



# IDW/AD '05

The 12th International Display Workshops  
in conjunction with Asia Display 2005



[Landscape of the Castle Town Takamatsu]  
(Kagawa History Museum)

*Final Program*

**December 6(Tue.) - 9(Fri.), 2005**  
**Sunport Takamatsu**  
**Takamatsu, Japan**

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## **IDW '06**

International Display Workshops

Dec. 6 – 8, 2006

Convention Hall Ohmi, Otsu Prince Hotel  
Otsu, Japan

<http://idw.ee.uec.ac.jp>

## **BANQUET**

Wednesday, December 7

19:00 – 21:00

at Hiten (3F)

ANA Hotel Clement Takamatsu

See page 9 for details

## **SID 2006**

Society for Information Display  
Symposium, Seminar & Exhibition

June 4–9, 2006

San Francisco, CA, USA

<http://www.sid.org>

# PROGRAM HIGHLIGHTS

Scientific and technological advances in information display research and development will be found at the 12th International Display Workshops in conjunction with Asia Display (IDW/AD 05). A feature of IDW/AD 05 is the integration of the following twelve workshops and three topical sessions.

## Workshops on

- LC Science and Technologies
- Active Matrix Displays
- FPD Manufacturing, Materials and Components
- CRTs
- Plasma Displays
- EL Displays, LEDs and Phosphors
- Field Emission Display
- Organic LED Displays
- 3D/Hyper-Realistic Displays and Systems
- Applied Vision and Human Factors
- Projection and Large-Area Displays and Their Components
- Electric paper

## Topical Sessions on

- MEMS for Future Displays and Related Electron Devices
- Optical Information Accumulation and Imaging Technique
- Novel Imaging Devices and Systems

The four-day conference will feature 554 papers, including two keynote addresses, two invited addresses, 83 invited papers, 195 oral and 196 poster presentations, and 76 late-news papers. Following keynote and invited addresses on Tuesday morning, presentations will begin and continue in six parallel sessions through Friday. Poster sessions and author interviews will enable participants to discuss presented issues in detail. Exhibitions from display and related industries will also be featured from Tuesday to Friday in parallel with workshops and topical sessions. IDW/AD '05 should be of interest not only to researchers and engineers, but also to those who manage companies and institutions in the display community.

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

Recent advances in LC materials and device technologies are presented. The session covers from fundamental studies to recent development in LCD technologies. New materials for LCD application, fast response LCDs, LC alignment process, LC mode, electronic paper, flexible LCD, panel & evaluation, optical design & measurement, and novel devices are discussed.

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

Recent progress in TFT technologies and active matrix displays are widely discussed. Sessions cover device and process technologies for a-Si, poly-Si, organic and new material TFTs, featuring nineteen topical invited talks. Their applications to active matrix displays including LC-TVs, mobile displays, electronic paper and OLED displays are presented. Furthermore, novel applications to sensors, detectors and system on panel are discussed.

### **Workshop on FPD Manufacturing Materials and Components (FMC)**

This workshop includes 8 invited papers dealing with the overview of technical trends and the new related technologies on FPDs. In the technical sessions, papers deal with optical components, lamps, process technologies, measurement systems, recycling technologies, etc. for FPDs.

### **Workshop on CRTs (CRT)**

This workshop covers the entire field of CRT technologies. This year, a "Slim CRTs" topical session is organized.

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

"PDP TV" is the key phrase for the most recent PDP R&D. The key phrase involves three major technological issues; realizing the full-spec HDTV performance, picture quality enhancement and reduction of power consumption, and cost reduction. About 60 papers pursue these aims from the viewpoints of gas discharge physics, materials, manufacturing process, driving, image quality, and ergonomics. Invited papers from leading researchers also highlight the technology advancements. Of special interest is a method of measuring the annual energy consumption of TV sets, which is relevant to all the FPD technologies, proposed by Dr. L. F. Weber.

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

This workshop covers the latest R&D achievement in inorganic ELDs, phosphors for emissive displays and solid-state illumination as well as LEDs. Invited talks present large-screen full-color ELDs, flexible EL sheets, the luminescent mechanism of blue phosphors for PDPs, phosphor for white LEDs, and potential application to phosphor materials and active displays. Contributed papers also include interesting topics such as nano-sized particle phosphors, thin-film phosphors and new phosphor materials for ELDs and PDPs. In addition, joint sessions will be held with the FED Workshop.

### **Workshop on Field Emission Display (FED)**

Recent progresses in carbon-nanotube (CNT) field emitters and their applications for field emission displays (FED) are presented. Operating characteristics of a surface-conduction electron-emitter display and a large size CNT-FED are also discussed at the joint session with "PH Workshop".

### **Workshop on Organic LED Displays (OLED)**

This workshop includes recent developments in organic light-emitting materials, devices and display systems. New organic fluorescent and phosphorescent materials are reported, and highly efficient OLEDs using these materials are presented. In addition, durability, the fabrication process and the evaluation system will be also discussed.

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

This workshop focuses on recent progress in 3D, holography and related visual science. It also covers 3D, hyper-realistic image processing such as multiview interpolation and high-fidelity color reproduction. Invited talks in this workshop include the topics from forefront of 3D/holographic technologies and the recent researches into advanced display systems.

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

This workshop covers the latest R&D achievements in the field of applied vision and human factors such as psycho-physiological effects of displays and their contents, still and moving image quality metrics, metrology, and improvement techniques. Other topics are temporal and spatial color reproduction and viewing angle dependence of color, grey shades, and defect visibility. The workshop provides an excellent opportunity to interact with world-renowned experts in the field.

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

The worldwide hottest technologies for projection displays will make this workshop exciting. Invited talks will cover topics on an extremely high performance projector for Digital TV applications. In the general talks, light valve technology, light source and optical systems for enhancing display performance will be discussed.

### **Workshop on Electronic Paper (EP)**

This workshop focuses on current topics on electronic paper, rewritable paper, paper-like display, and flexible display. Various novel technologies including electrophoretic, electrochromic, liquid crystal, electrowetting, and toner display systems will be reported. Concepts, systems, devices, materials, and human interfaces in this field are expected to be discussed.

### **Topical Session on MEMS for Future Displays and Related Electron Devices (MEMS)**

This session will cover all aspects of MEMS science and technologies for future displays, imaging devices, and related electron devices. It includes research areas such as materials, basic physics and fabrication processes. The session seeks to broaden the horizon of display technologies into MEMS technologies. As this meeting is the very first held in IDW, speakers are invited from research institutions around the world to inspire display researchers. The session is proud to invite researchers from institutions such as Cambridge Univ., Kyung Hee Univ., MIT, Ritsumeikan Univ., Samsung, Tohoku Univ., and Univ. of Tokyo (in alphabetical order).

### **Topical Session on Optical Information Accumulation and Imaging Technique (AIT)**

This Topical Session focuses on recent developments in AITs. It also covers THz imaging technique of biological samples and others by using femtosecond laser, and tomography techniques of living single-cells to improve the early detection and treatment of cancer. In addition, unique properties of quantum dots can be used as tags for fluorescence visualization of structure and functions of biological systems. Moreover, a coherent control technique for ultrafast optical imaging is also presented.

### **Topical Session on Novel Imaging Devices and Systems (IDS)**

Recent progresses in an ultra-high definition camera system, an ultra-high speed video camera and a high color reproducibility camera system are presented. Image pick-up characteristics of compact highly sensitive image sensor, organic image sensor, CMOS time-of-flight range image sensor, photon counting type X-ray image sensor are also discussed.

### **Outstanding Poster Paper Awards**

Awards will be presented for limited number of outstanding poster papers on December 9, from 12:20 to 13:30 in Room Tamamo (3F) in the ANA hotel following Takamatsu Festival.

### **Exhibition**

The IDW/AD '05 exhibition of display components and systems will open at 12:00 on December 6 and close at 14:00 on December 9. The latest display devices, appliance, manufacturing equipment, measuring instruments, software systems and materials for display technologies will be presented in Small Hall 2 (5F), Sunport Hall Takamatsu. Please take this opportunity to enjoy an informative discussion with exhibitors.

December 6: 12:00 – 18:00

December 7: 9:00 – 18:00

December 8: 9:00 – 18:00

December 9: 9:00 – 14:00

# GENERAL INFORMATION

## **SPONSORSHIP**

IDW/AD '05 is sponsored by the Institute of Image Information and Television Engineers (ITE) and the Society for Information Display (SID).

## **WORKSHOP SITE**

Sunport Takamatsu (Sunport Hall Takamatsu, Kagawa International Conference Hall, and ANA Hotel Clement Takamatsu)

2-1 Sunport, Takamatsu  
Kagawa 760-0019, Japan

## **ON-SITE SECRETARIAT**

Telephone and fax machines for IDW/AD '05 use will be temporarily set up in the secretariat room at Sunport Hall Takamatsu (Room 54) (December 5-9).

Phone: +81-87-823-9975

## **BANQUET**

A buffet-style banquet will be held on December 7 from 19:00 to 21:00 in Hiten (3F), ANA Hotel Clement Takamatsu. As the number of tickets is limited, you are urged to make an advance reservation by completing the enclosed registration form and returning it with payment.

## **EVENING GET-TOGETHER WITH WINE**

A get-together will be held on December 5 from 18:00 to 20:00 in the Main Hall Foyer (3F), Sunport Hall Takamatsu. Wine (sponsored by Merck Ltd., Japan) will be served to participants in a relaxed atmosphere for informal discussion.

## **OUTSTANDING POSTER PAPER AWARDS AND TAKAMATSU FESTIVAL**

Poster Awards will be given for outstanding poster papers, following Takamatsu Folk Entertainment, on December 9 from 12:20 to 13:30 in Tamamo (3F), ANA Hotel Clement Takamatsu.

## **REGISTRATION**

Registration is available in advance and on site. However, proceedings books might not be guaranteed for on-site registrants in the case of an unexpected excess of on-site registrations. Advance registration is strongly recommended.

## Registration Fees

The registration fee for IDW/AD '05 includes admission to the conference, a copy of the proceedings in printed book or USB memory form, and CD-ROM. The proceedings in USB memory form can be selected only by those who registered and paid by November 8.

	Paid by Nov. 8	After Nov. 8
Member of SID/ITE/ASO*	¥30,000	¥40,000
Non-Member	¥35,000	¥45,000
Student**	¥8,000	¥10,000
Life Member of SID/ITE	¥8,000	¥10,000
Banquet	¥8,000	¥10,000

Note that the reduced registration fee must be paid by November 8. In the case of payment after November 8 or on site, prices after November 8 will apply even if you sent the registration form by November 8, 2005. Also, please note that the number of banquet tickets to register on site is limited.

\*ASO:Academic Supporting Organizations

(See p.215 as well as "Supporting Organizations and Sponsors" at the end of each workshop/topical session section.)

\*\*Student ID is required.

For additional sets of the proceedings book or USB memory\*, and CD-ROM

	Book & CD-ROM	USB & CD-ROM
At the conference site	¥8,000	¥8,000
Airmail after the conference	¥12,000	not available
Sea/Domestic mail after the conference	¥10,000	not available

\*Additional USB memory and CD-ROM Sets can be selected only in application with payment by November 8.

## Payment

Three ways are provided for registration.

### (1) e-Registration

Access the following URL.

<http://idw.ee.uec.ac.jp/regist.html>

e-Registration is acceptable until 24:00, November 18, 2005 (JST).

### (2) Mail or Fax Registration

Complete the registration form (FORM A) at the centerfold and send it to the secretariat, together with all necessary payments, no later than 24:00, November 18, 2005 (JST).

IDW/AD '05 Secretariat

c/o Inter Group Corp.

Toranomon Takagi Bldg.

1-7-2 Nishi-shinbashi, Minato-ku, Tokyo 105-0003, Japan

Phone: +81-3-3597-1126 Fax: +81-3-3597-1097

E-mail: [idw@intergroup.co.jp](mailto:idw@intergroup.co.jp)

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

1. Bank transfer (only applicable to domestic participants) to:

Account name: IDW05

Account No.: 1236251 (ordinary account)

Bank Name: Sumitomo Mitsui Banking Corp.

Branch Name: Yamato Branch

Please attach a copy of your bank remittance form with the registration form to avoid possible problems.

2. Bank check made payable to "IDW05," together with the registration form

3. Credit card (only VISA or MasterCard accepted)

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

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

### **(3) On-site Registration**

Conference registration desk will be open:

December 5 (Mon.)	17:00–20:00
December 6 (Tue.)	8:30–18:00
December 7 (Wed.)	8:30–18:00
December 8 (Thu.)	8:30–18:00
December 9 (Fri.)	8:30–15:00

The on-site registration fee will be payable by:

1. Cash (JAPANESE YEN only)
2. Credit card (VISA or MasterCard only)

Bank transfer, bank check, and personal/traveler's checks are not accepted. Payment by cash is recommended.

### **Cancellation Policy**

Refunds for registration, the banquet, additional sets of proceedings etc. will be made for written cancellations received by the IDW/AD '05 secretariat **by November 8**. For cancellations received after November 8 or no-shows, refunds will not be made. After IDW/AD '05 closes, however, a set of the proceedings book/USB memory and CD-ROM will be sent to the registrants who have paid the registration fees.

### **INQUIRIES**

IDW/AD '05 Secretariat

c/o Inter Group Corp.

Toranomon Takagi Bldg.

1-7-2 Nishi-shinbashi, Minato-ku, Tokyo 105-0003, Japan

Phone: +81-3-3597-1126 Fax: +81-3-3597-1097

E-mail: [idw@intergroup.co.jp](mailto:idw@intergroup.co.jp)

Please look at the website (<http://idw.ee.uec.ac.jp/>) for the latest information.

## **EVENING GET-TOGETHER WITH WINE**

Monday, December 5

18:00 – 20:00

Main Hall Foyer (3F),

Sunport Hall Takamatsu

(Sponsored by Merck Ltd., Japan)

See page 9 for details

# HOTEL AND TRAVEL INFORMATION

## HOTEL RESERVATIONS

IDW/AD '05 executive committee has secured enough rooms for the participants. Participants who want to stay in Takamatsu during IDW/AD '05 should make reservations directly with the hotel by themselves as follows. Reservation will be made on a first-come, first-served basis.

### Methods of Application

1. Through the IDW/AD '05 website(<http://idw.ee.uec.ac.jp/hotelform.html>)
2. By fax, using the enclosed Form B (Please copy the form.)

### Confirmation from the Hotels

1. Confirmation will be sent to the applicants directly from the hotel a few days after receiving your application.
2. If your application is not accepted by the hotel, please select another hotel and send your request for a reservation to the hotel through the web or by fax using Form B.
3. In case there is no vacancy for your request again, please follow the procedure described above.

## VISAS

Visitors from countries whose citizens must have visas should apply to a Japanese consular office or diplomatic mission in their respective country. For further details, please contact your travel agent 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 for its application at least two months before the conference.

## JAPAN RAIL PASS

Tourists visiting Japan from abroad can save with a Japan Rail Pass. These 7-, 14-, or 21-day passes are valid for unlimited travel on the Shinkansen trains (except NOZOMI) and other JR lines, plus its buses and ferries.

For details, please ask your travel agent and purchase an exchange order at an authorized agent before coming to Japan. This pass cannot be purchased in Japan.

After you arrive in Japan, you turn in the exchange order to receive your JAPAN RAIL PASS at an applicable JR station that has a JAPAN RAIL PASS exchange office.

Ex.

Narita Airport	Travel Service Center	11:30-19:00
	Ticket Office	6:15-11:30, 19:00-21:45
Narita Airport Terminal 2	Travel Service Center	11:30-19:00
	Ticket Office	6:30-11:30, 19:00-21:50
Kansai Airport	Ticket Office	5:30-23:00
JR Nagoya Station	JAPAN RAIL PASS	10:00-18:00
	Exchange Corner	
JR Takamatsu Station	Travel Service Center	10:00-18:00

## CLIMATE

The average temperature in Takamatsu during the period is around 9 , with 13 in the daytime and 4 at night on the average.

## **TAKAMATSU CITY**

Takamatsu City is blessed with warm weather throughout the four seasons and a magnificent natural setting: the Seto Inland Sea, with its many islands, large and small; the green, gentle slopes of the Sanuki Mountains; the lovely Sanuki Plain, with its reservoirs and lovingly preserved shrines; the historic towns, alive with the aroma of a rich culture and history bequeathed to us by generation upon generation of our ancestors. With its central location on the Seto Inland Sea, Kagawa Prefecture has flourished since ancient times through trade and as a cultural center. It has developed into a key hub in Shikoku, home to many government branch offices as well as the local offices of many large corporations.

Ritsurin Park was designed to offer the visitor a different seasonal quality every number of steps. Kagawa has many sightseeing attractions, including Tamamo Park, Yashima, Takamatsu central arcade, National Resort Shionoe-Onsen, "Sunshine and Olive Island" Shodoshima, and a view of islands of all sizes dotting the Seto Inland Sea. Kotohiragu Shrine, with its sea-protecting deity and Shikoku's 88-temple pilgrimage route, including Zentsuji Temple and Okuboji Temple, are sought by visitors for their spiritual environments

## **PLACES OF INTEREST**

### **Ritsurin Park**

Ritsurin Park is a nationally designated cultural property and "place of scenic beauty." It is located at the foot of the hill known as Shiunzan and consists of six ponds and 13 hillocks. Formerly belonging to a daimyolord's family, visitors can walk through it and see spectacular scenes from many vantage points.

### **Tamamo Park (The Ruins of Takamatsu Castle)**

Tamamo Park is a refresh zone that is full of poetic sentiment and it is suitable as a first step for a trip to Takamatsu. When we hear Sanuki, we associate Tamamo. This park was made in the trace of Tamamo castle in 1955. (Tamamo castle is said to be one of the three best Japanese water castles). It has a beautiful garden and holds various events in the four seasons.

### **Yashima**

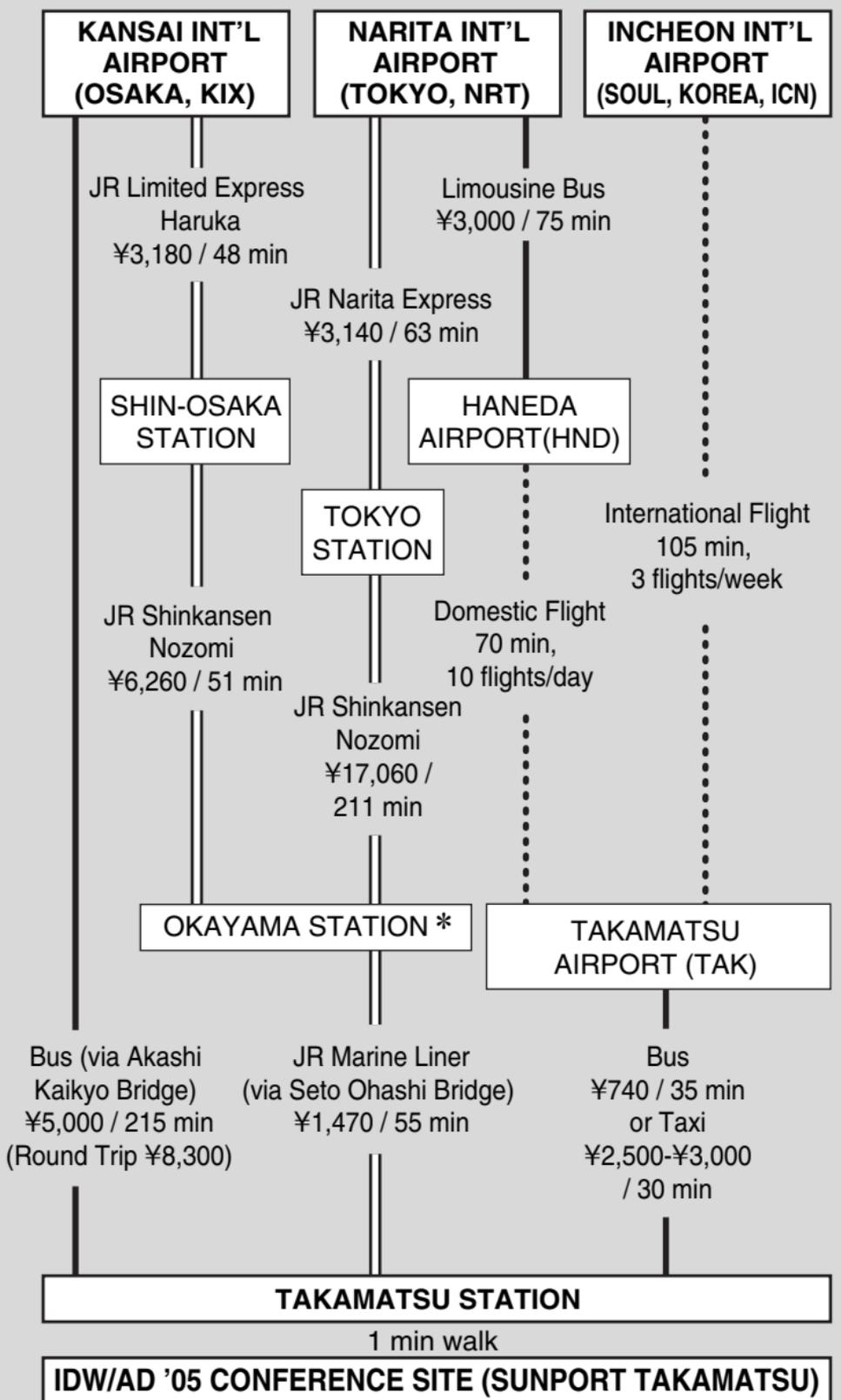
Its view is the best beauty spot of the Inland Sea of Japan national park. Yashima, which is famous for the Genpei battle, is the best lava tableland in the world. This outlook from the mountaintop is as wonderful as the Aegean Sea. It is 8km to the east from the center of Takamatsu city to Yashima by car via Route 11. We recommend that you go to the mountaintop by a driving route that has a mystery zone. If you use a highway, get off at Chuo interchange and move to Route 11. If you'd like to spend time leisurely, use the Kotoden train from the center of Takamatsu city to Katamoto station, and then climb to the mountaintop. There is a climbing route from there to Nagasaki No Hana. (It takes about 3.5 hours.)

More information is available on

<http://www.21kagawa.com/visitor/kanko/e-index.htm>

<http://www.city.takamatsu.kagawa.jp/kankou/>

# ACCESS TO TAKAMATSU

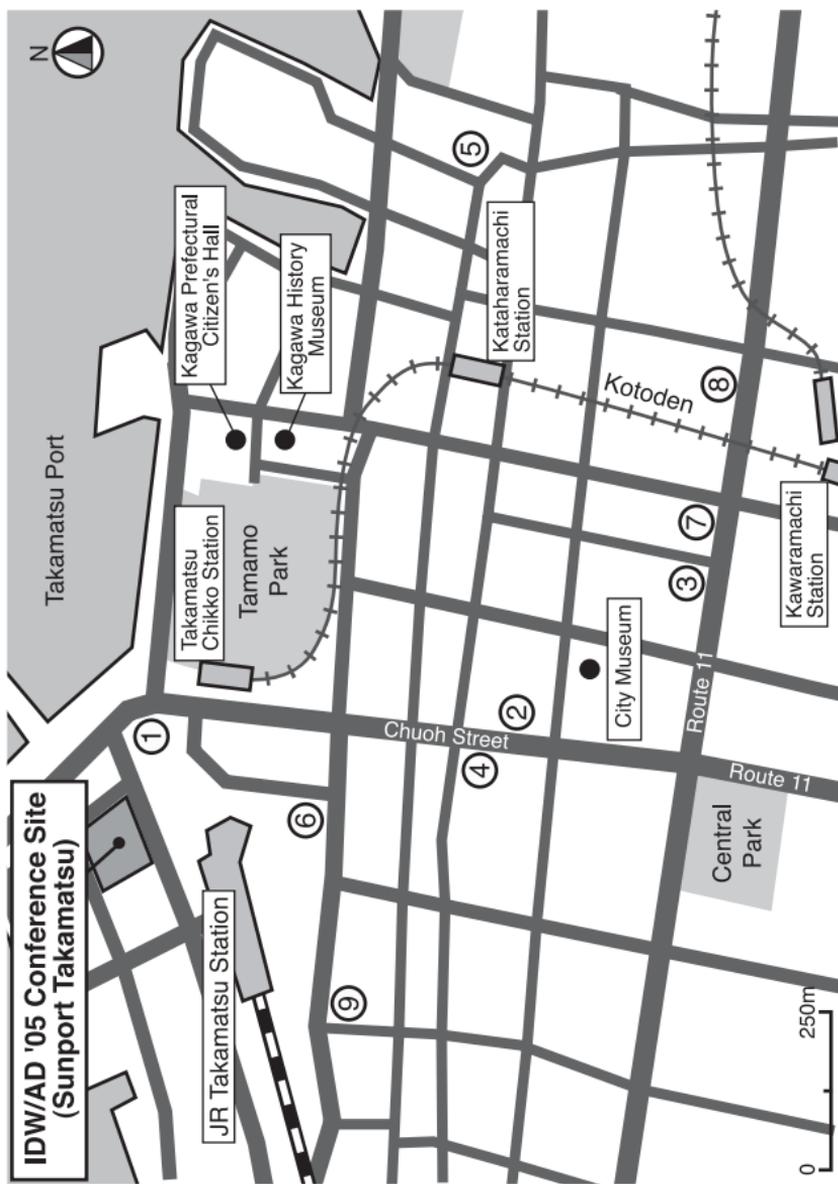


(as of July, 2005)

\*30 min, by bus from Okayama Airport. (International)

## Hotel Map

- ① ANA Hotel Clement Takamatsu  
Tel: +81-87-811-1111
- ② Rihga Hotel Zest Takamatsu  
Tel: +81-87-822-3555
- ③ Takamatsu Washington Hotel Plaza  
Tel: +81-87-822-7111
- ④ Takamatsu Tokyu Inn  
Tel: +81-87-821-0109
- ⑤ Okura Hotel Takamatsu  
Tel: +81-87-821-2222
- ⑥ Hotel New Frontier  
Tel: +81-87-851-1088
- ⑦ Royal Park Hotel Takamatsu  
Tel: +81-87-823-2222
- ⑧ Royal Park Hotel Takamatsu Annex  
Tel: +81-87-823-1111
- ⑨ Takamatsu Century Hotel  
Tel: +81-87-851-0558



# IDW/AD '05

**Tuesday, December 6**

**9:00 - 9:10**

**Sunport Hall Takamatsu Main Hall**

## Opening

Master of Ceremony : Y. Nagae, Executive Chair

### Opening Remarks

**9:00**

*T. Sugiura, General Chair,  
H. Mimura, Program Chair*

**9:10 - 10:30**

**Sunport Hall Takamatsu Main Hall**

## Keynote Addresses

Co-Chairs : H. Mimura, Program Chair  
T. Sugiura, General Chair

### Keynote Address - 1 The \$100 Laptop

**9:10**

*N. P. Negroponte  
MIT, USA*

No abstract was submitted.

### Keynote Address - 2 Future Trend of Broadband and Ubiquitous Networks

**9:50**

*T. Aoyama  
Univ. Tokyo, Japan*

In this talk, key technologies in photonic networks which enable to convey huge amount of traffic are presented. There are three categories of the key technologies for photonic networks which are high speed DWDM optical transmission technologies, high throughput optical routing and switching technologies and control technologies of optical networking such as GMPLS. Broadband applications over such high speed photonic networks are also shown.

----- Break -----

**10:40 - 11:50**

**Sunport Hall Takamatsu Main Hall**

## Invited Addresses

Co-Chairs : Y. Iimura, Program Vice-Chair  
T. Miyashita, Program Vice-Chair

**Invited Address - 1 The Future of Mobile Multimedia  
10:40 Communications**

*T. Horikoshi  
NTT DoCoMo, Japan*

The mobile phone has become an essential part of peoples' daily lives as the communications infrastructure for both voice and data. DoCoMo's 3G service "FOMA" has solidified its position as the next-generation infrastructure faster than expected. This paper introduces an overview of wireless technology for mobile communication, and notes the requirements of mobile phone display. Finally, we introduce the strategy of reality communication that is based on audio, visual, and biological information.

**Invited Address - 2 Present State and Prospect of LED for Back  
11:15 Light Module in Display Applications**

*S. Muguruma  
Nichia, Japan*

Today, a lot of type of back lighting is put to practical use, with LCD technology. From last to this generation, CCFL has been used for a standard lighting source for back lighting. In this generation, LED is becoming a kind of major lighting source, especially for small size LCD back lighting. With this presentation I try to explain about present status of LED back lighting, also prospect of LED back lighting in near future.

----- Lunch -----

## Workshop on LC Science and Technologies

Tuesday, December 6

13:30 - 15:00

Kagawa International Conference Hall

### LCT1: New Materials for LCD Applications

Chair : T. Uchida, Tohoku Univ., Japan

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

**LCT1 - 1:     *Invited*   Ferroelectric Particle/Liquid Crystal  
13:30            Dispersions for Display Applications**

*J. West, C. Cheon\**, *A. Glushchenko\*\**, *F. Li*  
*Kent State Univ., USA*

*\*Hoseo Univ., Korea*

*\*\*Univ. of Colorado, USA*

We present a new method of modifying the properties of liquid crystals by doping them with ferroelectric micro- and nanoparticles. In contrast to the traditional time consuming and expensive chemical synthetic methods these particle dispersion offer a simple means to enhance the electro-optical performance of many liquid crystal materials. We demonstrate that by changing the concentration and type of ferroelectric particles we can substantially change the physical properties of nematic, smectic, and cholesteric liquid crystal materials. We are able to increase the dielectric constants, birefringence, phase transition temperatures, and even the order parameter of the liquid crystal mixtures.

**LCT1 - 2:     *Invited*   Fast Electro-Optical Switching in Polymer-  
13:55            Stabilized Blue Phases**

*H. Kikuchi\*\*\**, *Y. Hisakado\**, *K. Uchida\**, *S. Hirata\**,  
*Y. Haseba\*\*\*\**, *T. Nagamura\**

*\*Kyushu Univ., Japan*

*\*\*Solution Oriented Res. for Sci. & Tech., Japan*

*\*\*\*Chisso, Japan*

Blue phases, kinds of liquid crystal phases, have two major advantages over commonly used nematic phases. First, the response is much faster. Second, the zero-electric field state is optically isotropic unlike nematic phases, that is, no surface treatment (no rubbing) is necessary, leading to a simplification of the fabrication process. We demonstrate the sufficiently large electric field-induced birefringence and the micro-second response of the polymer-stabilized blue phases without any surface treatment.

**LCT1 - 3**      **Fabrication of Polymer Films with Micro Domains of Uniformly Aligned Columnar Mesophase by the Combination of Infrared and UV Photonic Processes**  
**14:20**

*Y. Shimizu, H. Hori, H. Monobe, M. Heya\*, K. Awazu\**  
 AIST, Japan  
 \*Osaka Univ., Japan

Micro-sized domains with the uniformity of molecular alignment of a columnar liquid crystal with polymerizable groups were formed by polarized infrared laser to excite the aromatic C-C stretching mode of vibration. The following *in-situ* photopolymerization gave a polymer film in which such newly formed domains of mesophase are maintained. The domain structures were not be broken in a wider range of temperature, indicating the combination of polarized infrared irradiation and UV-photopolymerization could provide functional polymer devices performing electronic as well as optical functions in usage of highly ordered mesophase materials.

**LCT1 - 4**      **Carbon Nanotube-Doped Liquid Crystal Devices**  
**14:40**

*C.-Y. Huang, C.-Y. Hu, H.-C. Pan, K.-Y. Lo\**  
 Nat. Changhua Univ. of Education, Taiwan  
 \*Nat. Chia Yi Univ., Taiwan

Electro-optical characteristics of carbon nanotube-doped liquid crystal devices were investigated. The measured results reveal that anisotropic carbon nano-solids modify the dielectric anisotropy and the viscosity of the liquid crystal-carbon nanotube mixture, hence significantly modifying the threshold voltage and the switching behavior of the liquid crystal device. Doping a small amount of carbon nanotubes into the liquid crystal mixture is effective in improving the electro-optical characteristics of a LC device when the employed LC mixture is viscous.

----- Break -----

**15:10 - 16:35**

**Kagawa International Conference Hall**

**LCT2: Fast Response LCDs**

Chair : J. West, Kent State Univ., USA  
 Co-Chair : H. Yokoyama, AIST, Japan

**LCT2 - 1:**      ***Invited* Progress of OCB-Mode LCDs and Their Possibility in Future Application**  
**15:10**

*T. Uchida*  
 Tohoku Univ., Japan

Recently, large area liquid crystal television displays are progressed rapidly using in VA and IPS modes. In this application high quality property is required, and the optically compensated bend mode (OCB-mode) appeared newly in the market as a TV display last year. In this paper, the historical background of the OCB mode, its excellent properties, the design method and the future application are discussed.

**LCT2 - 2            Bend State Stability with Dynamic Driving in the  
15:35                OCB Panel**

*T. Kojima, T. Miyashita, T. Uchida, K. Nakao\*,  
H. Wakemoto\**  
*Tohoku Univ., Japan*  
*\*Toshiba Matsushita Display Tech., Japan*

OCB (Optically Compensated Bend) mode is promising for the LCD-TV because of its significance such as fast response and wide viewing angle. One of the important points of this mode is to stabilize the bend state. We have clarified the difference of bend state stability between static driving and dynamic driving. Furthermore, we enabled estimation of bend stability from the physical constants of material.

**LCT2 - 3            Fast Response No-Bias-Bend LCDs  
15:55**

*F. S. Y. Yeung, Y. W. Li, H. S. Kwok*  
*Hong Kong Univ. of Sci. & Tech., Hong Kong*

Fast response No-Bias-Bend (NBB) Liquid Crystal Displays using nano-textured high pretilt angle alignment surfaces has been demonstrated. Such alignment surfaces allow high pretilt angles of over 45° to be fabricated reliably. This NBB-LCD has a rise time of 1.8ms and a fall time of 80µs. The average response time is less than 1ms.

**LCT2 - 4            New Measurement Method of Three Viscosities of N-  
16:15                Type LC Using VA Mode Cells**

*T. Kishimoto, T. Miyashita\*, Y. Kuratomi\*, H. Yaginuma,  
T. Ishinabe\*, T. Uchida\**  
*Aomori Pref. CREATE, Japan*  
*\*Tohoku Univ., Japan*

We have already developed a novel method for measuring the three viscosities of p-type nematic liquid crystals using a separate fitting procedure (MVS-method). In another paper given at this conference, we proposed a method that can be applied to n-type liquid crystals, in which an initial bias voltage is applied. In this paper, we confirmed the validity of our method experimentally.

----- Break -----

**16:50 - 18:15**

**Kagawa International Conference Hall**

**LCT3: LC Alignment Process**

Chair :                H. Kikuchi, Kyushu Univ., Japan  
Co-Chair :            H. Fujikake, NHK, Japan

**LCT3 - 1:      *Invited* Photo-Rubbing: A Practical Photo-Alignment  
16:50            Solution**

*H. Yokoyama\*<sup>\*\*\*</sup>, M. Kimura\*<sup>\*\*</sup>  
\*AIST, Japan  
\*\*JSR, Japan  
\*\*\*NanoSys. Solutions, Japan*

A novel photo-alignment scheme using normally incident periodically intensity-modulated UV light has been developed and demonstrated to efficiently yield a stable pretilt angle of nematic liquid crystals by single exposure. The scheme, referred to as the "photo-rubbing", consists in unidirectional scan of the intensity-modulated UV light over the photo-alignment film, which causes asymmetrical photo-reactions in the film. We show here its successful application to multi-domain alignment processing. Thanks to the normal incidence, the photo-rubbing removes the instrumental disadvantages of the conventional oblique incidence technique, thereby providing a true practical solution for photo-alignment.

**LCT3 - 2            The Surface Energy of Polyimide Alignment Layer  
17:15            after Ion-Beam-Alignment Process**

*J.-H. Jaw, Y.-H. Chen, K.-W. Wang, S.-F. Liu, H.-A. Li,  
O. Sun, S.-T. Yang  
Chunghwa Picture Tubes, Taiwan*

It would result in the different surface energy on the polyimide alignment layer with variant recipe of post treatment. In this study, the contact angle of water of Recipe A is smallest due to the surface energy with Recipe A is the minimum, and then the reaction ability of polyimide alignment layer with Liquid Crystal and seal agent would be weak. Therefore, better display performance could be obtained from the Recipe A of post treatment.

**LCT3 - 3            High Contrast Ratio In-Plane-Switching TFT-LCD  
17:35            with Ion Beam Irradiated Polyimide Film as LC  
Alignment Layer**

*T. Suzuki, J. Matsushima, Y. Sasaki, M. Sugimoto,  
H. Tanaka\*, C. Mizoguchi\*, S. Onda, K. Mimura,  
K. Sumiyoshi  
NEC LCD Tech., Japan  
\*NEC Kagoshima, Japan*

The ion beam irradiation technique has been studied as an LC alignment process for some years. The anchoring strength is regarded as an important issue with such a non-rubbing alignment technique. We have evaluated the anchoring strength of ion beam irradiated polyimide alignment layers with a method based on a non-elastic model to find the optimum materials and conditions for the ion beam LC alignment process. Our prototype of in-plane-switching TFT-LCD features a high contrast ratio of 1200:1.

**LCT3 - 4      Induction of Splay-to-Bend Transition Using Twist  
17:55          Disclination Method for OCB-Mode LCDs**

*K. Kuboki, T. Miyashita, T. Ishinabe, T. Uchida  
Tohoku Univ., Japan*

Optically compensated bend (OCB) mode liquid crystal displays (LCDs), which have fast response, require an initial transition from a splay alignment to a bend alignment before operation. We clarified that the twist disclination act as a nucleus of the transition and also clarified the condition to form the nucleus. Based on this result, the transition was successfully induced by forming the right- and left-handed twist alignments by using partial rubbing treatment or micro protuberances.

**Author Interviews**

18:20 - 19:20

**Wednesday, December 7**

9:00 - 10:25

Kagawa International Conference Hall

**LCT4: LC Mode**

Chair :            H. Okada, Toyama Univ., Japan  
Co-Chair :        S. Kondoh, Citizen Watch, Japan

**LCT4 - 1:      *Invited*    Liquid Crystal Optical Security Device with  
9:00            Polarized Latent Images**

*R. Yamaguchi, S. Sato  
Akita Univ., Japan*

Optical security devices using alignment patterned LC cells are proposed. Latent images with continuous gray levels and high spatial resolution can be optically written and erased by using one or two polarizers. Two or three latent images can also be created in one guest host mode LC cell. Moreover, the alignment patterned LC cell is utilized as a key cell to visualize the latent information.

**IMID / IDMC 2006**

Aug. 22 – 25, 2006  
Daegu, Korea

**LCT4 - 2            An Optical Configuration of Super IPS LC Cell for  
9:25                Symmetrically Wide Viewing Angle**

*J. H. Lee<sup>\*,\*\*</sup>, C. H. Oh<sup>\*</sup>, W. R. Lee<sup>\*\*\*</sup>, J. C. Kim<sup>\*\*</sup>,  
G. D. Lee<sup>\*\*\*</sup>*

*\*LG.Philips LCD, Korea*

*\*\*Pusan Nat. Univ., Korea*

*\*\*\*Dong-A Univ., Korea*

In this paper we propose a novel optical configuration of the Super IPS LC cell which exhibits wide viewing angle even in diagonal direction. In addition, symmetrical wide viewing angle has been achieved by applying splayed homogeneous LC alignment. The proposed optical configuration consists of the splayed LC cell and uniaxial retarders, not biaxial films because it would be very hard to provide uniformity in large size LC display. The optical principle of the proposed configuration is explained on the Poin'care sphere and experimental result proves the improved optical characteristics of the proposed configuration.

**LCT4 - 3            Minimization of Dead Zone in a Transflective PVA LC  
9:45                Cell**

*J. I. Baek, J. C. Kim, T.-H. Yoon*

*Pusan Nat. Univ., Korea*

We propose an electrode structure for high bright-ness in a transflective PVA LC cell. Disclination lines of the bright state are minimized so that we obtained high light efficiency of the reflective part. By optimization of parameters, we can match the driving voltages of the reflective mode with that of the transmissive mode. The wide viewing angle property is also achieved by using a compensation film.

**LCT4 - 4L         Enhancement of the Performance of LCDs by  
10:05                Doping the Nanoparticles of MgO: The Reduction of  
Operating Voltage and Response Times Particularly  
Delay Times and the Increase in the Optical  
Throughput**

*S. Sano, T. Miyama<sup>\*</sup>, Jun. Xu<sup>\*\*</sup>, K. Takatoh<sup>\*\*\*</sup>,  
S. Kobayashi<sup>\*</sup>*

*Ube Material Ind., Japan*

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

*\*\*Fudan Univ., China*

*\*\*\*Toshiba Elect. Eng., Japan*

LCDs, such as TN, ECB, and VAN-mode doped with the nanoparticles of MgO exhibit the enhancement in their performance. As an example, a TN-LCD doped with the nanoparticles of MgO (0.1wt%) exhibits the reduction in the operation voltage by 26%, the reduction of the delay time by 50%, and the increase in the optical throughput by 10 times even at a low temperature, say at -10°C.

----- Break -----

10:40 - 12:00

Kagawa International Conference Hall

**EP5/LCT5: Flexible LCD**

Chair : T. Nose, Akita Pref. Univ., Japan  
 Co-Chair : Y. Toko, Stanley Elec., Japan

**EP5/LCT5 - 1 Flexible Field-Sequential-Color FLC Displays Using a Bendable Backlight Sheet with LED Chips**

*H. Fujikake, H. Sato, T. Murashige, Y. Fujisaki, H. Kikuchi,  
 T. Kurita  
 NHK, Japan*

We have developed a flexible full color moving-image display using a plastic-substrate-based monostable ferroelectric liquid crystal (FLC) panel and a bendable backlight sheet with thin small LED chips. The fabricated A4-sized FLC matrix panel with 96 x 64 image pixels was laminated with the three-primary-color backlight sheet and optical diffuser and spacer films, and was driven by an active matrix technique using external switch transistor array based on a field-sequential-color method.

**EP5/LCT5 - 2 Improvement of Dichroic Polymer Dispersed Liquid Crystal (PDLC) Performance for Flexible Display Using Lift-off Technique**

*A. Masutani, T. Roberts, B. Schüller, A. Sakaigawa\*,  
 A. Yasuda  
 Sony Deutschland GmbH, Germany  
 \*Sony, Japan*

The performance of dichroic sponge polymer dispersed liquid crystals (SPDLC) display can be improved further by incorporating a lift-off method using a substrate covered with a fluori-nated-organosilane. The resulting cells achieve improved contrast, improved response time, smaller switching voltages and better uniformity, compared with the previously reported dichroic SPDLCs. The display exhibits near magazine-standard reflectivity and contrast ratio. Furthermore, the lift-off method enables rubbing-free, low temperature, roll-to-roll processing techniques. Such displays are suitable for flexible sol-vent-sensitive, organic thin-film transistors (TFTs).

**EP5/LCT5 - 3 Inkjet Printed Cholesteric Liquid Crystal Display**

11:20

*J. M. Ding, Y. A. Sha, L. P. Hsin, H. L. Wang, C. C. Liao,  
 Y. R. Lin, C. C. Lu, C. H. Chen, I. C. Chen  
 Ind. Tech. Res. Inst., Taiwan*

The inkjet printing technology has been used to manufacture flexible cholesteric liquid crystal displays. The displays are fabricated from top to bottom by forming various functional layers on flexible substrates. Stable cholesteric liquid crystal droplets are obtained and jetted to fill the pixel areas by a piezoelectric drop-on-demand inkjet printer. Our technology has provided a novel process to fabricate a flexible, bistable, and multi-color reflective display with single display medium layer.

**EP5/LCT5 - 4 Flexible Photoaligned Permanent Bistable TN-LCD**

11:40

*X. H. Li, F. S. Y. Yeung, V. G. Chigrinov, H. S. Kwok  
Hong Kong Univ. of Sci. & Tech., Hong Kong*

Flexible Bistable Nematic Liquid Crystal Display ( $\pi$ -BTN) based on photo-alignment technology is developed on two 200 $\mu$ m plastic substrate. This display can be switched between  $\phi$  and  $\pi + \phi$  twisted states by means of breaking anchoring condition on one of the plastic substrates. Low baking temperature of 100 $^{\circ}$ C is needed to avoid high temperature distorting the substrates. The advantages of both photoalignment and  $\pi$ -BTN technologies, such as no contamination of electrical charges and impurities, high contrast and bistability are shown.

----- Lunch -----

13:40 - 15:05

Kagawa International Conference Hall

**LCT6: Panel and Evaluation**

Chair : H. Seki, Hachinohe Inst. Tech., Japan

Co-Chair : R. Yamaguchi, Akita Univ., Japan

**LCT6 - 1: *Invited* Low Power Consumption Displays Using  
13:40 Ferroelectric Liquid Crystal**

*S. Kondoh, A. Suguro, K. Noguchi, K. Iio, K. Ueda,  
N. Takahashi, M. Fujino  
Citizen Watch, Japan*

Now, we require low power consumption instruments for environmental conservation. So, We have been developing low power consumption displays using ferroelectric liquid crystals (FLC) with memory effects. It is difficult to get good alignment and memory effects by using ferroelectric liquid crystal displays (FLCDs) with organic alignment films. But we get good FLCDs with inorganic alignment films such as SiO or SiO<sub>2</sub> in this work. And we have developed FLCDs using plastic substrates with a new spacer technique for flexible displays.

**LCT6 - 2 Field-Sequential Color LCD Driven by Optimized  
14:05 Method for Color Breakup Reduction**

*H. Yamakita, M. Sakai, Y. Taniguchi, J. Asayama, K. Adachi  
Matsushita Elec. Ind., Japan*

We have built a prototype 2.2 in. FSC-LCD using novel LC materials, in order to optimize the driving method for color breakup reduction. The method we applied is the way to insert the intermediate color among the RGB periods. In this report, we propose an optimized driving method of FSC-LCD for color breakup reduction and its influence into power consumption.

**LCT6 - 3      10.4-in. Hybrid Color Reflective TFT-LCD**

14:25

*Y. Asao  
Canon, Japan*

This paper shows the 1st reflective hybrid color (HC) LCD with active matrix driving. Color displaying method, prototype configuration and its image output are discussed. The size is 10.4 inch and the resolution is 1536 lines in the horizontal direction by using mass-produced XGA (1024x3x768) TFT panel, which is 1.5 times higher resolution than that of the conventional RGB-CF method. This prototype can show the high-resolution character and the natural photo image with sufficient quality in the practical use.

**LCT6 - 4      Cell Parameter Measurements of Vertical Alignment  
Liquid Crystal Cells by Using Stokes Parameters**

14:45

*M. Kawamura, K. Sato, S. Sato  
Akita Univ., Japan*

We propose a two-dimensional (2D) measurement method for determining cell parameters such as a cell thickness and pretilt angle in a vertical alignment (VA) liquid crystal (LC) cell. The microscopic cell parameter distributions can be obtained by measuring Stokes parameters of the LC cell as changing an oblique angle of the incident light upon the LC cell.

**Author Interviews**

17:30 - 18:30

15:00 - 17:00

Exhibition Hall

**Poster    LCTp1: LCD Mode****LCTp1 - 1      The Comparison between Characteristics of Fringe-  
Field Switching Mode Using Positive & Negative LC***J. B. Park, H. Y. Kim, Y. H. Jeong, S. Y. Kim, Y. J. Lim  
BOE TFT-LCD SBU, Korea*

Under backlight spectrum considering real array and C/F substrate, we found out optimal retardation and compared the chromaticity in positive and negative LC. In both +LC and -LC, under rubbing direction, the chromaticity changes little regardless of increase of retardation. However, under observation making 45° regarding rubbing direction, as  $d$  or  $\Delta n$  increases toward optimal retardation, the chromaticity shift is weakened in +LC, while that is more significant in -LC.

**LCTp1 - 2      A Novel Color Hybrid Liquid Crystal Display**

*K. H. Liu, C. H. Chen, Y. A. Sha, J. S. Hsieh, C. C. Hsiao,  
P. J. Su, C. Y. Lin, K. H. Chang, J. D. Chen, C. C. Huang,  
S. Y. Fuh, H. L. Wang, Y. C. Chen, S. C. Jeng, Y. R. Lin,  
C. C. Liao, J. W. Shiu  
ERSO/ITRI, Taiwan*

A novel hybrid LCD technology has been developed. By replacing a glass color filter with a plastic color filter, a lighter and thinner hybrid LCD can be obtained. A 4" QVGA prototype has been demonstrated. A hybrid LCD can reduce 35% thickness and 36% weight compared with a conventional LCD with 2 glass substrates. This technology can be a good solution for portable display.

**LCTp1 - 3      Electro-Optic Characteristics of Fringe-Field Driven Transflective LCD with Dual Cell Gap**

*J. H. Song\*, D. H. Lim\*, J. B. Park\*, M. S. Kim\*\*,  
Y. H. Jeong\*\*, H. Y. Kim\*, S. Y. Kim\*, Y. J. Lim\*, S. H. Lee\*\*  
\*BOE TFT-LCD SBU, Korea  
\*\*Chonbuk Nat. Univ., Korea*

We have fabricated transflective liquid crystal (LC) cell with dual cell gap driven by fringe field using a nematic LC with positive dielectric anisotropy and studied electro-optic characteristics of the cell. This LC cell with optimized cell parameters shows low wavelength dispersion, low power consumption and contrast ratio greater than 5 in polar angles of over 50° in all directions and over 80° in certain azimuthal cross-sectional planes in the reflective and transmissive parts.

**LCTp1 - 4      Transflective LCD with Wide Viewing Angle and Low Driving Voltage**

*I. Fukuda, Y. Sakurai, T. Nakata, Y. Sakamoto  
Kanazawa Inst. of Tech., Japan*

We investigated the numerical relationship between the electro-optical properties and the on-voltage of a TFT-LCD, specifically the refractive indices of retardation films in a transflective homogeneous- cell with two biaxial retardation films, in order to reduce power consumption and increase viewing angles. Our results show that the LCD produces an achromatic high-quality image with wide viewing angles when the device parameters and refractive indices of retardation films are optimized, even when the on-voltage of the TFT-LCD is reduced to 2.0V.

**LCTp1 - 5      Optical Configurations of Horizontal-Switching Transflective LCDs in Double Cell Gap Structure**

*G. S. Lee, Y.-S. Kim\*, W.-S. Kang\*, I.-B. Kang\*, J. C. Kim,  
T.-H. Yoon  
Pusan Nat. Univ., Korea  
\*LG.Philips LCD, Korea*

We propose optical configurations of horizontal-switching transflective displays in double cellgap structure. All the configurations are designed on the basis of wide-band quarter-wave structure so that they show excellent spectral characteristics over the entire visible wavelengths

**LCTp1 - 6      Lateral Field Effect on Horizontal Switching in a Bistable Chiral Splay Nematic Liquid Crystal Device**

*J. H. Choi, C. G. Jhun, C. P. Chen, H. Shin, J. C. Kim, T.-H. Yoon*

*Pusan Nat. Univ., Korea*

The splay and  $\pi$  twist textures are used for the bistable state of a bistable chiral splay nematic (BCSN) liquid crystal device. Each state can be switched by applying a vertical or a horizontal electric field. In this work, we investigated the effect of the lateral field on the transition from the twist state to the splay state as we vary the amplitude and the pulse width of the lateral field.

**LCTp1 - 7      Study on Initial Setting Voltage and Response Time of the Optically Compensated Splay Cell**

*S. M. Oh, B. S. Jung, J. Y. Hwang\*, D. S. Seo\*, S. H. Lee*

*Chonbuk Nat. Univ., Korea*

*\*Yonsei Univ., Korea*

Setting voltage and response time of the optically compensated splay (OCS) cell have been studied as a function of surface pretilt angle. Setting voltage decreases and response time becomes faster with decreasing tilt angle. Further, we found that the liquid crystal domain surrounded by air had OCS structure initially.

**LCTp1 - 8      Dynamics of Locked Super Homeotropic Mode Depending on Size and Shape of Patterned Polymer**

*Y. M. Jeon, S. H. Park, M.-H. Lee, J. M. Rhee, S. H. Lee*

*Chonbuk Nat. Univ., Korea*

We have studied new vertically aligned liquid crystal mode for large size liquid crystal display with wide viewing angle characteristics and fast response time. Locked super homeotropic (LSH) mode, in which vertically aligned LCs are locked by surrounding polymer walls such as cubic, hexagonal and cylinder, has a simple fabrication process because of no rubbing process and free from spacer. In the device, the LCs tilt down symmetrically around the center of the cell with bias voltage and thus, it exhibits wide viewing angle characteristics.

