, the self heating effecting a-Si TFT is investigated. First, the self heating effect on the large-width a-Si TFT, composed of different unit cell width, is studied. The self heating effect on the a-Si TFT with different channel length is further discussed. Based on the results of these two topics, a method is proposed so that the reliability against self heating effect is improved for the large-width a-Si TFTs.

**AMDp - 27 Withdrawn**

**AMDp - 28 Temperature Dependence of Poly-Si TFT Characteristics Fabricated by Advanced Solid Phase Crystallization**

*H. S. Song<sup>\*,\*\*</sup>, T. Noguchi<sup>\*</sup>, K. Shirai<sup>\*</sup>, B. S. Bae<sup>\*\*</sup>,  
H. M. Koo<sup>\*\*\*</sup>, H. S. Choi<sup>\*\*\*</sup>*

*<sup>\*</sup>Univ. of the Ryukyus, Japan*

*<sup>\*\*</sup>Hoseo Univ., Korea*

*<sup>\*\*\*</sup>LG Display, Korea*

The device parameters were deduced from the p-type Si TFTs fabricated by ASPC. As a result of temperature dependence of the TFT characteristics, the threshold voltage increased and the hole mobility decreased with increase in the temperature. The conduction behavior is discussed by the device parameters based on trap states density.

## IDW Best Paper Award

This award will go to the most outstanding paper selected from those presented at IDW '11.  
The 2011 award winners will be announced on the IDW website: <http://www.idw.ne.jp/award.html>

**AMDp - 29      Effects of Li Doping on the Performance of Solution Processed ZnO Thin Film Transistors**

*B.-Y. Su, S.-Y. Chu, Y.-D. Juang\**

*Nat. Cheng Kung Univ., Taiwan*

*\*Nat. Univ. of Tainan, Taiwan*

In this paper, lithium (Li) doping on the performance of solution processed zinc oxide (ZnO) thin film transistors (TFTs) . However, the ZnO TFTs showed good electric characteristic of Ion / Ioff ratio over  $10^5$  with reasonable field-effect Mobility of  $1.5 \text{ cm}^2 / \text{V s}$ .

**AMDp - 30      Withdrawn**

**AMDp - 31L      A Novel Technology for a-Si TFTs with High Aperture Ratio**

*W.-Y. Lo, M.-S. Chen, W.-M. Huang*

*AU Optronics, Taiwan*

We have produced high aperture ratio and low power consumption a-Si TFT's panels, that we called "Hyper LCD". Just adjusted BCE process of a-Si, we can produce high performance LCD panel as good as made by LTPS. We preserved the advantages of high throughput and high yield of a-Si TFTs.

**AMDp - 32L      AC Gate-Drain-Bias Stress Study of a-Si Thin Film Transistors**

*C.-Y. Yang, S.-C. Huang, H.-L. Chiu, J.-S. Lin, C.-H. Chen*

*AU Optronics, Taiwan*

The reliability behavior of a-Si TFT under AC gate and drain bias stress is investigated. The duty ratio effect of AC gate pulse with the drain bias stress is studied. It is discovered that higher duty ratio causes worse  $V_{th}$  shift. Such behavior can be attributed to the accumulation of stress time and the effect of such behavior is discussed.

**AMDp - 33L      IR-Drop Compensation for Large Size AMOLED**

*B.-J. Sun, C.-H. Huang, K.-Y. Chen, S.-C. Huang*

*Chunghwa Picture Tubes, Taiwan*

The power degradation of AMOLED pixel circuit has improved with short programming method. This work has proposed a new pixel circuit for AMOLED, and the IR-drop effect decreased 35% at least comparing with conventional AMOLED pixel circuit. And, the pixel circuit is implemented with all p-type thin film transistors.

**AMDp - 34L Hydrogenation in Self-Aligned Metal Double-Gate LT Poly-Si TFTs**

*Y. Shika, Y. Okabe, H. Ogata, K. Kondo, A. Hara  
Tohoku Gakuin Univ., Japan*

We investigated the hydrogenation of LT poly-Si TFTs in terms of the gettering phenomena using high-performance self-aligned metal double-gate LT poly-Si TFTs. Our results show that the most effective hydrogenation temperature is between 370°C and 350°C.

**AMDp - 35L Characteristic Evaluation of an Operational Amplifier Using Poly-Si Thin-Film Transistors**

*Y. Ito, Y. Imuro, Y. Yamaguchi, M. Kimura  
Ryukoku Univ., Japan*

We have evaluated characteristics of an operational amplifier using poly-Si thin-film transistors. It is found that the cut-off frequency of the voltage follower has a strong temperature dependence. Therefore, it is important to consider the temperature characteristics when we design the circuit including them.

**AMDp - 36L High Reliable Amorphous IGZO Thin-Film Transistors Using the Copper as the Gate/Data Line Metal**

*C.-Y. Hou, Y.-C. Kao, C.-L. Chiang, S.-H. Lin, C.-N. Lin,  
W.-C. Tsai, C.-H. Chen  
AU Optronics, Taiwan*

Amorphous IGZO TFTs using Cu to serve as the gate/data line metal was studied. We have developed a copper-blocked process to prevent Cu from diffusing into the IGZO active layer. The TFTs showed excellent stability ( $\Delta V_{TH}$  shift <1 V at  $V_{GS} = \pm 30$  V; 80°C for 2000 s) under high temperature annealing without Cu contamination.

**AMDp - 37L Top-Emission AM-OLED Panel Driven by Organic TFTs with Semiconductor Layer Patterned by Ink-Jet Process**

*Y. Okumoto, T. Ukeda, M. Matsui, K. Okumoto,  
A. Miyamoto, K. Morita  
Panasonic, Japan*

We have developed an ink-jet process for organic semiconductor (OSC) layer in organic thin film transistors (OTFTs). The OSC crystallinity was improved by adjusting contact angles. The OTFTs showed the high mobility of 2.5 cm<sup>2</sup>/Vs. We also fabricated a 4-in. 80 ppi AM-OLED on glass substrate, which performed good uniformity in luminance and high moving picture quality.

**AMDp - 38L Layout Effect on the Self Heating Behavior of a-Si Thin Film Transistors**

*S.-C. Huang, C.-Y. Yang, H.-L. Chiu, J.-S. Lin,  
C.-H. Chen*

*AU Optronics, Taiwan*

The symmetric and asymmetric device layout are measured and stressed. It is discovered that the on current for the symmetric device is almost the same as the U-type under large  $V_G$ ,  $V_D$  as drain is probed at the I-part, and is larger than that as probed at the U part.

**AMDp - 39L H<sub>2</sub>O-Induced Negative-Bias-Temperature-Stress Instability of InGaZnO Thin Film Transistor**

*C.-Y. Wu, T. Hsieh, C.-N. Lin, W.-C. Tsai, C.-H. Chen*

*AU Optronics, Taiwan*

It is observed that the negative-bias-temperature-stress (NBTS) instability of IGZO is induced by the H<sub>2</sub>O in the environment. Two main mechanisms of the NBTS instability are proposed. The main reasons of hump and threshold voltage shift caused by NBTS will be discussed in this paper.

**AMDp - 40L Behavioral Model of an LCD Panel with Charge-Shared Pixel Structure**

*S.-H. Lee, J.-M. Kim, M. Kim, J. Kim, K. Kim, Y. Cho,  
S.-W. Lee*

*Kyung Hee Univ., Korea*

We propose an accurate behavioral model of an LCD panel with a complicated pixel structure. We develop a new technique to get T-V characteristics of the two sub-pixels. We analyze the panel to get precise voltage levels after sharing charges. Measurement and simulation results of a 46-in. CS-VA panel show an excellent match.

----- Break -----

<b>17:20 - 18:40</b>	<b>Room 141</b>
<b>AMD1/OLED3: AMOLED</b>	

Chair: S.-H. K. Park, ETRI, Korea  
Co-Chair: K. Takatori, NLT Techs., Japan

**AMD1/OLED3 - 1 A Polycrystalline Oxide TFT Driven AMOLED Display**

**17:20** *Y. Terai, T. Arai, N. Morosawa, K. Tokunaga,  
E. Fukumoto, T. Kinoshita, T. Fujimori, T. Sasaoka  
Sony, Japan*

We developed a high mobility polycrystalline oxide semiconductor, IGO, TFT for the AM-OLED display. The mobility was over 20 cm<sup>2</sup>/Vs and the shift of the threshold voltage after PBTS was smaller than 0.3 V. Moreover, the high resistance of polycrystalline IGO to HF etchant reduced a photolithography process.

- AMD1/ OLED3 - 2 17:40**      **A Novel Pixel Circuit Employing Pre-Charging Method for Large Area AMOLED Display**  
*S.-Y. Lee, B. Kim, Y. W. Lee, S.-J. Kim, M.-K. Han*  
*Seoul Nat. Univ., Korea*

We have proposed a new voltage modulated AMOLED pixel design employing the fast  $V_{data}$  storage and verified with SPICE simulation. The proposed pixel employing pre-charging method exhibits faster voltage memorizing time than the conventional 6T1C pixel circuit. It would be suitable for the high resolution and large area AMOLED display.

- AMD1/ OLED3 - 3 18:00**      **A New High-Speed LTPS-TFT Pixel Circuit with Highly Stable OLED Current for 3D AMOLED Displays**  
*P.-Y. Kuo, W.-Y. Chang, C.-C. Hung, K.-W. Chou, C.-L. Lin*  
*Nat. Cheng Kung Univ., Taiwan*

A new pixel structure and its driving scheme based on simultaneous emission for 3D AMOLED displays are proposed. The proposed pixel circuit can compensate both the threshold voltage variation of TFT and power line IR-drops at high-speed operation, and the current error rate of the proposed circuit is below 5%.

AMD

- AMD1/ OLED3 - 4 18:20**      **An External Compensated Method for AMOLED Display Based on Current Feedback**  
*F.-C. Chang, P.-Y. Kuo, C.-D. Tu, C.-L. Lin*  
*Nat. Cheng Kung Univ., Taiwan*

This work proposes a pixel circuit with an external compensated structure for AMOLED displays by using the LTPS process. Based on the simulation results, the OLED current is independent of the threshold voltage of TFTs and the variation is smaller than 50 nA while the  $\Delta V_{TH}$  is  $\pm 0.5$  V.

#### Author Interviews and Demonstrations

18:40 – 19:30

## IDW Outstanding Poster Paper Award

This award will go to the most outstanding paper selected from those presented at IDW '11 poster presentation.

The 2011 award winners will be announced on the IDW website: <http://www.idw.ne.jp/award.html>



## Thursday, December 8

9:00 - 10:25

Room 141

**FLX1/AMD2: Flexible Active-Matrix Devices**

Chair: H. Fujikake, NHK, Japan

Co-Chair: K. Nomoto, Sony, Japan

**FLX1/ AMD2 - 1: Invited New Organic Semiconducting Materials for Flexible TFTs**

9:05 K. Takimiya, E. Miyazaki, I. Osaka, S. Shinamura, M.-J. Kang

Hiroshima Univ., Japan

Recent advances in the development of small molecule-based organic semiconductors potentially applicable to flexible TFTs are presented. The authors have mainly focused on air-stable, p-channel semiconductors including dinaphthothienothiophenes (DNNT) and benzothienobenzothiophenes (BTBT). The presentation will include the synthesis, characterization, TFT characteristics, and structure-property relationship of these materials.

**FLX1/ AMD2 - 2: Low-Temperature and Low-Voltage, Solution-Processed Metal Oxide n-TFTs and Flexible Circuitry on Large-Area Polyimide Foil**

M. Rockel<sup>\*,\*\*</sup>, D.-V. Pham<sup>\*\*\*</sup>, J. Steiger<sup>\*\*\*</sup>,  
S. Botnars<sup>\*\*\*\*</sup>, D. Weber<sup>\*\*\*\*</sup>, J. Vanfleteren<sup>\*,\*\*\*\*</sup>,  
T. Sterken<sup>\*,\*\*\*\*</sup>, D. Cuypers<sup>\*,\*\*\*\*</sup>, S. Steudel<sup>\*</sup>, K. Myny<sup>\*</sup>,  
S. Schols<sup>\*</sup>, B. van der Putten<sup>\*\*\*\*</sup>, J. Genoe<sup>\*</sup>,  
P. Heremans<sup>\*,\*\*</sup>

<sup>\*</sup>imec, Belgium<sup>\*\*</sup>Katholieke Univ. Leuven, Belgium<sup>\*\*\*</sup>Evonik Degussa, Germany<sup>\*\*\*\*</sup>Univ. of Gent, Belgium<sup>\*\*\*\*\*</sup>Holst Ctr., the Netherlands

State-of-the-art solution-based oxide n-TFTs ( $\mu_{\text{sat}} \sim 2 \text{ cm}^2/\text{Vs}$  and  $I_{\text{on}}/I_{\text{off}} \sim 10^8$ ) processed at 250°C are realized on polyimide foil, resulting in fast and low-voltage flexible circuitry. Both high-speed and low-voltage operation makes the technology suited for both pixel driving and embedded line-drive circuitry at the borders of flexible AMOLED displays.

**IDW Best Paper Award**

This award will go to the most outstanding paper selected from those presented at IDW '11.

The 2011 award winners will be announced on the IDW website: <http://www.idw.ne.jp/award.html>

**FLX1/AMD2 - 3**  
**9:50**  
**Highly Reliable a-IGZO TFTs on a Plastic Substrate for Flexible AMOLED**  
*S. Nakano, N. Saito, K. Miura, T. Sakano, T. Ueda, K. Sugi, H. Yamaguchi, I. Amemiya, M. Hiramatsu\*, A. Ishida\*, K. Kanomaru, M. Sawada*  
*Toshiba, Japan*  
*\*Toshiba Mobile Display, Japan*

We have successfully reduced threshold voltage shifts of a-IGZO TFTs on transparent polyimide films against bias-temperature stress below 0.15 V, close to those on glass substrates. This high reliability was achieved by compressive IGZO thin films and high-temperature annealing. We have fabricated a 3.0-inch flexible AMOLED driven by a-IGZO TFT backplane.

**FLX1/AMD2 - 4L**  
**10:10**  
**Simple Solution Process for Manufacturing High-Performance Polymer Thin-Film Transistors on Highly Hydrophobic Surfaces**  
*M. Ikawa, Y. Horii, M. Chikamatsu, R. Azumi, H. Mogi\*, H. Matsui, T. Yamada, T. Hasegawa*  
*AIST, Japan*  
*\*Shin-Etsu Chem., Japan*

A novel solution process named push coating was developed for manufacturing polymer TFTs on highly hydrophobic substrates. In the process, a PDMS stamp is used to manufacture thin films of semiconducting polymers. By the method we produced the P3HT TFTs exhibiting mobility as high as 0.50 cm<sup>2</sup>/Vs.

----- Break -----

<b>10:40 - 12:10</b>	<b>Reception Hall 1</b>
<b>AMD3: Application (1)</b>	

Chair: T.-C. Huang, Univ. of Tokyo, Japan  
 Co-Chair: H. Hamada, Sanyo Elec., Japan

**AMD3 - 1:** **Invited Non-Volatile Graphene Channel Memory (NVGM) for Flexible Electronics**  
**10:40**  
*S. M. Kim, S. Seo\*, E. B. Song, D. H. Seo\*\*, H. Seok\*\*, K. L. Wang*  
*Univ. of California Los Angeles, USA*  
*\*Sejong Univ., Korea*  
*\*\*Samsung Elect., Korea*

A non-volatile memory exploiting single-layer graphene and multi-layer graphene as channel materials have been fabricated and the electrical performance were characterized. The injection of electrons into the trap sites of a triple high-k dielectric stack results in a memory window of more than 11.3 V. The NVGMs can be utilized for high-density-memory for flexible electronics.

AMD

**AMD3 - 2**      **Indium-Gallium-Zinc-Oxide Based Resistive**  
**11:05**          **Switching Memory for System-on-Glass Application**  
*Y.-S. Fan, C.-H. Hsu, P.-T. Liu, L.-F. Teng*  
*Nat. Chiao Tung Univ., Taiwan*

A new bipolar resistive random access memory (RRAM) based on amorphous InGaZnO was proposed with one order memory window (high to low resistance state) over two hundreds switching cycles. Besides, a conceptual co-operation scheme was also demonstrated between a-IGZO RRAM and TFT for the system-on-Glass application.

**AMD3 - 3**      **High Diffuse Reflectance Architecture for Memory in**  
**11:25**          **Pixel**  
*M. Yoshiga, S. Takahashi, Y. Haruyama, N. Sumi,*  
*M. Shibazaki, S. Chang\*, K. Yamashita*  
*TPO Displays Japan, Japan*  
*\*Chimei Innolux, Taiwan*

We have successfully developed 5.4-in. full reflective panel installing memory in pixel (MIP) function with wide process margin and better optical performance. We have analyzed process margin of MIP circuit and optical performance of reflective LCD. Then we optimized panel design and optical components for LCD with MIP circuit.

**AMD3 - 4:**    ***Invited* An Ultra Low-Power E-Paper System for**  
**11:45**          **Industrial Applications**  
*M. Sakamoto*  
*NLT Techs., Japan*

We have developed an ultra low-power consumption electrophoretic display system, composed of an e-ink display, a display controller and a power-management sub-CPU. Our system achieved three order magnitude reduction in stand-by-mode power consumption over existing commodity-based systems. A new driving scheme for the controller solves the image-sticking issue.

----- Lunch -----

## Evening Get-Together with Wine

Tuesday, December 6, 2011  
18:00 – 20:00  
at Skyview Restaurant Pastel (7F),  
Nagoya Congress Center  
(Sponsored by Merck Ltd., Japan)  
See page 10 for details

13:20 - 14:45

Reception Hall 1

**AMD4: Oxide TFT (1)**

Chair: G. S. Herman, Oregon State Univ., USA

Co-Chair: N. Morosawa, Sony, Japan

**AMD4 - 1: 13:20 Invited Bias Stability for a-In-Ga-Zn-O-TFTs: Origin of Threshold Voltage Instability and the Role of Thermal Annealing and Passivation***K. Nomura, T. Kamiya, H. Hosono**Tokyo Inst. of Tech., Japan*

We discuss how we can improve TFT characteristics and stability in relation to defects and the roles of thermal annealing and passivation. It was found that instability of unannealed TFTs originates from creation of bulk defects, while that of annealed TFTs is primarily attributed to interface and back channel defects.

**AMD4 - 2 13:45 Effects of the Back-Channel Defect States on IGZO-based Thin Film Transistor for Large-Sized AMOLED Display***S.-M. Park, C. Ha, K.-C. Choi, S.-J. Yun, H.-S. Kim, W.-C. Jung, K.-S. Yang, H.-S. Seo, B.-C. Kim, S.-Y. Cha**LG Display, Korea*

In this study, with the change of IGZO TFTs fabrication process, especially in active area photolithography step, we achieved improved device performance of oxide TFT in terms of transfer, hysteresis curves and PBTS property. A 31.0-in. diagonal HD WOLED display was demonstrated using the enhancement bottom gate IGZO TFTs.

**AMD4 - 3 14:05 Self-Assembled Monolayer Modified Back Interface of Oxide Semiconductor as a Protection Layer***S.-H. Cho, J.-S. Lee, S.-M. Song, T. Y. Choi\*, J. H. Noh\*, J.-Y. Kwon, M.-K. Han**Seoul Nat. Univ., Korea**\*Samsung Elect., Korea*

We successfully deposited SAM (Self-assembled Monolayer) as a protection layer of the back interface of an oxide semiconductor to reduce plasma and wet etchant damages during the source / drain patterning process. In addition, SAM inhibited the oxidization of Ti and the oxygen extraction from the IGZO layer.

**AMD4 - 4**      **Effect of Oxygen Partial Pressure on the Performance of a-IGZO TFTs with a Self-Aligned Top-Gate Coplanar Structure**

14:25

*S. H. Ryu, D. H. Kang, Y. Park\*, I. Kang, J. Jang*

*Kyung Hee Univ., Korea*

*\*Dongwoo Fine-Chem, Korea*

The control of threshold voltage ( $V_{th}$ ) is investigated in amorphous-indium-gallium-zinc-oxide (a-IGZO) thin-film transistors (TFTs) with a self-aligned coplanar structure by varying the oxygen partial pressure ( $P_O$ ) during the sputter deposition of the a-IGZO layer. The  $V_{th}$  shifts from -0.3 to 0.8 V, while the field-effect mobility ( $\mu_{FE}$ ) decreases from 20 to 8 cm<sup>2</sup>/V·s as the  $P_O$  increases from 2 to 16 sccm.

**Author Interviews and Demonstrations**

18:00 – 18:50

**Friday, December 9**

9:00 - 10:25

Reception Hall 1

**AMD5: Organic TFT**

Chair: K. Nomoto, Sony, Japan

Co-Chair: Y. Fujisaki, NHK, Japan

**AMD5 - 1: *Invited* Printing Technologies for Organic TFT Array**

9:00

*R. Matsubara, Y. Harada, K. Hatta, O. Kina, M. Ishizaki, M. Ito*

*Toppan Printing, Japan*

We have developed unique printing technologies for organic TFT. While offset-based printing can achieve fine patterns, flexographic printing can realize smooth surface. By using these two technologies, characteristics of the printed TFT shows remarkably high uniformity. Moreover, electronic paper was successfully driven by fully printed organic TFT array.

**AMD5 - 2      Organic Active-matrix TFTs with Air-Stable Organic Semiconductors**

9:25

*T. Uemura\*, M. Uno', \*\*, K. Nakayama\*, N. Shomoto\*\*\*, M. Itoh\*\*\*, K. Takimiya\*\*\*\*, J. Takeya\**

*\*Osaka Univ., Japan*

*\*\*TRI Osaka, Japan*

*\*\*\*Crystage, Japan*

*\*\*\*\*Hiroshima Univ., Japan*

Air-stable organic TFTs for AM displays are developed with dinaphtho[2,3-b:2',3'-f]thieno[3,2-b]thiophene (DNNT). Compared to commonly used pentacene with the HOMO level of -5.0 eV, the deeper HOMO level of DNNT (-5.4 eV) renders it much more stable in air. In this paper, we demonstrate the first operation of the DNNT AM-LCDs.

**AMD5 - 3: 9:45 Invited A Floating-Gate OTFT-Driven AMOLED Pixel Circuit for Variation and Degradation Compensation in Large-Sized Flexible Displays**

*T.-C. Huang, K. Ishida, T. Sekitani, M. Takamiya,  
T. Someya, T. Sakurai  
Univ. of Tokyo, Japan*

For the first time, we demonstrate an AMOLED pixel circuit on an 80- $\mu\text{m}$  thick film based on floating-gate organic TFTs (FG-OTFTs) to compensate for OTFT variations and OLED degradations. By programming  $V_{\text{TH}}$  of FG-OTFTs, we can realize less than 5% spatial non-uniformity and 85% power reduction compared with conventional voltage-programming.

**AMD5 - 4L 10:10 Fabrication of Air-Stable, High Mobility N-type Organic Thin-Film Transistor with Short Channel Length**

*Y. Fujisaki, Y. Nakajima, T. Takei, T. Yamamoto,  
H. Fujikake  
NHK, Japan*

Air-stable N-type Organic Thin-film transistor based on benzobis (thiadiazole) (BBT) derivative was fabricated at low-temperature process. The fabricated short-channel TFT showed excellent air-stability when combined with a cross-linkable orefin-type gate insulator. By optimizing deposition temperature of the BBT derivative, we achieved high electron mobility over 0.2  $\text{cm}^2/\text{Vs}$  under ambient air.

----- Break -----

<b>10:40 - 12:00</b>	<b>Reception Hall 1</b>
<b>AMD6: Si &amp; Oxide TFT</b>	

Chair: J. Lee, Samsung Elect., Korea  
Co-Chair: S. Horita, JAIST, Japan

**AMD6 - 1 10:40 Effective Activation of the Sputtered P-doped Si Film for High Performance Poly-Si TFT**

*T. Nishinohara, J. D. B. Mugiraneza, K. Shirai, T. Suzuki,  
T. Okada, T. Noguchi, T. Ohachi\*, H. Matsushima\*\*,  
T. Hashimoto\*\*, Y. Ogino\*\*, E. Sahota\*\*  
Univ. of the Ryukyus, Japan  
\*Doshisha Univ., Japan  
\*\*Hitachi Computer Peripherals, Japan*

After performing BLDA for phosphorus-doped Si films deposited by sputtering using Ne gas, the crystallinity of the films improved and sheet resistance decreased drastically. By applying the values of sheet resistance to source and drain region in device simulation, remarkable improvement of TFT characteristics were shown with shortening channel length.

**AMD6 - 2      Withdrawn****AMD6 - 5L      Novel Approach for Preventing Atmosphere Effects  
11:00            on  $V_{th}$  Stability of a-In-Ga-Zn-O Thin Film Transistor  
by Glass Sealing***K. Yamada, K. Nomura\*, S. Takeda, H. Hosono\***Asahi Glass, Japan**\*Tokyo Inst. of Tech., Japan,*

We report a novel approach to prevent atmosphere effects on threshold voltage ( $V_{th}$ ) stability of a-In-Ga-Zn-O TFTs. The surroundings of TFTs without a passivation layer were sealed by glass sealant. The  $V_{th}$  shift by constant current stress was well suppressed to  $\sim 0.5$  V for 20 hours even under high-humidity conditions.

**AMD6 - 3      Additional Film Induced Built-in Barrier for Leakage  
11:20            Lowering in Amorphous Si TFTs***W.-H. Wu, S.-H. Lin, C.-H. Chen**AU Optronics, Taiwan*

We develop a new and simple method to lower the leakage current of amorphous silicon ( $\alpha$ -Si) TFT. With additional  $N^+$  or Multi-  $N^+$   $\alpha$ -Si film being employed, the  $\alpha$ -Si TFT shows excellent holding capability. In this article, the influences of the  $N^+$  layer thickness on leakage performance will also be discussed.

**AMD6 - 4      Novel Shift Register Using Amorphous Silicon TFTs  
11:40            for Liquid Crystal Display Application***L.-W. Chu, M.-C. Yang, P.-T. Liu, Y.-C. Kuo**Nat. Chiao Tung Univ., Taiwan*

A new shift register has been successfully designed and integrated for a 3.8-in. WVGA (800xRGBx480) panel. With the proposed threshold voltage drop cancellation technique, output rise time can be substantially decreased by 24.6% for high resolution display application. Furthermore, the demonstrated panel shows almost no degradation after 500 hours operation.

----- Lunch -----

## **IDW Tutorial in Japanese**

**Tuesday, December 6, 2011****Room 131, Bldg.1****Nagoya Congress Center**

Detailed information is available on  
<http://www.sidchapters.org/japan/>

13:20 - 14:45

Reception Hall 1

**AMD7: Application (2)**

Chair: E. Fortunato, New Univ. of Lisbon, Portugal  
Co-Chair: M. Inoue, Chimei Innolux, Japan

**AMD7 - 1: Invited Development of Oxide TFT and Application to the Transparent Display**

13:20

*S.-H. K. Park, C.-S. Hwang, M. Ryu, S. Yang, H. Oh,  
J. E. Pi, I. Y. Eom, O. S. Kwon, E. Park  
ETRI, Korea*

The current status of oxide TFT technology has been reviewed. Negative bias enhanced light instability can be minimized by reducing oxygen related defects with post annealing under water, O<sub>2</sub>/N<sub>2</sub>O plasma treatment, or optimization of cation composition of the active layer. We also introduce the transparent AMOLED driven by oxide TFT.

**AMD7 - 2: Invited Introduction of Transparent LCD**

13:45

*J. Lee, J. Moon  
Samsung Elect., Korea*

In this presentation, a new user experience display technology is introduced, which is a transparent LCD display. We will review fundamental technologies of a transparent LCD and its value proposition and possible applications. Also, introduce a new business opportunities instead of a current display industry which is quite saturated in matter of technology wise and business wise.

**AMD7 - 3 Amorphous Silicon Thin-Film Transistor Integrating Robust Light Sensing Layer**

14:10

*M.-H. Lee, C.-C. Chiu, A.-T. Cho, C.-T. Peng  
AU Optronics, Taiwan*

A robust photo sensor was embedded into a-Si TFT LCDs. This sensor was realized by a PECVD photo-sensing layer and required no post-anneal step. Photo-electrical characteristics were investigated and excellent linearity and reliability under long-term operation was observed. A TFT-LCD panel which can adopt ambient illumination change was then demonstrated.

**AMD7 - 4L Wireless Communication with RFID on LTPS Substrate**

14:30

*K. Yamashita, S. Kawata  
TPO Displays Japan, Japan*

A loop aerial tuned in to 13.56 MHz, voltage rectifier to wirelessly electrify tag and ASK modulation switch are formed on LTPS substrate. Wireless power transfer of 220 μW to tag and half-duplex communication with 106 kbps are observed. This exemplifies the feasibility of radio frequency identification (RFID) application by LTPS technology.

----- Break -----



15:00 - 16:25

Reception Hall 1

**AMD8: Oxide TFT (2)**

Chair: K. Nomura, Tokyo Inst. of Tech., Japan

Co-Chair: H. Kumomi, Canon, Japan

**AMD8 - 1: Invited Recent Developments in Printed Transparent Oxide Semiconductors**

15:00

*G. S. Herman**Oregon State Univ., USA*

Oxide-based semiconductors for thin film transistor applications have been of much interest during the past decades. Considerable advances have been made both in new materials development, as well as methods to deposit the films through solution-based processes. An overview of solution-based oxide semiconductor research is given in this presentation.

**AMD8 - 2: Invited New Developments on Oxide Electronics**

15:25

*E. Fortunato, P. Barquinha, R. Martins**New Univ. of Lisbon, Portugal*

In this article we review the recent progress in n- and p-type oxide based thin film transistors (TFT), with special emphasis to solution-processed and p-type, and we will summarize the major milestones already achieved with this emerging and very promising technology.

**AMD8 - 3 Dechlorination and Crystallization of Solution-Processed Zinc Tin Oxide Thin Film Transistor with Various Annealing Temperature**

15:50

*J.-S. Lee, S.-H. Choi, S.-H. Kuk, M.-K. Song, Y.-H. Kim\*, J.-Y. Kwon, M.-K. Han**Seoul Nat. Univ., Korea**\*Korea Elect. Tech. Inst., Korea*

We investigated solution-processed zinc tin oxide (ZTO) thin film transistors (TFTs) with various annealing temperature. When the annealing temperature increased from 300°C to 500°C, ZTO film was dechlorinated and nano-crystallized, and saturation mobility of solution-processed ZTO thin film transistor increased from 0.18 cm<sup>2</sup>/V-sec to 2.15 cm<sup>2</sup>/V-sec.

**SID 2012**

International Symposium, Seminar and Exhibition

June 3-8, 2012

Boston, Massachusetts, U.S.A.

**AMD8 - 4L 16:10 Novel High Performance IGZO-TFT with High Mobility over 40 cm<sup>2</sup>/Vs and High Photostability Incorporated Oxygen Diffusion**

*M. Ono, M. Takata, F. Mochizuki, A. Tanaka, M. Suzuki  
FUJIFILM, Japan*

Amorphous IGZO stacked-layer channel thin film transistors were investigated. High field effect mobility over 40 cm<sup>2</sup>/Vs and high stability under monochromatic light illumination have been simultaneously achieved. The control of oxygen diffusion into active layer is essential, and is discussed in detail.

**Author Interviews and Demonstrations**

16:20 – 17:10

**Supporting Organization:**

Thin Film Materials & Devices Meeting

## BANQUET

Wednesday, December 7, 2011

19:30 – 21:30

Shirotori Hall (1F)

Nagoya Congress Center

See page 10 for details

## EXHIBITION

12:40 – 18:00 Wednesday, Dec. 7, 2011

10:00 – 18:00 Thursday, Dec. 8, 2011

10:00 – 14:00 Friday, Dec. 9, 2011

2F, 3F Lobby, Bldg. 2

Nagoya Congress Center

Free admission with your registration name tag

# Workshop on FPD Manufacturing, Materials and Components

Wednesday, December 7

14:00 - 15:20

Room 234

## FMC1: Optical Films

Chair: H.-M. P. Chen, Nat. Chiao Tung Univ., Taiwan  
Co-Chair: Y. Saitoh, FUJIFILM, Japan

### **FMC1 - 1      Zero-Zero-Birefringence Polymer in Quaternary 14:00          System for Liquid Crystal Displays**

*S. Iwasaki, Z. Satoh, H. Shafiee, A. Tagaya, Y. Koike  
Keio Univ., Japan*

Zero-zero-birefringence polymers which exhibit neither orientational nor photoelastic birefringence were successfully prepared with multiple compositions in a quaternary copolymerization system. Therefore, characteristics other than birefringence can be controlled appropriately for use applications such as polarizer protective films and light guide plates for polarized laser backlight, while maintaining zero-zero-birefringence.

### **FMC1 - 2      Withdrawn**

### **FMC1 - 5L      Control of Wavelength Dispersion by Optimization 14:20          of Laminated Structure: Extension of BDC Theory to Multi-layer System**

*H. Choi, M. Y. Lee\*, K. Y. In\*, H. Kim, M.-S. Jung  
Samsung Advanced Inst. of Tech., Korea  
\*Cheil Inds., Korea*

Compensation films with reverse wavelength dispersion property are ideal for preventing the color deviation on displays. Birefringence dispersion control (BDC) theory is well-known for describing reverse wavelength dispersion by copolymerization and blending with positive/negative birefringence polymers. In the article, we extend the theory to multi-layer systems for the compensation films.

### **FMC1 - 3      Development of Coating-Type Quarter-Wave 14:40          Retardation Film for 3D-LCDs**

*M. Ishiguro, K. Ohmuro, Y. Saitoh, Y. Takahashi,  
J. Watanabe, T. Arai, K. Mihayashi  
FUJIFILM, Japan*

A novel coating-type quarter-wave retardation film (QWF) for 3D-LCDs with good viewing-angle properties has been developed. In-plane retardation (Re) of the QWF needs to be adjusted within a certain range and that out-of-plane retardation (Rth) needs to be close to 0 nm. The QWF realized high performance 3D-LCDs.

**FMC1 - 4      Lyotropic Liquid Crystal Coated Compensation Film**  
**15:00**      *A. Lazarev, A. Krivoschepov, I. Kasianova*  
                 *Crysoptix, Japan*

Thin Birefringent Films (TBFs) with negative C-plate retardation function produced by coating technology have been prototyped on glass and TAC substrates. The TBF compensation films demonstrate a wide range of retardation values (up to 500 nm). The key concepts of the manufacturing process and characteristics of the compensation films are discussed.

----- Break -----

<b>15:40 - 16:20</b>	<b>Room 234</b>
<b>LIT2/FMC2: Backlight</b>	

Chair:            K. Käläntär, Global Optical Solutions, Japan  
Co-Chair:      Y. Yang, Sony, Japan

**LIT2/            *Invited* Photonics Polymers for Novel Liquid Crystal**  
**FMC2 - 1:      Displays**  
**15:40**      *A. Tagaya, Y. Koike*  
                 *Keio Univ., Japan*

We have demonstrated the zero-zero-birefringence polymers, the zero-birefringence pressure sensitive adhesives, and the highly scattered optical transmission (HSOT) polymer. Using these polymers, the HSOT polymer backlights and screens, the polarized laser backlight, and the reduction of light leakage through LCDs have been demonstrated, and proposed a novel LCD system.

FMC

**LIT2/            Optical Design of Front Diffuser for Collimated**  
**FMC2 - 2      Backlight and Front Diffusing System**  
**16:00**      *K. Nakamura, T. Fuchida, K. Yamagata, A. Nishimura,*  
                 *T. Takita, H. Takemoto*  
                 *Nitto Denko, Japan*

We designed the front diffuser for “collimated backlight and front diffusing system”, which had a target diffusion in spite of thin layer by means of scattering analysis under Mie scattering theory and the multiple scattering effect.

**LIT2/            Withdrawn**  
**FMC2 - 3**

**Author Interviews and Demonstrations**  
**18:40 – 19:30**

## Thursday, December 8

9:00 - 10:20

Reception Hall 1

**FMC3: Recycle & Environment**

Chair: R. Yamaguchi, Akita Univ., Japan

Co-Chair: T. Okada, Hokkaido Univ., Japan

**FMC3 - 1: *Invited* Development of Advanced Recycled Plastic and Application to the TV Housing**

9:00

*K. Ueda, T. Ohe, Y. Inagaki**Sony, Japan*

We have succeeded in developing a flame retardant recycled plastic for the bezel of TVs that contains 99% recycled materials (the world's highest ratio). The recycled plastic is superior to conventional virgin plastic in its physical properties, durability and environmental characteristics such as its carbon footprint and recyclability.

**FMC3 - 2: *Invited* Recycling System and Technologies of Electronics Appliances Including LCD in Japan**

9:20

*T. Nakamura**Tohoku Univ., Japan*

We will introduce experimental trials of collecting small-size E-scrap operated in Japan and how to recover minor metals from them. The previously-existing recycling processes are operated. According to the sustainable resource management and control, further progress for the minor metals recovery and controlling harmful elements may become the key issue.

**FMC3 - 3: *Invited* The Development of Mercury Free Light Source Having the Selectable UV Wavelength (and Its System)**

9:40

*T. Habu, S. Yabu, Y. Tagawa, S. Endo, S. Suzuki,  
J. Asayama, N. Takezoe**Ushio, Japan*

New fluorescent lamp that are selectable irradiate UV wavelength is successfully developed by material optimization based on Xe Excimer irradiation. This new lamp has the possibility to provide the new application for several process on the industry such as LCD manufacturing process.

**FMC3 - 4: *Invited* Recovery and Immobilization of Lead in Cathode Ray Tube Funnel Glass by a Combination of Reductive and Oxidative Melting Processes**

**10:00**

*T. Okada, H. Inano\*, N. Hiroyoshi*

*Hokkaido Univ., Japan*

*\*HRO, Japan*

Metallic lead was recovered from the funnel glass of cathode ray tubes with high lead removal rates by melting in a reductive atmosphere. The lead remaining in the glass was immobilized by melting in an oxidative atmosphere and was able to meet the Japanese criteria for recycle of the glass.

----- Break -----

**10:40 - 12:00**

**Room 141**

**FLX2/FMC4: Materials, Components and Processes for Flexible Devices**

Chair: Y.-F. Liu, Nat. Cheng Kung Univ., Taiwan

Co-Chair: H. Maeda, DNP, Japan

**FLX2/ *Invited* Transparent Polyimide Film for Flexible FMC4 - 1: Display**

**10:40**

*J. Oishi, Y. Miki*

*Mitsubishi Gas Chem., Japan*

MGC has developed three types of polyimide. Transparency of film and varnish is excellent. We can supply low CTE film. Polyimide varnish can be used as thin film on glass substrate with spin coating. T type varnish is high heat durability pressure sensitive adhesive but not colorless.

**FLX2/ Improvement of Barrier Properties of Transparent FMC4 - 2 Barrier Coating Prepared by Roll to Roll PECVD System**

**11:05**

*H. Tamagaki, T. Okimoto*

*Kobe Steel, Japan*

Improvement of the barrier performance of SiO<sub>x</sub> coating deposited by Roll to Roll PECVD System is attempted. By using Planarized PEN, which has better surface properties than standard PEN, the barrier performance is improved by a factor of 2-4, and WVTR below 5x10<sup>-4</sup> g/m<sup>2</sup>/day is obtained by 500 nm SiO<sub>x</sub> coating.

**FLX2/ Low Temperature Fabricated Conductive Lines on FMC4 - 3 Flexible Substrate by Inkjet Printing**

**11:25**

*Y.-F. Liu, Y.-F. Pai, W.-S. Hwang*

*Nat. Cheng Kung Univ., Taiwan*

The optimal conditions of inkjet-printed nano-silver suspension and silver nitrate solution for fabricating continuous narrow conductive lines on a polyimide substrate are investigated. In addition, the effects of driving pulse voltage and droplet coverage on the bulging of as-printed conductive lines are also examined.

**FLX2/ FMC4 - 4L 11:45**      **Study on Recrystallization of the Nano Graphene from Amorphous Carbon Films**  
*C.-M. Lee, J. Choi*  
*Kyung Hee Univ., Korea*

The nanographene films were directly deposited on the glass substrates without any metal catalyst by using CVD method. In this study, we observed that nanographene can be grown directly on glass as well as the crystal size of nanographene can be controlled by annealing thermally.

----- Lunch -----

13:20 - 16:20

Room 222-224

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

**FMCp - 1      Photo-Degradation of Optical Films for LCD Backlights Induced by Near-Ultraviolet Light**  
*H. T. Kwon, J.-H. Ko*  
*Hallym Univ., Korea*

The effect of the UV (ultraviolet) illumination at the wavelength of 352 nm on optical films for LCD backlight was investigated. The color shift due to UV irradiation was the largest for the PS (Prism Sheet) compared to the DS (Diffuser Sheet) and the reflective polarizer (3M, DBEF). Physical origins of the photo-degradation are discussed.

**FMCp - 2      A Simple Modeling of Anti-Glare Surface Scattering Effect on Dark-Room Contrast Ratio of Liquid Crystal Displays**  
*T. Suzuki, X. Ma, Y. Yang, C. Xie, G. Qin, X. Xu, J. You*  
*BOE, China*

Anti-glare surface treatment sacrifices contrast ratio of LCDs not only under ambient light but also in dark-room. This phenomenon is related to light distribution of backlight unit, viewing angle characteristics of liquid crystal cell, and anti-glare surface properties. We successfully established a simple model which quantitatively describes this effect.

**FMCp - 3      Designing Novel Pressure Sensitive Adhesives for High Definition Liquid Crystal Displays**  
*S. Yanai, H. Ito, A. Tagaya, S. Oda\*, Y. Koike*  
*Keio Univ., Japan*  
*\*Saiden Chem, Japan*

The system to create the zero-birefringence pressure sensitive adhesives (PSA), which reduced the amount of light leakage, was proposed by the authors. However, the system has not been established yet. To establish the system, we designed the zero-birefringence PSA with different viscoelasticity by changing the amount of cross-linker.

**FMCP - 4 Binder-Crosslinked Encapsulated Cholesteric Liquid Crystal Display**

*C. Y. Wu, M. H. Yang, S. Liu\*, C. C. Hsu, C. C. Tsai, Y. Z. Lee*

*ITRI, Taiwan*

*\*Nat. Formosa Univ., Taiwan*

The binder-crosslinked encapsulated cholesteric liquid crystal (En-ChLC) displays with higher reflectivity are demonstrated. The hardener chemicals are used to crosslink the gelatin binders by atomization treatment. In the optical performance, the improved reflectivity is clearly observed.

**FMCP - 5 Improvement of Life-Time and Image Quality for Thermal Printing**

*C.-W. Kung, T.-M. Liu, H.-P. Shih, C.-Y. Huang*

*ITRI, Taiwan*

For using a TPH writer on Ch-LCD e-Paper to perform multi-times printing, we optimized the module to reduce the impact of scratch issue. Also depending on the characteristics of Ch-LCD e-Paper, some methods for enriching image quality are demonstrated.

**FMCP - 6 A Novel Color Electrowetting Display without Using Color Filter**

*C.-J. Hsu, Y.-N. Pao, Y.-J. Chen, C.-H. Liao, W.-H. Yang, H.-H. Lin*

*ITRI, Taiwan*

FMCP

A cEWDs without using color filter was demonstrated and proved its feasibility. The cEWDs was consisted of blazed grating film and lenticular-lens arrays. The lenticular arrays converged RGB light rays on sub-pixels; respectively. The optical efficiency of the cEWDs was about 30% which was improved 1.5 times from conventional cEWDs.

**FMCP - 7 Observation of Reformation of CuNx Surface by Washing Process**

*M. Kwak, J. Jeon, K. Kim, Y. Yi, D. Choi, Y. Choi, K. Jeoung*

*LG Display, Korea*

Chemical characteristic change on copper nitride surface was compared using XPS and AFM after cleansing with atmospheric pressure plasma and excimer ultra-violet. As a result, oxygen content in copper nitride surface was shown high when it was cleansed with pressure plasma. This oxygen layer creates a weak boundary layer.



**FMCP - 8      Patterning of CNT Coated PET Film for Touch Panel Fabrication**

*S. W. Kim, J. M. Lee, Y. C. Jeong, C. S. Oh, E. H. Kim,  
H. J. Kim\*, L. S. Park*

*Kyungpook Nat. Univ., Korea*

*\*NPAC, Korea*

The CNT-PET film was fabricated by spray coating of CNT aqueous solution. The preparation of CNT coating solution was most effective with horn type sonificator and SDS as surfactant. The resistive touch panel fabricated with CNT-PET films showed nearly equal performance to the one made with ITO-PET films.

**FMCP - 9      Withdrawn****FMCP - 10      Surface Modified Carbon Black for High Resistivity Black Matrix and Touch Panel Applications**

*Z. Li, G. Moeser, A. Kyrilidis, S. Jacobs, K. Pai*

*Cabot, USA*

Cabot has developed surface modified carbon blacks for color filter and touch sensor applications that deliver high resistivity and high optical density. These materials are also capable of withstanding the high temperatures used in the post-baking process with less loss of resistivity than competitive materials based on polymer encapsulation.