**LCTp1 - 9      Color Switching in Liquid Crystal Display Using High Dichroic Fluorescent Dyes**

*R. Yamaguchi\*, K. Moriyama\*, S. Sato\*, X. Zhang\*\*, T. Thiemann\*\*, S. Mataka\*\**

*\*Akita Univ., Japan*

*\*\*Kyushu Univ., Japan*

Color switching properties in fluorescent liquid crystal displays (LCDs) are improved by using high dichroic fluorescent dyes of which dichroic ratio is about 9. A fluorescent homogeneous and twisted nematic (TN) LC cells are stacked and the voltage is applied to the TN cell. The fluorescent color can continuously be changed from the color of TN cell to that of homogenous cell with high chroma.

**LCTp1 - 10L Optically Rewriteable LC Display with a High Contrast and Long Life Time**

*A. Murauski, V. Chigrinov, X. Li, H.S. Kwok  
Hong Kong Univ. of Sci. & Tech., Hong Kong*

We propose an optically rewriteable TN LC display. TN LCD does not require an electronic scheme, a power supplier, conductive layers inside devices, which provides a possibility to use this type display in plastic cards, registration and other systems. We discuss the construction and methods of a rewriting image in optically rewriteable LC display with a high contrast and a long life time.

**LCTp1 - 11L An Alternative OCB Mode with Reverse-Wavelength-Dispersion Quarter Wave Plate**

*C. P. Chen, C. G. Jhun, S. R. Lee, T.-H. Yoon, J. C. Kim,  
J. D. Noh\*, D. H. Suh\*, J. Y. Lee\*  
Pusan Nat. Univ., Korea  
\*BOE HYDIS Tech., Korea*

An alternative optically compensated bend (OCB) liquid crystal display featuring reverse-wavelength-dispersion (RD) quarter wave plate (QWP) is to be presented. The application of this newly developed birefringent plate significantly simplifies the existing structure for wide-viewing OCB mode. Simulated results manifest its standout performance in comparison with other counterparts.

**LCTp1 - 12L Study on the Effects of Step-Coverage Structure for Parasitic Capacitances**

*M. S. Jung\*\*, D. W. Kim\*\*, T. Won\*\*, H. J. Yoon\*\*,  
C. S. Lee\*\*, S. I. Yoon\*\*, S. H. Yoon\*\*  
\*Inha Univ., Korea  
\*\*Sanayi Sys., Korea*

In this paper, we report the influences of the step-coverage on the effective capacitances in LC cell. In this work, we have analyzed the conventional TN mode LC cell by using the numerical simulator, TechWiz LCD. In order to calculate effective capacitances, the energy method is used. As a result, we found that the step-coverage structure causes the parasitic capacitance between the data line and the pixel electrode to be about 18 times as large as the parasitic capacitance resulted from a normal planar structure.

**LCTp1 - 13L Color Switching in Bistable Ferroelectric LCDs**

*P. Z. Xu, S. Valyukh\*, X. H. Li, V. Chigrinov  
Hong Kong Univ. of Sci. & Tech., Hong Kong  
\*Dalarna Univ., Sweden*

Memorable color switching in bistable ferroelectric liquid crystal displays for transmissive mode is studied. Optimal configuration parameters with retardation film taken into account are obtained in simulation. Prototype cells with memorized color are fabricated accordingly based on the simulation results, which agree well with theoretical results and show very good quality.

**LCTp1 - 14L Simulation of Wide Viewing Angle Characteristic in Simple Mode LCD using Different Rubbing Direction**

*D.-W. Kim*  
*Inha Univ., Korea*  
*\*Sanayi Sys., Korea*

In this paper, we propose an idea to implement multi-domain technology in two simple mode cells. In order to implement multi domain, we designed a VA and ECB mode cell which has different rubbing directions in unit cell. Optical characteristics are calculated by a numerical simulator(TechWiz LCD) and compared with that of PVA mode. The simulation results revealed that the proposed cells have wide viewing angle characteristic exactly like that of PVA mode.

15:00 - 17:00

Exhibition Hall

**Poster LCTp2: LCD Alignment**

**LCTp2 - 1 A Plastic Color TN-LCD Using a Photo Alignment Method**

*K. Maruyama, Y. Ono, Y. Suzuki\*, T. Ikariya*  
*TRADIM, Japan*  
*\*Dainippon Ink & Chems., Japan*

We have successfully developed a plastic color twisted nematic liquid crystal display (TN-LCD) using a photo-alignment (PA) method. The plastic color TN-LCD is very thinner and lighter than glass TN-LCDs. We can drive it as a multiplexed TN-LCD of 1/5 duty. Moreover, we carried out continuous coating with azo dye solution on a plastic substrate and continuous PA treatment. It is confirmed that LC alignment on a plastic substrate is possible under continuous processes.

**LCTp2 - 2 Improvement of Liquid Crystal Electric-Characteristic by Plasma Beam Alignment**

*C. Y. Lee, P. C. Liu, C. W. Chen, H. C. Tang, S. Lin,*  
*Y. Chang, W. T. Hsien, Y. J. Shih, J. M. Chen, C. D. Lee*  
*Ind. Tech. Res. Inst., Taiwan*

The plasma beam alignment (PBA) was treated by a sheet-like flux of accelerated plasma generated from anode layer thruster (ALT). PI and DLC film were treated in anisotropic plasma beam with ALT and conventional rubbing process. We can observe smoothly geometry on the surface by plasma beam treated and scratch surface by mechanical rubbing. Furthermore, we can reach the high voltage holding ratio (VHR), low residual direct current (Rdc) and good anchoring energy by the plasma beam treatment.

**LCTp2 - 3 Study on the Influence of Rubbing on the Multi-Domain Ch-LCD**

*Z. Jun, L. Qing, F. Weitao, T. Yongming, W. Baoping  
Southeast Univ., China*

The technology of rubbing is one of important methods to form the multi-domain structure in the reflective cholesteric liquid crystal display. We have studied the influence of the pile impression, the rotation frequency and the roller transport velocity on the phase transition voltage of the CHLCD respectively. The results of the experiments showed that a gentle pile impression with a small rotation frequency and a fast roller transport velocity can achieve a low phase transition voltage of the multi-domain CHLCD.

**LCTp2 - 4 New Photo-Alignment Technology Using Azo-Dye Materials**

*S.-J. Liu, J.-R. Zhang, Z.-H. Ling  
Chinese Ac. of Sci., China*

This paper describes a new photo-alignment technology using polyimide and azo-dye materials. We study the alignment performance of this new material called SY04, which contains two azo groups. In order to improve stability of the photo-aligned film, a sort of PI material is mixed. A fast response performance and a good electro-optical performance are acquired. These alignment materials can provide good thermostability and is stable under weak UV irradiation as well.

**LCTp2 - 5L Vertical Alignment of Liquid Crystal on a-SiO<sub>x</sub> Thin Film Surface by the Ion Beam Exposure**

*P. K. Son, S. S. Cha, J. H. Seo, S. P. Lee, J. C. Kim,  
T.-H. Yoon, S. J. Rho\*, B. K. Jeon\*, K. H. Kim\*  
Pusan Nat. Univ., Korea  
\*Samsung Elect., Korea*

Liquid crystal can be aligned vertically by the rotational oblique evaporation of a-SiO<sub>x</sub> thin films. However, switching behavior of liquid crystal along random directions will result in disclination lines when an electric field is applied. By using the ion beam exposure, we can achieve uniform vertical alignment without disclination lines. We can control the pretilt angle by changing ion beam parameters, such as the ion beam energy, the incident angle, and the exposure time. An excellent electro-optic switching behavior of an ion beam aligned liquid crystal cell was observed with the oblique ion beam exposure on a SiO<sub>x</sub> thin film surface.

15:00 - 17:00

Exhibition Hall

**Poster LCTp3: Materials****LCTp3 - 1 Novel Glass-Forming Liquid Crystals Containing Acrylic Acid Trimer Core Unit for Optical Films***S. Nakanishi\*\*\*, Y. Fujimura\*\*, M. Ueda\*\*\***\*Japan Chem. Innovation Inst., Japan**\*\*Nitto Denko, Japan**\*\*\*Tokyo Inst. of Tech., Japan*

To provide uniformly aligned liquid-crystalline (LC) films, novel amorphous medium molecular mass nematic LCs have been developed. The nematic LCs consist of acrylic acid trimer as a core structure and mesogenic moiety. The re-sulting materials showed nematic LC phase and vitrified to form monodomain films at room tem-perature. This glassy LCs miscible with a chiral photochromic dopant, providing monodomain aligned defect free cholesteric reflection films, which color is tunable by UV-irradiation.

**LCTp3 - 2 Physico-Chemical Properties of Compounds Having a Lactone Moiety at the Terminal Position***Y. Morita, K. Era, H. Okamoto, S. Takenaka**Yamaguchi Univ., Japan*

This paper describes physico-chemical properties of new liquid crystal materials having a lactone moiety such as chromen-2-one and 3,4 - dihydrochromen-2-one at the terminal position. All compounds show a large dielectric anisotropy ( $\Delta\epsilon$ ), and these results suggest that the terminal lactone group such as chromen-2-one and 3,4-dihydrochromen-2-one are useful components for enhancing positive  $\Delta\epsilon$ . The effect of terminal group will be discussed in terms of the chemical and electrostatic properties of the molecules.

**LCTp3 - 3 Effects of Carbon Nanotubes on Electro-Optic Characteristics of TN-LC Cells***S. Y. Jeon, K. A. Park\*, I.-S. Baik, K. H. An\*, J. Choi,**S. H. Lee, Y. H. Lee\***Chonbuk Nat. Univ., Korea**\*Sungkyunkwan Univ., Korea*

Twisted nematic (TN) liquid crystal (LC) cells doped by carbon nanotubes (CNTs) with various concentrations have been fabricated and their electro-optic characteristics have been studied. No significant difference in voltage-dependent transmittance curves between pure and CNT-doped LC cell is not observed. Nevertheless, CNT-doped LC cells show reduced residual DC and improved response time. Introducing CNTs in a LC cell may affect the physical properties of LC.

**LCTp3 - 4L Phase Transition and Piezoelectric Effect of the Ferroelectric Liquid Crystal**

*Y. Liu, Y. Yang, G. Xu  
Chinese Ac. of Sci., China*

The characteristic of phase transition and structure of the ferroelectric liquid crystal material were investigated. The relation between the temperature and the piezoelectric constant of ferroelectric liquid crystal was designed on the basis of the test theory to test the piezoelectric constant. The relation between  $\varepsilon$  and  $f$  was also studied.

**LCTp3 - 5L Novel Ag Alloy for a Reflector of Transflective LCD**

*H. N. Yum, J. S. Kim, J. H. Kim, S. H. Cho  
Samsung Elect., Korea*

We demonstrated the application of Ag-Mo alloy to a reflector of a transflective LCD. Pure Ag had been considered as promising material to replace a conventional material, Al-alloy. Due to discoloration and reflectance degradation, however, Ag could not have been widely used. In this paper, it is presented that Ag-Mo alloy shows higher reflectance than that of Al-alloy, and the optimized TFT fabrication process enables one to overcome the limitations of Ag in real process.

**LCTp3 - 6L Molecular Dynamics in a Series of Halogen Compounds Exhibiting Smectic B Phases**

*A. C. Ribeiro<sup>\*,\*\*</sup>, L. Gonçalves<sup>\*,\*\*\*</sup>, P. J. Sebastião<sup>\*,\*\*</sup>,  
L. Oswald<sup>\*\*\*\*</sup>, D. Guillon<sup>\*\*\*\*</sup>  
<sup>\*</sup>Centro de Física da Matéria Condensada, Portugal  
<sup>\*\*</sup>Instituto Superior Técnico Departamento de Física,  
Portugal  
<sup>\*\*\*</sup>Faculdade de Ciências e Tecnologia, Portugal  
<sup>\*\*\*\*</sup>IPCMS, France*

The molecular dynamics in a series of halogen liquid crystals exhibiting smectic B phases is presented. Standard and fast field cycling NMR techniques were used to obtain the proton spin-lattice relaxation dispersion over a broad frequency range. The results are analyzed in terms of potential contributions of different molecular motions. At high frequency the relaxation is dominated by rotations/reorientations while translational self-diffusion is dominant at low frequencies. The results clearly reflect the influence of the terminal halogen element's atomic weight.

15:00 - 17:00

Exhibition Hall

**Poster LCTp4: Optical Design and Measurement****LCTp4 - 1 Optical Design of Tunable Liquid Crystal Color Filter***Y. Sato\*, T. Ishinabe\*\*, T. Uchida\*\*, H. Seki\*,\*\*\***\*Hachinohe Inst. of Tech., Japan**\*\*Tohoku Univ., Japan**\*\*\*Aomori Pref. CREATE, Japan*

The wavelength tunable liquid crystal color filter is developed for the image analysis. The control of the transmitted spectrum is realized by introducing the new design concept. It is clarified that the compensation of the dispersion property in liquid crystal is possible by usual retardation film.

**LCTp4 - 2 Improvement in Viewing Angle Properties of IPS-LCDs Using a Negative A-Plate***S. Suzuki, N. Obara\*, Y. Iimura**Tokyo Univ. of A&T, Japan**\*Tosoh, Japan*

For reducing an intrinsic light leakage occurring in crossed polarizers at oblique incident angles, we have studied the optical compensation for crossed polarizers using a negative A-plate. Computer simulations tell us that, comparing with the case for a positive A-plate, the use of a negative A-plate is more effective to reduce the light leakage, which is also confirmed by the experimental results. A negative A-plate is also applied to improve a dark state of an IPS-LCD, and the effectiveness of the film on the optical compensation is clarified.

**LCTp4 - 3 Effects of Various Parameters of Discotic Compensation Films on Viewing Angle Properties in OCB-LCD***I. Fukuda, T. Nakata, Y. Sakurai, Y. Sakamoto**Kanazawa Inst. of Tech., Japan*

We investigated the effects of various parameters of discotic-compensation films on viewing-angle properties in an OCB-LCD. We verified that wide viewing angles greater than  $\pm 80^\circ$  (CR>50) could be obtained by optimizing the retardation and refractive indices of the discotic-compensation film, as long as the film's molecular alignment normalized at the thickness and that of liquid crystal layer in the black state are almost the mirror symmetry.

**LCTp4 - 4      Order Parameters of Liquid Crystals on Dual Easy Axes Substrate**

*C.-Y. Huang, Y.-S. Huang, J.-R. Tian  
Nat. Changhua Univ. of Education, Taiwan*

This work reports the measurement of the effective order parameter of liquid crystals on the dual easy axes substrate. The effective order parameter of liquid crystals is determined from the polarized ultraviolet absorption of host-guest liquid crystals in a wedge cell. Experimental findings indicate that the ratio of the rubbing strengths in the two rubbing directions and the cell thickness substantially affect the effective order parameter of the liquid crystal molecules. The energetic competition between the surface anchoring in the two rubbing directions contributes to the observed results.

**LCTp4 - 5      Measurement of Surface Order Parameter of Liquid Crystal Cell Using Phase Transition Droplet Method**

*S.-J. Oh, E. Kisara, K. Kuboki, T. Miyashita, T. Uchida  
Tohoku Univ., Japan*

The surface order parameter can be measured by observing the contact angle between an isotropic phase or nematic phase droplet and the polymer substrate at the nematic-isotropic phase transition temperature. We discuss the relationship between the surface order parameter and the droplet contact angle measuring the three-dimensional order parameter using infrared light absorbance and measuring the birefringence of the liquid crystal on the polymer surface. Based on the result, we established a new model of the droplet contact angle.

**LCTp4 - 6      Theoretical Approaches for Measurement of Three Viscosities of N-Type Liquid Crystals**

*Y. Kuratomi, T. Miyashita, T. Kishimoto\*, T. Ishinabe,  
T. Uchida  
Tohoku Univ., Japan  
\*Aomori Pref. CREATE, Japan*

We proposed a method for measuring three viscosities  $\gamma_1$ ,  $\eta_1$  and  $\eta_2$  of p-type nematic liquid crystals using dynamic retardation properties of ECB cells and tried to apply this method to n-type nematic liquid crystals. However, we found that a twist alignment appeared at the voltage-on state in VA cells, which became a severe problem for the viscosity measurement. In this paper, we propose a solution that involves applying initial bias voltage to the VA cells from theoretical analysis.

**LCTp4 - 7 Raman Spectral Study of Polymer Alignment Behaviors with Molecular Switching of Ferroelectric Liquid Crystal**

*T. Murashige, H. Fujikake, H. Sato, H. Kikuchi, T. Kurita  
NHK, Japan*

We clarified that molecular alignment of polymers dispersed in ferroelectric liquid crystal (FLC) moved under switching behaviors of the FLC using polarization Raman spectral microscopy. The polymer alignment change became large with the increase in the FLC switching angle. Polymer de-formations with the alignment change is thought to be useful for improving the switching angle and a threshold voltage of the FLC although the FLC switching behavior is suppressed by the polymer.

**LCTp4 - 8L New Method for Determination of Liquid Crystal Polar Anchoring Energy from Reflective Measurement**

*A. Murauski, V. Chigrinov  
HKUST, Hong Kong*

Liquid crystal (LC) polar anchoring energy was measured directly by determination of LC pretilt angle on the alignment surface analyzing the light reflected from the test cell. The LC cells with the cell gap less than 5  $\mu\text{m}$  with homogeneous and twist configuration were used in measurements.

**LCTp4 - 9L Practical Pretilt Angle and Gap Measurement Method for Vertically Aligned Cells**

*T. Nishioka, T. Satake, T. Kurata, Y. Maeda\*, M. Kaneko\*,  
T. Maehara\*  
Mitsubishi Elec., Japan  
\*Meiryo Technica, Japan*

We have developed a practical pretilt angle and gap measurement method for vertically aligned cells based on the crystal rotation method using a polarization microscope. The errors due to measurement point shift and undesired alignment near a protrusion can be avoided. Moreover, transmittance anisotropy in oblique incidence is compensated without refractive indices of substrate layers.

**LCTp4 - 10L High Sensitivity Pretilt Angle Measurement of Reflective Nematic Liquid Crystal Cells**

*S. J. Hwang, M. H. Hsu, H. H. Yu\*, J. H. Lin  
Nat. United Univ., Taiwan  
\*Nat. Formosa Univ., Taiwan*

A simple method for determining surface tilt angle of reflective liquid crystal (RLC) displays was proposed based on the common-path heterodyne interferometer and the modified crystal rotation configuration. The phase retardation -extremum technique was used to measure the pretilt angle for the planar LC cell.

**LCTp4 - 11L Liquid Crystal Analysis System (LCAS) -Complete  
LC Measurement in under One Minute-**

*M. Wand, A. Januszko\*, P. Kaszynski\**

*LC Vision, USA*

*\*Vanderbilt Univ., USA*

LCDs for computer and television applications have shown a dramatic increase in demand in the last few years. Testing of commercial nematic LCs in an LCD production line, as well as design of new LCs for improved displays is critical for fast development. A Powerful and yet simple to use instrument, the LCAS-2, has been developed for the quick and accurate measurement of almost all electrical and optical LC properties in under one minute, and will be described in detail.

15:00 - 17:00

Exhibition Hall

**Poster LCTp5: Novel Devices**

**LCTp5 - 1 Withdrawn**

**LCTp5 - 2 Transflective Spatial Filter Based on Azo-Dye-Doped  
Cholesteric Liquid Crystal Films**

*T.-H. Lin, Y.-G. Fuh*

*Nat. Cheng Kung Univ., Taiwan*

This work demonstrates the feasibility of exploiting the photoisomerization effect in azo-dye-doped cholesteric liquid crystal films (DDCLC) with a concomitant decline of the phase transition temperature from the cholesteric to an isotropic phase ( $T_{Ch-I}$ ) as a spatial filter. High- and low-pass images in the Fourier optical signal process can be simultaneously observed via reflected and transmitted signals, respectively.

**LCTp5 - 3 Holographic Imaging Device Having Polarization  
Selectivity Using Polymer Dispersed Liquid Crystal**

*A. Ogiwara, K. Kameda*

*Takamatsu Nat. College of Tech., Japan*

Holographic imaging device having the dominant polarization dependence has developed using a spatial light modulator (SLM) based on H-PDLC technique. The output image from the SLM is recorded in the device based on the alignment of liquid crystal molecules with internal grating structures. The device can offer the rigorous treatment of image information in security applications.

**LCTp5 - 4L Optical Switch Based on Nematic Liquid Crystals**

*A. Muravsky, V. Chigrinov*

*Hong Kong Univ. of Sci. & Tech., Hong Kong*

The switching possibilities of nematic liquid crystal mixtures were investigated. The bypass optical switcher based on two nematic liquid crystal cells with a switching time less than 0.2ms was demonstrated.

**Supporting Organizations:**

LC Physics and Condensed Matter Forum, JLCS  
Chemistry and LC Material Forum, JLCS  
Liquid Crystal Display Forum, JLCS  
LC Photonics and Optical Device Forum, JLCS  
Soft Matter Forum, JLCS  
Molecular-Alignment Electronics Forum, JLCS  
Technical Group on Information Display, ITE  
Technical Committee on Electronic Information Displays, Electronics Society, IEICE  
Technical Committee on Electron Devices, Electronics Society, IEICE

**IDRC**

Sept. 18 – 21, 2006  
Kent State University  
OH, U.S.A.

**Outstanding  
Poster Paper Awards**

Friday, December 9  
12:20 – 13:30  
(after Takamatsu Festival)  
Tamamo (3F),  
ANA Hotel Clement Takamatsu

See page 8 for details

# Workshop on Active Matrix Displays

Tuesday, December 6

13:30 - 14:45

Sunport Hall Takamatsu Main Hall

## AMD1: LC-TV

Chair : J. Jang, Kyung Hee Univ., Korea  
Co-Chair : M. Tsumura, Future Vision, Japan

### AMD1 - 1: *Invited* Technology Trend for High Quality Display 13:30 Image of LC-TV

*Y. Yamada, N. Kimura, Y. Ishii  
Sharp, Japan*

Recently, replacement from CRTs to FPDs has occurred rapidly, because of permeation of the digital broadcasting. Among FPDs, LCDs are most promising display device to satisfy the image quality for television. In this paper technologies for improving image quality such as response time, viewing angle and contrast ratio are presented.

### AMD1 - 2: *Invited* Nano Science of AFFS Technology for 13:55 Ubiquitous Personal Devices and LCD-TVs

*K. H. Lee, I. C. Park, K. H. Park, S. J. Jang, S. K. Lee,  
Y. J. Lim  
BOE HYDIS Tech., Korea*

Since the fringe field switching (FFS) technology was proposed in 1996, in recent, the AFFS have become the best leading technology over 70% shares in tablet PC region. AFFS have shown the competitive features such as a high transmittance ratio over 95%~130% to TN, a power saving of 30% to TN mode, a high contrast ratio over 700 ~ 1000:1, an ultra low reflectance under 0.5% in outdoor, a free of color shift under 0.02 ( $\Delta$ RGBWxy) in the single domain and an unlimited viewing angle over 180°/180°, respectively.

### AMD1 - 3: *Invited* Spectrum Sequential LC-TV 14:20

*M. J. J. Jak, J. J. L. Hoppenbrouwers, F. J. Vossen,  
O. Belik, G. J. Hekstra  
Philips Res. Labs., The Netherlands*

We have built a "Spectrum Sequential" LCD. It is equipped with a backlight with two types of fluorescent lamps with different phosphor coatings that alternately illuminate a regular LCD panel with RGB colour filters. In this way a display with 6 primary colours is obtained, having a wider colour gamut than the conventional panel. Since high brightness desaturated colours, such as white, can be made in both frames, colour break-up can be avoided.

----- Break -----

15:00 - 16:10

Sunport Hall Takamatsu Main Hall

**AMD2: Large Area Display Applications**

Chair : M. J. J. Jak, Philips Res. Labs., The Netherlands  
 Co-Chair : T. Sunata, Philips Mobile Display Syss., Japan

**AMD2 - 1: *Invited* Widegamut LCD Monitor Using LED  
 15:00 Backlight**

*H. Kaneko, S. Kagawa, J. Someya, H. Tanizoe, H. Sugiura  
 Mitsubishi Elec., Japan*

Authors have successfully developed wide color gamut liquid crystal display using LED backlight. We have tried some approaches for backlight system, in each case, we achieved a high performance.

**AMD2 - 2: *Invited* Medical Display Outlook**

**15:25** *F. Hayashiguchi  
 Int. Display Tech., Japan*

The TFT-LCD becomes more Medical Doctor's choice for Medical Imaging Applications compare to the legacy imaging devices. International Display Technology Co., Ltd. made a long-term progress in the past several years by providing multiple display products. The special requirements for the medical imaging displays and its solutions or remained problems based on current technology state will be covered.

**AMD2 - 3 A-Si TFT Off-Current Analysis for Flat-Panel X-Ray  
 15:50 Detector**

*A. Kinno, M. Ikeda, M. Atsuta, S. Uchikoga  
 Toshiba, Japan*

The characteristics of the TFT array for the flat-panel x-ray image detector have been improved by studying the uniformity and the temporal variation of the TFT off-current. The top gate structure was examined and found to be more effective than the bottom gate structure for evaluating the  $V_{th}$  shift due to charged impurities in the array from electrostatic analysis and the top gate TFT evaluation. By using the top gate structure evaluation we have improved the uniformity and the temporal variation of the TFT characteristics and realized excellent quality x-ray detector image.

----- Break -----

16:40 - 18:10

Sunport Hall Takamatsu Main Hall

**AMD3: Emerging TFT Technologies**

Chair : Y. Yamada, Sharp, Japan  
 Co-Chair : H. Hamada, Sanyo Elec., Japan

**AMD3 - 1: Invited High Performance FET Using Transparent  
16:40 Amorphous Oxide Semiconductor as Channel Layer  
on Plastic Substrate**

*H. Hosono\*\*\*, K. Nomura\*\*, T. Kamiya\*,\*\*  
\*Tokyo Inst. of Tech., Japan  
\*\*ERATO-SORST, JST, Japan*

We report the room temperature fabrication of transparent and flexible thin film transistors (TFTs) using an amorphous oxide semiconductor (AOS) in an  $\text{In}_2\text{O}_3\text{-ZnO-Ga}_2\text{O}_3$  system on a polyethylene terephthalate thin film substrate. These transistors exhibit a field effect mobility of  $\sim 10 \text{ cm}^2(\text{Vs})^{-1}$ , which is higher by an order of magnitude than that of amorphous Si:H and pentacene, and a high chemical stability in an ambient atmosphere.

**AMD3 - 2: Invited TFT Arrays for Biosensing Applications  
17:05**

*P. Estrela, A. G. Stewart, S. D. Keighley, F. Yan,  
P. Migliorato  
Univ. of Cambridge, UK*

Biotechnology is in great need of low-cost intelligent biochips for massive parallel detection of biomolecular interactions, using portable instrumentation. One way this may be achieved is to exploit mature semiconductor technologies for the development of biosensor arrays. New detection mechanisms have been developed using field effect devices such as MOS capacitors and TFTs. Examples will be given on the application of such devices for the detection of pH, enzymatic reactions, DNA hybridization and protein interactions.

**AMD3 - 3 Flexible Carbon Nanotube Thin-Film Transistors  
17:30**

*J. P. Novak, R. L. Fink, Z. Yaniv  
Appl. Nanotech, USA*

We describe the use of a carbon nanotube thin-film transistor (CNT-TFT) on flexible substrates to operate an LCD pixel. CNT-TFTs were constructed on polyimide as a random network conductive film. This film electronically behaves as a p-type semiconducting film with superior performance when compared to other low-temperature semiconducting materials used on plastic substrates. The CNT-TFTs are used to switch on and off a LCD pixel and modulate an LED.

**AMD3 - 4 Artificial Retina Using Thin-Film Photodiodes and  
17:50 Thin-Film Transistors**

*M. Kimura, T. Shima, T. Okuyama\*, S. Utsunomiya\*,  
W. Miyazawa\*, S. Inoue\*, T. Shimoda\*  
Ryukoku Univ., Japan  
\*Seiko Epson, Japan*

An artificial retina using thin-film photodiodes and thin-film transistors (TFTs) is proposed, which is expected to be suitable for living bodies and to be low emission and low cost. The characteristics of a thin-film photodiode and TFTs are evaluated. A retina circuit is shown and simulated with a photodiode and TFT model to verify that it can work. The edge enhancement is also confirmed.

**Author Interviews**

18:20 - 19:20

**Wednesday, December 7****9:00 - 10:25****Sunport Hall Takamatsu Main Hall****EP4/AMD4: Active Matrix Electronic Paper**

Chair : T. Asano, Kyushu Inst. of Tech., Japan

Co-Chair : H. Kawai, Seiko Epson, Japan

**EP4/AMD4 - 1: *Invited* Rollable Active-Matrix Electronic-Paper  
9:00 Displays***H. E. A. Huitema, G. H. Gelinck, E. van Veenendaal,  
P. J. G. van Lieshout, F. J. Touwslager  
Philips Tech. Incubator, The Netherlands*

A 100 $\mu$ m thick QVGA active-matrix display integrated into a functional device prototype is presented. The active-matrix is composed of alternating layers of organic materials and gold. A 6-mask photolithographic process is used. An electrophoretic electronic imaging film is laminated on top of the active matrix. The display is bendable to a radius of 7.5mm for more than 30.000 times.

**EP4/AMD4 - 2: *Invited* Rapid Switching in Multiple Color Active  
9:25 Matrix Driven Electrowetting Displays***B. J. Feenstra, R. A. Hayes, R. van Dijk, R. G. Boom,  
M. M. H. Wagemans, I. G. J. Camps, A. Giraldo,  
B. van der Heijden  
Philips Res. Labs., The Netherlands*

We present the attractive properties of our active matrix driven electrowetting displays. For the first time, we show all ingredients required for realizing video-speed, full-color displays. Two color architectures are presented: a single-layer display that has an improved optical and power performance at a lower projected cost compared to LCDs and a triple-layer display that has a revolutionary optical performance. We demonstrate the fast switching of the electrowetting technology by showing video content on a 170 ppi resolution display.

**EP4/AMD4 - 3 Manufacturing Flexible High Information Content  
Active Matrix Displays**

9:50

*S. E. Burns, K. Reynolds, W. Reeves, I. P. Johnson,  
B. H. Pui, M. Banach, T. Brown, K. Chalmers, N. Cousins,  
P. Cain, M. Etchells, C. Hayton, K. Jacobs, S. Markham,  
S. Orchard, A. Menon, P. Too, S. Siddique, C. Ramsdale,  
J. Herod, K. Saynor, J. Watts, T. von Werne, J. Mills,  
C. J. Curling, H. Siringhaus, K. Amundson\*,  
M. D. McCreary\*  
Plastic Logic, UK  
\*E Ink, USA*

We present a manufacturing process for flexible high information content active matrix backplanes compatible with low cost plastic substrates. Transistor performance, feature sizes and electrode conductivities of this process have been specified to enable 800x600 pixel displays at 100 pixels per inch (PPI), driving grey scale electrophoretic media. Here we report on early results showing this displays operation. This process has been developed on a 350mmx350mm Prototype Line. It is scalable to larger display sizes and higher PPI, and will enable a wide range of flexible display products.

**EP4/AMD4 - 4L 100- $\mu$ m-Thick, High-Resolution Rollable AM-EPD**

10:10

*T. Kodaira, S. Hirabayashi, Y. Komatsu, S. Utsunomiya,  
M. Miyasaka, H. Kawai, S. Nebashi, S. Inoue, T. Shimoda,  
T. Whitesides\*, S. Patry\*, M. McCreary\*  
Seiko Epson, Japan  
\*E Ink, USA*

We have developed a paper-thin 100- $\mu$ m-thick, high-resolution (192 ppi,) 2.1-inch QVGA flexible active-matrix electrophoretic display (AM-EPD). The TFT backplane with integrated peripheral driver circuits was first fabricated on a glass substrate and then transferred to a very thin (30- $\mu$ m) plastic film by employing Surface Free Technology by Laser Ablation / Annealing (SUFTLA<sup>®</sup>). An imaging sheet provided by E Ink Corporation was laminated on the backplane. Fine images were successfully displayed on the rollable AM-EPD.

----- Break -----

10:40 - 12:05

Sunport Hall Takamatsu Main Hall

**OLED4/AMD5: Active Matrix OLED**

Chair : B. J. Feenstra, Philips Res. Labs., The Netherlands  
Co-Chair : R. Hattori, Kyushu Univ., Japan

**OLED4/AMD5 - 1: *Invited* Development of Full Color Double Sided  
10:40 Active Matrix OLED**

*C.-W. Ko, S.-H. Hu, S.-H. Li, T.-H. Hsiao, K.-S. Lee,  
C.-J. Chen, J.-H. Chen, J.-J. Lih  
AU Optronics, Taiwan*

A 1.5-inch full color double sided AMOLED has been developed. The typical sub-pixel area is divided into two regions, which are designed for top-emission and bottom-emission structures. With the novel array design, independent images on both sides of the panel can be controlled by only one IC driver. Superior performance of the double sided AMOLED such as high color saturation and good power efficiency were achieved. Very thin form factor and light weight with capability of showing two independent images on both sides make the double sided AMOLED an excellent candidate for cell phone application.

**OLED4/AMD5 - 2 7-in. WVGA AM-OLED Display with Color Filter on  
11:05 Array (COA) and Pixel Compensation Technology**

*D.-Z. Peng, C.-H. Tseng, S.-C. Chang, P.-H. Yeh,  
H.-L. Hsu, Y.-M. Tsai  
Toppoly OptoElect. Taiwan, Taiwan*

We have developed a 7-inch WVGA full-color AM-OLED display with technology of color filter on array (COA) and pixel compensation circuit. To prevent precision mask misalignment issues, high efficiency white OLED with COA was applied for higher resolution. In addition, a pixel circuit which compensates both the TFT variations as well as EL power voltage drop was proposed to improve the uniformity on the panel. With these technologies, a large-size and high-resolution OLED display could be achieved.

**OLED4/AMD5 - 3 Novel Voltage-Sensing and Voltage-Programming  
11:25 Method for Large-Size and High-Resolution AM-  
OLED Panels**

*H.-J. In, P.-S. Kwag, J.-S. Kang, O.-K. Kwon, H.-K. Chung\*  
Hanyang Univ, Korea  
\*Samsung SDI, Korea*

A novel voltage-sensing and voltage-programming method is proposed for large-size and high-resolution AMOLED panels. The proposed method successfully compensates the threshold voltage and mobility variations of poly-Si TFTs throughout a large-size panel and overcomes the problem of charging a data line. The HSPICE simulation results show that the maximum emission current error for 30-inch full HDTV applications is less than 1.86%, when the mobility variation and the threshold voltage variation are +12.5% and +0.3V, respectively.

**OLED4/AMD5 - 4    New Current Compensation Theory in AM-OLED  
11:45                Pixel Circuit by Employing Voltage-Scaled  
                         Programming Method**

*W.-J. Nam, J.-H. Lee, S.-M. Han, H.-J. Lee, M.-K. Han  
Seoul Nat. Univ., Korea*

For the first time, we propose a new voltage-scaled programming pixel circuit of AMOLED displays. Data voltages are scaled-down by the capacitive-coupling of off-transition of the scan signal. The proposed scheme of data voltage modulation contributes to scale down the  $V_{TH}$  variation of the poly-Si TFT. The input range of data voltages is scaled up and the data addressing errors due to the clock feed-through of the scan signal are also reduced. Finally,  $I_{OLED}$  is compensated and the uniform current is successfully controlled.

----- Lunch -----

**13:40 - 15:00**

**Sunport Hall Takamatsu Main Hall**

**AMD6: Mobile Displays**

Chair :                H. E. A. Huitema, Philips Res. Labs., The Netherlands  
Co-Chair :            Y. Yamamoto, Sharp, Japan

**AMD6 - 1:    *Invited* Challenges to AM-OLED Technology for  
13:40            Mobile Display**

*H. D. Kim, K. J. Yoo, M.H. Kim, S. T. Lee, H. K. Chung  
Samsung SDI, Korea*

To meet the future trend of mobile display, we have developed successfully the world's highest resolution 302ppi 2.65inch full color VGA AMOLED and a system on panel 2inch QVGA AMOLED using several new technologies such as, short channel TFT, laser induced thermal imaging (LITI) color patterning and blue common layer technique which can reduce a patterning step. We have also developed a new micro cavity effect control technique by modulating the thickness of the hole-injection layer.

**AMD6 - 2            Circuit Techniques for Reduction of Number of  
14:05                Connections to a-Si AM-LCD**

*S. C. Deane, M. Cassidy, P. Collins, K. Yamashita\*,  
T. Inada\*, S. Kawata\*, M. Yoshiga\*, Y. Onda\*, J. R. Hector,  
M. Inoue\**  
*Philips Res. Labs., UK*  
*\*Philips Mobile Display Sys., Japan*

We have made 1.8" QVGA (222dpi) transfective a-Si AMLCDs with an integrated gate driver and column multiplexers. First, we discuss a gate driver design which minimizes the connection count to the external electronics to the minimum level. To further reduce the interconnect count, we have also integrated column multiplexers. This not only reduces the interconnection count radically, and driver IC cost, but it also can enable smaller pitch displays in a-Si technology due to reduced interconnection pitch.

**AMD6 - 3      A-Si Gate Driver Designs for Low Power AM-LCD  
14:25            Operation**

*K. Yamashita, T. Inada, M. Cassidy\*, S. C. Deane\*,  
P. Collins\*, S. Kawata, Y. Onda, M. Yoshiga, J. R. Hector\*,  
M. Inoue  
Philips Mobile Display Syss., Japan  
\*Philips Res. Labs., UK*

We have made 1.8" QVGA (222dpi) transfective a-Si AMLCDs with integrated gate drivers. One is optimized for a very low power normal operating mode. The other can switch to an arbitrary partial scan mode. Gate driver integration results in narrow, symmetric margins, reduced cost and interconnections. In another paper we explore minimizing the number of connections to the display, while here we allow a small increase in the number of connection lines to allow very significant power reduction.

**AMD6 - 4L      Development of a Novel Double-Sided LCD with a  
14:45            Single Panel and One Lighting System for Mobile  
Applications**

*S. Kang, Y. K. Cho, H. Y. Hong, H. H. Hwang, H. H. Choi\*,  
B. C. Hwang\*, J. S. Park\*, T. Maekawa\*\*  
Image Lab, Korea  
\*LG Innotek, Korea  
\*\*Fujitsu Kasei, Japan*

Using only a pair of LC panel and lighting system, we have developed a novel LCD system called "Double-Sided LCD". In spite of this simple composition it can work not only as a reflective-type display from the front side but also as a transmissive-type display from the rear side. Compared to the conventional dual-sided LCDs with two different LC panels and one or two lighting systems, its thickness and cost can be reduced drastically up to 1/2.

**Author Interviews**

17:30 - 18:30

**IDW '06**

International Display Workshops

Dec. 6 – 8, 2006

Convention Hall Ohmi, Otsu Prince Hotel  
Otsu, Japan<http://idw.ee.uec.ac.jp>

15:00 - 17:00

Exhibition Hall

**Poster OLEDp/AMDp: Active Matrix OLED****OLEDp/AMDp - 1 Novel Sub-Intra Gate Poly-Si TFT Structure for AM-OLED Pixel Drivers***C. J. Shih, C. H. Fang, D. H. Deng, P. C. Liu, C. P. Kuan, C. C. Lu**Chunghwa Picture Tubes, Taiwan*

The novel poly-Si thin film transistors based on sub-gate, intra-gate, and asymmetric dual-gate structures are developed to satisfy the strict requirements of AMOLED pixel drivers. Our experimental results show that the proposed design can optimize the performance of dual gate structures by suppressing kink current and light-induced leakage current, while the aperture ratio and field effect mobility are also improved remarkably.

**OLEDp/AMDp - 2 7-in. WQVGA p-Si LTPS AM-OLED with Novel Driving Architecture***I.-C. Shih, M.-T. Hsu**Chunghwa Picture Tubes, Taiwan*

This paper presents a novel driving architecture for AMOLED that adopts the commercialized TFT-LCD driver IC. By utilizing fully p-Si LTPS process, this architecture has been successfully implementation on the 7-inch AMOLED display.

**OLEDp/AMDp - 3 New Pixel Circuits for Driving Organic Light Emitting Diodes with Low Temperature Polycrystalline Si Thin Film Transistors***Y. H. Tai, B. T. Chen, Y. J. Kuo, Y. J. Wei, C. C. Tsai,**K. Y. Chiang, H. C. Cheng**Nat. Chiao Tung Univ., Taiwan*

Two new pixel circuits for active matrix organic light emitting diode (AM-OLED), based on the low-temperature polycrystalline Si thin-film transistors (LTPS-TFTs) are proposed and the  $V_{th}$  compensation ability is verified by SPICE simulation and measured results. The voltage-programming pixel circuits are formed by five TFTs, one additional control signal, and one storage capacitor. The simulation and measured results show that the pixel circuit has high immunity to the variation of poly-Si TFT characteristics.

**OLEDp/AMDp - 4 Non-Contact Method for Analysis of Pixel Circuits in Active Matrix OLED Using External Probes with Electrical Pulses and Photo-Multiplier Tube Detector**

*P. L. Huang, S. J. Tang  
Chunghwa Picture Tubes, Taiwan*

We presented an effective non contact way to probe TFTs and capacitor on pixels, which was used to control on/off of switches and data storage to light on AMOLED devices. The detecting system was a combination of external electrical pulses on panel leads and a photomultiplier tube (PMT) detector. The OLED emitting signal had been the clue to understand of the behaviors of pixel circuits by modifying the electrical signal, and performance of OLED had been successfully improved.

**OLEDp/AMDp - 5 New Pixel Driving Scheme Based a-Si:H TFTs by Eliminating Switching TFTs in OLED Current Path for Low Power Consumption**

*H.-S. Shin, J.-H. Lee, K.-S. Shin, M.-K. Han  
Seoul Nat. Univ., Korea*

We propose a new pixel design for active matrix organic light emitting diode (AM-OLED) displays using hydrogenated amorphous silicon thin-film transistors (a-Si:H TFTs). The proposed circuit is employed by a new scheme of threshold voltage compensation. As  $V_{DD}$  supply lines are utilized clock signal, the threshold voltage of the driving TFTs is memorized during the  $V_{DD}$  clock signal off. The proposed circuit needs only one driving TFT located in the OLED current path without any additional switching TFT for  $V_{TH}$  compensation, resulting in lower power consumption than the conventional pixel circuits.

**OLEDp/AMDp - 6 Adaptive Current Scaling Pixel Circuit for a-Si:H AM-OLED Displays**

*J. Z. Huang, J. A. Cheng, Y. C. Lin, W. Cheng,  
H.-P. D. Shieh  
Nat. Chiao Tung Univ., Taiwan*

An adaptive current scaling pixel circuit for a-Si: H TFT process has been demonstrated. The adaptive current scaling is achieved by inserting a small cascaded storage capacitor to the traditional pixel circuit without affecting the aperture ratio. The proposed pixel circuit is capable of shorting the programming time without sacrificing the power consumption. Hence, the proposed pixel circuit is suitable for the large size and high resolution AMOLED application.

**OLEDp/AMDp - 7L High Contrast Top Emission Active Matrix RGB OLED**

*R. Wood, R. Cheuk, WY. Kim  
Luxell Technologies, Canada*

This work centers on the design of a high contrast AM top emission OLED. The device is built on an AM backplane, with discreet RGB color pixels, and a semi-transparent cathode. The structure utilizes the cavity effects for enhanced emission while simultaneously incorporating a tuned cathode for destructive optical interference.

**OLEDp/AMDp - 8L 3-TFT Pixel Circuit Employing a Fraction Time Annealing to Improve a Current Stability of a-Si:H TFT AMOLED**

*J. H. Lee, W. J. Nam, H. S. Shin, M. K. Han  
Seoul Nat. Univ., Korea*

We have proposed and fabricated 3-TFT pixel circuit employing a fraction time annealing to improve a current stability for a-Si:H TFT based AMOLED backplane. The measurement results, after an electrical bias and temperature (60°C) stress of 12 hours, show that OLED current is decreased by 23% in conventional 2-TFT pixel, while decreased by 6% in the proposed 3-TFT pixel because a negative bias can reduce  $V_{TH}$  degradation of a-Si:H TFT itself.

**OLEDp/AMDp - 9L New Voltage Programmed AMOLED Pixel Circuit Using Reference Current**

*M. H. Jung, I. H. Choi, O. H. Kim, T. Y. Kim\*, Y. W. Shin\*,  
H. J. Chung\*  
POSTECH, Korea  
\*Kumoh Nat. Institute of Tech., Korea*

A new pixel structure composed of six TFTs and one capacitor adopting low temperature polysilicon (LTPS) is proposed. It can compensate both the TFT threshold voltage variation and the supply voltage drop on operation. Simulation of the proposed circuit is carried out with SMART SPICE of RPI poly-Si TFT model.

## Thursday, December 8

9:00 - 10:30

Sunport Hall Takamatsu Main Hall

### AMD7: TFT Technologies - Crystallization

Chair : H. Hosono, Tokyo Inst. of Tech., Japan  
Co-Chair : M. Kimura, Ryukoku Univ., Japan

**AMD7 - 1: 9:00 *Invited* System on Glass Display Fabrication Using LTPS-TFT Formed by SELAX (Selectively Enlarging Laser X'tallization) Technology**

*M. Hatano, T. Sato, M. Matsumura, Y. Toyoda, M. Tai,  
M. Ohkura\*, T. Miyazawa\*  
Hitachi, Japan  
\*Hitachi Displays, Japan*

SELAX technology can form TFTs with high mobility, low sub-threshold swing and small threshold voltage deviation that they can be used to integrate high performance circuits and valuable functions on glass substrates. By using hybrid laser crystallization technology:SELAX are applied to low-power, high-speed circuits, and conventional ELC are used for the high-voltage circuits, the process tact time can be reduced. Narrow frame size IPS-mode LCD panels with resolution of over 300 ppi have been developed utilizing SELAX based technologies.

**AMD7 - 2: Invited Single-Crystalline Silicon TFTs Fabricated with Comb-Shaped Beam in ZMR-ELA**

9:25

*M. Nakata<sup>\*,\*\*</sup>, H. Okumura<sup>\*,\*\*</sup>, H. Kanoh<sup>\*,\*\*</sup>, H. Hayama<sup>\*</sup>, S. Kaneko<sup>\*,\*\*</sup>*

*\*NEC, Japan*

*\*\*NEC LCD Tech., Japan*

We have developed nucleation control methods applicable to a zone-melting recrystallization excimer laser annealing process for poly-Si films. Ribbon-shaped Si grains of 2  $\mu\text{m}$ -width were successfully aligned side by side by means of a comb-shaped beam, and we have successfully fabricated single-crystalline silicon TFTs with channels formed in those grains. Electron mobility in the TFTs is as high as 677- $\text{cm}^2/\text{Vs}$ .

**AMD7 - 3 Novel Selected Area Laser Assisted (SALA) System for Crystallization and Doping Processes in Low-Temperature Poly-Si Thin-Film Transistors**

9:50

*R. Ishihara, A. Glazer<sup>\*</sup>, Y. Raab<sup>\*</sup>, P. Russian<sup>\*</sup>, M. Dorfan<sup>\*</sup>, B. Lavi<sup>\*</sup>, I. Leizeron<sup>\*</sup>, A. Kishnevsky<sup>\*</sup>, Y. van Aandel,*

*X. Cao, J. W. Metselaar, C. I. M. Beenakker,*

*S. Stolyarova<sup>\*\*</sup>, Y. Nemirovsky<sup>\*\*</sup>*

*Delft Univ. of Tech., The Netherlands*

*\*Orbotech, Israel*

*\*\*Technion-Israel Inst. of Tech., Israel*

CMOS poly-Si TFTs were fabricated through crystallization and GILD processes by a novel selected area laser assisted (SALA) system. The system enables a local area irradiation of small beams of a pulsed solid-state laser of frequency tripled Nd:YAG. The novel TFT process eliminated 3 doping mask steps of the conventional process. On-off current ratios for both types of poly-Si TFTs were improved by SALA. The field effect mobility of n- and p-channel TFTs is 84  $\text{cm}^2/\text{Vs}$  and 75  $\text{cm}^2/\text{Vs}$ , respectively.

**AMD7 - 4 High Field Effect Mobility Poly-Si TFTs Fabricated by Advanced Lateral Crystal Growth Process Using Double-Pulsed Laser Annealing System**

10:10

*S. Sakuragi, T. Kudo, K. Yamazaki, T. Asano<sup>\*</sup>*

*Sumitomo Heavy Ind., Japan*

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

The advanced lateral crystal growth (ALCG) process with the double-pulsed green laser annealing system enabled us to produce the high-quality Si thin-films for the high-performance n-channel poly-Si TFTs (L/W: 5 $\mu\text{m}$ /5 $\mu\text{m}$ ), characterized by the high field effect mobility of 650 $\text{cm}^2/\text{Vs}$  and the strong temperature dependence of the field effect mobility close to single crystal TFTs.

----- Break -----

10:50 - 12:10

Sunport Hall Takamatsu Main Hall

**AMD8: TFT Technologies - Modeling & Analysis**

Chair : M. Hatano, Hitachi, Japan

Co-Chair : S. Horita, JAIST, Japan

**AMD8 - 1: Invited Molecular-Dynamics Simulation of Nucleation and Growth of Crystalline Si Films During ELA Process**

10:50

*T. Endo, T. Warabisako, S. Munetoh\*, T. Motooka\***ALTEDEC, Japan**\*Kyushu Univ., Japan*

Initial stage of the nucleation and growth of crystallizing Si in a rapid cooling process like ELA is discussed by using molecular-dynamics simulations. A new simulation technique is introduced to exclude artificial temperature control and to realize pseudo-natural cooling conditions. Based on a statistical analysis of the atomic movements, it is suggested that Si nucleation and growth occur in an amorphous-like or a low-density liquid phase rather than the supercooled liquid as has been generally accepted so far.

**AMD8 - 2 Localized Resistance Across Grain Boundaries in Poly-Si Layer of TFT Measured by Scanning Spreading Resistance Microscopy**

11:15

*H. Yamagiwa, S. Abo, F. Wakaya, T. Sakamoto\***H. Tokioka\*, N. Nakagawa\*, M. Takai**Osaka Univ., Japan**\*Mitsubishi Elec., Japan*

Resistance distribution across grain boundaries in a low-temperature poly-Si layer of a thin film transistor with a lightly doped drain structure was investigated using scanning spreading resistance microscopy. The resistance around the grain boundaries was lower than that inside the grains. Slightly higher resistance areas surrounded by low resistance areas were observed at the center of the grain boundaries. The drastic resistance change at the LDD region was measured.

**AMD8 - 3 Process Simulation of Laser Crystallization and Analysis of Crystallization Process of Si Films**

11:35

*M. Kimura, R. Saito, S. Tsukamoto, Y. Hiroshima\***S. Inoue\*, T. Shimoda\*, R. Ishihara\*\***Ryukoku Univ., Japan**\*Seiko Epson, Japan**\*\*Delft Univ. of Tech., Japan*

Process simulation of laser crystallization has been executed to analyze crystallization process of Si films. It considers nucleation rate, crystal growth velocity and partial crystallization model. It is found that the nucleation occurs in the supercooling, the emission of latent heat prevents from other nucleation, and the whole Si film is at the same temperature due to the high thermal conductance of Si. It is applied to evaluate  $\mu$ -CZ, and its grain size is estimated to be 2.8  $\mu\text{m}$ .

**AMD8 - 4L      Advanced Phase-Modulators for Next-Generation  
11:55            Low-Temperature Si Film Crystallization Method**

*Y. Taniguchi, T. Katou, M. Matsumura  
Advanced LCD Tech. Dev. Ctr., Japan*

A phase-modulator having only 'holes' (or 'bumps') on a quartz plate has been found to have insufficient depth-of-focus characteristics. This poor depth-of-focus can be attributed to phase retardation effect. Based on this, two bipolar phase-modulators were developed. The first has a deep depth-of-focus and the second is a single-plate modulator that can generate a two-dimensional light intensity profile. It was confirmed experimentally that the second modulator could grow arrays of large grains with 5- $\mu\text{m}$  pitch.

----- Lunch -----

**13:40 - 15:00**

**Sunport Hall Takamatsu Main Hall**

**AMD9: TFT Technologies - Process Technologies**

Chair :            N. Matsuo, Univ. of Hyogo, Japan  
Co-Chair :        S. Utsunomiya, Seiko Epson, Japan

**AMD9 - 1            Process Evolution by Photolithographic Process  
13:40                Techniques and Improvement of Conventional 4-  
Mask Process Technologies**

*S. Kido\*, M. Yamashita\*, Y. Umihira\*, K. Akagami\*,  
Y. Murayama  
NEC LCD Tech., Japan  
\*NEC Kagoshima, Japan*

In TFT-LCD panel industry, the cost cut which is one of the subjects is considered from various viewpoints. Then, two new photoresist mask re-processing technology (redevelopment processing technology and chemical re-flow processing technology) was developed and put in practical use as photolithography process reduction technology in TFT board manufacture. So, in this report, these technology is introduced and improvement of the conventional 4-mask technology and new 4-mask technology are explained as the example of application.

**AMD9 - 2            Effect of High-Quality CVD-SiO<sub>2</sub> Interfacial Layer on  
14:00                Reliability of Poly-Si TFT**

*H. Hamamura, M. Matsumura, T. Mine, K. Torii  
Hitachi, Japan*

A new process named C-DOP (cyclic deposition with O<sub>2</sub> plasma treatment) was developed to obtain a high quality IL which can apply to low temperature process of poly-Si TFT. This process is effective to remove the residual impurities and making Si-O-Si network dense. By using the C-DOP formed IL, the flat band voltage shift ( $\Delta V_{fb}$ ) due to FN stress and drain current degradation due to DAHC stress were successfully suppressed.

**AMD9 - 3**      **High Performance/High Reliability Polycrystalline Silicon Thin Film Transistors with Sputtered Si and SiO<sub>2</sub> Films**  
**14:20**

*T. Serikawa, M. Miyashita\*, Y. Uraoka\*, T. Fuyuki\**  
*Univ. of Tokyo, Japan*  
*\*Nara Inst. of Sci. & Tech., Japan*

Low-temperature poly-Si TFTs with channel length down to 1 $\mu$ m were fabricated by using sputter-deposited Si and gate SiO<sub>2</sub> films. Resulted n- and p-channel poly-Si TFTs showed mobilities of 120 and 70 cm<sup>2</sup>/V·s. "Punch-through" effects in short-channel TFTs were effectively suppressed by thinning gate SiO<sub>2</sub> films down to 9.5 nm. C-MOS TFT circuits were also fabricated and high speed operations were confirmed. Moreover, sputter-poly-Si TFTs showed reliability much higher than CVD-poly-Si TFTs for DC and dynamic stresses.

**AMD9 - 4**      **Formation Process and Properties of a-Si TFT Using Selective and Dispersive Transfer Technique**  
**14:40**

*Y. Onozuka, Y. Hara, T. Hioki, M. Tanaka, K. Miura, K. Sugi, M. Akiyama, S. Uchikoga*  
*Toshiba, Japan*

The authors proposed a novel selective and dispersive transfer technique for low-cost, large-area TFT array fabrication. An individual TFT device having small size of several tens of microns and small thickness of about a micron has been transferred to an adhesion layer at high transfer yield of more than 99%. The reliability of the transferred TFT on the adhesive island with respect to bias-temperature stress has been confirmed to be almost the same as that of the reference TFT on the glass substrate.

**Author Interviews**

17:30 - 18:30

15:00 - 17:00

Exhibition Hall

**Poster AMDp: Active Matrix Displays**

**AMDp - 1**      **High-Speed Sequential Logic Circuitry Using Low-Temperature Poly Silicon Technology for TFT-LCD Panel**

*K. Ishikawa, Y. Suzuki, N. Nakanishi, K. Matsunaga*  
*Tokai Univ., Japan*

In this paper, a high-speed sequential logic circuitry used LTPS technology for TFT-LCD panel is proposed. The proposed new circuit is dynamic/static shift register, counter and so on. The high-speed sequential logic circuitry can operate at the high-operational frequency by about 2~4 times than the conventional circuit due to applying the wider swing-voltage than the power-supply voltage by using the Bootstrap Technology (BST). The new circuit is named the "BST-TFT Logic Circuitry".

**AMDp - 2      Effects of Peripheral Region on C-V Characteristics of Organic MIS Capacitors**

*K. D. Jung, S. H. Jin, C. A. Lee, C. B. Park, B. G. Park,  
H. C. Shin, J. D. Lee  
Seoul Nat. Univ., Korea*

MIS capacitors were fabricated and analyzed using pentacene as organic semiconductor. Special attention was given to the peripheral pentacene region which might change C-V characteristics when the substrate is used as a gate electrode. It was found that peripheral pentacene region of several tens of micrometers can make considerable differences on measured C-V characteristics. Therefore, when evaluating the characteristics of organic MIS capacitors, the effects of peripheral pentacene region should be considered to obtain the accurate C-V curve.

**AMDp - 3      Effect of Short-Term Plasma Treatments on LTPS TFT Characteristics and Reliability**

*Y. P. Yang, D. H. Deng, M. C. Ho, F. Y. Lu, C. H. Fang,  
C. C. Lu  
Chunghwa Picture Tubes, Taiwan*

In this study, we proposed a method to improve the electrical properties and uniformity of LTPS TFTs. Before deposition of gate oxides, the poly-Si films were treated with various kinds of plasma. Device performance and reliability of the LTPS TFTs have been investigated. Comparing with the conventional device, components with N<sub>2</sub>O, H<sub>2</sub> and NH<sub>3</sub> plasma treatment possessed better electrical characteristics and uniformity. And the N<sub>2</sub>O plasma treatment revealed higher reliability than H<sub>2</sub> and NH<sub>3</sub> plasma treatment.

**AMDp - 4      New High-Voltage Generator Using Low Temperature Poly Silicon Technology for TFT-LCD Panel**

*N. Ishii, Y. Suzuki, N. Nakanishi, N. Sasaki  
Tokai Univ., Japan*

In this paper, a new high-voltage generator using the LTPS technology for TFT-LCD panel is proposed. The power efficiency is about 86% when the new generator obtains the +16V output voltage with +1mA output current from the +2.5V single power supply voltage. The power efficiency of the new generator is improved around 30% value than that of the conventional generator.

**AMDp - 5      Crystal Structural Study of Pentacene Film in OTFT**

*T. C. Tien, J. F. Wein, T. S. Hu, J. C. Ho, L. J. Lin, S. C. Lo,  
H. C. Huang, S. M. Jeng  
Industrial Tech. Res. Inst., Taiwan*

The studies on crystal structure of pentacene film on electrode (ITO) and insulator (SiO<sub>2</sub>) in TFT shown the pentacene film on ITO would contain more amorphous phase than SiO<sub>2</sub>, and both of them composed of crystalline phase on surface. Where pentacene is getting closer to the surface, the pentacene/SiO<sub>2</sub> have more thin film phase than the pentacene/ITO. Gap and pore between pentacene/ITO interface were found on the incline of electrode might be induced from poor adhesion and thermo stress.

**AMDp - 6      Formation and Planarization of Si Ridges in Low-Temperature Si Process**

*J. Moon, C.-Y. Sohn, C.-H. Chung, Y.-H. Kim, J. H. Lee  
ETRI, Korea*

In this study, the characteristics of Si ridges formed after laser crystallization of a-Si films have been studied means of atomic force and secondary electron microcopies. We report on the ridge height dependency on parameters such as laser energy density and initial a-Si film thickness. To lessen ridge height, we have exercised single shot post-laser treatments at various laser energy densities. Post laser treatments on ridges have an effect of leveling the heights of ridges and lead to improved TFT characteristics.

**AMDp - 7      A-Si Gate Driver Integration with Time Shared Data Driving**

*B. Kim, Y. H. Jang, S. Y. Yoon, M. D. Chun, H. N. Cho,  
N. W. Cho, C. Y. Sohn, S. H. Jo, S. C. Choi, C.-D. Kim,  
I.-J. Chung  
LG.Philips LCD, Korea*

Integrated a-Si gate driver for time-shared data driving has been developed. We characterized large-sized a-Si TFTs made with a normal process and found that the conductance of TFTs could be scaled with nearly same mobility and threshold voltage. The circuit has been successfully integrated in 4" QVGA (320\*240) TFT-LCD panel, in which only one 480-channel driver IC is needed.

**AMDp - 8      Integrated Gate Driver Using Highly Stable a-Si TFTs**

*M. Chun, Y. H. Jang, S. Y. Yoon, B. Kim, H. N. Cho,  
S. C. Choi, N. W. Cho, H. Y. Kim, S. K. Kim, C.-D. Kim,  
I.-J. Chung  
LG.Philips LCD, Korea*

The degradation of integrated gate driver circuits for active matrix display has been analyzed. Integrated gate driver circuit using highly stable a-Si TFT's is more stable than that consisting of conventional ones and there is a strong correlation between clamping voltage of a circuit and threshold voltage of its pull-down transistors. The circuit has been integrated in 14.1 inch XGA (1024\*768) TFT-LCD panel.

**AMDp - 9      Effect of Pentacene Thickness on Bottom and Top Contact Organic Thin Film Transistors**

*D. Gupta, M. Katiyar, D. Gupta  
Indian Inst. of Tech. Kanpur, India*

In this paper we present the effect of pentacene thickness on the output and transfer characteristics of the bottom and top contact organic field effect transistor. The device parameters like threshold voltage, mobility, on/off ratio and subthreshold swing are calculated using ideal MOSFET equations for inorganic semiconductors. The thickness effect is discussed in terms of the thickness dependent changes in film morphology and device physics.

**AMDp - 10      Effect of Interface Plasma Treatments on Electrical Properties of a-Si:H TFTs**

*C. Y. Wu, C. H. Ma  
Chunghwa Picture Tubes, Taiwan*

The high stability of a-Si:H TFTs device is made of silicon nitride as dielectric are submitted to the different plasma treatments of the semiconductor/insulator interface by PECVD. The process parameters of plasma gas type, gas flow rate, RF power, and treatment time of interface treatment are taken into account and analyzed by Taguchi experimental design method. Results show the gas type is the major factor that affect the threshold voltage and mobility of a-Si:H TFTs device. In the future, the stressing experiments by using different stressing time with various stressing temperature are used to evaluate the performance of devices.

**AMDp - 11      Novel Pixel Structure of IPS Panel for High Aperture Ratio Using Inorganic Layer**

*H. S. Chang, D. H. Lee, W. S. Kang, H. S. Jin, Y. S. Jeong,  
D. S. Lee, I. J. Chung  
LG.Philips LCD, Korea*

A pixel design and a manufacturing process for in-plane switching (IPS) mode were optimized to increase aperture ratio of IPS panel using inorganic passivation layer with low dielectric constants. With this new design and process, we could realize 28% improvement in transmittance compared with conventional IPS panel, suppressing vertical crosstalk which is the trade-off with a pixel structure of higher aperture ratio.

**AMDp - 12      Pentacene OTFT Array for AM-OLED on Plastic with Self-Organized Process**

*J. H. Kim<sup>\*,\*\*</sup>, S. H. Han<sup>\*,\*\*</sup>, S. M. Cho<sup>\*,\*\*\*</sup>, S. H. Lee<sup>\*,\*\*</sup>,  
E. Y. Lee<sup>\*,\*\*</sup>, J. H. An<sup>\*,\*\*</sup>, M. H. Oh<sup>\*\*\*</sup>, D. J. Choo<sup>\*,\*\*</sup>,  
J. Jang<sup>\*,\*\*</sup>*

*\*Advanced Display Res. Ctr., Korea*

*\*\*Kyung Hee Univ., Korea*

*\*\*\*Dankook Univ., Korea*

We fabricated a 2 inch, 80 ppi AMOLED backplane with pentacene OTFT array using self-organized process. The organic bank formation is an important issue because the organic active layer can be damaged during the bank formation. The double layers of polyvinylalcohol and acryl were selected as a bank material. There were some degradation of mobility and subthreshold currents during the processes of passivation and bank formation by chemical solvent. Even though, the performance after whole process showed that the  $\mu_{SAT}$  of  $\sim 0.8 \text{ cm}^2/\text{Vs}$  and on-off current ratio of  $>10^7$  for the OTFTs, which are enough to drive AMOLED.

**AMDp - 13    11-Stage OTFT Ring Oscillator on Plastic**

S. M. Cho<sup>\*,\*\*</sup>, S. H. Han<sup>\*,\*\*\*</sup>, J. H. Kim<sup>\*,\*\*\*</sup>, S. H. Lee<sup>\*,\*\*\*</sup>,  
J. W. Choi<sup>\*,\*\*\*</sup>, E. Y. Lee<sup>\*,\*\*\*</sup>, J. H. An<sup>\*,\*\*\*</sup>, B. S. Bae<sup>\*,\*\*\*</sup>,  
D. J. Choo<sup>\*,\*\*\*</sup>, M. H. Oh<sup>\*\*</sup>, J. Jang<sup>\*,\*\*</sup>  
*\*Advanced Display Res. Ctr., Korea*  
*\*\*Dankook Univ., Korea*  
*\*\*\*Kyung Hee Univ., Korea*

We studied the inverter and ring oscillator made of pentacene TFTs on plastic substrate. A ring oscillator consists of inverters with bootstrapping transistor. The TFT has a field effect mobility of 0.5~0.6cm<sup>2</sup>/Vs, an on/off current ratio of 10<sup>7</sup>. It has a signal propagation delay as low as 4.4μsec per stage and its frequency is as high as 10 kHz at the bias voltage of 40V. These results indicate that the OTFT circuit can be widely used for electronic applications.

**AMDp - 14    LTPS TFT-Based Current Mode Digital Logic Circuit Design Method for System-on-Panel**

J. C. Lee, M. P. Hong, J. Y. Jeong  
*Univ. of Suwon, Korea*

We present two operation modes of the current mode logic inverter/buffer. For optimum delay and power consumption, we develop a systematic design procedure and verify that 78% and 28% improvement in power and chip area can be obtained compared to static CMOS counterpart.

**AMDp - 15    Temperature Dependence of Amorphous Silicon Oscillator**

J. W. Choi, Y. S. Kim, S. H. Kim, J. H. Oh, J. H. Hur,  
J. H. Cheon, B. S. Bae, J. Jang  
*Kyung Hee Univ., Korea*

A RC oscillator using amorphous silicon thin-film transistors was developed [1]. The frequency of oscillator was controlled by adjusting the feedback resistance of the oscillator. When V<sub>DD</sub> is 35 V, measured frequency of the oscillator was 143 kHz at 26°C, which is useful for low-end RFID (radio frequency identification). For the application to the RFID circuit, we studied the temperature dependence of oscillation frequency, output voltage and power consumption.

**AMDp - 16    Ion Doping Effect on Laser Crystallized Poly-Si Films**

E. H. Kim, K. H. Kim<sup>\*</sup>, S. J. Park, Y. M. Ku, C. O. Kim<sup>\*</sup>,  
J. Jang  
*Kyung Hee Univ., Korea*  
*\*Han Yang Univ., Korea*

Ion doping effect on laser crystallized poly-Si has been observed. The sheet resistance of ion doped poly-Si decreases with increasing B<sub>2</sub>H<sub>6</sub>/H<sub>2</sub> plasma ion dose. The sheet resistance of the ion doped CLC poly-Si was lower than that of ELA poly-Si under the same doping conditions. Comparing Raman spectra of ion doped poly-Si films measured before and after thermal annealing, it is observed that the surface damage due to ion doping on the poly-Si films can be recovered

**AMDp - 17      Adhesion Evaluation of Sputtered Copper Films on Glass Substrates by Microindentation Measurement for TFT-LCDs.**

*C. C. Lai, M. K. Tseng, H. K. Chiu, Y. P. Lin, Y. C. Kuan,  
K. S. Sun  
Chunghwa Picture Tubes, Taiwan*

Quantitative adhesion testing of copper films on glass substrate is investigated by microindentation measurement. The object of adhesion testing is to evaluate the adhesion of soft films on hard substrates by Vicker hardness testing. Experimental result shows interposing a transparent dielectric layer (SiNx) between copper films and glass substrates promotes adhesion abruptly. Furthermore, the effect of sputtering parameters and precleaning plasma treatment on adhesion is discussed by Taguchi method analysis.

**AMDp - 18      Direct-Deposition of Microcrystalline-Si:H at Low Temperature by ICP-CVD**

*C. J. Huang, I. H. Peng, L. T. Wang, T. C. Wong, J. F. Chang  
ERSO/ITRI, Taiwan*

High quality films of microcrystalline-Si:H ( $\mu\text{-Si:H}$ ) were directly deposited on glass substrates at 150°C by ICP-CVD. The crystallinity of  $\mu\text{-Si:H}$  is over 91% and the grain size is about 40 nm. The incubation layer observed is only about 2-3 nm thick, indicating good crystallinity and few amorphous phase remaining between the oxide and  $\mu\text{-Si:H}$ . The  $n^+$   $\mu\text{-Si:H}$  layer is also under development, sheet resistance value was lower than  $10^4 \Omega/\text{sq}$  and the resistivity was about 2.7  $\Omega\text{cm}$ .

**AMDp - 19      Manufacturing Process of 4 Mask a-Si TFT Panel by One Step Dry Etching on Mo/Al/Mo Data Line**

*S. Y. Yoo, H. S. Choi, J. I. Ryu, W. B. Lee, J. Y. Lee  
BOE HYDIS TFT LCD SBU, Korea*

Improved 4-Mask process applied with Al based multi-layer data line was developed in order to reduce manufacturing process. This process have several issues on  $n^+$  a-Si:H remain and Al corrosion because of applying to 1-step dry etch with Mo/Al/Mo data line. However, it brings a matter to a successfully settlement and meets with good results about an array process and display performance as new Al dry etch. Moreover, plasma treatment process are applied to the dry etch process.

**AMDp - 20 Short Channel Effects in Excimer Laser Crystallized Low Temperature Poly Silicon ( $\leq 500^{\circ}\text{C}$ ) Thin Film Transistors on Glass Substrates for Active Matrix Organic Light Emitting Diode Technology**

*B. Choi, D. Choi, H. Park, J. Jung, T. Yang, H. Kim, H. Chung*  
*Samsung SDI, Korea*

As LTPS poly silicon TFT technology evolves into near the sub-micrometer regime, as for single crystallinity, polysilicon devices also suffer from short channel effects. Their short channel effects thus have a direct impact on the LTPS poly silicon devices. The threshold voltage and DIBL coefficient versus the channel length of poly silicon devices has been reported as gate lengths scale down to  $1\mu\text{m}$ . The inverse subthreshold slope versus the channel length is also analyzed to  $1\mu\text{m}$  gate length for both n and p TFTs. Work on TFTs fabricated on glass substrates ( $370\times 400\text{ mm}$ ) is summarized.

**AMDp - 21 Low Cost and Uniform Solid Phase Crystallization without Metal Catalyst Employing Alternating Magnetic Field for AM-OLED**

*H.-S. Seo, D. H. Nam, N. B. Choi, S. H. Paek, T. J. Ahn, J. S. Yoo, J.-M. Yoon, S.-W. Lee, C.-D. Kim, I.-J. Chung*  
*LG.Philips LCD R&D Ctr., Korea*

P-channel polycrystalline silicon thin-film transistors (TFTs) have been fabricated employing alternating magnetic field crystallization (AMFC) method for AM-OLED panel, which exhibits no line mura due to uniform device characteristics. Pre-treatment using boron dopant before crystallization, and  $\text{H}_2$  plasma hydrogenation before deposition of  $\text{SiO}_2$  gate insulating layer remarkably improve the characteristics of TFTs, such as threshold voltage, mobility, and sub-threshold slope. AMFC is suitable for large size AM-OLED panel due to uniform TFT characteristics, no crystallization mura, no substrate bending, and lower cost than laser crystallized p-Si.

**AMDp - 22 Characterization of Poly-Si TFT Array on Plastic Substrate for AM-OLED**

*J. Y. Kwon\*, D. Y. Kim\*, J. S. Jung\*, J. M. Kim\*, H. Lim\*, K. B. Park\*, H. S. Cho\*, X. Zhang\*, H. Yin\*, W. Xianyu\*, T. Noguchi\*\**

*\*Samsung Advanced Inst. of Tech., Korea*

*\*\*Sungkyunkwan Univ., Korea*

We present the characterization of poly-Si TFT fabricated below  $170^{\circ}\text{C}$  on plastic substrate using excimer laser crystallization of Xe sputtered Si films and gate insulator by using inductively coupled plasma CVD. In addition, stability and uniformity of TFT array between before and after sintering will be compared.

**AMDp - 23      Fabrication of High Performance Low Temperature Poly-Si on Flexible Metal Foil**

*D. J. Park, Y. H. Kim, J. H. Chung, J. H. Mun, J. W. Lim,  
S. J. Yun, D. W. Kim, J. H. Lee  
ETRI, Korea*

We fabricated low temperature polycrystalline silicon TFT on metal foil substrate below 200°C. For preventing gate dielectric leakage current and enhancing electric field between gate and source, crystallizing and activation were processed before deposit gate dielectric. The n-channel TFTs with W/L=7/20 on metal foil exhibited the field-effect mobility of 176cm<sup>2</sup>/Vs, the on/off current ratio of 10<sup>6</sup>, the threshold voltage of 7V, and the subthreshold slope of 0.8V/dec.

**AMDp - 24      Ink-Jet Printed Organic Transistors Using Dihexylquaterthiophene (DH4T)**

*J. Y. Kim\*, D. H. Song\*, Y. K. Lee\*, T. J. Park\*, S. K. Kwon\*,  
M. H. Kang\*, S. H. Han\*, S. M. Cho\*\*, J. H. Kim\*,  
S. H. Lee\*, J. Jang\*, A. Sautter\*\*\*, D. Albertalli\*\*\*\*  
\*Kyung Hee Univ., Korea  
\*\*Dankook Univ., Korea  
\*\*\*H. C. Starck, Germany  
\*\*\*\*Litrex, U. S. A.*

We studied the fabrication of organic thin-film transistor (OTFT) using a DH4T (dihexylquaterthiophene) by inkjet printing. The OTFT has bottom gate, bottom contact structure on plastic. Au/Cr and Al were used as source/drain and gate, respectively. The gate insulator was a cross-linked PVP. The active layer was printed by jetting a DH4T solution. The OTFT exhibited an on/off current ratio of ~10<sup>5</sup> and a field-effect mobility of 1.5 x 10<sup>-2</sup> cm<sup>2</sup>/Vs.

**AMDp - 25      Effect of Buffer SiO<sub>2</sub> on Plastic Substrate for Laser Crystallization of Si Films**

*J. S. Jung, D. Y. Kim, J. M. Kim, J. Y. Kwon, K. B. Park,  
H. Lim, T. Noguchi\*  
Samsung Advanced Inst. of Tech., Korea  
\*Sungkyunkwan Univ., Korea*

We have investigated the factors that the effect of the buffer SiO<sub>2</sub> layer strongly related to crystallization of Si film during laser annealing. Crystallization of Si films on plastic substrate is strongly affected by thickness, roughness of buffer SiO<sub>2</sub> and substrate bending. The increasing buffer layer thickness prevents the agglomeration of Si film during laser irradiation. The stress in Si film by substrate bending also induces agglomeration of Si films. Finally higher RMS roughness of bottom layer under Si induced larger nucleation site during crystallization and hence smaller grains.

**AMDp - 26 ZnO TFT Fabricated at Low Temperature for Application of Active-Matrix Display**

*C.-S. Hwang, S.-H. K. Park, H. Y. Chu  
ETRI, Korea*

ZnO TFT was studied for the application of flexible display. We use ALD method for the active layer at low temperature (under 150°C). Adoption of ZnO:Al as source/drain layer, which is also grown using ALD method, gave low contact resistance and good device behavior as well as transparency. The manufactured TFT gave field effect mobility 0.95 cm<sup>2</sup>/Vs, and flat band voltage 1.7V.

**AMDp - 27 Oxygen Effect on Laser Crystallization of Sputtered a-Si Film on Plastic Substrate**

*J. M. Kim\*, D. Y. Kim\*, J. S. Jung\*, J. Y. Kwon\*, K. B. Park\*,  
H. Lim\*, T. Noguchi\*\*,\*\*  
\*Samsung Advanced Inst. of Tech., Korea  
\*\*Sungkyunkwan Univ., Korea*

We studied a-Si film deposited on plastic substrate by rf sputtering. a-Si films were deposited at room temperature and crystallized using excimer laser. It was found that the a-Si film was delaminated at low laser energy densities below the energy condition for distinct lateral grain growth. Oxygen contents were optimized for a-Si films deposited by Xe sputtering. The oxygen gas incorporation is speculated to increase the surface roughness and to induce the Si film agglomeration during laser crystallization.

**AMDp - 28 TRMVA, TRRVA and URTMVA LCDs for Mobile Applications**

*S. C. F. Jiang, C. H. Lin, Y. R. Chen, C. M. Chang,  
P. L. Chen, K. Y. Lin  
AU Optronics, Taiwan*

We developed the new technologies that are the transfective multi-domain vertical alignment (TRMVA), the transfective rubbed vertical alignment (TRRVA), and the ultra reflectivity transmissive multi-domain vertical alignment (URTMVA). These are used on the transfective liquid crystal displays (TRLCDs) for mobile application. TRMVA and TRRVA utilized the standard process steps and URTMVA utilized less process steps. These optical properties can be achieved the high contrast ratio and widely viewing angle in various environments.

**AMDp - 29      Fabrication of P-Type Ultra Low Temperature TFT under 200°C**

*H. Lim\*, K. B. Park\*, H. Yin\*, J. Y. Kwon\*, X. Zhang\*,  
H. S. Cho\*, J. M. Kim\*, D. Y. Kim\*, J. S. Jung\*, W. Xianyu\*,  
T. Noguchi\*\**

*\*Samsung Advanced Inst. of Tech., Korea*

*\*\*Sungkyunkwan Univ., Korea*

We studied the p-channel (p-ch.) poly silicon (Si) thin film transistor (TFT) using ultra low temperature processes below 200°C. By performing the low temperature thermal annealing after obtaining TFT, the device performances, such as the mobility of 64 cm<sup>2</sup>/Vs, and the sub-threshold slope (S.S) of 0.74 V/dec., improved drastically. The p-ch. circuits or complementary MOS (CMOS) design on plastic is expected for future advanced flexible flat panel display (FPD).

**AMDp - 30      New Low-Power Shift Register Driving Scheme for Active Matrix Displays**

*C.-W. Chang, C.-C. Chen  
InnoLux Display, Taiwan*

We have proposed a novel shift register driving scheme to implement on the glass which displacing the IC. The proposed driving scheme uses only two clock signals and lesser devices which can reduce bothersome clock pervert. By employing bootstrapped voltage and switching phase clocks, we achieve shift register driving successfully. The proposed scheme has lower power consumption and lower number mask in manufacture.

**AMDp - 31      New 3-Level Driving Scheme and Image Quality Improvement for Active Matrix Displays**

*C.-W. Chang, C.-C. Chen, Y.-C. Cheng, H.-M. Chen  
InnoLux Display, Taiwan*

We propose a novel 3-level register driving scheme for scan line to compensate the coupled voltage on the pixel. The proposed method of driving is good at reducing the effect of feedthrough voltage. In this paper, we compared 3-level driving with 2-level driving scheme. Through combine the electric and liquid crystal simulation, the simulation result also shows the comparison of image quality.

**AMDp - 32      Frequency Response Analysis of Low Capacitive Coupling Design for IPS and FFS Mode LCDs Applications**

*H. Y. Chen, T. H. Hsieh, Y. C. Kang, Y. C. Lin, S. T. Yan,  
C. L. Yang, J. P. Pang  
Innolux Display, Taiwan*

A novel method to suppress capacitive coupling between data line and pixel electrode for IPS and FFS pixels has been proposed in this work. By making a slit structure on ITO electrode close to data line at a well-calculated and designed location, the coupling noise can be drastically reduced to 4% compared with conventional structure. A frequency response analysis for this circuit has also been performed to ensure all operation frequency for panels is feasible.

**AMDp - 33 Moving Picture Quality Amelioration Using Adaptive Image Contrast Promotion Technique (ACPT) at TFT LC-TV Module**

*K.-H. Liu, C.-L. Wu, M.-W. Huang, J.-Y. Huang,  
W.-T. Tseng, H.-T. Yu  
Chunghwa Picture Tubes, Taiwan*

Apply the adaptive image contrast promotion technique (ACPT) in the TV module, users could arbitrarily adjust the enhancement degrees for they prefer, then the moving picture contrast ratio and brightness are enhanced automatically and adaptively based on the image data distribution of pervious n-k frames ( $k \geq 1$ ). Furthermore, this technique could overcome the drawbacks of contrast enhancement method such as histogram equalization using scaled histogram equalization with several restricting conditions and analog gamma voltages correction schema.

**AMDp - 34 New Charge Pump with Less Pumping Capacitors for LTPS Integrated Circuits**

*W.-C. Chen, H.-Y. Lin, C.-M. Chiu  
Toppoly OptoElect., Taiwan*

A novel X2 (X2) charge pump with less numbers of pumping capacitors was developed. The circuit shows not only output voltage equivalent to the conventional X4 charge pump but also higher power efficiency than conventional one due to the less pumping stages. Furthermore, less pumping capacitors also helps to reduce the external pin counts for less connection pins and cost saving especially for COG (chip on glass) type panel design.

**AMDp - 35 Overlap Scanning of CW Laser for Crystallization of a-Si**

*K. H. Kim<sup>\*\*</sup>, E. H. Kim<sup>\*</sup>, S. J. Park<sup>\*</sup>, Y. M. Ku<sup>\*</sup>, C. O. Kim<sup>\*\*</sup>,  
J. Jang<sup>\*</sup>  
<sup>\*</sup>Kyung Hee Univ., Korea  
<sup>\*\*</sup>Han Yang Univ., Korea*

Crystallization of a-Si by overlap scan using CW Nd:YVO<sub>4</sub> laser has been investigated with SEM, AFM, and Raman spectroscopy. The results show that the grains existing near each laser scan boundary meet together forming single grains. That means the width of grains formed by prior-scanning affects the width of the grains formed by the following scan. Thus, the overlap scanning method can be applied to large grained poly-Si fabrication for LTPS processing.

**AMDp - 36      Solid Phase Crystallization of Amorphous Silicon at Temperatures Higher than 600°C**

*W.-E. Hong, S.-J. Oh, J.-S. Ro  
Hongik Univ., Korea*

A metal foil would have a great potential as a substrate for the next generation flexible display. The annealing temperature of solid phase crystallization (SPC) is not restricted to 600°C when using a metal foil. Crystallization rate becomes dramatically rapid at higher temperatures since SPC kinetics is controlled by nucleation with high value of activation energy. We report SPC behaviors of high temperature, including kinetics, defect-recovery and texture-evolution, compared to those of low temperature.

**AMDp - 37      Effect of Multiple Reflection on Periodic Structure of Si Film Crystallized by Linearly Polarized Nd:YAG Laser**

*S. Horita, K. Nishioka, H. Kaki  
Japan Advanced Inst. of Sci. & Tech., Japan*

In the Si film crystallized by a linearly polarized Nd:YAG laser beam, the grain boundaries are aligned periodically. This periodic structure is produced by the periodic beam energy density profile generated by interference between the coherent incident and high order diffracted beams. The effect of multiple reflection in the Si film was investigated theoretically on the surface structure of the crystallized film. The suitable thickness for this method was estimated by this theoretical analysis and verified experimentally.

**AMDp - 38      Comparisons of a-Si:H TFTs on Glass and Plastic Substrate at 160°C**

*C.-C. Cheng, L.-T. Wang, J.-Y. He, Y.-F. Wu, Y.-H. Yeh  
ERSO/ITRI, Taiwan*

Low temperature process is an important factor for active matrix plastic display. Low temperature reduced the thermal stress and substrate deformation. In this study, a-Si:H TFTs were successfully fabricated at 160°C on glass and PES substrate. The maximum mobility is 0.2 cm<sup>2</sup>/V-s, the subthreshold swing is 0.8 V/decade, and the threshold voltage is 2.8 V. The off currents are below 10<sup>-12</sup> A and the I<sub>ON</sub>/I<sub>OFF</sub> ratio is 10<sup>7</sup> at V<sub>ds</sub>=10 V. Characteristics and reliability of a-Si:H TFTs were compared.

**AMDp - 39 Novel Compact SPICE Model for Pixel Signal Analysis of LCD Panel**

*S.-I. Yoon, C.-Y. Jung\*, S.-H. Yoon, T. Won\**  
*Sanayi Sys., Korea*  
*\*Inha Univ., Korea*

In this paper, we report a novel compact SPICE model for pixel signal analysis of AMLCDs. In this work, we generated a SPICE model for a unit cell of TFT-LCD by taking all of parasitic capacitances into account and we investigated the influence of the parasitic capacitance on a pixel voltage drop. In order to calculate the capacitance, we employed a finite element method. We calculated 21 capacitances including LC capacitance as a function of the applied voltage and used a piecewise linear voltage-controlled capacitor model with calculated values.

**AMDp - 40 Analysis of Degradation of LTPS-TFT under Inverter Operation and Improvement of Reliability by CLDD Structure TFT**

*N. Nakagawa, Y. Toyoda, K. Sugahara, T. Nakahata*  
*Mitsubishi Elec., Japan*

The hot carrier instability is the most important issue for LTPS-TFT technology. In this study, we analyzed that the degradation of N-ch TFT under inverter operation is caused by AC stress and DC stress during switching operation and our newly developed CLDD structure which has both GOLD and LDD regions shows extremely improved reliability compared to conventional LDD structure under high voltage and high frequency operation.

**AMDp - 41L Double Pulse Scan Method for Field Sequential Color Driving of an Optically Compensated Bend Cell**

*S. R. Lee, C. G. Jhun, T.-H. Yoon, J. C. Kim, J. D. Noh\*,*  
*D. H. Suh\*, J. Y. Lee\**  
*Pusan Nat. Univ., Korea*  
*\*BOE HYDIS Tech., Korea*

We propose an overdriving method that uses double pulse scan (DPS) within each sub-frame time. We applied it to a field-sequential color (FSC) driving of a thin-film-transistor liquid crystal display (TFT-LCD) in the optically compensated bend (OCB) mode. We have shown by experiment that the DPS method shorten the gray-to-gray response time remarkably so that FSC driving can be applied to a-Si TFT-LCDs with XGA resolution.

**AMDp - 42L Offset Cancelling Scheme of P-type Poly-Si Analog Buffer Employing Voltage Level-Shifter**

*W.-J. Nam, H.-S. Shin, W.-K. Lee, S.-G. Park, M.-K. Han  
Seoul Nat. Univ., Korea*

New analog buffer circuit using p-type poly-Si TFT for digital interface is proposed. The proposed source-follower type buffer memorizes and cancels the offset voltage between the input and the output. In order to reduce the output deviation, a voltage level shifter which preserves the node biasing condition of buffer TFT during the offset cancellation is employed. In our simulation results, it exhibits a small offset deviation regardless of  $V_{TH}$  variation of buffer TFT.

**AMDp - 43L Advanced Transmissive LCD with High Reflectance**

*M. C. Lee, C. Y. Tsai, W. C. Chang, D. L. Ting  
Toppoly OptoElect., Taiwan*

To realize a transmissive LCD with high reflectance for mobile phone, we propose the new ATR technology with high aperture ratio, new extra reflective film and novel backlight architecture. In this paper, we show the new ATR technology to improve a transmissive LCD image quality under sunlight. Reflectance could be achieved 2.5% and CR is about 6.5.

**AMDp - 44L Effects of Crystallographic Orientation of Single-Crystalline Seed on m-Czochralski Process in Excimer-Laser Crystallization**

*M. He, R. Ishihara, Y. Hiroshima\*\*, S. Inoue\*\*, T. Shimoda\*,  
J. W. Metselaar, C. I. M. Beenakker  
Delft Univ. of Tech., The Netherlands  
\*Seiko Epson, Japan*

Single-crystalline Si wafers are used as seeds for the location-controlled grain growth with  $\mu$ -Czochralski process during excimer laser crystallization (ELC). With an enough energy density, Si wafers seeds liquid epitaxial growth and grains with respective orientation were obtained at the predetermined positions. The islands grown from (100) seeds have the fewest twin boundaries, comparing to those from (110) and (111). By using (100) -orientated SOI wafer as the seeds, the fewer twin boundaries can be reduced further by the slow heat conduction to the substrate.

**AMDp - 45L High Sensitivity Test Circuit Constructed with Sense Amplifier on the p-Si TFT-LCD**

*I. Ishii, J. Masui, M. Murade, H. Iizuka, K. Sakata  
Seiko Epson, Japan*

We produced the high sensitivity test circuit which consisted of Sense Amplifier (SA) on the p-Si TFT glass panel. The development and mass production of a low cost panel become possible by means of short Turn-Around-Time feed back for the sudden problem in the array and array process development.

**AMDp - 46L Investigation on Double Layer Gate Electrode Etching Process for Flexible Display Application**

*C.-H. Wei, Y.-H. Chen\**

*Tatung Univ., Taiwan*

*\*AU Optronics, Taiwan*

A new process was developed in which plastic sheets are laminated on glass carrier wafers and run through standard TFT process. Due to the temperature limits, a tapered double layer gate electrode Al-Cr was proposed to increase the conductivity and prevent hillock. This structure was fabricated by a multi-step ICP etching and the contact resistance compared with MoW was good.

**AMDp - 47L Fabrication of Si Thin-Films with Arrays of Long and Narrow Grains for Next Generation TFTs**

*T. Katou, Y. Taniguchi, M. Hiramatsu, K. Azuma,*

*M. Matsumura*

*Advanced LCD Tech. Dev. Ctr., Japan*

Arrays of long and narrow grains were successfully grown by phase-modulated excimer-laser-annealing (PMELA) method of Si films. The width of grains reduced steadily by thinning the Si layer. Furthermore, the crystal orientation can be controlled at {110} along the growth direction and within {001}~{112} along the normal direction for a 30 nm-thick Si layer.

**AMDp - 48L Image Simulation for Full Analysis of TFT-LCD Panel**

*C. Jung, S. Yoon\*, T. Won*

*Inha Univ., Korea*

*\*Sanayi Sys., Korea*

In this paper we propose a novel simulation scheme for full analysis of large-area thin film transistor liquid crystal display (TFT-LCD) panel. The method provides viewable image as well as electrical characteristics of TFT-LCD panel including all pixels. We especially took into account the parasitic capacitors induced by the neighboring gate and data lines, and the voltage-dependent LC (liquid crystal) pixel capacitor. For an exemplary 10.4" SVGA (800×600) LCD panel, the simulation confirmed crosstalk, flickers, shading and grayscale error.

**AMDp - 49L Flexible Active-Matrix Cholesteric Display Driven by OTFT**

*T.-S. Hu, Y.-K. Wang, J.-Y. Yan, C.-C. Hsieh, T.-H. Lin,*

*T.-W. Lee, L.-Y. Huang, W.-L. Lin, H.-Y. Cheng, Y.-Y. Shen,*

*J.-C. Ho, C.-C. Lee, S.-H. Liu, Y.-C. Lin, K.-L. Cheng*

*EROS/ITRI, Taiwan*

Organic thin-film transistor arrays with 64×128 pixels are fabricated. Pentacene as organic semiconductor was deposited on bottom gate device. The OTFT show a mobility of 0.01 cm<sup>2</sup>/V-s and on/off current ratio of about 10<sup>5</sup>. Moreover, the active matrix OTFT-ChLCD was fabricated by integrating organic thin film transistor arrays and cholesteric liquid crystal display on plastic substrate.

**AMDp - 50L Ultra-Low Temperature (below 100°C) Si TFT Process for Fflexible Display**

*K. Park, H. Lim, J. Kwon, J. Jung, D. Kim, J. Kim, T. Noguchi\**

*Samsung Advanced Inst. of Tech., Korea*

*\*Sungkyunkwan Univ., Korea*

High quality silicon oxide films were deposited at 100°C by Inductively coupled plasma-chemical vapor deposition (ICP-CVD) system using dilute silane (in argon) and oxygen as reactant gases. The *I-V* curve showed a breakdown field with variation process parameter, resulting in the measured dielectric breakdown field strength of 7.8MV/cm. According to the various metal deposition methods, The C-V curves of SiO<sub>2</sub> showed the flat band voltage ( $V_{fb}$ ) shift from -29V to -5V. Also we fabricated SOI TFT, resulting in 487cm<sup>2</sup>/Vs, 0.19V/dec and 2.4V<sub>th</sub>. This method is compatible with flexible display device process using plastic substrates.

**AMDp - 51L Reliable Integrated a-Si Select Line Driver Driving Schemes**

*L. Lin\*\*, B. J. Liang\*, C. M. Huang\*\*, C.-C. Lai\*\*, S.-P. Chiang\*\**

*\*Univ. of Feng Chia, Taiwan*

*\*\*WINTEK, Taiwan*

A reliable integrated a-Si select line driver (RASD) has been developed and demonstrated in SID '05. Some advanced driving methods are continuing to build including the progressive scan driving schemes and the pre-charge scan schemes. All of them are simulated by utilizing the SPICE simulation first, and then implemented into our timing controlling circuits. These schemes are expected to richen the control signals of present a-Si gateless drivers.

**AMDp - 52L Low Power Consumption for Circuit Integration of Low Temperature Poly-Si TFT-LCDs**

*M. Karube, T. Tsunashima, H. Nishimura, H. Kimura,*

*A. Ishida, T. Motai, T. Nishibe*

*Toshiba Matsushita Display Tech., Japan*

Today's mobile devices strongly require lower power consumption of their displays. To meet this demand, we have studied Multi Driving method for six signal lines, Power Supply Control for buffer amplifiers, and CC Driving method though further circuits integration on the glass substrate. These circuit ideas are implemented in a 5.6-cm QVGA panel.

**AMDp - 53L Highly Efficient DC-DC Converter Employing P-Type Poly-Si TFTs for Active Matrix Displays**

*H.-J. Lee, W.-J. Nam, J.-H. Lee, S.-M. Han, M.-K. Han  
Seoul Nat. Univ., Korea*

P-type low temperature poly-Si (LTPS) TFTs DC-DC converter is proposed and verified. We have designed the negative output DC-DC converter employing 2 clock signals of 5V swing which are overlapped at high voltage. The output voltage and power efficiency depending on various output load current are investigated by SPICE simulation. The simulation results show that the proposed DC-DC converter may supply stable output voltage and have higher power efficiency than that of the widely used Dickson's charge pump considerably.

**AMDp - 54L Effect of Lightly Doped Drain in Short Channel Low Temperature Poly-Si Thin Film Transistor for Active Matrix Display**

*J. H. Park, W. J. Nam, J. H. Lee, K. Y. Lee\*, K. J. Yoo\*,  
H. H. Park\*, M. K. Han  
Seoul Nat. Univ., Korea  
\*Samsung SDI, Korea*

Decrease of threshold voltage in low temperature poly-Si thin film transistor with decreasing channel length is observed. The source barrier reduction in short channel makes threshold voltage decrease and on and off current increase in p-type poly-Si TFT without a lightly doped drain (LDD). The threshold voltage variation of poly-Si TFT with a LDD is very little due to relief overlapping of electrical field between source and drain.

**AMDp - 55L Bottom Contact Pentacene Thin Film Transistors with ITO Source and Drain Electrodes for Display Applications**

*C.-W. Han\*\*\*, H.-S. Shin\*, J.-H. Park\*, M.-K. Han\*,  
H.-S. Pang\*\*, K.-Y. Kim\*\*, I.-J. Chung\*\*  
\*Seoul Nat. Univ., Korea  
\*\*LG.Philips LCD, Korea*

Bottom contact organic thin film transistors (OTFTs) which employ indium tin oxide (ITO) as the source/drain electrodes instead of gold are fabricated. The pentacene TFT with ITO source/drain electrodes exhibits a saturation mobility of  $0.09\text{cm}^2/\text{Vs}$  and on-off current ratio of the order  $10^5$ . ITO electrode was modified to more hydrophobic surface with lower surface energy by itself after TFT fabrication. The fairly grain size of pentacene film up to  $0.3\ \mu\text{m}$  was observed on ITO electrode in OTFT.

**AMDp - 56L SLS-based CMOS LTPS Process and its Application to 2.2-inch QVGA Panel**

*M. K. Ryu, E. S. Kim, K. S. Son, J. H. Lee, J. S. Im,  
Y. B. Kook, H. S. Kwon, J. H. Park, G. Son, C. H. Kim,  
S. J. Yoo, S. S. Kim, J. W. Choi, J. M. Jun, J. Y. Lee  
BOE HYDIS Tech., Korea*

We report n-shot SLS (Sequential Lateral Solidification) process and its application to 2.2-inch QVGA (320x240) TFT-LCD with integrated gate driver and 3:1 demultiplexing RGB data-switch. Integrated CMOS circuits composed of 2 shot SLS poly-Si TFTs, were successfully operated. Pixel TFTs showed uniform and stable characteristics.

**Friday, December 9****9:00 - 10:30****Sunport Hall Takamatsu Main Hall****AMD10: System on Panel (1)**

Chair : C.-W. Ko, AU Optronics, Taiwan

Co-Chair : H. Haga, NEC, Japan

**AMD10 - 1: Invited Asynchronous Design: An Enabler for Flexible Microelectronics**

*N. Karaki, S. Inoue, T. Shimoda  
Seiko Epson, Japan*

Flexible microelectronics featuring LTPS TFT technology, surface-free technology by laser annealing/ablation (SUFTLA<sup>®</sup>) and asynchronous design language Verilog+ is an emerging technology expected to become a platform for developing thin flexible lightweight less-electromagnetic emissive low-power robust devices. Verilog+ comprises a subset of Verilog HDL<sup>®</sup> and minimal primitives for describing the communications between asynchronous processes. The design instance, a flexible 8-bit asynchronous microprocessor, ACT11 consumes 180uA running at 5V, 500KHz. The power level is 30% of the synchronous counterpart.

**AMD10 - 2: Invited Touch Panel Function Integrated LCD Using LTPS Technology**

*H. Nakamura, T. Nakamura, H. Hayashi, N. Tada,  
M. Yoshida, M. Ishikawa, T. Motai, T. Nishibe  
Toshiba Matsushita Display Tech., Japan*

We propose a new configuration of display having an image capture function suitable for low-temperature polycrystalline silicon (LTPS) TFT fabrication process. High density sensor and 1-bit A/D converter are monolithically integrated into the glass substrate. With this configuration, a touched location can be determined by generating a grayscale bitmap in the image processing LSI, for which smaller number of data pins are required, compared with those required for a conventional configuration having an external A/D converter LSI.

**AMD10 - 3      7-in. WVGA System on Panel LCD with Integrated Gate Driver Including Dual Logic Shift-Register**  
**9:50**

*K. E. Lee, K. M. Lim, M. K. Baek, J. S. Yoo, J. M. Yoon,  
 J. S. Yu, B. Y. Lee, H. C. Kang, Y. S. Yoo, C. D. Kim,  
 I. J. Chung  
 LG.Philips LCD, Korea*

A 7-in. WVGA SOP LCD employing an advanced CMOS LTPS technology has been developed. Integrated gate driver includes dual logic redundancy structure and integrated data driver comprises sequential analog sampling circuit having error compensation scheme. These increase the products yield and display quality.

**AMD10 - 4      Novel Flash Memory Structure Using Sequential Laterally Solidified Low Temperature Poly-Si Technology**  
**10:10**

*H. T. Chen, S. I. Hsieh\*, Y. C. Chen, P. H. Tasi, C. L. Chen,  
 C. J. Huang, J. X. Lin, C. J. Chang, Y. C. King\*  
 ERSO/ITRI, Taiwan  
 \*Nat. Tsing-Hua Univ., Taiwan*

A novel field-enhanced flash memory device fabricated by sequential lateral solidified (SLS) low temperature poly-Si (LTPS) technology on glass substrate was investigated. The poly-Si protrusions at grain boundaries (GB) as a result of SLS process can be well-controlled and located along the width direction of the transistor. Protrusions at the grain boundaries are utilized as emitting source to achieve a flash memory device with low operation voltage ( $\leq 20V$ ), fast program/erase time, and wide  $V_{th}$  window by field-enhanced channel hot electron (FE-CHE) injection for programming and field-enhanced band-to-band hot hole (FE-BBHH) injection for erase.

----- Break -----

**10:50 - 12:30**

**Sunport Hall Takamatsu Main Hall**

**AMD11: System on Panel (2)**

Chair :            N. Karaki, Seiko Epson, Japan  
 Co-Chair :        K. Takatori, NEC, Japan

**AMD11 - 1: Invited 510-Kb SOG-DRAM for Frame-Memory-Integrated Displays**

*H. Haga\*\*\*, T. Otose\*\*\*, Y. Nonaka\*\*\*, D. Sasaki\*, Y. Kamon\*, Y. Kitagishi\*\*\*, T. Matsuzaki\*\*\*, Y. Sato\*, H. Asada\*\*\**

*\*NEC, Japan*

*\*\*NEC LCD Tech., Japan*

A System On Glass (SOG) Dynamic Random Access Memory (DRAM), which enables the implementation of frame-memory-integrated displays, has been developed. To reduce the layout area, a dynamic one-transistor-one-capacitor memory cell and a compression/decompression (CODEC) circuit were developed and implemented. A frame-memory macro was created by combining the SOG-DRAM with an embedded controller that enables independent access for writing and reading. Its operation was verified by chip measurement and demonstration as a frame-memory operation of 262k-color QCIF+ displays.

**AMD11 - 2 Reliable Integrated a-Si Scan Driver (RASD) for 11:15 2.47-in. VGA a-Si TFT-LCD**

*H.-R. Han, J.-F. Tsai, Y.-L. Jou, W.-T. Liao, W.-C. Wang WINTEK, Taiwan*

A 2.47"VGA (480×640) a-Si TFT-LCD panel with reliable integrated a-Si scan driver (RASD) and novel pixel design is developed using a standard 5-mask BCE process. The RASD makes it possible to perform an operation regardless of the fluctuation in the threshold voltage of a-Si TFT after a long-term use. The novel pixel design raises the resolution of the TFT-LCD panel up to 480 × RGB × 640 and raises the brightness of the TFT-LCD panel up to 200 nits by maximizing the useful aperture.

**AMD11 - 3 Integrated Gate Driver Circuit Using a-Si TFT**

**11:35**

*C. C. Wei, W. C. Lin, S. H. Lo, C. J. Chang, Y. E. Wu AU Optronics, Taiwan*

A reliable a-Si gate driver circuit is integrated on the glass substrate and fabricated by a standard TFT process. The circuit operation voltages, optimized to balance the positive and negative AC stress, are independent of the output voltages. The measurement results show that the output of the new shift register circuit degrades in a much slower rate under long-term operation.

**AMD11 - 4 7-in WVGA LTPS TFT LCDs Manufactured by PMOS Process**

**11:55**

*C.-H. Lee, H.-Y. Lin, C.-M. Chiu, M. Kung Toppoly OptoElect., Taiwan*

A high performance 7-inch WVGA LTPS LCDs manufactured by PMOS process was developed. The gate driver with 2-phase clocks and level shifter were integrated on glass. The proposed driving scheme is very similar to conventional CMOS panels. The same performance as CMOS panels was achieved in reliability test and has acceptable power consumption. Furthermore, the PMOS process also dramatically improves the throughput in manufacturing due to less photo layers than CMOS one.

**AMD11 - 5L High Resolution LTPS AMLCD with Integrated DACs**  
**12:15**

*K. Hashimoto, K. Yamashita, F. Matsuki, H. Watsuda,  
 J. R. Ayres\*, M. J. Edwards\*  
 Philips Mobile Display Syss., Japan  
 \*Philips Res. Labs., UK*

A 257 dpi LTPS TFT LCD with integrated DACs for reduced system cost is described. The architecture is based on a 2-stage resistor-capacitor hybrid DAC that is well suited to high-resolution LTPS displays. We have confirmed that images with high uniformity can be achieved using this source driver architecture.

----- Lunch -----

**14:00 - 15:30**

**Sunport Hall Takamatsu Main Hall**

**AMD12: Organic TFT Technologies**

Chair : Y. Inoue, NHK, Japan  
 Co-Chair : M. Ikeda, Toshiba, Japan

**AMD12 - 1: *Invited* Organic Light Emitting Transistor-  
 14:00 Fundamental Characteristics and Applications**

*C. Adachi  
 Chitose Inst. of Sci. & Tech., Japan*

We succeeded in observing bright electroluminescence (EL) from 1wt%-rubrene doped tetraphenylpyrene (TPPy) as an active layer in an organic field-effect transistor (OFET) structure. We observed a maximum EL quantum efficiency ( $\eta_{\text{ext}}$ ) of ~1 %. Our device configuration provides novel organic light emitting diode structure where anode (source) and cathode (drain) electrodes are laterally arranged, giving us a chance to control drain current by changing gate bias.

**AMD12 - 2: *Invited* Sheet Image Scanner with Organic Transistor  
 14:25 Integrated Circuits**

*T. Someya, T. Sakurai, T. Sekitani, H. Kawaguchi, Y. Kato,  
 S. Iba  
 Univ. of Tokyo, Japan*

A sheet image scanner has been fabricated by integrating high-quality organic transistors with organic photodetectors. Because the sheet scanner requires no mechanical components, it is mechanically flexible, light to transport, shock-resistant and potentially inexpensive to manufacture.