**FMCP - 11      Atom-Migration During Crystallization of a-SiGe Films by SR Soft X-ray Irradiation**

*S. Kino, Y. Nonomura, A. Heya, N. Matsuo, K. Kanda,  
S. Miyamoto, S. Amano, T. Mochizuki, K. Toko\*,  
T. Sadoh\*, M. Miyao\**

*Univ. of Hyogo, Japan*

*\*Kyushu Univ., Japan*

We investigated a low-temperature crystallization of a-Si, a-Ge and a-Si<sub>1-x</sub>Ge<sub>x</sub> films by the synchrotron radiation (SR) soft X-ray irradiation at storage ring current of 25-220 mA. Crystallization of SiGe caused by the atomic migration during soft X-ray irradiation is effective as compared with the thermal annealing.

**FMCP - 12      Method for Quantitative Analysis of Unreacted Boric Acid in Polarizing Plates**

*S. Kunimasa, S. Morimoto, H. Yamada, A. Higo,  
K. Matsumoto, M. Tasaki*

*Sumitomo Chem., Japan*

We developed a quantitative analytical method of unreacted (or not bounded with poly vinyl alcohol (PVA)) boric acid in polarizing plates. Unreacted boric acid can be extracted selectively with 2-ethyl-1, 3-hexanediol/chloroform, and analyzed by ICP-AES.

**FMCP - 13     Annealing Behavior of a-IGZO Film Deposited by Rotation Magnet Sputtering***A. Hiroe<sup>\* \*\*</sup>, T. Goto<sup>\*\*</sup>, T. Ohmi<sup>\*\*</sup>**<sup>\*</sup>Tokyo Electron, Japan**<sup>\*\*</sup>Tohoku Univ., Japan*

We have developed Rotation Magnet Sputtering where small erosion loops move thereby creating uniform erosion over the target realizing high target utilization of more than 60%. Investigation on the annealing behavior deposited by Rotation Magnet Sputtering revealed that oxygen out diffusion during the post annealing depends on deposition chemistry.

**FMCP - 14     High Reliability of a-Si TFT Using Solution-Processed Photosensitive Passivation Layer with Low Dielectric Constant***A. Tanabe, M. Hanmura, T. Katoh, M. Tada**ZEON, Japan*

We have developed a solution-processed photosensitive passivation layer with low dielectric constant (PPLD) for amorphous Silicone TFTs. We have achieved high reliability performance for off-leakage current test of a-Si TFT. Furthermore, LCD panels using PPLD were fabricated, and were able to be operated without any remarkable problems.

**FMCP - 15     Effect of DC Sputtering Parameter of Molybdenum on Galvanic Reaction between Molybdenum and Copper Thin Films in Phosphoric Acid Solution***B.-H. Seo, S.-H. Lee, I.-S. Park, J. H. Seo, H. H. Choe, J.-H. Jeon, M.-P. Hong<sup>\*</sup>, J. Winkler<sup>\*\*</sup>**Korea Aerospace Univ., Korea**<sup>\*</sup>Korea Univ., Korea**<sup>\*\*</sup>Plansee Metal, Austria*

The galvanic reaction of Cu/Mo systems in phosphoric acid solution was strongly dependent on the molybdenum film deposition condition. The change of the molybdenum dissolution rate with varying deposition parameter resulted in the galvanic potential between the copper and molybdenum.

## Green & Recycling Technology

Highlighted Topics of FMC-WS

Thursday, Dec. 8, 2011

9:00 - 10:20 (FMC3)

Reception Hall 1, 4F of Bldg. 1

See page 60 for details

**FMCP - 16L In-Situ Characterization of Sputter-Deposited ZnO Field Effect Transistors**

*F. Watanabe, T. Kakinuma, A. Morita, H. Shimizu\*, H. Shirai*

*Saitama Univ., Japan*

*\*Saitama Ind. Tech. Ctr., Japan*

We present the in-situ characterization of sputter-deposited ZnO field-effect transistors (FETs). The TFT measurements were performed after each several tens nanometer thick film deposition using the bottom contact geometry with a Mo S-D electrode. The in-situ measurement is a powerful method to understand the charge depletion and accumulation layers.

----- Break -----

13:20 - 16:20

Room 222-224

**Poster LITp/FMCP: Backlight**

**LITp/  
FMCP - 1**

**Comparison of Phosphor-Coated LEDs and Remote-Phosphor LEDs for Illumination Applications**

*B.-W. Lee, J.-H. Ko*

*Hallym Univ., Korea*

Various illuminating characteristics of illumination devices based on phosphor-coated white LEDs and remote-phosphor white LEDs were investigated by using optical simulation based on a ray-tracing technique. The device efficiency, the color uniformity, and the illuminance distribution were systematically compared between these two types of LED devices.

**LITp/  
FMCP - 2**

**Polarization and Birefringence Properties of Prism Films Adopted in LCD Backlights**

*J. H. Kim, J.-H. Ko*

*Hallym Univ., Korea*

The polarization and birefringence properties of prism films adopted in LCD backlights were investigated by optical measurements. It was found that the p-polarization component was stronger than the s-polarized component in the emitted light from the prism film. The birefringence was confirmed to exist in the prism grooves.

**LITp/  
FMCP - 3**

**The Luminance Enhancement of LCD Backlight by Lenticular-Lens Films**

*J. S. Seo, J.-H. Ko*

*Hallym Univ., Korea*

A simulation study was carried out on lenticular-lens films (LLFs) to reveal their optical performances as functions of the aspect ratio and the refractive index of the one-dimensional lenticular lenses. There was an optimized height-to-width ratio as well as a refractive index at which the on-axis luminance gain became the maximum.

- LITp/  
FMCp - 4**      **The Effect of Inert Liquid on the Thermal and Optical Properties of High-Power White LED**  
*S.-S. Jeong, J.-H. Ko*  
*Hallym Univ., Korea*

The effect of inert liquid paraffin on the thermal and optical properties of high-power white LEDs was investigated. The time dependence of the temperature at various conditions was measured and explained by using an exponential function. Empirical functions were used to fit the measured spectrum of white LEDs.

- LITp/  
FMCp - 5**      **Proposal of Design Method for Scattering Films for Novel Liquid Crystal Display Systems**  
*D. Sekine, A. Tagaya, Y. Koike*  
*Keio Univ., Japan*

We proposed the analysis method for the multiple light scattering by the scattering media highly doped with particles. In this method, the film in which particles were precipitated in a single layer was set to be a basic component. We traced the rays which entered these components sequentially.

- LITp/  
FMCp - 6**      **Investigation of Novel Diffuser Films for 2D Light-Distribution Control**  
*M. Nishizawa<sup>\*</sup>, K. Kusama<sup>\*,\*\*</sup>, K. Sekiya<sup>\*</sup>, B. Katagiri<sup>\*</sup>,  
T. Kawakami<sup>\*</sup>, T. Uchida<sup>\*</sup>*  
*<sup>\*</sup>Tohoku Univ., Japan*  
*<sup>\*\*</sup>LINTEC, Japan*

We synthesized high transmissive films that had 2-dimensional light distribution patterns such as square and hexagon. With the materials which showed 1-dimensional anisotropic diffusion if cured with a tube-type UV light source, arrays of UV-LEDs produced films of 2-dimensional distribution patterns corresponding to the symmetries of the light source arrays.

- LITp/  
FMCp - 7**      **Thermal Dissipation Behavior Outward the Epoxy Mold of High-Power LED**  
*Y.-T. Bang, B.-H. Kim, D.-H. Kim, B.-K. Bae, K.-M. Park,  
J.-H. Bin, E.-J. Im, Y.-S. Lim, M.-R. Lee, M.-R. Son,  
C.-H. Moon*  
*Hoseo Univ., Korea*

Thermal dissipation behavior outward the epoxy mold of 4 chip LED package was investigated. Finite Volume Method (FVM) simulation was conducted to estimate the temperature distribution around the LED chip and the package. Thermal infrared (IR) image was obtained by FLIR T-250 IR microscopy camera to compare with it.

**LITp/  
FMCp - 8      Critical Dot Dimension to Eliminate Dot Pattern  
Mura for Edge LED TV**

*C.-C. Hu, K.-Y. Chang, L. Sun*

*Shenzhen China Star Optoelect. Tech., China*

A novel approach to eliminate Dot Pattern Mura, which is commonly observed in Edge LED TV, has been developed. The approach is to develop an equation to determine critical dot dimension for light guide plate for edge LED TV. This approach is set up from theoretical study and experiments.

**LITp/  
FMCp - 9      High Transmittance LCD by Using the Color-  
Matching Backlight**

*G. S. Lim, C. G. Son, H. J. Jeon, J. S. Gwag, G. J. Park\*,  
J. H. Kwon*

*Yeungnam Univ., Korea*

*\*Sunlin Univ., Korea*

A new LCD with high transmittance is developed by employing the color-matching backlight system that consists of the RGB LEDs and a micro lenticular lens array (MLLA). It is shown that the LCD transmittance can be increased by 230%.

**LITp/  
FMCp - 10      LED Coupler Lens Array for One Dimensional  
Collimating Backlight**

*H. W. Yang, H. H. Lin, J. C. Hsu, N. Y. Pao*

*ITRI, Taiwan*

A one dimensional collimating Backlight system has been developed in using LED coupler lens array. The light out through the backlight system has a high-collimating emitting property, in which the simulation FWHM is smaller than  $3.8^\circ$ . The FWHM of the prototype is collimated to  $8^\circ$ .

**LITp/  
FMCp - 11      Spiral Optical Fiber Configuration for Laser  
Backlight Applications**

*Y. Okuda, N. Mori, I. Fujieda*

*Ritsumeikan Univ., Japan*

We propose to guide optical power from a laser diode through an optical fiber arranged in a spiral manner. The guided light leaks out via the grooves fabricated on one side of the optical fiber. This simple light-guiding structure can reduce the cost of an LD-based backlight system.

**Author Interviews and Demonstrations**

18:00 – 18:50

Friday, December 9

9:00 - 10:20	Room 131
<b>FMC5: Materials</b>	

Chair: D. Lu, Henkel China, China  
 Co-Chair: T. Nonaka, AZ Elec. Materials, Japan

**FMC5 - 1      Latest Advances on Liquid Optically Clear  
 9:00            Adhesives for Display Applications**

*D. Lu, J. Wang, R. Zhang, C. Li, J. Yuan, J. Sawanobori\*,  
 J. Lin\*\*, A. Litke\*\*\*, M. Levandoski\*\*\*, P. Malanaphy\*\*\*,  
 J. Serenson\*\*\**

*Henkel China, China  
 \*Henkel Japan, Japan  
 \*\*Henkel, USA  
 \*\*\*Henkel of America, USA*

This paper will provide a comprehensive overview on the latest liquid optically clear adhesive (LOCA) technologies for touch panel and LCD assembly, including materials, application process, and performance, the recent technology trend of TFT-LCD polarizer, and Henkel's new LOCAs with ultra-low viscosity and excellent performance for next generation polarizer applications.

**FMC5 - 2      Novel Anti-Static Hard-Coat Film Formed by  
 9:20            Inorganic Oxide Nano-Particles Having Chain-Like  
                  Morphology**

*R. Muraguchi, Y. Hakoshima, M. Matsuda, T. Hirai,  
 M. Komatsu*

*JGC Catalysts & Chems., Japan*

Inorganic oxide nano-particles with pre-controlled chain-like morphology have been able to reduce the amount added to its limit, thus an optically transparent Hard-Coat layer with Anti-Static function could be achieved with only one coat using Ultra-Violet curable coating liquid which consists of the nano-particles, UV curable resins and organic solvents.

**FMC5 - 3      Development of Low Resistance ITO Film for  
 9:40            Capacitive Touch Screen Panel**

*T. Nashiki, D. Kajihara, M. Haishi, H. Sugawara*

*Nitto Denko, Japan*

For capacitive touch screen panel, lower resistance is demanded to improve input performance. Also, crystallized ITO layer is required for durability and optical properties. We report on the ITO crystallization technology and the low resistance technology that demands for the touch screen panel.

**FMC5 - 4      Novel Damage-Resistant Glass for Mobile Display Cover**  
**10:00**

*K. Hayashi, S. Akiba, J. Endo, T. Nakashima*  
*Asahi Glass, Japan*

A new damage-resistant glass for mobile display protection is introduced. The glass had better chemical strengthening characteristic than conventional soda-lime glass. The abraded strength of the glass was nearly 10 times higher than that of soda-lime glass. The glass is produced by float process which is suitable for stable supply.

----- Break -----

<b>10:40 - 11:40</b>	<b>Room 131</b>
<b>FMC6: Measurements</b>	

Chair: T. Shimada, Hokkaido Univ., Japan  
 Co-Chair: T. Unate, UNATE, Japan

**FMC6 - 1      Overview of Strength Tests for LCD Substrates and Panels**  
**10:40**

*S. T. Gulati, J. T. Westbrook, H. K. Vepakomma, T. Ono\*, J. S. Kim*  
*Corning, USA*  
*\*Corning Tech. Ctr., Japan*

The common test methods for measuring strength of thin glass substrates and LCD panels are reviewed. Specifically, 2-point, 3-point and 4-point bend tests, ring-on-ring test, and ball on ring test are discussed to help to select an appropriate test method for either proof testing or quantifying products strength.

**FMC6 - 2      A Mechanics Framework for Ball-Drop Test with Strengthened Glass**  
**11:00**

*H.-L. Lin, Y.-L. Chen, Y.-C. Liu, W.-C. Yang, M.-S. Chen, T. Huang*  
*AU Optronics, Taiwan*

Besides the surface resistibility by strengthened glass, the edge strength also affected the height of ball-drop test (BDTH). The increasing of shifted distance of impact position from edge, the BDTH was higher. From DOE experiments, the ball weight and impact position were the main-factors of the BDTH.

**FMC6 - 3: Invited Ultrasensitive and Rapid Measurement of Water Vapor Transmission Rate in Barrier Materials**

11:20

*T. Shimada, Y. Takahashi\*, T. Kanno\*\**

*Hokkaido Univ., Japan*

*\*TI, Japan*

*\*\*MORESCO, Japan*

We have developed an instrument for ultrasensitive ( $<10^{-6}$  g/m<sup>2</sup>/day) and rapid ( $<1$  day) measurement of water vapor transmission rate in gas barrier materials. Water vapor that has permeated through the barrier in atmospheric carrier gas is condensed by a cold trap and transferred to mass spectrometer in ultrahigh vacuum.

----- Lunch -----

**13:20 - 14:40**

**Room 131**

**FMC7: Manufacturing Technologies (1)**

Chair: C. Kurthen, Appl. Materials, Germany

Co-Chair: T. Nonaka, AZ Elec. Materials, Japan

**FMC7 - 1 A New Mask-Less Exposure Method for Flat Panel Displays**

13:20

*M. Mizumura, K. Fukaya, T. Iwamoto, T. Ando, M. Kanai, H. Otsuka, K. Kajiyama*

*V Tech., Japan*

We have been developing a new mask-less exposure head for FPD panels. The exposure head can make a fine pattern at 1  $\mu$ m in resolution. Also since the head can generate the exposure pattern up to 200 kHz, the throughput is remarkably improved in comparison with usual mask-less exposure head.

**FMC7 - 2 Micro Lens Array Scanning Exposure Method for Flat Panel Displays**

13:40

*M. Hatanaka, M. Mizumura, K. Kajiyama*

*V Tech., Japan*

A new scanning exposure system using MLA has been developed for FPD. A unique MLA projection exposure method has been applied. The MLA chip consists of 4 quartz glass plates, on both sides of which micro lenses are formed. The system can make a fine pattern with 2.5  $\mu$ m in resolution.



**FMC7 - 3: Invited Roll-to-Roll Manufacturing of Electronic Devices**

14:00

*C. Kurthen, R. Kukla, T. Deppisch, H. G. Lotz, N. Morrison*

*Appl. Materials, Germany*

Sputter roll coaters are being used nearly 30 years. Now new products like Touch Panels challenge the production equipment with enhanced requirements. This paper describes these requirements and how an advanced system such as the modular R2R coater platform SmartWeb can provide high quality deposition at low cost of ownership.

**FMC7 - 4 Touch Panel Deposition Process Development by Multi-Chamber Roll to Roll Type Sputter Equipment**

14:20

*G. Isoya, H. Honma, M. Hasegawa, S. Yamada, M. Sato, H. Kawamura, N. Tani, K. Saitou, S. Fujimoto, T. Hirono, I. Tada, H. Hirano*

*ULVAC, Japan*

Optimal deposition process for high-quality touch panel fabrication is developed by utilizing Multi-chamber Roll to Roll Type Sputter Equipment. This deposition process supports the traditionally, heavy used resistance type as well as capacitive type touch panel and also contributes to the quality improvement and price-reduction of touch panel.

----- Break -----

<b>15:00 - 16:20</b>	<b>Room 131</b>
<b>FMC8: Manufacturing Technologies (2)</b>	

Chair: R. Yamaguchi, Akita Univ., Japan

Co-Chair: S. Asari, ULVAC, Japan

**FMC8 - 1 Ultra Thin Glass Roll for Flexible AMOLED Display**

15:00

*T. Murata, T. Yanase, S. Miwa, H. Yamazaki*

*Nippon Elec. Glass, Japan*

Ultra thin glass roll, 50  $\mu\text{m}$  thick, 800 mm wide and over 100 m of long, has been successfully produced. The roll has high flexibility, smooth surface, high thermal stability and excellent impermeability to gases. The roll is useful for flexible AMOLED display driven by amorphous oxide TFTs.

**FMC8 - 2      Highly Heat Resistive Al-Alloy Thin Film for Gate Interconnections of Low-Temperature Poly-Silicon Thin Film Transistors**

**15:20**

*T. Kugimiya, H. Okuno, A. Miki  
Kobe Steel, Japan*

We have developed a new highly heat resistive Al-alloy thin film for gate interconnections of low-temperature poly-silicon-thin film transistors. Conventional refractory metal films such as Mo-alloy can be replaced by the proposed alloy system that is stable until 600°C with a low resistivity of  $\sim 5.0 \mu\Omega\text{cm}$  in future trend.

**FMC8 - 3:    *Invited*    Solution-Processed Organic Thin Film Transistors with Sputtering Gate Electrodes**

**15:40**

*H. Na, K. M. Kim, J. E. Lee, C. B. Park, J. U. Bae,  
C. D. Kim, M. Jun, Y. K. Hwang  
LG Display, Korea*

We have fabricated a 6-in. VGA Flexible electrophoretic display driven by solution-processed OTFTs with sputtering S/D metal (Cu/MoTi) and gate electrodes (Cr). We have used SAM treatment for low contact resistance, anthracene derivative for solution-processed organic semiconductor, and sputtering resistance layer, which shows mobility of  $\sim 0.1 \text{ cm}^2/\text{V}\cdot\text{sec}$  with on-off current ratio of  $\sim 10^5$ .

**FMC8 - 4      Developing of Advanced Technology on Liquid Crystal Panel Manufacturing**

**16:00**

*K. Kimura, T. Nakazono, K. Kitada, S. Koshio, T. Yura  
Nitto Denko, Japan*

This paper presents Developing of Advanced Technology on Liquid Crystal Manufacturing, which is an innovative manufacturing method to unify cutting process and laminating process of polarizer to LC cells.

**Author Interviews and Demonstrations**

16:20 – 17:10

**Supporting Organizations:**

The Japanese Society of Printing Science and Technology  
Japan Society of Colour Material  
The Technical Association of Photopolymers, Japan  
The Society of Photographic Science and Technology of Japan  
RadTech Japan  
The Japanese Research Association for Organic Electronics Materials  
Japan Electronics Packaging and Circuits Association

# Workshop on Plasma Displays

Wednesday, December 7

15:40 - 17:00

Room 231

## PDP1: Novel PDP

Chair: L. F. Weber, Consult., USA

Co-Chair: M. Uchidoi, Panasonic, Japan

### PDP1 - 1: *Invited* Plasma Display Technologies Leading the Future of a Super-Large-Area Display Era

*T. Shinoda, K. Awamoto, M. Ishimoto, H. Hirakawa*

*Shinoda Plasma, Japan*

PDPs are always leading development of large area display and making a new display field. The first 42-in. PDP has created a large FP-TV market and has changed the display culture of home. More large area displays are required for a life size display and PDP technologies contribute future world.

### PDP1 - 2 Arrays of Coplanar Electrode Microcavity Plasma Devices Fabricated in Aluminum Foil

16:00

*H. Wang, Z. Liang, Z. He, C. Liu, X. Zhang, Y. Hai*

*Xi'an Jiaotong Univ., China*

Arrays of coplanar electrode microcavity plasma devices have been fabricated in aluminum foil using photo lithography, wet etching, electrochemical anodic oxidation and other processes. It has advantages of high voltage margin, simple structure, and operating stably in Ne atmosphere, which make it possible to simplify the structure of traditional PDP.

### PDP1 - 3L: *Invited* Processing Issues of $\text{Ca}_x\text{Mg}_{1-x}\text{O}(\text{CMO})$ Protecting Layer for High Luminous Efficacy PDP

16:20

*Q. Yan, Z. Lu, F. Xing, X. Zhang, C. Tang, L. Chen, X. Deng, D. Peng\**

*Sichuan Shiji Shuanghong Display Device, China*

*\*Sichuan Changhong Elec., China*

Replacing MgO with  $\text{Ca}_x\text{Mg}_{1-x}\text{O}(\text{CMO})$  film as new protective layer can significantly improve luminous efficacy for PDP. Special processes are developed to prevent forming Calcium carbonate during PDP production. Good crystallinity of CMO is key to resist surface contamination. FTIR is used to monitor the carbonate formation during the PDP process.

**PDP1 - 4L: *Invited* Effects of Sealing Conditions on Firing Voltages of PDPs with (Mg, Ca)O Protective Layer**  
16:40  
*Y.-S. Kim, S.-Y. Kim*  
*Hongik Univ., Korea*

Effect of evacuation temperature on the firing voltage of test panels with (Mg,Ca)O protective film was evaluated. The results indicated that decomposition of compounds formed during sealing process could occur if proper evacuation conditions were selected.

----- Break -----

<b>17:20 - 18:20</b>	<b>Room 231</b>
<b>PDP2: Driving</b>	

Chair: Q. Yan, Changhong COC Display Device, China  
Co-Chair: T. Shinoda, Shinoda Plasma, Japan

**PDP2 - 1 Low Voltage and Wide Margin Erase Addressing of PDPs by Using Wall Charge Adjusting Pulse**  
17:20  
*Y. Morioka, T. Shiga*  
*Univ. of Electro-Commun., Japan*

A wall charge adjusting pulse is adopted to reduce the wall charges accumulated on the scan and display electrodes. This allows a use of higher scan voltage, resulting in low data voltage and wide operating-voltage margin. 40 V data voltage and 15.6 V margin are obtained with 0.67  $\mu$ s scanning speed.

**PDP2 - 2 Temperature Dependence of Address Discharge Characteristics for Write-Address and Erase-Address Methods in AC PDPs**  
17:40  
*M. Yoshita, Y. Hashimoto, T. Shiga*  
*Univ. of Electro-Commun., Japan*

Exo-electron emission increases at high temperature, thus write-address discharge delay becomes shorter and wall voltage after addressing becomes lower due to recombination. Exo-electron emission does not influence the erase-address discharge delay. But the delay becomes larger at high temperature since the other priming particles reduce the wall voltage before addressing.

PDP

**PDP2 - 3L      Effect of Intensified Discharge Nearby Ribs on PDP Performance**  
**18:00**

*S. Nagano*  
*Samsung SDI, Korea*

Discharge nearby ribs is intensified by forming proper clearance between ribs and the discharging front panel surface or by changing rib material to lower permittivity. This brings lower driving voltage or higher luminance. Besides, its luminous efficacy is even or rather higher In spite of larger discharge current.

**Author Interviews and Demonstrations**  
**18:40 – 19:30**

**Thursday, December 8**

<b>9:00 - 12:00</b>	<b>Room 222-224</b>
<b>Poster PDPp: Plasma Displays</b>	

**PDPp - 1      Comparative Studies about Visible Light Distribution between Measurement and 3D Optical Simulation**

*S. Eom, H.-M. Park, J. Kang*  
*Dankook Univ., Korea*

In this paper, the visible light distributions of PDP were examined. The light distributions from measurement and simulation were similar each other and the positions of high intensity region were almost identical. The difference of normalized green light intensities between measured and calculated data was less than 9%.

**PDPp - 2      Study on Emissive Characteristics of Four Different Sustain-Waveforms in AC PDPs**

*J. Park, J. Kang*  
*Dankook Univ., Korea*

In this paper, four different sustain-waveforms for ac-PDP were studied. The luminance, IR emission and current of sustain discharge were measured for four cases and these were compared to the results of a conventional. The proposed waveform showed 20% higher luminance and 55.6% higher efficiency than the conventional.

**PDPp - 3      Study on Large Cell Characteristics Using PDP Discharge**

*T. J. Kweon, Y.-S. Seo, S.-C. Kim, H.-H. Kim, Y.-S. Kim, Y.-J. Park*  
*Samsung SDI, Korea*

In this paper, we have studied a promising device for large cell flat panel display using PDP discharge. The discharge panel has high performance, an efficiency of 3.6 lm/W and the luminance 2,000 cd/m<sup>2</sup>.

**PDPp - 4      Effect of Impurity in Discharge Gas on High  $\gamma$  Properties of CeSrO Film**

*Y. Yamauchi, Y. Fukui, Y. Honda, M. Okafuji, M. Sakai,  
M. Nishitani, Y. Yamauchi\**

*Panasonic, Japan*

*\*NIMS, Japan*

We have investigated the degradation mechanism of high  $\gamma$  properties by the specially arranged demountable chamber system. CeSrO film is a high  $\gamma$  protective layer and is hardly deteriorated by sealing process. But the film is not recovered due to the CO<sub>2</sub> gas remaining in pumping process.

**PDPp - 5      Preparation of YAGG:Ce Phosphors Using Nano-Sized Al<sub>2</sub>O<sub>3</sub> and Their Photoluminescence Properties under VUV Excitation**

*M. Wu, S. Choi, H.-K. Jung*

*Korea Res. Inst. of Chem. Tech., Korea*

Ce-doped yttrium aluminum gallium garnet (YAGG:Ce) as a green-emitting phosphor was synthesized. Its photoluminescence properties under VUV excitation were investigated. The Al<sub>2</sub>O<sub>3</sub> phase and fluxing agents affected the luminescence characteristics of the phosphors. Especially, the nano-sized  $\gamma$ -Al<sub>2</sub>O<sub>3</sub>, and the combination of  $\alpha$ -Al<sub>2</sub>O<sub>3</sub>-BaF<sub>2</sub> and  $\gamma$ -Al<sub>2</sub>O<sub>3</sub>-AlF<sub>3</sub> resulted in the improvement of luminance.

**15:00 - 16:20**

**Room 231**

**PDP3: Protective Layer**

Chair: Y.-S. Kim, Hongik Univ., Korea

Co-Chair: R. Murai, Panasonic, Japan

**PDP3 - 1      CeSrO Protective Layer for Low-Voltage-Driving PDPs**

**15:00**

*Y. Honda, Y. Fukui, Y. Yamauchi, M. Okafuji, M. Sakai,  
M. Nishitani*

*Panasonic, Japan*

CeSrO protective layer has superior chemical stability against annealing at 500°C in air which simulate sealing process, and the sustain voltage is 50 V lower than that of MgO layer under the discharge gas of Ne/Xe = 85/15, 60 kPa.

**PDP3 - 2      Study on Protective Layer of MgO Thin Film Covered with CaO Powder**

15:20

A. Iwamoto<sup>\*</sup>, Y. Morita<sup>\*,\*\*</sup>, M. Nishitani<sup>\*,\*\*</sup>, M. Terauchi<sup>\*,\*\*</sup>,  
T. Tsujita<sup>\*,\*\*</sup>, I. Ueno<sup>\*</sup>, T. Nakayama<sup>\*</sup>, K. Yoshino<sup>\*,\*\*</sup>,  
K. Okuyama<sup>\*</sup>

<sup>\*</sup>Panasonic, Japan

<sup>\*\*</sup>Osaka Univ., Japan

We proposed a new protective layer, CaO powder / MgO formed by MgO thin film that was partly covered (15%) with CaO powder. An analysis of surface chemical composition revealed that there was MgCaO layer on the surface of the protective layer after discharge and it determined the firing voltage.

**PDP3 - 3      Effects of Ne/Xe Gas Mixture Ratio on Sputtering Rate of MgO Protective Layer**

15:40

K. Yoshino<sup>\*,\*\*</sup>, K. Nomoto<sup>\*</sup>, M. Goto<sup>\*</sup>, R. Murai<sup>\*</sup>,  
T. Tsujita<sup>\*,\*\*</sup>, M. Terauchi<sup>\*,\*\*</sup>, Y. Morita<sup>\*,\*\*</sup>, M. Nishitani<sup>\*,\*\*</sup>,  
M. Kitagawa<sup>\*</sup>

<sup>\*</sup>Panasonic, Japan

<sup>\*\*</sup>Osaka Univ., Japan

The effects of the Ne/Xe gas mixture ratio on the sputtering rate of the MgO protective layer were investigated by using panels and calculating results. With increases in the Xe concentration, the sputtering rate was increased and decreased in the Xe concentration range of 10~50% and 50~100%, respectively.

**PDP3 - 4L: *Invited* Address Discharge Characteristics of PDP with High Gamma Cathode Material and MgO Functional Layer**

16:00

K.-W. Whang, H.-W. Cheong, O. Kwon, T.-H. Lee,  
M.-S. Yoon

Seoul Nat. Univ., Korea

In this research, the address discharge characteristics of AC PDP with MgO-SrO double cathode layer and a functional layer made of MgO nano-powder were investigated. With a newly designed reset waveform, the voltage margin and address delay characteristics could be significantly improved.

**Author Interviews and Demonstrations**

18:00 – 18:50

**Sponsor:**

Plasma Display Technical Meeting

# Workshop on EL Displays and Phosphors

Wednesday, December 7

17:20 - 18:40

Room 234

## LIT3/PH1: Phosphors for Lighting

Chair: R.-S. Liu, Nat. Taiwan Univ., Taiwan  
Co-Chair: K. Hara, Shizuoka Univ., Japan

### LIT3/ PH1 - 1: **Invited Approach for Realization of Comfortable Lighting Environment Using LED**

17:20 *T. Kotani*

*Toshiba Lighting & Tech., Japan*

As luminous efficacy of white LEDs improves, white LEDs are expected to contribute to energy saving of lighting. However, the principle of the light emission of white LEDs is different from those of existing light sources. How can we make a comfortable space with LED lighting?

### LIT3/ PH1 - 2: **Invited White LED for General Lighting: Suppression of Discomfort Glare and Wide Emitting Angle**

17:50 *A. Nomura, O. Kuboyama, K. Enomoto, S. Sugimori,  
H. Daicho*

*Koito Manufacturing, Japan*

We developed the white LED with newly shape and emitting characteristics, compared to conventional LEDs. We realized wider emitting angle, high luminous flux, and moderate luminance all together. These properties can lead to lighting up a whole space uniformly without uncomfortable glare. Thus, our LED is suitable for general lighting.

### LIT3/ PH1 - 3: **Color-Tunable Fluorosulfide Phosphors for Solid- State Lighting: Structure and Luminescence Investigations**

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

*Nat. Chiao Tung Univ., Taiwan*

A novel  $Y_2(Ca,Sr)F_4S_2:Ce^{3+}$  fluorosulfide phosphor, was synthesized and its crystal structure was refined with Rietveld method.  $Y_2(Ca,Sr)F_4S_2:Ce^{3+}$  can be efficiently excited by blue light and shows yellow-to-orange broadband emission at 553-590 nm. Possible mechanism of the tunable luminescence properties was explained on the basis of the band structure calculations.

## Author Interviews and Demonstrations

18:40 – 19:30



## Thursday, December 8

9:00 - 10:30

Room 231

**PH2: Phosphors in EL**

Chair: R. Withnall, Brunel Univ., UK

Co-Chair: S. Okamoto, NHK, Japan

**PH2 - 1: Invited Properties Control of Colloidal Quantum Dots and Their Application to the QD Display**

9:00

*K.-S. Cho, T.-H. Kim, E. K. Lee, J. W. Kim, S. Y. Lee, B. L. Choi, J. M. Kim**Samsung Elect., Korea*

The size and surface of quantum dots (QDs) largely affect the band structure of them and the control of QD ordering changes the charge transport properties of QD devices. In this talk, the issues of QD property control and its application to the full-color QD display will be presented.

**PH2 - 2: Invited Recent Progress in Red Light-Emitting Diodes with Eu-Doped GaN**

9:30

*Y. Fujiwara, A. Nishikawa, Y. Terai**Osaka Univ., Japan*

A new type of red light-emitting diode has been developed using Eu-doped GaN. The LED can emit characteristic emission due to the intra-4f shell transitions of  $\text{Eu}^{3+}$  ions at room temperature. By optimizing several parameters, the output light power became larger by more than one order than before.

**PH2 - 3: Invited High-Luminance Electroluminescence Device Using Submicron-Sized Phosphors**

10:00

*S. H. Park, T. W. Jeong, M. J. Bae, S. J. Song, J. H. Lee, I. T. Han**Samsung Elect., Korea*

We introduce the fabrication of thin powder-type EL device. It can take both merits of thin film-type and powder-type EL devices which relate to the steep luminance property to the applied voltage and the flexibility of devices by using submicron-sized phosphors, respectively.

----- Break -----

10:40 - 12:05

Room 231

**PH3: Phosphors in General**

Chair: D. Y. Jeon, KAIST, Korea

Co-Chair: T. Hisamune, Mitsubishi Chem., Japan

**PH3 - 1: 10:40 *Invited* Aluminum Nitride Based Phosphors for Field Emission Display***R.-S. Liu, T.-C. Liu, T.-M. Chen\*, Y. Nakanishi\*\***Nat. Taiwan Univ., Taiwan**\*AU Optronics, Taiwan**\*\*Shizuoka Univ., Japan*

Semiconductor AlN doped with  $\text{Eu}^{2+}$  as a possible blue phosphor has been synthesized. Si was introduced to enhance  $\text{Eu}^{2+}$  dissolve in AlN lattice. Intense and thermal stable blue emission centered at 465 nm was observed and make AlN:  $\text{Eu}^{2+}$  a potential phosphor for field emission display.

**PH3 - 2 11:10 Surface Studies of  $\text{Y}_2\text{O}_3\text{:Eu}$ ,  $\text{YAG:Ce}$ ,  $\text{Y}_2\text{O}_2\text{S:Pr}$  and  $\text{Gd}_2\text{O}_2\text{S:M}$  ( $\text{M} = \text{Pr}$  or  $\text{Tb}$ ) Phosphors***J. Silver, R. Withnall, T. G. Ireland, X. Yan, K. Saltoun, J. J. Ojeda**Brunel Univ., UK*

Surfaces of  $\text{Y}_2\text{O}_3\text{:Eu}$  and  $\text{Y}_2\text{O}_2\text{S:Pr}$  phosphors, as well as pure  $\text{Y}_2\text{O}_3$ , showed evidence of reactions with the atmosphere. No evidence of such reactions was found on the surfaces of commercial phosphor samples protected with silica. Surfaces of samples of both in-house and commercial YAG:Ce showed no evidence of atmospheric reactions.

**PH3 - 3 11:30 Displaying Latent Fingerprints Using Phosphor Nanopowders***R. Withnall, J. Silver, A. Reip**Brunel Univ., UK*

Surface modified  $\text{Y}_2\text{O}_3\text{:M}^{3+}$  (where  $\text{M} = \text{Eu}$  or  $\text{Tb}$ ) nanometre sized phosphor particles were successfully synthesised and used to visualize fingerprints making use of the photoluminescent emission from the particles. The surface modifications manifested great adherence to the fingerprint residue even after a one year period.

pH

**IDW Best Paper Award**

This award will go to the most outstanding paper selected from those presented at IDW '11.

The 2011 award winners will be announced on the IDW website: <http://www.idw.ne.jp/award.html>

**PH3 - 4L**      **Defect Estimation of  $\text{Eu}^{2+}$ -Doped Green-Emitting Sr-sialon Phosphor by Electron Spin Resonance Measurement**

11:50

*Y. Fukuda, R. Hiramatsu, N. Matsuda, M. Kato*  
*Toshiba, Japan*

To investigate factors that affect photoluminescence efficiency, the synthesis and characterization of green-emitting  $(\text{Sr}_{0.9}\text{Eu}_{0.1})_3\text{Si}_{13}\text{Al}_3\text{O}_2\text{N}_{21}$  were carried out. The results of ESR and photoluminescence properties suggest that defects in the host crystal might be the origin of the color center which lowers the photoluminescence efficiencies of this phosphor.

----- Lunch -----

13:20 - 16:20

Room 222-224

**Poster PHp: Phosphors**

**PHp - 1**      **Synthesis of Red, Green, and Blue Nanophosphors for Demonstration of Full-Color Transparent Panels of Plasma Display**

*W. S. Song, K. H. Lee, H. Yang*  
*Hongik Univ., Korea*

Highly transparent red, green and blue emissive layers were generated by screen-printing hydrothermally synthesized  $\text{Y}(\text{V,P})\text{O}_4:\text{Eu}$ ,  $\text{LaPO}_4:\text{Ce,Tb}$ , and  $\text{Y}(\text{V,P})\text{O}_4:\text{Tm}$  nanophosphors, respectively. Utilizing the respective nanophosphor layers deposited on glass substrate, red-, green-, and blue-luminescing transparent panels of plasma display with a conventional device scheme were demonstrated along with a full-color panel.

**PHp - 2**      **Structural and Luminescent Properties of  $\text{Ca}_{15}\text{Si}_{20}\text{O}_{10}\text{N}_{30}:\text{Eu}^{2+}$**

*W. B. Park, S. P. Singh, Y. Jung, K.-S. Sohn*  
*Sunchon Nat. Univ., Korea*

New oxynitride phosphors,  $\text{Ca}_{15}\text{Si}_{20}\text{O}_{10}\text{N}_{30}:\text{Eu}^{2+}$ , were synthesized at  $1525^\circ\text{C}$  under an atmosphere  $\text{N}_2$ . Unlike well known  $\alpha$ -SiAlON,  $\text{Ca}_{15}\text{Si}_{18}\text{Al}_2\text{O}_{12}\text{N}_{28}:\text{Eu}^{2+}$  contain a larger number of calcium ions in the structure in the Pa-3 space group and the lattice size, (the lattice parameters  $a=b=c=15.48978 \text{ \AA}$ ,  $\alpha=\beta=\gamma=90^\circ$ ) was larger than typical Ca- $\alpha$ -SiAlON phosphors.

**PHp - 3      Effect of Temperature on the Structure and PL Intensity of Sr-Al-Si-O-N System Synthesized by GPS (Gas Pressured Sintering) Method**

*J. W. Park, J. H. Lee, K.-S. Sohn*

*Sunchon Nat. Univ., Korea*

Sr-Al-Si-O-N systems were screened by a Gas Pressure Sintering. The resultant phosphors were phase-identified, and the photo luminescences were examined. The Sr-Al-Si-O-N phosphors are blue-Green and orange in color and emit in the region of 520-630 nm depending on synthesized temperature. These materials can be used as novel conversion phosphor for White-LEDs.

**PHp - 4      Heuristics-Assisted Combinatorial Search for New Phosphate Phosphors for Use in the Light Emitting Diodes**

*K. H. Son, S. P. Singh, J. H. Kim, Y. J. Song, K.-S. Sohn*

*Sunchon Nat. Univ., Korea*

Genetic algorithm (GA) and particle swarm optimization (PSO), the most well-known population-based Heuristics, were used along with high throughput synthesis for discovery of new phosphors in  $\text{Eu}^{2+}$ -doped alkali-alkaline earth-phosphahte system. We pinpointed a promising phosphor, which could be used in white light emitting diodes.

**PHp - 5      Improved Degradation Characteristics of  $\text{Eu}(\text{TTA})_3\text{phen}$  by Thermal Treatment in Organic Solvent**

*S. Akiyama, N. Funaki, T. Fukuda, Z. Honda, Y. Ishimaru, N. Kamata*

*Saitama Univ., Japan*

Optical degradation characteristics of  $\text{Eu}(\text{TTA})_3\text{phen}$  were improved by annealing in N,N-dimethylformamide (DMF). In addition, photoluminescence (PL) and PL excitation spectra of solvent-annealed  $\text{Eu}(\text{TTA})_3\text{phen}$  were almost the same as the original  $\text{Eu}(\text{TTA})_3\text{phen}$ . This result suggests that the solvent-annealing in DMF is benefit to improve the long-term stability of  $\text{Eu}(\text{TTA})_3\text{phen}$ .

**PHp - 6      White-Emitting Organic Dye-Dispersed Hybrid Electroluminescent Device**

*C. Suzuki, Y. Noguchi, T. Uchida, T. Satoh*

*Tokyo Polytechnic Univ., Japan*

A powder electroluminescence device is a field luminescence device that can be fabricated by simple printing process. However, as powder EL devices have drawbacks such as low brightness and low color purity. To broaden the scope of applications, it is necessary to improve their brightness, color purity, and white-emitting quality.

**PHp - 7 Multiple-Annealing Process Effects on Fabrication of Well-Aligned ZnO Nanostructures***C. Li, D. Wang, T. Kawaharamura, Z. Li, M. Furuta**Kochi Univ. of Tech., Japan*

A novel multiple- annealing process was developed for forming well-aligned ZnO nanostructures on as-deposited ZnO thin films at a low temperature. It was found that oxygen annealing between two reducing annealing processes contributed to introduce much oxygen vacancies into the films resulting at forming efficiently nanostructures.

**PHp - 8 Thin-Film Electroluminescent Devices Fabricated Using Bi- and Eu-Coactivated La<sub>2</sub>O<sub>2</sub>S Phosphors***Y. Nishi, T. Miyata, T. Minami**Kanazawa Inst. of Tech., Japan*

The luminescent characteristics in La<sub>2</sub>O<sub>2</sub>S:Bi,Eu phosphor thin films were investigated. Relative to the original unsulfurized lanthanum oxide phosphor thin films, the resulting La<sub>2</sub>O<sub>2</sub>S:Bi,Eu thin films exhibited broadened PL excitation spectra with a red-shift and enhanced PL and EL intensities. In addition, the La<sub>2</sub>O<sub>2</sub>S:Bi,Eu thin films produced a high luminance in red EL emission.

**PHp - 9 PL and EL Characteristics in Eu-Activated Multicomponent Oxy-sulfide Thin-Film Phosphors Using Various Ba-La-O-S Host Materials***T. Hirano, Y. Nishi, T. Miyata, T. Minami**Kanazawa Inst. of Tech., Japan*

Red-emitting phosphor thin films using various Eu-activated multicomponent oxy-sulfides were prepared by sulfurizing oxide phosphors after magnetron sputtering deposition. Intense photoluminescent (PL) and electroluminescent (EL) emissions with spectral changes were observed from phosphor thin films prepared with various Eu contents using multicomponent Ba-La-O-S, Sr-La-O-S or Ca-La-O-S as a host material.

**PHp - 10L Thermal Analysis Depend on Different Phosphor Structure of White LED***H. H. Kim, Y. H. Cha, Y. H. Kim, D. H. Ryu, H. J. Park, J. W. Lee**LG Display, Korea*

Most of previously conducted studies related to phosphor focused on efficiency and color characteristics. However, the phosphor certainly affects the thermal and reliability performances. In this paper thermal characteristic of different phosphor layers such as dispersion, remote, and conformal type are analyzed by a commercialized simulation tool with experimental results.

**PHp - 11L      Enhancement the Color-Gamut of Displays Using Tantalate Based and Aluminate-Based CCFL Phosphors**

*Y.-C. Fang, X.-R. Huang, S.-Y. Chu*

*Nat. Cheng Kung Univ., Taiwan*

Development of CCFL green phosphors with high stability, efficiency, color purity and color gamut which can be well applied to lighting and display. The  $\text{La}_{0.95}\text{Tb}_{0.05}\text{TaO}_4$  and  $\text{Ce}_{0.67}\text{Tb}_{0.33}\text{Mg}_{0.88}\text{Mn}_{0.12}\text{Al}_{11}\text{O}_{19}$  exhibits 78% and 105% of the standard NTSC color gamut, respectively. Results indicate they can be applied in illumination devices and displays.

**PHp - 12L      Characteristics of EL Devices by External Sintering ZnS-Phosphors Sealed in Vacuum-tube**

*N. Taguchi, M. Susaki\*, M. Taniguchi\*\*, Y. Uraoka\*\**

*Image Tech, Japan*

*\*Osaka Pref. Univ. College of Tech., Japan*

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

We achieved a higher luminance of  $630 \text{ cd/m}^2$  in EL devices employing ZnS phosphors which were sintered in a quartz type vacuum tube using an electric furnace. Moreover, it was found that EL characteristics were extremely sensitive to the degree of external sintering temperatures.