**AMD12 - 3      Flexible Liquid Crystal Display Panel Driven by Low Voltage Operation Bottom-Contact Organic TFT**  
**14:50**

*Y. Fujisaki, T. Suzuki, T. Arai, H. Ohtake, H. Maruyama,  
H. Fujikake, Y. Inoue, S. Tokito, T. Kurita  
NHK, Japan*

An organic TFT (OTFT) -driven 16×16 polymer-dispersed liquid crystal (PDLC) display panel on a flexible plastic film has been developed. We fabricated the low-voltage-operation OTFT with Ta<sub>2</sub>O<sub>5</sub> gate insulator and bottom-contact structure, using a photolithography method at low temperature. The OTFT showed a carrier mobility of 0.3 cm<sup>2</sup>/Vs, a current on/off ratio of over 10<sup>5</sup>, a subthreshold slope of 0.3, and a low operating drain voltage of -6V. We also successively confirmed display operation of the fabricated 16×16 display panel.

**AMD12 - 4      Organic Thin-Film Transistors Based on Nanocomposite Gate Insulators for High-Current Driving Applications**  
**15:10**

*C.-S. Chuang, Y.-S. Lin, L.-J. Kung, D.-S. Chen,  
F.-C. Chen, H.-P. Shieh  
Nat. Chiao-Tung Univ., Taiwan*

Highly performance organic thin-film transistors (OTFTs) incorporated with nanoparticles in the dielectric insulators have been demonstrated. The dielectric layers consist of cross-linked poly-4-vinylphenol (PVP) and high dielectric titanium dioxide (TiO<sub>2</sub>) nanoparticles. In order to increase the solubility of TiO<sub>2</sub> nanoparticles in organic solutions, the surface of nanoparticles was modified with organosiloxane. Moreover, the concern of higher leakage current, while using the nano-composite insulators, has been overcome by P8 treatment. In addition, several models, which have been used to describe the dielectric behavior of composite materials, are also discussed.

**Author Interviews**

17:10 - 18:10

**Supporting Organizations:**

Chemistry and LC Material Forum, JLCS

LC Physics and Condensed Matter Forum, JLCS

Liquid Crystal Display Forum, JLCS

Technical Group on Information Displays, ITE

Technical Committee on Electronic Information Displays, Electronics Society, IEICE

Technical Committee on Electron Devices, Electronics Society, IEICE

Technical Committee on Silicon Devices and Materials, IEICE

# Workshop on FPD Manufacturing, Materials and Components

Tuesday, December 6

13:30 - 14:50

ANA Hotel Clement Takamatsu Hiten 1

## FMC1: Manufacturing Technologies (1)

Chair : K. Sarma, Honeywell, USA

Co-Chair : Y. Ukai, Sony, Japan

**FMC1 - 1: *Invited* Rapid Thermal Annealing Technique Using  
13:30 Thermal Plasma Jet and Its Application to Thin Film  
Transistor Fabrication**

*S. Higashi*

*Hiroshima Univ., Japan*

The temperature profile in the substrate during the thermal plasma jet irradiation has been investigated by an optical probe analysis. The surface temperature increased from 960 to 1,781 K by decreasing the gap between the plasma source and the substrate surface and increasing the Ar gas flow rate. Application of the annealing technique to crystallization of amorphous Si films and fabrication of high-performance thin-film transistor with the field effect mobility of  $62 \text{ cm}^2\text{V}^{-1}\text{s}^{-1}$  and threshold voltage of 3.4 V is demonstrated.

**FMC1 - 2: *Invited* Rapid Recrystallization of Amorphous Silicon  
13:50 Utilizing Microplasma Jet at Atmospheric Pressure**

*H. Shirai, Y. Sakurai, M. Yeo, T. Kobayashi\*, H. Hasegawa  
Saitama Univ., Japan*

*\*Inst. of Physics & Chem. Res., Japan*

The rapid recrystallization of amorphous silicon and its related materials, i. e., a-Si (P, B), a-SiGe and a-SiOH utilizing the RF plasma jet of argon at atmospheric pressure is presented. In addition to the rapid recrystallization of a-Si, the enhanced activation of P and B impurities has been realized by optimizing the stage velocity and flow rate of argon. The effects of the guest element, P, B, O, and Ge on the rapid recrystallization of a-Si by the plasma annealing are demonstrated.

**FMC1 - 3 Application of Induction Heater to FPD Production  
14:10 Equipment**

*Y. Ozaki, K. Shimamura, N. Sagawa  
Mitsui Eng. & Shipbuilding, Japan*

We have developed the anneal system for FPD with a new vertical structure making the best use of the feature of Zone Control Induction Heating (ZCIH). It has been proven that this system can provide not only a substrate heating with high quality, i. e., a rapid temperature transition speed, a splendid temperature uniformity and a substrate damage control characteristic in the high temperature heat-treatment process, but also 1.3 times faster throughput compared with the conventional model.

**FMC1 - 4            High Current Ion Implanter iG4 with Long Pole Gap  
14:30                Sector Magnet for FPD Manufacturing**

*Y. Inouchi, S. Dohi, Y. Matsuda, M. Konishi, J. Tatemichi,  
M. Nukayama, K. Nakao, K. Orihira, Y. Andoh  
Nissin Ion Equipment, Japan*

A mass analyzing high current ion implanter (called Ion Doping iG4) for FPD manufacturing was developed. In this system, the ion source has been developed to obtain higher current density ion beam for better performance on Source/Drain implantation. As the results, 300 $\mu$ A/cm for Boron ion beams and 400 $\mu$ A/cm for phosphorous ion beams were obtained.

----- Break -----

**15:10 - 16:30**

**ANA Hotel Clement Takamatsu Hiten 1**

**FMC2: Manufacturing Technologies (2)**

Chair : T.Miyashita, Tohoku Univ., Japan

Co-Chair : T. Itoh, Corning Japan, Japan

**FMC2 - 1            Withdrawn**

**15:10**

**FMC2 - 2            Applying Inkjet Technology to PI Alignment-Film  
15:30                Printing Conducted in LCD Panel Manufacturing**

*F. L. Hsu, K. H. Chen, P. Y. Liu, K. W. Wang, H. A. Li,  
S. Oliver, S. T. Yang  
Chunghwa Picture Tubes, Taiwan*

By referring to the drawback of Roller-to-Roller process, only 1~10 percent of polyimide material is effectively utilized. On the contrary, the effectively employed polyimide in inkjet printing process could achieve 70~95 percent usage. Inkjet technology has been a rising candidate offering the advantages of effective material usage, film thickness uniformity and switching panels with different specifications easily in manufacturing process. CPT has introduced the PI inkjet machinery in alignment-film printing, and successfully conducted PI alignment-film printing in demonstrating the exhibits of 7-inch and 20.1-inch panels.

**FMC2 - 3            Novel, Highly Reliable and Accurate Inkjet Print Head  
15:50                for Manufacturing Flat Panel Displays**

*J. Attard  
Xaar Plc, UK*

Xaar presents its 3rd generation, inkjet print head, "side shooter" technology. Also incorporating Xaar's unique greyscale technology, the side shooter is designed to meet manufacturing process specifications on reliability, lifetime, drop volume and drop placement accuracy in a number of process steps, including polyimide coating, color filter deposition, and P-OEL deposition. The concept, technology roadmap and initial test results will be presented.

**FMC2 - 4: Invited Evaluation of the Performance of an Ion Beam Using the Planner Distribution of a Twist Angle**

*A. Asahara, A. Horibe, H. Kimura, J. Nakagaki, T. Nishiwaki, H. Tokushige, T. Yamada, H. Kitahara, Y. Shiota*  
*IBM Japan, Japan*

A new scale, "twist angle", for estimation of the quality of an ion beam is proposed. The twist angle reflects the orientation of molecules in the resulting aligned layer. We found that the LCD panel quality is well correlated with the planar uniformity of twist angles. Using twist angle, we can evaluate the quality of ion beams without making product-level LCD panels.

----- Break -----

16:55 - 18:05

ANA Hotel Clement Takamatsu Hiten 1

**FMC3: Manufacturing Technologies (3)**

Chair : C.-C. Huang, Photon Dynamics, USA

Co-Chair : T. Unate, Sekisui Chem., Japan

**FMC3 - 1 Withdrawn**

16:50

**FMC3 - 4L Advances in Jet Dispensing for Flat Panel Applications**

16:55

*T. Ratledge, L. Fang, F. Suriawidjaja*  
*Asymtek, USA*

As the demand for OLEDs increases, manufacturers are investigating methods to improve the speed and quality of the production process. One process step, the dispensing of UV seals on glass substrates, can be significantly improved with the utilization of jet dispensing. This paper describes the recent improvements of this technology and its benefits for applying UV seals.

**FMC3 - 2 A New Method for Accurate Measurement of Display Flicker and Response Time**

17:10

*D. Glinel, V. Gibour, P. Boher, T. Leroux*  
*ELDIM, France*

We present a new system for accurate measurement of display flicker and response time based on an optical probe, an imaging CMOS sensor, a photo multiplier tube and a dedicated electronics. We show that the 14 bits converter provides a real 80db signal/noise ratio. We demonstrate that the response time repeatability is better than 0.1% and the accuracy better than 1%. A new method of signal treatment is applied for inter-gray level measurements where the signal variation is low to improve the accuracy.

**FMC3 - 3**      **Using Finite Element Methods to Simulate the Mura Phenomena Caused by the Thermal Deformation of Film Materials in the LCD Module**  
**17:30**

*C. R. Ou\*\*\*, R. Her\*, R. Tzeng\*, C. H. Chen\*, C. Y. Lin\*\*\**

*\*LEXM Res., Taiwan*

*\*\*Hsiuping Inst. of Tech., Taiwan*

*\*\*\*CADMEN, Taiwan*

In this article, we will discuss about the Mura phenomena caused by the thermal deformation of the thin film. Both FEM and analytical solutions is discussed for such phenomena. Although analytical solution is not an exact solution, it is found to be a more practical tool to explore the wrinkling of the film materials than the FEM for Mura analysis.

**FMC3 - 5L**      **Latest Focus, Magnification Control & Alignment Improvements of HMA 500 for Printing Future ” SOG’s”**  
**17:50**

*A. R. Nobari, S. Mourgue, F. Clube, M. Jorda, C. Iriguchi\*,*

*S. Inoue\*, E. Grass\*\*, H. Mayer\*\**

*Holtronic Technologies, Switzerland*

*\*Seiko Epson, Japan*

*\*\*Microfab AG, Liechtenstein*

The emerging systems on Glass (“SOG”s) based on LTPS or yet crystal-Silicon (c-Si) critically require not only very-high resolution lithography, as a patterning capability but also congruent capabilities of layer-to-layer alignment whilst being capable to overcome and compensate the process induced magnifications. We report the latest improved results of  $1.2\mu\text{m}$  at  $0.5\mu\text{m}$  resolution for depth of focus and alignment of  $0.19\mu\text{m}$   $3\sigma$  both axis with magnification control on a HMA 500. At  $3\mu\text{m}$  resolution, the DoF is  $30\mu\text{m}$ .

**Author Interviews**

18:20 - 19:20

**Wednesday, December 7**

**9:00 - 10:00**

**ANA Hotel Clement Takamatsu Hiten 1**

**FMC4: Color Filters (1)**

Chair : H. Mori, Fuji Photo Film, Japan

Co-Chair : K. Dantani, Dai Nippon Printing, Japan

**FMC4 - 1**      **Novel Convexity Pattern for Spacer or Bank on Plastic Substrate by Transfer Technique**  
**9:00**

*A. Yasuda, T. Furukawa  
 Kyodo Printing, Japan*

We have developed a novel convexity pattern used as spacer or bank for display device using a plastic substrate. This pattern can be formed in accurate position on a plastic substrate by transfer technique and have constant thickness and flat surface. Our transfer technique is also useful to form convexity pattern in addition to transparent electrode and color filter on a plastic substrate.

**FMC4 - 2**      **Introduction of Micro Coating Repair Method for LCD Color Filter**  
**9:20**

*Y. Takagi  
 NTN, Japan*

NTN has developed a repair system for LCD color filter applications. This system uses specially designed needles. Pico-litter level color resist was adhered to the surface area of the needle tip to coat on the "white defect" which generated in the manufacturing process of the color filter. This report contains an outline of equipment and relation between needle shape and the amount of coated color resist.

**FMC4 - 3**      **A Novel LCD Color Filter Repair Machine with Fully Dry Process**  
**9:40**

*T. Ishikawa, H. Miyai, T. Yamazaki, H. Seki, H. Kusunose,  
 H. Yoshimoto\*  
 Lasertec, Japan  
 \*Fuji Photo Film, Japan*

Lasertec has developed a new LCD color filter repair system (product name:CR), which has a new color repair function in addition to four conventional repair functions, height measurement, tape grinding repair, pulse laser shot and color microscope. The new color repair function was developed jointly with Fuji Photo Film, Co., Ltd. and a colored dryfilm is used as a repair material. CR machine is based on a fully dry color repair process, which increases the productivity of color filter manufacturing.

----- Break -----

**10:40 - 12:00**

**ANA Hotel Clement Takamatsu Hiten 1**

**FMC5: Color Filters (2)**

Chair :            C. H. Chen, ITRI, Taiwan  
 Co-Chair :        T. Taguchi, Toppan Printing, Japan

**FMC5 - 1 High Contrast Color Filter for LCD-TV**

10:40

*K. Minato, T. Ito, H. Ito  
Toppan Printing, Japan*

A new high contrast color filter (CF) for LCD-TV, of which the contrast ratio is 1.8 times higher than that of the conventional CF, has been developed by using the advanced pigment-dispersed color resist during a photolithography process. Consequently, the light leakage at the black image-displaying time in LCDs can be reduced. Furthermore, LCD-TV which suppresses tinting at the black image can be supplied by controlling the balance of contrast ratios in RGB segments.

**FMC5 - 2 Development of Color Filter Processes on Plastic Substrate**

11:00

*C. H. Chen, K. H. Liu, Y. A. Sha, L. P. Hsin, H. L. Wang,  
J. M. Ding, K. H. Chang, S. S. Liu, C. C. Liao, J. W. Shiu  
Ind. Tech. Res. Inst., Taiwan*

A 4.1-inch QVGA color filter using plastic substrate has been developed using pigment dispersion color resists and photolithography method. In order to improve the accuracy of superposition between different color layers, dimension and position of each pattern over entire plastic substrate must be controlled rigorously. The processes are optimized by tuning annealing condition, tact time from the end of pre-bake step to the start of exposing step, and post-bake condition. The performances of flexible color filters are reported.

**FMC5 - 3 Properties of Column-Spacers on a Flexible Color Filter Using a Roll-to-Roll Process**

11:20

*A. Sonehara, T. Eguchi, A. Sugizaki, T. Takahashi\*, T. Ito\*\*,  
A. Kumano\*\*\*  
TRADIM, Japan  
\*Dai Nippon Printing, Japan  
\*\*Sumitomo Bakelite, Japan  
\*\*\*JSR, Japan*

We were the first to develop column spacers (CS) using a roll-to-roll process for a flexible plastic substrate and demonstrated a prototype of LCD. The purpose of this paper is to obtain a stable cell gap of plastic LCD by disposing the CS. We derived the optimum condition for CS properties. As a result, the cell gap of the LCD was precisely maintained as well as that of conventional glass plates, and resulted in uniform luminance of the display.

**FMC5 - 4 Investigation of Cell Gap Defects Using Gap Simulation**

11:40

*S. Ichikawa, K. Suekuni, M. Ishimaru, H. Nakatani,  
T. Unate, A. Nakasuga  
Sekisui Chem., Japan*

Large LCD panels have some cell gap problems. For example, gravity defects are observed as thicker cell gap area of bottom of LCD panel at high temperature. Cold bubble defects are observed as bubbles in LCD panel at low temperature. We have developed a gap simulation method to investigate these problems. The calculation was made for both column spacer and ball spacer. It was shown that gap defects can be substantially reduced by using ball spacer.

**Author Interviews**

17:30 - 18:30

**Thursday, December 8**

9:00 - 10:20

ANA Hotel Clement Takamatsu Hiten 1

**FMC6: Environment Friendly Technologies & Backlight Systems (1)**

Chair : Y. Iimura, Tokyo Univ. of A &amp; T, Japan

Co-Chair : K. Niwa, JSR, Japan

**FMC6 - 1 Recycling of Liquid Crystal Recovered from TFT-LCD**

9:00

*H. Hasebe, K. Takeuchi, H. Takatsu  
Dainippon Ink & Chems., Japan*

The recycling of liquid crystals recovered from TFT-LCD panels has been studied. The liquid crystals were extracted from smashed waste LCD panels by washing with an organic solvent and were purified to recover Voltage Holding Ratio (VHR) as high as new liquid crystals. By optimizing purification processes, 99.2% of VHR has been achieved. Compensation of physical properties of the liquid crystals is also discussed.

**FMC6 - 2 Environment and Safety Activities of the Japanese LCD Association**

9:20

*S. Masui, M. Shiota\*, K. Matsumura\*\*, H. Kurokawa\*\*\*,  
H. Nishida\*\*\*\*, Y. Suzuki\*\*\*\*\***Sharp, Japan**\*JEITA, Japan**\*\*Toshiba Matsushita Display Tech., Japan**\*\*\*Hitachi, Japan**\*\*\*\*Hitachi Displays, Japan**\*\*\*\*\*NEC LCD Tech., Japan*

The Japanese LCD association has been coping with environment and safety issues from the beginning of the business. The display device environment and safety committee has four working groups (WGs). The PFC WG helped to found an international committee together with counterparts in Korea and Taiwan in 2001, and it has been making efforts to reduce PFCs emitted from LCD manufacturing facilities. Recently the recycling WG has focused on recycling waste LCD TVs.

**FMC6 - 3**      **Comparative Study on Sinusoidal and Square Wave Driving Methods of EEFL (External Electrode Fluorescent Lamp) for LCD TV Backlight**

9:40

*Y. J. Lee, W. S. Oh, S. S. Lee, K. M. Cho, G. W. Moon, M. S. Park\*, S. G. Lee\*, M. G. Kim\**  
 KAIST, Korea  
 \*Samsung Elect., Korea

EEFL is mostly driven by sinusoidal wave driving method. In the sinusoidal wave driving method, a transformer should be used in the inverter since the high voltage should be applied across the EEFL to turn on. As the transformer is removed, a square wave is applied directly to the both ends of EEFL by a cascaded three-stage inverter. And In the case of square wave, the high luminance and light efficiency have been achieved.

**FMC6 - 4**      **CCFL Inverter Circuit with a Ballast at Primary Side**

10:00

*H. Shinmen, R. Weger\**  
 Minebea, Japan  
 \*NMB-Minebea GmbH, Germany

This paper presents a new inverter circuit for driving multiple CCFL-lamp displays e.g. LCD-TV screens. The new inverter makes use of a transformer chain with in series connected primary windings. This electrically equals a virtual series connection of all CCFL lamps resulting in excellent current uniformity in all lamps and hence excellent brightness uniformity of the display. The paper explains the basic circuit operation and gives experimental results of the achieved current balancing.

----- Break -----

10:40 - 12:00

ANA Hotel Clement Takamatsu Hiten 1

**FMC7: Backlight Systems (2)**

Chair :            A. A. S. Sluyterman, Philips Lighting, The Netherlands  
 Co-Chair :        M. Takagi, Harrison Toshiba Lighting, Japan

**FMC7 - 1:**      ***Invited* What Is Needed in LCD Panels to Achieve CRT Like Motion Portrayal**

10:40

*A. A. S. Sluyterman*  
 Philips Lighting, The Netherlands

In LCD panels, motion portrayal as well as panel addressing speed and response time are critical. They need to be balanced carefully, in particular for HDTV. It will be shown which combination of technologies, like response-time improvement, black insertion, double frame rate and scanning backlight, can achieve CRT-like motion portrayal, without demanding extreme response speeds from the panel.

**FMC7 - 2      Spatio-Temporal Scanning LED Backlight for Large  
11:00          Size Field Sequential Color LCD**

*K. Sekiya, T. Kishimoto, K. Wako, S. Nakano, H. Ishigami,  
K. Kälântär\*, K. Shimabukuro\*, D. Kunioka\*,  
T. Miyashita\*\*, T. Uchida\*\*  
Aomori Pref. CREATE, JST, Japan  
\*Nippon Leiz, Japan  
\*\*Tohoku Univ., Japan*

Emerging problems related to backlights for large size field sequential color (FSC) LCDs are identified. A partitioned blockwise backlight is required and the control of light leakage over the partitions is found critical. If a high-definition FSC LCD is realized with dual scan (divided screen), change in the sequence of color fields is required. A 36.9 cm-diagonal spatio-temporally scanning backlight utilizing RGB LEDs is developed in combination with an OCB-mode FSC LCD and the discussion is verified on it.

**FMC7 - 3      The High Efficiency and Long Life Span Plasma Flat  
11:20          Fluorescence Lamp Equipped with Innovative Dual  
Driving Waveforms**

*C. C. Ting, Y. H. Hsieh, J. S. Chen, T. L. Chin, C. L. Lin,  
W. Y. Lo, J. Y. Zhang, H. P. Chong, W. Y. Tseng, S. J. Jeng,  
C. J. Chang, C. C. Chieu, J. N. Chen, H. W. Wu,  
X. H. Tseng, S. C. Lee, T. C. Lu, C. J. Yang, S. C. Wu,  
H. Y. Chou, S. H. Huang, C. H. Ai, X. R. Lin, O. Sun  
Chungwha Picture Tubes, Taiwan*

The plasma flat fluorescence lamp equipped with innovative dual driving waveforms had been successfully fabricated. Because of the specific driving waveform, the PFFL can entirely and homogeneously illuminate without any dark area, which results in high luminance efficiency and long life span of backlight unit.

**FMC7 - 4      Enhanced Luminescent Efficiency of Backlight's  
11:40          Blue Phosphor by Microwave Irradiation**

*C. C. Ting\*, S. P. Lee, K. T. Kuo, S. Y. Chen, Y. H. Hsieh\*,  
S. J. Jeng\*, O. Sun\*  
Nat. Chiao-Tung Univ., Taiwan  
\*Chungwha Picture Tubes, Taiwan*

Highly luminescent efficiency blue-light phosphors  $\text{BaMgAl}_{10}\text{O}_{17}:\text{Eu}^{2+}$  have been successfully produced by microwave irradiation treatment. The SEM images and XRD analysis reveal that the particle morphology of the blue-light phosphors can be notably modified from sheet-like to spherical shape by microwave irradiation and better crystallinity can be obtained. In addition, the vacuum ultraviolet (VUV) PL spectra shows that the microwave irradiation treatment can effectively enhance the luminescent efficiency by a factor of 2.5 for intensity in comparison with that without microwave treatment.

----- Lunch -----

13:40 - 15:00

ANA Hotel Clement Takamatsu Hiten 1

**FMC8: Backlight Systems (3)**

Chair : K. Kälântär, Nippon Leiz, Japan  
 Co-Chair : H. S. Lee, Samsung Advanced Inst. of Tech., Korea

**FMC8 - 1: Invited Highly Light Collimating Unit for Realization of Mosaic Structure Large Size RGB Backlight**

*K. Kälântär  
 Nippon Leiz, Japan*

For realizing a large-scale LCD backlight, a unit with three stacked functional light-guides has been developed. The unit transforms azimuthal light distribution of an LED to an intensive collimated light through a circular prism sheet. The unit has an optical efficiency of 78% and a thickness of 7mm.

**FMC8 - 2 Diffusive-Sheetless Backlight System for Mobile Phone**

*M. Yoshida, A. Funamoto, K. Sakurai, Y. Kawabata,  
 M. Ohira, S. Aoyama  
 OMRON, Japan*

The conventional backlight system has required a diffusive sheet and prism sheets to improve the uniformity and the brightness of the light emitted from a lightguide respectively. The integration of functions given from these sheets onto a lightguide was realized and the reduction of the thickness of the backlight system by 20% has been achieved. In this paper, the integration of diffusive sheet's function by the design of prisms' random arrangement with the prism size control is presented mainly.

**FMC8 - 3 Improvement of Color Dispersion in Holographic Back-Light Units Using Beat Patterns**

*H.-S. Lee, S. M. Lee, J. S. Choi, J. H. Min, K. Y. Kim,  
 Y. S. Choi, J. H. Yu, J. H. Kim, H. Y. Choi  
 Samsung Advanced Inst. of Tech., Korea*

We introduce beat patterns to a holographic back-light unit (HBLU) to improve color dispersion characteristics. HBLU has a color dispersion problem that comes from the nature of grating structures. The beat pattern structure for minimizing color dispersion is optimized using k-space method and the finite difference time domain (FDTD) simulation. The optimum structure is fabricated and evaluated. The experimental result shows that the  $\Delta x * \Delta y$  value of a proposed beat pattern HBLU in 1931 CIE chromaticity diagram reduces to 37% compared to a single-period model.



**FMCp - 3      A Study of Full Wavelength Spectroscopy-Integrated Dry Etching System***T.-C. Tsai**Ind. Tech. Res. Inst., Taiwan*

End point detection (EPD) technology has applied to auto-stop of dry etching and is gratifying with its sensitive process control. In this paper, we build an end point detector-based dry etching system, which integrates a full wavelength optical spectroscopy and an emission recorder. It was also verified by practical experiments that the new dry etcher was enough to detect stop timing without post-etch residue during the whole etch procedure and reached high reproducibility of the EPD signal profile for the same etched material.

**FMCp - 4      The Quality Improvement of ITO Deposition by DOE and SPC for FPD Fields***J. C. Liao, T. C. Tsai, M. W. Chang**Ind. Tech. Res. Inst., Taiwan*

To control the quality of deposition of indium-tin oxide (ITO) is so hard since its complex reaction. This study aims to improve the quality of ITO film by design of experiment (DOE) and then to monitor the quality trends with statistical process control (SPC). According this quality control cycle, the quality indexes of ITO film in thickness, resistivity and uniformity were greatly promoted from unqualified situation of ITO formation.

**FMCp - 5      Study on an Ion Beam Alignment System for Liquid Crystal Displays***T. Matsumoto, T. Sato\*, N. Nakamura, Y. Matsuda, Y. Andoh, Y. Iimura\***Nissin Ion Equipment, Japan**\*Tokyo Univ. of A&T, Japan*

We have developed an ion beam alignment system for a liquid crystal (LC) alignment process, which features its large ion beam size of 800 mm width. The ion beam exhibited an excellent uniformity, repeatability, stability, and a small divergence angle. The twisted nematic cells with ion-treated polyimide films showed a well-aligned LC texture. These indicate that this ion beam system is suitable for the application to a LC alignment process, especially when the LC panel size becomes larger.

**FMCp - 6      Performance of a RTA System for LTPS TFTs***M. Morita, K. Hashimoto, M. Mizuno, T. Ishihara, Y. Kawasaki**Ishikawajima Harima Heavy Ind., Japan*

The new high-speed annealing system for low-temperature poly silicone TFT was developed. This system offers high-speed temperature rising, glass cooling, and the good temperature uniformity in annealing. This system is applicable to activation of TFT, SPC of poly silicone, and pre-compression processing of a substrate etc.

**FMCp - 7 High Quality SiO<sub>2</sub> Insulator for LTPS-TFTs Deposited in ALD/PECVD Reactor**

*N. Miyatake, Y. Mori, K. Murata, K. Shimamura, Y. Uraoka\*, T. Fuyuki\**

*Mitsui Eng. & Shipbuilding, Japan*

*\*Nara Inst. of Sci. & Tech., Japan*

High quality gate insulator is a necessity to enhance performance of a Low-Temperature-Poly-Silicon (LTPS) TFT. We propose an all-new stacked gate insulator, which is prepared with the Atomic Layer Deposition (ALD) technology for an interfacial layer, and the monopole antenna Plasma Enhanced Chemical Vapor Deposition (PECVD) technology for a secondary layer. We have developed the ALD/PECVD reactor, which handles glass substrates of 370mm×470mm in size. The prepared SiO<sub>2</sub> film has excellent electrical property of an interface trap density of  $1 \times 10^{11} \text{cm}^{-2} \text{eV}^{-1}$ .

**FMCp - 8 Application of ACX (Al-C-Ni) Alloys with Low Resistivity for Single Gate Layer**

*D. L. Choi, J. I. Ryu, S. W. Kim, W. S. Kim, W. B. Lee, J. Y. Lee*

*BOE TFT-LCD SBU, Korea*

The possibility of application of ACX (Al-C-Ni) single metal with low resistivity for gate layer was investigated. Contact resistivity between ACX and ITO which mentioned major problem of Al-based alloy was improved by several treatments, and etch profile was also improved. The transfer property of ACX gate TFT was as good as TFT with Mo/Al/Mo three layers. Finally, 14"-based XGA module was manufactured and will be displayed during IDW/AD '05.

**FMCp - 9 Improvement of Physical Properties of Indium Tin Oxide (ITO) Nanoparticle for Flexible Display Using Gas Evaporation Synthetic Method**

*S.-J. Hong, S.-G. Chang\*, J.-I. Han*

*Korea Elect. Tech. Inst., Korea*

*\*Epixon, Korea*

Highly dense ITO target enhances characteristics of ITO thin film for flexible display at low temperature, and the high density can be achieved by applying nano-sized ITO particle. In this work, physical properties of ITO nanoparticle were attempted to improve applying gas evaporation method. As a result, high quality ITO nanoparticle with uniform particle size of 5 nm, surface area of 108 m<sup>2</sup>/g, (222) preferred cubic structure, and 91% In - 9% Sn was achieved by the gas evaporation method.

**FMCp - 10      High Reliability Alignment Material for Active Matrix LCD Fabricated at Low Temperature Bake Processes**

*T. Hirai, A. Kumano\*, S. Otsuki  
TRADIM, Japan  
\*JSR, Japan*

A new alignment material has been developed for Active Matrix Liquid Crystal Display (AM-LCD) which was fabricated at low temperature bake process. The liquid crystal cell used the alignment material exhibits high voltage ratio, low residual DC voltage and high reliability. The alignment material is suitable for high reliability plastic film based AM-LCD.

**FMCp - 11      Formation and Characterization of High-Ordered Self-Assembled Monolayers by a Novel Chemisorption Method**

*N. Nakamoto, Y. Fujita, H. Takeda, K. Kumazawa,  
M. Shimada, H. Suzuki, T. Hidaka  
Nippon Soda, Japan*

We have discovered a novel chemisorption method using octadecyltrimethoxysilane(ODMS), titanium alkoxide(TA), water, and toluene to form highly-ordered self-assembled monolayers(SAM)of ODMS. The SAMs were formed rapidly from the active solution even when it was kept for three months. The solution and layers were characterized by several methods. We propose a mechanism for the rapid formation of the ODMS-SAM.

**FMCp - 12      Withdrawn**

**FMCp - 13      The Study of Prism-Patterned Light Guide Plate for Increase of Efficiency in Monitor Back Light Unit**

*M. S. Lee, D. S. Park, Y. S. Oh, S. Y. Kim, Y. J. Lim  
BOE HYDIS Tech., Korea*

We focused developing without prism sheet in BLU. We made prism structures at the upper and the lower surface of LGP(17inch). Firstly, we examined the possibility by using the optical simulation. Then we made real sample by means of imprinting process at the raw LGP. Imprinting method includes the process of curing resin by UV exposure. As a result, we achieved brightness of 4984nits (at center) and uniformity of 70% in first sample, and 4673nits and 78.2% in second sample, without prism sheets.

**FMCp - 14      Optimization of TFT-LCD Light Source by Ray Tracing and Thermo-Flow Application**

*H. M. Chen, H. W. Chang, M. H. Liu, W. Z. Cheng  
InnoLux Display, Taiwan*

Conceptually, lamp house structure modification and CCFL operation at suitable temperature are two ways to enlarge brightness based on geometry optical theory and CCFL property. A high brightness and low temperature backlighting unit light source has been obtained by ray tracing and thermo-flow application. The components of the lamp house have been optimized enabling high luminance and low decay property.

**FMCP - 15      A New CCFL Arrangement of TFT-LCDs for Full-Surface Luminance Uniformity in Low Lamp Current Driving Situation**

*Y.-C. Cheng, Y.-J. Hsu, M.-H. Liu, H.-M. Chen  
InnoLux Display, Taiwan*

We demonstrate a new CCFL arrangement method called SAM (Stagger Arrangement Method) for improving the panel uniformity when low lamp-current driving. By introducing this technology, the uniformity can be highly raised due to the luminance compensation effect between two extremities of the CCFL. Both optical and thermal properties have been well analyzed. An experiment using 17 inch LCD module also evidences our contention.

**FMCP - 16      Improvement of Luminance Uniformity of Direct-Type LED Backlight**

*Y. Kim, J. Lee, S. Lim  
Dankook Univ., Korea*

The direct-type LED backlight can be designed to have the desired uniformity. In this paper, it is demonstrated that the luminance uniformity of LED backlight can be improved by using several combinations of reflector patterns placed in front of LED light sources and it was shown that the 72.2% of luminance uniformity of the LED backlight with reflector patterns was obtained.

**FMCP - 17      Equivalent Model and Statistical Analysis for the Ray Tracing of Backlight Modeling**

*C. R. Ou<sup>\*,\*\*</sup>, C. H. Chen<sup>\*\*</sup>, J. S. Fan<sup>\*\*\*</sup>  
<sup>\*</sup>Hsiuping Inst. of Tech., Taiwan  
<sup>\*\*</sup>LEXM Res., Taiwan  
<sup>\*\*\*</sup>Nat. Chiao Tung Univ., Taiwan*

This short communications discussed two methods to reduce the computational time for backlight unit (BLU) simulation. Several equivalent models and the practical statistical analysis are proposed.

**FMCP - 18      Optical Modeling and Simulation of a Cholesteric Liquid Crystal Polarizer**

*H. Pak<sup>\*</sup>, K. I. Kim<sup>\*</sup>, K. C. Yoon<sup>\*,\*\*</sup>, S. T. Kim<sup>\*</sup>, J. C. Jung<sup>\*</sup>,  
H. D. Park<sup>\*</sup>, J. R. Park<sup>\*\*\*</sup>  
<sup>\*</sup>Samsung Fine Chems., Korea  
<sup>\*\*</sup>KIST, Korea  
<sup>\*\*\*</sup>Chosun Univ., Korea*

Computational simulation of a cholesteric liquid crystal (CLC) polarizer was executed using a numerical model based on Berreman's 4x4 matrix approach. Explicit expressions of the 4x4 propagation matrices for the constituent optical films of a CLC polarizer were presented. We considered the light recycling processes by introducing empirical parameters for the optical efficiency and the depolarization of a recycling system. Numerical simulations for optical performances of a CLC polarizer were performed, and the simulation results were compared with experimental ones.

**FMCp - 19      A Roll to Roll Method for Production of an  
Achromatic Circular Polarizer by the Use of Photo-  
Alignment**

*K. Maruyama, H. Hayashi, Y. Ono, A. Nozaki, Y. Suzuki\*,  
S. Naitoh\*\*, T. Ikariya*

*TRADIM, Japan*

*\*Dainippon Ink & Chems., Japan*

*\*\*Sumitomo Chem., Japan*

We produced a roll of an achromatic circular polarizer by the use of photo-alignment. It consists of a half wave plate, a quarter wave plate and a linear polarizer, which were coated and laminated at angles with each other in a roll to roll process. The method can enhance efficiency in manufacturing an achromatic circular polarizer and give it in a roll to be applicable to a continuous manufacturing process of a plastic LCD.

**FMCp - 20      Determination of Optical Constants for Cholesteric  
Liquid Crystal Films Using Transmittance and  
Reflectance Spectra**

*H. Pak\*, K. I. Kim\*, K. C. Yoon\*\*\*, S. T. Kim\*, J. C. Jung\*,  
H. D. Park\*, J. R. Park\*\*\**

*\*Samsung Fine Chems., Korea*

*\*\*KAIST, Korea*

*\*\*\*Chosun Univ., Korea*

Optical constants for cholesteric liquid crystal (CLC) films were obtained by fitting theoretical spectra of transmittance and reflectance with measured ones. Calculation of theoretical spectra was executed using Berreman's 4x4 matrix approach. We applied the curve-fitting method to three CLC samples with different reflection bands and compared the fitted results for refractive indices with measured ones for a parallel-aligned LC sample.

**FMCp - 21L      Improvement of Adhesion Between Color Filter  
Resin BM Matrix and Glass**

*S. H. Chen, J. Tsai, A. Chang, W. Wang, C. M. Wu*

*Allied Material Tech., Taiwan*

Resin BM material has been applied to color filter for black matrix layer. Because of the different material characteristics between heavy metal Cr and organic polymer resin, the interface adhesion should be improved by ways of chemiacle bonding, surface cleanliness...etc. Backside exposure is one of effective ways to enhance adhesion of resin BM and glass, CF makers must continue to cooperate with photoresist developer to improve interface adhesion for high quality TFT LCD panels.

**FMCp - 22L Development of Conductive Elastic Ball for Fine Pitch Interconnection**

*S. J. Hong, M. J. Lee, J. H. Choi, C. J. Lee, W. G. Kim,  
G. W. Jeong\*, J. I. Han  
Korea Elect. Tech. Inst., Korea  
\*Jeong Eui Ind, Korea*

In this work, micro-sized conductive elastic ball was successfully fabricated for fine pitch interconnection. First, 2.8  $\mu\text{m}$  sized ball with small deviation of 10% was successfully synthesized. Its deformation shows elastic behavior between 31 and 39%. Also, electrically conductive layer of Au/Ni was successfully fabricated by electrolessplating. The plated layer shows good adhesion with the surface of the organic ball. So, elastic micro ball could be fabricated for fine pitch interconnection.

**FMCp - 23L Newly Developed Surface Film Suitable for FPD-TV**

*K. Mikami, Y. Iwata, Y. Nishimura, N. Nakamura  
Dai Nippon Printing, Japan*

We developed the surface film (DS2) of a new category for LCD-TV. It has the power of image clarity of a glare film and also has a function of anti-glare with minimum white-muddiness. Additionally, it has high hardness and is suitable for high-resolution panels.

**FMCp - 24L Trichromatic LED Backlight for Mobile LCDs**

*J.-H. Kim, M.-Y. Park, J.-J. Kim, H.-D. Kim, J.-H. Jun,  
J.-H. Park, S.-M. Cho, D.-W. Lee, H.-S. Jeong  
Samsung Electro-Mechanics, Korea*

We demonstrated a RGB LED backlight unit (BLU) for a 2.2 inch TFT LCD. The color gamut of the LC panel was enhanced from 39% to 73% when the conventional white LED BLU was replaced by the RGB LED BLU. Panel transmittance and contrast ratio were enhanced as well. The ambient temperature change was found to be the most significant cause of the color shift of the RGB LED backlight.

**Friday, December 9**

9:00 - 10:20

ANA Hotel Clement Takamatsu Hiten 1

**FMC9: Materials (1)**

Chair : A. Kyrilidis, Cabot, USA  
Co-Chair : H. Saito, Chisso, Japan

**FMC9 - 1: *Invited* Highly Polarized Polymer LED with a Dichroic Ratio More than 30!**

9:00

*M. Misaki*<sup>\*,\*\*</sup>, *S. Nagamatsu*<sup>\*</sup>, *M. Chikamatsu*<sup>\*</sup>,  
*Y. Yoshida*<sup>\*</sup>, *R. Azumi*<sup>\*</sup>, *N. Tanigaki*<sup>\*</sup>, *Y. Ueda*<sup>\*\*</sup>, *K. Yase*<sup>\*</sup>  
<sup>\*</sup>AIST, Japan  
<sup>\*\*</sup>Kobe Univ., Japan

Highly oriented polyfluorene thin film was fabricated by using a friction-transfer technique to estimate the anisotropic features in molecular orientation and optical properties. It was found that the electroluminescence from this device was really polarized with the ratio of more than 30.

**FMC9 - 2 Modified Carbon Black for Black Matrix Applications**

9:20

*A. Kyrlidis*, *K. Xiong*, *S. Sullivan*, *E. Step Cabot*, USA

Resin black matrices containing carbon black are being adopted to replace conventional chromium-based films in the color filters of liquid crystal flat panel displays. The filled film must have very high optical density and electrical properties beyond what is possible with conventional carbon black particles. Cabot has developed novel surface modified carbon blacks for black matrix films that provide enhanced dispersion characteristics and unique optical and tunable electrical properties.

**FMC9 - 3 The Effect of Adding Compatibilizer into OCL Materials for TFT Panel to Prevent the Rough Surface after Post-Baking Process**

9:40

*S. Takahashi*<sup>\*,\*\*\*</sup>, *Y. Zhang*<sup>\*</sup>, *K. Mochida*<sup>\*\*</sup>, *T. Ogata*<sup>\*\*\*</sup>,  
*S. Kurihara*<sup>\*\*\*</sup>  
<sup>\*</sup>AZ Elect. Materials, Japan  
<sup>\*\*</sup>Kyushu Univ., Japan  
<sup>\*\*\*</sup>Kumamoto Univ., Japan

Over coating Layer (OCL) materials are applied as over coating layer for TFT panels. When acrylic copolymer and epoxy compound are used for OCL materials, post baking process causes the rough surface of OCL film. Authors studied the mechanism of the rough surface phenomena, and found that the formation of the rough surface is closely related to microphase separation in the OCL film. Moreover some carboxylic acids with long alkyl chain were found to act as the compatibilizer in OCL film for preventing the microphase separation at post-baking process.

**FMC9 - 4**      **The Photolithographic and Electric Properties of  
10:00**      **Photosensitive Insulating Materials as a Passivation  
Layer on TFT LCDs**

*S. Nakamura, K. Azuma, Y. Kusaka, T. Unate, A. Nakasuga,  
K. Matsukawa\*, S. Murakami\*\*, K. Ohkura\*\*\*,  
T. Kikkawa\*\*\**

*Sekisui Chem., Japan*

*\*Osaka Municipal Tech. Res. Inst., Japan*

*\*\*Tech. Res. Inst. of Osaka Pref.*

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

Novel photosensitive insulating materials comprised of organic silsesquioxane (OSQ) have been developed. The OSQ showed high photosensitivity, insulating performance, transparency, and heat resistance required as a passivation layer on TFT LCDs. We examined features on the photolithographic and electric properties. The higher photosensitivity and resolution were obtained by the improvement of the material composition of OSQ. And we discussed the further evaluation of the  $V_{g-l_d}$  and  $V_{ds-l_d}$  characteristics on TFT devices.

----- Break -----

**10:40 - 11:40**

**ANA Hotel Clement Takamatsu Hiten 1**

**FMC10: Materials (2)**

Chair : C.-F. Huang, Tatung Univ., Taiwan

Co-Chair : T. Nagahara, AZ Chemical, Japan

**FMC10 - 1**      **Development of Fine Pattern Formation Process  
10:40**      **Using Silver Alloy Nano-Particles**

*I. Okada, K. Shimoda, K. Miyazaki*

*Sumitomo Elec. Ind., Japan*

We developed the fine pattern formation process with silver alloy nano-particles synthesized by the electro-chemical reaction. Nano-particles dispersed ink was coated on the glass substrate, and then sintered, metallic thin film was obtained. By the etching after photolithography process, we made fine pattern of line width  $10\mu\text{m}$  or less with low resistance  $3\mu\Omega\text{-cm}$  or less. This method does not need vacuum system, therefore it can be expected to reduce production cost.

**FMC10 - 2      A Transparent Antenna Printed on a Display for  
11:00            Portable DTV Reception**

*C.-F. Huang, S.-C. Chen\*, C.-N. Mo\*\*, C.-L. Liu\*\*  
Tatung Univ., Taiwan  
\*Central Res. Tech., Taiwan  
\*\*Chunghwa Picture Tubes, Taiwan*

Based on the technology previously developed for transparent antenna, this paper is to design a POD (Printed-On-Display) antenna operating in the UHF band for digital TV (DTV) reception. Design is assisted by computer simulation which employs the full-wave electromagnetic simulation package IE3D. Size-down technique is also introduced for making the associated POD antenna smaller. The return loss of the prototype antenna is measured for comparison with the simulated data.

**FMC10 - 3      New Platform for Mobile Display**

**11:20**

*H. Yamaguchi, S. Uchikoga  
Toshiba, Japan*

We propose a separate system instead of an all-in-one system as a new platform for mobile display. In a separate system, displays and other devices for human interface are separated physically and connected wirelessly to a base unit which has processing and storage functions. We have made a prototype of a mobile display in a separate system. The prototype weighs about 550g with a 12.1"XGA panel and an IEEE 802.11b/g wireless module. The issues concerning the requirements for displays are discussed.

----- Lunch -----

**14:00 - 15:20**

**ANA Hotel Clement Takamatsu Hiten 1**

**FMC11: Optical Films (1)**

Chair :            L. Wu, Optimax Tech., Taiwan  
Co-Chair :        H. Mori, Fuji Photo Film, Japan

**FMC11 - 1:    *Invited*    Polarizer for LCD Application**

**14:00**

*L. Wu  
Optimax Tech., Taiwan*

The developing trend of polarizer for LCD TV application was introduced in this paper. The ways how to improve optical performances including wide viewing, high contrast, low color shift at dark state from polarizer side was emphasized.

**FMC11 - 2 Development of Low-Retardation TAC Film**

14:20

*H. Nakayama, N. Fukagawa, Y. Nishiura, S. Nimura,  
T. Yasuda, T. Ito, K. Mihayashi  
Fuji Photo Film., Japan*

We have developed advanced technologies for reducing the out-of-plane birefringence of TAC (triacetyl cellulose) film. With these technologies, we have commercialized, for the first time, a new Low-Retardation TAC film, called FUJI FILM'Z-TAC'. This epoch-making TAC film's  $R_e$  value (in-plane retardation) and  $R_{th}$  value (out-of-plane retardation) are both nearly zero. This TAC film can remove LCD's color-shift at oblique incidence, especially for the IPS mode. Also, this Z-TAC film can use existing cost-effective roll-to-roll manufacturing process for polarizer film.

**FMC11 - 3 Development of Wide Viewing Angle Polarizer for IPS-LCD**

14:40

*K. Yoda, S. Yano, H. Yoshimi, T. Shouda  
Nitto Denko, Japan*

We studied problems about the viewing angle of a polarizer, and performed the design based on an optical theory. As a result of performing the examination by a simulation, the relation between the retardation in the thickness direction of a polarizer protection film has and the viewing angle characteristics (light leakage in the oblique direction, and color shift when the viewing angle is changed.) of a liquid crystal display (LCD) was clarified.

**FMC11 - 4 Super Wide-View Polarizer with Wide Wavelength Range for High Contrast Liquid Crystal Displays**

15:00

*T. Ishinabe, T. Uchida  
Tohoku Univ., Japan*

We developed a super wide-view polarizer with a broad wavelength range. By using a uniaxial film as a protection for the polarizer and two biaxial compensation films, we obtained a high contrast ratio for a wide viewing-angle range.

----- Break -----

15:40 - 16:40

ANA Hotel Clement Takamatsu Hiten 1

**FMC12: Optical Films (2)**

Chair : J. C. Lapp, Corning, USA

Co-Chair : Y. Fujimura, Nitto Denko, Japan

**FMC12 - 1: *Invited* A Novel Optical Compensation Film for OCB-LCDs**

*R. Matsubara, Y. Ito, S. Nakamura, H. Mori, K. Mihayashi  
Fuji Photo Film, Japan*

We have successfully developed and commercialized the OCB-WV film. The OCB-WV film has a PDM (polymerized discotic material) layer coated on a TAC substrate, giving excellent viewing angle characteristics for image-blurring-free OCB-TVs. In this paper, we show the concept of optical design of the film and the steps of optimization.

**FMC12 - 2      Liquid Crystalline Films as New Generation Retardation Films for Viewing Angle Compensation of LCDs**

*T. Seki, G. Suzaki, A. Mutou, T. Uesaka, S. Nishimura,  
H. Mazaki  
Nippon Oil, Japan*

We have developed liquid crystalline retardation film technology by using rod-like liquid crystalline polymer. The resulting liquid crystalline retardation film has several advantages over conventional uni- or biaxial stretched retardation film. By using liquid crystalline polymer, the direction of the optical axis can be determined freely for roll-to-roll lamination. High-order structures such as twisted nematic, hybrid nematic and homeotropic structures can be stabilized for ideal compensation of STN, TN, ECB, VA and IPS LCDs.

**FMC12 - 3      Optical Compensation Characteristics of Retardation-controlling Color Filter**

*T. Kawashima, K. Ikegami, S. Hayashi, N. Moriya  
Dai Nippon Printing, Japan*

The optical compensation characteristics of a retardation-controlling color filter made by directly stacking two retardation layers consisting of polymerizable liquid crystal (PLC) were investigated, with a special focus on the wavelength dispersion characteristics of the retardation. Fabricated retardation layers are very thin and have good thermal stability; and they were found to exhibit excellent optical compensation characteristics throughout the visible-light region.

**Author Interviews**

17:10 - 18:10

**Supporting Organizations:**

The Japan Society for Printing Science and Technology  
Japan Society of Colour Material  
The Technical Association of Photopolymers, Japan  
The Imaging Society of Japan  
Society of Photographic Science and Technology, Japan  
Japan Printed Circuit Association  
The Society of Radtech, Japan  
The Society of Polymer Science, Japan  
The Japanese Research Association of Organic Electronics Materials

# Workshop on CRTs

Tuesday, December 6

16:50 - 16:55

ANA Hotel Clement Takamatsu Hiten 2

## Opening

### Opening Remarks

16:50

*S. Shirai, Workshop Chair*

16:55 - 18:00

ANA Hotel Clement Takamatsu Hiten 2

## CRT1: Slim CRTs

Chair : S. C. Shin, Samsung SDI, Korea

Co-Chair : T. Sugawara, Asahi Glass, Japan

### CRT1 - 1: *Invited* Glass Bulb Design for Super Slim Tubes

16:55

*T. Kuwashima, T. Murakami, Y. Kobayashi  
Asahi Glass, Japan*

In the design work for Super Slim CRTs, how to reduce and disperse the vacuum stress induced on the seal portion between panel and funnel, and on the funnel body becomes a major issue to solve. This paper presents design optimization for Super Slim bulbs considering long-term reliability and safety characteristics.

### CRT1 - 2 The PF Band System for Vixlim

17:20

*J. H. Kim, S. S. Choi, J. H. Kim, S. C. Shin, H. S. Oh,  
J. S. Bae, E. S. Park, S. N. Lee  
Samsung SDI, Korea*

A CRT has great merits on screen quality, cost and so on. Therefore, it has the largest market sharing on display devices. However, it is front of serious challenge from FPD that has merits on slim thickness and light weight. One of the serious problem in slim CRT design is the increase of glass stress and weight according to shorten total length. We have developed PF Band System to solve this problem and this is the theme of this paper

### CRT1 - 3 Development of 29-in. SuperSlim CRT

17:40

*S. G. Kim, S. J. Cho, S. H. Jo, J. E. Choi, M. H. Lim,  
N. J. Koh  
LG.Philips Displays, Korea*

Since the introduction of 32-inch SuperSlim CRT, LG. Philips Displays has developed the slimmest 29-inch SuperSlim with 120 degrees deflection angle and deep gun insertion technology. With the excellent quality and comparable cost, 29" SuperSlim has the best competitiveness in the CRT models. 29" SuperSlim will make a great contribution to the extension of the life of CRT and make it possible to get advantage over FPDs.

**Author Interviews**

18:20 - 19:20

**Wednesday, December 7****9:00 - 9:50****ANA Hotel Clement Takamatsu Hiten 2****CRT2: CRT Market Trends**

Chair : M. Maeda, Maeda Consulting, Japan

Co-Chair : S. Shirai, Hitachi Displays, Japan

**CRT2 - 1: *Invited* The Future Development Trend of CRT TV Market in China****9:00***X. Yan**TCL Comps. SBU, China*

The current situation of CRT TV Market in mainland China is presented. Its further trend is discussed. It is possibly that the decline of CRT TV market in Mainland China is a little faster than most people thought.

**CRT2 - 2: *Invited* Display Scene : An Indian Perspective****9:25***J. Joseph, S. Talukdar**Samtel Color, India*

Display market in India is getting more and more importance globally due to its big potential. Booming economy, flooding of cable channels, emerging new display technologies and changing government policies are going a long way in boosting the display market size. With all the major contributing factors influencing the display market growth taken into account, CRT TV are expected to rule Indian Display Market for at least 4 to 10 years.

----- Break -----

**10:10 - 11:40****ANA Hotel Clement Takamatsu Hiten 2****CRT3: Electron Guns & Cathodes**

Chair : H. Y. Chen, Chungwa Picture Tubes, Taiwan

Co-Chair : Y. Wada, Matsushita Toshiba Picture Display, Japan

**CRT3 - 1: *Invited* Progress of Electron Gun Technology****10:10***S. Shirai**Hitachi Displays, Japan*

Electron Gun is key parts of the CRT to generate, focus and accelerate the electron beam. The CRT picture quality and lifetime are largely determined by the gun design. This paper describes beam forming region and main lens design concept, reduction of the focus characteristics distribution, etc. The latest challenge is how to cancel the strong astigmatism of the large angle (125 degrees) deflection yoke of the slim tube.