**PHp - 13L      Photo- and Cathodoluminescent Properties of  $\text{ZnAl}_2\text{O}_4$  Powder Doped with Heavy Metal**

*H. Kominami, T. Iguchi, S. Namba, Y. Nakanishi, K. Hara*

*Shizuoka Univ., Japan*

Heavy metal doped  $\text{ZnAl}_2\text{O}_4$  phosphor which shows UV emission under the EB excitation has been investigated for the UV devices. The emission wavelength of  $\text{ZnAl}_2\text{O}_4$  was controllable by the doping. From the PLE spectra, it is thought that the energy level of oxygen vacancy was depended on the doped materials.

**PHp - 14L      Low-Temperature Synthesis of Single-Crystal AlN Particles by Chemical Vapor Deposition for Phosphor Applications**

*M. Fukazawa, T. Mori, H. Kominami, Y. Nakanishi, K. Hara*

*Shizuoka Univ., Japan*

The fabrication of AlN single-crystal particles at low reaction temperatures from 1350 to  $1400^\circ\text{C}$  have been achieved by the chemical vapor method using  $\text{AlCl}_3$  and  $\text{NH}_3$  as sources. The mechanism of particle formation was discussed in terms of the balance of nuclear generation and crystal growth processes.

- PHp - 15L      Synthesis of  $\text{SrSiN}_2\text{:Eu}^{2+}$  Deep Red-Emitting Phosphor for White-LEDs by New Synthetic Process**  
*S. H. Cheong, A. Kirakosyan, D. S. Kang\*, D. Y. Jeon*  
*KAIST, Korea*  
*\*Univ. of Southern California, USA*

The luminescence properties of deep red-emitting  $\text{Eu}^{2+}$  activated  $\text{SrSiN}_2$  were optimized for application to blue light-emitting diodes (LEDs). This phosphor can be synthesized at low temperature, lower than  $1200^\circ\text{C}$ , and this phosphor showed broad red emission peaking at 720 nm under 450 nm blue excitation.

----- Break -----

13:20 - 16:20

Room 222-224

**Poster LITp/PHp: Phosphors**

- LITp/  
PHp - 1      Embedding Manganese-Doped Zinc Sulfide Quantum Dots in Gallium Nitride LEDs Based on Photonic Crystals**  
*J. Silver, X. Yan, R. Withnall, G. R. Fern, J. W. S. Sumner\*, P. Shields\*, D. Allsopp\**  
*Brunel Univ., UK*  
*\*Univ. of Bath, UK*

Doped quantum dots (ca. 3.3(1) nm size) of  $\text{ZnS:Mn}$  phosphor have been synthesized and their photoluminescence (PL) properties have been characterised. The particles were successfully drop cast into the holes in a photonic crystal grown in the layers of a GaN LED crystal (previously grown on a sapphire substrate).

- LITp/  
PHp - 2      Iron-Doped Lithium Aluminate Embedded in Polypropylene as a Potential Infra-Red Emitter for Stimulating Plant Growth**  
*J. Silver, R. Withnall, R. Li, A. L. Lipman, P. J. Marsh, G. R. Fern, K. Tarverdi, P. Bishop\*, B. Thiebaut\**  
*Brunel Univ., UK*  
*\*Johnson Matthey Tech. Ctr., UK*

Iron doped lithium aluminate,  $\text{LiAlO}_2\text{:Fe}$ , has been synthesized and produced on an industrial scale. The excitation and emission characteristics of this phosphor, both as a pure powder and embedded in polypropylene, are reported. The phosphor has applications for use as a UV degradation inhibitor when embedded in polymers.

LITp/  
PHp - 3

**Incorporating Cerium-Doped Yttrium Aluminium Garnet (YAG:Ce<sup>3+</sup>) Nanophosphors into Gallium Nitride LEDs Based on Photonic Crystals**

*R. Withnall, J. Silver, C. Catherall, T. G. Ireland, G. R. Fern, J. W. S. Sumner\*, P. Shields\*, D. Allsopp\*, P. W. Reip\*\*, S. Subbiah\*\**

*Brunel Univ., UK*

*\*Univ. of Bath, UK*

*\*\*Intrinsic Materials, UK*

YAG:Ce<sup>3+</sup> nanometre sized particles have been synthesized on an industrial scale and their photoluminescence (PL) properties have been characterised. The particles were successfully drop cast into the holes in a photonic crystal etched within the layers of a GaN LED crystal (previously grown on a sapphire substrate).

LITp/  
PHp - 4

**Thermal Quenching of the Luminescence of Some LED Phosphors**

*R. Withnall, J. Silver, T. G. Ireland*

*Brunel Univ., UK*

The thermal quenching of the luminescence of different families of phosphors has been investigated in order to assess the suitability of using these phosphors on LED chips operating in the 25-200°C temperature range. Thermal quenching properties of garnet, nitride and alkaline earth silicate phosphors are reported.

LITp/  
PHp - 5

**Modular Type LED Package with Silicone Light-Guide Layer for Improved Luminance Uniformity of a Backlight Unit**

*J. K. Yoon, M. J. Jin, J. B. Choi, H. J. Park, J. W. Lee*

*LG Display, Korea*

In this study, a modular type package structure with optimized Light-guide Layer is proposed to achieve broad radiation characteristics with the fewest LEDs for direct-light type BLUs. Light-guide Layer combined with integrated optical lenses (IOL) is capable of achieving uniform luminance distribution by assisting light emitted from luminous light sources.

LITp/  
PHp - 6

**Photometric and Colorimetric Characteristics of White-LED Composed of Four Primary Colors**

*K. Misono*

*Miyakonojo Nat. College of Tech., Japan*

We investigated the luminous efficacy, color rendering index and color gamut of white-LED composed of four primary colors: red, yellow, green and blue. The candidates of spectral power distributions of RYGB that achieve luminous efficacy $\geq 350$  (lm/Wrad), Ra $\geq 90$  (Group 1A) and %Gamut1=140 $\pm$ 10% were obtained.



**LITp/  
PHp - 7**

**Fabrication of  $\text{CuInS}_2/\text{ZnS}$  Quantum Dot-Polymer Composite Plate for Application to White Light-Emitting Diodes**

*D.-E. Nam, W.-S. Song, H.-J. Kim, J. C. Lee, E.-P. Jang, H. Yang*

*Hongik Univ., Korea*

Yellow-emitting  $\text{CuInS}_2/\text{ZnS}$  core/shell quantum dots with a quantum yield of 65% were prepared by a consecutive solvothermal technique. QD composite plate was generated by blending with pre-polymerized methyl methacrylate and drying. White LEDs were fabricated by placing QD-plate onto a blue LED chip and their optical properties were evaluated.

**LITp/  
PHp - 8**

**Effect of Li Doping on High Color Purity  $\text{CaTiO}_3:\text{Eu}$  Red Phosphor for Solid-State Lighting**

*Y.-F. Wu, Y.-T. Nien, Y.-J. Wang, I.-G. Chen*

*Nat. Cheng Kung Univ., Taiwan*

In this study,  $\text{Li}^+$  was co-doped in  $\text{CaTiO}_3:\text{Eu}^{3+}$  to study its effect on photoluminescence and color purity. This incorporation of  $\text{Li}^+$  ion into the  $\text{CaTiO}_3:\text{Eu}^{3+}$  system could not only increase the photoluminescence intensity of 1.6 times but also enhance the color purity to 92.1%.

**LITp/  
PHp - 9**

**Withdrawn**

**LITp/  
PHp - 10**

**Spectral Evaluations of Color Rendering Properties of LED Light Sources by Using Hyper Spectral Sensor**

*H. Seki, K. Uto, Y. Kosugi*

*Tokyo Inst. of Tech., Japan*

By using Hyper Spectral Sensor, mainly featured with very high wavelength resolution, we measured spectral reflectance of color samples under D65 standard illuminant and testing LED light sources. It was confirmed that the method can be applied to evaluate spectral and quantitative color rendering properties of LED light sources.

**LITp/  
PHp - 11**

**Chromatic Measurement Using Two-Dimensional Imaging Colorimeter**

*C. H. Cho, Y. S. Chang, C. W. Lo*

*ITRI, Taiwan*

To meet the demand of quick colorimetric measurement in industry, we proposed a two-dimensional colorimeter which shares a configuration of color filter analyzer. The luminance and chromaticity of each point within wide field of view are deduced. Real-field test result with comparison of current commercial machine is also provided.

**LITp/  
PHp - 12****Precise Luminance and Color Temperature Control  
for BRCR Measurement System***Y. Wang, Y. Tang, J. Zhang, Y. Zheng**Southeast Univ., China*

A novel BRCR measurement system is presented with a color mixing algorithm ensuring relative error below 5% which is insensitive to color coordinate changes of LEDs caused by manufacturing error, aging, etc. Its color temperature adjustable range is 3,000~10,000 K. Maximum luminance is among 1,600~3,000 lx with different color temperature setting.

**LITp/  
PHp - 13L****Luminous Efficiency of White LEDs with Different  
Spatial Phosphor Distributions for LCD Backlighting***G. Y. Park, D. J. Jun, D.-G. Kim, H. J. Park, J. W. Lee**LG Display, Korea*

In this paper, optical effects of dispersed, conformal and remote phosphor structures for LED package are studied while maintaining identical color coordinates for each type of structure. In conclusion, we have found that the luminous efficiency is strongly influenced by backward light scattered from a phosphor layer.

**LITp/  
PHp - 14L****Investigation into Various Color Beta SiAlON:  
Eu<sup>2+</sup> and Its Influence on Efficiency of White LEDs  
and Color Gamut of LCDs***A. Ohishi<sup>\*,\*\*</sup>, R. Ohtsuka<sup>\*</sup>, T. Hisamune<sup>\*</sup>**<sup>\*</sup>Mitsubishi Chem., Japan**<sup>\*\*</sup>Mitsubishi Chem. Group S&T Res. Ctr., Japan*

We succeeded in producing beta type-(Si,Al)<sub>8</sub>(O,N)<sub>8</sub>:Eu<sup>2+</sup> (beta SiAlON) that had various emission spectra and high efficiency. We investigated its influence on white LED efficiency in which beta SiAlON was used for the green component and the color gamut of LCDs with LED backlights.

**Author Interviews and Demonstrations**

18:00 – 18:50

**Supporting Organizations:**

The 125th Research Committee on Mutual Conversion between  
Light and Electricity, Japan Society for Promotion of Science  
Phosphor Research Society, The Electrochemical Society of Japan

# Workshop on Field Emission Display and CRT

Friday, December 9

9:00 - 9:05

Room 232

## Opening

### Opening Remarks

9:00

*M. Takai, Osaka Univ., Japan*

9:05 - 10:35

Room 232

## FED1: CNT Emitters & Applications

Chair: C. J. Lee, Korea Univ., Korea

Co-Chair: M. Sasaki, Univ. of Tsukuba, Japan

### FED1 - 1: *Invited* Optimization of CNT Emitters for Field Emission Device Applications

9:05

*Y.-H. Song<sup>\*,\*\*</sup>, J.-W. Kim<sup>\*,\*\*</sup>, J.-T. Kang<sup>\*</sup>, J.-W. Jeong<sup>\*</sup>,  
S. Choi<sup>\*</sup>, J. T. Moon<sup>\*</sup>*

*<sup>\*</sup>ETRI, Korea*

*<sup>\*\*</sup>Univ. of S&T, Korea*

The carbon nanotube (CNT) emitters were optimized in terms of both process and device structure for various field emission device applications. The field emission lamp requires a triode CNT emitter configuration on a large glass substrate meanwhile the X-ray sources need a very large emission current with high temperature durability.

### FED1 - 2: *Invited* Development of Backlight and X-ray Source Based on Printed Carbon Nanotube Field Emitters

9:35

*Y. C. Kim, I. H. Kim, S. H. Park, T. W. Jung, D. Y. Kim,  
I. T. Han, Y. H. Kim, J. M. Kim*

*Samsung Advanced Inst. of Tech., Korea*

Recent results and technical issues on CNT based backlight panel with additional X-ray source. Mainly on the performance of the printed CNTs together with issues on the architecture of the devices are intensively discussed.

**FED1 - 3: Invited Direct Grown Carbon Nanotubes Emitter for Field Emission Devices**  
**10:05**

*K. C. Park, A. N. Ha, S. W. Lee, W. M. Bae, H. C. Woo,  
Y. J. Eom, J. Jang  
Kyung Hee Univ., Korea*

The carbon nanotube emitters on silicon substrate were grown for field emission devices. CNT emitters were grown with the resist-assisted patterning (RAP) process. The emitters have unique properties, such as silicon coating on emitters, robust on mechanical stress, and enhanced electron emission.

----- Break -----

**10:45 - 11:55**

**Room 232**

**FED2: CNT Emitters & Novel Devices**

Chair: M. Takai, Osaka Univ., Japan  
Co-Chair: Y. H. Song, ETRI, Korea

**FED2 - 1: Invited Carbon Nanotube Based Point Typed Field Emitters**  
**10:45**

*D. H. Shin, Y. Song, Y. Sun, J. H. Shin, C. J. Lee  
Korea Univ., Korea*

Point-typed field emitters show promise for x-ray sources and electron beam sources. Here, fabrication methods of the several types of carbon nanotube point emitters will be introduced, and their field emission properties will be investigated in detail.

**FED2 - 2 Large Emission Current from CNT Point Emitters Fabricated by the Free Standing CNT Film**  
**11:15**

*D. H. Shin, J. H. Shin, Y. Sun, Y. Song, C. J. Lee  
Korea Univ., Korea*

Carbon nanotube (CNT) point emitters were fabricated by free standing CNT films. The point emitters showed large emission current up to 3.0 mA at the electric field of 2.34 V/ $\mu\text{m}$  and good emission stability over 24 hr. Moreover, the emitted electrons were focused well without any focusing lens.

**FED2 - 3 Proposition of Novel Photo-Cathode by Surface Plasmon Resonance and Its Emission Property**  
**11:35**

*Y. Neo, T. Matsumoto\*, C. H. Chen, T. Aoki, H. Mimura  
Shizuoka Univ., Japan  
\*Stanley Elec., Japan*

The new photocathode consisting of a prism and metal film is proposed. We had optimally designed the thickness to use surface plasmon resonance and successfully obtained the photo emission current and confirmed the relationship between reflective ratio and emission. It showed the enhancement of emission current as predicted theoretically.

FED2 - 4      Withdrawn

----- Lunch -----

13:20 - 14:40	Room 232
<b>FED3: FE Materials &amp; Structures (1)</b>	

Chair: H. Mimura, Shizuoka Univ., Japan  
 Co-Chair: Y. C. Kim, Samsung Advanced Inst. of Tech., Korea

**FED3 - 1      Field Emission from Atomically Thin Edges of  
 13:20      Reduced Graphene Oxide**

*K. Murakami, H. Yamaguchi<sup>\*</sup>, G. Eda<sup>\*\*</sup>, T. Fujita<sup>\*\*\*</sup>,  
 P. Guan<sup>\*\*\*</sup>, W. Wang<sup>\*\*\*\*</sup>, C. Gong<sup>\*\*\*\*</sup>, J. Boisse<sup>\*</sup>,  
 S. Miller<sup>\*</sup>, M. Acik<sup>\*\*\*\*</sup>, K. Cho<sup>\*\*\*\*</sup>, Y. J. Chabal<sup>\*\*\*\*</sup>,  
 M. Chen<sup>\*\*\*</sup>, F. Wakaya, M. Takai, M. Chhowalla<sup>\*</sup>*  
*Osaka Univ., Japan*  
*<sup>\*</sup>Rutgers Univ., USA*  
*<sup>\*\*</sup>Imperial College London, UK*  
*<sup>\*\*\*</sup>Tohoku Univ., Japan*  
*<sup>\*\*\*\*</sup>Univ. of Texas, USA*

Electron emission from thin edges of reduced graphene oxide were investigated by field emission microscopy (FEM) and in-situ field ion microscopy (FIM). The FEM images consisted of alternating bright and dark fringe bands, while the FIM image showed an array of bright spots. These results suggest the electron wave interference.

**FED3 - 2      Field Emission from the Edge of Highly Oriented  
 13:40      Pyrolytic Graphite (HOPG)**

*H. Tsurumi, T. Higuchi, Y. Yamada, M. Sasaki*  
*Univ. of Tsukuba, Japan*

We have already observed superior field emission characteristics from the carbonized mechanical pencil lead. To clarify the mechanism, in this paper, we examine field emission from the highly oriented pyrolytic graphite (HOPG) edge and find that the edge of graphite is not responsible for the superior field emission characteristics.

**FED3 - 3      Field Emission Property of Titanium-Oxide  
 14:00      Nanostructure Fabricated on Glass Substrate with  
                  Control of Density and Length**

*F. Wakaya, T. Nakatani, S. Abo, M. Takai*  
*Osaka Univ., Japan*

Density and length of titanium-oxide nanostructures on a glass substrate were successfully controlled by changing NaOH immersion time and annealing temperature, respectively. Electron field emission from the nanostructures was observed. It is pointed out that high electric field surface treatment without annealing provides very low temperature process.

**FED3 - 4      Vertical Thin Film FEA Based on Ion-Induced Bending**  
**14:20**

*T. Yoshida, M. Nagao*  
*AIST, Japan*

A field-emitter-array (FEA) fabrication process based on conventional thin-film microfabrication process was developed. The emitting tip of this FEA was formed by vertically bending thin film using ion-induced bending technique. The procedural advantages of IIB are that it uses small quantities of material and non-specialized equipment.

----- Break -----

**FED**

<b>15:00 - 16:20</b>	<b>Room 232</b>
<b>FED4: FE Materials &amp; Structures (2)</b>	

Chair: K. C. Park, Kyung Hee Univ., Korea  
 Co-Chair: F. Wakaya, Osaka Univ., Japan

**FED4 - 1      Comparison of Field Emission Properties between Hafnium Nitride and Niobium Nitride Field Emitter Arrays**  
**15:00**

*Y. Gotoh, K. Ikeda, H. Tsuji*  
*Kyoto Univ., Japan*

Electron emission properties of niobium nitride field emitter arrays (NbN-FEAs) and hafnium nitride field emitter arrays (HfN-FEAs) were investigated. The HfN-FEA showed a higher current than the NbN-FEA and showed a good stability comparable to the NbN-FEA.

**FED4 - 2      Measurements of Work Function of W(100) Modified by Nd Oxide by Using PEEM and FEM**  
**15:20**

*T. Kawakubo, T. Kitaguchi\*, H. Nakane\**  
*Kagawa Nat. College of Tech., Japan*  
*\*Muran Inst. of Tech., Japan*

It is well known that the work function of W(100) surface is reduced when the surface is modified by transition metal oxide. In this research, we measured the work function of W(100) modified by neodymium oxide by using PEEM and FEM. Two resultant values were in fairly good agreement.

**FED4 - 3      Effects of Anodization Current Density and Time on Porous Silicon Morphology and Electron Emission Characteristics**  
**15:40**

*Y. Zhang, X. Duan, X. Zhang, W. Wang, C. Liu*  
*Xi'an Jiaotong Univ., China*

Porous silicon (PS) electron emitter with a structure of metal/PS/Si/metal is obtained for FED. The pore diameter of PS increases as anodization current density increases. The thickness of PS and the threshold voltage of electrons emission increase as anodization current density and time increase. The maximum emission efficiency is 7.5%.

**FED4 - 4**      **Effects of Electrochemical Oxidation Treatment on**  
**16:00**        **Ballistic Electron Surface-Emitting Display of**  
                  **Porous Silicon**

*W. Du, Y. Zhang, X. Duan, X. Zhang, W. Wang*  
*Xi'an Jiaotong Univ., China*

BSD is a promising electronic source for FED. With electrochemical oxidation current density and time increasing, threshold voltages of BSD increase while the maximum efficiency decrease. Electro-forming appears which lead to dramatic increase in emission current. The linear fitted F-N curves demonstrate field-induced tunneling process occurs in oxide film.

**Author Interviews and Demonstrations**

16:20 – 17:10

**Sponsor:**

JSPS 158th Committee on Vacuum Nanoelectronics

## **EXHIBITION**

12:40 – 18:00 Wednesday, Dec. 7, 2011

10:00 – 18:00 Thursday, Dec. 8, 2011

10:00 – 14:00 Friday, Dec. 9, 2011

2F, 3F Lobby, Bldg. 2

Nagoya Congress Center

Free admission with your registration name tag

## **Evening Get-Together with Wine**

Tuesday, December 6, 2011

18:00 – 20:00

at Skyview Restaurant Pastel (7F),

Nagoya Congress Center

(Sponsored by Merck Ltd., Japan)

See page 10 for details

# Workshop on OLED Displays and Related Technologies

Wednesday, December 7

14:00 - 15:20

Room 141

## LIT1/OLED1: OLED for Lighting Application

Chair: Y. Kijima, Sony, Japan

Co-Chair: T. Ikuta, JNC Petrochem., Japan

### LIT1/OLED1 - 1: *Invited* World's First All Phosphorescent OLED Product for Lighting Application

14:00

*T. Tsujimura, K. Furukawa, H. Ii, H. Kashiwagi, M. Miyoshi, S. Mano\*, H. Araki\*, A. Ezaki\**

*Konica Minolta Tech. Ctr., Japan*

*\*Konica Minolta Holdings, Japan*

A world's first OLED lighting product using all phosphorescent emitters is reported. Blue phosphorescent emitting system enables very high luminous efficacy as a commercial product: 45 lm/W. It is a debut of phosphorescent lighting product in human history. Merits of all phosphorescent OLED and its device decay modeling are also discussed.

### LIT1/OLED1 - 2: *Invited* Efficient White PIN OLED Structures with Internal and External Light Outcoupling Enhancement

14:25

*D. Pavičić, Y. Shen, F. Löser, C. Rothe, T. W. Canzler, S. Murano, O. Fadhel, M. Hofmann, Q. Huang, A. Haldi, A. Werner, J. Birnstock*

*Novalled, Germany*

Bottom and top emission white and monochrome PIN OLED structures with efficient outcoupling method based on vacuum-processable materials are reported. In combination with external microlens array film, a power efficiency of 60 lm/W at 1000 cd/m<sup>2</sup> with colour coordinates of 0.47/0.43 and CRI of 87 has been demonstrated.

### LIT1/OLED1 - 3: *Organic Light-Emitting Diodes with Enhanced Out-Coupling Efficiency Using High Refractive Index Glass Frit*

14:50

*T. Yagi, Y. Yamada, H. Kang\*, R. Satoh*

*Samsung Yokohama Res. Inst., Japan*

*\*Samsung Elect., Korea*

We fabricated a novel type of substrate for Organic light-emitting diodes (OLEDs). It was fabricated by forming a flat layer using a high refractive index B<sub>2</sub>O<sub>3</sub>-SiO<sub>2</sub>-Bi<sub>2</sub>O<sub>3</sub> glass on the light diffusive glass substrate. By preventing total reflections, light out-coupling efficiency was improved more than 1.6 times higher.



**LIT1/  
OLED1 - 4  
15:05**      **Two Different types of Organic Quantum Well  
Structures on High Efficiency White Organic Light  
Emitting Devices**

*Y.-C. Chen, M.-H. Wu, S.-Y. Chu*

*Nat. Cheng Kung Univ., Taiwan*

In this study, the effect of MQW structures adopting two different types organic materials have been demonstrated (C545T and TPBi). Brightness, current efficiency was significantly enhanced with a NPB/C545T MQW structure being inserted. The mobility was measured to account for this, which demonstrated the effect of two different MQW structures.

----- Break -----

**15:40 - 16:57**

**Room 141**

**OLED2: Organic TFTs**

Chair: K. Nakayama, Yamagata Univ., Japan

Co-Chair: H. Kuma, Idemitsu Kosan, Japan

**OLED2 - 1: *Invited* Improvements in Stability of Polymer-TFT  
15:40      Devices for Flexible Displays**

*S. Tokito, D. Kumaki*

*Yamagata Univ., Japan*

We have realized highly stable polymer-based thin-film transistor (TFT) devices consisting of liquid-crystalline semiconducting polymer and fluorinated-polymer gate insulator materials. These devices were prepared with spin coating processes, and the source-drain electrode surfaces were specially treated with an aqueous solution of molybdenum oxide in order to decrease their contact resistance.

**OLED2 - 2      Flexible QQVGA AMOLED Display with Organic  
16:05      TFTs**

*S. Steudel, K. Myny, S. Schols, P. Vicca, S. Smout,  
A. Tripathi\*, B. van der Putten\*, J.-L. van der Steen\*,  
M. van Neer\*, F. Schütze\*\*\*, O. R. Hild\*\*\*,  
E. van Veendendaal\*\*, M. van Mil\*\*, J. Genoe,  
G. Gelinck\*, P. Heremans*

*imec, Belgium*

*\*TNO/Holst Ctr., the Netherlands*

*\*\*Polymer Vision, the Netherlands*

*\*\*\*Fraunhofer IPMS, Germany*

We present a QQVGA top emitting monochrome AMOLED display with 85 dpi resolution using an organic TFT backplane on low temperature PEN-foil. The aperture ratio of the top-emitting OLEDs is over 75%. For operation at 10 V supply voltage, the brightness of the display using red, green or blue OLEDs exceeds 200 cd/m<sup>2</sup>.

**OLED2 - 3: *Invited* A Large-Area, Flexible Active Matrix Display  
16:20 Circuit Using High-Definition Screen Printing**

*T. Sekitani<sup>\*,\*\*</sup>, T. Someya<sup>\*,\*\*</sup>*

*<sup>\*</sup>Univ. of Tokyo, Japan*

*<sup>\*\*</sup>JST, Japan*

We report high-definition screen-printing technologies for manufacturing large-scale, all-printed organic transistor integrated circuits on plastic films. The printed transistors exhibit a mobility as high as  $0.18 \text{ cm}^2/\text{Vs}$  and on/off ratio  $\sim 10^6$ . Using the printed transistors, large-area active matrices with 2-mm periodicity were constructed for application to large-area sensors and displays.

**OLED2 - 4L Effect of Methanol on the High Mobility Pentacene  
16:45 Field Effect Transistors with Silk Fibroin as the Gate Dielectric**

*C.-H. Wang, J.-C. Hwang*

*Nat. Tsing Hua Univ., Taiwan*

We present pentacene OFETs with the water-insoluble silk fibroin film by a post-treatment with methanol as the gate dielectric. The water-soluble silk fibroin dielectric exhibit high field-effect mobility value ( $\mu_{\text{FE,sat}}$ )  $25 \text{ cm}^2/\text{Vs}$ . The  $\mu_{\text{FE,sat}}$  degrade to  $8.1 \text{ cm}^2/\text{Vs}$  owing to the formation of  $\beta$ -sheet crystalline structure in the water-insoluble silk fibroin film.

----- Break -----

OLED

17:20 - 18:40

Room 141

**AMD1/OLED3: AMOLED**

Chair: S.-H. K. Park, ETRI, Korea

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

**AMD1/  
OLED3 - 1 A Polycrystalline Oxide TFT Driven AMOLED  
Display**

17:20

*Y. Terai, T. Arai, N. Morosawa, K. Tokunaga,  
E. Fukumoto, T. Kinoshita, T. Fujimori, T. Sasaoka*

*Sony, Japan*

We developed a high mobility polycrystalline oxide semiconductor, IGO, TFT for the AM-OLED display. The mobility was over  $20 \text{ cm}^2/\text{Vs}$  and the shift of the threshold voltage after PBTS was smaller than 0.3 V. Moreover, the high resistance of polycrystalline IGO to HF etchant reduced a photolithography process.

**AMD1/  
OLED3 - 2  
17:40**      **A Novel Pixel Circuit Employing Pre-Charging  
Method for Large Area AMOLED Display**  
*S.-Y. Lee, B. Kim, Y. W. Lee, S.-J. Kim, M.-K. Han*  
*Seoul Nat. Univ., Korea*

We have proposed a new voltage modulated AMOLED pixel design employing the fast  $V_{\text{data}}$  storage and verified with SPICE simulation. The proposed pixel employing pre-charging method exhibits faster voltage memorizing time than the conventional 6T1C pixel circuit. It would be suitable for the high resolution and large area AMOLED display.

**AMD1/  
OLED3 - 3  
18:00**      **A New High-Speed LTPS-TFT Pixel Circuit with  
Highly Stable OLED Current for 3D AMOLED  
Displays**  
*P.-Y. Kuo, W.-Y. Chang, C.-C. Hung, K.-W. Chou,  
C.-L. Lin*  
*Nat. Cheng Kung Univ., Taiwan*

A new pixel structure and its driving scheme based on simultaneous emission for 3D AMOLED displays are proposed. The proposed pixel circuit can compensate both the threshold voltage variation of TFT and power line IR-drops at high-speed operation, and the current error rate of the proposed circuit is below 5%.

**AMD1/  
OLED3 - 4  
18:20**      **An External Compensated Method for AMOLED  
Display Based on Current Feedback**  
*F.-C. Chang, P.-Y. Kuo, C.-D. Tu, C.-L. Lin*  
*Nat. Cheng Kung Univ., Taiwan*

This work proposes a pixel circuit with an external compensated structure for AMOLED displays by using the LTPS process. Based on the simulation results, the OLED current is independent of the threshold voltage of TFTs and the variation is smaller than 50 nA while the  $\Delta V_{\text{TH}}$  is  $\pm 0.5$  V.

#### **Author Interviews and Demonstrations**

18:40 – 19:30

## **EXHIBITION**

12:40 – 18:00 Wednesday, Dec. 7, 2011

10:00 – 18:00 Thursday, Dec. 8, 2011

10:00 – 14:00 Friday, Dec. 9, 2011

2F, 3F Lobby, Bldg. 2  
Nagoya Congress Center

Free admission with your registration name tag

## Thursday, December 8

9:00 - 12:00

Room 222-224

**Poster OLEDp: OLED Technologies****OLEDp - 1    Withdrawn****OLEDp - 2    Pentacene Based Thin Film Transistor with Bi-layer MoO<sub>3</sub>/Au Electrode***M. W. Alam, Z. Wang, S. Naka, H. Okada  
Univ. of Toyama, Japan*

We have investigated top contact organic thin-film transistors (OTFTs) with bilayer MoO<sub>3</sub>/Au electrode. We have found that the device performance and carrier mobility has been improved significantly by insertion of small amount of MoO<sub>3</sub> layer. The highest field-effect mobility (0.72 cm<sup>2</sup>/ (Vs)) is achieved by 5 nm MoO<sub>3</sub> device.

OLED

**OLEDp - 3    Light-Emitting Organic Photovoltaic Devices Based on Dye-Doped P3HT: PCBM Blends***Y. Lou, Z. Wang, S. Naka, H. Okada  
Univ. of Toyama, Japan*

We demonstrate an organic device based on small molecular dye rubrene-doped P3HT: PCBM blends, which show photovoltaic (PV) properties with a power conversion efficiency 1.05% and electroluminescence (EL) properties with a maximum luminance 65 cd/m<sup>2</sup> under reverse-biased condition under illumination and by forward-biased condition, respectively.

**OLEDp - 4    Bipolar Material Containing Carbazole and 1,2,4-Triazole for Electrophosphorescent Host Application***Y. Chen, J.-W. Wu, C.-S. Wu  
Nat. Cheng Kung Univ., Taiwan*

A bipolar compound (CTF) consisting of hole-transporting carbazole, electron-transporting 1,2,4-triazole, and spirofluorene was synthesized. It was blended with polyvinyl carbazole (PVK) to improve the performance of electrophosphorescent device [ITO/PEDOT:PSS/PVK+CTF:Ir(ppy)<sub>3</sub>/BCP(10 nm)/Ca(50 nm)/Al(100 nm)]. The maximum current efficiency was enhanced to 9.9 cd/A from 5.6 cd/A of PVK-based device.

**OLEDp - 5    Solution Processable Phosphorescent Red Luminescent Polymer for OLED Devices**

*R. Adhikari, A. Postma, J.-H. Li, K. Arima, T. Hirai,  
H. Shimizu, M. Bown, K. Ueno*

*CSIRO Materials Sci. & Eng., Australia*

Narrow dispersity linear and multi-arm red emitter polymers with good solution processability were synthesized by the Reversible addition-fragmentation chain transfer (RAFT) mediated radical polymerization using tris-cyclometalated Ir(piq)<sub>3</sub> dopant RAFT agent and styryl functionalized host monomer. In this paper, the photo-physical properties of monomers, polymers and preliminary device results are discussed.

**OLEDp - 6    Improvement of Properties of Organic Light Emitting Diodes with Various Hole Injection Materials**

*R. Ito, H. Yamauchi, M. Kawamura, Y. Abe, K. H. Kim*

*Kitami Inst. of Tech., Japan*

We have investigated properties of OLEDs with ZnO as a HIL and its optimum thickness was found to be 0.5 nm. Lower operating voltage of the OLED with ZnO HIL compared to those with other HILs seems to be caused by a lower barrier height between HIL and HTL.

**OLEDp - 7    Energy Transfer Mechanism of OLED Using Two Fluorescence Dopants in Single Emissive Layer**

*Y. H. Kim, N. H. Kim, J. A. Yoon, C.-B. Moon, P. S. Kim\*,  
W. Y. Kim*

*Hoseo Univ., Korea*

*\*BOE Tech. Group, China*

Organic light-emitting diodes (OLEDs) with single emissive layer structures using C545T and DCJTb of two fluorescent dopants in MADN host were fabricated and characterized their electrical and optical properties with different dopants concentrations. Förster energy transfer was observed between host and dopants in the device.

**OLEDp - 8    Optimization of Charge Trapping and Doping Concentration in an Emission Layer for High Efficiency Phosphorescence OLED**

*Y. J. Doh, W. S. Jeon, J. H. Kwon*

*Kyung Hee Univ., Korea*

We report optimization methods of charge trapping and doping concentration in an emission layer for high efficiency phosphorescence OLED. A high external quantum efficiency of 20.7% in a green phosphorescent OLED is demonstrated with these optimization methods.

### OLEDp - 9 Solution-Processed Organic Light-Emitting Diode Fabricated by Electrospray Deposition Method with Additional Solvent

*T. Fukuda<sup>\*,\*\*</sup>, H. Asaki<sup>\*,\*\*</sup>, T. Asano<sup>\*,\*\*</sup>, K. Takagi<sup>\*,\*\*</sup>,  
Z. Honda<sup>\*</sup>, N. Kamata<sup>\*</sup>, T. Aoyama<sup>\*\*</sup>, J. Ju<sup>\*\*</sup>,  
Y. Yamagata<sup>\*\*</sup>*

*<sup>\*</sup>Saitama Univ., Japan*

*<sup>\*\*</sup>RIKEN, Japan*

We demonstrated the smooth surface roughness of the poly[9,9-dioctylfluorenyl-2,7-diyl]-co-1,4-benzo-(2,1,3)-thiadiazole (F8BT) thin film fabricated by the electrospray deposition technique. The root mean square roughness of the F8BT thin film was reduced by the addition of dimethyl sulfoxide in tetrahydrofuran. Furthermore, the organic light-emitting diode was also demonstrated by this method.

### OLEDp - 10 Electrical Annealing for Flexible Organic Light-Emitting Diodes Having Poly(3,4-Ethylenedioxythiophene): Poly(Styrene Sulfonate) Anodes

*H. G. Jeon, C. Y. Cho, Y. H. Huh, B. Park*

*Kwangwoon Univ., Korea*

We herein present efficient light emission from flexible organic light-emitting diodes (FOLEDs) having conductive polymer anodes on a polyethersulfone substrate. We have successfully demonstrated high bright and efficient solution-processed green FOLEDs, which show a peak luminescence of 6,100 cd/m<sup>2</sup> and a maximum current efficiency of 16.4 cd/A.

### OLEDp - 11 A Novel Stereoscopic AMOLED Display

*S.-C. Chu, H.-S. Lin, S.-H. Tseng, L.-H. Chang, Y.-H. Lin*

*AU Optronics, Taiwan*

The display is composed of an active retarder panel and an AMOLED image panel. Viewers can see 3D images without resolution loss. Besides, because of the rapid response time and high contrast ratio of AMOLED image panel, the 3D ghost effect has also been greatly reduced.

### OLEDp - 12 The Most Important Role of Filler Orientation for Gas Barrier Properties of OLED Sealant

*X. Wang, T. Kanno, H. Tabuchi<sup>\*</sup>, K. Tanaka<sup>\*</sup>, H. Usui<sup>\*</sup>*

*MORESCO, Japan*

*<sup>\*</sup>Tokyo Univ. of A&T, Japan*

Water vapor and gas barrier property is required as one of the most important properties for sealant of organic devices. By using Wide Angle X-Ray Diffraction (WAXD) and Scanning Electronic Microscope (SEM), we found that filler orientation plays the most important role for the gas barrier property in OLED sealant.

**OLEDp - 13 Moisture Barrier Property of Multilayer Structures for Thin Film Encapsulation of Flexible OLED Lightings**

*S. W. Seo, E. Jung, L. S. Bu, H. K. Chung, S. M. Cho*  
*Sungkyunkwan Univ., Korea*

ALD/MLD are applied as the hybrid multilayer, which has property for the moisture barrier for the thin film encapsulation of flexible OLEDs. Plastic substrate was used for the substrate, 7-OTS as the organic layer, TIP as inorganic layer. The moisture barrier property was estimated by measuring WVTR by Ca test.

**OLEDp - 14 Controllable Surface Plasmon Resonance in Gold Nanocomposites for Organic Light-Emitting Diodes**

*C.-Y. Chang, Y.-L. Lin, P.-J. Cheng<sup>\*</sup>, J.-A. Cheng<sup>\*\*</sup>, S.-M. Chang*

*Nat. Taipei Univ. of Tech., Taiwan*

*<sup>\*</sup>Nat. Chiao Tung Univ., Taiwan*

*<sup>\*\*</sup>Feng Chia Univ., Taiwan*

The water dispersible gold nanoparticles coordinated with various surfactants for surface plasmon enhancement were synthesized. Via moderating the refractive indexes of surfactants, the surface plasmon resonance wavelength can be varied between 520 and 570 nm. As a result, the photoluminescence efficiency of fluorescent was enhanced to be 2.7 times.

**OLEDp - 15L Optimization of Carrier-Transport Layers for Quantum Dots Based Light Emitting Diodes (QDs-LE Display)**

*Q. Khan, J. Chen, L. Wei*  
*Southeast Univ., China*

We report optimization of charge-carrier transport layer of TiO<sub>2</sub> thin films to achieve maximum possible efficiency for Quantum Dot based LED applications. Sol-gel method has been adapted for the synthesis of TiO<sub>2</sub> while annealing time has been varied to control/optimize the electrical and surface properties of these thin films.

**OLEDp - 16L Doping Influence in Organic Hole-Transport Material on Electrical Models Determined by Impedance Spectroscopy**

*J. Boizot, L. Deyra, H. Doyeux*  
*CEA/LETI Grenoble, France*

The hole-transport electrical properties of Spiro-TTB doped with F4-TCNQ were investigated using impedance spectroscopy based on single layer structure. Frequency-dependent complex impedance was measured under discrete voltages for undoped then doped STTB. Depletion zones induced only by doping were characterized and model by a specific electrical equivalent circuit.

### OLEDp - 17L Electroluminescence Properties of Light-Emitting Devices Comprising 2-Pyran-4-Ylidene-Malononitrile Conjugated Polymers

*R.-H. Lee, L.-W. Liu\**

*Nat. Chung Hsing Univ., Taiwan*

*\*Nat. Yunlin Univ. of S&T, Taiwan*

A series of main-chain type (MPFM and MPTM) and triazine-branched fluorene and thiophene copolymers (HPFM and HPTM) containing a 2-pyran-4-ylidene-malononitrile derivative were synthesized. A brightness as high as 1,031 cd/m<sup>2</sup> and an efficiency of 1.97 cd/A was achieved by the HPFM-based device.

### OLEDp - 18L Study of Self-Aligned Bank Formation Technique Using Ink-Jet Printing Method

*M. Itagaki, T. Miyabayashi\*, M. Ohmori\*, S. Suzuki\*,  
M. Murase\*\*, H. Hayashi\*\*, S. Naka\*\*\*, H. Okada\*\*\**

*Chubu S&T Ctr., Japan*

*\*Brother Inds., Japan*

*\*\*Nagoya Municipal Ind. Res. Inst., Japan*

*\*\*\*Univ. of Toyama, Japan*

For low cost fabrication process, optimization of self-Aligned (SA) bank formation technique using Ink-Jet Printing (IJP) method was studied. By mixing solvents, power efficiency of organic light-emitting diodes (OLEDs) could be improved as 3.4 lm/W.

### OLEDp - 19L High Efficiency Fluorescent Yellow Organic LED

*C.-I. Chiang, Y.-S. Wang, J.-H. Jou*

*Nat. Tsing Hua Univ., Taiwan*

We demonstrates a multi-emissive layer device architecture with smooth cascading energy levels to improve markedly the efficiency and roll-off of a fluorescent yellow organic light-emitting diode. The high quality may be attributed to the stepwise energy levels that enable a reduction in injection barriers, and a wider recombination zone.

### OLEDp - 20L White Organic Light-Emitting Devices with an Orange-Red Osmium Complex $\delta$ -Layer

*C.-Y. Chang, C.-M. Hsu, W.-T. Wu, S.-Y. Li*

*Southern Taiwan Univ., Taiwan*

White organic light-emitting diodes (WOLED) with an osmium complex emissive  $\delta$ -layer to modify C.I.E. coordinates and threshold voltage have been successfully fabricated. WOLED devices consisting of an ITO/a-NPD (30 nm)/TCTA(50 nm)/Os(bpftz)<sub>2</sub>(PPh<sub>2</sub>Me)<sub>2</sub> (0.1 nm)/mCP: Firpic(15 nm)/TAZ(30 nm)/LiF(0.5 nm)/Al(200 nm) structure performed optimized characteristics with the C.I.E. coordinates of (0.33, 0.32) and threshold voltage of 5.5 V at 1 mA/cm<sup>2</sup>.



**OLEDp - 21L White OLEDs Consisting of Stacking Emitting Layers Fabricated by One-Step Coating Using "Self-Layered Technique"***H. Sakuma, S. Atratani**Hitachi, Japan*

We developed white organic light-emitting diodes (WOLEDs) consisting of stacking emitting layers fabricated by one-step coating using a 'self-layered technique'. The current efficiency of these OLEDs was higher than that of OLEDs consisting of a single emitting layer with two kinds of dopants.

**OLEDp - 22L Solution Processed Organic Light Emitting Device with Improved Solubility of the Green Dopant***J.-Y. Liao, T.-C. Chao, J.-S. Lin, M.-R. Tseng**ITRI, Taiwan*

The solution processed green light emitting devices composed of a newly developed host material, CzDBS, and solubility improved green emitter, CF<sub>3</sub>BNO-acac, are studied. Devices with efficacies of 34.7 cd/A and 17.3 lm/W are reported with the brightness of ca. 1000 nits.

**OLEDp - 23L Highly Efficient White Light Emitting Devices Using Solution Process***J.-Y. Liao, J.-S. Lin, T.-C. Chao, M.-R. Tseng**ITRI, Taiwan*

The solution processed white light emitting devices composed of a newly developed host material, CzDBS, and orange emitter, PO-01-TB, are studied. Devices with efficacies of 36.9 cd/A and 18.4 lm/W are reported with the brightness of ca. 1000 nits.

**OLEDp - 24L Design of Electrode Edge Structure and Pentacene Film Growth for Low-Threshold-Voltage Bottom-Contact Thin-Film Transistors***T. Yamada, T. Hasegawa**AIST, Japan*

We fabricated high-performance bottom-contact pentacene thin-film transistors (mobility in the linear regime = 0.6 cm<sup>2</sup>/Vs, subthreshold slope = 0.2 V/dec, threshold gate voltage ~0 V) by designing an edge structure of the source/drain electrodes and thereby controlling the growth of polycrystalline pentacene thin films around the electrode edges.

**OLEDp - 25L Solution-Processible TIPS-Pentacene OTFT with Low Voltage Driving by Self-Assembled Monolayer Gate Dielectric**

*D. Lee<sup>\*</sup>, J. H. Lee<sup>\*</sup>, J.-S. Kim<sup>\*,\*\*</sup>, D. Y. Jeon<sup>\*</sup>*

*<sup>\*</sup>KAIST, Korea*

*<sup>\*\*</sup>Imperial College London, UK*

In this study, TIPS-PEN OTFTs were fabricated on self-assembled monolayer gate dielectric for low-driving voltage. Also, seed layer was introduced in order to enhance thin-film quality and subsequent device performance. Mobility was increased from 0.0058 cm<sup>2</sup>/V-sto 0.045 cm<sup>2</sup>/V-s with maintaining low-driving voltage characteristic.

----- Lunch -----

OLED

9:00 - 12:00	Room 222-224
<b>Poster LITp/OLEDp: OLED Technologies</b>	

**LITp/ OLEDp - 1 Thickness Dependence of J-V Characteristic for Multi-layer OLED Device Using Numerical Simulation**

*S.-G. Lee, H.-S. Kim, S.-K. Kwon, S.-H. Lee, K.-S. Kim, S.-J. Lee, Y.-H. Tak*

*LG Display, Korea*

The current density-voltage (J-V) Simulation for organic light emitting diode (OLED) was performed by using the injection-limited current (J<sub>ILC</sub>), bulk-limited current (J<sub>BLC</sub>) and interface model at heterojunction interface. The accuracy of this simulation was represented by comparing with the results from experimental data as a variable of EML thicknesses for multi-layer OLED device.