**CRT3 - 2      Electron Gun Using Dome Cathode for Full Spec. Hi-Vision TV**  
**10:35**

*Y. J. Yoon, M. C. Bae, H. C. Kim, T. W. Kim*  
*Samsung SDI, Korea*

Electron gun using impregnated dome cathode has been studied for realizing full spec hi-vision TV. Latest display device is requiring high brightness and high resolution, but it is very difficult to improve both qualities in the conventional flat cathode structure. Therefore, we have developed the new cathode structure, which is dome shaped cathode to realize initial orbits as from an object point. We can set the cathode near the first accelerated grid (G2). By this method, we can get the 2.5 times larger current than the conventional method and restrict the enlargement of working area.

**CRT3 - 3      Optimum Gun Design with the Improved E4 Main Lens for Large Screen Color TV Tubes**  
**10:55**

*Y. Wada, H. Tomoyasu\*, T. Ishihara, H. Morimoto*  
*Matsushita Toshiba Picture Display, Japan*  
*\*Matsushita Elec. Ind., Japan*

New electron guns have been developed both of dynamic focus and non-dynamic (or static) focus types for large screen color TV tubes, realizing excellent picture quality with the improved E4 main lens. In order to reduce mass-production costs, oxide cathodes are utilized instead of expensive impregnated cathodes. And almost the same design for each electrode is adopted in both types of the new electron guns.

**CRT3 - 4:      *Invited* Rare Earth Oxide Doping of Oxide Cathodes**  
**11:15**

*D. den Engelsen*  
*LG.Philips Displays, The Netherlands*

The effect on life performance by doping oxide coated cathodes with rare earth oxides is explained in terms of electrolysis of the emitter coating. Poisoning of the emission with O<sub>2</sub> can be explained with the same theory. Furthermore, a model of the crystal imperfections (defects) of BaO is proposed. This explains the experimentally observed relationship between conductivity and dopant concentration.

----- Lunch -----

**13:40 - 15:00**

**ANA Hotel Clement Takamatsu Hiten 2**

**CRT4: Masks & Glass**

Chair :            D. den Engelsen, LG.Philips Displays, The Netherlands  
 Co-Chair :        T. Kusunoki, Sony, Japan

**CRT4 - 1      Improvement of Doming and White Uniformity in  
13:40          Real Flat AK Mask CRT**

*Y. M. Poon, K. M. Kok, K. Y. Lim, C. S. Queek, C. T. Lau,  
K. W. Tan, C. C. Chao  
Chunghwa Picture Tubes, Malaysia*

For the improvement of doming and screen performance of real flat aluminiumkilled (AK) CRT tube, mask trajectory modeling is introduced to illustrate the mask aperture trajectory relative to the preferential beam trajectory during doming. Several optimal measures such as introducing enhanced curve mask and minimizing mask expansion restriction result in landing shift decreases up to 60%. Screen white uniformity is optimized using distinctive pattern filters, where improvement in color different of up to 65% is recorded.

**CRT4 - 2      Analytical Prediction of Local Doming in SuperSlim  
14:00          CRTs**

*EWC. Coenen\*, P. Martens, R.M. Jungblut  
LG.Philips Displays, The Netherlands  
\*Eindhoven Univ. of Tech., The Netherlands*

In slim tube designs we strive for as flat as possible shadow masks preferably made of AKOCA. This makes the tube sensitive to local doming. An analytical model is presented allowing quick optimisation of the mask contour giving insight into geometrical and material properties influencing mask deformation due to local heating. The principle of minimum strain energy is used to find a static mechanical equilibrium. The ratio between stiffness in North-South and East-West direction is decisive for the performance.

**CRT4 - 3      Effects of Nano Bismuth Oxide Coating on Shadow  
14:20          Mask**

*S. M. Kim, N. J. Koh  
LG.Philips Displays, Korea*

Nano bismuth oxide as new electron reflection material was studied in 29" Real Flat CPT. As results, When nano bismuth oxide with 80 nm of average diameter was used, Spray coating was done clearly without mask hole clogging and the doming properties were improved more than before in comparison with the average 3.5  $\mu\text{m}$  of the conventional bismuth oxide.

**CRT4 - 4      Development of Fast Sealing Solder Glass for CRTs  
14:40**

*N. Horie, Y. Segawa, Y. Hatakenaka, K. Okita, T. Sugiu,  
K. Watanabe, R. Tanabe, A. Nakamura\*  
Asahi Glass, Japan  
\*Asahi Techno Glass, Japan*

We have developed a fast sealing solder glass which is possible to seal in a short time to reduce a cost of CRT and to improve a productivity. A sealing time of a new solder glass is 25 min. It is 10 min. reduction compared to a conventional one. The basic properties and bulb properties of the new one are enough high.

**Author Interviews**

17:30 - 18:30

15:00 - 17:00

Citizen's Gallery

**Poster CRTp: CRTs****CRTp - 1 An Enhanced Clear Gun Design for 21" EDTV Application**

*C. T. Chan, W. N. Chang\*, P. H. Chong, C. C. Chao*  
*Chunghwa Picture Tubes, Malaysia*  
*\*Chunghwa Picture Tubes, Taiwan*

In order to get better focus performance for 21" EDTV, and to reduce the cost of grid part, an enhanced clear gun design has been implemented. We change the main lens gun structure to meet the above requirements. Due to the bigger equivalence lens diameter, the smaller spot size (on gun exit point) could be obtained. Moreover, using common grid parts with other types also reduce the cost of related grid parts by 30%.

**CRTp - 2 Improvement of Projection CRT Electron Gun with Overlapping G3 & G41 Structure**

*W. N. Chang, C. T. Wang, J. L. Huang, C. H. Yeh*  
*Chunghwa Picture Tubes, Taiwan*

A new designed to improve the focus performance of PCRT is studied. To narrow the G1&G2 aperture diameter and the G41 aperture, then to extend the G41 grid part into G3. The beam divergent angle is suppressed and the spherical aberration is reduced. Due to the overlap of G3&G41, the blur of the spot size from the side field of G3&G5 connector is prevented. A small spot size is obtained to improve the quality of PCRT.

**CRTp - 3 Body Color Improvement of High Transmittance Panel for Low Power CRTs**

*L. Yang, Z. Huang, W. Lin*  
*CPTF Optronics, China*

To cut down power consumption of CRTs, the thickness of panel is reduced. With the reduction of thickness, the body color of CRTs gets bad. A certain Ni alloy target is used to improve the body color, replacing the Ti target in surface sputter coating. The body color of low power CRTs with Ni alloy film is similar with the semi-tint CRTs.

**Supporting Organizations:**

Technical Group on Information Display, ITE  
 Technical Committee on Electronics Information Displays, Electronics Society, IEICE

# Workshop on Plasma Displays

Wednesday, December 7

13:40 - 15:00

Sunport Hall Takamatsu Small Hall 1

## PDP1: Protective Layer

Chair : L. F. Weber, Consultant, USA  
 Co-Chair : T. Shinoda, Fujitsu Labs., Japan

### PDP1 - 1: *Invited* Integrated Computational Chemistry System for Material Design of PDP

A. Miyamoto\*, H. Kikuchi\*, H. Tsuboi\*, M. Koyama\*,  
 A. Endou\*, M. Kubo\*\*, C. A. Del Carpio\*, H. Kajiyama\*\*\*  
 \*Tohoku Univ., Japan  
 \*\*JST-PRESTO, Japan  
 \*\*\*Univ. of Tokyo, Japan

First-principles calculations suggested that both positive and negative charges accumulated in MgO protecting layer decrease its stability. Moreover, we proposed that Al cation is an effective dopant for the MgO protecting layer, because it increases both the stability and secondary electron emitting ability. Our tight-binding quantum chemical molecular dynamics method revealed that oxygen vacancy decreases the stability of the MgO protecting layer. Finally, we concluded that our integrated computational chemistry system is very effective to design plasma display panel.

### PDP1 - 2 Quantum Chemical Molecular Dynamics, Classical Molecular Dynamics, and Kinetic Monte Carlo Approach to Design of MgO Protecting Layer in PDP

M. Kubo\*\*, H. Kikuchi\*, H. Tsuboi\*, M. Koyama\*,  
 A. Endou\*, C. A. Del Carpio\*, H. Kajiyama\*\*\*,  
 A. Miyamoto\*  
 \*Tohoku Univ., Japan  
 \*\*JST-PRESTO, Japan  
 \*\*\*Univ. of Tokyo, Japan

We succeeded in the development of a new kinetic Monte Carlo program to simulate the destruction processes of the MgO protecting layer in plasma display panel by the electric charge accumulated in the MgO surface. Simulation results proposed that MgO (111) surface with nano-dot structures covered by (001) facets has the highest stability under electric field condition, which is against the previous knowledge on the thermal stability of MgO. The mechanism of the high stability of the above structure was clarified.

**PDP1 - 3      Secondary Electron Emission from MgO Films on  
14:20      Metal Substrates**

*H. Kajiyama\*, K. Tsutsumi\*, T. Fukasawa\*, M. Ishimoto\*\*,  
G. Uchida\*, T. Nishio\*, T. Shinoda\*\*\**

*\*Univ. of Tokyo, Japan*

*\*\*Fujitsu Labs., Japan*

Secondary electron emission coefficient,  $\gamma$ , of MgO deposited on a metal substrate was measured at the temperatures below and above the deposition temperatures. The  $\gamma$  was temperature dependent and had a broad convex peak at the temperature a little bit higher than the deposition temperature. The mechanism of temperature dependence of  $\gamma$  is discussed based on the thermal stress induced by the mismatch of thermal expansion coefficient between an MgO film and a metal substrate.

**PDP1 - 4:      *Invited* Discharge Time Lag Shortening by New  
14:40      Protective Layer in AC PDP**

*M. Amatsuchi, A. Hirota, H. Lin, T. Naoi, E. Otani,*

*H. Taniguchi, K. Amemiya*

*Pioneer, Japan*

A new material shortening discharge lag time (DLT) for plasma display panels (PDPs) has been developed. New cell structure in which the material is formed as a layer in each cell. We named it "Crystal Emissive Layer" (CEL) and CEL structure. DLT of the new cell is reduced to 1/8 of the conventional one. DLT of CEL structure panels keeps short for the various cell conditions such as Xe concentration, cell size, RGB phosphor and so on.

**Author Interviews**

17:30 - 18:30

15:00 - 17:00

Citizen's Gallery

**Poster PDPp1: PDP (1)**

**PDPp1 - 1      Improvement of Bright-Room Contrast of PDP by  
Optical Filters Using Organic Dyes**

*M. Morohashi, H. Minami, T. Kitagawa, A. Morimoto, T. Ito,  
T. Okamura*

*Mitsui Chems., Japan*

Optical filters which can improve image qualities of Plasma Display Panels (PDPs) have been studied. We obtained optical filters that realize high bright-area contrast and good surface color of PDPs under various external illuminants, e.g. three-band fluorescent lamps, by utilizing colored adhesive containing organic dyes that selectively absorb unpreferable light.

**PDPp1 - 2      Development of Novel Chassis of 42-in. PDP Module for Reducing Material Cost and Weight**

*K. Jeong, I. Cho, K. Lee  
Samsung SDI, Korea*

As a continuing effort to reduce module cost of PDPs, a novel approach for chassis structure is proposed in this study. Up to now chassis structure is made of aluminum alloy for its excellent characteristics of thermal and electrical conductivities. Adopting plastic material instead of traditional aluminum as for a chassis, both the cost and weight can be reduced more than 30 percent. Thermal and electrical substructures are also devised for the purpose of both electrical ground and thermal dissipation.

**PDPp1 - 3      Suppression of Visible Defects Caused by Microscopic Particles in Direct Filter Attached on PDP**

*N. Hori, Y. Kawanami  
Fujitsu Hitachi Plasma Display, Japan*

We have introduced a novel adhesive layer into the surface filter attached on PDP. The adhesive layer avoids visible defects induced by the incidental microscopic particles between the filter and the front glass substrate of PDP, by involving them with little air bubble. This filter is successfully laminated on the final-tested PDP module.

**PDPp1 - 4      Withdrawn****PDPp1 - 5      New 256-ch PDP Address Driver IC with Reducing Switching Noise**

*T. Nomiyama, K. Kawamura, A. Fukuchi, K. Sato,  
Y. Shigeta, G. Tada  
Fuji Elec. Device Tech., Japan*

We have developed new 256-ch PDP address driver IC with reducing switching noise and good cost performance. To solve switching noise problem, we have developed gate controlled output technique which can reduce switching noise successfully. In addition, we adopted semi-slim type layout to keep GND stable in TCP, and to prevent from operational errors. By new type layout, we could shrink die size per output down to  $0.067\text{mm}^2$ , 15% smaller than our conventional slim type IC.

**PDPp1 - 6 Current Injection Energy Recovery Sustaining Driver with Phase Shift Control for PDP**

*C.-L. Liu, S.-T. Yang, J.-W. Chen\*, C.-Y. Lee\*, C.-H. Lu\*,  
S.-H. Wang\*, W.-C. Chang\**  
*Chunghwa Picture Tubes, Taiwan*  
*\*Tatung Univ., Taiwan*

An energy recovery sustaining driver with phase shift control for AC PDP is presented in this paper. Both simulation and experimental results show that the switching losses and current stress on switches can be reduced significantly so that the efficiency is increased. With current injection mode, a cost-effective energy recovery is proposed to produce more stable light waveforms and reduces voltage across switches. It is most important that with optimum shift angle the panel temperature can be lowered effectively.

**PDPp1 - 7 New Two Stage Recovery (TSR) Driving Method for Low Cost AC PDP**

*K. Ito, B.-G. Cho\*, M. K. Lee, J. W. Song, S. C. Kim,  
H.-S. Tae\*, N.-S. Jung, K.-S. Lee*  
*Samsung SDI, Korea*  
*\*Kyungpook Nat. Univ., Korea*

In this paper, a new driving scheme and energy recovery method is proposed to reduce the cost of plasma display panel (PDP). In proposed driving scheme, two electrodes in three-electrode type AC PDP are used and sustain pulse which consist of positive and negative pulse is applied to a scan electrode. In order to embody positive and negative sustain pulse, PDP driving circuit that adopted the TSR (Two Stage Recovery) method is proposed. Proposed driving scheme and energy recovery method can reduce cost for driving circuit without increasing power consumption.

**PDPp1 - 8 New Cost-Effective Driving Method Based on Vt Close Curve Analysis in AC PDP**

*B.-G. Cho, H.-S. Tae, K. Ito\*, J. W. Song\*, M. K. Lee\*,  
S.-C. Kim\*, N.-S. Jung\*, K.-S. Lee\**  
*Kyungpook Nat. Univ., Korea*  
*\*Samsung SDI, Korea*

A new driving waveform was proposed to reduce the cost in 42 inch PDP-TV based on Vt close curve by eliminating the common board. Due to the misfiring problem during sustain-period when applying new driving waveform, the wall voltage was measured and analyzed using Vt close curve. As a result of adopting proposed driving waveform designed using Vt close curve analysis, the cost of PDP module could reduce about 20 % compared with the conventional PDP module without misfiring discharge.

**PDPp1 - 9      A Two-Step-Discharge Driving Method and Quantitative Analysis of Increased Luminous Efficiency of AC PDPs**

*K. Yamamoto, K. Suzuki, T. Kishi\*, T. Sakamoto\**  
*Hitachi, Japan*  
*\*Fujitsu Hitachi Plasma Display, Japan*

A driving method for sustain-modulation two-step discharge was developed, and factors in increased luminous efficiency of ac-PDPs were quantitatively analyzed. The panel luminous efficiency achieved by this method was 61% higher than that achieved by the conventional method. The factors in increased luminous efficiency are (1) a 51% increase in discharge luminous efficiency due to a lower discharge space voltage, and (2) a 7% increase in discharge power efficiency because of lower discharge current peaks in the panel.

**PDPp1 - 10      Reducing Average Address Power of PDPs**

*X. Zhang, C. Liu, J. Zhang, Z. Tu*  
*Xi'an Jiaotong Univ., China*

Address power is proportional to the change rate of subfield data in vertical direction. It can be reduced obviously using address energy recover circuit for some picture with high change rate, but increase address power for others with low change rate. According to the change rate, adaptive energy recover circuit is developed and it can keep address power in low for any picture.

**PDPp1 - 11      Effects of Priming Particles on Reset Discharge Produced by Dual-Slope Ramp Reset Waveforms in AC PDP**

*J. K. Lim, H.-S. Tae*  
*Kyungpook Nat. Univ., Korea*

The effects of priming particles on the weak reset discharge characteristics in the dual-slope ramp reset waveform are examined. The first voltage-slope ramp waveform plays a role in producing the priming particles, which has a significant influence on the reset discharge during the second voltage-slope period. That is, the priming particles produced by the first voltage-slope ramp waveform contribute to facilitating and lowering the IR emission intensity during the second voltage-slope period.

**PDPp1 - 12 New Address-While-Display Driving Method for High Picture Quality PDP**

*J.-C. Jung, K. H. Seo, J. K. Kim\*, K.-W. Whang  
Seoul Nat. Univ., Korea  
\*Hankyong Nat. Univ., Korea*

We propose a new address-while-display (AWD) driving method to obtain a high contrast ratio and a wide driving margin in which short ramp reset (SRR) pulse made it possible to assure a high dark room contrast ratio of 10000 to 1 or more and a wide operating voltage margin of 40V by redistributing the wall charges between address and scan electrode effectively. Moreover, the improved moving picture quality could be obtained by reducing the dynamic false contour through the alternating subfield arrangement (ASA) method without any other additional image processing.

**PDPp1 - 13 Optical Characteristics for Image Sticking on AC PDP**

*Y. G. Han, S. B. Lee, C. G. Son, S. H. Jeong, N. L. Yoo,  
H. J. Lee, J. H. Lee, K. B. Song, B. D. Ko, J. M. Jeong,  
P. Y. Oh, M. W. Moon, K. B. Jung, E. H. Choi\*  
Kwangwoon Univ., Korea  
\*LG. Philips LCD, Korea*

We have investigated the driving method of AC-PDP for preventing image sticking. The preventing method of image sticking was proposed by adopting the SRP(Sticking Removal Pulse). The variation of brightness is most affected by the MgO formed on the surface of the phosphor layer. Using SRP we could take off the MgO on the phosphor. As a result, the image sticking is reduced when the driving method adopted an SRP.

**PDPp1 - 14 Degradation Characteristics of MgO Protective Layer and Phosphor in AC PDP**

*K. B. Song, P. Y. Oh, S. B. Lee, H. J. Lee, C. G. Son,  
E. H. Choi  
Kwangwoon Univ., Korea*

We have investigated the characteristics of degradation of MgO protective layer and phosphor, which correlates to the image-sticking in AC-PDP. Firing and sustain voltages have been lowered as compared with those for normal MgO protective layer and barrier rib. But the test panel without phosphor and barrier rib has been shown to have higher firing and sustain voltages than those for the test panel with both barrier rib and phosphors in AC-PDP. It is also found that the discharge current was further delayed for the test panel without rear plate than those with both barrier rib and phosphors.

**PDPp1 - 15L New Driving Method for High Contrast Ratio of AC PDPs**

*J. G. Bae, J. Y. Kim  
Sejong Univ., Korea*

A new driving method that requires less reset time and that significantly improves the dark room contrast ratio is introduced. Using this new driving method, the required time for reset could be reduced to 150 $\mu$ s from 350 $\mu$ s of the conventional ramp reset method, and almost infinite dark room contrast ratio is obtainable because the luminance of the off-cell is almost zero.

**Thursday, December 8**

**9:00 - 10:20**

**Sunport Hall Takamatsu Small Hall 1**

**PDP2: Driving (1)**

Chair : H. Tolner, Consultant, The Netherlands  
Co-Chair : M. Uchidoi, Pioneer, Japan

**PDP2 - 1: *Invited* Challenge of Measuring Annual Energy Consumption of TV Sets**

*L. F. Weber  
Consultant, USA*

The complex TV-signal-dependent energy consumption characteristics of PDP TVs are analyzed to arrive at an energy measurement method that is fair to all TV display technologies including: LCD, PDP, CRT, OLED, FED and Projection.

**PDP2 - 2 Driving of High Contrast and High Speed Discharging PDP**

*K. Sakata, T. Tokunaga, M. Nishimura, S. Iwaoka,  
N. Saegusa  
Pioneer, Japan*

New driving waveform optimized for CEL structure (new cell design using Crystal Emissive Layer) has been introduced. CEL has made stable and very weak reset discharge possible, and dark room contrast ratio of 4000:1 is obtained. High speed discharging of CEL structure and low address power consumption of CLEAR driving method have realized the single scan addressing of XGA plasma display panel (PDP). We assure that these technologies will open the much higher resolution PDP era.

**PDP2 - 3      High-Speed Driving of PDPs with Wall-Charge  
9:40            Elimination Write-Address Scheme**

*T. Sawada, T. Koike, D. H. Kim, T. Shiga, K. Igarashi,  
S. Mikoshiba  
Univ. of Electro-Commun., Japan*

A high-speed driving technique is introduced in which addressing is done by eliminating, instead of accumulating, the wall charges. The data pulse of 1.33 $\mu$ s wide and 100V was realized in a Ne+10%Xe PDP. A contrast of 3200:1 was obtained by providing one setup period in a TV field.

**PDP2 - 4      New LLC Resonant Converter with Multiple Outputs  
10:00           for High Efficiency and Low Cost PDP Power Module**

*C.-E. Kim, K.-H. Yi, S.-W. Choi, G.-W. Moon, D.-W. Kim\*,  
K.-I. Oh\*, N.-S. Jung\*, K.-S. Lee\*  
KAIST, Korea  
\*Samsung SDI, Korea*

A new LLC resonant converter with multiple outputs is proposed for high efficiency and low cost plasma display panel (PDP) power module. By employing the transformer, which has the two and more secondary side, the proposed converter can have multiple outputs and they show the great cross-regulation characteristics. Therefore, the proposed converter can be implemented with high efficiency, low cost, and compact size, and then the proposed converter is suitable for high efficiency and low cost PDP power module.

----- Break -----

10:40 - 12:00

Sunport Hall Takamatsu Small Hall 1

**PDP3: Discharge and Driving (2)**

Chair :            K. W. Whang, Seoul Nat. Univ., Korea  
Co-Chair :        S. Mikoshiba, Univ. of Electro-Commun., Japan

**PDP3 - 1      Analysis on Reset Discharge Characteristic in AC  
10:40           PDP with Sustain Gap of 200 $\mu$ m**

*K.-H. Park, S.-K. Jang, H.-S. Tae, J.-H. Seo\*, S.-H. Lee\*\*  
Kyungpook Nat. Univ., Korea  
\*Incheon Univ., Korea  
\*\*Inha Univ., Korea*

The reset discharge characteristic is investigated in a sustain gap of 200  $\mu$ m. As the sustain gap is wider, the stable weak discharge region using an MgO cathode condition is decreased, whereas the unstable weak discharge region using a phosphor cathode condition is increased. To reduce the unstable reset discharge in a sustain gap of 200 $\mu$ m, the bias voltage ( $V_{\text{add-bias}}$ ) needs to be applied additionally to the address electrode during the ramp-up period and the X-bias voltage ( $V_{\text{com-bias}}$ ) needs to be controlled properly to the common(X)electrode during the ramp-down period. The reset discharge in a sustain gap of...

**PDP3 - 2      Feasibility of Driving PDP with 1-Volt Data and 30-Volt Scan Pulses by Utilizing Self-Erase-Discharge Threshold**

*A. Saito, T. Shiga, S. Mikoshiba  
Univ. of Electro-Commun., Japan*

Data and scan pulse voltages can be reduced to 1 and 30 volts, respectively, by utilizing a sharp threshold of self-erase-discharge ignition, provided that the panel has perfectly uniform characteristics. If the panel has a breakdown voltage non-uniformity of  $\Delta V$ , then the data pulse voltage has to be increased by  $\Delta V$ . To realize the low voltage addressing operation, the erase-addressing scheme is adopted together with accumulating an appropriate amount of wall charges prior to the addressing.

**PDP3 - 3      Study on Characteristics of AC PDP with Stacked Facing Electrode**

*J. W. Ok, H. J. Lee, W. S. Choi, Y. M. Jang, H. J. Lee,  
C. H. Park, J. S. Kim\*, J. H. Ryu\*  
Pusan Nat. Univ., Korea  
\*LG Elect., Korea*

In this study, we propose a new structure of stacked facing-electrode. The proposed structure has a long discharge gap, low discharge currents, high luminance, so it has high luminous efficiency. On the basis of results from 2-D simulation model, we make 4-inch test panel formed by the structure of stacked facing-electrode. When compared with the conventional structure of coplanar-electrode, proposed structure showed about 2.9 times increment of luminous efficiency, 49% improvement of luminance, and 62% decrement of discharge currents.

**PDP3 - 4      High Luminous Efficacy AC PDP with Auxiliary Electrodes**

*N.H. Shin, K. S. Lee, S. C. Song, B. J. Shin, K. C. Choi\*  
Sejong Univ., Korea  
\*KAIST, Korea*

High luminous efficacy AC PDP with the auxiliary electrodes in the front plate was proposed and investigated. The auxiliary electrode located at the center of scan and common electrode was made of transparent ITO. The efficacy had its maximum value when the spacing between scan and common electrode was 200 $\mu$ m. The maximum efficacy of test panel with stripe barrier rib, VGA resolution, and green cell was 6.7 lm/W for Ne+13%Xe and 8.7 lm/W for Ne+20%Xe gas-mixture, respectively.

**Author Interviews**

17:30 - 18:30

15:00 - 17:00

Exhibition Hall

**Poster PDPp2: PDP (2)****PDPp2 - 1 High Resolution Photosensitive Ag Paste and Photolithographic Process for PDP**

*L. S. Park, H. S. Yoon, D. G. Kim, S. H. Kim, Y. J. Hur,  
A. Tawfik*

*Kyungpook Nat. Univ., Korea*

Several methods are available for the fabrication of electrode pattern for the plasma display panel (PDP) including screen printing, photolithographic and piezo-type ink-jet printing methods. In this work we synthesized acrylic terpolymers with different acid value and molecular weight as binder polymers and examined their effect on the photolithographic patterning of electrodes on the PDP panel from the view point of high definition TV application.

**PDPp2 - 2 Prevention of Yellowing of Bi-Based Transparent Dielectric Layers in PDP**

*J. S. Park, J. H. Hwang, C. Y. Kim, T. Masaki\*, D. K. Choi\*\*,  
K. J. Hong\*\*\**

*Korea Inst. of Ceramic Eng. & Tech., Korea*

*\*Halla Univ., Korea*

*\*\*Hanyang Univ., Korea*

*\*\*\*Phoenix PDE, Korea*

Method of the preventing yellowing which is caused by the formation of Ag colloids was examined. To prevent yellowing, we examined the effect of firing temperature of dielectric layer, metal oxide additives and the particle size of transparent dielectric glass. Yellowing was diminished as the firing temperature increased. Among the many kinds of metal oxide additives, best result of preventing yellowing was obtained by the addition of CuO. With the effect of particle size, large particle size showed the less yellowing.

**PDPp2 - 3 Withdrawn****PDPp2 - 4 Withdrawn****PDPp2 - 5 Temperature Dependence of Secondary Electron Emission from MgO**

*K. Tsustumi\*, M. Ishimoto\*\*, T. Fukasawa\*, G. Uchida\*,  
H. Kajiyama\*, T. Shinoda\*,\*\**

*\*Univ. of Tokyo, Japan*

*\*\*Fujitsu Labs., Japan*

Secondary electron emission (SEE) from MgO is measured at the temperatures between 373 and 673 K. The sample is the one deposited at 523 K on indium tin oxide (ITO) coated glass substrate. We find that there are three SEE phases depending on the temperatures: low emission phase above 573 K, high emission phase below 423 K and transition phase at intermediate temperatures.

**PDPp2 - 6      Electro-Optical and Degradation Characteristics of MgO Protective Layer after RF Plasma Treatment**

*C. G. Son, H. J. Lee, Y. G. Han, S. H. Jeong, N. L. Yoo, S. B. Lee, J. E. Lim, J. H. Lee, B. D. Ko, J. M. Jeoung, M. W. Moon, P. Y. Oh, J. C. Jung, W. B. Park\*, E. H. Choi Kwangwoon Univ., Korea  
\*LG Elect., Korea*

We investigated electro-optical and degradation characteristics of MgO protective layer after radio frequency (RF) plasma treatment. Specially, O<sub>2</sub> plasma treatment has best discharge characteristics, because O<sub>2</sub> plasma removed the contaminating materials from the surface of MgO through the physical etching and the chemical reaction. These surface properties changing have an effect on degradation characteristics. The degraded MgO have been changed the surface morphology. As deposited MgO surface morphology is changed more than O<sub>2</sub> plasma treatment MgO. This result means that O<sub>2</sub> plasma treatment MgO surface is harder than as deposited MgO surface.

**PDPp2 - 7      Sputtering Yield of MgO Protective Layer in AC PDPs**

*H. J. Lee, C. G. Son, S. H. Jung, Y. K. Han, S. B. Lee, N. L. Yoo, J. E. Lim, J. H. Lee, K. B. Song, M. W. Moon, P. Y. Oh, B. D. Ko, J. M. Jeoung, J. W. Hyun, E. H. Choi Kwangwoon Univ., Korea*

The sputtering yield of MgO protective layer is related with the image sticking. In this research, we have investigated the sputtering yield of various MgO protective layers. So we have measured ion induced secondary electron emission coefficient, the sputtering yield and erosion rate of MgO protective layer and have observed the surface of MgO layer. As a result, we have concluded that fused poly MgO is the most stability material as protective layer of AC-PDP.

**PDPp2 - 8      Characteristics of Discharge and Secondary Electron Emission Coefficient for MgAl<sub>2</sub>O<sub>4</sub>/MgO Protective Layer in AC PDPs**

*J. M. Jeoung, B. D. Ko, P. Y. Oh, M. Y. Moon, K. B. Song, J. H. Lee, J. E. Leem, H. J. Lee, Y. K. Han, S. B. Lee, S. H. Jeong, C. K. Son, N. R. Yu, E. H. Choi Kwangwoon Univ., Korea*

The secondary electron emission coefficient ( $\gamma$ ) of the MgAl<sub>2</sub>O<sub>4</sub>/MgO protective layer has been investigated by  $\gamma$ -focused ion beam( $\gamma$ -FIB) system. The MgAl<sub>2</sub>O<sub>4</sub>/MgO protective layer have been found to have higher values from 0.09 up to 0.12 than those for MgAl<sub>2</sub>O<sub>4</sub> protective layer from 0.06 up to 0.07 for Ne<sup>+</sup> ion energies ranged from 90eV to 200 eV. Also it is found that for the MgAl<sub>2</sub>O<sub>4</sub>/MgO protective layer of secondary electron emission coefficient ( $\gamma$ ) is similar to that for the MgO protective layer.

**PDPp2 - 9 Measurement of Excited Xe Atom Density, Micro-Discharge Plasma Density and Electron Temperature in AC PDP**

*P. Y. Oh, J. H. Lee, S. H. Jeong, S. B. Lee, M. W. Moon, E. H. Choi*  
*Kwangwoon Univ., Korea*

The plasma ion density in AC-PDP is increased from  $5.6 \times 10^{11} \text{ cm}^{-3}$  to  $9.0 \times 10^{11} \text{ cm}^{-3}$  as the Xe mixture ratio to neon increase from 1 % to 10 %, respectively, at 400 Torr. It is also noted that  $5.2 \times 10^{12} \text{ cm}^{-3}$  in the  $1s_5$  metastable state and  $1.2 \times 10^{12} \text{ cm}^{-3}$  in the  $1s_4$  resonance state for the same condition. It is observed that the excited Xe atom density and the plasma ion density are in strong correlation sharp between each other in this experiment.

**PDPp2 - 10 Measurement of Excited Xe Atom Density with Position on Sustaining Electrode in AC PDPs**

*S. B. Lee, P. Y. Oh, J. H. Lee, H. J. Lee, Y. G. Han, S. H. Jeong, C. G. Son, B. D. Ko, J. M. Jeoung, J. E. Lim, N. L. Yoo, M. W. Moon, K. B. Song, E. H. Choi*  
*Kwangwoon Univ., Korea*

In this study, we have been measured in the  $1s_5$  metastable state by varying position of bus electrodes with ITO gap of 50  $\mu\text{m}$  distances under the fixed gas pressure of 350 Torr and Ne-Xe(10%) mixture gas by laser absorption spectroscopy in AC-PDP. It is noted that the maximum excited xenon atoms densities are  $1.8 \times 10^{13} \text{ cm}^{-1}$ ,  $1.6 \times 10^{13} \text{ cm}^{-1}$  and  $1.7 \times 10^{13} \text{ cm}^{-1}$  for the outbus, middle, and inside ones. And the voltage margin for the inside, middle side and outside cases is 70 V, 95 V, 84V respectively. However, there is no difference of discharge current delay.

**PDPp2 - 11 Influence of Permittivity of Dielectric Layer on Discharge Characteristics in High-Resolution AC PDP**

*Y. Hirano, K. Ishii, Y. Murakami*  
*NHK, Japan*

In order to explore the possibility of realizing the high-resolution AC PDP, we have been examining the discharge characteristics of a fine-pitch discharge cell. The discharge region in AC PDP is surrounded by insulator materials, and so the electrical characteristics of the material have a greater effect on the discharge characteristics. In this study, we have attention to permittivity of panel material, and we performed analysis for the discharge characteristics of the fine-pitch discharge cell using 3-D discharge simulation.

**PDPp2 - 12    Spatial Density Distribution of 1s<sub>5</sub> Excited Xe Atoms with Operating Time Measured by Laser Absorption Spectroscopy in AC PDP**

*J. H. Lee, P. Y. Oh, S. B. Lee, H. J. Lee, Y. G. Han,  
S. H. Jeong, M. W. Moon, E. H. Choi  
Kwangwoon Univ., Korea*

In this study, we have measured the absorption signals for the 1s<sub>5</sub> xenon metastable state in the PDP cell with gap distances of 120μm under the gas pressure of 350Torr and He(50%)-Ne-Xe(10%)mixture gas in accordance with degradation times for the 72hours. It is found that the peak of excited xenon atoms density was increased rapidly at operation time of 12 hours from  $6.56 \times 10^{12} \text{cm}^{-3}$  to  $8.78 \times 10^{12} \text{cm}^{-3}$ . And then it was increased continuously and slowly as operation time passed until 72hours. And it is found that the peak of excited xenon atoms density was broad as the degradation time was long.

**PDPp2 - 13    Front Address Structure for High Luminous Efficacy AC PDPs**

*Y. Okumura, Y. Shintani, T. Ishibashi, M. Yoshinari,  
T. Komaki  
Pioneer, Japan*

8-inch AC Plasma Display Panels with front address (FA) structures are developed. Deep barrier ribs and high Xe content gas are applied to FA structures for high luminous efficacy. FA structures have some advantages under conditions of deep barrier ribs and high Xe content gas.

**PDPp2 - 14    Numerical Analysis of Capacitance between X-Y Electrodes, and A-Y Electrodes on Cell Parameter in AC PDPs**

*E. Y. Jung, J. C. Ahn, S. B. Kim, K. J. Suh, E. G. Heo,  
B. H. Lee, K. S. Lee, S. B. You, J. S. Jung, J. Y. Park,  
S. B. Song, H. Y. Lee  
Samsung SDI, Korea*

The characteristics of charge distribution on cell parameters are investigated by using numerical simulation in order to find a relation between wall charge distribution with respect to cell parameters and realize a full HD PDP. The simulation results show that both capacitance of front panel (C<sub>xy</sub>) and rear panel (C<sub>ay</sub>) strongly depend on the address electrode width, and barrier rib properties such as rib height, permittivity, rib shape. In addition, the wall charge distribution has strong correlation and a influence on determining a discharge characteristics with respect to cell geometry.

**PDPp2 - 15 Effect of Kr and Ar on Discharge Time Lag and Image Retention in AC PDP with High Xe Content**

*S. H. Kim, K. C. Choi\*, B. J. Shin, K.-Y. Choi\*\*, E.-H. Yoo\*\*  
Sejong Univ., Korea  
\*KAIST, Korea  
\*\*LG Elect., Korea*

The additive gas effect on the discharge time lag of address pulse and the image retention was investigated in AC PDP with Ne+13%Xe gas-mixture. The discharge time lag was improved by adding a small amount Kr gas to Ne+13%Xe gas-mixture up to 2% and thereafter gotten worse. In the case of the addition of Ar gas to the Ne+13%Xe, the discharge time lag of address pulse was not improved. The image retention time was improved in AC PDP with Ne+13%Xe+[Kr or Ar] gas-mixture when the concentration of Ar or Kr was varied from 1 to 5%.

**PDPp2 - 16 Vacuum Ultraviolet Luminous Efficiency of He-Ne-Xe Gas Mixture in AC PDP**

*N. L. Yoo, J. H. Lee, Y. G. Han, S. B. Lee, C. G. Son,  
S. H. Jeong, H. J. Lee, J. E. Lim, P. Y. Oh, M. W. Moon,  
J. M. Jeoung, B. D. Ko, K. B. Jung\*, H. S. Uhm\*\*,  
E. H. Choi  
Kwangwoon Univ., Korea  
\*LG.Philips LCD, Korea  
\*\*Ajou Univ., Korea*

The gas mixture ratio is major factor to improve the luminous efficiency. To achieve the high luminous efficiency, high VUV emission efficiency is needed. Currently ternary gas(He-Ne-Xe) is being researched actively to improve luminous efficiency. To find the optimal gas mixture ratio for improving VUV luminous efficiency, we measured VUV intensities of 147 nm and 173 nm. The VUV emission characteristics of He(50%)-Ne-Xe showed similar to He(70%)-Ne-Xe tendency. And the VUV emission efficiency of He(50%)-Ne-Xe is nearly similar to He(70%)-Ne-Xe.

**PDPp2 - 17 Influence of Oxidation of MgO Pellet on Discharging Properties of AC PDP**

*B. D. Ko, J. M. Jung, H. J. Lee, C. K. Son, P. Y. Oh,  
M. W. Moon, K. B. Song, J. E. Leem, Y. K. Han, S. B. Lee,  
S. H. Jung, N. R. Yu, J. H. Lee, E. H. Choi  
Kwangwoon Univ., Korea*

In order to remove Oxygen Vacancy in the MgO pellet of a raw material of protective layer of AC-PDP, We had impregnated with O<sub>2</sub> gas of high pressure to MgO pellet. And we measured content of Hydrogen and Carbon in the pellet by EA(Elemental Analyzer), and also we measured film density, secondary electron emission coefficient( $\gamma$ ). The result is content of impurities are lower than conventional type pellet. And the film from oxidation pellet, and the film density, secondary electron emission coefficient, and lower discharging voltage than the film from conventional type pellet.

**PDPp2 - 18      Influence of Crystal Orientation on Secondary Electron Emission of Polycrystalline MgO Film on Silicon**

*H. K. Yu, W. K. Kim, J.-L. Lee, J. S. Kim\*, J. H. Ryu\**  
*Pohang Univ. of Sci. & Tech., Korea*  
*\*LG Elect., Korea*

The relationship between crystal orientation and secondary electron emission characteristics of polycrystalline MgO films was investigated. The secondary electron emission coefficient significantly increased with decreasing deposition rate ( $\leq 5 \text{ \AA}/\text{sec}$ ). The X-ray diffraction results showed that the (111) to (200) peak intensity ratio of MgO films increased with deposition rate, which was due to the higher surface energy of MgO (111) plane. MgO films predominantly (111) oriented axis have higher work function, leading to the decrease of secondary electron emission coefficient.

**PDPp2 - 19      Relationship between Density of MgO Thin Films and Panel Properties of AC PDP**

*W. C. Lee, S. O. Kim, K. L. Chen\*, S. Chen\*, C. P. Lee\*, C. M. Huang\**  
*Nat. Chiao Tung Univ., Taiwan*  
*\*Chunghwa Picture Tubes, Taiwan*

The MgO thin films for AC-PDPs are deposited by e-beam evaporation with varied oxygen flow rate and e-beam current. The panel properties such as luminance, response time, dynamic margin, color temperature and CIE coordinate are characterized as a function of time with the aging environment. The result reveals that a plasma display panel with MgO thin film of lower O<sub>2</sub> flow rate would provide better panel properties due to higher density of MgO thin film and higher crystallinity accompanied with higher surface roughness.

**PDPp2 - 20      Withdrawn**

**PDPp2 - 21      Physical Stability of Cathode Materials from Ion-Bombardment in Discharge**

*M. L. Cha, H. S. Kim*  
*Inha Univ., Korea*

No abstract was submitted.

**PDPp2 - 22      Study of Discharge for 25-in. SVGA SM-PDP without ITO**

*X. Zhang, Y. Tu, Q. Li, Y. Tang, Z. Fan, L. Yang, Y. Zheng, B. Wang*  
*Southeast Univ., China*

A 25 inch SVGA ACPDP with shadow mask (SMPDP) is presented in this paper. Capacitance has been reduced over 20% by adopting ITO-less structure, which enables high speed addressing for large capacity display. Color purity has been improved by applying high Xe content. Discharge characteristics are studied by capturing discharging process with ICCD camera.

**PDPp2 - 23L Discoloration of Transparent Dielectric with Bi<sub>2</sub>O<sub>3</sub> Glass Frit**

*S. J. Hwang, M. L. Cha, H. S. Kim  
Inha Univ., Korea*

In display industry the lead glass has been altered to lead free oxide glass due to the environment regulation. However, thick films of lead free oxide glass discolor after firing. The aim of the present paper is to give the source of discoloration with evaluating the bismuth glass frit surface. Based on our preliminary results, the lead free glass should be considered with designing composition, selecting a milling solution, and dealing with non-contamination.

**Friday, December 9****9:00 - 10:20****Sunport Hall Takamatsu Small Hall 1****PDP4: Image Quality**

Chair : C. Wedding, Imaging Syss. Tech., USA

Co-Chair : K. Nunomura, Pioneer, Japan

**PDP4 - 1: *Invited* Ergonomic Requirements for Large-Area Flat Panel TVs**

*M. Takahashi  
Osaka Kyoiku Univ., Japan*

Large-area flat panel PDP- and LCD-TVs are being used more and more these days in home. These new kinds of TVs were evaluated from ergonomic viewpoints of display visibility and visual fatigue. The results showed that LCD-TVs caused a noticeable luminance and chromatic variation of the picture with viewing angle, and decrease of visual acuity in prolonged watching of video image with rapid motion. This current ergonomic evaluation suggests that PDP-TVs can be superior to LCD-TVs as home-use.

**PDP4 - 2 Driving Waveform for Reducing Temporal Dark Image Sticking in AC PDP**

*C.-S. Park, B.-G. Cho, J.-H. Han, H.-S. Tae, D. H. Lee,  
S.-I. Chein, B. J. Shin\*  
Kyungpook Nat. Univ., Korea  
\*Sejong Univ., Korea*

The experimental observation on the IR emission during a ramp-up reset period shows that the activated MgO surface and the wall charges accumulating on the address electrode prior to the reset period are two dominant factors for a temporal dark image sticking phenomenon. As a result of monitoring the difference in the IR emission and luminance between the cells with and without image sticking, the new driving waveforms, including pre-reset and reset waveforms, and negative-going ramp-type X bias, are proposed for a complete elimination of the temporal dark image sticking without deteriorating the address discharge characteristics.

**PDP4 - 3      Firing Voltage Fluctuation Phenomenon Caused by  
9:40            Gas Density Nonuniformity in PDPs**

*T. Kosaka, K. Sakita, K. Betsui  
Fujitsu Hitachi Plasma Display, Japan*

The mechanism of temporal image sticking in PDPs is not understood in detail. This paper shows that the temperature-dependent characteristics of the firing voltage related to the image sticking are derived from gas density nonuniformity in a panel, and its principle is based on the Paschen's law. Using this mechanism, we found that the temporal image sticking can be controlled by changing the gas pressure in a panel.

**PDP4 - 4      Discharge Characteristics under Various Panel  
10:00           Temperature and Modified Ramp-Reset Waveform  
Robust for Variable Panel Temperature**

*S.-K. Jang, H.-S. Tae, S.-B. Kim\*, E.-Y. Jung\*, K.-J. Suh\*,  
J.-C. Ahn\*, E.-G. Heo\*, B.-H. Lee\*, K.-S. Lee\*  
Kyungpook Nat. Univ., Korea  
\*Samsung SDI, Korea*

The changes in the discharge characteristics such as a firing voltage and IR emission among the three electrodes are examined relative to the low or high panel temperature ranging from -10 to 80°C based on the  $V_t$  close curve measurement method. It is observed that the variation in the panel temperature has a significant influence on the surface discharge between the MgO surfaces rather than the plate gap discharge between the MgO and phosphor layers. Based on this experimental observation, the modified reset waveform that alleviates the surface discharge during a ramp-up period is proposed. As a result of...

----- Break -----

10:40 - 11:55

Sunport Hall Takamatsu Small Hall 1

**PDP5: Novel PDPs**

Chair :            R. L. Johnson, Info. Tech., USA  
Co-Chair :        R. Murai, Matsushita Elec. Ind., Japan

**PDP5 - 1:      Invited Technologies for Cost Competitive PDP  
10:40**

*W.-S. Jang  
LG Elect., Korea*

In order to reduce the cost of PDP(Plasma Display Panel)materials and process should be innovated as well as PDP cell design and driving circuitries. By adopting new materials and process, the cost can be reduced to half of current cost, and it will ensure the competitiveness in the market.

**PDP5 - 2            Electronic Drive Technique for Plasma-Sphere  
11:00                Displays**

*C. Wedding, J. Guy, E. Peters  
Imaging Syss. Tech., USA*

Imaging Systems Technology (IST) is engaged in the research and development of large flexible monochrome and color displays using Plasma-spheres as the pixel elements. Plasma-spheres are hollow spheres formed of glass containing an ionizable gas. The Plasma-sphere is a closed cell structure that provides unique advantages over a conventional open cell plasma display or a gas plasma tube display. In this paper, IST will report on various drive techniques applied to the Plasma-sphere display.

**PDP5 - 3            Fabrication of 25-in. SVGA SMPDP Panel  
11:20**

*Q. Li, X. Zhang, Y. M. Tang, Z. W. Fan, Y. S. Zheng,  
B. P. Wang  
Southeast Univ., China*

The fabrication techniques of the 25-inch SVGA SMPDP panel are studied in this paper. The bus electrode without ITO was employed in the front substrate, which is made by Aluminum with thin film process instead of conventional Ag with thick film process. Due to this amelioration, the uniformity of the dielectric layer had been improved. Only five fabrication processes, including photolithography, were needed during the manufacture of the front/rear substrate. The characteristics of this panel were also presented in order to verify the new fabrication techniques.

**PDP5 - 4L         A New Improved Reset Waveform for High Dark  
11:40                Room Contrast Ratio and Reduction of the Reset  
                          Time in AC PDPs**

*I.-M. Lee, J.-Y. Kim  
Sejong Univ., Korea*

A new improved reset waveform for the high contrast ratio and reduction of the reset time is presented. Except the first subfield, a new improved reset waveform with only ramp-up period is adopted. The experimentally measured background luminance was zero whereas the conventional reset method generated background luminance of 0.40 cd/m<sup>2</sup>. Thus, we obtained infinitely high dark room contrast ratio. The new improved reset waveform reduced the required time for reset per subfield to 165us except the first subfield.

----- Lunch -----

14:00 - 15:25

Sunport Hall Takamatsu Small Hall 1

**PDP6: High Resolution Technologies**

Chair :                B. P. Wang, Southeast Univ., China  
Co-Chair :            H. Uchiike, Japan

**PDP6 - 1:     Invited   Spatiotemporal Behavior of Excited Atoms in  
14:00           Discharge Cell of High-Resolution AC PDP**

*K. Ishii, Y. Hirano, Y. Murakami, K. Tachibana\**  
*NHK, Japan*  
*\*Kyoto Univ., Japan*

The spatiotemporal behavior of excited Xe atoms which leads to the VUV emission was estimated by a microscopic laser absorption spectroscopy with a 100  $\mu\text{m}$  horizontal cell pitch coplanar structure AC-PDP. The metastable  $\text{Xe}^*(1s_5)$  atoms converted to  $\text{Xe}_2^*$  dimers in a short time, thus stronger VUV emissions were estimated at higher gas pressure. In addition, it was found that the gap length-related alteration of the luminance characteristics was dependent on the enlarging excited atoms formation area on the anode side.

**PDP6 - 2        Arrays of Microcavity Plasma Devices: Concepts for  
14:20           Future PDPs**

*S.-J. Park, K.-F. Chen, S.-H. Sung, T. Spinka, J. G. Eden*  
*Univ. of Illinois, USA*

Microcavity plasma devices having characteristic dimensions below 100  $\mu\text{m}$  have been investigated as a candidate for the next generation of plasma displays. Arrays of inverted pyramid microcavity devices, fabricated in Si with emitting apertures of  $(50 \mu\text{m})^2$  and designed for AC excitation, demonstrate a luminous efficacy above 6  $\text{lm/W}$  at pressures beyond one atmosphere of Ne/Xe mixtures. Also a new ceramic multilayered device has been fabricated and characterized. Stable microdischarges with high spatial-contrast are observed in 100~200  $\mu\text{m}$  diameter microcavities.

**PDP6 - 3L      50-in. 1080p High-Definition PDP TV  
14:40**

*T. Komaki*  
*Pioneer, Japan*

50-inch 1080p high-definition plasma TV is newly developed. The cell size is 0.191(H) x 0.575(V) mm. Luminous efficacy is about 1.8  $\text{lm/W}$ , because of using CEL (Crystal Emissive Layer structure) technology. It is effective to improve discharge probability, static delay time and luminous efficacy. Gray scale is almost the same as that of wide-XGA.

**PDP6 - 4L      High-Contrast 55-in. Full High-Definition PDP  
14:55**

*M. Onozawa, T. Matsui, K. Ohira, M. Sawa, H. Harada,*  
*H. Ikeda, M. Tajima, T. Kishi*  
*Fujitsu Hitachi Plasma Display, Japan*

We have developed a 55-inch full high-definition (full HD) PDP with 2.07 M (1920x1080) pixels. We designed new panel and increased drive frequency to obtain high luminance. A high-contrast reset system was employed to obtain a high contrast ratio. We have achieved the white peak luminance of 960  $\text{cd/m}^2$  and the black luminance of 0.17  $\text{cd/m}^2$ , which leads to a contrast ratio of 5600:1.

**PDP6 - 5L 65 in. Full-Spec HD PDP**  
15:10

*I. Kawahara, S. Okumura, H. Taniguchi, H. Setoguchi,  
Y. Tsujita, R. Murai  
Matsushita Elec. Ind., Japan*

Having developed a 65" Full HD PDP(1920 x 1080 progressive), we launched it onto the market this October as our first consumer product. We describe here the 65" full HD panel structure, comparing it with the latest 65" HD(1366 x 768)panel. We also discuss the issues of picture quality from a new aspect, focusing on characteristics such as moving definition and contrast ratio in which it is superior to LCDs.

**Author Interviews**

17:10 - 18:10

**Sponsor:**

Plasma Display Technical Meeting

**PDP International Forum '05**

10:00 - 15:30, Saturday, Dec. 10

History Museum (5-min walk from IDW venue)

Meet Prof. Don Bitzer, the inventor of PDP, at the luncheon with wine. Join discussion on "how to dominate the TV world" with internationally well-known scientists. Everyone is welcome.

inquiry: [pdp-forum@townsend.ee.uec.ac.jp](mailto:pdp-forum@townsend.ee.uec.ac.jp)

## Workshop on EL Displays, LEDs and Phosphors

Wednesday, December 7

13:40 - 15:20

ANA Hotel Clement Takamatsu Hiten 1

### PH1: Phosphors in General

Chair : Y. Nakanishi, Shizuoka Univ., Japan

Co-Chair : S. Itoh, Futaba Corp., Japan

**PH1 - 1: 13:40**     *Invited*   **Pictures of The Future - A Specific Approach to Industrial Foresight: Application Potential to Materials and Active Displays ?**

*D. Theis*

*Siemens AG, Germany*

Reliable assessments of future developments in technologies and markets are necessary for industry. As a complementary approach to the frequently employed roadmapping a Siemens foresight method identifying comprehensive megatrends in various business segments called "Pictures of the Future" is explained. This method helps identifying future needs, requirements and applications including display technologies from a system integrator's point of view.