**LITp/ OLEDp - 2 Polarized White Electroluminescence from OLEDs with a Quarter-Wave Retardation Plate Films and a Reflective Polarizer**

*B. Park, Y. H. Huh, J. C. Shin, Y. C. Kim, Y. B. Kim<sup>\*</sup>*

*Kwangwoon Univ., Korea*

*<sup>\*</sup>Korea Inst. of Ind. Tech., Korea*

We present a highly polarized WOLEDs using a quarter-wave plate film and a reflective polarizer, which exhibited emissions of 14,000 cd/m<sup>2</sup> with peak efficiency of 18 cd/A and degree of polarization over 35. These are almost two times higher than those of the polarized WOLED using only a reflective polarizer.

----- Lunch -----

15:00 - 16:05

Room 141

**OLED4: Materials and Device Technologies**

Chair: T. Wakimoto, Merck, Japan

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

**OLED4 - 1: *Invited* Novel Conceptual Organic Semiconductors  
15:00 Useful for Organic Light Emitting Diodes***C. Adachi**Kyushu Univ., Japan*

We report a material having a very small energy gap between its singlet and triplet excited states,  $\Delta E_{1-3}$ , that realizes efficient up-conversion of triplet excitons into a singlet state, leading to efficient thermally activated delayed fluorescence (TADF). We demonstrate that intense TADF provides a novel pathway for high efficiency electroluminescence.

**OLED4 - 2 Highly Efficient and Stable Red Phosphorescent  
15:25 OLED Using Platinum Complex as Guest Material***H. Fukagawa, T. Shimizu, H. Hanashima\*, Y. Osada\*,  
M. Suzuki, H. Fujikake**NHK, Japan**\*Tokyo Univ. of Sci., Japan*

We demonstrate a highly efficient and stable red phosphorescent OLED using a platinum complex. The OLED exhibits a maximum external quantum efficiency of about 20% with CIE = (0.66, 0.34) and an expected half lifetime of about 10,000 h from an initial luminance of 1000 cd/m<sup>2</sup>.

**OLED4 - 3: *Invited* New Deep Blue Fluorescent Materials and  
15:40 Their Application to High Performance OLEDs***T. Arakane, Y. Kawamura, H. Kuma, M. Funahashi,  
M. Kawamura, Y. Mizuki, H. Saito, R. Naraoka,  
K. Nishimura, Y. Jinde, T. Iwakuma, C. Hosokawa**Idemitsu Kosan, Japan*

We developed highly efficient deep blue fluorescent materials for OLEDs. For top-emission blue, current efficiency of 7.5 cd/A at CIEy=0.062 were achieved with a organic capping layer. According to the optical calculation, the organic capping layer has a function to suppress the plasmon quenching of emitting dipole.

----- Break -----

16:40 - 17:50

Room 141

**OLED5: Display Technologies for Next Generation**

Chair: C. Adachi, Kyushu Univ., Japan  
Co-Chair: S. Naka, Univ. of Toyama, Japan

**OLED5 - 1: *Invited* Development of a 3-in. AMOLED Using Solution Technologies**

16:40

*T. Matsumi, T. Yoshinaga, T. Matsumoto, T. Hirano,  
T. Sasaoka  
Sony, Japan*

We have developed a 3-in. VGA-AMOLED display including our original structure, "the advanced hybrid device structure". It has separately-patterned red and green emissive layers by a printing method and a blue common layer evaporated following the hybrid connecting layer. The prototype has high-resolution and good performances for the TV applications.

OLED

**OLED5 - 2 Efficiency and Contrast Enhancement in Organic Light Emitting Device with Omnidirectional Antireflection Nanopillars**

17:05

*Y.-H. Ho<sup>\*,\*\*</sup>, C.-C. Liu<sup>\*</sup>, Y.-T. Chang<sup>\*\*</sup>, H. Liang<sup>\*</sup>,  
W.-C. Tian<sup>\*\*</sup>, P.-K. Wei<sup>\*</sup>  
<sup>\*</sup>Academia Sinica, Taiwan  
<sup>\*\*</sup>Nat. Taiwan Univ., Taiwan*

We demonstrated omnidirectional antireflection structures to improve the light extraction and reduce the ambient light reflection simultaneously. The reflectivity of the patterned polycarbonate substrate in visible wavelength was reduced to 3.3% in the optimized case. With the antireflection structure, the efficiency was improved 69% as compared to the referenced device.

**OLED5 - 3 6-in. Transparent AMOLED Based on Solid-Phase Crystallized LTPS TFTs**

17:20

*H.-H. Hsieh, H.-S. Lin, C.-C. Kao, H.-H. Chen,  
L.-Y. Cheng, C.-C. Liu, T.-C. Huang, S.-F. Hsu,  
L.-H. Chang, C.-S. Chuang, J. Wu, Y. Lin  
AU Optonics, Taiwan*

A 6 inch transparent AMOLEDs was developed based on solid-phase crystallized LTPS TFTs. For different design, the transparency at 550 nm of such see-through displays is ranged from 24% ~ 39%. Such technology renders many novel applications possible.

**OLED5 - 4      XGA OLED Micro Display for Personal Display  
17:35            Application**

*C. Y. Park, C.-H. Hyun, S.-K. Kang, B.-C. Kwak\*,  
O.-K. Kwon\**

*Samsung Mobile Display, Korea*

*\*Hanyang Univ., Korea*

A 0.6-in. XGA OLED Microdisplay was developed. Integrated driving circuit was fabricated on Si wafer backplane and white OLED aligned with color filter array on encapsulation glass at each sub pixels was fabricated to show color images. A current efficiency of 19.5 cd/A for simple stack top emitting white OLED was achieved.

**Author Interviews and Demonstrations**

18:00 – 18:50

## **SID 2012**

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## **IDW Tutorial in Japanese**

Tuesday, December 6, 2011

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Nagoya Congress Center

Detailed information is available on

<http://www.sidchapters.org/japan/>

# Workshop on 3D/Hyper-Realistic Displays and Systems

Wednesday, December 7

14:00 - 17:00

Room 222-224

## Poster 3Dp: 3D/Hyper-Realistic Displays and Systems

### 3Dp - 1      **Generating Integral Image from 3D Object by Using Oblique Projection**

*Y. Iwadate, M. Katayama  
NHK, Japan*

Oblique projection was applied to generating an integral image from a 3D object. The software was coded by OpenGL Shading Language for acceleration. It can be executed in real time with frame rate of around 10 fps for a 3D object of 90-k polygons.

### 3Dp - 2      **Stereo Video Algorithms for Conversion from Two-View to Multi-View**

*S.-C. Liu, C.-Y. Chiang  
Chunghwa Picture Tubes, Taiwan*

In this paper, we research on 2-view stereo video convert to multi-view. Calculating the relationships between stereo video, the converting algorithm could interpolate the new view videos which are captured by virtual cameras. Moreover, this work designs an acceleration mechanism in order to speed up calculating time of our system.

### 3Dp - 3      **Holographic Switch for 3D Display**

*W.-B. Hung, W.-C. Su  
Nat. Changhua Univ. of Education, Taiwan*

An electrically controllable polarization holographic gratings for switching 3D and 2D image on liquid crystal display (LCD) panel is developed in this study. We use external AC voltage to adjust the diffraction efficiency of polarization gratings generated by two opposite circular polarized writing beams in dye-doped liquid-crystal films.

### 3Dp - 4      **Active Liquid-Crystal Device for Arc 3D Display**

*C. Maeda, S. Toyama, N. Saka, H. Yamamoto,  
S. Suyama  
Univ. of Tokushima, Japan*

We propose an active liquid-crystal device for arc 3D display. This active device can switch on/off arc 3D display by changing scattered angle. This active device is composed of liquid-crystal multi-prism structure. As a result, scattered angle range can be successfully changed using active liquid-crystal device by changing applied voltage.

**3Dp - 5      Liquid Crystal Fresnel Lens for Autostereoscopic Display**

*H.-J. Im, B.-J. Lee, S.-W. Kim, Y.-K. Lee, S.-C. Lee,  
K.-M. Lim, Y.-K. Hwang*

*LG Display, Korea*

We propose a new 2D/3D switching method using the Fresnel lens effect solely caused by LC director distribution under controlled non-uniform electric field distribution. Using that, we made 55-in. 2D/3D switchable display. Our proposed structure is the most competitive in these respects of structure simplicity and process compatibility.

**3Dp - 6      The Novel Patterned Retarder 3D Display with Wideband and Wide-View Circular Polarizer**

*B. J. Mun, W. S. Kang, J. H. Lee\*, B. K. Kim\*, H. C. Choi\*,  
G. D. Lee*

*Dong-A Univ., Korea*

*\*LG Display, Korea*

We present a novel patterned retarder configuration of stereoscopic 3D display which can show the wideband and wide-viewing angle to reduce the crosstalk in the vertical direction. We calculated the retardation of each film on a Poincaré sphere. We confirmed the reduced crosstalk of the proposed configuration in vertical direction.

**3Dp - 7      Autostereoscopic 3D with Wide Viewing Angle Using Gyro-Sensor**

*H.-S. Woo, J.-M. Choi, Y.-S. Kim, S.-H. Park, J.-H. Lee,  
D.-H. Kim, J.-H. Lee, B.-K. Kim*

*LG Display, Korea*

We present a new switchable barrier concept in autostereoscopic 3D. It is realized using a moving barrier and a gyro-sensor detecting movement of an object. A major issue of autostereoscopic 3D is the limited 3D viewing angle. In this paper, we propose the solution for autostereoscopic 3D viewing angle issue.

**3Dp - 8      Glasses-Type Three-Dimensional Display System Combined with Super Multi-View Configuration**

*H.-M. Lee, J.-H. Park, N. Kim, K.-C. Kwon*

*Chungbuk Nat. Univ., Korea*

Most glasses-type three-dimensional displays have accommodation-vergence mismatch problem. Super multi-view displays address this problem by presenting numerous views with small view point separation, but the resolution loss is significant. In this report, we combined shutter glasses with super multi-view configuration, relieving accommodation-vergence mismatch with minimal resolution loss.

**3Dp - 9      Projector Type KANSEI Multimedia Display and Its Evaluation**

*A. Tomono, H. Katsuyama, S. Yamamoto\*, K. Tomono*

*Tokai Univ., Japan*

*\*Wartburg College, USA*

We propose a projector type of a new visual display system that lets a person imagine a scene of an image by emitting a scent through a screen. An airflow generator was placed behind the screen so that the display was able to present scents and airflow.

**3Dp - 10      Protruding DFD(Depth-Fused 3-D) Perception**

*H. Sonobe, K. Sadakuni, H. Yamamoto, S. Suyama*

*Univ. of Tokushima, Japan*

Perceived depth in protruding DFD (Depth-fused 3-D) display has been evaluated by changing distance between front and rear plane. Perceived protruding distance ratio decreases as the distance between two planes increases. The perceived distance protruding backward from rear plane is almost the same as distance protruding from front plane.

**3Dp - 11      Stereoscopic Depth Perception and Image Position Uncertainty in Relation with Visual Fatigue**

*S. Ge, L. Xu, C. Lin, Y. Chien*

*AU Optronics Trade, China*

3D perceived depth is compared with the theoretical designed depth, and we find that the farther the virtual target is designed offset from the screen, the larger depth deviation is observed. The relationship between deviation and depth is discussed.

**3Dp - 12      Withdrawn**

**3Dp - 13      Passive Glass 3D Display Crosstalk Homogeneity Characterization**

*P. Boher, T. Leroux, T. Bignon, P. Blanc\**

*ELDIM, France*

*\*FNAC, France*

Passive Glass 3D displays are characterized using imaging systems across one of the glass filters. The crosstalk homogeneity on the entire display surface is deduced for luminance and versus wavelength for radiance. Local defects due to imperfect alignment of the quarter wave plate and the pixel rows are observed.



**3Dp - 14      Crosstalk Analysis of Stereoscopic Display in Terms of Brightness and Size of Test Pattern**

*C.-C. Huang\*, H.-S. Chen\*, R. Luo\*\**

*\*Nat. Taiwan Univ. of S&T, Taiwan*

*\*\*Univ. of Leeds, UK*

The side-by-side patterns with different brightness and size were investigated. Each pair of the white-to-gray patterns were placed on one screen. The analytical results show the factor of brightness deviations is larger than pattern-size factor in 3D crosstalk formation for glasses-based stereoscopic TVs (polarizer glasses and shutter glasses).

**3Dp - 15      Accommodation and Convergence During 2D and 3D Images Gaze**

*H. Hori, T. Shiomi, K. Uemoto, M. Miyao*

*Nagoya Univ., Japan*

The aim of this study was to compare fixation distances between accommodation and convergence in young subjects while they viewed 2D and 3D images. Thus, we measured accommodation and convergence simultaneously while subjects viewed 2D and 3D images. Report on the results.

**3Dp - 16      Accommodative Response in Gazing Stereoscopic Images on HMD**

*T. Shiomi, H. Hori, K. Uemoto, M. Miyao*

*Nagoya Univ., Japan*

To investigate the effects of stereoscopic images on human vision, we measured accommodation in subjects as they performed stereopsis on a head mounted display (HMD). In this report we give the results of measurements when subjects gazed at Power 3D, Sky vision, and ordinary 3D with natural binocular vision.

----- Break -----

## IDW Outstanding Poster Paper Award

This award will go to the most outstanding paper  
selected from those presented at IDW '11  
poster presentation.

The 2011 award winners will be announced on the  
IDW website: <http://www.idw.ne.jp/award.html>

Thursday, December 8

9:00 - 10:20	Room 234
<b>INP4/3D1: 3D Input Technology (1)</b>	

Chair: T. Hamamoto, Tokyo Univ. of Sci., Japan  
 Co-Chair: O. Matoba, Kobe Univ., Japan

**INP4/3D1 - 1:** *Invited* **Smart Image Sensors and Their Application to 3D Imaging**  
 9:00 T. Hamamoto, H. Yamagishi, T. Hosaka  
 Tokyo Univ. of Sci., Japan

This paper explains the recent trend of smart image sensors. Next, as an application of the image sensor, we introduces our 3D imaging system for the real-time synthesis of arbitrary viewpoint image by using nine CMOS image sensors we have designed and fabricated.

**INP4/3D1 - 2** **Performance Analysis of Stereo Image Retargeting with Shift-Map**  
 9:20 R. Nakashima\*, K. Utsugi\*\*, K. Takahashi\*\*\*, T. Naemura\*  
 \*Univ. of Tokyo, Japan  
 \*\*Hitachi, Japan  
 \*\*\*Univ. of Electro-Commun., Japan

The performance of our stereo image retargeting algorithm based on shift-maps has been thoroughly evaluated. Various resolutions were tested for the target images to evaluate the effectiveness and processing time. A comparison with another stereo image retargeting algorithm, seam carving for stereo images, is also presented.

**INP4/3D1 - 3** **Development and Analysis of Quad-HD Multi-Camera System**  
 9:40 S. Sato, S. Tanaka, M. Kitagawa, M. Seo, T. Wakabayashi, T. Shimura, T. Imai, K. Omori, S. Saito, T. Hosaka\*, T. Hamamoto\*  
 Sharp, Japan  
 \*Tokyo Univ. of Sci., Japan

This paper describes how to develop and analyze multi-camera system, which generates Quad-HD video in real time. We propose new high-resolution image synthesis algorithms based on disparity estimation suitable for hardware. Experimental results showed that Quad-HD resolution was obtained. We concluded that our algorithms are effective for high-resolution cameras.

3D

**INP4/  
3D1 - 4  
10:00**      **Compressive Acquisition of Ray-Space in Circular Camera Arrangement**  
*S. Yang, M. P. Tehrani, T. Fujii, M. Tanimoto*  
*Nagoya Univ., Japan*

In this paper, we propose a method for acquisition of Ray-Space from sparsely data captured in circular camera arrangement. Usually we must capture the large amount of data. But in this method, we can capture important data only by curve linear integral transform.

----- Break -----

<b>10:40 - 12:00</b>	<b>Room 234</b>
<b>3D2/INP5: 3D Input Technology (2)</b>	

Chair: N. Yoshikawa, Saitama Univ., Japan  
Co-Chair: S. Aihara, NHK, Japan

**3D2/  
INP5 - 1:  
10:40**      ***Invited* Acquisition of 3D Information Using Frequency Domain Analysis**  
*N. Yoshikawa*  
*Saitama Univ., Japan*

A full-frame 3D measurement system using frequency domain analysis is developed to generate quantitative 3D information. The proposed method is based on a computationally efficient implementation of the FFT. For real-time operation, we implement the proposed method using a GPU and demonstrate high-resolution real-time 3D measurements.

**3D2/  
INP5 - 2  
11:00**      **Aperture Diffraction Degrades Images Captured through the Screen**  
*A. Travis, T. Large, N. Emerton, S. Bathiche*  
*Microsoft, USA*

Wedge light-guides image objects in front of an LCD as if from a point deep behind and this enables video- conferencing with eye contact. But the color filters in the LCD cause aperture diffraction which degrades image resolution and we discuss strategies to manage this.

**3D2/  
INP5 - 3:  
11:20**      ***Invited* Color Image Sensor with Vertically-Stacked Organic Photoconductive Films**  
*S. Aihara, H. Seo, T. Sakai, M. Kubota, N. Egami,*  
*M. Furuta\*, T. Hirao\**  
*NHK, Japan*  
*\*Kochi Univ. of Tech., Japan*

A stacked image sensor with blue-, green- and red-sensitive organic photoconductive films, each having a readout circuit array of zinc oxide-thin film transistor, was fabricated. The number of pixels was 128 x 96 on each color. The sensor produced a color image with a resolution corresponding to the pixel number.

**3D2/**                      **Withdrawn**  
**INP5 - 4**

**3D2/**                      **Invited Phase-Modulation Based 3D Optical**  
**INP5 - 5:**              **Visualization for Wide Viewing Zone**  
**11:40**                      *O. Matoba, N. Ueda*  
                                  *Kobe Univ., Japan*

A 3D display system using phase-only distribution for wide viewing zone is presented. The phase-only distribution is calculated from CG data. For wide viewing zone, phase distributions to reconstruct a 3D object from  $-20^\circ$  to  $20^\circ$  with an angle step of  $10^\circ$  are calculated. Numerical and experimental results are presented.

----- Lunch -----

<b>13:20 - 14:22</b>	<b>Room 234</b>
<b>3D3: 3D Display (1)</b>	

Chair:                      S. Yoshida, NICT, Japan  
 Co-Chair:                H. Yamamoto, Univ. of Tokushima, Japan

**3D3 - 1:**              **Invited Comparison of Image Composition between**  
**13:20**                      **MV and IP**  
                                  *J.-Y. Son, M.-C. Park\*, H. Lee\*, K.-T. Kim\*\**  
                                  *Konyang Univ., Korea*  
                                  *\*KIST, Korea*  
                                  *\*\*Hannam Univ., Korea*

The compositions of images projected to viewers' eyes at the various viewing sub-regions of the viewing zone formed in one-dimensional IP and MV (Multiview) are compared. The pattern of viewing sub-regions in the viewing zone of IP is the same as that of viewing sub-regions in front of the viewing zone cross section in MV.

**3D3 - 2**                      **Development of New Glasses-Free 8-in. WVGA 3D**  
**13:46**                      **LCD Based on the Scan Backlight Type**  
                                  *N. Kanda, T. Higano, K. Nakao, Y. Nishimoto,*  
                                  *H. Wakemoto*  
                                  *Toshiba Mobile Display, Japan*

We have developed two types of glasses-free 8-in. WVGA 3D LCD based on the scan backlight type. The two LCDs are the short type and the middle type different in the 3D viewing distance. The short distance type is the best solution for tablet-size 3D LCDs with touch-panel operation.

**3D3 - 3**                      **Withdrawn**

**3D**

**3D3 - 4  
14:04 Modulation with Super High Resolution in  
Electronic Holography**

*T. Wakizaka, K. Nitta, O. Matoba  
Kobe Univ., Japan*

A novel method for electronic holography is presented. In this method, two spatial light modulators are utilized. Three dimensional images are obtained by synthesis of two kinds of optical wave modulated on several modulators. It is shown that the proposed method is effective for 3D reconstruction with wider viewing angle.

----- Break -----

<b>15:00 - 16:20</b>	<b>Room 234</b>
<b>3D4: 3D Display (2)</b>	

Chair: J.-Y. Son, Daegu Univ., Korea  
Co-Chair: M. Tsuboi, NTT Docomo, Japan

**3D4 - 1: 15:00 *Invited* fVisiOn: Design Concept and Implementation  
of Glasses-Free Tabletop 3-D Display**

*S. Yoshida  
NICT, Japan*

fVisiOn is a novel glasses-free tabletop 3-D display with a design concept based on floating virtual 3-D objects on a flat tabletop surface. It provides horizontal parallax to multiple viewers around the table. Therefore, many people can naturally share the 3-D images displayed together with real objects on the table.

**3D4 - 2 15:26 Floating Display of LED Signage by Use of Crossed  
Mirrors**

*H. Bando\*, S. Suyama\*, H. Yamamoto\*,\*\*  
\*Univ. of Tokushima, Japan  
\*\*JST, Japan*

We propose a floating information display for signage by use of a reflective optical element, which is designed to image an LED array with a certain spread of LED lamps. The reflective optical element has been fabricated from crossed mirrors. Floating display of LEDs has been realized successfully.

**3D4 - 3 15:44 A New Maxwellian View Display for Accommodation  
Trouble Free**

*A. Yuuki, K. Itoga, T. Satake  
Mitsubishi Elec., Japan*

We studied the new display system which realizes the Maxwellian view. The new display system is composed of a normal display and a fly-eye-lens-sheet with micro-pinholes. It was confirmed that the new display system can extend the depth of focus of an aged person.

**3D4 - 4  
16:02 Time-Multiplexed Full-Resolution Autostereoscopic Display with Optical Scanning Device**

*C.-L. Wu, C.-J. Lee, B.-W. Xiao, C.-N. Ku, M.-C. Lin, C.-H. Tsai, S.-H. Yu\*, C.-C. Tsai\**

*ITRI, Taiwan*

*\*Chunghwa Picture Tubes, Taiwan*

A 4-view naked-eye 3D display using 240 Hz LCD has been demonstrated. It consists of a scanning backlight, a lenticular plate, and a high speed liquid crystal panel. It provides full resolution in each viewing zone and can perfectly integrate 2D and 3D image on the same screen.

----- Break -----

<b>16:40 - 18:05</b>	<b>Room 234</b>
<b>3D5: 3D Image Crosstalk</b>	

Chair: C.-L. Wu, ITRI, Taiwan

Co-Chair: S. Yano, NHK, Japan

**3D5 - 1  
16:40 Human Visual Perception to Gray to Gray Crosstalk Evaluation**

*Y. L. Chen, N. W. Chang, C. W. Chen, R. L. Dong*

*AU Optronics, Taiwan*

This study tried to link the human perception and evaluation of crosstalk through practical human factor experiment. On the gray to gray look-up table, the comparisons between the threshold function and the different crosstalk algorithms' results can help to find the most suitable algorithm based on human perception.

**3D5 - 2  
16:58 Gray to Gray Crosstalk Analysis Considering Human Perception in 3D Displays**

*S. Kim, J. Lee, J. Lee, W. Cheon, S. Shin*

*Samsung Elect., Korea*

In this paper, we proposed a new analysis method of gray to gray crosstalk in 3D displays. We studied crosstalk more intensively to match the human visual perception. The crosstalk values contracted by our method correspond with subjective evaluation.

**3D5 - 3  
17:16 A Novel Evaluation Method of Shutter-Type 3D Crosstalk**

*W. Liu, X. Chen, M. Qiao, J. Cao*

*Hisense Elec., China*

During measuring crosstalk of shutter-type 3D display and carrying out a visual perception experiment, we find some crosstalk definition does not truly describe the 3D display of crosstalk or not fully. Thus, we complete the derivation of viewer crosstalk definition of shutter-type 3D display, and propose an evaluation method.

**3D5 - 4      The Method for Reducing the 3D Crosstalk of  
17:34      Directional Backlight Display Device**

*D.-C. Yu, J.-S. Liao, H.-H. Chen, W.-T. Tseng, C.-R. Lee  
Chunghwa Picture Tubes, Taiwan*

Chunghwa Picture Tubes, LTD. has presented an algorithm of reducing 3D crosstalk for Directional backlight autostereoscopic display device. This technique will cause the response time to be insufficient So that the 3D crosstalk will occur. In this paper, CPT using the method of data compensation to reduce the 3D crosstalk.

**3D5 - 5L      Studies of Vision Recognition of 3D Images  
17:52**

*J.-Y. Huang, Y.-C. Fang, C.-M. Tsai\*, L.-F. Chen  
Nat. Kaohsiung First Univ. of S&T, Taiwan  
\*Kun Shan Univ., Taiwan*

This study focuses on capability of recognition of human eye with regard to two-dimensional (2D) and three-dimensional (3D) images. In addition, we discussed the display of the brightness variations, noise and other factors applied to recognition ability of the human eye.

**Author Interviews and Demonstrations**

18:00 – 18:50

**Friday, December 9**

<b>9:00 - 10:02</b>	<b>Reception Hall 2</b>
<b>3D6: 3D Image Processing</b>	

Chair: M.-C. Park, KIST, Korea  
Co-Chair: T. Mishina, NHK, Japan

**3D6 - 1:      Invited FTV (Free-Viewpoint TV) for Transmission of  
9:00      3D Space**

*M. Tanimoto  
Nagoya Univ., Japan*

FTV is the ultimate 3DTV that transmits 3D spatial information, and enables us to view the scene by freely changing our viewpoints. We realized FTV by developing various types of ray capture, processing and display technologies. The international standardization of FTV has been conducted in MPEG.

**3D6 - 2**      **Single Viewpoint 3D Graphics Rendering for Non-Flat Tiled Displays**

9:26

*X. Xu, C. Yuan, D. Messing*  
*Sharp Labs., USA*

In this paper, we propose an approach to rendering a perspective correct image of a 2D image or 3D scene for single viewpoint on a potentially irregular display surface. The proposed algorithm has many applications for non-flat tiled displays including scientific visualization, education, entertainment, consumer amusement and military training etc.

**3D6 - 3**      **Auto-Stereoscopic Image Generation for Ultra-High Definition and Large Display Panel**

9:44

*M. S. Park, J. Y. Kim, C. W. Park, N. D. Kim, J. K. Kim\*, J. H. Lee\**  
*Samsung Elect., Korea*  
*\*Sungkyunkwan Univ., Korea*

In this paper, we present a depth-image-based rendering (DIBR) technique for making auto-stereoscopic image for ultra-high definition and large display. As panel size is larger than 70-in. and resolution is growing up to UD, the scene depth is quite different from middle size display.

**3D6 - 4**      **Withdrawn**

----- Break -----

<b>10:40 - 12:00</b>	<b>Reception Hall 2</b>
<b>DES4/3D7: Post-HDTV</b>	

Chair: T. Yamamoto, NHK, Japan  
Co-Chair: S. Yano, NHK, Japan

**DES4/3D7 - 1:**      **Invited Development of Super Hi-Vision Camera System for High-Quality Content Production**

10:40

*K. Arai, T. Kikkawa*  
*NHK, Japan*

NHK has developed an UHDTV system that has 16 times the number of pixels compared to HDTV, that it will be the next-generation broadcasting standard. A practical use camera, a compressed recorder, and a editorial system with a color grading processor have been developed to realize an efficient production workflow.



**DES4/  
3D7 - 2:  
11:00**      ***Invited* High Performance Video Codec for Super Hi-Vision**  
*K. Kazui, A. Nakagawa, Y. Shishikui\*, K. Iguchi\*,  
 S. Sakaida\**  
*Fujitsu Labs., Japan*  
*\*NHK, Japan*

This paper describes the 3rd generation real-time codec for the SUPER Hi-VISION (SHV) system which is being developed by NHK as a future broadcast system. The 3rd generation codec achieves bitrate reduction by 50% and downsize by 50% compared with previous codecs.

**DES4/  
3D7 - 3:  
11:20**      ***Invited* High-Speed Reliable IP Transmission Technologies for Super Hi-Vision Transmission**  
*M. Ogawara, N. Kimura, T. Fujii*  
*NTT, Japan*

NTT have succeeded in achieving Super Hi-Vision (SHV) transmission over globally shared IP networks. The key technologies for transmitting SHV are low jitter control and IP stream synchronization. This paper describes a high-speed, reliable IP transmission system that incorporates these technologies as well as the results of experiments.

**DES4/  
3D7 - 4:  
11:40**      ***Invited* Proposal for a Complementary Field Offset Sampled Scanning and Its Application to a Super Hi-Vision Projector**  
*F. Okano, M. Kanazawa\*, Y. Kusakabe\*, M. Furuya\*\*,  
 Y. Uchiyama\**  
*NHK-ES, Japan*  
*\*NHK, Japan*  
*\*\*JVC Kenwood, Japan*

A scanning method based on complementary field offset sampling is proposed. Its Nyquist frequency in both horizontal and vertical directions is doubled. The method can be almost free from the artifacts caused by the interlace scanning or the field offset sampling. It has been applied to a Super Hi-vision projector.

----- Lunch -----

## BANQUET

Wednesday, December 7, 2011

19:30 – 21:30

Shirotori Hall (1F)

Nagoya Congress Center

See page 10 for details

13:20 - 14:40

Reception Hall 2

### 3D8/VHF8: 3D Image Quality and Ergonomics

Chair: T. Kurita, NICT, Japan  
Co-Chair: T. Koike, Hitachi, Japan

**3D8/  
VHF8 - 1:** ***Invited* Improvement of 3D Visual Image Quality by  
Using High Frame Rate**  
**13:20** *Y. Kuroki*  
*Sony, Japan*

The 3D motion image shot and displayed using 240 fps allows finer discrimination of depth for the viewer compared to systems using 120 fps or 60 fps. High frame rate is considered to provide rich information of depth for motion images, and the resulting perception of depth brings more realistic visual image quality.

**3D8/  
VHF8 - 2** **Motion Artifact on Depth Perception for  
Stereoscopic Displays**  
**13:46** *N.-W. Chang, C.-W. Chen, R.-L. Dong*  
*AU Optronics, Taiwan*

We researched the relation between motion artifact and depth perception. The optical measurement and ergonomic test could prove an innate motion artifact which would cause the error depth perception existed on Time-multiplexed stereoscopic display but didn't exist on Spatial-multiplexed. Finally, we proposed a model to estimate the error depth position.

**3D8/  
VHF8 - 3** **Correction of Stereo Imperfections and Depth  
Adjustment for Visual Comfort**  
**14:04** *I. Tsubaki, M. Seto, H. Hattori, H. Kumai, H. Shigemasu\**  
*Sharp, Japan*  
*\*Kochi Univ. of Tech., Japan*

This paper describes the approach to correct imperfections in stereo pairs such as vertical disparities and color discrepancies for reducing visual discomfort with 3D viewing. The algorithm fulfills the functions of disparity estimation, disparity map processing and view synthesis. Depth image based rendering is applied to view synthesis.

3D

## Green & Recycling Technology

Highlighted Topics of FMC-WS

Thursday, Dec. 8, 2011

9:00 - 10:20 (FMC3)

Reception Hall 1, 4F of Bldg. 1

See page 60 for details

**3D8/  
VHF8 - 4  
14:22**

**Ergonomic Assessment Theory for the  
Standardisation of 3D Displays**

*C. Kato<sup>\*,\*\*</sup>, S. Uehara<sup>\*,\*\*\*</sup>, H. Ujike<sup>\*,\*\*\*\*</sup>, Y. Hisatake<sup>\*,\*\*\*\*\*</sup>*

*\*Japanese Ergonomics Nat. Committee, Japan*

*\*\*Hitachi, Japan*

*\*\*\*Toshiba, Japan*

*\*\*\*\*AIST, Japan*

*\*\*\*\*\*Toshiba Mobile Display, Japan*

We establish an ergonomic assessment theory to express the interface between a human and 3D display, and propose an analytical method to set requirements for avoiding the display's negative effects on human visual system. Our proposal makes it possible to set the requirements with a small number of measurement data.

----- Break -----

<b>15:00 - 16:12</b>	<b>Reception Hall 2</b>
<b>3D9: 3D Image Quality</b>	

Chair: M. Tanimoto, Nagoya Univ., Japan

Co-Chair: M. Tsuchida, NTT, Japan

**3D9 - 1  
15:00**

**Finite-distance Moiré Patterns in Autostereoscopic  
3D Displays**

*V. Saveljev, S.-K. Kim*

*KIST, Korea*

The finite-distance moiré patterns were studied analytically and with using computer simulation. The formulas were obtained for the wavelength and displacement of moiré patterns. Arbitrary transparency functions were supported in simulation. The moiré effect in non-orthogonal gratings was also simulated. The computer simulation confirmed analytical formulas.

**3D9 - 2  
15:18**

**Quality Control of Auto-Stereoscopic 3D Display  
Using Video-Luminance Meter**

*P. Boher, T. Leroux, T. Bignon*

*ELDIM, France*

A commercial auto-stereoscopic 3D display is characterized using an imaging video-luminance-meter positioned at the working distance and laterally shifted. Crosstalk homogeneity on the entire surface of the display is deduced and correlated to local Fourier optics viewing angle measurements. We show that local imperfections can increase the crosstalk drastically.

**3D9 - 3**      **Interactive 3D Simulator for Autostereoscopic Display Systems**  
**15:36**

*M.-C. Park, H.-D. Lee, J.-Y. Son\**

*KIST, Korea*

*\*Konyang Univ. Hospital, Korea*

Crosstalk to reduce leakage of one eye's image into the image of the other eye, and light intensity for computing visual comfort zone are important factors in designing autostereoscopic display system. Interaction enables instinctive design. This paper describes an interactive 3D simulator to design the system instinctively in 3D space.

**3D9 - 4**      **Visibility Evaluation of 3D and 2D Character Representation on Mobile Displays**  
**15:54**

*S. Sano, T. Shiomi, T. Kanda, H. Hori, K. Uemoto, A. Hasegawa, M. Miyao*

*Nagoya Univ., Japan*

For the visibility evaluation, we measured time lag for first recognition, time required for full reading, and maximum distance of 3D objects popping out from the fixed display. We also report the dependency of the results on the age of subjects in comparison with 2D and 3D representations.

3D

**Author Interviews and Demonstrations**

16:20 – 17:10

**Supporting Organizations:**

3-D Image Technology Research Group, ITE  
 Holographic Display Artists and Engineers Club

# **IDW/AD '12**

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

December 4-7, 2012

Kyoto International Conference Center

Kyoto, Japan

<http://www.idw.ne.jp>

# Workshop on Applied Vision and Human Factors

Wednesday, December 7

14:00 - 15:30

Room 232

## VHF1: Display Measurement

Chair: J. Bergquist, Nokia, Japan

Co-Chair: T. Kurita, NICT, Japan

### VHF1 - 1: *Invited* New Evaluation Index on Moving Picture 14:00 Performance by Probing Maximum Motion Speed Holding Display's Native Resolution

*I. Kawahara<sup>\*,\*\*</sup>*

*\*Panasonic Plasma Display, Japan*

*\*\*Advanced PDP Dev. Ctr., Japan*

New evaluation index for moving picture performance of display was developed by probing the maximum image speed up to which the native resolution is maintained. Unified frequency-domain approach eliminates restrictions for motion speed, pixels numbers, device types, and human factors, offering ultimate solution for evaluation, realizing simple and robust metrics.

### VHF1 - 2 Measurement Method for Image Sticking Using CSF 14:30

*G. Park, J. Lee, N. Kwon, T. Kim, S. Shin*

*Samsung Elect., Korea*

We are suggesting a new method to quantify image sticking using CSF( Contrast Sensitivity Function) in this paper. CSF was implied to consider visual sensitivity such as contrast, spatial frequency, and Mach bands illusion. As a result, new method has high correlation with human perceptual level of image sticking.

### VHF1 - 3 A Spatio-Velocity Extension of Barten's CSF Model 14:50

*H. Sasaki*

*Toshiba Semiconductor & Storage Products, Japan*

A spatio-velocity extension of Barten CSF is proposed. It simultaneously treats spatio-velocity characteristics for eye-tracking and spatio-temporal characteristics for flicker, so that we can discuss small-area artifacts caused by block-wise signal processing such as memory compression of LCD overdrive. It also gives the first unified understanding of flickering and blurring.

**VHF1 - 4**  
**15:10**      **A Quantitative Evaluation Method for Luminance and Color Uniformity of a Display Screen Based on Human Perception**

*K. Nagamine, S. Tomioka, T. Tamura\*, Y. Shimpuku*

*Sony, Japan*

*\*Tokyo Polytechnic Univ., Japan*

We developed a quantitative evaluation method for luminance and color uniformity on a backlight screen. In this paper, we report the analysis result of a viewer's perception of luminance and color uniformity. We propose an integrated evaluation model that combines luminance and color uniformity.

----- Break -----

**15:40 - 17:00**

**Room 232**

**VHF2: Image Quality**

Chair: A. Yoshida, Sharp, Japan

Co-Chair: J. Bergquist, Nokia, Japan

**VHF2 - 1**  
**15:40**      **Improving Content Viewability by Adaptive Image Brightening for High Ambient Displays**

*L. Kerofsky, X. Xu*

*Sharp Labs., USA*

Displays may suffer from reduced contrast and viewability when operated at high ambient lighting environments or operated at low power mode. This paper presents algorithms for improving content viewability for high ambient viewing of LC displays by ambient and content adaptive image brightening.

**VHF2 - 2**  
**16:00**      **A Method of Improving Display Visibility under the Bright Environment**

*A. Higashi, T. Nagatsuma\*, M. Kabe\*, Y. Matsui\*,  
A. Sakaigawa\**

*Sony Mobile Display, Japan*

*\*Sony, Japan*

Many mobile devices are implemented with displays, and are often used outdoors. But in the event that an external light source irradiates the devices, or under the bright environment, the visibility of the display deteriorates. This paper describes a new method that solves this problem by using the RGBW technology with tonal correction.

**VHF2 - 3      Optimum Tone Rendering of Reflective Displays  
Based on Optical Scattering Modulation**

**16:20**

*L.-C. Lin, P.-C. Yeh, C.-H. Shih, W.-M. Huang*

*AU Optronics, Taiwan*

The scattering modulation of reflective liquid crystal display has different human visibility with the well-known transmissive or reflective liquid crystal display due to individual display mechanism. This paper mainly describes the optima tone rendering for this scattering modulation of reflective liquid crystal display.

**VHF2 - 4      Appropriate Observation Condition of Diagonal-  
Pixel-Offset Projection for Improving Visual  
Resolution**

**16:40**

*T. Horiuchi, Y. Fukuda, Y. Kohda, S. Tominaga*

*Chiba Univ., Japan*

This paper investigates the appropriate observation conditions for a diagonal-pixel-offset projection that improve visual resolution without introducing visible artifacts. Experimental results suggest that the most effective condition is to observe a projected image under a viewing resolution of 20 (pixel/deg.); the improvement is confirmed within 20-60 (pixel/deg.).

----- Break -----

**17:20 - 18:20**

**Room 232**

**VHF3: Human Factors**

Chair: T. Wake, Kanagawa Univ., Japan

Co-Chair: N. Hiruma, NHK, Japan

**VHF3 - 1      Operational Efficiency of Single and Multiple  
Display Systems in an Actual Work Environment**

**17:20**

*H. Shibata*

*Fuji Xerox, Japan*

This paper quantitatively measures the efficiency of users' window operations in different display environments. We analyzed window operation logs of eight persons in real world work situations. Results show that dual small (17-in.) displays are superior to a single large (24-in.) display in performing window operations efficiently.

## **IDW Best Paper Award**

This award will go to the most outstanding paper selected from those presented at IDW '11.

The 2011 award winners will be announced on the IDW website: <http://www.idw.ne.jp/award.html>

**VHF3 - 2      Novel Interactive Presentation of Two-Dimensional Matrix Codes in Digital Signage**  
**17:40**

*A. U. Rehman, S. Fukumoto, J. Morito<sup>\*</sup>, S. Ohtsuka,  
 Y. Sambe<sup>\*\*</sup>, H. Tanaka<sup>\*\*</sup>, K. Takeda<sup>\*\*</sup>, Y. Nomura<sup>\*\*</sup>*  
*Kagoshima Univ., Japan*  
*<sup>\*</sup>NTT COMWARE, Japan*  
*<sup>\*\*</sup>NTT DATA, Japan*

A novel dynamic display technique for two-dimensional matrix codes is proposed. Experiments suggest that (1) its average acquisition time is 1.8 seconds shorter, (2) its average acquisition distance is 50% greater than those of the conventional method, and (3) all subjects familiar with QR codes preferred the proposed method.

**VHF3 - 3      Theoretical Derivation of Accommodation-Optimised Document Line Spacing**  
**18:00**

*T. Miyata, T. Matsui*  
*Gunma Univ., Japan*

We formulate a two-dimensional mathematical model of the accommodation mechanism in human vision and clarify that the proposed model can be successfully applied to developing a framework that theoretically derives the optimal display condition (the optimal line space) to make document images the most legible in terms of accommodation.

**Author Interviews and Demonstrations**  
 18:40 – 19:30

VHF

**Thursday, December 8**

9:00 - 12:00	Room 222-224
<b>Poster VHFp: Applied Vision and Human Factors</b>	

**VHFp - 1      Age-Related Text Visibility of Displays Illuminated by LED Lamps**

*M. Sakurai, S. Sugimoto, T. Shibuya, S. Yamamoto*  
*Tokyo Univ. of Sci., Japan*

To examine the visibility with age-related changes in text of display illuminated by the incandescent-type lamps, the visibility in the text was judged using the subjective evaluation. As the results, it is necessary to the luminance contrast beyond 0.5-in. log scale to be easy to read for all ages.



**VHFp - 2      Ergonomic Analysis of Perceptual Contrast Ratio Limitation for LCD**

*S.-Y. Pan, K.-C. Chang, C.-Y. Lee*  
*AU Optronics, Taiwan*

Ultra-high contrast ratio is not proportional to the contrast perception of human vision. Three ergonomic tests were proposed to analyze the perceptual contrast. We found the just noticeable luminance threshold of black surround under dark room, and also the perceptual contrast under white disturbance and bright ambient condition.

**VHFp - 3      Development of a Digital Pseudoisochromatic Plate on Well-Calibrated LCD Monitor**

*Y.-C. Tsai, H.-S. Chen, R. Luo\**  
*Nat. Taiwan Univ. of S&T, Taiwan*  
*\*Univ. of Leeds, UK*

A computer based tool, named Digital Colour Vision Test Plate (DCVTP), was developed to examine the colour vision. It's based upon a well-calibrated LCD monitor. An experimental database, just-noticeable chromaticity differences, was established for checking colour vision deficiency. The DCVTP can be accurately quantified the degree of abnormal colour vision.

**VHFp - 4      Person Authentication Based on Image Features Extracted from Lip Region**

*M. Itoh, F. Saitoh*  
*Gifu Univ., Japan*

This paper proposes an individual authentication system using lip images. This method performs biometrics authentication using physical character focused on lip shape. The proposed system, which is non-contacting system because we input images from camera, is more effective than contacting system where psychological resistance and conformability are required.

**VHFp - 5      Image Contrast Improvement Based on Local Differential Gray-Level Histograms**

*M. Murase, F. Saitoh*  
*Gifu Univ., Japan*

The objective of this research improves contrast of both the whole image and the image details. This paper proposes a spatial characteristic, the image segmentation, linear interpolation in order to improve contrast method. The experimental results showed that the image had good and natural contrast by the proposed method.

**VHFp - 6      Detecting Perceptive Curves in Images Based on Perceptual Grouping Factor**

*T. Takagi, F. Saitoh*  
*Gifu Univ., Japan*

This article proposes a detecting method for global and indefinite curves from binary images that include discontinuous curves and noises. This method is based on Delaunay Triangulation and perceptual grouping factor.

**VHFp - 7      Reliable Template Matching Using First Derivation Edge-Direction**

*A. Hirose, F. Saitoh*  
*Gifu Univ., Japan*

This paper proposes a new method for template-matching. A template image is separated into block areas and sum of inferior angle between edge-directions of target image and template image are calculated. A coordinate that is the highest similarity gets a vote and a target coordinate is decided by its result.

**VHFp - 8      Plural Image Area Searching Based on Genetic Algorithm with Immune System and Hill-Climbing Flight Insect Method**

*Y. Shimohira, F. Saitoh*  
*Gifu Univ., Japan*

This paper proposed a method keep diversity of individuals and extract plural target image areas with free locations, inclination and scale that are similar to template image by using hill-climbing flight insect method. Experimental results show that the proposed method can search more plural local solutions than conventional methods.

**VHFp - 9      High-Speed Image Matching by Selecting Effective Feature Pixel in Template**

*S. Nakamura, F. Saitoh*  
*Gifu Univ., Japan*

This paper proposes a high-speed match method by selecting the effective feature pixel in the template. The proposal method uses the pixel not on the edge but around the edge to detect the object. As a result, this method could be detected fast without lowering the detection performance.

**VHFp - 10      Background Image Generation Using Spatio-Temporal Fluctuation Based on Amount of Characteristic Pixel Value**

*R. Kagami, F. Saitoh  
Gifu Univ., Japan*

A dynamic picture image has a feature what pixel value is stability in the background frames and is fluctuation in the moving object frames. We defines their features of a dynamic picture image as fluctuation of pixel value, and then presents background image generation using their definitions.

**VHFp - 11      Withdrawn**

**VHFp - 12      Natural Image Sharpening Process Based on Human Visual Characteristics**

*H. Yamamori, F. Saitoh  
Gifu Univ., Japan*

This paper proposes a method to sharp color or monochrome photographic images. To generate natural sharp images, the method uses the characteristics of human visual process for sharpening. The experimental results showed natural sharp images were obtained by the proposed method.

**VHFp - 13      Ch-LCD Display Color Simulation and Image Sticking Assessment**

*S.-P. Wang, M.-Y. Lu, B.-W. Xiao, K.-J. Hu  
ITRI, Taiwan*

In this study, we built a simulator for Ch-LCD with a projector and verified the reproduction performance by a subjective experiment. The simulator was utilized to conduct human subjective experiments to find out the just acceptable color difference and just noticeable color difference thresholds for assessing image sticking phenomenon.

**VHFp - 14      Primary and Mixed Color Analysis for Color Accuracy**

*E. Lee, J.-K. Song  
Sungkyunkwan Univ., Korea*

Some have doubt about OLED display's color accuracy due to its current driving method which is more difficult to control than voltage driving method. Primary and mixed color analysis according to changing gray level is carried out for proving color accuracy of OLED and LCD display.

9:00 - 12:00

Room 222-224

**Poster AUTOp/VHFp: Human Factors Related to Automobiles**

**AUTOp/  
VHFp - 1**

**Visual Contrast of LED Traffic Lights for People  
with Imperfect Color Vision**

*H. Isono*

*Nippon Inst. of Tech., Japan*

We calculated the visual contrast that governs the visibility of LED traffic lights using the spectral luminous efficiency of persons with imperfect color vision. The results indicated that, for person with imperfect color vision, the visual contrast of red and yellow LEDs is significantly reduced and visibility is adversely affected.

**AUTOp/  
VHFp - 2**

**Training Method for Improving Cognitive Function  
of Middle Age While Driving and Evaluation of Its  
Effects**

*Y. Takahashi, K. Mizuno, H. Yamasaki, M. Kawasumi,  
M. Yamada, S. Yamamoto, T. Nakano*

*Meijo Univ., Japan*

An increase in the traffic accident caused by elderly and dementia drivers becomes serious problem. This paper presents training methods for activating the prefrontal area and their effects, which have been evaluated by comparing cognitive function before and after training.

**AUTOp/  
VHFp - 3**

**Method for Evaluating Performance of Wipers Based  
on Forward Visibility**

*T. Kitayama, M. Kawasumi, H. Yamasaki, T. Nakano,  
S. Yamamoto, M. Yamada, Y. Doi\**

*Meijo Univ., Japan*

*\*ASMO, Japan*

In the visibility evaluation in rainy driving, it is important to examine spatial frequency and contrast of objects in forward view. We prepared for background board with stripe pattern. Spatial frequency and contrast of the background board which were affected by the raindrops are possible to calculate by proposed method.

**AUTOp/  
VHFp - 4**

**Study on the Effect in Relieving Fatigue  
by Fragrance Presentation for the Driver**

*C. Kato, M. Yoshida, K. Tanaka, M. Kawasumi,  
H. Yamasaki, S. Yamamoto, T. Nakano, M. Yamada*

*Meijo Univ., Japan*

The effect of the fragrance is applied to the aromatherapy, and the application to relaxation and arousal effect can be also expected. We obtained verification results that fragrance presentation is effective in awaking the drowsy driver. Then, it has aimed to verify the effect in relieving fatigue by fragrance presentation.

VHF

**AUTOp/  
VHFp - 5      Study on Stimulation Alerting Effect for Driver  
Based on Fragrance Presentation**

*M. Yoshida, C. Kato, N. Asami, M. Kawasumi,  
H. Yamasaki, S. Yamamoto, T. Nakano, M. Yamada  
Meijo Univ., Japan*

The falling asleep at the wheel is big problem that should be exterminated. Then we pay attention to the method by "Fragrance presentation" with which it doesn't interfere in the driving operation and are examining it. We tested difference of alerting duration by the kind of smell and presentation method.

**AUTOp/  
VHFp - 6      Examination of Detectability of Driver's Fatigue  
Level by Neural Network Using Hyper Spectrum  
Camera**

*K. Endo, Y. Nakamura, S. Yamamoto, T. Nakano,  
M. Kawasumi, M. Yamada, T. Maeda\*, Y. Aizu\*,  
T. Simizu\*\*, Y. Iwata\*\**

*Meijo Univ., Japan  
\*Muroran Inst. of Tech., Japan  
\*\*Aisin Cosmos R&D, Japan*

This study aims to examine the potential measurement of fatigue levels. Special focus is on deoxygenization of blood hemoglobin strongly related to fatigue from exercise. The possibility to discriminate fatigue from normal state was examined using a hyper spectrum camera (HSC).

**AUTOp/  
VHFp - 7      Study to Detection Accuracy of Suspicious  
Behaviors inside a Vehicle**

*T. Suzuki, K. Sakai, S. Yamamoto, T. Nakano,  
M. Kawasumi, M. Yamada*

*Meijo Univ., Japan*

Monitoring of the vehicle driving environment and driver state are important for vehicle safety. Meanwhile, criminal acts in taxis and vehicle occur frequently. Therefore, the system development is a pressing need. The purpose of this research was to develop a system that can detect suspicious behavior of passengers and vehicle.

**AUTOp/  
VHFp - 8      Detection of Driver Condition Based on Pupillary  
Light Reflex**

*Y. Nakamura, K. Endo, N. Asami, K. Masuda,  
S. Yamamoto, T. Nakano, M. Kawasumi, M. Yamada*

*Meijo Univ., Japan*

This paper describes a method for detecting if a driver can drive safely by measuring pupillary light reflex to active photic stimulus before he/she starts driving. We conducted some experiments on drunk and sober drivers, and confirmed that our index "63% dilation time" is effective to classify those drivers.

**AUTOp/  
VHFp - 9**

**On Screening Elderly Adults with Low Cognitive Functions by Measuring Driving Performances**

*Y. Kuroyanagi, T. Numayama, O. Yamamoto,  
M. Kawasumi, H. Yamasaki, M. Yamada, S. Yamamoto,  
T. Nakano*

*Meijo Univ., Japan*

Although driving ability decreases with advanced age, few elderly people recognize the decline in their own visual, cognitive and decision performances; this lack of awareness is a major cause of accidents. This paper presents a method for detecting cognitive decline in elderly driver by driving performances to prevent serious accidents.

**AUTOp/  
VHFp - 10**

**Development of System for Comprehensively Measuring Driving Ability for Elderly Safe Driving**

*Y. Oishi, S. Matsuura, C. Kato\*, M. Kawasumi,  
M. Yamada, S. Yamamoto, T. Nakano*

*Meijo Univ., Japan*

*\*FORUM8, Japan*

Japan faces "super-aged" society, and the number of accidents caused by elderly drivers is increasing. Although driving ability decreases with advanced age, few elderly people recognize the decline in driving ability. For this research, we develop the driving simulator which quantitatively measures necessary driving ability.

**AUTOp/  
VHFp - 11**

**Cognitive Characteristics for an ARIS (Augmented Reality Interface System) Applied to an Automotive Head-Up Display**

*W. Kaneko, R. Ando, S. Okabayashi*

*Meijo Univ., Japan*

Assuming that the ARIS is applied to automotive display equipment, we investigated cognitive characteristics in terms of how fast and accurately displayed information can be recognized. It was also verified that ARIS shows markedly better characteristics when both the driver's outward forward view and the displayed images are more complex.

----- Lunch -----

VHF

Call for Papers  
**Special Section  
on Electronic Displays**

**IEICE Transactions on Electronics**

Submission Deadline: Feb. 24, 2012

<http://ny7084.rie.shizuoka.ac.jp/eid/top-e.htm>

13:20 - 14:40	Room 131
<b>VHF4/DES1: Color (1)</b>	

Chair: H. Okumura, Toshiba, Japan  
 Co-Chair: T. Matsumoto, Sony, Japan

**VHF4/DES1 - 1:** *Invited* **Measuring Light and Color: Some Remarks on Defining Colorimetric Values**  
**13:20** *N. Ohta*  
*Rochester Inst. of Tech., USA*

The CIE recommended the use of tristimulus values X, Y, Z as typical colorimetric values in 1931. In my present talk, I will talk some noteworthy points when defining X, Y, Z, which are: 1. Errors occurring numerical integrations, 2. Variation of color matching function.

**VHF4/DES1 - 2:** *Invited* **An Approach for Reproducing Illuminant Colors and Specular Highlight on Television Using Color-Mode-Index (CMI)**  
**13:50** *T. Fujine, T. Kanda, M. Sugino, M. Teragawa, N. Ohta\**  
*Sharp, Japan*  
*\*Rochester Inst. of Tech., USA*

We show an approach for reproducing illuminant colors and specular highlights on television using Color-Mode-Index (CMI), which is new evaluation index for color-appearance of reproduced color. We quantify lightness of color-mode boundary and show that it is possible to reproduce non-surface colors with realistic impression by controlling color-mode using CMI.

**VHF4/DES1 - 3** **High-Resolution Representation for Multi-Primary Displays with Checkerboard Alignment**  
**14:20** *S. Nakagawa, H. Furukawa, H. Miyata, K. Yoshiyama, Y. Yoshida*  
*Sharp, Japan*

We introduce a method to represent high-frequent signals using MPC-specialized sub-pixel rendering on four-primary and checkerboard alignment displays. For the method, displays equip a feature; four of sub-pixels which line up horizontally or vertically involve all primaries. The method reproduces high-frequent signals along both horizontally and vertically without increasing pseudo-colors.

----- Break -----

15:00 - 16:20

Room 131

**VHF5/DES2: Color (2)**

Chair: N. Ohta, Rochester Inst. of Tech., USA

Co-Chair: T. Matsumoto, Sony, Japan

**VHF5/DES2 - 1: Invited Rendering Digital Cinema and Broadcast TV Content to Wide Gamut Display Media**

15:00

*R. L. Heckaman, J. Sullivan\***Rochester Inst. of Tech., USA**\*Entertainment Experience, USA*

Much more is possible in achieving brighter, more vibrant colors for a richer visual experience in emerging, wide-gamut display media. Yet, both digital cinema and broadcast TV content fall well short of this promise. In this paper, we provide the means for realizing this promise.

**VHF5/DES2 - 2: Invited Consideration on Color Reproduction in Next Generation Image Systems**

15:30

*Y. Shimodaira**Shizuoka Univ., Japan*

Desirable color reproduction in next generation image systems is considered in comparison with weak points of current image systems, e.g. color gamut, color difference and dynamic range. Those are essential for colorimetric color reproduction. Many users are eager to adopt image systems of colorimetric color reproduction for their business fields.

**VHF5/DES2 - 3: Enhancement Methods in sRGB to Six-Primary LCD Color Space**

16:00

*C.-K. Chang, H. Yaguchi, Y. Mizokami**Chiba Univ., Japan*

This study provides some methods in order to enhance the six-primary color space. It contains three stages: (1) sRGB expansion, (2) specialized gamut mapping (3) through a psychophysical experiment to inspect the result. According to the result, the proposed method is better than the non-corrected one.

----- Break -----

**IDW Tutorial in Japanese**

Tuesday, December 6, 2011

Room 131, Bldg.1

Nagoya Congress Center

Detailed information is available on  
<http://www.sidchapters.org/japan/>



16:40 - 18:05	Room 131
<b>VHF6/DES3: Color (3)</b>	

Chair: M. Ayama, Utsunomiya Univ., Japan  
 Co-Chair: K. Sekiya, Tohoku Univ., Japan

**VHF6/DES3 - 1: 16:40** *Invited* **Novel Addressing Method for a Stencil-FSC LCD Based on Human Visual System**  
*F.-C. Lin, Y.-P. Huang, Y.-H. Hsieh, H.-P. D. Shieh*  
*Nat. Chiao Tung Univ., Taiwan*

According to the human visual system, a novel TFT addressing method is proposed to gain more 85% time for LC response, which makes Stencil-FSC methods more feasible. Two indexes of PDR and relative CBU are introduced to evaluate image difference and color breakup for an FSC display.

**VHF6/DES3 - 2 17:10** **Wide Gamut LCD Using Local Dimmable Four-Primary-Color LED Backlight**  
*Y. Sano, R. Nonaka, M. Baba*  
*Toshiba, Japan*

We designed an LED backlight consisting of an additional only-cyan LED with three-primary-color LEDs to reproduce all colors in the real world. An LCD with the developed four-primary-color LED backlight is able to cover almost all colors defined by the SOCS database by using a four-primary-color dimming algorithm.

**VHF6/DES3 - 3 17:30** **Pseudo Multi-Primary Color Rendering for Wide Color Gamut Images**  
*X.-F. Feng, D. Zhang\**  
*Sharp Labs., USA*  
*\*Apple Computer, USA*

We present an advanced algorithm for wide color gamut. It uses the crosstalk color from the green LED to blue LCD to achieve a new pseudo cyan primary. A single pass rendering algorithm is developed which renders input color in CIEXYZ to RGB LED and RGB LCD driving values.

**VHF6/DES3 - 4L 17:50** **Does Dimmed LCD Guarantee Better Color Performance?**  
*M. Kim, J.-M. Kim, J. Kim, Y. Cho, S.-H. Lee, K. Kim, S.-W. Lee*  
*Kyung Hee Univ., Korea*

It is widely known that dimming technologies tend to degrade the color accuracy. We, however, present that color performance of a dimmed LCD is better than a conventional one. The dimming technology can makes LCDs better in not only power consumption but also color performance.

**Author Interviews and Demonstrations**  
 18:00 – 18:50

Friday, December 9

10:40 - 11:50	Room 133
<b>VHF7: Color (4)</b>	

Chair: Y. Shimodaira, Shizuoka Univ., Japan  
 Co-Chair: A. Yoshida, Sharp, Japan

**VHF7 - 1: 10:40** *Invited Trends in the International Commission on Illumination (CIE) and the International Colour Association (AIC)*  
*M. Ayama*  
*Utsunomiya Univ., Japan*

Color and Light are important factors for observing images in display. Two international organizations concerning color and light, International Colour Association (AIC) and International Commission on Illumination had meetings this year. Trends in these conferences are reported in this paper.

**VHF7 - 2 11:10** *Preference of Color Images with Color-Weak Correction Assessed by Color Anomalous and Normal Observers*  
*Y.-C. Chen, L. Guan, T. Ishikawa, H. Eto\*\* , T. Nakatsue\*\* , J. Chao\* , M. Ayama*  
*Utsunomiya Univ., Japan*  
*\*Chuo Univ., Japan*  
*\*\*Sony, Japan*

In this study, we propose color images with color-weak correction on the basis of Mochizuki's model with an aim to achieve color customization in displays for color anomalous observers. The study results show that color-weak correction is effective in increasing the preference scores of protan and deutan observers.

**VHF7 - 3 11:30** *Perceptual Viewing Angle Performance Measurement Method of Display*  
*T. Jun, J. Lee, S. Kim, J. Han, J. Lee, S. Shin*  
*Samsung Elect., Korea*

Currently, LCD viewing angle performance is defined by the amount of the C/R decrease by viewing angle. This method is valued no longer effective as the quality improvement of LCD. This paper suggests a new viewing angle measurement method which applies a modified color difference ( $\Delta E$ ) fit for display viewing angle performance.

----- Lunch -----

VHF

13:20 - 14:40

Reception Hall 2

### 3D8/VHF8: 3D Image Quality and Ergonomics

Chair: T. Kurita, NICT, Japan  
Co-Chair: T. Koike, Hitachi, Japan

**3D8/VHF8 - 1: 13:20** *Invited* **Improvement of 3D Visual Image Quality by Using High Frame Rate**  
*Y. Kuroki*  
*Sony, Japan*

The 3D motion image shot and displayed using 240 fps allows finer discrimination of depth for the viewer compared to systems using 120 fps or 60 fps. High frame rate is considered to provide rich information of depth for motion images, and the resulting perception of depth brings more realistic visual image quality.

**3D8/VHF8 - 2: 13:46** **Motion Artifact on Depth Perception for Stereoscopic Displays**  
*N.-W. Chang, C.-W. Chen, R.-L. Dong*  
*AU Optronics, Taiwan*

We researched the relation between motion artifact and depth perception. The optical measurement and ergonomic test could prove an innate motion artifact which would cause the error depth perception existed on Time-multiplexed stereoscopic display but didn't exist on Spatial-multiplexed. Finally, we proposed a model to estimate the error depth position.

**3D8/VHF8 - 3: 14:04** **Correction of Stereo Imperfections and Depth Adjustment for Visual Comfort**  
*I. Tsubaki, M. Seto, H. Hattori, H. Kumai, H. Shigemasu\**  
*Sharp, Japan*  
*\*Kochi Univ. of Tech., Japan*

This paper describes the approach to correct imperfections in stereo pairs such as vertical disparities and color discrepancies for reducing visual discomfort with 3D viewing. The algorithm fulfills the functions of disparity estimation, disparity map processing and view synthesis. Depth image based rendering is applied to view synthesis.

## Green & Recycling Technology

Highlighted Topics of FMC-WS

Thursday, Dec. 8, 2011

9:00 - 10:20 (FMC3)

Reception Hall 1, 4F of Bldg. 1

See page 60 for details

3D8/  
VHF8 - 4  
14:22

**Ergonomic Assessment Theory for the  
Standardisation of 3D Displays**

C. Kato<sup>\*,\*\*</sup>, S. Uehara<sup>\*,\*\*\*</sup>, H. Ujike<sup>\*,\*\*\*\*</sup>, Y. Hisatake<sup>\*,\*\*\*\*\*</sup>

<sup>\*</sup>Japanese Ergonomics Nat. Committee, Japan

<sup>\*\*</sup>Hitachi, Japan

<sup>\*\*\*</sup>Toshiba, Japan

<sup>\*\*\*\*</sup>AIST, Japan

<sup>\*\*\*\*\*</sup>Toshiba Mobile Display, Japan

We establish an ergonomic assessment theory to express the interface between a human and 3D display, and propose an analytical method to set requirements for avoiding the display's negative effects on human visual system. Our proposal makes it possible to set the requirements with a small number of measurement data.

**Author Interviews and Demonstrations**

16:20 – 17:10

**Supporting Organizations:**

Technical Group on Information Display, ITE

Technical Committee on Electronic Information Displays, Electronics Society, IEICE

**BANQUET**

Wednesday, December 7, 2011

19:30 – 21:30

Shirotori Hall (1F)

Nagoya Congress Center

See page 10 for details

VHF

**Evening Get-Together  
with Wine**

Tuesday, December 6, 2011

18:00 – 20:00

at Skyview Restaurant Pastel (7F),

Nagoya Congress Center

(Sponsored by Merck Ltd., Japan)

See page 10 for details

# Workshop on Projection and Large-Area Displays and Their Components

Thursday, December 8

13:20 - 16:20

Room 222-224

## Poster PRJp: PRJ Posters

### PRJp - 1 A Projection-Type LED Signage

13:20

*H.-H. Lo, C.-C. Lin, H.-L. Hu, C.-H. Lin, C.-W. Li  
ITRI, Taiwan*

A programmable digital signage using an active LED matrix and a high speed projector lenses system is developed. The signage system with F/1 high speed projection lenses projects the active LED matrix on the screen to form a 100-in. image at distance of 3.5M.

### PRJp - 2 A Study of New Optical Design and Optimization of High Efficiency LED Projector

*C.-M. Tsai, Y.-C. Fang, W.-T. Li\*, C.-A. Chen, C.-T. Lin  
Kun Shan Univ., Taiwan  
\*Nat. Kaohsiung First Univ. of S&T, Taiwan*

The research focuses on prospect module of LED projector with high contrast and high efficiency. This is a completely new design which takes advantage of less heat interference and compactness. Simulation shows that light efficency of this design might be up to 46%.

### PRJp - 3 USB Pico-Projector Accessory for Smart Phones

*K. Sung, J. Kwon, H. Lee, H. Kim, B. Park, J. Lee,  
D. Jang  
Samsung Elect., Korea*

We present the first pico-projector accessory platform compatible with SAMSUNG Galaxy phones and tablets through USB interface. Galaxy-S dose not supported OTG function by itself. Therefore we overcame it in the proposed method; development of display applications in Android OS and device drivers, Linux kernel, and injection of 5 V power.

### PRJp - 4 Simplified Optical Setup for Holographic Pico-Projection

*M. Makowski, I. Ducin, A. Siemion, K. Kakarenko,  
M. Sypek, A. Kolodziejczyk  
Warsaw Univ. of Tech., Poland*

An extremely simple and compactable setup for image projection is presented, consisting of point-like light sources and a spatial light modulator. We use a space division method for sharing the modulator surface between three color light beams. Rich-color images are successfully reconstructed from especially designed holograms.

----- Break -----

16:40 - 18:07

Room 231

**PRJ1: 3D and Digital Cinema**

Chair: H. Kikuchi, NHK, Japan

Co-Chair: T. Suzuki, JVC Kenwood, Japan

**PRJ1 - 1: Invited Interference Filter Design for Flicker Reduction in Stereoscopic Systems**

16:40

*A. Simon, H. Jorke**Infitec, Germany*

3D-projection systems usually provide alternating image frames and black frames for each eye. At 120 Hz mode flickering is still perceived. The wavelength multiplexing technology offers the possibility to mix the color sequence of left and right images, so that flickering is minimized. Solutions for 3-Chip systems will be presented.

**PRJ1 - 2: Invited 200-in. Glasses-Free 3D Display Using Projector Array**

17:03

*M. Kawakita, S. Iwasawa, M. Sakai\*, Y. Haino\*, M. Sato\*, T. Kurita, N. Inoue**NICT, Japan**\*JVC Kenwood, Japan*

We have developed a 200-in. glasses-free 3D display using a projector array. Multiple viewers can simultaneously observe natural-looking 3D images based on the viewer's movements without special glasses. The developed display can depict high-definition, highly realistic 3D images of large objects, such as a life-size cars and humans.

**PRJ1 - 3 A New Driving Method for Brightness Improvement in 3-Dimensional Projection Display**

17:26

*T. Aoki, T. Tokumura, H. Iisaka, A. Ito**Seiko Epson, Japan*

A new driving method for 3-Dimensional projection displays is developed. This method consists of three scanning stages and expands the opening time of the shutter glasses by shortening the updating time of images. The available brightness of 3-D image increases by approximately 1.8 times with current circuit and panel performance.

PRJ

**SID 2012**

International Symposium, Seminar and Exhibition

June 3-8, 2012

Boston, Massachusetts, U.S.A.

**PRJ1 - 4: *Invited* Recent Deployment of Digital Cinema and Its Alternative Applications**

*T. Fujii*

*Tokyo City Univ., Japan*

10 years has passed since the world first 4K digital cinema demonstration at SIGGRAPH 2001. In 2005, DCI opened Digital Cinema System Specification, including 4K image. Digital cinema revolution breaks out now. This paper presents the overview of the digital cinema deployment and explores its alternative new applications.

**Author Interviews and Demonstrations**

18:00 – 18:50

**Friday, December 9**

<b>9:00 - 10:10</b>	<b>Room 231</b>
<b>LIT4/PRJ2: Solid State Projection Light Sources</b>	

Chair: K. Yamamoto, Osaka Univ., Japan

Co-Chair: K. Takeda, Seiko Epson, Japan

**LIT4/  
PRJ2 - 1:  
9:00** *Invited* **Multi-Watt Class, Red, Green, and Blue,  
Direct Emitting and Frequency Doubled Laser  
Diodes**

*H. Hatanaka, G. T. Niven\**

*Ushio, Japan*

*\*Necsel Intellectual Property, USA*

We provide multi-watt class red, green, and blue lasers as a solid state light source solution for projectors and other display products. The technology and reliability will be reviewed and discussed based on measured data. Life test demonstrated over 38,500 hours of actual operation.

**LIT4/  
PRJ2 - 2:  
9:25** *Invited* **Recycling LEDs and LED Arrays for Pico-  
Projectors to Digital Cinema Projectors**

*K. Li*

*Wavien, USA*

Increase of LED brightness has been achieved using Recycling LED Technology. This is applied to pico-projectors using packaged RGB and RGBW LEDs in a single heat sink, standard red, green, blue, and white LEDs are also developed for desktop projectors and in a 7-LED arrays for digital cinema projectors.

**LIT4/ PRJ2 - 3 9:50**      **Green and Blue InGaN-Based Laser Diodes for Display Applications**  
*J. W. Raring, M. C. Schmidt, C. Poblentz, Y. Lin, E. Goutain, H. Huang, C. Bai, P. Rudy, J. S. Speck, S. P. Denbaars, S. Nakamura*  
*Soraa, USA*

We present state-of-the-art performance from green and blue InGaN laser diodes fabricated on nonpolar and semipolar GaN substrates. Using these novel orientations, we demonstrate laser diodes with continuous-wave operation from 445 nm to 525 nm, including over 100 mW at 516 nm and 1.4 W at 445 nm.

----- Break -----

<b>10:40 - 12:05</b>	<b>Room 231</b>
<b>PRJ3: Laser Projectors</b>	

Chair: P. Janssens, Barco, Belgium  
 Co-Chair: H. Sugiura, Mitsubishi Elec., Japan

**PRJ3 - 1: 10:40**      ***Invited* The Smart Laser Display**  
*K. Yamamoto*  
*Osaka Univ., Japan*

Smart Laser displays are attractive because of their low electric power consumption and the wide range of colors. The high efficiency and small etendue of lasers are advantageous for downsizing display systems. In this paper, smart laser display technologies and their applications are reviewed.

**PRJ3 - 2 11:05**      **Proposal of Zoomable Holographic Projection Method without Zoom Lens**  
*T. Shimobaba, A. Gotchev\*, N. Masuda, T. Ito*  
*Chiba Univ., Japan*  
*\*Tampere Univ. of Tech., Finland*

We propose a zoomable holographic projection technique without using a zoom lens and verify the method using numerical simulation. The method can reconstruct any zoom-in and zoom-out image between the 0th and 1st order diffraction lights, and the processing time for the zoom is constant.

**PRJ3 - 3 11:25**      **Fiber-Coupled Laser Cinema Projector**  
*P. Janssens, P. Gerets, D. Maes, N. Van den Bulcke, B. Van den Bossche, G. Van den Bergh, K. Vermeirsch*  
*Barco Tech. Ctr., Belgium*

Barco has built an experimental 3000 lm fiber-coupled laser DLP projector, which is based on Barco's DP1200 cinema projector. The projector is compliant with the DCI specifications and speckle levels are down to 4% for the three primaries.

**PRJ**



**PRJ3 - 4      Rear Projection Type Laser Phosphor Display Using  
11:45      Two Uni-Axial MEMS Scanning Mirror Devices**

*J.-H. Park, N. Asada<sup>\*</sup>, Y. Kawakami<sup>\*\*</sup>, K. Yamaguchi<sup>\*\*\*</sup>,  
M. Aso<sup>\*\*\*</sup>, J. Akedo*

*AIST, Japan*

*<sup>\*</sup>MICRO PRECISION, Japan*

*<sup>\*\*</sup>NEC TOKIN, Japan*

*<sup>\*\*\*</sup>Fine Rubber Lab., Japan*

We developed prototype system of rear-projection type laser phosphor displays, having two uni-axial MEMS scanning devices and phosphor screen. We found that the low power consumption of less than 40W might be required for realizing 60-in. TV with a brightness of 500 cd/m<sup>2</sup>.

----- Lunch -----

<b>13:20 - 14:25</b>	<b>Room 231</b>
<b>PRJ4: Pico and Mini Projectors</b>	

Chair: K. Guttag, Syndiant, USA  
Co-Chair: S. Shikama, Setsunan Univ., Japan

**PRJ4 - 1:      *Invited*      HD Pico Projectors with Laser Illumination**

**13:20**      *K. M. Guttag, A. Russell, C. Waller, S. Hurley  
Syndiant, USA*

The paper will discuss the issues associated with small HD resolution microdisplays and their use with laser illumination for pico projectors. Supporting HD for embedded applications will leverage laser illumination requires a small pixel with a high fill factor and very low power per pixel.

**PRJ4 - 2      Withdrawn**

**PRJ4 - 4L      Glasses-Free Projection Continuous 3D Displays**

**13:45**      *H. P. Kuo, K. H. Tan, M. Ye, R. L. Cobene, X. Li, L. Hubby,  
A. M. Bratkovsky, B. Culbertson  
Hewlett-Packard, USA*

We have developed a front projection glasses-free continuous-3D display system and automated calibration and alignment techniques. We demonstrate that with our system a group of viewers see simultaneously perspective-correct 3D images naturally through binocular and motion parallax within a contiguous viewing region without having to wear special viewing glasses.

**PRJ4 - 3 14:05 Achromatic Design in the Illumination System for a Mini Projector with LED Light Source**

*S.-H. Lin, J.-W. Pan, H.-H. Wang, P.-J. Tsai, Y.-C. Su, Y.-W. Hu*

*Nat. Chiao Tung Univ., Taiwan*

We provide a novel achromatic design in the illumination system for a mini projector with an LED light source. The lateral color aberration at the corners of the DMD active area can be reduced to 0.48  $\mu\text{m}$  by our compact ATIR prism. The total prism size is 4091  $\text{mm}^3$ .

----- Break -----

<b>15:00 - 16:20</b>	<b>Room 231</b>
<b>PRJ5: Projection Components</b>	

Chair: D. Cuypers, imec, Belgium  
Co-Chair: H. Kanayama, Sanyo Elec., Japan

**PRJ5 - 1 15:00 Characterization of DC-Offset Related Flicker in LCOS Devices**

*D. Cuypers, H. D. Smet\*, A. V. Calster\**  
*imec, Belgium*  
*\*Ghent Univ., Belgium*

A characterization of the flicker-inducing DC offset in asymmetric (LCOS) LC cells is performed making use of barrier layers to differentiate between electro-chemical reactions and ionic impurities. This characterization is used to understand the internal behavior of LCOS cells and to improve their functioning.

**PRJ5 - 2 15:20 A New Electrode and New Driving Scheme for Short-arc Ultra-High-Pressure Mercury Lamp for Long Life**

*T. Yamashita, M. Fukuda, A. Imamura, K. Goto*  
*Ushio, Japan*

As the light source for the projector, we have several options such as ultra-high-pressure mercury lamp, xenon lamp, and solid state light source. In this paper, we present a new electrode and lamp driving scheme for improvement of life performance of ultra-high-pressure mercury lamp to compete against other light sources.

PRJ

## IDW Best Paper Award

This award will go to the most outstanding paper selected from those presented at IDW '11.  
The 2011 award winners will be announced on the IDW website: <http://www.idw.ne.jp/award.html>

- PRJ5 - 3**      **Development of High-Brightness and High-Reliability Dual-Lamp Projector**  
**15:40**  
*Y. Yaji, A. Yamada, K. Kojima, T. Iwai, A. Michimori, K. Minami, H. Sugiura*  
*Mitsubishi Elec., Japan*

We developed a projector that can display clear pictures even in spacious and bright places. This projector is equipped with a dual-lamp optical system and automatic self-cleaning filter to assure a brightness of 7,000 lumens and a high contrast ratio of 2,000 to 1 and high reliability.

- PRJ5 - 4**      **Holographic Optical Elements Fabricated with Polymer-Dispersed-Liquid-Crystals for Head Mounted Displays**  
**16:00**  
*C.-W. Yen, W.-C. Su, C.-Y. Chen\*, H.-W. Ho\*, M.-H. Tsai*  
*Nat. Changhua Univ. of Education, Taiwan*  
*\*Nat. Yunlin Univ. of S&T, Taiwan*

We presented holographic optical elements fabricated with polymer-dispersed-liquid-crystal for head mounted displays. The polymer-dispersed-liquid-crystal consists of E7, APTMS, TMPTA, PI and PS. The thickness of the material used in the experiment is 20  $\mu\text{m}$ , and the diffraction efficiency of the holographic optical element is about 52 %.

**Author Interviews and Demonstrations**  
**16:20 – 17:10**

**Supporting Organizations:**  
 Technical Group on Information Display, ITE  
 Laser Display Technology Research Group, Optical Society of Japan

## IDW/AD '12

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

December 4-7, 2012

Kyoto International Conference Center  
 Kyoto, Japan

<http://www.idw.ne.jp>

# Workshop on Electronic Paper

Wednesday, December 7

13:55 - 14:00

Reception Hall 1

## Opening

### Opening Remarks

13:55

*M. Omodani, Tokai Univ.*

14:00 - 15:20

Reception Hall 1

## EP1: Electrochromic Displays (1)

Chair: H. Higuchi, NIMS, Japan

Co-Chair: Y. Hotta, RICOH, Japan

### EP1 - 1: *Invited* Multi-Layered Electrochromic Display

14:00

*Y. Naitoh, T. Yashiro, S. Hirano, Y. Okada, S. C. Kim,  
K. Tsuji, H. Takahashi, K. Fujimura, H. Kondoh  
RICOH, Japan*

We had developed a full-color multi-layered electrochromic display (mECD) technology based on the subtractive color mixing theory. The mECD promises to improve brightness and color reproducibility of reflective display because of its unique structure. We report the latest topic of applicability of mECD to flexible substrate in this paper.

### EP1 - 2 Photophysical Analysis of Novel Dual Mode Display Material Composed of Luminescent Lanthanide(III) Complexes and Diheptyl Viologen

14:25

*K. Nakamura, K. Kanazawa, N. Kobayashi  
Chiba Univ., Japan*

Photophysical investigations of novel dual mode displaying material were precisely carried out. The material was composed of luminescent lanthanide complex and electrochromic molecule of diheptyl viologen. As the result, the switching between emissive mode and reflective mode was achieved by intermolecular energy transfer from lanthanide complex to diheptyl viologen.

**EP1 - 3**      **The Effect of Structure and Materials on**  
**14:45**      **Characteristics of Reflective-Emissive Dual-Mode**  
**Display Cell**

*Y. Watanabe<sup>\*,\*\*</sup>, Y. Ibata<sup>\*</sup>, K. Nakamura<sup>\*</sup>, N. Kobayashi<sup>\*</sup>*

*<sup>\*</sup>Chiba Univ., Japan*

*<sup>\*\*</sup>JSPS, Japan*

We are studying novel dual-mode display (DMD) driven by electrochemical reaction. Our DMD cell shows electrochromic (EC) properties as reflective mode and electrochemiluminescent (ECL) properties as emissive mode. In this paper, we reported the effect of structure and materials on characteristics of reflective-emissive dual-mode display cell.

**EP1 - 4L**      **Electrochromic Device with Multiple Colors in a**  
**15:05**      **Single Unit Cell**

*C. H. Noh, R. R. Das, S. J. Jeon, J. W. Kim, S. Y. Lee*

*Samsung Elect., Korea*

Three colors, red (R), green (G), and blue (B), have been realized in single unit cell, together with white (W) color using electrochromic (EC) materials. New materials showing black color electrochromic can also be prepared. The precise control of operating conditions in electrochromic compounds allows this new type of pixel structure to be realized.

----- Break -----

**15:40 - 16:40**

**Reception Hall 1**

**EP2: Electrochromic Displays (2)**

Chair: N. Kobayashi, Chiba Univ., Japan

Co-Chair: Y. Toko, Stanley Elec., Japan

**EP2 - 1**      **Electrochromic Display Devices Using Organic-**  
**15:40**      **Metallic Hybrid Polymers**

*M. Higuchi<sup>\*,\*\*</sup>*

*<sup>\*</sup>NIMS, Japan*

*<sup>\*\*</sup>JST-CREST, Japan*

Organic-metallic hybrid polymers are prepared by quantitative complexation of organic ligands and metal ions and show excellent electrochromic properties based on the redox of the metal ions. We herein report flexible, rewritable, multi-colour electronic paper using the organic-metallic hybrid polymer film.

**EP2 - 2                      Improvement of Imaging Quality of an ECD with Passive-Matrix Drive**

**16:00**

*T. Higuchi, M. Suzuki, S. Kihara, K. Harumoto,  
T. Shimomura, M. Ono, M. Omodani\**

*Funai Elec., Japan*

*\*Tokai Univ., Japan*

By using a display device utilizing electrochromism of leuco dye, we have obtained images with high resolution, high density and high white reflectivity. New passive matrix driving methods, gelation of imaging liquids, and functional layer on counter electrode are effective to improve clarity of character images with high contrast ratio.

**EP2 - 3                      Novel Silver Deposition-Based Electrochromic Cell Showing Clear Transparent, Silver-Mirror and Black Color States**

**16:20**

*K. Kobayashi, S. Araki, K. Nakamura, N. Kobayashi*

*Chiba Univ., Japan*

Novel electrochromic (EC) cell based on electrochemical silver deposition mechanism was successfully demonstrated. The novel EC cell consisting of flat ITO electrode and ITO particle-modified electrode enabled selective three imaging states of clear transparent, silver-mirror and black color in single cell by changing bias polarity.

----- Break -----

**17:20 - 18:35**

**Reception Hall 1**

**EP3: Electrowetting Displays**

Chair: T. Kitamura, Chiba Univ., Japan

Co-Chair: N.-S. Roh, Samsung Elect., Korea

**EP3 - 1:                      Invited High Performance, High Reliability Electrowetting Displays for E-Paper Applications**

**17:20**

*M. van de Weijer, A. Giraldo, A. Slack*

*Samsung LCD, the Netherlands*

In this paper we discuss the application of Liquavista Technology for ePaper applications and consider those aspects of the technology that influence and improve performance, whilst maintaining the scalability and manufacturability of the technology within the lifetime and reliability expectations of a consumer electronics application.

**EP3 - 2: Invited Oil Motion Control in Electrowetting Displays by Inclined Pixel Walls****17:45***D. Figura, M. Hampton**Samsung LCD, the Netherlands*

Visual uniformity will make or break a display technology. A novel way of controlling oil motion (and thus visual) uniformity in electrowetting displays is by the use of inclined walls. This paper will detail the principle of inclined pixel walls and an experiment to validate the hypothesis.

**EP3 - 3: Invited Large-Sized Bistable Electrowetting Graphic Display****18:10***K. Blankenbach\*, D. Jerosch, F. Bartels, J. Rawert**ADT, Germany**\*Pforzheim Univ., Germany*

Basing on ADT's bistable electrowetting technology, Passive Matrix displays with a resolution of 10 x 14 and 85 x 85 pixels (size 1.5 x 1.5 mm<sup>2</sup>, display 7.2-in.) were developed. They show high reflectivity and sunlight readability. A broad range of applications is possible; a QR code system is presented.

**Author Interviews and Demonstrations**

18:40 – 19:30

**Thursday, December 8****9:00 - 10:25****Room 131****EP4: Electrophoretic Displays**

Chair: M. Tsuchiya, E-ink, Japan

Co-Chair: G. F. Zhou, Philips Res., the Netherlands

**EP4 - 1 Reflective Full Color Electrokinetic Displays****9:00***B. Benson, Q. Liu, T. R. Koch, J. Mabeck, R. L. Hoffman,**D. A. Mourey, G. Combs, Z.-L. Zhou, D. Henze**Hewlett-Packard, USA*

Novel architectures and electrically addressable inks have been developed to provide print-like full color reflective displays. The thin, flexible, low-power electrokinetic media is fabricated with roll-to-roll manufacturing, and integrated with a multi-component oxide thin-film transistor backplane to produce active matrix reflective electronic displays.

**EP4 - 2: Invited Novel Approaches to Addressing Greyscale and Color in Electrophoretic Displays**

9:20

*A. Henzen, J. van de Kamer, H. Brons, J. Groenewold\*, P. Bai\*\*, G. F. Zhou\*\*\**

*IRX innovations, the Netherlands*

*\*Utrecht Univ., the Netherlands*

*\*\*South China Normal Univ., China*

*\*\*\*Philips Res., the Netherlands*

Electronic paper is now evolving from novelty to mainstream. However, the interface with the user has not yet simultaneously evolved. Better and faster interaction methods are necessary, and these will become available through improved driving techniques, and tuning the driving method to the application in the user interface.

**EP4 - 3: Invited Research in Color e-paper: Overview and Future Perspective in China**

9:45

*P. F. Bai, M. L. Jin, L. L. Shui, M. S. Ren, X. Zhang, J. Groenewold\*, J. van de Kamer\*\*, A. Henzen\*\*, H. Brons\*\**

*South China Normal Univ., China*

*\*Utrecht Univ., the Netherlands*

*\*\*IRX innovations, the Netherlands*

Within the framework of co-operation between IRX Innovations, University of Utrecht in the Netherlands and South China Normal University, we started developing color e-paper displays. In this paper, we will give an update on the most recent results and electronic paper display research in China.

**EP4 - 4L Readability Evaluation of e-Proceedings on a Display - Disadvantage of Two-Column Format -**

10:10

*Y. Nakayama, M. Omodani*

*Tokai Univ., Japan*

We have compared reading performances of four kinds of displaying format on an A5 size screen and found a lower performance of two-column format. We suggest that the two-column format should not be used for electronic proceedings for display screens smaller than A4.

----- Break -----

11:00 - 12:00

Room 131

**Short Presentation EPp: Electronic Paper**

Introductory oral presentations, five minutes in length, will be given by the authors of the poster papers with ★ marks in their paper number.

----- Lunch -----



13:20 - 16:20

Room 222-224

**Poster EPp: Electronic Paper****EPp - 1★ Improvement of Electrochromic Behavior on Novel Dual Mode Display Device Containing Luminescent Lanthanide (III) Complex and Electrochromic Materials**

*K. Kanazawa, K. Nakamura, N. Kobayashi  
Chiba Univ., Japan*

We constructed novel display device with dual emissive and reflective display mode. The device consisted of  $\text{Eu(hfa)}_3(\text{TPPO})_2$  and an diheptyl viologen. In order to improve the response time of dual-mode cell and decrease the driving voltage for dual-mode representation, we introduced prussian blue modified electrode as an electrochromical redox material.

**EPp - 2 Effect of  $\text{TiO}_2$  Nanoparticles on Electro-Chemiluminescent Properties in  $\text{Ru}(\text{bpy})_3$  Based Emissive Display**

*M. Takase, J. Sugimoto, K. Nakamura, N. Kobayashi  
Chiba Univ., Japan*

Electrochemiluminescence (ECL) is known as electrochemical reaction exhibiting emission, and is applicable to new imaging device. We studied the effects of  $\text{TiO}_2$  nanoparticles(Rutile and Anatase) on electrochemiluminescence of  $\text{Ru}(\text{bpy})_3(\text{PF}_6)_2$ . The luminescence of cell with  $\text{TiO}_2$  (rutile and anatase) are durable compare to cell without  $\text{TiO}_2$ .

**EPp - 3 Withdrawn****EPp - 4 The Temperature Effect on Optical-Electrical Properties of Cholesteric Liquid Crystal Display**

*K.-T. Chen, Y.-J. Chao, C.-C. Lai, Y.-S. Tsai, K.-W. Wu,  
Y.-C. Lai, C.-C. Hsu, Y.-S. Chang, C.-J. Chen, C.-M. Wu  
ITRI, Taiwan*

This study reveals that the environment temperature will affect the operating voltage and the image quality of ChLCD. The data demonstrate that with the decrease of temperature the operating voltage will be increased and we found that we can maintain the operating voltage by increase the addressing time.

**EPp - 5      Optimization of Cholesteric Liquid Crystal Characteristics to Get Lower Driving Voltage and Better Optical Performance**

*B.-S. Ciou, S. Chen, C.-Y. Shen, S.-F. Liu*

*Chunghwa Picture Tubes, Taiwan*

The reflective Cholesteric Liquid Crystal Display (ChLCD) has many merits including lower power consumption and lower product cost, but its optical performance is much poor than the conventional TFT LCD. We optimize the characteristics of ChLC material to improve the NTSC from 12.7% to 20.7%, and lower the driving voltage from 25 V to 15 V.

**EPp - 6★      Study of Novel Ag Nanoparticle Films as Rewritable Imaging Media**

*T. Suzuki, Y. Fujii, Y. Onaka, S. Maeda*

*Tokai Univ., Japan*

We have recently discovered a novel method for preparing colored Ag nanoparticle films using a calcium sulfide solution as a coloring agent. The focus of this present work is to explore the possibility of these colored Ag nanoparticle films as rewritable media.

**EPp - 7★      Janus Particles for Electronic Paper Applications**

*H. Yabu, M. Kanahara, T. Jinno, S. Sato, M. Shimomura, Y. Tsuda\*, M. Bamba\**

*Tohoku Univ., Japan*

*\*Toray Eng., Japan*

The aim of this research is realizing a high resolution and a fast color switching of electronic papers. We developed micron-sized Janus particles having pigments introduced into respective hemispheres, which can be applicable to the particle rotation type electric paper that is one of the display methods in the electronics.