**PH1 - 2 14:10**     **Correlation between Cathodeluminescence Enhancement and Surface Charges of ZnS:Mn Thin Film Phosphor Induced by Ultrasonication Treatment**

*D. C. Lee, J. H. Kang, S. J. Yun\*, S. A. Bukesov\*\*,*

*D. Y. Jeon*

*KAIST, Korea*

*\*Elect. & TeleCommun. Res. Lab., Korea*

*\*\*Seoul Semiconductor, Korea*

Correlation between cathodeluminescence (CL) enhancement and surface charges of ZnS:Mn thin film phosphor after ultrasonication treatment was investigated using surface analysis technique. After ultrasonication treatment in KOH solutions, CL property of ZnS:Mn phosphor film was improved, but photoluminescence (PL) was not. Luminescence properties indicated that CL enhancement was mostly caused by surface charges formed by ultrasonication treatment. Through specified surface analysis technique, it was confirmed that CL property was improved with the amount of surface charges.

**PH1 - 3 Luminescent Properties of ZnO:Er Thin Films**  
**14:30 Prepared by RF Magnetron Sputtering**

*H. Song, Y. J. Kim*  
*Kyonggi Univ., Korea*

ZnO:Er films were deposited on c-plane sapphire substrates by rf magnetron sputtering, and annealed at 700°C in different atmospheres, air and H<sub>2</sub>. The effects of sputtering parameters and the annealing conditions on the luminescence were investigated. Highly c-axis oriented ZnO:Er films could be obtained on c-plane sapphire substrates. They showed emission bands at around 465nm and 525nm, while ZnO:Er powders at 520nm and 575nm. Luminescent properties rarely depended on the crystallinity of films, but were strongly affected by annealing atmosphere.

**PH1 - 4: Invited Crystal Chemistry, Defect Chemistry, and**  
**14:50 Degradation Processes in BaMgAl<sub>10</sub>O<sub>17</sub>:Eu<sup>2+</sup>**

*A. L. Diaz, B. Dawson*  
*Central Washington Univ., USA*

It is well known that the color and efficiency of BaMgAl<sub>10</sub>O<sub>17</sub>:Eu<sup>2+</sup>(BAM) degrade after heating in air or after exposure to vacuum ultraviolet(VUV) radiation. Research conducted in the last decade has led to a fairly comprehensive understanding of these degradation processes and their relationship to the crystal and defect chemistry of BAM. These connections are discussed, and attempts to improve the blue phosphor for VUV applications are described.

**Author Interviews**

17:30 - 18:30

15:00 - 17:00

Citizen's Gallery

**Poster PHp: Phosphors**

**PHp - 1 Effects of Surface Modification on**  
**Photoluminescence Properties of LaPO<sub>4</sub>:Ce,Tb**  
**Nano-Phosphor Synthesized by Solvothermal**  
**Reaction**

*F. Nishimura, T. Isobe*  
*Keio Univ., Japan*

LaPO<sub>4</sub>:Ce,Tb nano-phosphors are synthesized from lanthanum acetate, cerium acetate, terbium acetate and trimethyl phosphate by the solvothermal reaction. The surface modification of LaPO<sub>4</sub>:Ce,Tb nano-phosphor powder by lauryl phosphate increases the PL intensity by a factor of 18. The surface modification is effective for LaPO<sub>4</sub>:Ce, but not for LaPO<sub>4</sub>:Tb. The surface-passivation plays a significant role in the suppression of energy loss and the higher site-symmetry around Ce<sup>3+</sup>.

**PHp - 2      Enhancement of Photoluminescence Properties of  $Y_2O_3:Eu^{3+}$  Nanophosphor by Pre-Dispersing Synthetic Method with Organic Solvent**

*S.-J. Hong, M.-G. Kwak, J.-I. Han  
Korea Elect. Tech. Inst., Korea*

In this work, photoluminescence properties of the  $Y_2O_3:Eu^{3+}$  nanophosphor was enhanced by applying newly developed pre-dispersing synthetic method with organic solvent. The particle size was smaller than 4 nm, and crystallinity of  $I(222)/I(511)$  was enhanced to 10.5. Also, using the 250 nm ultraviolet source, the highly intensive photoluminescence properties could be achieved at 611 nm with the pre-dispersing synthetic method with organic solvent.

**PHp - 3      Synthesis of  $SrY_2S_4:Eu$  Red-Emitting Phosphor**

*A. Mimoto, H. Kominami, K. Hara, Y. Nakanishi,  
Y. Hatanaka\*  
Shizuoka Univ., Japan  
\*Aichi Univ. of Tech., Japan*

$SrY_2S_4:Eu$  red emitting phosphor was prepared using solid phase reaction.  $SrY_2S_4$  phase was obtained by XRD measurements, however,  $SrS$  and  $Y_2O_2S$  phases was also appeared. The powders were fired in active-carbon and sulfur mixed atmosphere, and changed the ratio of active-carbon and sulfur. The broad spectrum peaked around 640 nm from  $Eu^{2+}$  transition was obtained on PL measurement excited by 325 nm of He-Cd laser or Xe lamp.

**PHp - 4      Photoluminescent Properties of Eu-Activated  $Y_2O_3-SrF_2$  Powders**

*Y. Tsuchiya  
NHK, Japan*

$Eu^{3+}$ -activated  $Y_2O_3-SrF_2$  powders are fabricated for the full compositional range of  $Y_2O_3-SrF_2$ . Their photoluminescent and crystallographic properties are investigated. Powders of 2 to 60%  $SrF_2$  concentration show photoluminescence more than two times stronger than the Sr-undoped  $Y_2O_3:Eu$  specimen. Also studied are the effects of successive sintering on the luminance, Eu concentrations on the chromaticity, and boron codoping on the porosity.

**PHp - 5      New Silicate Phosphors for White LED**

*K. Toda, Y. Kawakami, S. Kousaka, Y. Ito, A. Komeno,  
K. Uematsu, M. Sato  
Niigata Univ., Japan*

This study specifically addresses development of new silicate phosphors for a white LED. In the europium doped  $A_2O-BO-SiO_2$  ( $A = Li^+, Na^+$ ;  $B = Ca^{2+}, Sr^{2+}, Ba^{2+}$ ) ternary system, three LED phosphor candidates -  $Li_2SrSiO_4:Eu^{2+}$ ,  $Ca_3Si_2O_7:Eu^{2+}$  and  $Na_2SrSi_2O_6:Eu^{3+}$  were found. Luminescent properties under near UV and visible excitation were investigated for the new  $Eu^{2+}$  and  $Eu^{3+}$  doped LED silicate phosphors. The new phosphor has a relatively strong absorption band in a long wavelength region.

**PHp - 6 Preparation of  $\text{La}_2\text{O}_2\text{S}:\text{Eu}$  Thin Film Phosphors for Near UV Excitation**

*M. Kato, H. Kominami, K. Hara, Y. Nakanishi, Y. Hatanaka\**  
*Shizuoka Univ., Japan*

*\*Aichi Univ. of Tech., Japan*

$\text{La}_2\text{O}_2\text{S}:\text{Eu}$  thin films for near ultraviolet (NUV) excitation were prepared by sulfurization of  $\text{La}_2\text{O}_3:\text{Eu}$  thin film deposited by EB evaporation on quartz substrate.  $\text{La}_2\text{O}_2\text{S}$  phase was obtained by sulfurization process using annealing in  $\text{H}_2\text{S}$  atmosphere above 30 minutes. The red-emission of  $\text{La}_2\text{O}_2\text{S}:\text{Eu}$  was observed under excitation by 325 nm of He-Cd laser. The intensity of the film annealed 30 minutes was the highest.

**PHp - 7 Synthesis and Luminescence Properties of New LED Yellow Phosphor  $\text{Li}_2\text{SrSiO}_4:\text{Eu}^{2+}$**

*Y. Ito, M. Kawamoto, K. Uematsu, K. Toda, M. Sato*  
*Niigata Univ., Japan*

Divalent europium activated  $\text{Li}_2\text{SrSiO}_4$  was investigated as a phosphor for the application to a white emitting light source using a blue LED. The  $\text{Li}_2\text{SrSiO}_4:\text{Eu}^{2+}$  phosphor was efficiently excited by visible light (400 - 480 nm), yielding a yellow emission at 570 nm. The phosphor showed a good thermal luminescence property at high temperatures. The yellow phosphor,  $\text{Eu}^{2+}$ -activated  $\text{Li}_2\text{SrSiO}_4$ , is a promising material for LED applications because of its broad excitation band, excellent emission color and high thermal stability.

**PHp - 8 Luminescent Properties of  $(\text{Sr}_{1-x}\text{M}_x)_3\text{SiO}_5:\text{Eu}^{2+}$  (M = Ca, Ba) Phosphor for White Emitting Light Source Using Blue/Near UV LEDs**

*H. S. Jang, W. B. Im, D. Y. Jeon*  
*KAIST, Korea*

$\text{Eu}^{2+}$  doped  $\text{Sr}_3\text{SiO}_5$  was investigated as a phosphor for the application to white emitting light source using blue/near ultraviolet (n-UV) LEDs.  $\text{Sr}_3\text{SiO}_5:\text{Eu}^{2+}$  phosphors were synthesized by solid state reaction method and their luminescent properties were investigated.  $\text{Sr}_3\text{SiO}_5:\text{Eu}^{2+}$  phosphor showed a bright orange-yellow emission under the excitation with a blue radiation and or n-UV radiation. The blue LED pumped and n-UV LED pumped Strontium silicate white light sources were fabricated and their luminescent properties were investigated.

**PHp - 9 In Situ Neutron Powder Diffraction Analyses of  $\text{BaMgAl}_{10}\text{O}_{17}:\text{Eu}^{2+}$  Phosphor with Increasing Temperature**

*W. B. Im, Y.-I. Kim\*, D. Y. Jeon*  
*KAIST, Korea*

*\*Korea Res. Inst. of Standards & Sci., Korea*

In this study, in situ neutron powder diffraction (NPD) analyses were carried out on commercial  $\text{BaMgAl}_{10}\text{O}_{17}:\text{Eu}^{2+}$  (BAM) phosphor with increasing temperature for the first time. The structural parameters of BAM were successfully determined by the Rietveld refinement against NPD data at room temperature, 500, 700, and 900 °C, respectively. And nuclear density of 2d site occupying Eu atoms was calculated using maximum entropy method.

**PHp - 10 Sites of Doped Divalent Europium Ions in BAM Investigated by X-Ray Near Edge Structure Measurement**

*I. Hirose, T. Honma, K. Kato, N. Kijima\*, Y. Shimomura\**  
*Japan Synchrotron Radiation Res. Inst., Japan*  
*\*The Mitsubishi Chem., Japan*

We performed Eu  $L_{III}$  XAFS measurement of BAM and  $E_2O_3$  to discuss occupation site of doped europium. Fourier-filtered EXAFS wiggle could be reproduced by both BR and a-BR sites occupations introducing shifts of nearest neighboring oxygen atoms from their ideal positions. Simulated XANES spectrum based on BR occupation better fitted to the observed one than that of a-BR site occupation. Thus, it can be considered that doped europium dominantly occupies BR site in BAM.

**PHp - 11 XAFS Study of Luminescent Center in Blue PDP Phosphor  $CaMgSi_2O_6:Eu$**

*T. Honma, T. Kunimoto\*, S. Yamaguchi\*\*, Y. Shao\*\*, K. Ohmi\*\*, H. Kobayashi\**  
*Japan Synchrotron Radiation Res. Inst., Japan*  
*\*Tokushima Univ., Japan*  
*\*\*Tottori Univ., Japan*

Eu luminescent center in blue PDP phosphor  $CaMgSi_2O_6:Eu$  (CMS) has been investigated by X-ray absorption fine structure analysis. To clarify the correlation between  $Eu^{2+}/Eu^{3+}$  ratio in CMS and synthesis parameters such as Eu concentration and flow rate of reducing gas, the Eu  $L_3$ -edge X-ray absorption near edge structure spectra has been analyzed.

**PHp - 12 Synthesis and Characterization of  $Ca(La,Gd)_4Si_3O_{13}:Tb$  Green PDP Phosphor for  $Xe_2$  Excimer Excitation**

*A. Yamane, S. Yamaguchi, T. Kunimoto\*, Y. Shao, K. Ohmi, H. Kobayashi\**  
*Tottori Univ., Japan*  
*\*Tokushima Univ., Japan*

Luminescent characteristics of  $Ca(La,Gd)_4Si_3O_{13}:Tb$  phosphor have been investigated. This phosphor shows the green emission due to  $Tb^{3+}$  with the CIE color coordinate  $(x, y) = (0.337, 0.562)$ . The photoluminescence (PL) peak intensity is comparable with  $Zn_2SiO_4:Mn$  commercial phosphor. The PL excitation band lies continuously in the wavelength region from 130 to 250 nm, so the phosphor is a candidate for a green PDP phosphor for  $Xe_2$  excitation.

**PHp - 13      Effect of ZnS Buffer Layer on Luminescent Characteristics of  $Y_2O_2S:Eu$  TFEL Devices Prepared by Sulfurization of  $Y_2O_3:Eu$**

*N. Kurihara, H. Kominami, Y. Nakanishi, K. Hara, Y. Hatanaka\**  
*Shizuoka Univ., Japan*  
*\*Aichi Univ. of Tech., Japan*

$Y_2O_2S:Eu$  TFEL device on Si substrate prepared using sulfurization of  $Y_2O_3:Eu$  thin film was studied. EL emission was obtained when the emitting layer was sandwiched by ZnS buffer layers. It indicates that ZnS buffer layers were contributed as the layer for generation, acceleration and injection of hot-electron into  $Y_2O_2S:Eu$  emitting layer.

**PHp - 14      Flexible Inorganic Thin-Film Electroluminescent Devices Using a Flexible Ceramic Substrate**

*T. Miyata, Y. Mochizuki, S. Tsukada, T. Minami*  
*Kanazawa Inst. of Tech., Japan*

Flexible inorganic thin-film electroluminescent(TFEL)devices have been newly developed. High-luminance thin and flexible EL lamps have been demonstrated using two types of double-insulating-layer TFEL device structures, consisting of a sulfide or oxide phosphor emitting layer and insulating layers, fabricated on a flexible oxide ceramic sheet with a thickness of approximately 50 or 100  $\mu m$ . In particular, stable operation at high temperatures above 200°C was obtained in flexible EL lamps fabricated using oxide phosphors.

**PHp - 15      Blue and Red Dichromatic Luminescence of  $12CaO-Al_2O_3$ -Based Phosphor with Subnano Cage Structure**

*T. Nagata, H. Murakami*  
*ULVAC, Japan*

$12CaO \cdot 7Al_2O_3$  (C12A7) has subnano atomic cages in its crystal structure. Here we report the successful synthesis of a phosphor with an entirely new cage structure using this C12A7 oxide. This phosphor showed blue and red dichromatic luminescence which was not previously known in conventional phosphors. Moreover, the blue displayed higher chromaticity than that of the conventional phosphor used in CRT.

**PHp - 16      Synthesis and Characterization of Sol-Gel Derived  $Y_2O_3:Eu$  Thick-Film Phosphors**

*J. Y. Cho, K. Y. Ko, Y. R. Do*  
*Kookmin Univ., Korea*

$Y_2O_3:Eu$  thick-film phosphors were grown on quartz or sapphire substrates using a simple spin coating technique of semi-gel solution. Optical and structural properties of  $Y_2O_3:Eu$  thick-films were characterized by XRD, AFM, SEM, PL and CL. By using sol-gel process, we prepared single-phase  $Y_2O_3:Eu$  thick-film phosphors which have good optical properties, high crystallinity and crack-free morphology with thickness of  $\sim 2\mu m$ .

## Thursday, December 8

9:00 - 10:30

ANA Hotel Clement Takamatsu Hiten 2

**PH2: Phosphors for LEDs**

Chair : D. Theis, Siemens AG, Germany  
 Co-Chair : M. Tamatani, Toshiba, Japan

**PH2 - 1: Invited Nitride and Oxynitride Phosphors and Their  
 9:00 Application to White Light-Emitting Diode Lamps**

*K. Sakuma, N. Hirotsuki\*, N. Kimura, R.-J. Xie\*,  
 S. Hirafune, Y. Yamamoto\*, T. Suehiro\*  
 Fujikura, Japan  
 \*Nat. Inst. for Materials Sci., Japan*

Recently developed nitride/oxynitride phosphors are promising candidates for a white light-emitting diode.  $\beta$ -SiAlON:Eu, Ca- $\alpha$ -SiAlON:Eu and CaAlSiN<sub>3</sub>:Eu phosphors are able to be excited by blue light and emit green, yellowish orange and red light, respectively. High brightness warm-white LED lamps of over 50 lm/W luminous efficacy have been realized by combination of a blue LED die and Ca- $\alpha$ -SiAlON:Eu. High color-rendering index white LED lamps of over Ra 80 have been also realized using the three color phosphors.

**PH2 - 2 Heterostructures of ZnO-Related Semiconductor  
 9:30 Materials for Visible-Light Emitting Devices**

*A. Nakamura, K. Yamamoto, J. Ishihara, T. Aoki, J. Temmyo  
 Shizuoka Univ., Japan*

Wurtzite Zn<sub>1-x</sub>Cd<sub>x</sub>O / ZnO heterostructures were successfully grown by remote plasma enhanced metalorganic chemical vapor deposition (RPE-MOCVD) and were investigated by photoluminescence (PL) spectroscopy. In the double heterostructures consisting of Mg<sub>0.036</sub>Zn<sub>0.964</sub>O / Zn<sub>0.77</sub>Cd<sub>0.23</sub>O / Mg<sub>0.036</sub>Zn<sub>0.964</sub>O, temperature and excitation intensity dependence of PL spectra were examined. The PL emission is characterized as localized and free exciton emission. A linear dependence with a slope near unity is obtained from the excitation dependence of the PL intensity. Blue-green emission (2.78eV) was demonstrated from the double-heterostructure at room temperature.

**PH2 - 3**      **Photoluminescent Properties of (Sr<sub>1-x</sub>Ba<sub>x</sub>)S:Eu Red-Emitting Powder for NUV Excitation**  
**9:50**

*H. Kominami, K. Sugiura, Y. Nakanishi, K. Hara, Y. Hatanaka\**  
*Shizuoka Univ., Japan*  
*\*Aichi Univ. of Tech., Japan*

(Sr<sub>1-x</sub>Ba<sub>x</sub>)S:Eu powder prepared by changing the ratio x and firing condition were investigated. XRD patterns fired in active carbon shows only (Sr, Ba)S:Eu phase, however, that fired in S shows (Sr, Ba)SO<sub>4</sub> phase in addition of (Sr, Ba)S phase. Photoluminescent spectra excited by 380nm of Xe lamp show peaks from 607 to 680nm as the changing x ratio. At x=0.25, emission peaks of both powder showed 645nm. Interestingly, the intensity of these powders were quite different, the powder fired in S showed 4 times higher than that fired in active carbon. The powder in S includes much oxide atoms, then it indicates...

**PH2 - 4**      **Synthesis and Luminescent Properties of Eu Doped Calcium Sulfoapatite**  
**10:10**

*S. H. Jung, J. W. Kim, Y. J. Kim*  
*Kyonggi Univ., Korea*

Eu doped calcium sulfoapatite was synthesized by firing the mixture of CaCO<sub>3</sub>, Ca<sub>2</sub>P<sub>2</sub>O<sub>7</sub>, and Eu<sub>2</sub>O<sub>3</sub> in the electric furnace at 900°C in H<sub>2</sub> atmosphere. According to XRD, Eu was successfully substituted for Ca, therefore Ca<sub>9.12</sub>Eu<sub>0.88</sub>(PO<sub>4</sub>)<sub>6</sub>S<sub>1.44</sub> phase was observed as well as Ca<sub>10</sub>(PO<sub>4</sub>)<sub>6</sub>S. However, strong XRD peaks of the secondary phase, Ca<sub>3</sub>(PO<sub>4</sub>)<sub>2</sub> also appeared. PL properties were measured for the first time. PL spectra of Ca<sub>9.12</sub>Eu<sub>0.88</sub>(PO<sub>4</sub>)<sub>6</sub>S<sub>1.44</sub> exhibited a strong red emission at around 650nm with the excitation wavelength of 470 nm.

----- Break -----

10:50 - 12:25

ANA Hotel Clement Takamatsu Hiten 2

**PH3: ELDs (1)**

Chair : X. Wu, iFire Tech., Canada  
 Co-Chair : N. Miura, Meiji Univ., Japan

**PH3 - 1:**      **Invited A Study of Electroluminescent Process and Efficiency in ZnS Particles**  
**10:50**

*K. Ogawa, Y. Tadakuma, K. Kawato, M. Nakanishi, Y. Miyashita, S. Yamashita*  
*Fuji Photo Film, Japan*

We elucidated behavior of electrons and holes in ZnS:Cu,Cl phosphor particles for dispersion-type electroluminescence (EL) devices. Electrons trapped at donor (Cl<sup>-</sup>) sites recombine with holes trapped at acceptor (Cu<sup>+</sup>) sites in 0.5 ms after they are trapped by the Cl centers in 1μs and move between the conduction band of ZnS and the Cl sites. We understand that decrease in luminous efficiency in high-brightness range arises from brightness saturation at luminous centers nearby electron-emitting sites known as Cu<sub>x</sub>S.

**PH3 - 2                    Red Emitting Ba<sub>2</sub>ZnS<sub>3</sub>:Mn Thin Film**  
**11:20                    Electroluminescent Devices Prepared by Electron-Beam Evaporation**

*K. Hara, M. Yamasaki, Y. Ouchi, K. Ohmi, H. Kobayashi\**  
*Tottori Univ., Japan*  
*\*Tokushima Bunri Univ., Japan*

Ba<sub>2</sub>ZnS<sub>3</sub>:Mn thin film electroluminescent (EL) devices have been prepared by electron-beam evaporation method and post-deposition annealing. The TFEL devices show a reddish-orange EL emission with the CIE color coordinates of (x, y) = (0.60, 0.41). The luminance and efficiency at 1 kHz are 140 cd/m<sup>2</sup> and 0.05 lm/W, respectively. Since Ba<sub>2</sub>ZnS<sub>3</sub>:Mn thin films are enough crystallized at 600°C, Ba<sub>2</sub>ZnS<sub>3</sub>:Mn is a promising red EL phosphor for low temperature process.

**PH3 - 3                    Blue Luminescence from Eu-Activated BaO-Based**  
**11:40                    Multicomponent Oxide Phosphor Thin Films**

*T. Miyata, Y. Mochizuki, T. Minami*  
*Kanazawa Inst. of Tech., Japan*

Intense photoluminescence and electro-luminescence in purplish blue emission were observed in newly developed phosphorous-treated(BaO-Ga<sub>2</sub>O<sub>3</sub>):Eu and(BaO-In<sub>2</sub>O<sub>3</sub>):Eu and Ba<sub>0.638</sub>Mg<sub>0.276</sub>Al<sub>10.724</sub>O<sub>17</sub>:Eu thin films that were first deposited on thick BaTiO<sub>3</sub> ceramic sheets using a combinatorial r.f. magnetron sputtering deposition method and then postannealed in an Ar+H<sub>2</sub>(10%)gas atmosphere. Typical CIE chromaticity coordinates for blue emission from Eu-activated oxide phosphor thin films were(x=0.165, y=0.066).

**PH3 - 4L:                *Invited* CdSe and InGaN quantum dots for short**  
**12:00                    wavelenght light emitters**

*D. Hommel, A. Gust, T. Passow, M. Klude, T. Yamaguchi,*  
*E. Roventa, A. Pretorius, R. Kröger, K. Sebald, J. Gutowski*  
*Univ. of Bremen, Germany*

We will compare CdSe/ZnSSe quantum dot laser emitting at 560 nm to a LD emitting at the same wavelength with a quarternary ZnCdSSe quantum well as active region. Furthermore, the hope of reaching the green spectral region for nitride-based LDs is connected with InGaN quantum dots. We will show that under modified capping conditions optically active InGaN dots can be obtained giving raise to the hope for a nitride-based quantum dot laser.

----- Lunch -----

13:40 - 15:05

ANA Hotel Clement Takamatsu Hiten 2

**PH4: ELDs (2)**

Chair : T. Miyata, Kanazawa Inst. Tech., Japan  
 Co-Chair : K. Ohmi, Tottori Univ., Japan

**PH4 - 1: Invited Recent Development of Large-Area TDEL Flat Panel Display**

*X. Wu, D. Carkner, I. Yoshida\*, H. Hamada\*, K. Oda\*\*, M. Kutsukake\*\**  
*iFire Tech., Canada*  
*\*Sanyo Elec., Japan*  
*\*\*Dai Nippon Printing, Japan*

Thick-Dielectric Electroluminescent(TDEL)technology is one of the most suitable flat panel displays for HDTV application. TDEL has achieved large screen size and full color capability with a simple and solid-state structure. A low-cost, light weight, and thin-shape HD-TV will be achieved by TDEL technology. Recently, a pilot production line for 34-inch, wXGA TDEL panels has been started up. The newly developed production system includes a large-area sputtering tool for high brightness BaAl<sub>2</sub>S<sub>4</sub>:Eu blue phosphor.

**PH4 - 2 Blue Emitting Barium Thioaluminate Phosphors by Sputtering of Alloy Targets**

*J. Acchione, A. Kosyachkov*  
*iFire Tech., Canada*

A process is developed for fabrication of thin film Ba-Al-S:Eu phosphors for inorganic full-color Thick Dielectric Electroluminescent (TDEL) displays. It involves reactive sputtering of a single Ba-Al-Eu alloy target in H<sub>2</sub>S containing atmosphere. The phosphors exhibit EL-luminance over a thousand cd/sq.m at the CIE color coordinates of X=0.14 and Y=0.11-0.13. The process is evaluated as a prospective one for commercial production of TDEL panels.

**PH4 - 3 Blue-Emitting BaAl<sub>2</sub>S<sub>4</sub>:Eu Electroluminescent Thin-Films Grown by MBE**

*K. Tanaka, S. Okamoto*  
*NHK, Japan*

We have investigated the crystallinity of blue-emitting BaAl<sub>2</sub>S<sub>4</sub>:Eu electroluminescent(EL)thin films grown by molecular beam epitaxy(MBE) system. As-grown thin-film shows pure blue EL, and the peak wavelength of spectrum is at 474 nm. The oxygen in the thin films is under the detectable level. The co-doping of flux-agent has greatly improved the crystallinity of thin films. The FWHM value of the(121)X-ray diffraction line is 0.156°, which is the narrowest value ever observed for BaAl<sub>2</sub>S<sub>4</sub>:Eu thin films.

**PH4 - 4L Blue Electroluminescent Devices Utilizing Tm Doped ZnS Nanocrystals as Emission Layer Material**  
**14:50**

*D. Adachi, H. Haze, H. Shirahase, T. Toyama, H. Okamoto  
 Osaka Univ., Japan*

Blue emitting thin-film EL (TFEL) device comprised of Tm<sup>3+</sup> doped ZnS nanocrystals (NCs) has been investigated. Compared with the conventional double-insulating-layer-type ac TFEL device, intensity ratio of blue to infrared emission band due to the intra-shell transitions of Tm<sup>3+</sup> is 10 times improved. Moreover, utilizing ZnS NCs doped with Tm<sup>3+</sup>, Tb<sup>3+</sup> and Mn<sup>2+</sup> as the blue, green and red emission layer material, respectively, full-color TFEL device is demonstrated.

**Author Interviews**

17:30 - 18:30

**Friday, December 9**

10:50 - 11:50

ANA Hotel Clement Takamatsu Hiten 2

**FED2/PH5: FEDs and Phosphors for FEDs**

Chair : M. Nakamoto, Shizuoka Univ., Japan

Co-Chair : T. Hisamune, Kasei Optonics, Japan

**FED2/PH5 - 1: *Invited* High-Brightness, High-Resolution, High-Contrast and Wide-Gamut Features of Surface-Conduction Electron-Emitter Displays**  
**10:50**

*Y. Ishizuka, T. Oyaizu, T. Oguchi, H. Hoshi, E. Yamaguchi  
 SED, Japan*

Surface-conduction Electron-emitter Displays (SEDs) have many advantages for application to TVs. Surface Conduction electron Emitters (SCEs) provide the benefits of high brightness and high resolution owing to their focused and controlled electron beams. In addition, non-linear I-V characteristics of the emitters enable to express deep black. Furthermore, phosphor screens with color filters realize a CRT-grade color gamut. Combination of the emitter and the screen offers the excellent performance for TV application.

**FED2/PH5 - 2 Development of Large Size CNT-FED**

**11:20**

*T. Tonegawa, M. Taniguchi, S. Itoh, K. Nawamaki,  
 Y. Marushima, Y. Kubo, Y. Fujimura, T. Yamaura  
 Futaba, Japan*

The carbon nanotube (CNT) FED panel for information board was developed. This large size display panel realizes a lightweight, wide viewing angle and low power consumption. A unit panel size is 96 x 96 mm, thickness is about 2.2 mm, anode voltage is 120 V, and spot brightness is more than 1,000 cd/m<sup>2</sup>. The panel's emitter is formed by screen-printing of multi walled CNT which were made by arc-discharged method. FEDs will be used for not only the TV applications but also large-size panels for public information.

**FED2/PH5 - 3 Full Color Graphite Nanofiber FED with 0.15mm Pixel Pitch**  
11:35

*K. Hagiwara, T. Takei, T. Sakai, T. Muroi, M. Ushirozawa,  
T. Yamamoto  
NHK, Japan*

To achieve a fine pitch FED, a GNF-FED with focus electrode was developed. The new fabrication process was developed and the growth conditions of GNF were optimized. The dependence of focus voltage on electron beam divergence was examined and the beam focusing was confirmed. Assembling with the RGB phosphor screen, full-color video was successfully reproduced on the GNF-FED with 0.15-mm pixel pitch.

**Author Interviews**

17:10 - 18:10

**Sponsors:**

The 125th Research Committee on Mutual Conversion between Light and Electricity, JSPS  
Phosphor Research Society, The Electrochemical Society of Japan

## Takamatsu Festival

Takamatsu Folk Entertainment

Friday, December 9

12:20 – 13:30

(before Outstanding Poster Paper Awards)

Tamamo (3F),

ANA Hotel Clement Takamatsu

See page 9 for details

# Workshop on Field Emission Display

Friday, December 9

9:00 - 9:10

ANA Hotel Clement Takamatsu Hiten 2

**Opening**

**Opening Remarks**

9:00

*M. Takai, Workshop Chair*

9:10 - 10:35

ANA Hotel Clement Takamatsu Hiten 2

**FED1: CNT Emitters and FEDs**

Chair : J. Ishikawa, Kyoto Univ., Japan

Co-Chair : Y. Iguchi, Sony EMCS, Japan

**FED1 - 1: Invited 6-in. Video CNT-FED with Improved Uniformity**

*J. Dijon, C. Bridoux, A. Fournier, T. G. De Monsabert, B. Montmayeul, M. Levis, D. Sarrasin, R. Meyer LETI, France*

A model of display uniformity based on the physics of CNT emission is presented. This model is in good agreement with our experimental results. It shows that there is no intrinsic limitation to overcome in order to achieve 1% uniformity on HDTV panel using the cathode structure developed at LETI and spaghetti like CNT material. Uniformity results achieved on 1cm<sup>2</sup> displays are already better than 2% and a 6 inches CNT display with uniformity within 5% is demonstrated.

**FED1 - 2: Invited Narrow-CNT Emitter for High-Resolution FED**

9:30

*H. Kurachi, S. Uemura, J. Yotani, T. Nagasako, H. Yamada, T. Ezaki, T. Maesoba, T. Nakao, M. Ito, A. Sakurai, H. Shimoda, Y. Saito\*, H. Shinohara\* Noritake, Japan \*Nagoya Univ., Japan*

A high-resolution carbon nanotube (CNT) -field emission display (FED) was investigated for graphic-displays. The sub-pixel size was 0.2mm x 0.6mm. We developed a new growth technique of narrow carbon nanotubes (CNTs) on metal-base electrode by thermal-CVD to reduce the driving voltage of high-resolution CNT-FED. The diameter of CNT was reduced down to 6-10nm. The emission was extremely increased at lower voltage, compared to the conventional characteristic of 40nm-diameter CNT-layer.

**FED1 - 3      Improvement of Emission Distribution by Electrical  
9:50            Activating Cathode Surface for CNT-FED**

*S. Watanabe, T. Shiroishi, Y. Suzuki, K. Nishimura,  
T. Sawada, M. Fujikawa, A. Hosono, S. Nakata, S. Okuda  
Mitsubishi Elec., Japan*

A uniform emission distribution of the panel is necessary for picture quality of CNT-FED. The effect of aging by the pulse current was examined in the test panel of the diode structure. As the result of the investigation, an electrical activating the cathode surface by emission current is effective for improving the emission uniformity. It is found that uniformity of the CNTs height distributions brings about improvement of luminescence distribution.

**FED1 - 4      Surface Treatment of CNT Cathodes Using KrF  
10:05           Excimer Laser for FEDs**

*T. Honda, C. B. Oh, K. Murakami, K. Ohsumi, S. Abo,  
F. Wakaya, M. Takai  
Osaka Univ., Japan*

CNT cathodes prepared with and without glass fillers were irradiated by a KrF (248 nm) excimer laser light with a homogeneous beam intensity profile at various laser power densities. The electron emission characteristics were greatly improved by adding glass fillers to the paste. The turn-on-field became as low as 0.34 V/ $\mu\text{m}$  and the emission density became as high as 5.88 mA/cm<sup>2</sup> at a field of 2 V/ $\mu\text{m}$  by KrF laser irradiation.

**FED1 - 5      Estimate of Structural Modification of Laser  
10:20           Irradiated CNTs by Seppen-Katamuki Analysis**

*Y. Kawamura, Y. Gotoh, T. Niiya, H. Tsuji, J. Ishikawa,  
A. Hosono\*, S. Okuda\*  
Kyoto Univ., Japan  
\*Mitsubishi Elec., Japan*

We have measured the electron emission characteristics of the carbon nanotubes irradiated by two different lasers. From the emission characteristics, we estimated the structural modification of carbon nanotubes due to laser irradiation by Seppen-Katamuki analysis. The feasibility of the present method was verified by observation of the CNT length with scanning electron microscope.

----- Break -----

10:50 - 11:50

ANA Hotel Clement Takamatsu Hiten 2

**FED2/PH5: FEDs and Phosphors for FEDs**

Chair : M. Nakamoto, Shizuoka Univ., Japan

Co-Chair : T. Hisamune, Kasei Optonics

**FED2/PH5 - 1: *Invited* High-Brightness, High-Resolution, High-Contrast and Wide-Gamut Features of Surface-Conduction Electron-Emitter Displays**

10:50

*Y. Ishizuka, T. Oyaizu, T. Oguchi, H. Hoshi, E. Yamaguchi  
SED, Japan*

Surface-conduction Electron-emitter Displays (SEDs) have many advantages for application to TVs. Surface Conduction electron Emitters (SCEs) provide the benefits of high brightness and high resolution owing to their focused and controlled electron beams. In addition, non-linear I-V characteristics of the emitters enable to express deep black. Furthermore, phosphor screens with color filters realize a CRT-grade color gamut. Combination of the emitter and the screen offers the excellent performance for TV application.

**FED2/PH5 - 2 Development of Large Size CNT-FED**

11:20

*T. Tonegawa, M. Taniguchi, S. Itoh, K. Nawamaki,  
Y. Marushima, Y. Kubo, Y. Fujimura, T. Yamaura  
Futaba, Japan*

The carbon nanotube (CNT) FED panel for information board was developed. This large size display panel realizes a lightweight, wide viewing angle and low power consumption. A unit panel size is 96 x 96 mm, thickness is about 2.2 mm, anode voltage is 120 V, and spot brightness is more than 1,000 cd/m<sup>2</sup>. The panel's emitter is formed by screen-printing of multi walled CNT which were made by arc-discharged method. FEDs will be used for not only the TV applications but also large-size panels for public information.

**FED2/PH5 - 3 Full Color Graphite Nanofiber FED with 0.15mm Pixel Pitch**

11:35

*K. Hagiwara, T. Takei, T. Sakai, T. Muroi, M. Ushirozawa,  
T. Yamamoto  
NHK, Japan*

To achieve a fine pitch FED, a GNF-FED with focus electrode was developed. The new fabrication process was developed and the growth conditions of GNF were optimized. The dependence of focus voltage on electron beam divergence was examined and the beam focusing was confirmed. Assembling with the RGB phosphor screen, full-color video was successfully reproduced on the GNF-FED with 0.15-mm pixel pitch.

----- Lunch -----

13:05 - 15:00

ANA Hotel Clement Takamatsu Hiten 2

**FED3: CNT Emitters for FEDs**

Chair : S. Uemura, Noritake, Japan

Co-Chair : S. Nakata, Mitsubishi Elec., Japan

**FED3 - 8L      Reflective Structure for Carbon Nano-Tube Backlight  
13:05            Unit**

*T. H. Tsou, M. H. Lin, B. N. Lin, W. Y. Lin, Y. C. Jiang,  
C. H. Fu, L. Y. Chiang, Y. Y. Chang, M. H. Hsiao, C. C. Lee  
EROS/ITRI, Taiwan*

EROS/ITRI has developed the novel and low-cost structure for the LCD-TV backlight by using CNT-FED technology. In this new structure on the anode plate, a metal layer was coated as a reflector and a conductor. Therefore, all of the lights will emit from the cathode plate and the surface temperature is lower as the room temperature. We had demonstrated a reflective structure for CNT-BLU to increase the light emitting efficiency which is about 1.7 times compared to the conventional structure.

**FED3 - 1        Field Emission Properties of MgO Coated  
13:15            Multiwalled Aligned CNTs**

*S. Chakrabarti, L. Pan, H. Tanaka, Y. Nakayama  
Osaka Pref. Univ., Japan*

Well-aligned carbon nanotubes in specific pattern were synthesized by catalytic thermal chemical vapor deposition technique. The carbon nanotubes were then coated with MgO layer of different thicknesses to improve the field emission property. Stable emission with a low turn-on voltage of about 116 V was observed from the aligned nanotubes coated with a MgO layer of thickness 10 nm. The current fluctuation for 8hr was found to be as low as 20% for MgO (10 nm) coated nanotubes.

**FED3 - 2        Synthesis of CNTs on Unheated Substrate by ECR-  
13:30            CVD**

*W.-T. Wu, K.-H. Chen, C.-M. Hsu  
Southern Taiwan Univ. of Tech., Taiwan*

Multi-walled carbon nanotubes (CNTs) were grown onto unheated silicon wafer covered with cobalt catalyst by electron cyclotron chemical vapor deposition. The diameters of CNTs vary directly with the thickness of catalyst films. The morphologies of nanotubes are mainly related with the microwave power and the flow ratio of  $C_3H_8/N_2$ . Graphitized CNT structures were identified using Transmission Electron Microscope and Raman spectra with a clear peak at  $1580\text{ cm}^{-1}$ .

**FED3 - 3        Fabrication of CNT Emitter Device by Using Rf-  
13:45            PECVD at Low Temperature**

*T. Migita, Y. Shiratori, T. Kishino, Y. Takeuchi  
Int. Ctr. for Materials Res., Japan*

Carbon nanotube (CNT)-cathode device with micron-sized gate holes to be applied for field emission display (FED) was produced. This cathode device is fabricated by a combination of usual lithography process and radio frequency plasma enhanced chemical vapor deposition at low temperature. CNT-FED is believed to be next generation of FEDs due to excellent field emission characters of CNTs. Simple fabrication process and the good field emission characteristics are reported for the prepared devices.

**FED3 - 4                      Uniform Fabrication of CNT Film on Cathodes by  
14:00                      Electrophoresis Deposition Method**

*C.-Y. Hsiao\**, *S.-H. Lee\*\**, *K. Cheng\*\**, *Y.-A. Li\*\**,  
*J.-L. Tsai\*\**, *J.-S. Fang\*\**, *C.-C. Kuo\*\**, *T.-F. Chan\**  
*\*TECO Nanotech, Taiwan*  
*\*\*TECO Elec. & Machinery, Taiwan*

Electrophoresis deposition method is a well know technology, but it is new to fabricate CNT film on the cathode. Also this method has developed many years, there still has many key technology must be solved, such us CNT well suspension in solution, electro field control, polarization phenomena, etc. In this paper we proposed an easy method to improve polarization. We call it as "batch method". From final results, this method can solve polarization problem successfully, and CNT film uniformity on cathodes were also improved.

**FED3 - 5                      High Anode Voltage Characteristic of TMG Structure  
14:15                      for CNT-FED**

*J. W. Jeong*, *Y. H. Song*, *D. J. Kim*, *S. H. Lee*, *J. H. Lee*,  
*K. Y. Kang*  
*ETRI, Korea*

We proposed the mesh gate structure for carbon nanotube (CNT) field emitter with a high accelerating anode voltage, and here renamed it the tapered macro gate (TMG) to clarify its function. The TMG has relatively tall and tapered holes compared with CNT emitter. The tapered gate hole was shown to protect the CNT emitters from the anode field perfectly, enabling us to apply a high anode voltage over 10 kV along with an electron beam focusing effect.

**FED3 - 6                      Anodic Aluminum Oxide as a Template for CNT Field  
14:30                      Emitters and AAO-CNT Triode Structure**

*C.-C. Lin*, *F.-M. Pan*, *M. Liu\**, *K.-C. Chang*, *P.-L. Chen*,  
*C.-T. Kuo*, *C.-N. Mo\**  
*Nat. Chiao-Tung Univ., Taiwan*  
*\*Chunghwa Picture Tubes, Taiwan*

We have used anodic aluminum oxide (AAO) as the template to grow carbon nanotubes (CNTs) for the application of field-emission display technology. In order to obtain optimal field emission properties, we have tried to control the density and the length of the CNTs grown from AAO pore channels by tuning the growth time and the CH<sub>4</sub> concentration of the precursor gas mixture. AAO pore channel arrays were grown in the triode structure, which was fabricated on silicon wafers by conventional integrated circuit processes.

**FED3 - 7**      **Morphology Study on CNT Emitters through  
14:45**      **Optimization of Paste Composition**

*D. J. Kim, Y. H. Song, J. W. Jung, S. H. Lee, J. H. Lee,  
K. Y. Kang  
ETRI, Korea*

In order to improve field emission performances, the optimizing process of carbon nanotube (CNT) paste was investigated in terms of surface morphology. The CNT emitters were formed by a photolithography process and then a surface treatment was applied to protrude and align CNTs vertically. The surface morphology and field emission properties were found to be strongly dependent on the paste composition. The CNT emitters with the optimized paste composition showed great improvements in field emission characteristics including the effective emission density, uniformity and life time.

----- Break -----

**15:15 - 17:00**

**ANA Hotel Clement Takamatsu Hiten 2**

**FED4: FE Materials and Novel Device**

Chair :            T. Asano, Kyusyu Inst. of Tech., Japan

Co-Chair :        M. Suzuki, Hitachi, Japan

**FED4 - 1**      **Various Nanostructured Carbon Films for FED  
15:15**      **Applications**

*Z. Sun, Z. J. Zhang, Y. W. Chen, T. Chen, L. L. Wang,  
P. S. Guo, Z. Y. Cao, S. Ni, Y. Sun\*  
East China Normal Univ., China  
\*Nanocs Int., USA*

Nanostructured carbon (nm-C), including carbon nanotubes/fibers, nanodiamonds, nanocarbon composites, diamond-like films, for novel field emission display (FED) applications is reviewed. The synthesis and properties of various nm-C films, the related fabrication system, device structure and package, is studied. By using chemical vapor deposited (CVD) nm-C as the cathode, the low cost nm-C-FED prototypes have been developed, and showing excellent field emission properties, such as low emission field, high stability, high brightness and uniform emission.

**FED4 - 2**      **Fabrication of Poly-Si TFT Controlled FED**

**15:30**

*M. Nagao, C. Yasumuro, Y. Sakamura, H. Tanoue,  
S. Kanemaru, J. Itoh  
Nat. Inst. of Advanced Ind. Sci. & Tech., Japan*

We fabricated poly-Si TFT controlled FEA and demonstrated complete control of emission current. The response time of the TFT-FEA is about 15  $\mu$ s, which is sufficient for active controlled display. We also fabricated active matrix FED and sealed in vacuum envelop using unique packaging process; that is exhaust-tube-less vacuum sealing.

**FED4 - 3      Field Emission Distributions from HfC Thin Films  
15:45           Studied with STM**

*T. Sato\*\*\*, M. Saida\*, K. Horikawa\*, K. Adachi\*,  
M. Nagao\*\*, S. Kanemaru\*\*, S. Yamamoto\*\*, M. Sasaki\*  
\*Univ. of Tsukuba, Japan  
\*\*Nat. Inst. of Advanced Ind. Sci. & Tech., Japan*

Nanometer-scale distributions of field emission (FE) from HfC films are obtained by using an STM with sample-hold circuits, where the tip-surface distance is controlled by constant current STM operation, and emission current from the surface is measured under a sufficient bias voltage for a brief time. From the obtained FE images, we find that electrons are dominantly emitted from grain boundaries of the HfC films, indicating that FE can be determined by other properties than geometry or microscopic work function.

**FED4 - 4      Field Emission Characteristics of Boron Carbon  
16:00           Nitride Films Deposited at Various Growth  
                         Temperatures**

*K. Okada\*, C. Kimura\*, K. Okamoto\*\*, M. Wada\*\*,  
T. Sugino\*  
\*Osaka Univ., Japan  
\*\*Maizuru Nat. College of Tech., Japan*

Field emission characteristics of the boron carbon nitride (BCN) films deposited on the iron substrate at various temperatures are investigated. The growth rate of BCN films deposited on the iron substrate is higher than that deposited on the Si substrate. The carbon composition ratio and the surface roughness increases with decreasing growth temperature. The turn-on electric field as low as 5.1 V/ $\mu\text{m}$  is achieved for the BCN film deposited at 200°C on the glass substrate.

**FED4 - 5      Work Function Measurement of Modified Tungsten  
16:15           Surface by Use of Photoemission Electron  
                         Microscope**

*Y. Nakano, K. Minami, K. Yamane, H. Nakane, H. Adachi  
Muran Inst. of Tech., Japan*

Work function of ZrO/W (100) surface is successfully measured by the use of Photoelectron emission microscope (PEEM) to be  $2.85 \pm 0.05 \text{ eV}$ , which is in the range of so far reported values of 2.7~2.9eV with the Fowler-Nordheim plot. The work function calculated from the slope of the Fowler-Nordheim plot is widely accepted for the index of the cathode performance, but it includes some ambiguities because of difficulty in estimating field strength. Photo-emission directly gives work function as a physical quantity.

**FED4 - 6**      **LEED and XPS Studies on Modified Molybdenum  
Surface by Zirconium and Oxygen**

16:30

*S. Satoh, H. Nakane, H. Adachi  
Muroran Inst. of Tech., Japan*

It has been reported that ZrO/Mo (100) has a Fowler-Nordheim work function of 2.1eV, which is much smaller value than 2.7-2.9eV for the ZrO/W (100) Schottky emitter. A specific LEED pattern of c (2 x 4) is observed, which is very similar to the already reported results for ZrO/W (100). In situ XPS analysis for Zr 3d peak indicates that the "ZrO complex" is also formed. These observing evidences suggest that the work function reduces very similar mechanism to the case of ZrO/W (100) Schottky emitter.

**FED4 - 7**      **4.5-in. Triode-Type Flat Lamp Fabrication by Using  
Novel Metal Gate Structure**

16:45

*W.-S. Cho<sup>\*,\*\*</sup>, H.-J. Lee<sup>\*,\*\*</sup>, Y.-D. Lee<sup>\*</sup>, Y.-H. Lee<sup>\*\*</sup>,  
J.-K. Kim<sup>\*</sup>, J.-H. Park<sup>\*\*</sup>, B.-K. Ju<sup>\*\*</sup>  
<sup>\*</sup>Korea Inst. of Sci. & Tech., Korea  
<sup>\*\*</sup>Korea Univ., Korea*

A triode type flat lamp (4.5 inch) with screen printed carbon nanotube emitters and metal gate is fabricated and its field emission properties have been investigated. The metal gate is designed to the reversed-trench structure and fabricated by a conventional etch process. This structure could decrease the vibration of the metal mesh by electric field and the charging by the between cathode and metal gate. As a result, the uniformity and stability of the flat lamp are improved.

**Author Interviews**

17:10 - 18:10

**Sponsor:**

158th Committee on Vacuum Nanoelectronics, JSPS

**BANQUET**

Wednesday, December 7

19:00 – 21:00

at Hiten (3F)

ANA Hotel Clement Takamatsu

See page 9 for details

# Workshop on Organic LED Displays

Tuesday, December 6

13:20 - 14:50

Sunport Hall Takamatsu Small Hall 1

## OLED1: High Efficiency

Chair : J. Kido, Yamagata Univ., Japan  
Co-Chair : A. Mikami, Kanazawa Inst. of Tech., Japan

### OLED1 - 1: *Invited* Recent Progress in Phosphorescent OLED 13:20

*S. R. Forrest  
Princeton Univ., USA*

No abstract was submitted.

### OLED1 - 2 **Charge Transport Layers Doped with Molecular Donors and Acceptors: High Power Efficiency and Long Lifetimes for Display and Lighting Applications** 13:50

*A. Werner, J. Birnstock, M. Hofmann, S. Murano,  
M. Vehse, A. Lux, M. Limmert, A. Gruessing,  
J. Blochwitz-Nimoth  
Novaled GmbH, Germany*

Doped charge transport layers reduce the operating voltages of organic light-emitting devices (OLED) for various kinds of device environments such as substrate or electrode material. Development of suitable dopant compounds and optimized device design yield OLEDs with very high power efficiency for bottom and top emission configuration and very long lifetime. The recent progress in doping technology is discussed. Using doping technology, superior performance and stability for OLED applications, e.g. displays and lighting applications, are possible.

### OLED1 - 3 **High Efficiency Bottom-Emitting OLED with External Weak Microcavities** 14:10

*Y. W. Song, J. S. Oh, S. H. Jo, O. K. Song, Y. M. Koo,  
Y. C. Kim  
Samsung SDI, Korea*

High Efficiency bottom-emitting Organic Light Emitting Device (OLED) with external weak microcavities (EWM) was developed. The external microcavities consisted of a cathode metal mirror and interfaces with refractive index contrast which were realized by inserting single pair of the dielectric layers of high and low refractive index (R.I.) between ITO and glass substrate. It was proved that the efficiency in red, green, blue color could be enhanced by 158%, 53%, 30%, respectively without severe deterioration in viewing angle characteristics. A 128x160 passive matrix OLED with external microcavities was fabricated and showed 20% higher brightness.

**OLED1 - 4 High Efficiency White Organic Light Emission Device  
14:30 Based on New Orange Phosphorescence Material**

*X. M. Yu, W. Y. Wong\*, H. J. Peng, B. Z. Tang, M. Wong,  
G. J. Zhou\*, H. S. Kwok  
Hong Kong Univ. of Sci. & Tech., Hong Kong  
\*Hong Kong Baptist Univ., Hong Kong*

White light emitting device based on a new orange phosphorescent material Ir(DPA-FIpy)<sub>3</sub> ((DPA-FIpy)H = (9,9-diethyl-7-pyridinylfluoren-2-yl)diphenylamine) has been fabricated. The white OLED consists of it and a blue phosphorescent material FIrPic (iridium-bis(4,6-difluorophenylpyridinato-N,C<sup>2</sup>)-picolinate). The threshold voltage is 4.2V, and the brightness reaches 3200 cd/m<sup>2</sup> at 10V, 30.3 mA/cm<sup>2</sup>. The color of the light corresponds to a CIE coordinate of (0.31, 0.41). The highest efficiency of the device can reach 17.8 cd/A or 7 lm/W at 8V, 2mA/cm<sup>2</sup>.

----- Break -----

15:05 - 16:35

Sunport Hall Takamatsu Small Hall 1

**OLED2: Process Technology**

Chair : S. R. Forrest, Princeton Univ., USA  
Co-Chair : A. Mikami, Kanazawa Inst. of Tech., Japan

**OLED2 - 1: *Invited* Advances in P-OLED Technology**

15:05 *J. Halls  
Cambridge Display Tech., UK*

No abstract was submitted.

**OLED2 - 2 Development of Polymer Light-Emitting Diode(PLED)  
15:35 Displays Using a Printing Method**

*K. Takeshita, H. Kawakami, T. Shimizu, E. Kitazume,  
K. Oota, T. Taguchi, I. Takashima  
Toppan Printing, Japan*

We have developed a printing method for producing polymer light-emitting diode (PLED) displays. This method is a kind of direct printing, and we have achieved it by modifying a common printing method, so it is a relatively simple and cost-effective method. By using this method, we have been able to make a patterned PLED layer accurately. We have started trial production of full color PLED displays and have achieved 70 ppi resolution.

**OLED2 - 3      Fabrication of Flexible Phosphorescent OLED  
15:55            Display by Ink-Jet Printing**

*M. Suzuki, T. Tsuzuki, T. Kurita, T. Koyama\*, T. Yamaguchi\*,  
T. Furukawa\*\*, S. Tokito  
NHK, Japan  
\*Showa Denko, Japan  
\*\*Kyodo Printing, Japan*

We have fabricated flexible OLED display by ink-jet printing. Highly efficient phosphorescent materials were used as the ink solutions. Molecular weights of the host polymer and solvents were optimized for the ink formulation. ITO anode and polyimide bank structures were fabricated on the plastic film by using a transfer method. The PEDT/PSS and the emitting layer were exactly printed in the pixels, and sample video image could be clearly observed.