**EPp - 8★      Integration Process for Color Reflective Display**

*S.-T. Lam, R. Henze, T. Tran, P. Beck, G. Gibson, X. Sheng, Y. Jeon, Z.-L. Zhou*

*Hewlett-Packard, USA*

We report integration of static optical layers with a transparent-to-black optical shutter over color elements as a means to obtain an improved full-color or spot color reflective display suitable for cost-sensitive applications. The process is developed for compatibility with conventional and emerging active matrix flexible backplanes.

- EPp - 9★      Characteristics of Displays of E-Book Terminals on Text Readability**  
*A. Hasegawa<sup>\*,\*\*</sup>, S. Hasegawa<sup>\*\*</sup>, T. Kanda<sup>\*</sup>, M. Omori<sup>\*\*\*</sup>, M. Miyao<sup>\*</sup>*  
<sup>\*</sup>Nagoya Univ., Japan  
<sup>\*\*</sup>Nagoya Bunri Univ., Japan  
<sup>\*\*\*</sup>Kobe Women's Univ., Japan

This study evaluated readability of different types of electronic book readers. The e-book readers used were an Apple iPad tablet computer and Amazon Kindle with electronic paper. They were compared with a paper book.

- EPp - 10      Evaluation of E-Paper Readability**  
*T. Kanda, S. Hasegawa<sup>\*</sup>, A. Hasegawa, M. Miyao*  
*Nagoya Univ., Japan*  
<sup>\*</sup>Nagoya Bunri Univ., Japan

To evaluate the readability of e-paper, we carried out experiments to read texts. The positive and negative polarity display images were used in their experiments. Reading time was found to increase with decreasing visual function. It is different to be easy to read display by cloudy cataract.

- EPp - 11      Tone Characteristics and Color Gamut Evaluations of Electronic-Book Devices and Paper Media**  
*Y.-J. Li<sup>\*</sup>, H.-S. Chen<sup>\*</sup>, R. Luo<sup>\*,\*\*</sup>*  
<sup>\*</sup>Nat. Taiwan Univ. of S&T, Taiwan  
<sup>\*\*</sup>Univ. of Leeds, UK

The aim of this study was to compare color qualities between self-luminous e-book, reflective e-book, and color hardcopy printed by laser printer. Three categories of the rendered images were used to evaluate their color reproduction qualities in terms of lightness range, color gamut and tone response curve in physical measurement.

- EPp - 12L      Improvment of Toner type Display Characteristics by Single Particle**  
*E. K. Kim, S. Y. Jeong, G. J. Shin, K. H. Choi, S. Lee*  
*Korea Inst. of Ind. Tech., Korea*

We studied on the size effect of polymer particle with electric charge on the display properties in a toner type display. The surface of polymer particle simply was modified with nano-sized silica by using solvent system. Particularly, the surface modified polymer particle showed the very outstanding results in display.

**EPp - 13L★ A Color Display Based on Thermo-Chromic Pigments**

*K. C. Heo, B. C. Jang, J. Yi, J. H. Kwon, J. S. Gwag  
Yeungnam Univ., Korea*

A reflective thermochromic display fabricated by very simple method using three kinds of thermochromic pigments is presented and the thermo-optical characteristics is investigated. The reflective display cell exhibits continuous grey color with temperature change, which is crucial for multi-color display. It shows wide viewing angle over 80°.

**EPp - 14L★ Performance of Vivid Image Projection against Bright Room Using E-Paper Active Screen**

*T. Kinjo, M. Omodani  
Tokai Univ., Japan*

We have suggested a new projection system using electronic paper screen. It is consisted of electronic paper active screen, LCD projector and LED room lighting. We have confirmed that our new system can bring an ideal condition, for audience, which can realize a vivid image projection in a bright room.

**Author Interviews and Demonstrations**

18:00 – 18:50

**Friday, December 9**

<b>9:00 - 10:30</b>	<b>Room 141</b>
<b>EP5: Bistable Displays</b>	

Chair: A. Suzuki, Chiba Univ., Japan  
Co-Chair: T. Fujisawa, DIC, Japan

**EP5 - 1: 9:00 Invited Electrofluidic Displays and the Future of E-Paper Technology**

*J. Heikenfeld  
Univ. of Cincinnati, USA*

e-Paper is now established, growing in volume despite increased competition from LCDs. The application space for e-Paper is larger than what it can currently satisfy. This presentation reviews leading technologies for satisfying monochrome, color signage, and color-video e-Paper. In addition, a recent breakthrough in electrofluidic displays will be introduced and compared to existing e-Paper.



**EP5 - 2: Invited Full Color and Flexible Electronic Paper Display**

9:25

*M. Nishii, R. Sakurai, S. Ohno, Y. Masuda, R. Hattori\**

*Bridgestone, Japan*

*\*Kyushu Univ., Japan*

A full color and flexible electronic paper of quick response liquid powder display (QR-LPD) technologies have been achieved. Colorization of the monochromic panels and the development of flexible displays are focused. The originally developed materials and roll-to-roll manufacturing processes have enabled us to fabricate the full color and flexible displays.

**EP5 - 3 A Portable Color R2R Ch-LCD e-Tag System**

9:50

*T.-H. Yu, P.-C. Yeh, C.-W. Sun, H.-Y. Chen, Y.-S. Chang,*

*C.-C. Wu, C.-J. Chen, C.-C. Hsu*

*ITRI, Taiwan*

A portable color e-Tag system is proposed in this paper. The system is developed with R2R Ch-LCD. It is portable because the whole system is small and using rechargeable battery as power source. Due to these features, the e-Tag system is suitable to be message tags in public places.

**EP5 - 4 Novel Multi-Selection Method for Gray Scale Generation in Dynamic Driving Scheme of Cholesteric LCD**

10:10

*Q. Fu, C. Xu*

*Saarland Univ., Germany*

A novel multi-selection pattern for generating more grayscales combined with the dynamic driving scheme of the ChLCD is purposed for the first time. This method could easily increase the number of grayscales without additional IC cost and complicated voltage levels, but only by new waveform patterns.

----- Break -----

## EXHIBITION

12:40 – 18:00 Wednesday, Dec. 7, 2011

10:00 – 18:00 Thursday, Dec. 8, 2011

10:00 – 14:00 Friday, Dec. 9, 2011

2F, 3F Lobby, Bldg. 2

Nagoya Congress Center

Free admission with your registration name tag

10:40 - 11:40

Room 141

**EP6: New Approaches**

Chair: S. Maeda, Tokai Univ., Japan  
Co-Chair: H. Arisawa, Fuji Xerox, Japan

**EP6 - 1      Fast Full-Color Reflective Display  
10:40      via Photoluminescent Enhancement**

*G. A. Gibson, X. Sheng, D. Henze, S. Lam, P. Beck  
Hewlett-Packard Labs., USA*

Reflective displays are attractive in applications requiring low power or daylight readability. However, there are no low-cost reflective technologies capable of bright colors and video rate switching. By employing photoluminescence to more efficiently use ambient light, we demonstrate a low-cost approach to bright, full-color reflective displays with potential for video.

**EP6 - 2      AC-Driven Electrochemiluminescence toward a  
11:00      Novel Light-Emitting Device for Displays**

*T. Nobeshima, K. Nakamura, N. Kobayashi  
Chiba Univ., Japan*

An AC bias-driven electrochemiluminescent (ECL) cell was fabricated as a novel light-emitting cell, and some advantages of the AC-ECL were studied. The cell can be fabricated very simply. The emission turn-on response time and emission intensity were dramatically improved by introducing the AC method.

**EP6 - 3      Basic Operation Principles of Floating Metal Ball  
11:20      Actuator Mode Driven by Active Matrix Array  
Addressing for Novel Electronic-Paper Displays**

*H. Yoon, H. Park, M. P. Hong, J. Lee\*, B. Bae\*, J. Lee\*\*,  
K. Choi\*\*, B. Kim\*\*  
Korea Univ., Korea  
\*Hoseo Univ., Korea  
\*\*Dongjin Semichem, Korea*

Newly proposed reflective display mode using metal coated ball was explored for novel electronic-paper displays, named as Floating Metal Ball Actuator (FMBA) mode. We devised the active matrix addressing driving scheme without Thin Film Transistor (TFT) and capacitor and fabricated in-plane 10x10 FMBA. It demonstrated memory effect and rapid response.

----- Lunch -----

13:20 - 14:45

Room 141

**FLX5/EP7: Flexible Electronic Paper**

Chair: M. Kimura, Nagaoka Univ. of Tech., Japan  
Co-Chair: Y. Masuda, Bridgestone, Japan

**FLX5/EP7 - 1: Invited 13.3-in. Flexible Color Electrophoretic Display Driven by Low-Temperature a-Si TFTs**

13:20

*K. Akamatsu, A. Nishiike, K. Masuda, Y. Kato,  
T. Maruyama, M. Suzuki, R. Yasuda, K. Teramoto,  
T. Tanikawa, A. Yumoto, T. Kamei, K. Nomoto  
Sony, Japan*

We have developed a 13.3-in. flexible color electrophoretic display driven by low-temperature a-Si TFTs. We have developed (1) a plastic film transportation technology, (2) a reliable low-temperature a-Si TFT, and (3) a flexible CFA film. These technologies enable us to manufacture a high-resolution flexible EPD by a conventional mass-production system.

**FLX5/EP7 - 2: Invited Advanced Flexible Electrophoretic Display**

13:45

*Y.-I. Park, C.-H. Park, S.-H. Paek, O.-N. Kwon,  
C.-D. Kim, M.-C. Jun, Y.-K. Hwang  
LG Display, Korea*

We have developed flexible electrophoretic display with better optical property and world largest 19-in. size being applied gate-in-panel technology using E-ink micro-encapsulated technology. Through these EPD displays, we will be able to wide its application fields because advanced color image and large screen as well as flexibility and paper-like look.

**FLX5/EP7 - 3: Flexible Electrochromic Display Using a Viologen-Modified ZnO Nanowire Array Electrode**

14:10

*Q. Li, J. Chen, Y. Zheng, Y. Cui  
Southeast Univ., China*

The flexible electrochromic display using viologen-modified ZnO nanowire array as electrode is reported. The ZnO array was grown on a flexible ITO substrate by aqueous thermal decomposition method which seed layer was evaporated firstly by sputtering under low temperature. The devices show the low driving voltage and fast switch time.

**FLX5/  
EP7 - 4L  
14:30**

**A 5.0-in. Segment Type Reflective Flexible  
Electrowetting Display**

*C.-Y. Chen, C.-Y. Wang, W.-C. Wang, L.-H. Tsai, T.-Y. Lai  
WINTEK, Taiwan*

A 5.0-in. segment type reflective flexible electrowetting display had been developed by using plastic PEN substrate. By applying the dipping process to dose the black ink and introducing the photo spacer design, this simple structure, polarizer-free flexible reflective electrowetting display could be easily achieved.

**Author Interviews and Demonstrations**

16:20 – 17:10

**Supporting Organization:**

The Imaging Society of Japan

## Green & Recycling Technology

Highlighted Topics of FMC-WS

Thursday, Dec. 8, 2011

9:00 - 10:20 (FMC3)

Reception Hall 1, 4F of Bldg. 1

See page 60 for details

## IDW/AD '12

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

December 4-7, 2012

Kyoto International Conference Center

Kyoto, Japan

<http://www.idw.ne.jp>



# Workshop on MEMS and Emerging Technologies for Future Displays and Devices

Thursday, December 8

9:00 - 9:05

Room 232

## Opening

### Opening Remarks

9:00

*M. Nakamoto, Shizuoka Univ., Japan*

9:05 - 10:05

Room 232

## MEET1: MEMS Imaging and Sensing

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

Co-Chair: S. Coe-Sullivan, QD Vision, USA

### MEET1 - 1: *Invited* ZnO Based SAW and FBAR Devices for Lab-on-a-Chip Applications

9:05

*W. I. Milne, Y. Q. Fu<sup>\*\*</sup>, L. Garcia-Gancedo, G. Ashley<sup>\*</sup>,  
J. K. Luo<sup>\*</sup>, P. B. Kirby<sup>\*\*\*</sup>, X. Zhao<sup>\*\*\*\*</sup>, J. R. Lu<sup>\*\*\*\*</sup>,  
A. J. Flewitt*

*Cambridge Univ., UK*

*<sup>\*</sup>Univ. of Bolton, UK*

*<sup>\*\*</sup>Herriot Watt Univ., UK*

*<sup>\*\*\*</sup>Univ. of Cranfield, UK*

*<sup>\*\*\*\*</sup>Univ. of Manchester, UK*

Acoustic wave devices were fabricated incorporating ZnO films deposited using both a standard rf magnetron and a novel HiTUS Sputtering System. Our results demonstrated the feasibility of using a single SAW-based actuation mechanism for both microfluidics and sensing. To further improve the sensitivity we have also investigated ZnO based FBARS.

### MEET1 - 2 A Compact 8 x 8 Infrared Array Sensor "Grid-EYE"

9:25

*Y. Nakamura, H. Yamanaka, K. Tsuji, Y. Hagihara,  
M. Kumahara, M. Kiriara*

*Panasonic Elec. Works, Japan*

This paper reports a newly developed compact digital output 8x8 infrared array sensor, named "Grid-EYE". Combination of highly sensitive infrared array sensor die with simplified fabrication process and readout circuit with digital output of temperature data produces easy conventional area sensing to obtain temperature distribution without any mechanical scan unit.

**MEET1 - 3      Stabilization of Temperature Dependence of an  
9:40              Uncooled Infrared Image Sensor**

*H. Kwon, H. Honda, K. Suzuki, H. Yagi, M. Atsuta,  
I. Fujiwara, K. Sasaki, K. Ishii, G. Kawata, H. Funaki  
Toshiba, Japan*

We developed a 22  $\mu\text{m}$  pitch and 320  $\times$  240 pixel uncooled infrared image sensor. The partially released pixels were structured on a SOI wafer as reference pixels which were insensitive to the infrared absorption. The differential amplifier circuits were utilized for stable operation to the ambient temperature.

**MEET1 - 4      Withdrawn**

**MEET1 - 5L    Pixel-Controlling-Substrates of FPD Fabricated by  
9:55              Micro-Assembling of Millions of IC Chips and  
Automatic Metal Interconnection among Chips**

*T. Yagi, N. T. T. Kieu, H. Kugai, K. Ohdaira, H. Matsumura  
JAIST, Japan*

This paper presents novel technologies to make pixel-controlling-substrates (PCS) of FPD by the assembling of millions of crystalline-Si integrated circuit (IC) chips at the positions of pixels. Precise deposition of chips at pixel positions and automatic formation of metal lines show feasibility of new FPD fabrication systems.

----- Break -----

<b>10:40 - 12:00</b>	<b>Room 232</b>
<b>MEET2: Fundamental Components and Process Technologies (1)</b>	

Chair:                D. Pribat, Sungkyunkwan Univ., Korea  
Co-Chair:        S. Tanaka, Tohoku Univ., Japan

**MEET2 - 1:    *Invited* Solution Processed Metal-Oxide for Large  
10:40              Area Electronics**

*J. Jang, C. Avis, M. S. Ryu, S. H. Kim  
Kyung Hee Univ., Korea*

Solution processed metal oxide layers can be used for large area electronics. Metal oxides for anode buffer and cathode buffer can be used for OLED and OPV. And also for active layer and gate insulator of TFT are also used by metal-oxide, which will be reviewed.

**MEET2 - 2: *Invited* Fabrication Process Design for an All Organic AMOLED Pixel Structure**

**11:00**

*Y. Bonnassieux\*, O. Yaghmazadeh\*, D. Aldakov\*,  
D. Tondelier\*, B. Geffroy\*,\*\**

*\*Ecole Polytechnique, France*

*\*\*CEA-DSM-IRAMIS, France*

OTFT driven OLED on glass substrate are presented. These top-emission OLED pixels consists of two bottom-contact pentacene TFTs working as switching and driving transistors. Fabrication method and the performances with good mobility and stability will be discussed. We propose also a new approach by electroless depositing and soft lithography to make the OLED diode on the top of OTFT.

**MEET2 - 3 Nanometer-Order Size and Extremely Stable Transfer Mold Field Emitter Arrays**

**11:20**

*W. Kuroda, M. Nakamoto, J. H. Moon*

*Shizuoka Univ., Japan*

Extremely sharp, uniform, low operation voltage, 36 nm base length Transfer Mold Mo FEAs exhibit the most stable field emission characteristics having the emission fluctuation ratio of  $\pm 1.6\%$ , which is the lowest values ever reported. Transfer Mold Method can realize the very stable field emission displays and field emission lamps.

**MEET2 - 4 Fabrication of High Current CNTs Emitter with Resist-Assisted Patterning Process**

**11:35**

*A. N. Ha, S. W. Lee, W. M. Bae, H. C. Woo, Y. J. Eom,  
J. Jang, K. C. Park*

*Kyung Hee Univ., Korea*

The high electron emission property of carbon nanotube (CNT) emitter grown is studied. CNT emitters were grown on silicon wafer by the resist-assisted patterning process. The current of grown CNT emitter was high level more than 50 mA. Through structural and electrical analysis, we discuss about the property of grown emitters.

**MEET2 - 5L The Effect of Isopropyl Alcohol on the Reflection Loss for Single Crystalline Silicon**

**11:50**

*C. Wei, Y.-H. Chien*

*Tatung Univ., Taiwan*

The effect of potassium hydroxide with isopropyl alcohol with soft mask on surface texturization is investigated. The adding of isopropyl alcohol resulted in a smoother surface and reduced etching rate. The reflectance reduction is slightly improved for 20 min etching time.

----- Lunch -----

13:20 - 14:40

Room 232

**MEET3: Fundamental Components and Process Technologies (2)**

Chair: W. I. Milne, Cambridge Univ., UK

Co-Chair: Y. Koike, Keio Univ., Japan

**MEET3 - 1: *Invited* Full-Color Active-Matrix Quantum Dot Light Emitting Device Displays**

*J. Perkins, Z. Zhou, M. Stevenson, G. Mahan,  
B. Mashford, Y. Niu, C. Breen, C. Hamilton, J. S. Steckel,  
J. Ritter, V. Bulovic, S. Coe-Sullivan, P. T. Kazlas  
QD Vision, USA*

Quantum dot light emitting devices (QLEDs) are a printable thin film electroluminescent technology that delivers exceptional color and efficiency at low cost of manufacture for display and solid-state lighting applications. We report on our fabrication of full-color active-matrix QLED displays, and include recent advances in device performance.

**MEET3 - 2: *Invited* Interconnected Silicon Nanowires and Silicon-Based Core-Shell Structures for High Capacity Li-Ion Battery Anodes**

*D. Pribat, T. H. Nguyen  
Sungkyunkwan Univ., Korea*

Although silicon nanowires are usually studied for applications in thin film transistors, they are also used for energy storage, particularly as anodes for Li-ion batteries. We present here some strategies to improve their stability, based either on highly interconnected Si nanowire arrays or on the use of  $\text{NiSi}_x\text{-Si}$  core-shell structures.

**MEET3 - 3: *Invited* Self-Assembled QD Based Nanophotonic Device**

*T. Yatsui, H. Fujita, M. Ohtsu  
Univ. of Tokyo, Japan*

This paper reviews recent progress of nanophotonic device using self-assembled quantum dots (QDs). We developed a self-assembly method that aligns nanometre-sized QDs into a straight line along which photonic signals can be transmitted by optically near-field effects.

**MEET3 - 4: *Invited* Realization of Full-Color Quantum Dot Display**

*B. L. Choi, T.-H. Kim, K.-S. Cho, E. K. Lee, J. W. Kim,  
S. Y. Lee, J. M. Kim  
Samsung Elect., Korea*

Colloidal quantum dot (QD) display has recently received considerable attention due to their many strengths of QD property. In this talk, the issues of QD EL and successful embodiment of full-color QD display by transfer printing of QD pattern will be presented.

----- Break -----

15:00 - 16:20

Room 232

**MEET4: Displays and Imaging**

Chair: Y. Bonnassieux, Ecole Polytechnique, France

Co-Chair: T. Yatsui, Univ. of Tokyo, Japan

**MEET4 - 1: Invited Threshold Voltage Shift of Bottom-Gate Polymorphous Silicon Thin-Film Transistors under High Field**

15:00

*F. Templier, J. Brochet, B. Aventurier**CEA-LETI, France*

Mechanisms of voltage shift in pm-Si:H TFTs have been investigated under high field conditions. Under low  $V_{ds}$ , when gate voltage is increased, charge trapping is progressively the dominant mechanism. Under high  $V_{ds}$ , opposite behaviour is observed. TFT degradation is ruled by gate field rather than drain-source field.

**MEET4 - 2 Low Operation Voltage Transfer Mold Field Emitter Arrays by Plasma Treatment Using Vacuum In-Situ Fabrication and Evaluation Method**

15:20

*K. Eto, M. Nakamoto, J. H. Moon**Shizuoka Univ., Japan*

Transfer Mold field emitter arrays (FEAs) have been developed by the combination of plasma treatment method and vacuum in-situ emitter fabrication and evaluation method to realize the stable emission characteristics and low operation voltage field emission displays (FEDs) and field emission lamps (FELs).

**MEET4 - 3 Wrinkle Formation in Conformable Liquid Crystal Cells for Use in a Contact Lens Display**

15:35

*J. D. Smet\*, A. Avci\*, R. Beernaert\*, D. Cuypers\*\*,  
H. D. Smet\*,\*\***\*Ghent Univ., Belgium**\*\*imec, Belgium*

Wrinkle formation in conformable liquid crystal cells for use in a contact lens display was investigated. Smooth cells with minimal thickness were obtained when using an asymmetric configuration with a thin layer at the convex side and a thicker but threshold dependent layer at the concave.

**MEET4 - 4      Enhanced Electron Emission of Graphite Coated CNTs**

15:50

*S. W. Lee<sup>\*,\*\*</sup>, W. M. Bae<sup>\*</sup>, A. N. Ha<sup>\*</sup>, H. C. Woo<sup>\*</sup>,  
Y. J. Eom<sup>\*</sup>, J. Jang<sup>\*</sup>, K. C. Park<sup>\*</sup>*

*<sup>\*</sup>Kyung Hee Univ., Korea*

*<sup>\*\*</sup>LG Display, Korea*

We studied the effect of resin treatment of carbon nanotubes (CNTs) on field emission from CNT emitters grown using the resist-assisted patterning (RAP) process. The electron emission current and stability of emission current of graphite coated CNTs were remarkably improved.

**MEET4 - 5      Electrowetting Display in Transparent Display Application**

16:05

*Y. H. Tsai, K. W. Lan, C. L. Cheng, Y. S. Ku, S. W. Kuo,  
T. M. Liu, K. L. Lo, W. Y. Cheng*

*ITRI, Taiwan*

For transparent display application, electro-wetting display (EWD) is one of the potential technologies because of higher transparency, colorful choosing, and fast response. In this paper, the authors used the transparent mode EWD to realize the concept of single color and multi color transparent display.

----- Break -----

16:35 - 18:00	Room 232
<b>MEET5: Emerging Technologies</b>	

Chair: F. Templier, CEA-LETI, France

Co-Chair: B. L. Choi, Samsung Adv. Inst. of Tech., Korea

**MEET5 - 1: *Invited* Advanced Photonic Polymers for Fiber-to-the-Display**

16:35

*Y. Koike*

*Keio Univ., Japan*

Introducing advanced functional photonic polymer materials, we are proposing "Fiber-To-The-Display" concept where high-speed graded index plastic optical fiber (GI POF) network is directly connected to the high-definition and large-size display installed inside homes and buildings which allow us to have lively face-to-face communication even in distance.

**MEET5 - 2: *Invited* Hetero-Integrated Microsystem Technology****16:55***S. Tanaka, M. Esashi**Tohoku Univ., Japan*

Hetero-integration defined in this paper is the wafer-level integration of MEMS and IC plus the use of functional materials. There are technical problems in terms of allowable process temperature, thermal expansion mismatch, material-to-material process compatibility etc. New process technologies to overcome these problems and some hetero-integrated devices are presented.

**MEET5 - 3      Evaluation of Stress Concentration and Deformation of Drum-Type Micromirror****17:15***S. K. Kundu, A. Hikita, S. Kumagai, M. Sasaki**Toyota Tech. Inst., Japan*

A flat and lightweight drum-type micromirror is realized using a tense polycrystalline (poly-) Si membrane across a rigid crystalline (c-) ring. The fabricated drum-type micromirror is capable of providing high scanning speed and retaining optical flatness simultaneously. The circumference stress concentration and surface deformation of the designed micromirror are characterized.

**MEET5 - 4      Development of Miniaturized Piezoelectric Energy Harvesters****17:30***J. Ogawa, N. Yamauchi, K. Goto, T. Matsushima,  
K. Aizawa, I. Kanno\*, H. Kotera\***Panasonic Elec. Works, Japan**\*Kyoto Univ., Japan*

We have developed miniaturized piezoelectric vibration-type energy harvesters with piezoelectric thin films fabricated by MEMS technologies. Harvesters of several resonant frequencies revealed very high energy density. The module including a harvester and electrical circuit lighted up a LED for vibration of 510 Hz and 3 m/s<sup>2</sup>.

## **IDW/AD '12**

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

December 4-7, 2012

Kyoto International Conference Center  
Kyoto, Japan

<http://www.idw.ne.jp>

MEET5 - 5  
17:45**MEMS Resonator Improved by Controlling  
Generation of Crystallization Nuclei in Si Thin Film  
Structure***S. Kumagai<sup>\*,\*\*\*</sup>, H. Murase<sup>\*</sup>, S. Miyachi<sup>\*</sup>,  
I. Yamashita<sup>\*\*\*</sup>, Y. Uraoka<sup>\*\*\*</sup>, M. Sasaki<sup>\*\*\*</sup>**<sup>\*</sup>Toyota Tech. Inst., Japan**<sup>\*\*</sup>Nara Inst. of S&T, Japan**<sup>\*\*\*</sup>CREST/JST, Japan*

Generation of crystallization nuclei in an amorphous Si film is controlled by metal-induced lateral crystallization (MILC) using Ni nanoparticles that are synthesized within cage-shaped protein, apoferritin supramolecules. The MILC improved the crystallinity of the Si film. Fabricated MEMS device with the crystallized Si film achieves improved resonance characteristics.

MEET

**Author Interviews and Demonstrations**

18:00 – 18:50

Call for Papers  
**Special Section  
 on Electronic Displays**

**IEICE Transactions on Electronics**

Submission Deadline: Feb. 24, 2012

<http://ny7084.rie.shizuoka.ac.jp/eid/top-e.htm>**EXHIBITION**

12:40 – 18:00 Wednesday, Dec. 7, 2011

10:00 – 18:00 Thursday, Dec. 8, 2011

10:00 – 14:00 Friday, Dec. 9, 2011

2F, 3F Lobby, Bldg. 2

Nagoya Congress Center

Free admission with your registration name tag



# Workshop on Display Electronic Systems

Thursday, December 8

9:00 - 12:00

Room 222-224

## Poster DESp: Display and System

### DESp - 1 Low Power High-Speed Class AB Buffer Amplifier for LCD Applications

*H.-S. Cho, Y.-S. Jang, S.-G. Lee*

*KAIST, Korea*

This paper proposes low power high-speed buffer amplifier. To improve the speed of the buffer amplifier, a new slew-enhancement technique is proposed. The proposed buffer amplifier consumes 4  $\mu$ A of static current under 12 V of supply. With 6 k $\Omega$ , 300 pF load condition, the rail-to-rail settling time is 5.3  $\mu$ s/4.8  $\mu$ s for rising and falling respectively

### DESp - 2 Color Compensated Adaptive Dimming for Low Power LCD TVs

*H. Nam*

*Kyung Hee Univ., Korea*

Color distortion in an active dimming LCD system caused by mismatches between gamma values of pixel compensation algorithm and RGB sub-pixels, is analyzed and lowered by the proposed color compensation algorithm. This color compensation algorithm achieves the dramatic reduction on the color distortion without any loss of power saving performances.

### DESp - 3 Wireless Cloud Touch Display System

*Y.-H. Li, P.-H. Chou, S.-M. Chang*

*Chunghwa Picture Tubes, Taiwan*

This paper proposes wireless cloud mobile equipment (WCME) with display and touch functions. This WCME connects to personal computer and notebook by wireless transmission called as local cloud computing system (LCCS). The LCCS proceeds the remote control as the same as Tablet PC without CPU and OS.

### DESp - 4 Dynamic Backlight Control with Fuzzy Theory

*D.-W. Kuo, J.-S. Liao, H.-H. Chen, W.-T. Tseng,  
C.-R. Lee*

*Chunghwa Picture Tubes, Taiwan*

The paper takes Fuzzy theory as a controller to select the backlight's luminance. Because Fuzzy is mainly based on human subjective perception by the description of linguistic variables to achieve control, the control method can adjust depending on situations when designing controller.

**DESp - 5L      Accurate Optical Simulation Solution by Removing Leaked Light from Black Pixels**

*K. Kim, J.-M. Kim, J. Kim, M. Kim, S.-H. Lee, Y. Cho, S.-W. Lee*

*Kyung Hee Univ., Korea*

This paper proposes a method to accurately simulate LCD color performance by removing the effect of the leaked light from black sub-pixels. In addition, we propose a new method to optimize the off-axis color performance without actual fabrication. We can see the simulation results and measurement data are matched well.

----- Lunch -----

<b>13:20 - 14:40</b>	<b>Room 131</b>
<b>VHF4/DEs1: Color (1)</b>	

Chair: H. Okumura, Toshiba, Japan  
Co-Chair: T. Matsumoto, Sony, Japan

**VHF4/      Invited    Measuring Light and Color: Some Remarks**  
**DEs1 - 1:      on Defining Colorimetric Values**

**13:20**      *N. Ohta*

*Rochester Inst. of Tech., USA*

The CIE recommended the use of tristimulus values X, Y, Z as typical colorimetric values in 1931. In my present talk, I will talk some noteworthy points when defining X, Y, Z, which are: 1. Errors occurring numerical integrations, 2. Variation of color matching function.

**VHF4/      Invited    An Approach for Reproducing Illuminant**  
**DEs1 - 2:      Colors and Specular Highlight on Television Using**  
**13:50      Color-Mode-Index (CMI)**

*T. Fujine, T. Kanda, M. Sugino, M. Teragawa, N. Ohta\**

*Sharp, Japan*

*\*Rochester Inst. of Tech., USA*

We show an approach for reproducing illuminant colors and specular highlights on television using Color-Mode-Index (CMI), which is new evaluation index for color-appearance of reproduced color. We quantify lightness of color-mode boundary and show that it is possible to reproduce non-surface colors with realistic impression by controlling color-mode using CMI.

**VHF4/  
DES1 - 3**      **High-Resolution Representation for Multi-Primary  
Displays with Checkerboard Alignment**  
**14:20**      *S. Nakagawa, H. Furukawa, H. Miyata, K. Yoshiyama,  
Y. Yoshida*  
*Sharp, Japan*

We introduce a method to represent high-frequent signals using MPC-specialized sub-pixel rendering on four-primary and checkerboard alignment displays. For the method, displays equip a feature; four of sub-pixels which line up horizontally or vertically involve all primaries. The method reproduces high-frequent signals along both horizontally and vertically without increasing pseudo-colors.

----- Break -----

<b>15:00 - 16:20</b>	<b>Room 131</b>
<b>VHF5/DES2: Color (2)</b>	

Chair:            N. Ohta, Rochester Inst. of Tech., USA  
Co-Chair:       T. Matsumoto, Sony, Japan

**VHF5/  
DES2 - 1:**      ***Invited* Rendering Digital Cinema and Broadcast TV  
Content to Wide Gamut Display Media**  
**15:00**      *R. L. Heckaman, J. Sullivan\**  
*Rochester Inst. of Tech., USA*  
*\*Entertainment Experience, USA*

Much more is possible in achieving brighter, more vibrant colors for a richer visual experience in emerging, wide-gamut display media. Yet, both digital cinema and broadcast TV content fall well short of this promise. In this paper, we provide the means for realizing this promise.

**VHF5/  
DES2 - 2:**      ***Invited* Consideration on Color Reproduction in Next  
Generation Image Systems**  
**15:30**      *Y. Shimodaira*  
*Shizuoka Univ., Japan*

Desirable color reproduction in next generation image systems is considered in comparison with weak points of current image systems, e.g. color gamut, color difference and dynamic range. Those are essential for colorimetric color reproduction. Many users are eager to adopt image systems of colorimetric color reproduction for their business fields.

**VHF5/DES2 - 3**      **Enhancement Methods in sRGB to Six-Primary LCD Color Space**  
**16:00**      *C.-K. Chang, H. Yaguchi, Y. Mizokami*  
*Chiba Univ., Japan*

This study provides some methods in order to enhance the six-primary color space. It contains three stages: (1) sRGB expansion, (2) specialized gamut mapping (3) through a psychophysical experiment to inspect the result. According to the result, the proposed method is better than the non-corrected one.

----- Break -----

<b>16:40 - 18:05</b>	<b>Room 131</b>
<b>VHF6/DES3: Color (3)</b>	

Chair: M. Ayama, Utsunomiya Univ., Japan  
 Co-Chair: K. Sekiya, Tohoku Univ., Japan

**VHF6/DES3 - 1:**      ***Invited* Novel Addressing Method for a Stencil-FSC LCD Based on Human Visual System**  
**16:40**      *F.-C. Lin, Y.-P. Huang, Y.-H. Hsieh, H.-P. D. Shieh*  
*Nat. Chiao Tung Univ., Taiwan*

According to the human visual system, a novel TFT addressing method is proposed to gain more 85% time for LC response, which makes Stencil-FSC methods more feasible. Two indexes of PDR and relative CBU are introduced to evaluate image difference and color breakup for an FSC display.

**VHF6/DES3 - 2**      **Wide Gamut LCD Using Local Dimmable Four-Primary-Color LED Backlight**  
**17:10**      *Y. Sano, R. Nonaka, M. Baba*  
*Toshiba, Japan*

We designed an LED backlight consisting of an additional only-cyan LED with three-primary-color LEDs to reproduce all colors in the real world. An LCD with the developed four-primary-color LED backlight is able to cover almost all colors defined by the SOCS database by using a four-primary-color dimming algorithm.

**VHF6/DES3 - 3**      **Pseudo Multi-Primary Color Rendering for Wide Color Gamut Images**  
**17:30**      *X.-F. Feng, D. Zhang\**  
*Sharp Labs., USA*  
*\*Apple Computer, USA*

We present an advanced algorithm for wide color gamut. It uses the crosstalk color from the green LED to blue LCD to achieve a new pseudo cyan primary. A single pass rendering algorithm is developed which renders input color in CIEXYZ to RGB LED and RGB LCD driving values.

DES

**VHF6/**  
**DES3 - 4L**  
**17:50**  
**Does Dimmed LCD Guarantee Better Color Performance?**  
*M. Kim, J.-M. Kim, J. Kim, Y. Cho, S.-H. Lee, K. Kim, S.-W. Lee*  
*Kyung Hee Univ., Korea*

It is widely known that dimming technologies tend to degrade the color accuracy. We, however, present that color performance of a dimmed LCD is better than a conventional one. The dimming technology can makes LCDs better in not only power consumption but also color performance.

**Author Interviews and Demonstrations**

18:00 – 18:50

**Friday, December 9**

<b>10:40 - 12:00</b>	<b>Reception Hall 2</b>
<b>DES4/3D7: Post-HDTV</b>	

Chair: T. Yamamoto, NHK, Japan  
Co-Chair: S. Yano, NHK, Japan

**DES4/**  
**3D7 - 1:**  
**10:40**  
**Invited Development of Super Hi-Vision Camera System for High-Quality Content Production**  
*K. Arai, T. Kikkawa*  
*NHK, Japan*

NHK has developed an UHDTV system that has 16 times the number of pixels compared to HDTV, that it will be the next-generation broadcasting standard. A practical use camera, a compressed recorder, and a editorial system with a color grading processor have been developed to realize an efficient production workflow.

**DES4/**  
**3D7 - 2:**  
**11:00**  
**Invited High Performance Video Codec for Super Hi-Vision**  
*K. Kazui, A. Nakagawa, Y. Shishikui\*, K. Iguchi\*, S. Sakaida\**  
*Fujitsu Labs., Japan*  
*\*NHK, Japan*

This paper describes the 3rd generation real-time codec for the SUPER Hi-VISION (SHV) system which is being developed by NHK as a future broadcast system. The 3rd generation codec achieves bitrate reduction by 50% and downsize by 50% compared with previous codecs.

**DES4/ 3D7 - 3: 11:20**     ***Invited* High-Speed Reliable IP Transmission Technologies for Super Hi-Vision Transmission**  
*M. Ogawara, N. Kimura, T. Fujii*  
*NTT, Japan*

NTT has succeeded in achieving Super Hi-Vision (SHV) transmission over globally shared IP networks. The key technologies for transmitting SHV are low jitter control and IP stream synchronization. This paper describes a high-speed, reliable IP transmission system that incorporates these technologies as well as the results of experiments.

**DES4/ 3D7 - 4: 11:40**     ***Invited* Proposal for a Complementary Field Offset Sampled Scanning and Its Application to a Super Hi-Vision Projector**  
*F. Okano, M. Kanazawa<sup>\*</sup>, Y. Kusakabe<sup>\*</sup>, M. Furuya<sup>\*\*</sup>, Y. Uchiyama<sup>\*</sup>*  
*NHK-ES, Japan*  
<sup>\*</sup>*NHK, Japan*  
<sup>\*\*</sup>*JVC Kenwood, Japan*

A scanning method based on complementary field offset sampling is proposed. Its Nyquist frequency in both horizontal and vertical directions is doubled. The method can be almost free from the artifacts caused by the interlace scanning or the field offset sampling. It has been applied to a Super Hi-vision projector.

----- Lunch -----

<b>13:20 - 14:40</b>	<b>Room 133</b>
<b>DES5: Augmented Reality and Visualization</b>	

Chair: L. Kerofsky, Sharp Labs. of America, USA  
 Co-Chair: H. Okumura, Toshiba, Japan

**DES5 - 1: 13:20**     ***Invited* Tracking and Registration Technologies for Augmented Reality**  
*H. Kato*  
*Nara Inst. of S&T, Japan*

Many applications using Augmented Reality (AR) have been released with the spread of smart phones. AR is a new media representation technique created from integration of sensing and 3D CG technology. This paper explains about the registration technology which is important core technology for AR.

DES

**DES5 - 2: *Invited* Display Technologies for Augmented Reality**  
**13:40** *K. Kiyokawa*  
*Osaka Univ., Japan*

This article introduces research trends and future visions of head mounted displays (HMDs) for mixed and augmented reality. Specifically, studies on head mounted visual displays, head mounted multi-modal displays, and head mounted sensing technologies for mixed and augmented reality are introduced, and challenges and visions are discussed.

**DES5 - 3: *Invited* The Future of Augmented Reality in Our**  
**14:00** **Everyday Life**  
*M. Billinghurst*  
*Univ. of Canterbury, New Zealand*

Augmented Reality (AR) is technology that allows virtual imagery to be overlaid on the real world. Although invented forty years ago, it can now be used by almost anyone. We review the state of the art and describe how AR could be part of everyday life in the future.

**DES5 - 4: *Invited* Directing Visual Attention through**  
**14:20** **Visualization Techniques**  
*S. Takahashi*  
*Univ. of Tokyo, Japan*

We present techniques for intentionally directing the observers' visual attention to specific features of the visual representation. This is accomplished by modulating the bottom-up and top-down saliency of the visual representation in our approach.

----- Break -----

<b>15:00 - 16:00</b>	<b>Room 133</b>
<b>DES6: Advanced Display and System</b>	

Chair: H. Sasaki, Toshiba, Japan  
 Co-Chair: T. Fujine, Sharp, Japan

**DES6 - 1** **Hand-Waving Decodable Display by Use of a High**  
**15:00** **Frame Rate LED Panel**  
*S. F. B. Norizan<sup>\*</sup>, S. Suyama<sup>\*</sup>, H. Yamamoto<sup>\*,\*\*</sup>*  
<sup>\*</sup>*Univ. of Tokushima, Japan*  
<sup>\*\*</sup>*JST, Japan*

We propose a novel way of displaying information using a kind of steganography. A text is hidden in successive frames so that it is unnoticeable when being displayed on an LED panel with a high frame rate. This hidden text is decodable by viewing through a waving hand.

**DES6 - 2      Accelerate LC-Lens Autostereoscopic Display  
15:20      Using GPU Computing**

*C.-Y. Chiang, C.-W. Chang*

*Chunghwa Picture Tubes, Taiwan*

Playing a video on LC lens type autostereoscopic display not only can switch 2D and 3D, but also has good quality. Because it needs lots of system resources for display, we can not synchronize between video and audio. Our solution uses parallel processing with GPU to solve the problem effectively.

**DES6 - 3      A Novel Driving Method to Improve Image Quality  
15:40      and Reduce Power Consumption for Shutter  
Glasses Type 3D TFT-LCDs**

*C.-C. Chiu, C.-H. Chen*

*Chunghwa Picture Tubes, Taiwan*

We propose a novel driving method for shutter glasses type 3D displays. We control the timing of shutter glasses and backlight on/off so that we can save the power consumption of the backlight 67% compared to the conventional backlight control, improve flicker of shutter glasses in environment light.

**Author Interviews and Demonstrations**

16:20 – 17:10

**Supporting Organizations:**

Technical Committee on Electronic Information Displays, Electronics Society, IEICE

Technical Committee on Image Engineering, Information and Systems Society, IEICE

Information Sensing Research Committee, ITE

Special Interest Group on Mixed Reality, The Virtual Reality Society of Japan

Technical Group on Information Display, ITE

## IDW Outstanding Poster Paper Award

This award will go to the most outstanding paper  
selected from those presented at IDW '11  
poster presentation.

The 2011 award winners will be announced on the  
IDW website: <http://www.idw.ne.jp/award.html>



# Workshop on Flexible Displays

Thursday, December 8

9:00 - 9:05

Room 141

## Opening

### Opening Remarks

9:00

*H. Fujikake, NHK, Japan*

9:05 - 10:25

Room 141

## FLX1/AMD2: Flexible Active-Matrix Devices

Chair: H. Fujikake, NHK, Japan

Co-Chair: K. Nomoto, Sony, Japan

### FLX1/ AMD2 - 1: *Invited* New Organic Semiconducting Materials for Flexible TFTs

9:05

*K. Takimiya, E. Miyazaki, I. Osaka, S. Shinamura, M.-J. Kang*

*Hiroshima Univ., Japan*

Recent advances in the development of small molecule-based organic semiconductors potentially applicable to flexible TFTs are presented. The authors have mainly focused on air-stable, p-channel semiconductors including dinaphthothienothiophenes (DNNT) and benzothienobenzothiophenes (BTBT). The presentation will include the synthesis, characterization, TFT characteristics, and structure-property relationship of these materials.

### FLX1/ AMD2 - 2: Low-Temperature and Low-Voltage, Solution-Processed Metal Oxide n-TFTs and Flexible Circuitry on Large-Area Polyimide Foil

9:30

*M. Rockelé<sup>\*, \*\*</sup>, D.-V. Pham<sup>\*\*\*</sup>, J. Steiger<sup>\*\*\*</sup>, S. Botnaras<sup>\*\*\*</sup>, D. Weber<sup>\*\*\*</sup>, J. Vanfleteren<sup>\*, \*\*\*\*</sup>, T. Sterken<sup>\*, \*\*\*\*</sup>, D. Cuypers<sup>\*, \*\*\*\*</sup>, S. Steudel<sup>\*</sup>, K. Myny<sup>\*</sup>, S. Schols<sup>\*</sup>, B. van der Putten<sup>\*\*\*\*\*</sup>, J. Genoe<sup>\*</sup>, P. Heremans<sup>\*, \*\*</sup>*

*<sup>\*</sup>imec, Belgium*

*<sup>\*\*</sup>Katholieke Univ. Leuven, Belgium*

*<sup>\*\*\*</sup>Evonik Degussa, Germany*

*<sup>\*\*\*\*</sup>Univ. of Gent, Belgium*

*<sup>\*\*\*\*\*</sup>Holst Ctr., the Netherlands*

State-of-the-art solution-based oxide n-TFTs ( $\mu_{\text{sat}} \sim 2 \text{ cm}^2/\text{Vs}$  and  $I_{\text{on}}/I_{\text{off}} \sim 10^8$ ) processed at 250°C are realized on polyimide foil, resulting in fast and low-voltage flexible circuitry. Both high-speed and low-voltage operation makes the technology suited for both pixel driving and embedded line-drive circuitry at the borders of flexible AMOLED displays.

**FLX1/  
AMD2 - 3**      **Highly Reliable a-IGZO TFTs on a Plastic Substrate  
for Flexible AMOLED**

9:50

*S. Nakano, N. Saito, K. Miura, T. Sakano, T. Ueda,  
K. Sugi, H. Yamaguchi, I. Amemiya, M. Hiramatsu\*,  
A. Ishida\*, K. Kanomaru, M. Sawada*

*Toshiba, Japan*

*\*Toshiba Mobile Display, Japan*

We have successfully reduced threshold voltage shifts of a-IGZO TFTs on transparent polyimide films against bias-temperature stress below 0.15 V, close to those on glass substrates. This high reliability was achieved by compressive IGZO thin films and high-temperature annealing. We have fabricated a 3.0-inch flexible AMOLED driven by a-IGZO TFT backplane.

**FLX1/  
AMD2 - 4L**      **Simple Solution Process for Manufacturing High-  
Performance Polymer Thin-Film Transistors on  
Highly Hydrophobic Surfaces**

10:10

*M. Ikawa, Y. Horii, M. Chikamatsu, R. Azumi, H. Mogi\*,  
H. Matsui, T. Yamada, T. Hasegawa*

*AIST, Japan*

*\*Shin-Etsu Chem., Japan*

A novel solution process named push coating was developed for manufacturing polymer TFTs on highly hydrophobic substrates. In the process, a PDMS stamp is used to manufacture thin films of semiconducting polymers. By the method we produced the P3HT TFTs exhibiting mobility as high as 0.50 cm<sup>2</sup>/Vs.

----- Break -----

10:40 - 12:00

Room 141

**FLX2/FMC4: Materials, Components and Processes for Flexible Devices**

Chair: Y.-F. Liu, Nat. Cheng Kung Univ., Taiwan

Co-Chair: H. Maeda, DNP, Japan

**FLX2/  
FMC4 - 1:**      **Invited Transparent Polyimide Film for Flexible  
Display**

10:40

*J. Oishi, Y. Miki*

*Mitsubishi Gas Chem., Japan*

MGC has developed three types of polyimide. Transparency of film and varnish is excellent. We can supply low CTE film. Polyimide varnish can be used as thin film on glass substrate with spin coating. T type varnish is high heat durability pressure sensitive adhesive but not colorless.

**FLX2/  
FMC4 - 2  
11:05**      **Improvement of Barrier Properties of Transparent  
Barrier Coating Prepared by Roll to Roll PECVD  
System**

*H. Tamagaki, T. Okimoto  
Kobe Steel, Japan*

Improvement of the barrier performance of SiO<sub>x</sub> coating deposited by Roll to Roll PECVD System is attempted. By using Planarized PEN, which has better surface properties than standard PEN, the barrier performance is improved by a factor of 2-4, and WVTR below 5x10<sup>-4</sup> g/m<sup>2</sup>/day is obtained by 500 nm SiO<sub>x</sub> coating.

**FLX2/  
FMC4 - 3  
11:25**      **Low Temperature Fabricated Conductive Lines on  
Flexible Substrate by Inkjet Printing**

*Y.-F. Liu, Y.-F. Pai, W.-S. Hwang  
Nat. Cheng Kung Univ., Taiwan*

The optimal conditions of inkjet-printed nano-silver suspension and silver nitrate solution for fabricating continuous narrow conductive lines on a polyimide substrate are investigated. In addition, the effects of driving pulse voltage and droplet coverage on the bulging of as-printed conductive lines are also examined.

**FLX2/  
FMC4 - 4L  
11:45**      **Study on Recrystallization of the Nano Graphene  
from Amorphous Carbon Films**

*C.-M. Lee, J. Choi  
Kyung Hee Univ., Korea*

The nanographene films were directly deposited on the glass substrates without any metal catalyst by using CVD method. In this study, we observed that nanographene can be grown directly on glass as well as the crystal size of nanographene can be controlled by annealing thermally.

----- Lunch -----

<b>15:00 - 16:20</b>	<b>Reception Hall 1</b>
<b>FLX3: Advanced Technologies for Flexible Devices (1)</b>	

Chair: J. Oishi, Mitsubishi Gas Chem., Japan  
Co-Chair: M. Funahashi, Kagawa Univ., Japan

**FLX3 - 1: 15:00**      ***Invited* Ultraflexible Organic Integrated Circuits for  
Bio/Medical Sensors**

*T. Sekitani, T. Someya  
Univ. of Tokyo, Japan*

We report the fabrication of ultraflexible transistors and integrated circuits that continue to operate without failure, during folding of the circuits. Further, we fabricated intelligent tube-type integrated circuits that the surface of very fine medical catheter is covered by pressure sensor networks that can detect the spatial distribution of pressure.

**FLX3 - 2      The Key Factors of Flexible AMOLED De-Bonding  
15:25      from Carrier Glass Using Flexible Universal Plane  
Technology**

*J.-C. Ho, G. Chen, L.-Y. Jiang, S.-T. Yeh, Y.-Y. Chang,  
J.-Y. Yan, K.-Y. Ho, C.-C. Lee*

*ITRI, Taiwan*

Flexible AMOLED de-bonding force from glass carrier is strongly related to OLED encapsulation materials and structure by using Flexible Universal Plane (FlexUP) technology. The results revealed that different package glue materials and thickness of metal foil dominate the de-bonding force and performance.

**FLX3 - 3      Modeling Flexible Substrate Warpage Using DOE  
15:45      and Flexible Universal Plane Technology**

*Y.-H. Liao, L. Y. Chiang, D. S. Chen, H. F. Wei, P. M. Tsai,  
Y. C. Hsiao, M. L. Tsai, Y. Y. Chang, G. Chen*

*ITRI, Taiwan*

This study investigated the warpage of polyimide (PI) flexible display substrate through a Design of Experiment (DOE) approach. The significant factors were selected to be included in the regression model. The results showed that a high production yield could be achieved by following the guidance of the predictive model.

FLX

**FLX3 - 4L      ZnO Nanorods: Production and Characterisation of  
16:05      the Nanocrystals Grown by Potentiostatic and  
Galvanostatic Electrocrystallisation**

*Y. Suzuki, P. Kathirgamanathan\*, A. Nathan*

*Univ. College London, UK*

*\*Brunel Univ., UK*

ZnO nanorods were grown electrochemically under potentiostatic and galvanostatic conditions in an undivided three electrodes (PS) or two electrodes (GS) cell arrangement onto ITO/glass and ITO/Polyester. Their physical properties were examined using SEM, absorption spectroscopy and XRD. Conditions for the production of consistent quality of ZnO-nR have been established.

----- Break -----

16:40 - 17:55

Reception Hall 1

**FLX4: Advanced Technologies for Flexible Devices (2)**

Chair: T. Sekitani, Univ. of Tokyo, Japan  
Co-Chair: M. Ito, Toppan Printing, Japan

**FLX4 - 1: 16:40 *Invited* The Mass Production Development of Flexible Electrophoretic Display Using Hybrid a-Si Device Technology**

*C. J. Hu, P. Y. Wang, P. F. Wang, S. H. Tseng, C. S. Chan, Y. F. Tzeng, C. C. Wu*  
*AU Optronics, Taiwan*

The flexible electrophoretic display was successfully fabricated in G3.5 MP line. We had developed several flexible display driven by organic and in-organic hybrid device formed on 20  $\mu\text{m}$  polyimide, the display can keep normal function without additional failures under thermal storage 700 hrs ( 600°C/ 90% RH ) and 20000 times cycle rolling.

**FLX4 - 2 17:05 Amorphous Oxide Transistor Electrokinetic Reflective Display on Flexible Glass**

*D. A. Mourey, R. L. Hoffman, S. M. Garner\*, A. Holm, B. Benson, G. Combs, J. E. Abbott, X. Li\*, P. Cimo\*, T. R. Koch*  
*Hewlett-Packard, USA*  
*\*Corning, USA*

Thin flexible glass substrates represent an enabling technology towards high throughput roll-to-roll manufacturing with exceptional surface quality as well as thermal and dimensional stability. This paper describes the integration of a high performance back-channel etch amorphous oxide TFT backplane with an electrokinetic reflective frontplane on 100 micron thick flexible glass.

**FLX4 - 3L 17:25 Study of Low Cost Dual-Select-Diode AMLCD Technology for Application to Pixel Switching or Light Emission Elements at Low Temperature (180°C)**

*S.-Y. Kang, K.-S. Keum, K.-M. Lee, J.-H. Park, W.-S. Hong, T.-H. Song*  
*Univ. of Seoul, Korea*

Dual select diode (DSD) structures were fabricated at substrate temperatures below 180°C for applications to flexible displays. We observed a tunneling diode behavior associated with presence of midgap states that can be controlled by adjusting the film deposition parameters.

FLX4 - 4L  
17:40**Solution-Processed 4,11-bis(Triisopropyl-Silylethynyl) Dinaphthothienothiophene Organic Field Effect Transistor***Y. Ikeda, A. Hamaguchi, T. Negishi, S. Ohmori, T. Shiro  
Teijin, Japan*

Soluble 4,11-bis(triisopropyl-silylethynyl) dinaphtho-thienothiophene (TIPS-DNTT) has been developed for printed O-FETs. TIPS-DNTT has a solubility of 0.2 wt% in chloroform at room temperature. O-FETs using TIPS-DNTT were fabricated on silicon substrates by vacuum deposition and a solution-process; their mobility value was  $0.4 \text{ cm}^2/\text{Vs}$ .

**Author Interviews and Demonstrations**

18:00 – 18:50

**Friday, December 9**

9:00 - 12:00

Room 222-224

**Poster FLXp: Flexible Materials and Devices**

FLX

FLXp - 1

**Organic-Inorganic Hybrid Film for Flexible Display***N. Noda**JNC, Japan*

JNC Corporation has developed organic-inorganic hybrid type film "Sila-DEC" that can be used as a substrate for flexible display. This film has high transparency, high heat resistance and excellent dimensional stability. The "Sila-DEC" film will help to realize thinner, lighter weight and flexible FPD.

FLXp - 2

**Colorless Polyimide-Based Flexible LCD***G. H. Kim, W. J. Lee, S. Kim, K. H. Choi\***ETRI, Korea**\*KITECH, Korea*

Transparent colorless polyimide substrate was developed. With high optical transparency, C. PI substrates thermally stable to endure display manufacturing process and have good chemical stability against various process chemicals. To explore the performance and process-ability of this substrate, C. PI-based 2-in. TN-LCD clock was fabricated, and its electro-optic characteristics were investigated.

**FLXp - 3      Flexible Bistable Chiral Splay Nematic Mode with Enhanced Memory Characteristics by Surface Treatment**

*K.-S. Bae, C.-J. Yu, J.-H. Kim*

*Hanyang Univ., Korea*

We propose a flexible bistable chiral splay nematic (BCSN) display device with an enhancement of memory characteristics. By the surface treatment with reactive mesogen (RM), our device is given rise to impede to relaxation in a memory mode and thus a memory retention time is significantly improved in the flexible BCSN device.

**FLXp - 4      Opto-Electrical and Structural Properties of Poly(3,4-Ethylenedioxythiophene)-Tetramethacrylate on Polyethylene Naphthalate**

*C. Takahashi, K. H. Kim, H. Yamauchi, M. Suzuki, M. Kawamura, Y. Abe*

*Kitami Inst. of Tech., Japan*

Electrical, optical, and structural properties of poly(3,4-ethylenedioxythiophene)-tetramethacrylate (PEDOT-TMA) thin films on indium tin oxide (ITO)/polyethylene naphthalate (PEN) substrates with various thicknesses and UV-ozone exposure times were investigated. UV-ozone treatment on PEDOT-TMA thin films was an effective way to modify the surface properties.

**FLXp - 5      Electro spray Deposition Process for Transparent Flexible Silver Nanowire Electrodes**

*J. Li, H. Chae*

*Sungkyunkwan Univ., Korea*

Silver nanowires (AgNWs) films were fabricated as transparent flexible electrodes by electrostatic spray deposition (ESD) on PET substrates at atmospheric pressure and room temperature. AgNWs thin film was produced with ca. 20  $\Omega/\square$  sheet resistance and 85% transparency in the visible range.

**FLXp - 6      Fabrication of Transparent Metal-Grid Substrate for Flexible OLED Lighting**

*E. Jung, H. Lee, S. Seo, H. An, H. Chae, S. Cho*

*Sungkyunkwan Univ., Korea*

We fabricated the flexible OLED using metal-grid substrate as electrode. The metal-grid deposited aluminum on plastic substrate was formed a pattern by photolithography and oxidation process. Its transmittance and resistivity are around 80% and 21  $\Omega/\square$  respectively. The flexible device's performance using metal-grid substrate is 18,000  $\text{cd}/\text{m}^2$  at 15 V driving voltage.

**FLXp - 7**      **Withdrawn**

**FLXp - 8L**      **Study of Filament Geometry for Large Area nc-Si TFTs Fabricated at Low Temperature( $\leq 100^{\circ}\text{C}$ ) by Cat-CVD on Flexible Substrates**

*K.-S. Keum, K.-M. Lee, J.-H. Park, S.-Y. Kang,  
T.-H. Song, W.-S. Hong  
Univ. of Seoul, Korea*

We fabricated silicon(Si) films for nc-Si TFTs fabricated at low temperature ( $\leq 100^{\circ}\text{C}$ ) by Cat-CVD. The filament was arranged in a row. Filament distance and length was changed to uniformity at a low process temperature. Deviations and deposition rates of Si film thickness were dependent on filament distance.

**FLXp - 9L**      **High-Performance LT Poly-Si TFTs Fabricated on Flexible Glass**

*K. Kondo, Y. Okabe, H. Ogata, Y. Shika, A. Hara  
Tohoku Gakuin Univ., Japan*

High-performance p-ch LT poly-Si TFTs with lateral large grains were fabricated on transparent flexible glass with a thickness of  $150\text{ }\mu\text{m}$ , at  $550^{\circ}\text{C}$ . The fabricated TFTs exhibited a field-effect mobility of  $65\text{ cm}^2/\text{Vs}$ , s-value of  $280\text{ mV/dec}$ , and a threshold voltage of  $-0.9\text{ V}$ .

**FLXp - 10L**      **Conductivity of Ion Beam Treated Indium Tin Oxide Film**

*S. H. Yu, D. H. Kim, J. H. Kwon, J. S. Gwag  
Yeungnam Univ., Korea*

We report conductivity characteristic of low temperature-deposited-ITO film treated by ion beam. The experimental data show that ITO film treated by ion beam has higher conductivity than it by the thermal treatment. The effect of ion beam treatment may be driven by increase of density of ITO by atomic collisions.

----- Lunch -----

# BANQUET

Wednesday, December 7, 2011

19:30 – 21:30

Shirotori Hall (1F)

Nagoya Congress Center

See page 10 for details

FLX



13:20 - 14:45

Room 141

**FLX5/EP7: Flexible Electronic Paper**

Chair: M. Kimura, Nagaoka Univ. of Tech., Japan  
 Co-Chair: Y. Masuda, Bridgestone, Japan

**FLX5/EP7 - 1:** *Invited* **13.3-in. Flexible Color Electrophoretic Display Driven by Low-Temperature a-Si TFTs**  
**13:20**

*K. Akamatsu, A. Nishiike, K. Masuda, Y. Kato,  
 T. Maruyama, M. Suzuki, R. Yasuda, K. Teramoto,  
 T. Tanikawa, A. Yumoto, T. Kamei, K. Nomoto  
 Sony, Japan*

We have developed a 13.3-in. flexible color electrophoretic display driven by low-temperature a-Si TFTs. We have developed (1) a plastic film transportation technology, (2) a reliable low-temperature a-Si TFT, and (3) a flexible CFA film. These technologies enable us to manufacture a high-resolution flexible EPD by a conventional mass-production system.

**FLX5/EP7 - 2:** *Invited* **Advanced Flexible Electrophoretic Display**  
**13:45**

*Y.-I. Park, C.-H. Park, S.-H. Paek, O.-N. Kwon,  
 C.-D. Kim, M.-C. Jun, Y.-K. Hwang  
 LG Display, Korea*

We have developed flexible electrophoretic display with better optical property and world largest 19-in. size being applied gate-in-panel technology using E-ink micro-encapsulated technology. Through these EPD displays, we will be able to wide its application fields because advanced color image and large screen as well as flexibility and paper-like look.

**FLX5/EP7 - 3** **Flexible Electrochromic Display Using a Viologen-Modified ZnO Nanowire Array Electrode**  
**14:10**

*Q. Li, J. Chen, Y. Zheng, Y. Cui  
 Southeast Univ., China*

The flexible electrochromic display using viologen-modified ZnO nanowire array as electrode is reported. The ZnO array was grown on a flexible ITO substrate by aqueous thermal decomposition method which seed layer was evaporated firstly by sputtering under low temperature. The devices show the low driving voltage and fast switch time.

**FLX5/  
EP7 - 4L  
14:30**

**A 5.0-in. Segment Type Reflective Flexible  
Electrowetting Display**

*C.-Y. Chen, C.-Y. Wang, W.-C. Wang, L.-H. Tsai, T.-Y. Lai  
WINTEK, Taiwan*

A 5.0-in. segment type reflective flexible electrowetting display had been developed by using plastic PEN substrate. By applying the dipping process to dose the black ink and introducing the photo spacer design, this simple structure, polarizer-free flexible reflective electrowetting display could be easily achieved.

----- Break -----

**15:00 - 16:00**

**Room 141**

**FLX6: Advanced Technologies for Flexible Devices (3)**

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

**FLX6 - 1: *Invited* 13.3-in. UXGA Flexible Electrophoretic  
15:00 Display Driven by Solution-Processed OTFTs**

*N. Yoneya, H. Ono, Y. Ishii, K. Himori, N. Hirai, H. Abe,  
A. Yumoto, N. Kobayashi, K. Nomoto  
Sony, Japan*

A 13.3-in. UXGA flexible electrophoretic display driven by OTFTs has been developed. The display functions with no additional failures when it is bent to a radius of 5 mm. The OTFT uses a soluble semiconductor, a peri-xanthenoxanthene derivative, for the active channel and exhibits a mobility of 0.5 cm<sup>2</sup>/V s.

**FLX6 - 2 Fabrication of OLEDs Using Coated Stainless Steel  
15:25 Foil**

*N. Yamada, T. Ogura, S. Ito, K. Nose  
Nippon Steel, Japan*

We have developed HP-3 film with a thickness of 4.5 μm and a heat-resistance of 450°C. HP-3 film on stainless steel foil showed a quite low leakage current in a relatively large area. A top-emitting OLED was fabricated on HP-3 coated stainless steel foil.

**IDW Tutorial in Japanese**

Tuesday, December 6, 2011

Room 131, Bldg.1

Nagoya Congress Center

Detailed information is available on  
<http://www.sidchapters.org/japan/>

FLX

**FLX6 - 3L**  
**15:45**

**Glass Cloth-Reinforced Transparent Film for Plastic Displays**

*T. Abe, H. Kishimoto, S. Hashimoto*

*Panasonic Elec. Works, Japan*

We have developed a transparent organic and inorganic composite film that combines glass cloth with epoxy resin. This film features better heat resistance and dimensional resistance to temperature changes than conventional plastic film. It is currently being studied for application to substrates for plastic displays.

**Author Interviews and Demonstrations**

16:20 – 17:10

**Supporting Organizations:**

Technical Group on Information Display, ITE

Technical Committee on Electronic Information Displays, IEICE

## **Green & Recycling Technology**

Highlighted Topics of FMC-WS

Thursday, Dec. 8, 2011

9:00 - 10:20 (FMC3)

Reception Hall 1, 4F of Bldg. 1

See page 60 for details

## **Evening Get-Together with Wine**

Tuesday, December 6, 2011

18:00 – 20:00

at Skyview Restaurant Pastel (7F),

Nagoya Congress Center

(Sponsored by Merck Ltd., Japan)

See page 10 for details

# Workshop on Touch Panels and Input Technologies

Wednesday, December 7

13:55 - 14:00

Room 133

## Opening

### Opening Remarks

13:55

*I. Fujieda, Ritsumeikan Univ., Japan*

14:00 - 15:00

Room 133

## INP1: Touch Panel (1)

Chair: K. Nozawa, Atmel Japan, Japan

Co-Chair: H. Okumura, Toshiba, Japan

### INP1 - 1: *Invited* Touch Panel Technology Features: Look into Atmel Technologies

14:00

*K. Nozawa*

*Atmel Japan, Japan*

Touch technology has become the new user interface that consumers expect from not only their smart phone but many electronic devices. An in depth look at the technology behind the touch screen is presented here using Atmel touch controller solutions as a reference.

### INP1 - 2 An Integrated Touch Controller Design for Electromagnetic and Capacitive Touch Technologies

14:20

*Y.-T. Chen, K.-C. Chiu, Y.-C. Chen, H.-H. Chen,  
W.-T. Tseng, C.-R. Lee*

*Chunghwa Picture Tubes, Taiwan*

Chunghwa Picture Tubes has successfully developed the 7-in. dual mode touch integrating electromagnetic and capacitive touch technologies. This new technology can touch the screen by using the stylus pen or fingers and also show the new application in touch products.

### INP1 - 3 A Charge Transfer Scheme Based on Differential Driving for Capacitive Touch Sensor

14:40

*Y. Jang, Y. Ko, J. Choi\*, J. Kim\*, S. Lee*

*KAIST, Korea*

*\*Silicon Works, Korea*

A charge transfer circuit utilizing a differential driving scheme is proposed for capacitive sensing applications. The differential driving scheme eliminates the need for an off-chip capacitance, improving the level of integration and lowering the cost. It also acts to improve sensitivity by using the entire input range of the ADC.

----- Break -----

15:40 - 16:40

Room 133

**INP2: Touch Panel (2)**

Chair: H. Haga, NLT Techs., Japan  
Co-Chair: D. Douchamps, Cyberdyne, Japan

**INP2 - 1: Invited Novel Interactive Display with IR-Sensitive Backlights for Touch and Hover Sensing**

15:40

*K. Yi, C. Choi, S. Suh, B. Yoo, J.-J. Han, D. Park, C. Kim  
Samsung Elect., Korea*

A novel interactive display architecture with hover sensing capability based on infrared sensor array is described. The proposed architecture has an advantage over multi-touch LCD displays in that it maintains a slim form-factor of LCD displays without loss of a display quality while it can sense touches and hovers simultaneously.

**INP2 - 2 Depth-Aware Display Using Synthetic Refocusing**

16:00

*S. Suh, K. Yi, C. Choi, D. S. Park, C. Y. Kim  
Samsung Elect., Korea*

This paper describes a novel display architecture which can capture objects in front of the display. By displaying invisible pinhole patterns in an LCD screen during an imaging mode, the depth of objects is estimated by synthetic refocusing with multi-view images captured on an image sensor behind the LCD screen.

**INP2 - 3: Invited True Multi-Touch Displays: What, How and Why**

16:20

*D. Douchamps, J. G. Hale  
Cyberdyne, Japan*

The characteristic feature of a true multi-touch display is the handling of a large number of interaction points. In this short discussion, we describe how these displays work, why they are ideally suited for large multi-user systems and what kinds of new user-experience they facilitate.

----- Break -----

# Green & Recycling Technology

Highlighted Topics of FMC-WS

Thursday, Dec. 8, 2011

9:00 - 10:20 (FMC3)

Reception Hall 1, 4F of Bldg. 1

See page 60 for details

17:20 - 18:40

Room 133

**INP3: User Interface**

Chair: Y. Nakatani, Ritsumeikan Univ., Japan  
Co-Chair: K. Nagashima, Funai Elec., Japan

**INP3 - 1: Invited Displays as Advanced Human-Computer Interface**

17:20  
*Y. Nakatani*  
*Ritsumeikan Univ., Japan*

This paper briefly summarizes the historical background of a new human-computer interface used in the current mobile computers. Based on the analysis of the history, a key concept may be "user experience." Gesture recognition should be introduced, but gesture has different meanings in different cultures. Is the next technology culture-bound?

**INP3 - 2: Invited 3D Revolving User Interface Optimized for Tablets and a Cloud-Based Media Service**

17:40  
*I. Keshi, S. Yamaguchi, T. Mukai, H. Yamamura,*  
*H. Hinode, H. Inoue, M. Nakazawa, S. Ota, A. Azuma,*  
*Y. Matsumoto*  
*Sharp, Japan*

This paper presents the 3D UI optimized for touch-screen devices and a cloud-based media service. We describe how we produced 3D models of a revolving bookshelf and created a fast and comfortable animation in 3D space using physically realistic flick scrolling.

**INP3 - 3: Invited An Application to User Interface of Laser Pico Projector**

18:00  
*K. Nagashima*  
*Funai Elec., Japan*

We have been developing the application of new user interface device with the pico-projector of the laser scanning type. This device making use of the characteristic of the scanning is able to be used for a display and a user input at the same time.

**INP3 - 4 Point TV: A New User Interface for TV**

18:20  
*A. Kay, M. Juvonen, C. Brown, H. Walton*  
*Sharp Labs. of Europe, UK*

We report a TV user interface system that operates by simply pointing at the screen. The system is based on efficient computer vision algorithms that reduce the required computational resources by over 10x compared to conventional approaches. The result is a commercially viable system that is responsive, reliable and easy-to-use.

**Author Interviews and Demonstrations**

18:40 – 19:30

Thursday, December 8

9:00 - 10:20	Room 234
<b>INP4/3D1: 3D Input Technology (1)</b>	

Chair: T. Hamamoto, Tokyo Univ. of Sci., Japan  
 Co-Chair: O. Matoba, Kobe Univ., Japan

**INP4/3D1 - 1:** *Invited* **Smart Image Sensors and Their Application to 3D Imaging**  
 9:00 T. Hamamoto, H. Yamagishi, T. Hosaka  
 Tokyo Univ. of Sci., Japan

This paper explains the recent trend of smart image sensors. Next, as an application of the image sensor, we introduces our 3D imaging system for the real-time synthesis of arbitrary viewpoint image by using nine CMOS image sensors we have designed and fabricated.

**INP4/3D1 - 2** **Performance Analysis of Stereo Image Retargeting with Shift-Map**  
 9:20 R. Nakashima\*, K. Utsugi\*\*, K. Takahashi\*\*\*, T. Naemura\*  
 \*Univ. of Tokyo, Japan  
 \*\*Hitachi, Japan  
 \*\*\*Univ. of Electro-Commun., Japan

The performance of our stereo image retargeting algorithm based on shift-maps has been thoroughly evaluated. Various resolutions were tested for the target images to evaluate the effectiveness and processing time. A comparison with another stereo image retargeting algorithm, seam carving for stereo images, is also presented.

**INP4/3D1 - 3** **Development and Analysis of Quad-HD Multi-Camera System**  
 9:40 S. Sato, S. Tanaka, M. Kitagawa, M. Seo, T. Wakabayashi, T. Shimura, T. Imai, K. Omori, S. Saito, T. Hosaka\*, T. Hamamoto\*  
 Sharp, Japan  
 \*Tokyo Univ. of Sci., Japan

This paper describes how to develop and analyze multi-camera system, which generates Quad-HD video in real time. We propose new high-resolution image synthesis algorithms based on disparity estimation suitable for hardware. Experimental results showed that Quad-HD resolution was obtained. We concluded that our algorithms are effective for high-resolution cameras.

**INP/3D1 - 4**  
**10:00**  
**Compressive Acquisition of Ray-Space in Circular Camera Arrangement**  
*S. Yang, M. P. Tehrani, T. Fujii, M. Tanimoto*  
*Nagoya Univ., Japan*

In this paper, we propose a method for acquisition of Ray-Space from sparsely data captured in circular camera arrangement. Usually we must capture the large amount of data. But in this method, we can capture important data only by curve linear integral transform.

----- Break -----

<b>10:40 - 12:00</b>	<b>Room 234</b>
<b>3D2/INP5: 3D Input Technology (2)</b>	

Chair: N. Yoshikawa, Saitama Univ., Japan  
 Co-Chair: S. Aihara, NHK, Japan

**3D2/INP5 - 1:**  
**10:40**  
**Invited Acquisition of 3D Information Using Frequency Domain Analysis**  
*N. Yoshikawa*  
*Saitama Univ., Japan*

A full-frame 3D measurement system using frequency domain analysis is developed to generate quantitative 3D information. The proposed method is based on a computationally efficient implementation of the FFT. For real-time operation, we implement the proposed method using a GPU and demonstrate high-resolution real-time 3D measurements.

INP

**3D2/INP5 - 2**  
**11:00**  
**Aperture Diffraction Degrades Images Captured through the Screen**  
*A. Travis, T. Large, N. Emerton, S. Bathiche*  
*Microsoft, USA*

Wedge light-guides image objects in front of an LCD as if from a point deep behind and this enables video- conferencing with eye contact. But the color filters in the LCD cause aperture diffraction which degrades image resolution and we discuss strategies to manage this.

**3D2/INP5 - 3:**  
**11:20**  
**Invited Color Image Sensor with Vertically-Stacked Organic Photoconductive Films**  
*S. Aihara, H. Seo, T. Sakai, M. Kubota, N. Egami, M. Furuta\*, T. Hirao\**  
*NHK, Japan*  
*\*Kochi Univ. of Tech., Japan*

A stacked image sensor with blue-, green- and red-sensitive organic photoconductive films, each having a readout circuit array of zinc oxide-thin film transistor, was fabricated. The number of pixels was 128 x 96 on each color. The sensor produced a color image with a resolution corresponding to the pixel number.



**3D2/**                      **Withdrawn**  
**INP5 - 4**

**3D2/**                      **Invited Phase-Modulation Based 3D Optical**  
**INP5 - 5:**              **Visualization for Wide Viewing Zone**  
**11:40**                      *O. Matoba, N. Ueda*  
                                  *Kobe Univ., Japan*

A 3D display system using phase-only distribution for wide viewing zone is presented. The phase-only distribution is calculated from CG data. For wide viewing zone, phase distributions to reconstruct a 3D object from  $-20^{\circ}$  to  $20^{\circ}$  with an angle step of  $10^{\circ}$  are calculated. Numerical and experimental results are presented.

----- Lunch -----

<b>13:20 - 16:20</b>	<b>Room 222-224</b>
<b>Poster INPp: Touch Panels &amp; Input Technologies</b>	

**INPp - 1**                      **Withdrawn**

**INPp - 2**                      **Withdrawn**

**INPp - 3**                      **Single Layered and One-Side Wired Capacitive**  
**Touch Panel Using Transient Electrical Response**  
*K. Kyoung, K. Yuge, R. Hattori*  
                                  *\*Kyushu Univ., Japan*

We proposed in this paper the capacitive sensing method based on measuring transient response. Proposed capacitive sensing method with single layered one-dimensional electrode arrays can achieve multi-touch function and narrow bezel area by one-side wiring. The capacitive sensing method was verified by SPICE simulations and evaluation kits.

**INPp - 4**                      **A Novel Embedded Touch Display with Integrated**  
**Chip Solution**  
*H.-Y. Liu, C.-C. Chang, S.-H. Huang, H.-H. Chen*  
                                  *Chunghwa Picture Tubes, Taiwan*

This paper presents an innovative IC solution which is integrated in projected capacitive touch with TFT display. And this integrated chip IC can reduce the thickness of module and noise interference. Hence, this innovative IC can improve the competition of mass production in low cost for LCD panel vendor.

**INPp - 5      A Cover Glass with Variable Color Function on Capacitive Touch Module**

*C. W. Li, C. Y. Chou, F. C. Wu, H. H. Liao, C. F. Hsu, W. C. Wang*

*WINTEK, Taiwan*

Capacitive TP is the dominant touch technology for portable devices presently. It needs cover glass (CG) to protect the touch panel. But there is only pure color on fringe of CG, and is insipid for portable device. Here we propose a variable color for fringe of CG with users' favorite.

**INPp - 6      Imaging Fingers through a Light-Diffusing Film for 3D Input-Display Fusion**

*M. Nishino, T. Matsuno, Y. Okuda, I. Fujieda*

*Ritsumeikan Univ., Japan*

A camera acquires infrared images of fingers through a light-diffusing film on which an image is projected along the same optical axis. The distance between the fingers and the film can be determined by analyzing the image. This paves a way to realization of a crystal ball-like user interface.

**INPp - 7      A 3D Touch System**

*J. C. Lin, C. Y. Chiang*

*Chunghwa Picture Tubes, Taiwan*

We use Microsoft's "Kinect" sensor and OpenNI framework with OpenCV image processing to realize a 3D touch system. You can control computer by your hand gesture instead of the mouse. The depth image with "Z" information is created by Kinect sensor.

**INPp - 8L      Capacitive Type Touch Sensor Readout Circuit Using Passive I- $\Sigma\Delta$ M Based C-to-V Converter**

*Y.-M. Lee, K.-S. Lee\**

*Sun Moon Univ., Korea*

*\*Univ. of Akron, USA*

This works describes a touch sensor readout circuit using passive I- $\Sigma\Delta$ M C-to-V converter, where the panel capacitance is used as the integral part of the  $\Sigma\Delta$ M. As a result, the readout circuit can be realized using only one small capacitor, which considerably reduces the area, whereas achieving improved detection accuracy.

**Author Interviews and Demonstrations**

18:00 – 18:50

**Supporting Organizations:**

Human Interface Society

Information Sensing Research Committee, ITE

# Topical Session on Lighting Technologies

Wednesday, December 7

14:00 - 15:20

Room 141

## LIT1/OLED1: OLED for Lighting Application

Chair: Y. Kijima, Sony, Japan

Co-Chair: T. Ikuta, JNC Petrochem., Japan

### LIT1/ OLED1 - 1: **Invited World's First All Phosphorescent OLED Product for Lighting Application**

14:00

*T. Tsujimura, K. Furukawa, H. Ii, H. Kashiwagi,  
M. Miyoshi, S. Mano\*, H. Araki\*, A. Ezaki\**

*Konica Minolta Tech. Ctr., Japan*

*\*Konica Minolta Holdings, Japan*

A world's first OLED lighting product using all phosphorescent emitters is reported. Blue phosphorescent emitting system enables very high luminous efficacy as a commercial product: 45 lm/W. It is a debut of phosphorescent lighting product in human history. Merits of all phosphorescent OLED and its device decay modeling are also discussed.

### LIT1/ OLED1 - 2: **Invited Efficient White PIN OLED Structures with Internal and External Light Outcoupling Enhancement**

14:25

*D. Pavičić, Y. Shen, F. Löser, C. Rothe, T. W. Canzler,  
S. Murano, O. Fadhel, M. Hofmann, Q. Huang, A. Haldi,  
A. Werner, J. Birnstock*

*Novalled, Germany*

Bottom and top emission white and monochrome PIN OLED structures with efficient outcoupling method based on vacuum-processable materials are reported. In combination with external microlens array film, a power efficiency of 60 lm/W at 1000 cd/m<sup>2</sup> with colour coordinates of 0.47/0.43 and CRI of 87 has been demonstrated.

### LIT1/ OLED1 - 3: **Organic Light-Emitting Diodes with Enhanced Out-Coupling Efficiency Using High Refractive Index Glass Frit**

14:50

*T. Yagi, Y. Yamada, H. Kang\*, R. Satoh*

*Samsung Yokohama Res. Inst., Japan*

*\*Samsung Elect., Korea*

We fabricated a novel type of substrate for Organic light-emitting diodes (OLEDs). It was fabricated by forming a flat layer using a high refractive index B<sub>2</sub>O<sub>3</sub>-SiO<sub>2</sub>-Bi<sub>2</sub>O<sub>3</sub> glass on the light diffusive glass substrate. By preventing total reflections, light out-coupling efficiency was improved more than 1.6 times higher.

**LIT1/  
OLED1 - 4  
15:05**      **Two Different types of Organic Quantum Well Structures on High Efficiency White Organic Light Emitting Devices**

*Y.-C. Chen, M.-H. Wu, S.-Y. Chu*

*Nat. Cheng Kung Univ., Taiwan*

In this study, the effect of MQW structures adopting two different types organic materials have been demonstrated (C545T and TPBi). Brightness, current efficiency was significantly enhanced with a NPB/C545T MQW structure being inserted. The mobility was measured to account for this, which demonstrated the effect of two different MQW structures.

----- Break -----

**15:40 - 16:20**

**Room 234**

**LIT2/FMC2: Backlight**

Chair: K. Kälantär, Global Optical Solutions, Japan

Co-Chair: Y. Yang, Sony, Japan

**LIT2/  
FMC2 - 1:  
15:40**      ***Invited* Photonics Polymers for Novel Liquid Crystal Displays**

*A. Tagaya, Y. Koike*

*Keio Univ., Japan*

We have demonstrated the zero-zero-birefringence polymers, the zero-birefringence pressure sensitive adhesives, and the highly scattered optical transmission (HSOT) polymer. Using these polymers, the HSOT polymer backlights and screens, the polarized laser backlight, and the reduction of light leakage through LCDs have been demonstrated, and proposed a novel LCD system.

**LIT2/  
FMC2 - 2  
16:00**      **Optical Design of Front Diffuser for Collimated Backlight and Front Diffusing System**

*K. Nakamura, T. Fuchida, K. Yamagata, A. Nishimura,  
T. Takita, H. Takemoto*

*Nitto Denko, Japan*

We designed the front diffuser for “collimated backlight and front diffusing system”, which had a target diffusion in spite of thin layer by means of scattering analysis under Mie scattering theory and the multiple scattering effect.

**LIT2/  
FMC2 - 3**      **Withdrawn**

----- Break -----

17:20 - 18:40

Room 234

**LIT3/PH1: Phosphors for Lighting**

Chair: R.-S. Liu, Nat. Taiwan Univ., Taiwan  
 Co-Chair: K. Hara, Shizuoka Univ., Japan

**LIT3/PH1 - 1: Invited Approach for Realization of Comfortable Lighting Environment Using LED**

**17:20** *T. Kotani*

*Toshiba Lighting & Tech., Japan*

As luminous efficacy of white LEDs improves, white LEDs are expected to contribute to energy saving of lighting. However, the principle of the light emission of white LEDs is different from those of existing light sources. How can we make a comfortable space with LED lighting?

**LIT3/PH1 - 2: Invited White LED for General Lighting: Suppression of Discomfort Glare and Wide Emitting Angle**

**17:50** *A. Nomura, O. Kuboyama, K. Enomoto, S. Sugimori, H. Daicho*

*Koito Manufacturing, Japan*

We developed the white LED with newly shape and emitting characteristics, compared to conventional LEDs. We realized wider emitting angle, high luminous flux, and moderate luminance all together. These properties can lead to lighting up a whole space uniformly without uncomfortable glare. Thus, our LED is suitable for general lighting.

**LIT3/PH1 - 3: Color-Tunable Fluorosulfide Phosphors for Solid-State Lighting: Structure and Luminescence Investigations**

**18:20** *Y.-C. Wu, Y.-C. Chen, C.-S. Lee, T.-M. Chen*

*Nat. Chiao Tung Univ., Taiwan*

A novel  $Y_2(Ca,Sr)F_4S_2:Ce^{3+}$  fluorosulfide phosphor, was synthesized and its crystal structure was refined with Rietveld method.  $Y_2(Ca,Sr)F_4S_2:Ce^{3+}$  can be efficiently excited by blue light and shows yellow-to-orange broadband emission at 553-590 nm. Possible mechanism of the tunable luminescence properties was explained on the basis of the band structure calculations.

**Author Interviews and Demonstrations**

18:40 – 19:30

## Thursday, December 8

9:00 - 12:00

Room 222-224

**Poster LITp/OLEDp: OLED Technologies****LITp/  
OLEDp - 1****Thickness Dependence of J-V Characteristic for Multi-layer OLED Device Using Numerical Simulation***S.-G. Lee, H.-S. Kim, S.-K. Kwon, S.-H. Lee, K.-S. Kim, S.-J. Lee, Y.-H. Tak**LG Display, Korea*

The current density-voltage (J-V) Simulation for organic light emitting diode (OLED) was performed by using the injection-limited current ( $J_{ILC}$ ), bulk-limited current ( $J_{BLC}$ ) and interface model at heterojunction interface. The accuracy of this simulation was represented by comparing with the results from experimental data as a variable of EML thicknesses for multi-layer OLED device.

**LITp/  
OLEDp - 2****Polarized White Electroluminescence from OLEDs with a Quarter-Wave Retardation Plate Films and a Reflective Polarizer***B. Park, Y. H. Huh, J. C. Shin, Y. C. Kim, Y. B. Kim\***Kwangwoon Univ., Korea**\*Korea Inst. of Ind. Tech., Korea*

We present a highly polarized WOLEDs using a quarter-wave plate film and a reflective polarizer, which exhibited emissions of 14,000 cd/m<sup>2</sup> with peak efficiency of 18 cd/A and degree of polarization over 35. These are almost two times higher than those of the polarized WOLED using only a reflective polarizer.

----- Lunch -----

13:20 - 16:20

Room 222-224

**Poster LITp/FMCp: Backlight****LITp/  
FMCp - 1****Comparison of Phosphor-Coated LEDs and Remote-Phosphor LEDs for Illumination Applications***B.-W. Lee, J.-H. Ko**Hallym Univ., Korea*

Various illuminating characteristics of illumination devices based on phosphor-coated white LEDs and remote-phosphor white LEDs were investigated by using optical simulation based on a ray-tracing technique. The device efficiency, the color uniformity, and the illuminance distribution were systematically compared between these two types of LED devices.

**LITp/  
FMCP - 2      Polarization and Birefringence Properties of Prism  
Films Adopted in LCD Backlights**

*J. H. Kim, J.-H. Ko  
Hallym Univ., Korea*

The polarization and birefringence properties of prism films adopted in LCD backlights were investigated by optical measurements. It was found that the p-polarization component was stronger than the s-polarized component in the emitted light from the prism film. The birefringence was confirmed to exist in the prism grooves.

**LITp/  
FMCP - 3      The Luminance Enhancement of LCD Backlight  
by Lenticular-Lens Films**

*J. S. Seo, J.-H. Ko  
Hallym Univ., Korea*

A simulation study was carried out on lenticular-lens films(LLFs) to reveal their optical performances as functions of the aspect ratio and the refractive index of the one-dimensional lenticular lenses. There was an optimized height-to-width ratio as well as a refractive index at which the on-axis luminance gain became the maximum.

**LITp/  
FMCP - 4      The Effect of Inert Liquid on the Thermal and Optical  
Properties of High-Power White LED**

*S.-S. Jeong, J.-H. Ko  
Hallym Univ., Korea*

The effect of inert liquid paraffin on the thermal and optical properties of high-power white LEDs was investigated. The time dependence of the temperature at various conditions was measured and explained by using an exponential function. Empirical functions were used to fit the measured spectrum of white LEDs.

**LITp/  
FMCP - 5      Proposal of Design Method for Scattering Films  
for Novel Liquid Crystal Display Systems**

*D. Sekine, A. Tagaya, Y. Koike  
Keio Univ., Japan*

We proposed the analysis method for the multiple light scattering by the scattering media highly doped with particles. In this method, the film in which particles were precipitated in a single layer was set to be a basic component. We traced the rays which entered these components sequentially.

**LITp/  
FMCp - 6      Investigation of Novel Diffuser Films for 2D Light-Distribution Control**

*M. Nishizawa<sup>\*</sup>, K. Kusama<sup>\*,\*\*</sup>, K. Sekiya<sup>\*</sup>, B. Katagiri<sup>\*</sup>,  
T. Kawakami<sup>\*</sup>, T. Uchida<sup>\*</sup>*

*<sup>\*</sup>Tohoku Univ., Japan*

*<sup>\*\*</sup>LINTEC, Japan*

We synthesized high transmissive films that had 2-dimensional light distribution patterns such as square and hexagon. With the materials which showed 1-dimensional anisotropic diffusion if cured with a tube-type UV light source, arrays of UV-LEDs produced films of 2-dimensional distribution patterns corresponding to the symmetries of the light source arrays.

**LITp/  
FMCp - 7      Thermal Dissipation Behavior Outward the Epoxy Mold of High-Power LED**

*Y.-T. Bang, B.-H. Kim, D.-H. Kim, B.-K. Bae, K.-M. Park,  
J.-H. Bin, E.-J. Im, Y.-S. Lim, M.-R. Lee, M.-R. Son,  
C.-H. Moon*

*Hoseo Univ., Korea*

Thermal dissipation behavior outward the epoxy mold of 4 chip LED package was investigated. Finite Volume Method (FVM) simulation was conducted to estimate the temperature distribution around the LED chip and the package. Thermal infrared (IR) image was obtained by FLIR T-250 IR microscopy camera to compare with it.

**LITp/  
FMCp - 8      Critical Dot Dimension to Eliminate Dot Pattern Mura for Edge LED TV**

*C.-C. Hu, K.-Y. Chang, L. Sun*

*Shenzhen China Star Optoelect. Tech., China*

A novel approach to eliminate Dot Pattern Mura, which is commonly observed in Edge LED TV, has been developed. The approach is to develop an equation to determine critical dot dimension for light guide plate for edge LED TV. This approach is set up from theoretical study and experiments.

**LITp/  
FMCp - 9      High Transmittance LCD by Using the Color-Matching Backlight**

*G. S. Lim, C. G. Son, H. J. Jeon, J. S. Gwag, G. J. Park<sup>\*</sup>,  
J. H. Kwon*

*Yeungnam Univ., Korea*

*<sup>\*</sup>Sunlin Univ., Korea*

A new LCD with high transmittance is developed by employing the color-matching backlight system that consists of the RGB LEDs and a micro lenticular lens array (MLLA). It is shown that the LCD transmittance can be increased by 230%.