**OLED2 - 4      Analysis, Detection and Repair of Pixel Shorts in  
16:15            PM-OLEDs**

*M. Kimura, Y. Kubo  
Ryukoku Univ., Japan*

First, pixel shorts in PM-OLEDs are analyzed, and it is found that some actual shorts concoct many imaginary shorts. Next, a detection method of the pixel shorts is invented, where light emission is observed in order to detect the exact locations of the actual shorts. Finally, repair ideas for the pixel shorts are proposed, which is expected to effectively separate the pixel shorts and repair PM-OLEDs.

----- Break -----

**16:50 - 18:10**

**Sunport Hall Takamatsu Small Hall 1**

**OLED3: Device Structure**

Chair : J. Halls, CDT, UK  
Co-Chair : Y. Sato, JST, Japan

**OLED3 - 1      Lifetime Optimization of Multi-Primary OLED  
16:50            Displays**

*O. Belik, N. Cordes, F. Budzelaar, J. Hoppenbrouwers,  
A. Giraldo, N. van der Vaart  
Philips Res. Labs., The Netherlands*

Polymer and Small Molecule OLED self-emissive displays have high brightness, almost perfect viewing angle, and fast response time. An OLED display with an extra fourth primary can reproduce a wider colour gamut than a conventional three primary RGB display. Apart from that it allows to increase the lifetime of the OLED display. This paper shows how a multi-primary display with a wider gamut can use the redundancy to increase its lifetime.

**OLED3 - 2      High Efficiency Green-Light-Emitting  
17:10          Phosphorescent Organic Devices Based on a Side-  
                  Coupling Color-Conversion Technique**

*A. Mikami, Y. Iida, K. Seishu, Y. Nishita  
Kanazawa Inst. of Tech., Japan*

A high efficiency phosphorescent yellowish-green-OLED has been developed based on a Side-Coupling-Color-Conversion-Method (SC<sup>3</sup>M), in which the green-light emission from an organic layer is laterally transferred to an adjacent color-conversion layer. The device with SC<sup>3</sup>M structure showed an external quantum efficiency (EQE) of 22.3% by using a phosphorescent excitation light with an EQE of 15.1%, which is exceed to the theoretical limit for an out-coupling efficiency.

**OLED3 - 3      Improved Light Out-Coupling Efficiency of Top-  
17:30          Emitting Organic EL Devices with Ultra-Thin  
                  Transparent Electrode**

*T. Miyashita\*, S. Naka\*,\*\*, H. Okada\*,\*\*, H. Onnagawa\*,\*\*  
\*Toyama Univ., Japan  
\*\*JST, Japan*

We have investigated light out-coupling efficiency of top-emitting organic electroluminescent devices varied with thickness of transparent electrode and anode electrodes. Out-coupling efficiency changed periodically with indium-zinc-oxide (IZO) thickness and maximum luminance was obtained for IZO thickness of 25 nm. For the device with ultra-thin Au electrode of 10 nm and MoO<sub>3</sub> buffer layer, luminance and current efficiency are also improved as 8,000 cd/m<sup>2</sup> and 2.2 cd/A, respectively.

**OLED3 - 4      A Novel Carbon Film on ITO to Enhance the  
17:50          Performance Organic Light Emitting Diodes**

*C. K. Tzen, W. J. Shen, Y. L. Kao, S. J. Tang  
Chunghwa Picture Tubes, Taiwan*

Carbon films (CC<sub>n</sub>) as a HIL layer on ITO surface have been prepared in different deposition rates of CF<sub>x</sub> in the PECVD, followed by UV and plasma treatment. Higher ratio of CF<sub>x</sub> was turned into CC<sub>n</sub> after UV treatment, compared to gaseous Ar and N<sub>2</sub> plasma treatment. Ultra-thin CF<sub>x</sub> remained at outer surface of CC<sub>n</sub> were shown in the XPS spectra. Higher brightness of OLED with CC<sub>n</sub> as a HIL on ITO has been observed.

**Author Interviews**

18:20 - 19:20

**IMID / IDMC 2006**

Aug. 22 – 25, 2006  
Daegu, Korea

## Wednesday, December 7

10:40 - 12:05

Sunport Hall Takamatsu Main Hall

### OLED4/AMD5: Active Matrix OLED

Chair : B. J. Feenstra, Philips Res. Labs., The Netherlands  
 Co-Chair : R. Hattori, Kyushu Univ., Japan

#### OLED4/AMD5 - 1: **Invited Development of Full Color Double Sided 10:40 Active Matrix OLED**

*C.-W. Ko, S.-H. Hu, S.-H. Li, T.-H. Hsiao, K.-S. Lee,  
 C.-J. Chen, J.-H. Chen, J.-J. Lih  
 AU Optronics, Taiwan*

A 1.5-inch full color double sided AMOLED has been developed. The typical sub-pixel area is divided into two regions, which are designed for top-emission and bottom-emission structures. With the novel array design, independent images on both sides of the panel can be controlled by only one IC driver. Superior performance of the double sided AMOLED such as high color saturation and good power efficiency were achieved. Very thin form factor and light weight with capability of showing two independent images on both sides make the double sided AMOLED an excellent candidate for cell phone application.

#### OLED4/AMD5 - 2 **7-in. WVGA AM-OLED Display with Color Filter on 11:05 Array (COA) and Pixel Compensation Technology**

*D.-Z. Peng, C.-H. Tseng, S.-C. Chang, P.-H. Yeh,  
 H.-L. Hsu, Y.-M. Tsai  
 Toppoly OptoElect. Taiwan, Taiwan*

We have developed a 7-inch WVGA full-color AM-OLED display with technology of color filter on array (COA) and pixel compensation circuit. To prevent precision mask misalignment issues, high efficiency white OLED with COA was applied for higher resolution. In addition, a pixel circuit which compensates both the TFT variations as well as EL power voltage drop was proposed to improve the uniformity on the panel. With these technologies, a large-size and high-resolution OLED display could be achieved.

#### OLED4/AMD5 - 3 **Novel Voltage-Sensing and Voltage-Programming 11:25 Method for Large-Size and High-Resolution AM-OLED Panels**

*H.-J. In, P.-S. Kwag, J.-S. Kang, O.-K. Kwon, H.-K. Chung\*  
 Hanyang Univ, Korea  
 \*Samsung SDI, Korea*

A novel voltage-sensing and voltage-programming method is proposed for large-size and high-resolution AMOLED panels. The proposed method successfully compensates the threshold voltage and mobility variations of poly-Si TFTs throughout a large-size panel and overcomes the problem of charging a data line. The HSPICE simulation results show that the maximum emission current error for 30-inch full HDTV applications is less than 1.86%, when the mobility variation and the threshold voltage variation are +12.5% and +0.3V, respectively.

**OLED4/AMD5 - 4    New Current Compensation Theory in AM-OLED  
11:45                Pixel Circuit by Employing Voltage-Scaled  
                         Programming Method**

*W.-J. Nam, J.-H. Lee, S.-M. Han, H.-J. Lee, M.-K. Han  
Seoul Nat. Univ., Korea*

For the first time, we propose a new voltage-scaled programming pixel circuit of AMOLED displays. Data voltages are scaled-down by the capacitive-coupling of off-transition of the scan signal. The proposed scheme of data voltage modulation contributes to scale down the  $V_{TH}$  variation of the poly-Si TFT. The input range of data voltages is scaled up and the data addressing errors due to the clock feed-through of the scan signal are also reduced. Finally,  $I_{OLED}$  is compensated and the uniform current is successfully controlled.

**Author Interviews**

17:30 - 18:30

15:00 - 17:00

Exhibition Hall

**Poster    OLEDp/AMDp: Active Matrix OLED**

**OLEDp/AMDp - 1    Novel Sub-Intra Gate Poly-Si TFT Structure for AM-OLED Pixel Drivers**

*C. J. Shih, C. H. Fang, D. H. Deng, P. C. Liu, C. P. Kuan,  
C. C. Lu  
Chunghwa Picture Tubes, Taiwan*

The novel poly-Si thin film transistors based on sub-gate, intra-gate, and asymmetric dual-gate structures are developed to satisfy the strict requirements of AMOLED pixel drivers. Our experimental results show that the proposed design can optimize the performance of dual gate structures by suppressing kink current and light-induced leakage current, while the aperture ratio and field effect mobility are also improved remarkably.

**OLEDp/AMDp - 2    7-in. WQVGA p-Si LTPS AM-OLED with Novel Driving Architecture**

*I.-C. Shih, M.-T. Hsu  
Chunghwa Picture Tubes, Taiwan*

This paper presents a novel driving architecture for AMOLED that adopts the commercialized TFT-LCD driver IC. By utilizing fully p-Si LTPS process, this architecture has been successfully implementation on the 7-inch AMOLED display.

**OLEDp/AMDp - 3    New Pixel Circuits for Driving Organic Light Emitting Diodes with Low Temperature Polycrystalline Si Thin Film Transistors**

*Y. H. Tai, B. T. Chen, Y. J. Kuo, Y. J. Wei, C. C. Tsai,  
K. Y. Chiang, H. C. Cheng  
Nat. Chiao Tung Univ., Taiwan*

Two new pixel circuits for active matrix organic light emitting diode (AM-OLED), based on the low-temperature polycrystalline Si thin-film transistors (LTPS-TFTs) are proposed and the  $V_{th}$  compensation ability is verified by SPICE simulation and measured results. The voltage-programming pixel circuits are formed by five TFTs, one additional control signal, and one storage capacitor. The simulation and measured results show that the pixel circuit has high immunity to the variation of poly-Si TFT characteristics.

**OLEDp/AMDp - 4    Non-Contact Method for Analysis of Pixel Circuits in Active Matrix OLED Using External Probes with Electrical Pulses and Photo-Multiplier Tube Detector**

*P. L. Huang, S. J. Tang  
Chunghwa Picture Tubes, Taiwan*

We presented an effective non contact way to probe TFTs and capacitor on pixels, which was used to control on/off of switches and data storage to light on AMOLED devices. The detecting system was a combination of external electrical pulses on panel leads and a photomultiplier tube (PMT) detector. The OLED emitting signal had been the clue to understand of the behaviors of pixel circuits by modifying the electrical signal, and performance of OLED had been successfully improved.

**OLEDp/AMDp - 5    New Pixel Driving Scheme Based a-Si:H TFTs by Eliminating Switching TFTs in OLED Current Path for Low Power Consumption**

*H.-S. Shin, J.-H. Lee, K.-S. Shin, M.-K. Han  
Seoul Nat. Univ., Korea*

We propose a new pixel design for active matrix organic light emitting diode (AM-OLED) displays using hydrogenated amorphous silicon thin-film transistors (a-Si:H TFTs). The proposed circuit is employed by a new scheme of threshold voltage compensation. As  $V_{DD}$  supply lines are utilized clock signal, the threshold voltage of the driving TFTs is memorized during the  $V_{DD}$  clock signal off. The proposed circuit needs only one driving TFT located in the OLED current path without any additional switching TFT for  $V_{TH}$  compensation, resulting in lower power consumption than the conventional pixel circuits.

**OLEDp/AMDp - 6 Adaptive Current Scaling Pixel Circuit for a-Si:H AM-OLED Displays**

*J. Z. Huang, J. A. Cheng, Y. C. Lin, W. Cheng,  
H.-P. D. Shieh  
Nat. Chiao Tung Univ., Taiwan*

An adaptive current scaling pixel circuit for a-Si: H TFT process has been demonstrated. The adaptive current scaling is achieved by inserting a small cascaded storage capacitor to the traditional pixel circuit without affecting the aperture ratio. The proposed pixel circuit is capable of shorting the programming time without sacrificing the power consumption. Hence, the proposed pixel circuit is suitable for the large size and high resolution AMOLED application.

**OLEDp/AMDp - 7L High Contrast Top Emission Active Matrix RGB OLED**

*R. Wood, R. Cheuk, WY. Kim  
Luxell Technologies, Canada*

This work centers on the design of a high contrast AM top emission OLED. The device is built on an AM backplane, with discreet RGB color pixels, and a semi-transparent cathode. The structure utilizes the cavity effects for enhanced emission while simultaneously incorporating a tuned cathode for destructive optical interference.

**OLEDp/AMDp - 8L 3-TFT Pixel Circuit Employing a Fraction Time Annealing To Improve a Current Stability of a-Si:H TFT AMOLED**

*J. H. Lee, W. J. Nam, H. S. Shin, M. K. Han  
Seoul Nat. Univ., Korea*

We have proposed and fabricated 3-TFT pixel circuit employing a fraction time annealing to improve a current stability for a-Si:H TFT based AMOLED backplane. The measurement results, after an electrical bias and temperature (60°C) stress of 12 hours, show that OLED current is decreased by 23% in conventional 2-TFT pixel, while decreased by 6% in the proposed 3-TFT pixel because a negative bias can reduce  $V_{TH}$  degradation of a-Si:H TFT itself.

**OLEDp/AMDp - 9L New Voltage Programmed AMOLED Pixel Circuit Using Reference Current**

*M. H. Jung, I. H. Choi, O. H. Kim, T. Y. Kim\*, Y. W. Shin\*,  
H. J. Chung\*  
POSTECH, Korea  
\*Kumoh Nat. Institue of Tech., Korea*

A new pixel structure composed of six TFTs and one capacitor adopting low temperature polysilicon (LTPS) is proposed. It can compensate both the TFT threshold voltage variation and the supply voltage drop on operation. Simulation of the proposed circuit is carried out with SMART SPICE of RPI poly-Si TFT model.

15:00 - 17:00

Exhibition Hall

**Poster OLEDp: OLED poster****OLEDp - 1 Improvement of Electron Injection and Transport Ability of C<sub>60</sub> Electron Transport Layer**

*T. J. Park, Y. K. Lee, J. Y. Kim, S. K. Kwon, M. H. Kang,  
D. H. Song, J. H. Kwon, J. Jang  
Kyung Hee Univ., Korea*

We have developed a new electron transport layer (ETL) of a n-typed doped C<sub>60</sub> composite for small molecule organic light-emitting diodes (OLEDs). The device using a n-type doped C<sub>60</sub> material as an ETL showed much higher electron injection ability compared with un-doped one. The current density of n-type doped C<sub>60</sub> device exhibited 30mA/cm<sup>2</sup> at 3.4 V, while un-doped C<sub>60</sub> device showed 2.5mA/cm<sup>2</sup> at the same voltage. This result indicates that n-type doped C<sub>60</sub> facilitates electron injection and transport from Al cathode without any electron injection barrier

**OLEDp - 2 Study of High Efficient Top-Emitting Multi-Photon OLED**

*N. Nagai, Y-C. Lou, N. Miura, N. Tsutsui  
Int. Test & Eng. Service, Japan*

The top-emitting multiphoton OLED of two unit luminescence layers has been studied. IZO has been used for CGL (Charge Generation Layer) and MoO<sub>3</sub> also has been applied for the buffer on organic layer. The luminescence of this top-emitting multiphoton device has shown the efficiency at twice of the single structure's value.

**OLEDp - 3 Nickel Embedded Indium Tin Oxide Anode for Flexible Organic Light-Emitting Devices**

*C.-M. Hsu, Y.-S. Chen, C.-L. Tsai, W.-T. Wu  
Southern Taiwan Univ. of Tech., Taiwan*

Characteristics of an organic light-emitting diode (OLED) with a structure of Al/tris(8-hydroxyquino-line) aluminum (Alq<sub>3</sub>)/N, N'-bis-(1-naphthyl)-N, N'-diphenyl-1,1'-biphenyl-4, 4'-diamine (NPB)/indium tin oxide (ITO)/PET film have been improved by nickel embedded ITO anode. A turn-on voltage of 2.3 V can be reduced with the Ni-embedded OLED. The surface roughness of ITO and Ni is also lowered due to the use of a chemical-mechanical polishing process. The Ni-embedded ITO approach is hence capable of providing better OLED opto-electrical characteristics and improved lifetime at the same time.

**OLEDp - 4      Enhanced Lifetime of Organic Light-Emitting Devices Using a Nickel-Doped Indium Tin Oxide Anode**

*C.-M. Hsu, W.-C. Hsu, C.-S. Kuo, W.-T. Wu  
Southern Taiwan Univ. of Tech., Taiwan*

The lifetime of an organic light-emitting diode(OLED)has been improved by the introduction of Ni atoms in the surface of ITO anodes. A co-sputter of Ni and ITO generates a high ITO surface work function and hence enhances the hole injection efficiency. It is demonstrated that the lifetime of the OLED device with Ni-doping can be 1.7 times longer than that without Ni-doping. The results suggest that the existence of Ni atoms in ITO surface can improve OLED characteristics without any drawback in lifetime.

**OLEDp - 5      Using Tunneling Junction to Enhance Hole-Injection in Organic Light-Emitting Diodes**

*C.-C. Chang, S.-W. Hwang, M.-T. Hsieh, J.-W. Ma,  
C.-H. Chen, J.-F. Chen  
Nat. Chiao Tung Univ., Taiwan*

We demonstrate enhanced hole-injection and lower driving voltage in vacuum-deposited organic light-emitting diodes (OLEDs) with a novel tunneling junction composed of the Mg: Alq<sub>3</sub>/WO<sub>3</sub> layer. The device, ITO/Mg: Alq<sub>3</sub>/WO<sub>3</sub>/NPB/Alq<sub>3</sub>/ LiF/Al, achieved one of the lowest driving voltages of 5.8 V at 20mA/cm<sup>2</sup> for conventional small molecule OLEDs. We propose the laminated Mg: Alq<sub>3</sub>/WO<sub>3</sub>/NPB functions as a Fowler Nordheim tunneling junction, which can improve hole-injection. It was found to also prolong device lifetime under dc driving, that is comparable to the best reported for the Alq<sub>3</sub> emitter.

**OLEDp - 6      Enhancing the Organic Electroluminescent Property by Using Cerium Fluoride as an Electron Injection Layer**

*H.-L. Hsu, H.-W. Chen, E.-J. Chen, P.-H. Yeh, Y.-M. Tsai  
Toppoly OptoElect., Taiwan*

In this study, the properties of organic electroluminescent (EL) devices using cerium fluorides as an electron injection layer were investigated. The results show that the device containing the cerium fluorides layer is with a higher brightness and electroluminescent efficiency than the device without this layer. The maximum electroluminescent efficiency of the cerium fluorides with 0.1nm/Al cathode device was 10.28 cd/A, which is higher than the 9.67 cd/A of the LiF 1 nm/Al cathode device.

**OLEDp - 7      A Full Color Pixel with Vertical Stack of RGB Transparent OLEDs**

*T. Uchida, M. Ichihara, D. Ito, T. Tamura, M. Ohtsuka, T. Otomo\**

*Tokyo Polytechnic Univ., Japan*

*\*MATSUBO, Japan*

Transparent organic electro-luminescence device (TOLED) has a specific feature that it is transparent when light is not emitted. By choosing a light emissive material for each color, we can fabricate such a transparent device that emits red, green or blue light respectively. Furthermore, it enables us to fabricate a full color display by stacking these R,G,B, TOLEDs. In this display, RGB lights are emitted from one pixel and a full color display is achieved by controlling each emission of light individually and simultaneously.

**OLEDp - 8      Modification of Polycrystalline Silicon as Efficient Anode for Active Matrix Organic Light-Emitting Diodes**

*X. L. Zhu, J. X. Sun, H. J. Peng, Z. G. Meng, M. Wong, H.-S. Kwok*

*The Hong Kong Univ. of Sci. & Tech., China*

The effects of different modification methods for polycrystalline silicon (*p*-Si) on the performance of *p*-Si anode OLEDs have been studied. UV-ozone treatment of *p*-Si improved the device performance with suitable UV time, while O<sub>2</sub> plasma treatment led to deterioration. By depositing ultra-thin high work function metal oxides, such as V<sub>2</sub>O<sub>5</sub> and MoO<sub>3</sub>, on *p*-Si anode, the performance of OLEDs was greatly improved compared with those using bare *p*-Si as anode and competitive with that of the conventional devices with ITO anode.

**OLEDp - 9      White Light Emitting Devices from Polyfluorene-Based Blue and MeH-PPV Polymer Blending System**

*S. K. Kwon, Y. K. Lee, M. H. Kang, J. Y. Kim, T. J. Park, D. H. Song, J. K. Jin\*, D. C. Shin\*, W. J. Choi\*, H. You\*, J. H. Kwon, J. Jang*

*Kyung Hee Univ., Korea*

*\*SK, Korea*

We have fabricated white polymeric light-emitting devices (WPLEDs) from polyfluorene-based (PFO) blue and MEH-PPV polymer blending systems. A device structure of ITO / PEDOT:PSS / polymer / LiF / Al was employed. A current efficiency of 4.3 cd/A (4,230 cd/m<sup>2</sup>, QE=1.9%) and a brightness value of 21,430 cd/m<sup>2</sup> at 9.2 V with (0.35, 0.37) CIE coordinates at 5V and (0.29, 0.30) at 9V were obtained.

**OLEDp - 10 The Effect of Anode Carrier Concentration on OLEDs Performance**

*J. Hu, F. R. Zhu, L.-W. Tan, K. S. Ong, X. T. Hao\**  
*Inst. of Materials Res. & Eng., Singapore*  
*\*Chiba Univ., Japan*

A study was carried out to understand the effect of carrier concentration in anode on the electroluminescent performance of the OLEDs. The surface electronic structure of ITO was found to be relevant to the carrier concentration in ITO film. The anode contact property at ITO/organic interface can be optimized by controlling ITO bulk carrier concentrations and its surface properties through surface modification. The electroluminescent characteristics of devices reveal that carrier concentration in ITO plays a role in improving device performance.

**OLEDp - 11 See-Through PLED Display**

*L.-W. Tan, C. C. Choy, K. S. Ong, X.-T. Hao\*, E. C.-W. Ou,*  
*F. R. Zhu*  
*Inst. of Materials Res. & Eng., Singapore*  
*\*Chiba Univ., Japan*

A high performance dual-sided top-emitting polymer OLED exhibited a total luminous efficiency of ~5.0 cd/A at 4.0 V, which is comparable to that for a control device having bottom emission structure. A laser ablation technology was developed to define the pixels. The cathode separation was achieved without using the conventional reverse trapezoid type. A prototype of see-through polymer light-emitting passive matrix display has a matrix of 100×32 with a display area of 32.25 by 11.15 mm.

**OLEDp - 12 Failure Mechanism of Organic Light-Emitting Diodes on Flexible Substrate under Static and Dynamic Mechanical Stress**

*J.-S. Oh, M. A. Karim, H.-Y. Shin, Y.-R. Cho*  
*Pusan Nat. Univ., Korea*

The mechanism of failure of patterned ITO electrodes on PET was investigated under static and cyclic bending in the mechanical stress mode. When mechanical stresses are increased, two types of micro-cracks are observed depending on the stress modes. The direction of the micro-crack in ITO electrodes is perpendicular to the load for the static mode. The electrical resistance of an ITO electrode is related to the density of the micro-cracks and failure mechanism of ITO electrode.

**OLEDp - 13    Enhancement of Luminance Characteristics in Top Emitting OLEDs with Cr/Al/Cr Anodes**

*S. M. Chung, C. S. Hwang, J. I. Lee, S. H. Park, Y. S. Yang, L. M. Do, H. Y. Chu*

*Elect. & Telecommun. Res. Inst., Korea*

We report on the effects of anode deposition methods on the TEOLED characteristics. Top-emitting organic light-emitting diode was fabricated on chromium and aluminum multilayer of Cr/Al/Cr anode using Si wafer as a substrate. Chromium layers have been deposited by two different deposition methods of sputtering and e-beam depositions. The TEOLED containing the chromium layer deposited by sputtering method showed higher luminance and efficiency than that containing the chromium layer deposited by e-beam deposition.

**OLEDp - 14    An Investigation of the Emission Mechanism for White Organic Light-Emitting Diodes Comprising Blue Fluorescence and Phosphorescent Iridium Complexes**

*J.-F. Li, S.-F. Chen\*, S.-S. Su\*\*, M. Yokoyama\*\*, K.-S. Hwang*

*Nat. Chung-Cheng Univ., Taiwan*

*\*Nat. Chiao-Tung Univ., Taiwan*

*\*\*I-Shou Univ., Taiwan*

We report on a highly efficient white organic light-emitting diode (WOLED), and establish the possible emission mechanisms of WOLED configured with blue fluorescence and phosphorescent iridium complexes. Evidence showed that by utilizing the suitable thickness of green and red emitting layer (400 Å), a higher luminance performance of WOLED could be obtained. It is suggested that the optimal thickness of green and red emitting layer could effectively assist the carrier injection and emitting in green and red emitting layer.

**OLEDp - 15    Comparison between Laser and Wet Etching of Indium Tin Oxide on Optoelectrical Properties of Organic Light-Emitting Diodes**

*J.-F. Li, S.-H. Su\*, G.-T. Chen\*, M. Yokoyama\*, K.-S. Hwang*

*Nat. Chung-Cheng Univ., Taiwan*

*\*I-Shou Univ., Taiwan*

We investigated the influence on optoelectrical properties of organic light emitting diode (OLED) by both etching methods of indium tin oxide (ITO) substrates. Experimental results showed that the OLED with a laser-etched ITO substrate exhibits a lower drive voltage than that with a wet-etched substrate. However, a laser-etched device results in a lower luminance performance. By scanning electron microscopy (SEM) measurement, we found the different surface morphology of ITO pattern edge was get after both of the different ITO etched methods.

**OLEDp - 16 Solution-Processible Organic Light-Emitting Device Based on Quinolato-Complex Supramolecules**

*J.-A. Cheng, C. H. Chen, H.-P. D. Shieh  
Nat. Chiao Tung Univ., Taiwan*

A new type of supramolecular light-emitting materials Al (SCarq)<sub>3</sub> was synthesized by 5-*N*-(3-car-bazylpropyl)-*p*-methylaniline-sulfonyl-8-hydroxyquinoline. Via molecular engineering, its solid photoluminescence shows blue-green at 488 nm and two HOMO sites were -5.44 and -5.93 eV. For OLEDs fabrication using spin-coating techniques, the turn-on voltage and the maximum luminescent were 9.6 V and 35.0 cd/m<sup>2</sup>, respectively. Due to the electroplex formation, the chromaticity of EL was shifted to green-yellow with 1931 CIE<sub>x</sub>, <sub>y</sub> (0.40, 0.47).

**OLEDp - 17 Formation of Dark Spots Induced by Crystallization of Organic Layers in Organic Light-Emitting Diodes**

*S. Y. Kim, K.-H. Hong, C. W. Bark, Y.-M. Koo, K. Y. Kim\*,  
Y.-H. Tak\*, J.-L. Lee  
Pohang Univ. of Sci. & Tech., Korea  
\*LG Elect., Korea*

We report electroluminescence degradation in organic light emitting diode as a function of applying bias. A number of dark spots were produced as applying bias increased. Microscope image showed that dark spots are related to many protrusions and hollows formed on Al electrode. X-ray diffraction and x-ray micro-diffraction indicate that Joule heat from high electric field induced the crystallization of organic materials, forming dark spots *via* peeling-off the Al cathode from Alq<sub>3</sub> layers.

**OLEDp - 18 Pure Aluminum as the Anode in Top Emission OLED Fabrication Process**

*X. M. Yu, H. J. Peng, X. L. Zhu, J. X. Sun, M. Wong,  
H. S. Kwok  
Hong Kong Univ. of Sci. & Tech., Hong Kong*

Good performance top emitting organic light emitting diode (TOLED) with pure aluminum metal layer as the bottom anode has been fabricated. The brightness of the device could reach 4500cd/m<sup>2</sup> at applied voltage 12V. The highest current efficiency is about 6.8cd/A at a driving current density 50mA/cm<sup>2</sup>, which is much higher than that of the standard device and nearly twice as high as that of the TOLED with additional high work function silver deposited on aluminum as the anode.

**OLEDp - 19 Control of ITO Characteristics by Heat Treatment in Organic Light Emitting Diodes**

*L. Fenenko\*\*\*, C. Adachi\**

*\*Chitose Inst. of Sci. & Tech., Japan*

*\*\*NASU, Ukraine*

ITO modification using heat treatment for low driving voltage of OLEDs is proposed. Annealing of a regular ITO layer at 250°C in a GB led to both structural and surface changes. As a result, ITO work function was decreased, reducing the injection barrier to holes and facilitating the tunneling of carriers. The decrease of driving voltage with an increase of annealing time was obtained.

**OLEDp - 20 Design and Fabrication of Integrated Shadow Mask for Passive Matrix OLED Displays**

*Z. H. Huang, W. M. Su, G. J. Qi, X. T. Zeng*

*Singapore Inst. of Manufacturing Tech., Singapore*

This paper reports a structural design and fabrication process of an advanced integrated shadow mask, which is used for fabrication of passive matrix OLED display panel. The shadow mask is featured with easy fabrication, low cost and ability for large or even full angle deposition. The influence of process parameters on mask pillar profile was discussed. A prototype of mono color passive matrix (132X64) OLED display device was fabricated by using such an integrated shadow mask.

**OLEDp - 21 Organic Light Emitting Displays with a Single Isolation Layer**

*K.-H. Choi, B.-H. Byun, S.-W. Youn, S. J. Yi, D.-H. Choi*

*Daewoo Elect., Korea*

We developed an organic light emitting display with a new isolation method. In the new isolation method, insulators and cathode separators are formed simultaneously with a single layer of image reversal photoresist. The fabrication process is reduced to about 30% compared to the conventional isolation method and the width of the isolation layers is minimized since the insulators and the separators are self-aligned in the new isolation method.

**OLEDp - 22 The Measurement of Degradation in Organic Light-Emitting Displays for Aging Compensation**

*H. Yang, C. L. Chien, K. C. Liu, J. W. Chen*

*Nat. Taipei Univ. of Tech., Taiwan*

The concept of measuring the voltage-drop increment across an organic light-emitting device (OLED) as a pixel while degrading during operation was investigated by using an attached detection circuit as a real-time measurement unit. Several detection circuits based on comparators with both analog and digital design were studied by using SPICE simulation. Our study reveals that some specific detection circuits can effectively measure the voltage-drop increment across an OLED while degradation occurs at initial turn-on status within the range of less than one volt. The percentage error of our measured voltage-drop increment can be controlled within 1.5%.

**OLEDp - 23 Impedance Spectroscopy of Polymer Light-Emitting Diodes**

*H. Azuma, T. Okachi, N. Watanabe, T. Kobayashi, H. Naito  
Osaka Pref. Univ., Japan*

Impedance spectroscopy (IS) measurements have been carried out on poly(9,9-dioctylfluorene) (F8) polymer light emitting diodes (PLEDs) in order to determine the equivalent circuits of F8 PLEDs. Below the threshold voltage for electroluminescence (EL), F8 PLEDs can be modeled by an equivalent circuit of one RC component. Above the threshold for EL, F8 PLEDs can be modeled by a R - L series branch attached parallel to the RC component. The origin of these equivalent circuits is discussed.

**OLEDp - 24 Fiber OLED Array for Flexible Display**

*K. Yase, K. Suzuki, M. Hiroshima, A. Mimura, Y. M. Shuu\*,  
S. Toda\*, H. Koaizawa\*  
AIST, Japan  
\*Furukawa Elec., Japan*

We have successfully fabricated organic light emitting diode (OLED) on glass fiber as an one-dimensional substrate, whose diameter of 50–300  $\mu\text{m}$  corresponds to the pixel size for flat panel display (FPD).

**OLEDp - 25L The Power Consumption Reduction Algorithm of OLED Display**

*S. R. Shin, H. H. Hwang, S. H. Kim\*, J. S. Park\*  
Image Lab, Korea  
\*LG Innotek, Korea*

We have developed the power consumption reduction algorithm of the OLED display that could lower the power of it to about 30 % level of the conventional OLED display driving. We applied this algorithm to manufactured PM OLED models and confirmed its effect. Above all things, this method makes it possible to drive the OLED display below a constant power level, which can be decided by users freely. We think that this method contributes to making it easier to commercialize the OLED display such as a mobile product display and a large size TV.

**OLEDp - 26L Efficient Blue to UV OLEDs Base on the Novel Emitters**

*Y. M. Kim, Y. W. Park, J. S. Park\*, Y. S. Man, S. K. Yun\*\*,  
M. H. Lee\*\*\*, J. K. Kim\*, B. K. Ju  
Korea Univ., Korea  
\*Korea Inst. of Sci. & Tech., Korea  
\*\*NANO LCD, Korea  
\*\*\*VNF INNOVATION, Korea*

Two-layer organic light-emitting diodes (OLEDs) in the range of 380 nm to 440 nm are reported. An efficient and stable electroluminescence with a maximum at 400nm was observed at room temperature under a forward bias about 5V. With the novel small molecular organic materials for blue to ultraviolet (UV) emission, the low operating voltage (5V) and high current efficiency (3 cd/A) have been obtained at 2mA/cm<sup>2</sup>

**OLEDp - 27L Analysis of the Degradation Mechanism of Phosphorescence OLED II**

*R. Kamoto, K. Araki\*, M. Ichikawa\*, Y. Taniguchi\**  
*Micro Analysis Lab., Japan*  
*\*Shinshuu Univ., Japan*

Phosphorescence OLED of Ag-Mg/Alq<sub>3</sub>/BCP/CBP-FIrpic/NPD/ITO, EL intensity of which was reduced by half in nitrogen gas under continuous electric driven, was analyzed by micro analysis method. Changes in molecular structure of the all components are found to have occurred by electrically driven, and compared with results of heat annealing treatment.

**OLEDp - 28L Suppression of Dark-Spots Formation Varied With Cathode Interface in Organic Light Emitting Devices**

*Y. Motono, S. Naka, H. Okada, H. Onnagawa*  
*Toyama Univ., Japan*

Suppression of dark spots formation varied with organic layer/ cathode structure has investigated. Basic structure for evaluation was ITO/ TPD+ Rubrene/ Alq<sub>3</sub>/(LiF or BCP/LiF or BCP)/ Cathode. Device structure without LiF layer, number of dark spot dramatically decreased while bright-spots appeared. By inserting BCP layer, number of dark-spots also decreased. Dark-spots disappeared for the device with BCP/AlNd. Trans-mission electron microscope observations at the dark-spot and durability test fitted using Weibull distribution also were discussed.

**OLEDp - 29L Efficient OLED Fabricated by All Wet Process Using Alcohol-Soluble and Wide Energy Gap Organic Semiconductor**

*Y. Goto, T. Hayashida\*, M. Noto\**  
*Kyushu Elec. Power Inc, Japan*  
*\*Daiden, Japan*

We demonstrated highly efficient OLED fabricated by all wet process employed the electron transporting material, called DYETM-4. DYETM-4 have wide energy gap of 4.26eV. The all wet processed OLED using electron transporting DYETM-4 exhibited efficient EL performance; maximum current efficiency  $\eta_{MAX}$  was evaluated to be 41.7 cd A<sup>-1</sup> (an external quantum efficiency = 11.6%) at an applied voltage of 9V at a luminance of 57.4cd m<sup>-2</sup>.

**OLEDp - 30L Mixed Layers in OLED Devices - Hole and electron mobility in a model system  $\alpha$ -NPD / TAZ.***H.-P. Loebel, C. Zimmermann\***Philips Res., Germany**\*Inst. of Electromagnetic Theory, Germany*

Efficient small molecule OLEDs attract interest for lighting applications. To improve lifetime and efficiency, balanced carrier concentration in the recombination region is required. This can be achieved realizing equal mobility of electrons and holes in a mixed layer. We used a model system consisting of a hole conductor ( $\alpha$ -NPD) and an electron conductor (TAZ) to study the change in carrier mobility due to mixing. The hole mobility is reduced strongly due to mixing, while the electron mobility in the mixture remains constant. The results are explained with hopping transport in diluted systems.

**OLEDp - 31L Electroluminescent Characterization of Polymer-Based Light-Emitting Diodes with Doping Nanostructured Carbon***H. S. Koo, M. Chen\*, S. K. Kwon, Y. K. Lee, T. J. Park,**J. Y. Kim, D. H. Song, K. C. Park, J. H. Kwon, J. Jang**Kyung Hee Univ., Korea**\*Ming-Hsin Univ. of Sci. & Tech., Taiwan*

A polymer-based light-emitting diodes with doping minor amount nanostructured carbons have technically been fabricated by the solution-based spin coating technique. Electroluminescent characterization of the CNTs-doped polymeric light-emitting diodes have instrumentally been measured and basically analyzed from the experimental results. The performance of polymer light-emitting diodes in electroluminescence have effectively been improved by doping nanostructured carbon at a limited extent of magnitude.

## **EVENING GET-TOGETHER WITH WINE**

Monday, December 5

18:00 – 20:00

Main Hall Foyer (3F),  
Sunport Hall Takamatsu  
(Sponsored by Merck Ltd., Japan)

See page 9 for details

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

Thursday, December 8

13:40 - 15:10

ANA Hotel Clement Takamatsu Hiten 3

### 3D1: Perception and System Design

Chair : M. Katayama, NHK, Japan

Co-Chair : M. Tsuchida, NICT, Japan

#### **3D1 - 1:        *Invited*    Effects of Display Size on Visually Induced 13:40            Motion Sickness**

*H. Ujike, T. Yokoi, S. Saida\**

*Nat. Inst. of Advanced Ind. Sci. & Tech., Japan*

*\*Nat. Defense Ac., Japan*

To investigate effects of display size on vection and visually induced motion sickness, we presented 20 minutes video picture, which had been taken by hand-holding video-camera, on four different sizes of liquid crystal displays. Number of 138 observers' task was to answer the Simulator Sickness Questionnaire, or SSQ, before and after watching the video picture. The difference of total score of SSQ shows more severer sickness for larger number of observers was observed for larger display sizes. Moreover, we found that difference of gender, age and susceptibility to motion sickness affects the results.

#### **3D1 - 2                Added Value of a Multi-View Auto-Stereoscopic 3D 14:10                Display in Gaming Applications**

*R. J. E. Rajae-Joordens, E. H. A. Langendijk, P. Wilinski\*,  
I. E. J. Heynderickx*

*Philips Res., The Netherlands*

*\*Philips 3D Solutions, The Netherlands*

The longer-term use of multi-view 3D displays in gaming applications was investigated with 20 experienced gamers. During two gaming sessions, one in 2D and one in 3D, galvanic skin response and heart rate were measured (both assumed to assess emotions and presence), followed by questionnaires at the end of each session. The results show that 3D displays provoke significantly higher positive emotions and stronger feelings of presence than 2D displays, indicating that 3D displays have added value in gaming applications.

**3D1 - 3  
14:30 Examination on Stereoscopic Representation with Accommodation**

*K. Ohta, T. Shibata, T. Kawai, M. Otsuki\*, N. Miyake\*,  
Y. Yoshihara\*\*, T. Iwasaki\*\*\**

*Waseda Univ., Japan*

*\*Nikon, Japan*

*\*\*Arisawa Manufacturing, Japan*

*\*\*\*Univ. of Occupational & Environmental Health, Japan*

We have developed a stereoscopic 3-D display system with dynamic optical correction that reduces the optical discrepancy. The contents of this system allows various camera controls in virtual space to produce different impressions. This is accomplished by means of a customized VR authoring tool attached to the system. We examined camera control patterns in VR space and effective expression techniques using this system. The results show that various camera control patterns significantly affect the subject's impression of the images.

**3D1 - 4  
14:50 Analysis of Reproduced 3D Space by Stereoscopic Large LED Display**

*H. Noto\*, H. Yamamoto\*, Y. Hayasaki\*, S. Muguruma\*\*,  
Y. Nagai\*\*, Y. Shimizu\*\*, N. Nishida\**

*\*Univ. of Tokushima, Japan*

*\*\*Nichia, Japan*

We have developed a stereoscopic display system of real-world images by use of camera devices. In the developed stereoscopic display using full-color LED panel, reproduced positions are formulated based on camera arrangements and eye positions. Furthermore, the limitations of fusion of stereoscopic images shown on the stereoscopic large LED display have been calculated for different camera arrangements and the results suggest that there is an optimal arrangement of cameras to maximize the reproduced three-dimensional space.

**Author Interviews**

17:30 - 18:30

## SID 2006

Society for Information Display  
Symposium, Seminar & Exhibition

June 4–9, 2006

San Francisco, CA, USA

<http://www.sid.org>

15:00 - 17:00

Citizen's Gallery

**Poster 3Dp: 3D Display (Late News)****3Dp - 1L      Autostereoscopic Display Using Dual Liquid Crystal Display Panel***T. Nishida, K. Sakamoto  
Shimane Univ., Japan*

Many 3D visualization technologies have been invented, but none ever had a broad success. This report describes the field lens display for viewing the 2-views stereoscopic images. The conventional systems have the defect that it needs the complicated optical system for combining a stereo pair image. To overcome this optical problem, we developed the dual LCD panel using two liquid crystal layers. This display panel enables observers to view full screen high resolution images. This study shows that it is possible to simplify the optical system.

**3Dp - 2L      A Moire Method 43-inch 3-D Display System Using Lenticular Screen***C. Yamada, K. Irikura, H. Isono  
Nippon Inst. of Tech., Japan*

The authors produced a rear projection type 43-inch pseudoscopic 3-D display using lenticular screen as creating a big depth perception on moiré method 3-D display that allows viewers to see a 3-D image without special glasses. With this display, viewers are able to see a image surrounded by moiré patterns that appear to be either floating or sinking without special glasses. This ability to produce deep 3-D visual effects is a useful means for presentations and storefront advertisements.

**3Dp - 3L      Dual Views Display: Polarizer Slits Enable Full Screen High Resolution Viewing***M. Yoshigi, K. Sakamoto  
Shimane Univ., Japan*

Conventional parallax barrier display systems have demerits such that the barrier cuts resolution of a screen in half. This report describes the development of a desktop dual views display using polarizer slits for collaborative tasks. The polarizer slits enable observers to view full screen high resolution images, and this proposal can solve the resolution problem of the conventional system.

**3Dp - 4L      A Turn-Type 64 Colors 3-D Display Using LEDs***T. Yamaguchi, Y. Sakamoto, I. Fukuda  
Kanazawa Inst. of Tech., Japan*

We have developed a turn type a color 3-D (3 Dimensional) display designed with a vertical array of LEDs (Light Emitting Diodes) to increase the number of depth sampling display colors to 64. The movement of the LED array allows two dimensional images to be perceived by the effect of afterglow. The movement of the 13 arrays arranged depth direction enables 3-D images to be displayed in real space. We have achieved displaying 64-colors 3-D images with high brightness.

## Friday, December 9

10:40 - 12:25

Kagawa International Conference Hall

**3D2: Advanced Display Systems**

Chair : S. Otsuka, NTT Data, Japan

Co-Chair : S. Yano, NHK, Japan

**3D2 - 1: 10:40 Invited A 3D Video System for Archiving of Japanese Traditional Performing Art***M. Katayama, K. Tomiyama, Y. Orihara, Y. Iwadata  
NHK, Japan*

We are studying how to archive Japanese intangible cultural heritage in the form of dynamic 3D model. The dynamic 3D model is generated from video images captured by multiple cameras surrounding a target subject. By synthesizing the dynamic 3D model of the Noh actor with a CG of Noh stage, we can see an entire Noh scene from any viewpoint. We report on the outline of a 3D video system for archiving of Japanese traditional performing art.

**3D2 - 2 11:10 Optimization of Camera Parameters in Volume Intersection***H. Iwase, K. Shoji, F. Toyama, S. Sakamoto  
Utsunomiya Univ., Japan*

This paper examines attempts to optimize camera parameters with errors by reconstructing a 3D shape via the method of volume intersection. Reprojecting the reconstructed 3D shape to image planes, the camera parameters are determined by finding the reprojected silhouette images that result in minimal lost area when compared to the original silhouette images.

**3D2 - 3 11:30 Compact Six-Primary Color DLP Projection Display System for High-Fidelity Color Reproduction***M. Tsuchida\*, H. Fukuda\*, J. Kishimoto\*, H. Kanazawa\*,  
M. Yamaguchi\*\*, H. Haneishi\*\*\*, N. Ohyama\*\*  
\*Nat. Inst. of Info. & Commun. Tech., Japan  
\*\*Tokyo Inst. of Tech., Japan  
\*\*\*Chiba Univ., Japan*

We developed a compact six-primary-color DLP projection display consisting of two single-chip DLP projectors. Two different types of filler are inserted into each projector so that six primary colors are obtained. The auto calibration processor hardware calibrates images from each projector to remove geometrical distortion in real-time from the six primary-color images when they are overlapped on the screen. The image size on the screen is 20 inches, and the resolution is SXGA+.

**3D2 - 4**                    **Small Cylindrical Display Using an Aspherical Mirror  
11:50**                    **for Anthropomorphic Agents**

*T. Kawanishi\**, *M. Tsuchida\*\**, *S. Takagi\*\*\**, *A. Kimura,*  
*J. Yamato*

*NTT, Japan*

*\*Plala Networks, Japan*

*\*\*NTT Data, Japan*

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

We have developed a small cylindrical display for anthropomorphic agents that communicate with multiple users in a 3D environment. A previously reported cylindrical display was dark with poor contrast in the lower part of the screen because the pixel density is much lower than in the upper part. We improved the uniformity of the pixel density by using an aspherical mirror. Experimental results show that our new display has better luminance and better contrast than the previously reported display.

**3D2 - 5L**                    **Pixel Design for Optimized 2D/3D Displays**  
**12:10**

*C. van Berkel, M. Inoue\**, *T. Inada\**, *H. Louwsma\*\**,  
*S. T. de Zwart\*\*\**, *J. R. Hector*

*Philips Res. Labs., UK*

*\*Philips Mobile Display Syss., Japan*

*\*\*Philips Mobile Display Syss., The Netherlands*

*\*\*\*Philips Res. Labs., The Netherlands*

A 2D/3D switchable 1.8" QVGA AMLCD has been made with optimised colour filter and pixel layout. In 2D mode the display provides full resolution and brightness, while in 3D mode it provides full brightness, 4-view multiview 3D with high resolution per view, minimized inter-view cross talk and large freedom of viewing position.

----- Lunch -----

**13:50 - 15:00**

**Kagawa International Conference Hall**

**3D3: Holography**

Chair : J.-Y. Son, Hanyang Univ., Korea

Co-Chair : M. Tsuchida, NICT, Japan

**3D3 - 1:           Invited Real-Time Electroholography by Special-Purpose Computer HORN**  
**13:50**

*T. Ito<sup>\*,\*\*</sup>, N. Masuda<sup>\*\*</sup>, A. Shiraki<sup>\*\*</sup>, T. Shimobaba<sup>\*\*\*</sup>*  
*\*JST, Japan*  
*\*\*Chiba Univ., Japan*  
*\*\*\*Yamagata Univ., Japan*

We have developed special-purpose computers, named HORN, for a computer-generated hologram. The latest machine HORN-5 calculates a hologram with a 1,408 by 1,050 resolution at video rate for an object consisting of 10,000 points. It is 1,000 times faster than a today's personal computer. We discuss the effectiveness of a special-purpose computer system for a real-time electroholography which requires enormous calculation cost. 50- to 80-word abstract is required.

**3D3 - 2            A Colored Interactive Three-Dimensional Display System by Use of Electroholographic Display Unit**  
**14:20**

*T. Shimobaba, A. Shiraki<sup>\*</sup>, N. Masuda<sup>\*</sup>, T. Ito<sup>\*,\*\*</sup>*  
*Yamagata Univ., Japan*  
*\*Chiba Univ., Japan*  
*\*\*JST, Japan*

We report a colored interactive three dimensional (3D) display system by use of an electroholographic display unit consisting of a special-purpose chip for holography and a high resolution liquid crystal display panel. An observer can perform interactive operations, such as rotation and movement, to the reconstructed color 3D object by use of a keyboard, while viewing the reconstructed color 3D object.

**3D3 - 3            Parallax Barrier 3D Reflection Display Using Holographic Screen**  
**14:40**

*K. Sakamoto, M. Takaki, M. Nishida*  
*Shimane Univ., Japan*

The 3D reflection display system using an LCD projector has superior characteristics, such as having a large screen with wide field of view. However the conventional projection 3D display system has such disadvantage that the observer needs to wear special glasses for viewing stereoscopic images. This paper describes the 3D reflection display system with a holographic screen. This 3D display can avoid the problem of the conventional system. Moreover, the observer can view glasses-free 3D images without the pseudoscopic problem.

----- Break -----

**15:10 - 17:15**

**Kagawa International Conference Hall**

**3D4: 3D Display**

Chair :            I. Yuyama, Utsunomiya Univ., Japan

Co-Chair :        T. Mishina, NHK, Japan

**3D4 - 1:      *Invited*    Development of Lenticular-Type  
15:10            Autostereoscopic Liquid Crystal Display Based on  
                         One-Dimensional Integral Imaging**

*K. Taira, Y. Hirayama  
Toshiba, Japan*

We developed an autostereoscopic display using a vertical lenticular sheet and a liquid crystal display with modified color pixel arrangement. This autostereoscopic display had more than ten horizontal parallaxes generated by employing the integral imaging method that realize easy-to-view, natural, and less-fatiguing stereoscopic images. We also proposed a flatbed-type display that brought about a more effective stereoscopic experience than that available in the case of the conventional upright-type display.

**3D4 - 2            High-Appearance Images Generated by High-Density  
15:40            Directional Display**

*Y. Takaki, T. Dairiki  
Tokyo Univ. of A&T, Japan*

The ray reflection and refraction should be precisely controlled in order to reproduce the appearances of objects, such as specularity and transparency of objects. The high-density directional display can reproduce the appearances of objects because it can control a large number of directional images projected in different horizontal directions with directional rays. The prototype display which generates directional rays in 72 different horizontal directions with the angle pitch of  $0.38^\circ$  was constructed and the impression analysis experiments showed its effectiveness.

**3D4 - 3            Full Parallax Image Generation with a Single Viewing  
16:00            Zone Forming Optics**

*J.-Y. Son, V. V. Saveljev, S.-Y. Chung\*, K.-H. Cha\*  
Hanyang Univ., Korea  
\*Samsung Elect., Korea*

Three different arrangements of different view images in the multiview imaging systems are examined and their constructing methods are investigated to build full parallax 3 dimensional imaging systems with use of a viewing zone forming optics which is composed of one dimensionally aligned elementary optics. By arranging the images two dimensionally in the pixel cell, depth sense for almost 180deg inclination angle of viewer's head to the shoulder is obtained

**3D4 - 4            Latest Developments in a Multi-User 3D Display  
16:20**

*P. Surman\*, I. Sexton\*, K. Hopf\*\*, W. K. Lee\*, R. Bates\*,  
T. Koukoulas\*  
\*De Montfort Univ., UK  
\*\*Heinrich-Hertz-Inst., Germany*

The principle of operation of the De Montfort University (DMU) multi-user 3D display is described. The DMU display enables several viewers to move freely over a large area and to all see the same stereo image pair without the use of special glasses. A brief description of the first prototype, and the problems identified from this, will be given. Work on an improved prototype that is currently being built is described.

**3D4 - 5**      **Fractional Viewing Systems to Reduce Banding in Lenticular Based 3D Displays**  
**16:40**

*O. H. Willemsen, S. T. de Zwart, W. L. IJzerman  
Philips Res. Labs., The Netherlands*

In this paper we describe the design of a 5 view lenticular based 2D/3D display for mobile applications. A very noticeable such displays is the occurrence of dark bands. We will show that, despite slanting the lenticular and defocusing the lens, banding becomes unacceptable when the display is viewed from an angle. We introduce fractional viewing systems to reduce the banding intensity by almost two orders of magnitude. The resulting 3D display can be viewed from any direction without banding.

**3D4 - 6L**      **Depth Reproducibility for Inclined View in DFD (Depth Fused 3-D) Display**  
**17:00**

*M. Date\*, H. Takada\*, Y. Gotoh\*\*, S. Suyama\*  
\*NTT, Japan  
\*\*Kyoto Univ., Japan*

The depth reproduction characteristics of the DFD display were studied when an observer views it at an oblique angle. The tendency can be roughly explained considering binocular disparity induced by all combinations of side edges of front and rear images. If the spatial low-pass-filter effect in edge detection is considered, the experimental results agree well with theoretical calculations.

**Author Interviews**

17:10 - 18:10

## EXHIBITION

12:00 – 18:00 Tuesday, Dec. 6  
9:00 – 18:00 Wednesday, Dec. 7  
9:00 – 18:00 Thursday, Dec. 8  
9:00 – 14:00 Friday, Dec. 9  
Small Hall 2 (5F)  
Sunport Hall Takamatsu

Free admission with your registration name tag.