**LITp/  
FMCP - 10      LED Coupler Lens Array for One Dimensional  
Collimating Backlight**

*H. W. Yang, H. H. Lin, J. C. Hsu, N. Y. Pao*

*ITRI, Taiwan*

A one dimensional collimating Backlight system has been developed in using LED coupler lens array. The light out through the backlight system has a high-collimating emitting property, in which the simulation FWHM is smaller than  $3.8^\circ$ . The FWHM of the prototype is collimated to  $8^\circ$ .

**LITp/  
FMCP - 11      Spiral Optical Fiber Configuration for Laser  
Backlight Applications**

*Y. Okuda, N. Mori, I. Fujieda*

*Ritsumeikan Univ., Japan*

We propose to guide optical power from a laser diode through an optical fiber arranged in a spiral manner. The guided light leaks out via the grooves fabricated on one side of the optical fiber. This simple light-guiding structure can reduce the cost of an LD-based backlight system.

----- Lunch -----

**13:20 - 16:20**

**Room 222-224**

**Poster LITp/PHp: Phosphors**

**LITp/  
PHp - 1      Embedding Manganese-Doped Zinc Sulfide  
Quantum Dots in Gallium Nitride LEDs Based on  
Photonic Crystals**

*J. Silver, X. Yan, R. Withnall, G. R. Fern,  
J. W. S. Sumner\*, P. Shields\*, D. Allsopp\**

*Brunel Univ., UK*

*\*Univ. of Bath, UK*

Doped quantum dots (ca. 3.3(1) nm size) of ZnS:Mn phosphor have been synthesized and their photoluminescence (PL) properties have been characterised. The particles were successfully drop cast into the holes in a photonic crystal grown in the layers of a GaN LED crystal (previously grown on a sapphire substrate).

**LITp/  
PHp - 2**      **Iron-Doped Lithium Aluminate Embedded in Polypropylene as a Potential Infra-Red Emitter for Stimulating Plant Growth**

*J. Silver, R. Withnall, R. Li, A. L. Lipman, P. J. Marsh, G. R. Fern, K. Tarverdi, P. Bishop\*, B. Thiebaut\**

*Brunel Univ., UK*

*\*Johnson Matthey Tech. Ctr., UK*

Iron doped lithium aluminate,  $\text{LiAlO}_2\text{:Fe}$ , has been synthesized and produced on an industrial scale. The excitation and emission characteristics of this phosphor, both as a pure powder and embedded in polypropylene, are reported. The phosphor has applications for use as a UV degradation inhibitor when embedded in polymers.

**LITp/  
PHp - 3**      **Incorporating Cerium-Doped Yttrium Aluminium Garnet ( $\text{YAG:Ce}^{3+}$ ) Nanophosphors into Gallium Nitride LEDs Based on Photonic Crystals**

*R. Withnall, J. Silver, C. Catherall, T. G. Ireland, G. R. Fern, J. W. S. Sumner\*, P. Shields\*, D. Allsopp\*, P. W. Reip\*\*, S. Subbiah\*\**

*Brunel Univ., UK*

*\*Univ. of Bath, UK*

*\*\*Intrinsiq Materials, UK*

$\text{YAG:Ce}^{3+}$  nanometre sized particles have been synthesized on an industrial scale and their photoluminescence (PL) properties have been characterised. The particles were successfully drop cast into the holes in a photonic crystal etched within the layers of a GaN LED crystal (previously grown on a sapphire substrate).

**LITp/  
PHp - 4**      **Thermal Quenching of the Luminescence of Some LED Phosphors**

*R. Withnall, J. Silver, T. G. Ireland*

*Brunel Univ., UK*

The thermal quenching of the luminescence of different families of phosphors has been investigated in order to assess the suitability of using these phosphors on LED chips operating in the 25-200°C temperature range. Thermal quenching properties of garnet, nitride and alkaline earth silicate phosphors are reported.

**LITp/  
PHp - 5**      **Modular Type LED Package with Silicone Light-Guide Layer for Improved Luminance Uniformity of a Backlight Unit**

*J. K. Yoon, M. J. Jin, J. B. Choi, H. J. Park, J. W. Lee*

*LG Display, Korea*

In this study, a modular type package structure with optimized Light-guide Layer is proposed to achieve broad radiation characteristics with the fewest LEDs for direct-light type BLUs. Light-guide Layer combined with integrated optical lenses (IOL) is capable of achieving uniform luminance distribution by assisting light emitted from luminous light sources.

**LITp/  
PHp - 6      Photometric and Colorimetric Characteristics  
of White-LED Composed of Four Primary Colors**

*K. Misono*

*Miyakonojo Nat. College of Tech., Japan*

We investigated the luminous efficacy, color rendering index and color gamut of white-LED composed of four primary colors: red, yellow, green and blue. The candidates of spectral power distributions of RYGB that achieve luminous efficacy  $\geq 350$  lm/Wrad,  $R_a \geq 90$  (Group 1A) and %Gamut1 =  $140 \pm 10\%$  were obtained.

**LITp/  
PHp - 7      Fabrication of  $\text{CuInS}_2$ /ZnS Quantum Dot-Polymer  
Composite Plate for Application to White Light-  
Emitting Diodes**

*D.-E. Nam, W.-S. Song, H.-J. Kim, J. C. Lee, E.-P. Jang,  
H. Yang*

*Hongik Univ., Korea*

Yellow-emitting  $\text{CuInS}_2$ /ZnS core/shell quantum dots with a quantum yield of 65% were prepared by a consecutive solvothermal technique. QD composite plate was generated by blending with pre-polymerized methyl methacrylate and drying. White LEDs were fabricated by placing QD-plate onto a blue LED chip and their optical properties were evaluated.

**LITp/  
PHp - 8      Effect of Li Doping on High Color Purity  $\text{CaTiO}_3$ : Eu  
Red Phosphor for Solid-State Lighting**

*Y.-F. Wu, Y.-T. Nien, Y.-J. Wang, I.-G. Chen*

*Nat. Cheng Kung Univ., Taiwan*

In this study,  $\text{Li}^+$  was co-doped in  $\text{CaTiO}_3:\text{Eu}^{3+}$  to study its effect on photoluminescence and color purity. This incorporation of  $\text{Li}^+$  ion into the  $\text{CaTiO}_3:\text{Eu}^{3+}$  system could not only increase the photoluminescence intensity of 1.6 times but also enhance the color purity to 92.1%.

**LITp/  
PHp - 9      Withdrawn**

**LITp/  
PHp - 10      Spectral Evaluations of Color Rendering Properties  
of LED Light Sources by Using Hyper Spectral  
Sensor**

*H. Seki, K. Uto, Y. Kosugi*

*Tokyo Inst. of Tech., Japan*

By using Hyper Spectral Sensor, mainly featured with very high wavelength resolution, we measured spectral reflectance of color samples under D65 standard illuminant and testing LED light sources. It was confirmed that the method can be applied to evaluate spectral and quantitative color rendering properties of LED light sources.

**LITp/  
PHp - 11      Chromatic Measurement Using Two-Dimensional  
Imaging Colorimeter**

*C. H. Cho, Y. S. Chang, C. W. Lo  
ITRI, Taiwan*

To meet the demand of quick colorimetric measurement in industry, we proposed a two-dimensional colorimeter which shares a configuration of color filter analyzer. The luminance and chromaticity of each point within wide field of view are deduced. Real-field test result with comparison of current commercial machine is also provided.

**LITp/  
PHp - 12      Precise Luminance and Color Temperature Control  
for BRCR Measurement System**

*Y. Wang, Y. Tang, J. Zhang, Y. Zheng  
Southeast Univ., China*

A novel BRCR measurement system is presented with a color mixing algorithm ensuring relative error below 5% which is insensitive to color coordinate changes of LEDs caused by manufacturing error, aging, etc. Its color temperature adjustable range is 3,000~10,000 K. Maximum luminance is among 1,600~3,000 lx with different color temperature setting.

**LITp/  
PHp - 13L      Luminous Efficiency of White LEDs with Different  
Spatial Phosphor Distributions for LCD Backlighting**

*G. Y. Park, D. J. Jun, D.-G. Kim, H. J. Park, J. W. Lee  
LG Display, Korea*

In this paper, optical effects of dispersed, conformal and remote phosphor structures for LED package are studied while maintaining identical color coordinates for each type of structure. In conclusion, we have found that the luminous efficiency is strongly influenced by backward light scattered from a phosphor layer.

**LITp/  
PHp - 14L      Investigation into Various Color Beta SiAlON:  
Eu<sup>2+</sup> and Its Influence on Efficiency of White LEDs  
and Color Gamut of LCDs**

*A. Ohishi<sup>\*,\*\*</sup>, R. Ohtsuka<sup>\*</sup>, T. Hisamune<sup>\*</sup>*

*<sup>\*</sup>Mitsubishi Chem., Japan*

*<sup>\*\*</sup>Mitsubishi Chem. Group S&T Res. Ctr., Japan*

We succeeded in producing beta type-(Si,Al)<sub>8</sub>(O,N)<sub>8</sub>:Eu<sup>2+</sup> (beta SiAlON) that had various emission spectra and high efficiency. We investigated its influence on white LED efficiency in which beta SiAlON was used for the green component and the color gamut of LCDs with LED backlights.

## Friday, December 9

9:00 - 10:10

Room 231

**LIT4/PRJ2: Solid State Projection Light Sources**

Chair: K. Yamamoto, Osaka Univ., Japan

Co-Chair: K. Takeda, Seiko Epson, Japan

**LIT4/  
PRJ2 - 1:  
9:00** *Invited* **Multi-Watt Class, Red, Green, and Blue,  
Direct Emitting and Frequency Doubled Laser  
Diodes***H. Hatanaka, G. T. Niven\***Ushio, Japan**\*Necsel Intellectual Property, USA*

We provide multi-watt class red, green, and blue lasers as a solid state light source solution for projectors and other display products. The technology and reliability will be reviewed and discussed based on measured data. Life test demonstrated over 38,500 hours of actual operation.

**LIT4/  
PRJ2 - 2:  
9:25** *Invited* **Recycling LEDs and LED Arrays for Pico-  
Projectors to Digital Cinema Projectors***K. Li**Wavien, USA*

Increase of LED brightness has been achieved using Recycling LED Technology. This is applied to pico-projectors using packaged RGB and RGBW LEDs in a single heat sink, standard red, green, blue, and white LEDs are also developed for desktop projectors and in a 7-LED arrays for digital cinema projectors.

**LIT4/  
PRJ2 - 3  
9:50** **Green and Blue InGaN-Based Laser Diodes  
for Display Applications***J. W. Raring, M. C. Schmidt, C. Poblenz, Y. Lin,  
E. Goutain, H. Huang, C. Bai, P. Rudy, J. S. Speck,  
S. P. Denbaars, S. Nakamura**Soraa, USA*

We present state-of-the-art performance from green and blue InGaN laser diodes fabricated on nonpolar and semipolar GaN substrates. Using these novel orientations, we demonstrate laser diodes with continuous-wave operation from 445 nm to 525 nm, including over 100 mW at 516 nm and 1.4 W at 445 nm.

**Author Interviews and Demonstrations**

16:20 – 17:10

**Supporting Organizations:**

Japan Electric Lamp Manufacturers Association  
Japan Luminaires Association

# Topical Session on Automotive Displays

Wednesday, December 7

15:40 - 17:00	Room 131
<b>AUTO1: Vision in Vehicles</b>	

Chair: V. Charissis, Glasgow Caledonian Univ., UK  
 Co-Chair: S. Okabayashi, Meijo Univ., Japan

**AUTO1 - 1: *Invited* Traffic Accident Simulation by Instrumented  
 15:40 Vehicle with LCD**

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

Understanding of driver behaviour during pre-crash period is important for developing preventive safety measures or driver support systems. Although driving simulators is frequently used for such research purposes, there are practical problems. Therefore, an instrumented vehicle was developed to reproduce realistic pre-crash scenarios without any actual collision risk.

**AUTO1 - 2: *Invited* Ambient Information Display Designed  
 16:00 for Peripheral Vision**

*M. Funakawa*  
*Nissan Motor, Japan*

Nearly all visual information displays use only foveal and not peripheral vision. We propose a new method of information display for peripheral vision. The proposed display is composed of blurred, swinging, and coarse 'will-o'-the-wisp' patterns, that are discriminable by peripheral vision and free from any effect on eye movement and accommodation.

**AUTO1 - 3: *Invited* How Drivers Can Cognize Human Presence  
 16:20 in Far-Infrared Images**

*G. Kasagi<sup>\*,\*\*</sup>, S. Okabayashi<sup>\*</sup>*  
<sup>\*</sup>*Meijo Univ., Japan*  
<sup>\*\*</sup>*Seijoh Univ., Japan*

Infrared images are not displayed in color, but in monochromatic. In this paper, we have investigated how drivers can cognize the human presence in the monochromatic images. It can be concluded the contour of the human silhouette, particularly a portion of a head, plays an important role in this cognitive process.

AUTO

**AUTO1 - 4: *Invited* The Assessment of Risky Driving Caused by  
16:40 the Amount of Time Focused on an In-Vehicle  
Display System**

*J. B. Ryu*

*Road Traffic Authority, Korea*

An experimental study was conducted, using a driving simulator, to establish the proper standard of the maximum distraction time per unit-task to the extent that an in-vehicle display devices do not cause any disturbance on safe driving. The results showed that the 2-second condition differed from the control condition.

----- Break -----

**17:20 - 19:00**

**Room 131**

**AUTO2: Displays in Vehicles**

Chair: S. Okabayashi, Meijo Univ., Japan

Co-Chair: V. Charissis, Glasgow Caledonian Univ., UK

**AUTO2 - 1: *Invited* Investigation of Prototype Full-Windshield  
17:20 Head-Up Display Interface Impact on Users' Driving  
Patterns under Adverse Weather Conditions**

*V. Charissis*

*Glasgow Caledonian Univ., UK*

The paper presents a prototype full-windshield Head-Up Display interface and discusses the users' driving patterns arising from the use of a proposed HUD system, under low visibility in a motorway environment. Finally the paper offers a tentative plan of future research work.

**AUTO2 - 2: *Invited* The Development of Surround View System  
17:40 Considering Color Vision Characteristics**

*T. Taiko, J. Kadowaki, K. Honda, H. Hosoi*

*Aisin Seiki, Japan*

We developed the in-vehicle camera system that adapted Color Universal Design. The difference of distinguishability and recognition for the layered guideline expression (colors and drawings) on camera images was evaluated based on color vision characteristics. As a result, we figured out most recognizable color combinations and acquired the CUD certification.

**AUTO2 - 3: *Invited* Head Up Display Technology for Automotive  
18:00**

*Y. Yonemoto*

*DENSO, Japan*

This research is about a display-performance of Head Up Display for a vehicle. Among the display-performance, we will mention especially the difference of the visual image seeing by the both eyes of the driver when he feels uncomfortable.

**AUTO2 - 4      Depth Perception Effect of Dynamic Perspective  
18:20            Method for Monocular Head-Up Display Realizing  
                     Augmented Reality**

*A. Hotta, T. Sasaki, H. Okumura  
Toshiba, Japan*

We developed a novel depth perception control method for a monocular head-up display, which utilizes movement of an HUD image as a depth perception cue and achieves a depth perception position of 120 m within an error of 30%. This is further than in the case of using a still image.

**AUTO2 - 5      Development of an Eye Tracking System  
18:40            for the Monocular Head-Up Display**

*A. Moriya, T. Sasaki, H. Okumura  
Toshiba, Japan*

The principal problem concerning a monocular head-up display is the narrowness of the field of vision. We have developed a technique. A driver's facial image is captured, and a mirror is controlled by the eye detecting algorithm. As a result, we expanded the field of vision  $\pm 10$  cm.

**Author Interviews and Demonstrations  
18:40 – 19:30**

**Thursday, December 8**

<b>9:00 - 12:00</b>	<b>Room 222-224</b>
<b>Poster AUTOp/VHFp: Human Factors Related to Automobiles</b>	

**AUTOp/            Visual Contrast of LED Traffic Lights for People  
VHFp - 1        with Imperfect Color Vision**

*H. Isono  
Nippon Inst. of Tech., Japan*

We calculated the visual contrast that governs the visibility of LED traffic lights using the spectral luminous efficiency of persons with imperfect color vision. The results indicated that, for person with imperfect color vision, the visual contrast of red and yellow LEDs is significantly reduced and visibility is adversely affected.

**AUTO**



**AUTOp/  
VHFp - 2**

**Training Method for Improving Cognitive Function of Middle Age While Driving and Evaluation of Its Effects**

*Y. Takahashi, K. Mizuno, H. Yamasaki, M. Kawasumi,  
M. Yamada, S. Yamamoto, T. Nakano*

*Meijo Univ., Japan*

An increase in the traffic accident caused by elderly and dementia drivers becomes serious problem. This paper presents training methods for activating the prefrontal area and their effects, which have been evaluated by comparing cognitive function before and after training.

**AUTOp/  
VHFp - 3**

**Method for Evaluating Performance of Wipers Based on Forward Visibility**

*T. Kitayama, M. Kawasumi, H. Yamasaki, T. Nakano,  
S. Yamamoto, M. Yamada, Y. Doi\**

*Meijo Univ., Japan*

*\*ASMO, Japan*

In the visibility evaluation in rainy driving, it is important to examine spatial frequency and contrast of objects in forward view. We prepared for background board with stripe pattern. Spatial frequency and contrast of the background board which were affected by the raindrops are possible to calculate by proposed method.

**AUTOp/  
VHFp - 4**

**Study on the Effect in Relieving Fatigue by Fragrance Presentation for the Driver**

*C. Kato, M. Yoshida, K. Tanaka, M. Kawasumi,  
H. Yamasaki, S. Yamamoto, T. Nakano, M. Yamada*

*Meijo Univ., Japan*

The effect of the fragrance is applied to the aromatherapy, and the application to relaxation and arousal effect can be also expected. We obtained verification results that fragrance presentation is effective in awaking the drowsy driver. Then, it has aimed to verify the effect in relieving fatigue by fragrance presentation.

**AUTOp/  
VHFp - 5**

**Study on Stimulation Alerting Effect for Driver Based on Fragrance Presentation**

*M. Yoshida, C. Kato, N. Asami, M. Kawasumi,  
H. Yamasaki, S. Yamamoto, T. Nakano, M. Yamada*

*Meijo Univ., Japan*

The falling asleep at the wheel is big problem that should be exterminated. Then we pay attention to the method by "Fragrance presentation" with which it doesn't interfere in the driving operation and are examining it. We tested difference of alerting duration by the kind of smell and presentation method.

**AUTOp/  
VHFp - 6      Examination of Detectability of Driver's Fatigue  
Level by Neural Network Using Hyper Spectrum  
Camera**

*K. Endo, Y. Nakamura, S. Yamamoto, T. Nakano,  
M. Kawasumi, M. Yamada, T. Maeda\*, Y. Aizu\*,  
T. Simizu\*\*, Y. Iwata\*\**

*Meijo Univ., Japan*

*\*Muroran Inst. of Tech., Japan*

*\*\*Aisin Cosmos R&D, Japan*

This study aims to examine the potential measurement of fatigue levels. Special focus is on deoxygenization of blood hemoglobin strongly related to fatigue from exercise. The possibility to discriminate fatigue from normal state was examined using a hyper spectrum camera (HSC).

**AUTOp/  
VHFp - 7      Study to Detection Accuracy of Suspicious  
Behaviors inside a Vehicle**

*T. Suzuki, K. Sakai, S. Yamamoto, T. Nakano,  
M. Kawasumi, M. Yamada*

*Meijo Univ., Japan*

Monitoring of the vehicle driving environment and driver state are important for vehicle safety. Meanwhile, criminal acts in taxis and vehicle occur frequently. Therefore, the system development is a pressing need. The purpose of this research was to develop a system that can detect suspicious behavior of passengers and vehicle.

**AUTOp/  
VHFp - 8      Detection of Driver Condition Based on Pupillary  
Light Reflex**

*Y. Nakamura, K. Endo, N. Asami, K. Masuda,  
S. Yamamoto, T. Nakano, M. Kawasumi, M. Yamada*

*Meijo Univ., Japan*

This paper describes a method for detecting if a driver can drive safely by measuring pupillary light reflex to active photic stimulus before he/she starts driving. We conducted some experiments on drunk and sober drivers, and confirmed that our index "63% dilation time" is effective to classify those drivers.

**AUTOp/  
VHFp - 9      On Screening Elderly Adults with Low Cognitive  
Functions by Measuring Driving Performances**

*Y. Kuroyanagi, T. Numayama, O. Yamamoto,  
M. Kawasumi, H. Yamasaki, M. Yamada, S. Yamamoto,  
T. Nakano*

*Meijo Univ., Japan*

Although driving ability decreases with advanced age, few elderly people recognize the decline in their own visual, cognitive and decision performances; this lack of awareness is a major cause of accidents. This paper presents a method for detecting cognitive decline in elderly driver by driving performances to prevent serious accidents.

- AUTOp/  
VHFp - 10**      **Development of System for Comprehensively  
Measuring Driving Ability for Elderly Safe Driving**  
*Y. Oishi, S. Matsuura, C. Kato\*, M. Kawasumi,  
M. Yamada, S. Yamamoto, T. Nakano*  
*Meijo Univ., Japan*  
*\*FORUM8, Japan*

Japan faces "super-aged" society, and the number of accidents caused by elderly drivers is increasing. Although driving ability decreases with advanced age, few elderly people recognize the decline in driving ability. For this research, we develop the driving simulator which quantitatively measures necessary driving ability.

- AUTOp/  
VHFp - 11**      **Cognitive Characteristics for an ARIS (Augmented  
Reality Interface System) Applied to an Automotive  
Head-Up Display**  
*W. Kaneko, R. Ando, S. Okabayashi*  
*Meijo Univ., Japan*

Assuming that the ARIS is applied to automotive display equipment, we investigated cognitive characteristics in terms of how fast and accurately displayed information can be recognized. It was also verified that ARIS shows markedly better characteristics when both the driver's outward forward view and the displayed images are more complex.

**Supporting Organization:**  
 Society of Automotive Engineers of Japan

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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 Shikoku Elect.
	M. Nagao	AIST
	M. Nakamoto	Shizuoka Univ.
	S. Okuda	Nitta

### **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
Program Committee:	C. Adachi	Kyushu Univ.
	M. Akiyama	Toshiba
	S. Aratani	Hitachi
	Y. Fujita	Sharp
	R. Hattori	Kyushu Univ.
	T. Ikuta	JNC Petrochem.
	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. S & T Res. Ctr.
	T. Shimizu	NHK
	S. Tokito	Yamagata Univ.



T. Tsuji Pioneer

### **Workshop on 3D/Hyper-Realistic Displays and Systems**

Workshop Chair:	S. Yano	NHK
Program Chair:	M. Tsuchida	NTT
General Secretary:	K. Yamamoto	NICT
Program Committee:	T. Fujii	Nagoya Univ.
	T. Koike	Hitachi
	K. Mashitani	Sanyo Elec.
	T. Mishina	NHK
	S. Ohtsuka	Kagoshima Univ.
	J.-Y. Son	Daegu 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	NICT
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	Nippon Inst. of Tech.
	S. Kubota	Seikei Univ.
	T. Mitsunashi	Shobi Univ.
	Y. Shimodaira	Shizuoka Univ.
	J. Someya	Mitsubishi Elec.
	T. Tamura	Tokyo Polytech. Univ.
	T. Wake	Kanagawa Univ.
	Y. Yamamoto	Sharp
	A. Yoshida	Sharp
	R. Yoshitake	IBM Japan

### **Workshop on Projection and Large-Area Displays and Their Components**

Workshop Chair:	K. Takeda	Seiko Epson
Program Chair:	T. Hayashi	3M
Program Vice-Chair:	H. Kikuchi	NHK
	S. Shikama	Setsunan Univ.
General Secretary:	T. Suzuki	JVC Kenwood
Program Committee:	O. Akimoto	Sony
	Y. Asakura	Nittoh Kogaku
	Y. Fushimi	Panasonic
	H. Kanayama	Sanyo Elec.
	S. Koike	Seiko Epson
	Y. Moromizato	Techno Syss. Res.
	H. Nakano	Barco
	T. Ogura	Panasonic
	K. Ohara	Texas Instr. Japan
	S. Ouchi	Hitachi
	J. Park	AIST
	M. Sakai	Ushio
	H. Sugiura	Mitsubishi Elec.
	Z. Tajima	Mobara Atecs
	M. Takaso	Techno Syss. Res.

### **Workshop on Electronic Paper**

Workshop Chair:	M. Omodani	Tokai Univ.
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Program Chair:	T. Fujisawa	DIC
Program Vice-Chair:	Y. Toko	Stanley Elec.
General Secretary:	H. Arisawa	Fuji Xerox
Program Committee:	M. Higuchi	NIMS
	Y. Hotta	Ricoh
	T. Kitamura	Chiba Univ.
	N. Kobayashi	Chiba Univ.
	S. Maeda	Tokai Univ.
	Y. Masuda	Bridgestone
	N.-S. Roh	Samsung Elect.
	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 Elec. Works
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	SAIT, Samsung Elect.
	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:	H. Okumura	Toshiba
Program Chair:	K. Sekiya	Tohoku Univ.
General Secretary:	T. Yamamoto	NHK
Program Committee:	T. Fujine	Sharp
	S. Itoh	Shizuoka Univ.
	K. Kälantär	Global Optical Solutions
	L. Kerofsky	Sharp Labs. of America
	T. Kim	Apple
	M. Klompenhouwer	Philips Res.
	H.-S. Koo	Ming-Hsing Univ. of S&T
	O.-K. Kwon	Hanyang Univ.
	A. Nagase	Mitsubishi Elec.
	H. Nitta	Hitachi
	S. Ono	Panasonic
	H. Sasaki	Toshiba
	S. Takamura	NTT
	K. Takeuchi	Univ. of Electro-Commun.

### **Workshop on Flexible Displays**

Workshop Chair:	H. Fujikake	NHK
Program Chair:	T. Furukawa	Yamagata Univ.

General Secretary:	T. Shiro	Teijin
Program Committee:	M. Funahashi	Kagawa Univ.
	H. Hirata	Toray Eng.
	M. Itoh	Toppan Printing
	T. Kamata	AIST
	M. Kimura	Nagaoka Univ. of Tech.
	H. Maeda	DNP
	Y. Masuda	Bridgestone
	K. Nomoto	Sony
	T. Ogura	Nippon Steel
	T. Sekitani	Univ. of Tokyo
	T. Tomono	Toppan Printing

### **Workshop on Touch Panels and Input Technologies**

Workshop Chair:	I. Fujieda	Ritsumeikan Univ.
Program Chair:	N. Hashimoto	Citizen Holdings
General Secretary:	I. Mihara	Toshiba
Program Committee:	H. Haga	NLT Techs.
	T. Horie	Wacom
	S. Itoh	Shizuoka Univ.
	H. Kato	Sharp
	Y. Mizushima	Corning Holding Japan
	T. Nakamura	Toshiba Mobile Display
	K. Nakatani	Touchpanel Labs.
	H. Okumura	Toshiba
	M. Omodani	Tokai Univ.
	K. Takatori	NLT Techs.

### **Topical Session on Lighting Technologies**

Session Chair:	Y. Kijima	Sony
Program Committee:	M. Shinohara	Omron
	K. Hara	Shizuoka Univ.
	T. Ikuta	JNC Petrochem.

### **Topical Session on Automotive Displays**

Session Chair:	S. Okabayashi	Meijo Univ.
Program Chair:	K. Morita	Nat. Traffic Safety and Environment Lab.
General Secretary:	K. Sekiya	Tohoku Univ.

### **FINANCIAL SUPPORTING ORGANIZATIONS (as of November 2, 2011)**

ADEKA Corporation  
 ASAHI GLASS CO., LTD.  
 Corning Holding Japan G.K.  
 Dai Nippon Printing Co., Ltd.  
 FUJIFILM Corporation  
 JNC CORPORATION  
 JSR Corporation  
 Nichia Corporation  
 Semiconductor Energy Laboratory Co., Ltd.  
 SHARP CORPORATION  
 Sumitomo Chemical Co., Ltd. Tsukuba Material Development Laboratory  
 Toshiba Corporation  
 Toshiba Mobile Display Co., Ltd.  
 Ube Material Industries, Ltd.

### **SUPPORTING MEMBERS A (as of November 2, 2011)**

EIZO NANA O CORPORATION  
 JAPAN BROADCASTING CORPORATION  
 Merck Ltd. Japan  
 Nippon Steel Chemical Co., Ltd.

Panasonic Corporation  
ULVAC, Inc.  
ZEON CORPORATION

**SUPPORTING MEMBERS B (as of November 2, 2011)**

NLT Technologies, Ltd.  
PIONEER CORPORATION  
SHIMADZU CORPORATION  
TOPPAN PRINTING CO., LTD.

**LIST OF EXHIBITORS COMPANIES (as of November 2, 2011)**

Grand Seiko Co., Ltd.  
HORIBA Ltd.  
Jedat Inc.  
KEISOKU GIKEN Co., Ltd.  
MEIRYO TECHNICA CORPORATION  
Nanobrick Co., Ltd.  
OPTO SCIENCE, INC.  
PTT Company Limited  
RSoft Design Group JAPAN K.K.  
SHIMADZU CORPORATION  
SHINTECH, Inc.  
SILVACO Japan Co., Ltd.  
Technology Research Association for Advanced Display Materials  
TOPCON TECHNOHOUSE CORPORATION  
TOYO Corporation

**LIST OF EXHIBITORS UNIVERSITIES (as of November 2, 2011)**

Fujieda Lab., Ritsumeikan Univ.  
Hoseo Univ.  
Maeda Lab., Tokai Univ.  
Mutsu and Matsu Lab./Ryukoku Extension Center, Ryukoku Univ.  
Nagaoka Univ. of Technology  
Nakamoto Lab., Shizuoka Univ.  
Omodani Lab., Tokai Univ.  
Suyama and Yamamoto Lab., the Univ. of Tokushima  
Univ. of Hyogo  
Univ. of the Ryukyus

## **SID 2012**

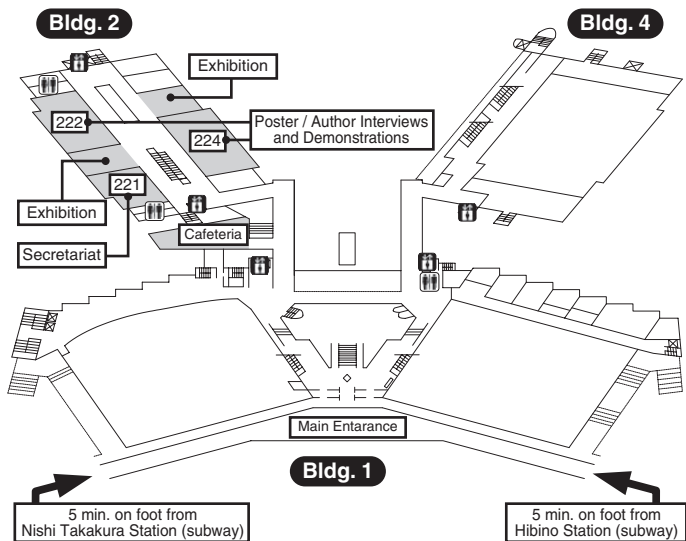
International Symposium, Seminar and Exhibition

June 3-8, 2012

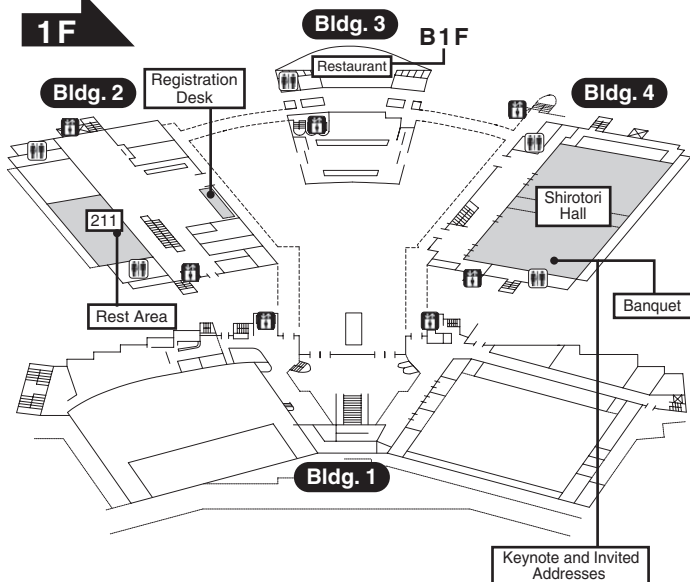
Boston, Massachusetts, U.S.A.

# FLOOR MAP

**2F**



**1F**



# How to find your room

2



Bldg. No.

3



Fl. No.

4



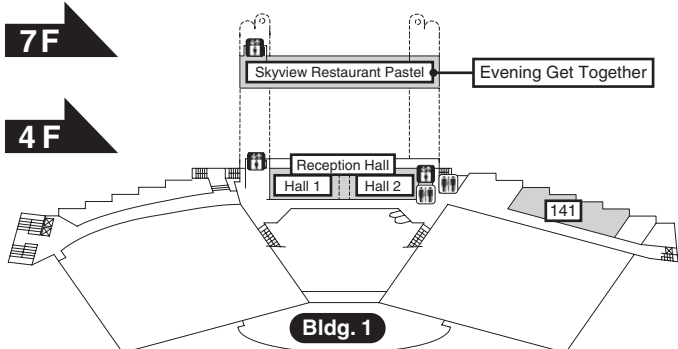
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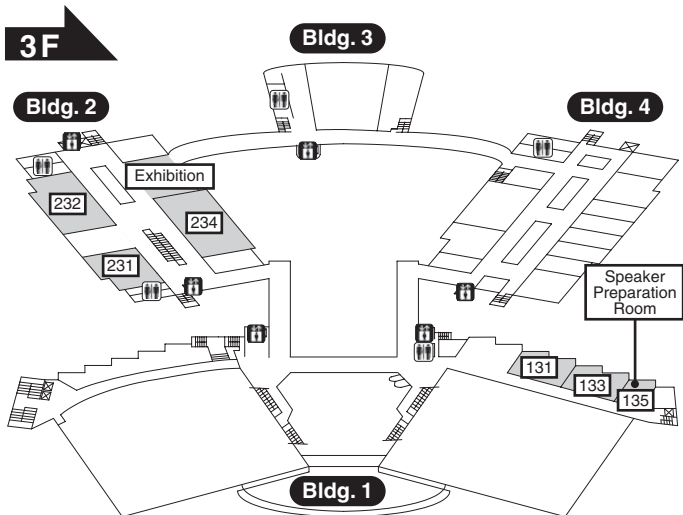
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7F

4F



3F



# MEMO

# MEMO



# MEMO

# IDW '11 Timetable

Date	1F Lobby (Bldg.2)	Shirotori Hall (1F, Bldg.4)	Room 131 (3F, Bldg.1)	Room 133 (3F, Bldg.1)	Room 231 (3F, Bldg.2)	Room 232 (3F, Bldg.2)	Room 234 (3F, Bldg.2)	Room 141 (4F, Bldg.1)	Reception Hall 1 (4F, Bldg.1)	Reception Hall 2 (4F, Bldg.1)	Room 222-224 (2F, Bldg.2)	2F, 3F Lobby (Bldg.2)		
Tue., Dec. 6	Registration 17:00-20:00	Evening Get-Together at Skyview Restaurant Pastel (7F, Bldg.1) 18:00-20:00												
Wednesday, December 7	Registration 8:00-18:00	Opening, Keynote Addresses 9:30-11:00												
		Break												
		Invited Addresses 11:20-12:40												
		Lunch										AMDp, 3Dp  14:00-17:00	Exhibition 12:40-18:00	
				INP1 13:55-15:00		VHF1 14:00-15:30	FMC1 14:00-15:20	LIT1/OLED1 14:00-15:20	EP1 13:55-15:20	LCT1 14:00-15:25				
		Break												
			AUTO1 15:40-17:00	INP2 15:40-16:40	PDP1 15:40-17:00	VHF2 15:40-17:00	LIT2/FMC2 15:40-16:20	OLED2 15:40-16:57	EP2 15:40-16:40	LCT2 15:40-16:40				
		Break												
			AUTO2 17:20-19:00	INP3 17:20-18:40	PDP2 17:20-18:20	VHF3 17:20-18:20	LIT3/PH1 17:20-18:40	AMD1/OLED3 17:20-18:40	EP3 17:20-18:35	LCT3 17:20-18:00				
												Author Interviews 18:40-19:30		
Banquet at Shirotori Hall (1F, Bldg.4) 19:30-21:30														
Thursday, December 8	Registration 8:00-18:00		EP4 9:00-10:25		PH2 9:00-10:30	MEET1 9:00-10:05	INP4/3D1 9:00-10:20	FLX1/AMD2 9:00-10:25	FMC3 9:00-10:20	LCT4 9:00-10:25	PDPp, OLEDp, VHFp, DESp, LITp/OLEDp, AUTOp/VHFp	Exhibition 10:00-18:00		
		Break												
			EPp* 11:00-12:00		PH3 10:40-12:05	MEET2 10:40-12:00	3D2/INP5 10:40-12:00	FLX2/FMC4 10:40-12:00	AMD3 10:40-12:10	LCT5 10:40-11:40			9:00-12:00	
		Lunch												
			VHF4/DES1 13:20-14:40			MEET3 13:20-14:40	3D3 13:20-14:22		AMD4 13:20-14:45	LCT6 13:20-14:20	FMCp, PHp, PRJp, EPp, INPp, LITp/FMCp, LITp/PHp			
		Break												
			VHF5/DES2 15:00-16:20		PDP3 15:00-16:20	MEET4 15:00-16:20	3D4 15:00-16:20	OLED4 15:00-16:05	FLX3 15:00-16:20				13:20-16:20	
		Break												
			VHF6/DES3 16:40-18:05		PRJ1 16:40-18:07	MEET5 16:35-18:00	3D5 16:40-18:05	OLED5 16:40-17:50	FLX4 16:40-17:55					
												Author Interviews 18:00-18:50		
Friday, December 9	Registration 8:00-13:00		FMC5 9:00-10:20		LIT4/PRJ2 9:00-10:10	FED1 9:00-10:35		EP5 9:00-10:30	AMD5 9:00-10:25	3D6 9:00-10:02	LCTp, FLXp  9:00-12:00	Exhibition 10:00-14:00		
		Break												
			FMC6 10:40-11:40	VHF7 10:40-11:50	PRJ3 10:40-12:05	FED2 10:45-11:55		EP6 10:40-11:40	AMD6 10:40-12:00	DES4/3D7 10:40-12:00				
		Lunch												
			FMC7 13:20-14:40	DES5 13:20-14:40	PRJ4 13:20-14:25	FED3 13:20-14:40		FLX5/EP7 13:20-14:45	AMD7 13:20-14:45	3D8/VHF8 13:20-14:40				
		Break												
		FMC8 15:00-16:20	DES6 15:00-16:00	PRJ5 15:00-16:20	FED4 15:00-16:20		FLX6 15:00-16:00	AMD8 15:00-16:25	3D9 15:00-16:12					
											Author Interviews 16:20-17:10			

\*Short Presentations

# IDW '11 Session Navigator

	Wednesday, Dec. 7					Thursday, Dec. 8					Friday, Dec. 9				
	9:30-12:40	PM			18:40-19:30	AM		PM		18:00-18:50	AM		PM		16:20-17:10
	Shirotori Hall														
<b>Keynote &amp; Invited</b>	Opening, Keynote & Invited Addresses														
<b>LCT</b>		Reception Hall 2			Room 222-224	Reception Hall 2		Reception Hall 2			Room 222-224		Room 222-224		
		Blue Phase	LC Alignment Technology	LCD Characterizations	A.I.	3D & New Functional LCDs	LCD Materials	Ferroelectric LCs & New LCD Modes			A.I.		Posters		
<b>AMD</b>		Room 222-224		Room 141	Room 222-224	Room 141	Reception Hall 1	Reception Hall 1			Room 222-224		Reception Hall 1		Room 222-224
		Posters		*AMOLED	A.I.	*Flexible Active-Matrix Devices	Application (1)	Oxide TFT (1)			A.I.		Organic TFT	Si & Oxide TFT	Application (2)   Oxide TFT (2)   A.I.
<b>FMC</b>		Room 234			Room 222-224	Reception Hall 1	Room 141	Room 222-224			Room 222-224		Room 131		Room 222-224
		Optical Films	*Backlight		A.I.	Recycle & Environment	*Materials, Components & Processes for Flexible Devices	Posters			A.I.		Materials	Measurements	Manufacturing Technologies (1)   Manufacturing Technologies (2)   A.I.
<b>PDP</b>		Room 231			Room 222-224	Room 222-224			Room 231		Room 222-224				
		Novel PDP		Driving	A.I.	Posters			Protective Layer		A.I.				
<b>PH</b>				Room 234	Room 222-224	Room 231		Room 222-224			Room 222-224				
				*Phosphors for Lighting	A.I.	Phosphors in EL	Phosphors in General	Posters			A.I.				
<b>FED</b>											Room 232		Room 232		Room 222-224
											CNT Emitters & Applications	CNT Emitters & Novel Devices	FE Materials & Structures (1)	FE Materials & Structures (2)	A.I.
<b>OLED</b>		Room 141			Room 222-224	Room 222-224			Room 141		Room 222-224				
		*OLED for Lighting Application	Organic TFTs	*AMOLED	A.I.	Posters			Materials & Device Technologies	Display Technologies for Next Generation	A.I.				
<b>3D</b>		Room 222-224				Room 234			Room 234		Room 222-224		Reception Hall 2		Room 222-224
		Posters				*3D Input Technology (1)	*3D Input Technology (2)	3D Display (1)	3D Display (2)	3D Image Crosstalk	A.I.		3D Image Processing	*Post-HDTV	*3D Image Quality & Ergonomics   3D Image Quality   A.I.
<b>VHF</b>		Room 232			Room 222-224	Room 222-224		Room 131			Room 222-224		Room 133		Room 222-224
		Display Measurement	Image Quality	Human Factors	A.I.	Posters		*Color (1)	*Color (2)	*Color (3)	A.I.		Color (4)		*3D Image Quality & Ergonomics   A.I.
<b>PRJ</b>								Room 222-224		Room 231	Room 222-224		Room 231		Room 222-224
								Posters		3D & Digital Cinema	A.I.		*Solid State Projection Light Sources	Laser Projectors	Pico & Mini Projectors   Projection Components   A.I.
<b>EP</b>		Reception Hall 1			Room 222-224	Room 131		Room 222-224			Room 222-224		Room 141		Room 222-224
		Electrochromic Displays (1)	Electrochromic Displays (2)	Electrowetting Displays	A.I.	Electrophoretic Displays	Short Presentations	Posters			A.I.		Bistable Displays	New Approaches	*Flexible Electronic Paper   A.I.
<b>MEET</b>						Room 232		Room 232			Room 222-224				
						MEMS Imaging & Sensing	Fundamental Components & Process Technologies (1)	Fundamental Components & Process Technologies (2)	Displays & Imaging	Emerging Technologies	A.I.				
<b>DES</b>						Room 222-224		Room 131			Room 222-224		Reception Hall 2		Room 222-224
						Posters		*Color (1)	*Color (2)	*Color (3)	A.I.		*Post-HDTV		Augmented Reality & Visualization   Advanced Display & System   A.I.
<b>FLX</b>						Room 141		Reception Hall 1			Room 222-224		Room 222-224		Room 222-224
						*Flexible Active-Matrix Devices	*Materials, Components & Processes for Flexible Devices		Advanced Technologies for Flexible Devices (1)	Advanced Technologies for Flexible Devices (2)	A.I.		Posters		*Flexible Electronic Paper   Advanced Technologies for Flexible Devices (3)   A.I.
<b>INP</b>		Room 133			Room 222-224	Room 234		Room 222-224			Room 222-224				
		Touch Panel (1)	Touch Panel (2)	User Interface	A.I.	*3D Input Technology (1)	*3D Input Technology (2)	Posters			A.I.				
<b>LIT</b>		Room 141	Room 234		Room 222-224	Room 222-224		Room 222-224					Room 231		Room 222-224
		*OLED for Lighting Application	*Backlight	*Phosphors for Lighting	A.I.	Posters		Posters					*Solid State Projection Light Sources		A.I.
<b>AUTO</b>			Room 131		Room 222-224	Room 222-224									
			Vision in Vehicles	Displays in Vehicles	A.I.	Posters									

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

LIT: Topical Session on Lighting Technologies

AUTO: Topical Session on Automotive Displays

A.I.: Author Interviews & Demonstrations

\*: Joint Session

IDW '11 Secretariat:  
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3-3-6 Kudan Minami, Chiyoda-ku,  
Tokyo 102-0074, Japan  
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FAX: +81-3-3263-1264  
E-mail: [idw@idw.ne.jp](mailto:idw@idw.ne.jp)

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