# Workshop on Applied Vision and Human Factors

**Wednesday, December 7**

**9:00 - 9:10**

**ANA Hotel Clement Takamatsu Hiten 3**

## Opening

### Opening Remarks

9:00

*H. Isono, Workshop Chair*

**9:10 - 10:50**

**ANA Hotel Clement Takamatsu Hiten 3**

## VHF1: Viewing Angle Dependent Image Quality

Chair : Y. Shimodaira, Shizuoka Univ., Japan

Co-Chair : T. Kurita, NHK, Japan

### **VHF1 - 1      Can We Predict LCD Aspect Using Local Viewing 9:10            Angle Measurements?**

*P. Boher, V. Gibour, T. Leroux*

*ELDIM, France*

The paper study if the aspect of LCDs is driven by local emission inhomogeneities or by geometrical consideration. To clear this point we use viewing angle measurements at different positions on the surface of a display and simulate the LCD aspect versus observer position. Comparison to video colorimeter images of the same displays show that both local and global properties of the display must be taken into account to predict correctly the aspect of the displays.

### **VHF1 - 2      Subjective Evaluation of Various Grayscale Viewing 9:30            Angle Characteristics Using Simulated Images**

*Y. Hisatake, M. Obi, H. Ito, C. Tago, Y. Kawata,*

*A. Murayama*

*Toshiba Matsushita Display Tech., Japan*

Patience Limit (PL) and Just Noticeable Difference (JND) of various grayscale viewing angle characteristics were evaluated subjectively using simulated images. In the evaluation, ten test subjects evaluated 4 types of picture images and those of 8 different images; 2 kinds of reverse images, 3 kinds of black crushing images and 3 kinds of white omission images with several grayscale difference levels. The results show that the concerns depend on not only kinds of pictures but also these images significantly.

**VHF1 - 3      The Gray Level Distortion Value for Off-Axis Image  
9:50            Quality Evaluation**

*Y. P. Huang, W. K. Huang, M. C. Wu, C. H. Tsao, J. J. Su,  
T. R. Chang, P. L. Chen, Y. C. Lin, K. Y. Lin  
AU Optronics, Taiwan*

A gray-level ratio distortion (GRD) value was proposed to easily evaluate the off-axis image quality in the more sensitive gray level of human eyes. Accordingly, the pixel structure with  $GRD(60^\circ, 0^\circ) = 0.22$  was designed on a 32-inch advanced MVA-LCD for low color-washout at large viewing angle.

**VHF1 - 4      A Viewing Angle Evaluation Method for LCDs  
10:10         Considering Visual Adaptation Characteristics**

*M. Yamada, Y. Mitsumori, K. Miyazaki, M. Ishida  
Fuji Photo Film, Japan*

A new evaluation method of viewing angle characteristics for liquid-crystal displays(LCDs) has been studied. We adopted CIE based color difference formula for evaluating color reproduction characteristics of LCDs, and we found that mean color difference  $\Delta E_{uv}$  of all pixels between im-ages are well correspond to the psychophysical image quality estimation results. Moreover, we consider adaptation state of the human vision, and we can obtain viewing angle evaluation index which suited the appearance of LCD images.

**VHF1 - 5      Secure Information Display by Use of Composite  
10:30         Visual Cryptography of a Secret Image and  
                  Identification Images**

*H. Yamamoto, Y. Hayasaki, N. Nishida  
Univ. of Tokushima, Japan*

We propose a secure display technique that ensures security of displayed information. We have developed a set of composite visual cryptography codes with which secret information is embedded in a displayed image and a decoding mask, both of which show identification images independent of the secret. With placing the decoding mask in front of an information display, the secret information is perceived when the displayed image is viewed through the decoding mask within a limited viewing zone.

----- Break -----

**11:10 - 12:15**

**ANA Hotel Clement Takamatsu Hiten 3**

**VHF2: Moving Image Quality (1)**

Chair :            T. Kurita, NHK, Japan  
Co-Chair :        Y. Shimodaira, Shizuoka Univ., Japan

**VHF2 - 1: 11:10 *Invited* Moving Picture Response Improvement Technology for LCD Televisions : "Clear Focus Drive"**

*R. Otake, Y. Ishikawa, S. Kitao, T. Funamoto, K. Miyabe  
Matsushita Elec. Ind., Japan*

The "Clear Focus Drive technique" which improves drastically in the moving picture display performance of LCD- TVs has been successfully developed. This technique is composed of "Motion compensation type frame rate conversion" and "Synchronous scanning type blinking backlight". Then, we can reduce the hold time to cause moving picture blurring of LCD- TVs, in the half of the conventional one. This presents a realistic video picture of LCD- TVs.

**VHF2 - 2 11:40 TFT-LCD with CRT-Like Moving Picture Response Time (MPRT)**

*F. T. Pai, D. Lin, S. M. Lee, H. K. Hsieh, X. Q. Chang,  
C. H. Hsu, A. Chao, T. S. Jen  
HannStar Display, Taiwan*

A CRT-like motion picture quality of TFT-LCD was developed. The motion picture quality evaluated by the index of moving picture response time (MPRT), using Otsuka MPRT-1000 system, is similar to that of CRT. The measured average MPRT are (a) 19.30ms for TFT-LCD without advanced over-drive technology (AOT), (b) 7.92ms for TFT-LCD with AOT, and (c) 12.5ms for CRT monitor, respectively.

**VHF2 - 3L 12:00 Proposal of High-Picture-Quality LCD System Based on Moving Picture Simulation "OCB Possibility for High-Picture-Quality LCD System"**

*N. Yamagishi, H. Ishibashi, A. Kakinuma, T. Arai,  
H. Yamagami  
Fuji Photo Film, Japan*

Possibilities of improvement in moving picture quality on LCD were investigated using moving picture blur simulation. As a result, it has been clarified that OCB mode with fast responsive capability is promising for high performance LC TVs when 120 Hz driving coupled with black data insertion. An LCD with moving picture display performance substantially in the same level as that of CRT can be achieved.

----- Lunch -----

14:00 - 15:00

ANA Hotel Clement Takamatsu Hiten 3

**VHF3: Moving Image Quality (2)**

Chair : J. Bergquist, Nokia Japan, Japan

Co-Chair : N. Hiruma, NHK, Japan

**VHF3 - 1      Dynamic Gamma: Applications to Hold Type Motion  
14:00      Blur Reduction Using Synchronized Backlight  
Flashing**

*X.-F. Feng, H. Pan, S. Daly  
Sharp Labs. of America, USA*

We modeled backlight flashing using motion blur model and conducted backlight flashing experiment on a LCD display with a LED backlight. The LED was flashed at a fraction of the LCD frame period. We found that although motion blur was greatly reduced with flashing, new artifacts such as ghosting were observed. The cause is due to poor synchronization and incorrect overdrive. Conventional overdrive can not guarantee the LCD to reach the target level at flashing time thus causing the ghosting. We modified the dynamic gamma metric to incorporate flashing timing which reduced the ghosting.

**VHF3 - 2      Moving Picture Color Artifacts Measured by Using a  
14:20      Pursuit Camera System**

*Y. Enami, K. Oka\*  
Otsuka Elect., Japan  
\*Nanosoftware, Japan*

Since human eye recognizes motion blur as a distortion of both luminance and chromaticity, motion blur should be analyzed based on both luminance and chromaticity. we study method of evaluating colored motion blurring in a point of chromaticity. And colored blurring edge is evaluated from moving picture response curve of color difference  $\Delta E_{uv}$ .

**VHF3 - 3      Image Quality Degradation of Moving Pictures: Trial  
14:40      to Obtain a Metric in JND Unit**

*K. Oka, Y. Enami\*  
Nanosoftware, Japan  
\*Otsuka Elect., Japan*

Motion blur is most important among many motion artifacts, which degrade image quality. A method to determine a blur width on a pursuit image of moving test pattern is proposed. FFT filtering by using CSF provides stimuli curve expressing Mach band. The width is obtained from a distance between maximum and minimum peaks. This will be called a "Perceived Blur Edge Width". The widths are compared with extended blur edge widths.

**Author Interviews**

17:30 - 18:30

**Thursday, December 8**

9:00 - 10:20

ANA Hotel Clement Takamatsu Hiten 3

**VHF4: Color Reproduction**

Chair : H. Isono, Nippon Inst. of Tech., Japan  
Co-Chair : T. Tamura, Tokyo Polytech. Univ., Japan

**VHF4 - 1:     *Invited*   Color Issues and Solutions for AMLCD  
9:00            Technology**

*G. Marcu  
Apple Computer, USA*

This paper discusses few factors affecting the color rendition on typical LCDs, with emphasis on notebook displays. The paper presents few correction algorithms for improving color performance of these displays in the area of gray tracking, color variation with the viewing angle and response time. The implementation of each algorithm does not require special hardware additions or changes of the graphic system. The solutions are general and can be applied to any LCD panel as needed.

**VHF4 - 2:     *Invited*   Comparison of Three Different Color  
9:30            Sequential Display Techniques**

*E. H. A. Langendijk  
Philips Res. Labs., The Netherlands*

This paper discusses the pros and cons of three different field sequential displays: 1) a display with no color filters using three color fields (generated with a red, green, and blue LED), 2) a display with three color filters, using two color fields (generated with two different types of fluorescent lamps with different spectra), and 3) a display with two color filters using two color fields (generated with a green + blue LED and a green + red LED).

**VHF4 - 3        Color Reproduction Method to Reduce Color  
10:00           Difference Caused by Device Drift, Imperfect  
                  Additivity and Color Tracking**

*M. Takaya, T. Wakebe, Y. Shimodaira  
Shizuoka Univ., Japan*

A highly accurate color reproduction method is proposed for displays. In order to reduce color difference caused by the color-tracking phenomenon, device drift and imperfect additivity, a color conversion method previously proposed by two of the authors, exponential regression and linear multiple regression are adopted and the methods are optimally combined. Applying the method to a set of 100 colors resulted in 2 times color difference improvement compared with that of the current standard method, the Shaper/Matrix model.

----- Break -----

**10:40 - 12:25**

**ANA Hotel Clement Takamatsu Hiten 3**

**VHF5: Image Quality & Ergonomics**

Chair :           G. Marcu, Apple Computer, USA  
Co-Chair :       N. Hiruma, NHK, Japan

**VHF5 - 1: 10:40** *Invited* **From Image Fidelity to Subjective Quality: A Hybrid Qualitative/Quantitative Methodology for Measuring Subjective Image Quality for Different Image Contents**

*G. Nyman, J. Radun, T. Leisti, T. Vuori\**  
*Univ. of Helsinki, Finland*  
*\*Nokia, Finland*

A hybrid, qualitative/quantitative measurement approach was developed for evaluating subjective image quality of high quality, sharpness manipulated images. The images were produced by MTF simulations and reproduced photographically. Naive observers were used as subjects. The approach has been applied in several contexts, but here we demonstrate a case of subjective sharpness evaluation. The method offers useful feedback to technical designers of imaging systems. It also suggests ways to develop standardized test material for different image quality evaluation contexts.

**VHF5 - 2 11:10** **The Just Noticeable Difference in Color Saturation, Black Level, White Level and Contour Rendering in Natural Images**

*J. Xia, S. L. Qin, L. Liu, I. Heynderickx\*, H. C. Yin*  
*Southeast Univ., China*  
*\*Philips Res. Labs., The Netherlands*

To determine the relative importance of colorfulness, brightness, contrast and sharpness on perceived image quality, we needed the just noticeable difference in chromaticity, black level, white level and contour rendering. Therefore, we performed a subjective experiment to measure these just noticeable differences with natural image content instead of with homogeneously colored patches. The results indicate that when using natural image content the just noticeable differences are considerably higher than what is reported in literature for homogeneously colored patches.

**VHF5 - 3 11:30** **Simulator Sickness Symptoms in Virtual Display Gaming**

*J. Haekkinen<sup>\*,\*\*</sup>, J. Takatalo<sup>\*\*</sup>, J. Komulainen<sup>\*\*</sup>,  
H. Saerkelae<sup>\*\*</sup>, J. Havukumpu<sup>\*\*\*</sup>, G. Nyman<sup>\*\*</sup>*  
*\*Nokia Res. Ctr., Finland*  
*\*\*Univ. of Helsinki, Finland*  
*\*\*\*Helsinki Polytechnic Stadia, Finland*

We compared the simulator sickness symptoms induced by two car racing games in Olympus head-worn virtual display and in ordinary tabletop display. The results show that a game with fast movements and strong optical flow induced worse symptoms than a static game without fast movements or optical flow. There were no differences in symptoms between the virtual display and the tabletop display. We can conclude that the sickness was mostly caused by the optical flow shown in a large visual field either in the virtual or in the tabletop display.

**VHF5 - 4      Psychophysiological Effects of Monocular Head  
11:50          Mount Display**

*S. Kishi, T. Yamazoe, T. Shibata, T. Kawai  
Waseda Univ., Japan*

In this study, the authors examined the psycho-physiological effects related to asthenopia and caused by viewing image contents using a monocular head mount display(HMD). In the psychological responses, although a significant increase in asthenopic subjective symptoms was found after 30 minutes' viewing, recovery to near pre-viewing conditions was possible by taking 15 minutes rest. On the other hand, in terms of physiological responses, few changes of the refraction of the eye after viewing were found.

**VHF5 - 5L      Correlation between Objective and Subjective  
12:10          Evaluations of Sensation of Presence for Designing  
Future Television System**

*M. Sugawara, M. Emoto, K. Masaoka, Y. Nojiri  
NHK, Japan*

This paper describes experiments on evaluating the sensation of presence conducted to obtain a guide in developing a future television. Subjective and objective evaluations were performed under the same conditions. For the objective measurements, body sway was used as an index for human equilibrium stability. A seven-grade categorical method was used for the subjective evaluation. The correlation coefficient between these results was 0.13.

**Author Interviews**

17:30 - 18:30

15:00 - 17:00

Citizen's Gallery

**Poster VHFp: Human Factors and Image Quality**

**VHFp - 1      Measurement Method of the Vision of the Elder  
Driver in Driving Situation**

*T. Hagi, Y. Takagi, A. Yasui, T. Nakano, S. Yamamoto  
Meijo Univ., Japan*

Aging goes on rapidly in Japan and traffic accidents of elderly driver are increasing. A main cause of the accidents is that most elderly drivers are not aware of the reduction in their visual functions. The purpose of this research is to develop the system that measures the elderly visual perceptions necessary for safe driving and improves their perceptions by education and training. This paper describes how to measure main visual perceptions; visual field, dynamic visual acuity and depth perception.

**VHFp - 2      Ambient Illumination Influences on Legibility of Electronic Paper**

*S.-C. Jeng, Y.-R. Lin, C.-C. Liao, C.-H. Wen, C.-Y. Chao\*, K.-K. Shieh\**

*Ind. Tech. Res. Inst., Taiwan*

*\*Nat. Taiwan Univ. of Sci. & Tech., Taiwan*

Influences of ambient illuminance and light source on legibility of electronic paper, electrophoretic display and cholesteric liquid crystal display, have been studied and compared with conventional office paper. Legibility was evaluated by using the method of letter-search task and subjective visual comfort rating. The results show that legibility depends on the illumination level but light source. Paper has the highest visual comfort rating than the other two displays although they have similar performance in the letter-search task.

**VHFp - 3      Relation between Just Noticeable Difference(JND) Contrast of “mura” in LCDs and Its Background Luminance.**

*T. Tamura, K. Tanaka, T. Satoh, T. Furuhata*

*Tokyo Polytechnic Univ., Japan*

The relation between “just noticeable difference (JND) contrast” of the luminance non-uniformity, or “mura”, of liquid crystal displays and its background luminance was investigated. We have carried out two experiments in order to estimate the change of JND contrast on various background luminance levels. In this paper, we analyze the relation between JND contrast and its background luminance based on the results of the experiments. And then, we propose a formula which express the JND contrast on various background luminance levels.

**VHFp - 4      The Dithering Algorithms for Stitching Exposure in TFT-LCD Panels**

*G. F. Wei, F. Liu, M. S. Lai, A. Wang*

*AU Optronics, Taiwan*

Stitching mura is always a concern while using stitching exposure to produce large-size TFT-LCD panels. The study here shows that using different algorithms can make some improvement to the stitching mura. If dithering codes can be examined and slightly modified, it can be also ensured that there are no unexpected periodic patterns but better dithering effects in stitching areas. However, the more efficient and direct way to blur stitching areas is to enlarge overlap widths of adjacent exposure shots.

**VHFp - 5      Magnification Method for Displayed Image Based on Gradient Direction and Strength by Pixel**

*K. Muto, F. Saitoh  
Gifu Univ., Japan*

The magnification of an image is important and general purposed method for image processing. The typical conventional methods for image magnification are the nearest neighbor, the bi-liner interpolation and the cubic convolution. These methods often generate a blurred and unclear magnified image because spatial features included in an image are not used. This paper proposes a new magnification method by using the gradient direction and the gradient strength by pixel in an objective image. The experimental results show that the clear magnified images were generated by the proposed method in comparison with by the conventional methods.

**VHFp - 6      Displayed Image Generation with Higher Contrast from Scene Image by Optimizing Combination of Frames**

*Y. Kuze, F. Saitoh  
Gifu Univ., Japan*

This paper proposes a method to generate a single fixed displayed image including an area of interest with good contrast from a scene image including a moving object in very poor contrast. To obtain an output image with good quality, only useful frames are selected in an objective scene image and the selected frames are accumulated after two-dimensional alignment.

**VHFp - 7      A Novel Method for Image Contrast Enhancement: Fuzzy Contrast Correction (FCC) Based on Timing Controller**

*T.-C. Hsu, C.-F. Su, M.-S. Wu  
Chunghwa Picture Tubes, Taiwan*

This paper presents a new method for image contrast enhancement that uses fuzzy theory to decide suitable enhance function. This real-time timing controller-based method can improve the defect correction over conventional methods, and also get more colorful TFT-LCD images for better human vision.

**VHFp - 8      Integration Methods of Color Coordinate Calculation for Ray Tracing Application**

*C. R. Ou\*\*,\*, C. H. Chen\*  
\*LEXM Res., Taiwan  
\*\*Hsiuping Inst. of Tech., Taiwan*

The calculation of the CIE coordinate requires the integrate operation for the entire visible wavelengths, but most optical software will limit the number of wavelengths for proceed the ray tracing. This short communication will discusses how the integration methods and related parameters affect the calculated CIE coordinates.

**VHFp - 9      3-D Interpretation of Single Line Drawings in  
Perspective Projection**

*J. Kawashima, K. Shoji, F. Toyama, J. Miyamichi  
Utsunomiya Univ., Japan*

The human visual system can interpret 2-D line drawings as 3-D wire frames. Previously, we proposed a principle to minimize the entropy of angle distribution between line segments in a 3-D wire frame as a concrete definition of the law of Prägnanz in Gestalt psychology for 3-D interpretation of line drawings. And we implemented the principle as a simulation model using a genetic algorithm. In this work, we expand the type of projection assumed in the model into perspective one.

**VHFp - 10L      Age-Related Changes of Relative Luminance and  
Contrast for LED Lights of Different Colors**

*H. Isono, Y. Takiguchi, C. Yamada  
Nippon Inst. of Tech., Japan*

Human sensitivity to color deteriorates as people grow older, becoming less perceptive to certain colors, especially blue. This paper studied people of various ages from teenagers to those in their 70s to find how age affects relative luminance and contrast for LED lights of different colors. The results showed that calculated relative luminance and contrast by age begins to fall for LED lights, especially for blue.

## **IDRC**

Sept. 18 – 21, 2006  
Kent State University  
OH, U.S.A.

## **Outstanding Poster Paper Awards**

Friday, December 9  
12:20 – 13:30  
(after Takamatsu Festival)  
Tamamo (3F),  
ANA Hotel Clement Takamatsu

See page 8 for details

# Workshop on Projection and Large-Area Displays, and Their Components

Thursday, December 8

15:00 - 17:00

Citizen's Gallery

## Poster LADp: Projection Display Technologies

### LADp - 1      **Pixel-Based Optical Feedback to Correct Aging and Non-Uniformities in Large-Area Displays**

*S. Maeyaert, J. Doutreloigne, A. Van Calster  
Ghent Univ., Belgium*

An optical feedback mechanism is proposed to correct non-uniformities and to extend the lifetime of LAD's. Therefore a new addressing method consisting of pixel per pixel addressing is described. The basic functioning and different architectures of the optical feedback loop are presented as well as different silicon photodetectors that were designed in AMIS I<sup>2</sup>T technology.

### LADp - 2      **The Control Method of Rear-Projection TV**

*C.-H. Huang, W.-C. Tai, M. Liu, C.-N. Mo, S.-T. Yang  
Chunghwa Picture Tubes, Taiwan*

A rear-project TV which use a high intensity discharge lamp in a projection system such as LCOS, DLP etc, A new procedure of rear-project TV control method has been used and approved, according to user turn on or off power command. User's power on or off command will be response immediately during the simulated on or off state. This method and algorithm can be implied by using software program or IC chip design.

### LADp - 3      **The Study of One-Drop-Filling Process on LCOS Panel Manufacturing**

*J. M. Wang, Y. C. Lo, S. F. Liu, L. C. Huang, K. H. Chen,  
K. H. Liu, H. A. Li, S. Oliver, S. T. Yang  
Chunghwa Picture Tubes, Taiwan*

One-Drop-Filling (ODF) process is an advanced vacuum filling process in LCOS manufacture line. The merits not only increase the throughput of liquid crystal filling process but also reduce the number of equipments. Studying application of ODF process in LCOS panel manufacturing is the purpose of is this article. The accuracy of liquid crystal drop size, the stability of seal dispensing and the nozzle size etc. In the tiny panel manufacture are more important than those factors in normal panel manufacture.

**LADp - 4      VAN LCOS Panel in 65-inch/1080p High Definition RPTV**

*C. J. Lin, C. H. Huang, C. L. Liu, C. N. Mo  
Chunghwa Picture Tubes, Taiwan*

CPT has developed a VAN mode LCOS microdisplays, which inherits the advantages of conventional drive the VAN mode LCOS such as contrast ratio than 3000:1, high resolution, high efficiency and high reliability. The VAN mode LCOS microdisplays offers substantial increase in system contrast and excellent quality picture has been achieved.

**LADp - 5      A Study of Stability for LCOS Optical Engine**

*Y. Kuo, Y. Chen, S. Wu, C. Mo  
Chunghwa Picture Tubes, Taiwan*

CPT has developed a Liquid Crystal on Silicon (LCOS) optical engine with the color management system, which has the high performance in image quality. In this article we have done some long-time measurement of optical qualities to test the stability of this LCOS optical engine. The result shows that the optical engine maintains good stability during the test.

**LADp - 6      An Instrument Design for Measuring the Chromatic Focal Shift to Optimize the Image Quality of LCOS RPTV System**

*W.-C. Lin, W.-C. Tai, S.-M. Wu, C.-N. Mo, S.-D. Shei\*  
Chunghwa Picture Tubes, Taiwan  
\*Univ. of Chung-Yung, Taiwan*

When the different wavelength of light passing through the projection lens, it will cause the "Chromatic Focal shift". The phenomenon will reduce the quality of LCOS RPTV system. In this paper, an instrument was designed for measuring this phenomenon, it provides the sufficient data for us to correct the BFL (Back Focal Length) when alignment the position of panel, and then optimizing the image quality in LCOS RPTV, which is critical in color focusing for its high resolution.

**Friday, December 9****9:00 - 10:15****ANA Hotel Clement Takamatsu Hiten 3****LAD1: Market and Trend**

Chair :            K. M. Gutttag, Syndiant, USA  
Co-Chair :        Z. Tajima, Hitachi Displays, Japan

**LAD1 - 1:     *Invited*   Changing Projection TV and Large Display  
9:00             Market**

*M. Takaso*  
*Techno Syss. Res., Japan*

The environment of the projection TV market has changed considerably from what it was only a few years ago. This paper shows how the competitors, prices and front projector market have changed in recent years. The analysis of the next steps to be taken in the industry is presented in such a way as to expand the scope of the projection TV business further, and to include new approaches that differ substantially from the con-ventional methods of selling large-screen TVs.

**LAD1 - 2:     *Invited*   Advancements in DLP Technology: The New  
9:25             10.8 $\mu$ m Pixel and Beyond**

*J. Grimmitt, J. Huffman*  
*Texas Instrs., USA*

The competitive display market has driven demanding requirements on cost and performance to the panel manufacturers. Texas Instruments, Inc. DLP Technology has positioned the design and process of the Digital Micromirror Device (DMD) to enable higher performance and resolution at reduced cost. The key attribute to the design and process advancements is pixel pitch scaling. This presentation will detail this attribute and other advancements that are driving the direction for the future DLP microdisplay.

**LAD1 - 3:     *Invited*   New Technological Trend in HTPS TFT LCD  
9:50**

*S. Koike*  
*Seiko Epson, Japan*

The MD PTV market has continued to grow. We have achieved high performance HTPS TFT LCD for the consumer market by developing new driving technology and new formation technology of the alignment layer. This time, we are introducing brand-new technology of HTPS TFT LCD that continue to evolve and achieve high performance from an image quality and cost competitiveness standpoint.

----- Break -----

**10:40 - 12:25**

**ANA Hotel Clement Takamatsu Hiten 3**

**LAD2: Optics and Imaging**

Chair :           A. Conner, 3MPO, USA  
Co-Chair :       H. Nakano, Barco Japan, Japan

**LAD2 - 1:     Invited   Wide-Angle Projection Optics for Thin Rear  
10:40           Projectors**

*M. Kuwata, T. Sasagawa, K. Kojima, J. Aizawa, A. Miyata,  
S. Shikama  
Mitsubishi Elec., Japan*

One of the most significant problems in rear projector technology is how to reduce equipment depth. Thanks to studies on wide-angle projection optics that shortens the rear projector depth, the projection angle has steadily increased. We report on the recent progress of wide-angle projection optics for rear projectors and examples of systems we have developed.

**LAD2 - 2           Highly-Reliable, Precise and Uniform Optical Trim  
11:05           Retarders Based on All-Dielectric Nano-Gratings for  
                  LCOS Projection Systems**

*J. Wang, P. Sciortino, F. Liu, R. Varghese, A. Nikolov,  
X. Deng, J. Bacon  
NanoOpto, USA*

Based on all-dielectric nano-gratings, we developed optical trim retarders which are highly reliable, precise and uniform with a size up to 100 mm in diameter. Various retardance values from ~ 4nm to ~ 20 nm for R, G, and B bands were realized with a standard deviation of < 5% across a 100 mm diameter size. Those trim retarders are highly reliable with extremely low thermal dispersion. LCOS projectors based on the trim retarders have achieved > 4000:1 contrast.

**LAD2 - 3           A New LCD Projection System Using a Scrolling  
11:25           Prism for the Moving Picture**

*H. Kojima, Y. Itoh, K. Hiramatsu, O. Wada  
Seiko Epson, Japan*

A new LCD projection system has been developed with improved moving picture quality. The system uses a scrolling prism that scans an illumination light on the LCD panel. As a result, the hold-type display becomes an imitative impulse-type display and the system is able to reduce motion blur in hold-type displays such as LCD panels.

**LAD2 - 4           Evaluation of Super Fine-Pitch Screen for Rear  
11:45           Projection TV**

*Y. Igarashi, S. Iwata, A. Kagotani, S. Takahashi, T. Abe  
Toppan Printing, Japan*

Recently, the demand on large-size display has increased and an advanced screen for application on LCD/LCOS/DMD Rear Projection TV has been developed. We achieved a lenticular lens of 64 $\mu$ m pitch to correspond to such TV. In this paper, we report the results that we measured the optical properties and image reproducibility of 64 $\mu$ m lenticular lens screen.

**LAD2 - 5 Estimation of LCOS Rear Projection TV Throughput**

12:05

*Y. Chen, S. Wu, C. Mo  
Chunghwa Picture Tubes, Taiwan*

The design of illumination system of integrator is important for DLP or LCoS projectors, because this effects engine throughput which is directly expressed on screen luminance. In this paper, we summary some issues about projection efficacy between single, triple panel LCOS and DLP systems and predicted to have an accuracy of +/-10% with new developed optical engine. The designed and constructed system with >400 lumen under 120W lamps has the potential for consumer market.

----- Lunch -----

14:00 - 15:25

ANA Hotel Clement Takamatsu Hiten 3

**LAD3: Light Source and Illumination**

Chair : S. Dewald, Texas Instruments, USA

Co-Chair : K. Ohara, Texas Instruments Japan, Japan

**LAD3 - 1: Invited System Performance Considerations in Using**

**14:00 LEDs as the Illumination Source for Microdisplay Rear Projection TV**

*R. Auerbach, S. Magarill, A. Conner, T. Rutherford,  
E. English  
3M Precision Optics, USA*

LED illumination for microdisplay television is close to commercialization. Brightness of green LEDs is the major challenge today. Achieving the brightest TV requires careful system design as well as optimization of the illuminator. The brightest systems use liquid crystal on silicon (LCOS) imaging devices. This paper discusses some of the design criteria and practical considerations.

**LAD3 - 2 LEXM QUBE: An LED Based MINI Projector for  
14:25 Portable Device**

*R. Tzeng\*, C. H. Chen\*, R. Her\*, C. R. Ou\*\*  
\*LEXM Res., Taiwan  
\*\*Hsiuping Inst. of Tech., Taiwan*

In this article, we propose a mini projector system with LCOS panel called LEXM QUBE. The size of this optical engine for this system is the smallest among the present systems with fewer LED light source. Several comments to other technologies will be discussed.

**LAD3 - 3      LED Based Cable-Less Projector with High  
14:45      Efficiency Collimation Optics**

*M. Maeda, Y. Kurosaka, T. Miwa, T. Ikeda, H. Kanayama,  
H. Murata  
Sanyo Elec., Japan*

By using a new collimator comprised of four aspherical surfaces and controlling the luminous flux from a LED, we have developed a LED-based compact projector with a high efficiency illumination system. The LED as a light source enables a projector downsizing and battery-driving. In addition, using a SD-card as an image source, a cable-less handy projector has been realized. In this paper, we describe our concept of new illumination system and the characteristics of the prototype projector.

**LAD3 - 4      Illumination System Suitable for Small Imaging  
15:05      Panels for Low Cost Projection Display Applications**

*K. Li, S. Inatsugu, A. Kazmierski\*  
Wavien, USA  
\*Phoenix Elec., Japan*

The Wavien's Dual Paraboloid Reflector (DPR) system utilizes the 1:1 imaging scheme to preserve the brightness of the arc. The resulting system is characterized by high coupling efficiency and consistency within a wide range of arc gaps. This allows the use of high wattage; long arc gap lamps to be used while maintaining the long lifetime required in rear projection television applications. The concept of system lifetime versus lamp lifetime will be presented in which the system lifetime using DPR is much longer than the system lifetime using traditional reflectors using the same lamp.

----- Break -----

15:40 - 17:05

ANA Hotel Clement Takamatsu Hiten 3

**LAD4: Light Valve**

Chair :            K. Li, Wavien, USA

Co-Chair :        T. Hayashi, Sumitomo 3M, Japan

**LAD4 - 1:      Invited    VAN Cell Technology of Digital D-ILA**

**15:40**            *S. Shimizu, Y. Ochi, A. Nakano, S. Nakagaki  
Victor, Japan*

VAN mode is becoming widely used in LCOS projection systems. The digital driving of VAN cell has a new type of disclination effect, which does not appear in analog driving. We have successfully suppressed it using our technologies and have developed a fully digital 1080p device. We'll also present the features of the RPTV using this device.

**LAD4 - 2      A 1080p Digital LCOS Microdisplay Supporting  
16:05          Greater Than 12-bits per Color**

*K. Guttag, J. Lund, C. Waller, M. Harward  
Syndiant, USA*

We have built an all digital LCOS microdisplay and drive board that supports greater than 12-bits per color using Pulse Width Modulation (PWM). The device has 1920 by 1080 mirrors (1080P) with an 8.1 micron mirror pitch resulting in a 0.7inch display diagonal. A number of device design and system features make it very cost effective for consumer front and rear projection applications and scalable for both higher resolution and smaller display sizes.

**LAD4 - 3      Vcom Drift Phenomena in VAN LCOS Panels  
16:25**

*D. Cuypers, A. Van Calster\*, H. De Smet\*  
IMEC vzw, Belgium  
\*Ghent Univ., Belgium*

Flicker is an important artefact in liquid crystal displays. From our measurements on VAN LCOS devices, the so-called Vcom voltage appears to be the main contributor to this flicker. Measurement data on the nature and time behaviour of this Vcom will be presented. An early attempt for an explanation of the evolution of the Vcom voltage is also given. This data can be useful for understanding and eliminating flicker in displays.

**LAD4 - 4      New Driving Method for Next Generation HTPS TFT  
16:45          Light Valve**

*H. Hosaka, H. Iisaka, T. Takeuchi, H. Kawata, K. Ishii  
Seiko Epson, Japan*

We developed a new driving method called "Alternate Frame Scan (AFS)" for the fine pitch High Temperature Poly-Silicon (HTPS) TFT Light Valve. AFS is essentially disclination-free driving method and enables the next-generation light valve structure that is smaller on the diagonal and offer higher resolution and a higher contrast ratio than their predecessors.

**Author Interviews**

17:10 - 18:10

**Supporting Organizations:**

Technical Group on Information Display, ITE

Technical Committee on Electronic Information Displays, Electronics Society, IEICE

Opto-electronic Materials and Devices Study Specialty Section, IEIJ  
Liquid Crystal Display Forum, JLCS

# Workshop on Electronic Paper

Tuesday, December 6

13:30 - 14:35

ANA Hotel Clement Takamatsu Hiten 3

## EP1: Electronic Paper (1)

Chair : M. Omodani, Tokai Univ., Japan

Co-Chair : H. Arisawa, Fuji Xerox, Japan

### EP1 - 1: *Invited* Novel Type of Bistable Reflective Display 13:30 QR-LPD Using Electronic Powder

*Y. Masuda, S. Ryo, N. Nihei, R. Hattori\**  
*Bridgestone, Japan*  
*\*Kyusyu Univ., Japan*

We have developed a novel reflective display using electric powder. It has a paper-like appearance and good image stability. In addition, QR-LPD is suited for flexible display applications since it does not require either a high temperature or complicated manufacturing process. QR-LPD can maintain an excellent paper-like image. In this paper, an IC card display is proposed as one of the possible applications for flexible QR-LPD, as a so-called electronic paper application.

### EP1 - 2 Development of One-Particle EPD System 13:55 Containing Non-Electrophoretic White Particle Dispersion

*Y. Naijo, T. Kitamura*  
*Chiba Univ., Japan*

We developed one-particle electrophoretic display (EPD) system containing electrophoretic black and non-electrophoretic white particles. Electrophoresis of these particles was observed using parallel type electrodes cell. The black and white particles exhibit electrophoretic and non-electrophoretic phenomenon, respectively. EPD device using dispersion of these particles performed high contrast ratio. It seems that no flocculation occurred between white and black particles.

### EP1 - 3 Fabrication of Bichromal Microbeads for Rotating 14:15 Ball Display Using a Droplet Formation by Microchannel Technique

*T. Torii, T. Nisisako, T. Takahashi\*, Y. Takizawa\*, T. Higuchi*  
*Univ. of Tokyo, Japan*  
*\*Soken Chem. & Eng., Japan*

This paper describes the fabrication of bichromal beads for rotating ball display using a droplet formation technique. The beads were hemispherically black and white beads. Two phase flow of black and white monomer was produced in a microchannel, and the hemispherically black and white droplets were produced using "sheath flow method". The droplets were monodispersed with CV of 5%. After polymerization, the beads showed good rotating performance.

----- Break -----

15:10 - 16:30

ANA Hotel Clement Takamatsu Hiten 3

**EP2: Electronic Paper (2)**

Chair : A. Suzuki, Ricoh, Japan  
 Co-Chair : S. Maeda, Oji Paper, Japan

**EP2 - 1: Invited Flexible Active-Matrix Electrophoretic  
 15:10 Displays for Electronic Paper Applications**

*H. Kawai, M. Miyasaka, A. Miyazaki, S. Nebashi,  
 T. Shimoda  
 Seiko Epson, Japan*

In the paper, we review our work on flexible active-matrix electrophoretic displays (AM-EPDs) aiming for electronic paper applications. SUFTLA, a technology of transferring LTPS-TFTs from an original substrate onto another, and a microencapsulated electrophoretic imaging material have been successfully developed and integrated to realize flexible AM-EPD panels. A film-based 2-inch QVGA AM-EPD panel with integrated peripheral drivers is reported as an example of results of the work.

**EP2 - 2 Effect of Carbon Black on the Optical Properties of  
 15:35 Pigment Dispersion for the Electrophoretic Display**

*K. Takeshita, A. Esaki, Y. Sekine\*, H. Akimoto\*  
 Mitsubishi Chem. Group Sci. & Tech. Res. Ctr., Japan  
 \*Mitsubishi Chem., Japan*

Carbon black can considerably influence the optical properties of the electrophoretic displays, although the amount of carbon black in it is small. The oxidation treatment for carbon black was effective to improve the contrast ratio. The dispersant for carbon black also affected the contrast ratio. Therefore, the appropriate selection of carbon black and dispersant for it is important in order to improve the optical properties of the electrophoretic displays.

**EP2 - 3 Conductance of Charging Agent in Electrophoretic  
 15:55 Displays**

*A. R. M. Verschueren, F. Strubbe\*, L. J. M. Schlangen,  
 K. Neyts\*  
 Philips Res. Labs., The Netherlands  
 \*Ghent Univ., Belgium*

A novel approach -based on electrical transient currents- is used to characterise the conductance process of a charging agent. Charging agents provide the charge on pigments used in electrophoretic displays, but also introduce ions in the solution. This is investigated by accurate transient current measurements in micro-cells. Satisfactory quantitative agreement is achieved with a continuum model of migration and diffusion. And, physical values for concentration, charge and mobility of the ions are obtained.

**EP2 - 4L      Flexible Active-Matrix TFT Array with Amorphous  
16:15      Oxide Semiconductors for Electronic Paper**

*M. Ito, M. Kon, M. Ishizaki, N. Sekine  
Toppan Printing, Japan*

We demonstrate, for the first time, a flexible, active-matrix, electronic paper display driven with amorphous oxide semiconductors. A transparent and flexible backplane is deposited by standard sputtering technique at room temperature using amorphous In-Ga-Zn-O as an active channel, which is fully compatible with plastic substrate and large scale manufacturing. The combination of electrophoretic front panel and amorphous oxide backplanes creates new future for flexible electronic paper.

----- Break -----

16:50 - 17:45

ANA Hotel Clement Takamatsu Hiten 3

**EP3: Electronic Paper (3)**

Chair :            T. Kitamura, Chiba Univ., Japan  
Co-Chair :        T. Fujisawa, Dainippon Ink & Chem., Japan

**EP3 - 1      Difference of Performances of Proofing Tasks  
16:50      between on Papers and Displays: A Study for  
              Electronic Paper**

*M. Omodani, E. Izawa  
Tokai Univ., Japan*

Paper is generally preferred over displays when we must perform proofing tasks. This is because we believe that we cannot successfully find all mistakes when using a display. This study aims to confirm the differences in performance when performing proofing tasks on paper and on a display. Analysis that identifies the reason for the difference is the final target of this study. Experimental proofing tasks on a display showed worse error discovery rates and shorter time taken than on paper. This result indicates that displays encourage us to hurry up and complete the task even though it remains unfinished.

**EP3 - 2      Rewritable Paper Using Leuco Dyes: Coloring/  
17:10      Decoloring Effects of Long-Chain Alkyl Group**

*S. Yamamoto, H. Furuya, K. Tsutsui, Y. Bando\*,  
T. Sadoshima\*, S. Ueno\*, K. Sato\*  
Ricoh, Japan  
\*Hiroshima Univ., Japan*

Rewritable printing system is composed of leuco dye molecules and acidic developer molecules with long-chain alkyl groups, which exhibits reversible colored/declored states by varying the heat conditions. In this paper, we discuss the structural effects of long-chain alkyl group. We found that controlling the physical properties of the long-chain alkyl group of the developer is the key to achieving both thermal stability of the colored state and rapid erasability.

**EP3 - 3L            Hollow Fibers Containing Various Display Elements -  
17:30                A Novel Structure for Electronic Paper-**

*M. Nakata, M. Sato, Y. Matsuo, S. Maeda, S. Hayashi  
Oji Paper, Japan*

This paper describes a novel structure for electronic paper displays using hollow fibers, which are comprised of an outer transparent polymer tube and inner display elements (rotating balls, electrophoretic dispersion fluid, or cholesteric liquid crystals). The fibers are prepared by a conventional melt spinning method and then woven into fabric sheets. The resulting fabric of hollow fibers is a promising candidate for electronic paper displays, which have flexibility and paper-like visibility due to the woven structure.

**Author Interviews**

18:20 - 19:20

**Wednesday, December 7**

**9:00 - 10:25**

**Sunport Hall Takamatsu Main Hall**

**EP4/AMD4: Active Matrix Electronic Paper**

Chair :                T. Asano, Kyushu Inst. of Tech., Japan

Co-Chair :         H. Kawai, Seiko Epson, Japan

**EP4/AMD4 - 1: *Invited* Rollable Active-Matrix Electronic-Paper**

**9:00                 Displays**

*H. E. A. Huitema, G. H. Gelinck, E. van Veenendaal,  
P. J. G. van Lieshout, F. J. Touwslager  
Philips Tech. Incubator, The Netherlands*

A 100 $\mu$ m thick QVGA active-matrix display integrated into a functional device prototype is presented. The active-matrix is composed of alternating layers of organic materials and gold. A 6-mask photolithographic process is used. An electrophoretic electronic imaging film is laminated on top of the active matrix. The display is bendable to a radius of 7.5mm for more than 30,000 times.

**EP4/AMD4 - 2: Invited Rapid Switching in Multiple Color Active Matrix Driven Electrowetting Displays**

9:25

*B. J. Feenstra, R. A. Hayes, R. van Dijk, R. G. Boom, M. M. H. Wagemans, I. G. J. Camps, A. Giraldo, B. van der Heijden  
Philips Res. Labs., The Netherlands*

We present the attractive properties of our active matrix driven electrowetting displays. For the first time, we show all ingredients required for realizing video-speed, full-color displays. Two color architectures are presented: a single-layer display that has an improved optical and power performance at a lower projected cost compared to LCDs and a triple-layer display that has a revolutionary optical performance. We demonstrate the fast switching of the electrowetting technology by showing video content on a 170 ppi resolution display.

**EP4/AMD4 - 3 Manufacturing Flexible High Information Content Active Matrix Displays**

9:50

*S. E. Burns, K. Reynolds, W. Reeves, I. P. Johnson, B. H. Pui, M. Banach, T. Brown, K. Chalmers, N. Cousins, P. Cain, M. Etchells, C. Hayton, K. Jacobs, S. Markham, S. Orchard, A. Menon, P. Too, S. Siddique, C. Ramsdale, J. Herod, K. Saynor, J. Watts, T. von Werne, J. Mills, C. J. Curling, H. Sirringhaus, K. Amundson\*, M. D. McCreary\*  
Plastic Logic, UK  
\*E Ink, USA*

We present a manufacturing process for flexible high information content active matrix backplanes compatible with low cost plastic substrates. Transistor performance, feature sizes and electrode conductivities of this process have been specified to enable 800x600 pixel displays at 100 pixels per inch (PPI), driving grey scale electrophoretic media. Here we report on early results showing this displays operation. This process has been developed on a 350mmx350mm Prototype Line. It is scalable to larger display sizes and higher PPI, and will enable a wide range of flexible display products.

**EP4/AMD4 - 4L 100- $\mu$ m-Thick, High-Resolution Rollable AM-EPD**

10:10

*T. Kodaira, S. Hirabayashi, Y. Komatsu, S. Utsunomiya, M. Miyasaka, H. Kawai, S. Nebashi, S. Inoue, T. Shimoda, T. Whitesides\*, S. Patry\*, M. McCreary\*  
Seiko Epson, Japan  
\*E Ink, USA*

We have developed a paper-thin 100- $\mu$ m-thick, high-resolution (192 ppi,) 2.1-inch QVGA flexible active-matrix electrophoretic display (AM-EPD). The TFT backplane with integrated peripheral driver circuits was first fabricated on a glass substrate and then transferred to a very thin (30- $\mu$ m) plastic film by employing Surface Free Technology by Laser Ablation / Annealing (SUFTLA). An imaging sheet provided by E Ink Corporation was laminated on the backplane. Fine images were successfully displayed on the rollable AM-EPD.

----- Break -----

10:40 - 12:00

Kagawa International Conference Hall

**EP5/LCT5: Flexible LCD**

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

Co-Chair : Y. Toko, Stanley Elec., Japan

**EP5/LCT5 - 1 Flexible Field-Sequential-Color FLC Displays Using a Bendable Backlight Sheet with LED Chips**

10:40

*H. Fujikake, H. Sato, T. Murashige, Y. Fujisaki, H. Kikuchi,  
T. Kurita  
NHK, Japan*

We have developed a flexible full color moving-image display using a plastic-substrate-based monostable ferroelectric liquid crystal (FLC) panel and a bendable backlight sheet with thin small LED chips. The fabricated A4-sized FLC matrix panel with 96 x 64 image pixels was laminated with the three-primary-color backlight sheet and optical diffuser and spacer films, and was driven by an active matrix technique using external switch transistor array based on a field-sequential-color method.

**EP5/LCT5 - 2 Improvement of Dichroic Polymer Dispersed Liquid Crystal (PDLC) Performance for Flexible Display Using Lift-Off Technique**

11:00

*A. Masutani, T. Roberts, B. Schüller, A. Sakaigawa\*,  
A. Yasuda  
Sony Deutschland GmbH, Germany  
\*Sony, Japan*

The performance of dichroic sponge polymer dispersed liquid crystals (SPDLC) display can be improved further by incorporating a lift-off method using a substrate covered with a fluoro-nated-organosilane. The resulting cells achieve improved contrast, improved response time, smaller switching voltages and better uniformity, compared with the previously reported dichroic SPDLCs. The display exhibits near magazine-standard reflectivity and contrast ratio. Furthermore, the lift-off method enables rubbing-free, low temperature, roll-to-roll processing techniques. Such displays are suitable for flexible sol-vent-sensitive, organic thin-film transistors (TFTs).

**EP5/LCT5 - 3 Inkjet Printed Cholesteric Liquid Crystal Display**

11:20

*J. M. Ding, Y. A. Sha, L. P. Hsin, H. L. Wang, C. C. Liao,  
Y. R. Lin, C. C. Lu, C. H. Chen, I. C. Chen  
Ind. Tech. Res. Inst., Taiwan*

The inkjet printing technology has been used to manufacture flexible cholesteric liquid crystal displays. The displays are fabricated from top to bottom by forming various functional layers on flexible substrates. Stable cholesteric liquid crystal droplets are obtained and jetted to fill the pixel areas by a piezoelectric drop-on-demand inkjet printer. Our technology has provided a novel process to fabricate a flexible, bistable, and multi-color reflective display with single display medium layer.

**EP5/LCT5 - 4 Flexible Photoaligned Permanent Bistable TN-LCD**

11:40

*X. H. Li, F. S. Y. Yeung, V. G. Chigrinov, H. S. Kwok  
Hong Kong Univ. of Sci. & Tech., Hong Kong*

Flexible Bistable Nematic Liquid Crystal Display ( $\pi$ -BTN) based on photo-alignment technology is developed on two 200 $\mu$ m plastic substrate. This display can be switched between  $\phi$  and  $\pi + \phi$  twisted states by means of breaking anchoring condition on one of the plastic substrates. Low baking temperature of 100°C is needed to avoid high temperature distorting the substrates. The advantages of both photoalignment and  $\pi$ -BTN technologies, such as no contamination of electrical charges and impurities, high contrast and bistability are shown.

**Author Interviews**

17:30 - 18:30

15:00 - 17:00

Exhibition Hall

**Poster EPp: Electronic Paper****EPp - 1 A Power-Efficient Way to Operate High-Voltage Bistable Display Drivers**

*A. Monte, J. Doutreloigne, A. Van Calster  
Ghent Univ., Belgium*

The analog and digital part of a power-efficient high-voltage bistable display driver is presented. A new algorithm for the global reset and a summary of the most interesting power-saving principles that will be used to drive the displays, together with some theoretical results and a short description of the high-voltage switches that will be used to connect the voltages to the display, are given.

**EPp - 2 New Dichroic Dyes for Guest-Host Liquid Crystal Mode**

*T. Katoh, H. Okamura  
Fuji Photo Film, Japan*

New anthraquinone dichroic dyes were developed, which were suitable for TFT guest-host liquid crystal display (GH-LCD). New developed dyes consist of liquid crystalline parts, 4-alkylcyclohexyl-4-biphenyl, which possess both the high order parameter and solubility for fluoro substituted host liquid crystals.

**EPP - 3      A New Color Electronic Paper with Organic Electrochromic Technology**

*Y. Goh, S. Sunohara, M. Nishimura\*, N. Kobayashi\**  
*Japan Chem. Innovation Inst., Japan*  
*\*Chiba Univ., Japan*

We studied organic electrochromic materials, which showed vivid color change to cyan, magenta or yellow upon electrochemical stimulation, from a view point of a new class of color electronic paper. The sandwich-type cell was constructed to evaluate the electrochromic properties. Coloring and bleaching could be repeated without any decay over 500 cycles. Further, flexible electrochromic cell with gel polymer electrolyte has also been demonstrated.

**EPP - 4      Color Toner Display Based on the Control of Color-Particle Movement**

*T. Yamamoto, D. Takahashi, S. Nakamura, T. Kitamura*  
*Chiba Univ., Japan*

We studied on the movement of three particles independently to display color image in toner display. Two positively charged color particles with different amount of charge to mass ratio and negatively charged white particle were enclosed in the toner display cell. Cyan, yellow and white images were displayed by an application of voltage of a saw wave pattern.

**EPP - 5      The Effect of Nano-Sized Silica on Charged Two Particles for Reflective Paper-Like Display**

*S. G. Lee, S. H. Kwon, W. K. Cho, B. G. Ryu, M.-B. Song*  
*LG Elect., Korea*

We manufactured reflective paper-like display (PLD) using opposite-charged two particles. The particles were composed of polymer, colorant (TiO<sub>2</sub>, carbon black) and external additives (nano-sized silica). Using blade mixing method, the nano-sized silica was physically adsorbed on surface of polymer particles. The surface morphology of polymer particle was changed dramatically with changing silica content. In addition, the coated silica affected the electrostatic property of charged polymer particles.

**EPP - 6      Optical Characteristics of EPD Utilizing Electrophoretic Colored Particles**

*S. Sunohara, T. Kitamura\**  
*Japan Chem. Innovation Inst., Japan*  
*\*Chiba Univ., Japan*

We have studied on electrophoretic colored particles for EPD (Electrophoretic Display) and developed a noble method for synthesis of these particles by complexing organic color pigment (cyan, yellow, and magenta) with negatively charged functional polymer. The EPD using these electrophoretic colored and TiO<sub>2</sub> particles showed a high contrast ratio. And we have investigated color EPD utilizing three particles, such as electrophoretic colored, TiO<sub>2</sub>, and black particles. This color EPD exhibited color, white, and black state by changing applied voltage respectively.

**EPP - 7      Electrodeposition of Microcapsule Containing  
Electrophoretic Pigments for Electrophoretic Display**

*A. Baba, S. Sunohara, T. Kitamura\**  
*Japan Chem. Innovation Inst., Japan*  
*\*Chiba Univ., Japan*

We have recently developed the electrodeposition coating to form a layer of microcapsules for electrophoretic display. The both of microcapsule and aqueous urethane resin move and deposit to the electrode in an electrodeposition process. The mono layer of close-packed gelatin microcapsules is formed directly on the electrode. The coating of microcapsule in proportion to the electrode pattern is possible utilizing an electrodeposition process.

**EPP - 8L      Development of Ultrafine Titania Nanoparticle with  
Uniform Crystallographic Orientation for Powder  
Type Electronic Paper**

*M. J. Lee, S. J. Hong, W. K. Kim, J. I. Han*  
*Korea Elect. Tech. Inst., Korea*

Synthetic conditions of titania nano particles as coating particles on polymer core particles for dry powder type electronic paper were investigated to improve uniformity of crystallographic orientation and ultrafine particle size, which are important to attach charge component uniformly on surface of ink powder. Particle size and uniformity of crystallinity depended on concentration of source materials ( $C_9H_{19}NO_4Ti$ ) in ethanol solvent, pH, and concentration of D.I. water. Finally, titania particle with size of 10 nm and uniformly crystallized were acquired.

**Supporting Organization:**

The Imaging Society of Japan

## Takamatsu Festival

Takamatsu Folk Entertainment

Friday, December 9

12:20 – 13:30

(before Outstanding Poster Paper Awards)

Tamamo (3F),

ANA Hotel Clement Takamatsu

See page 9 for details

## Topical Session on MEMS for Future Displays and Related Electron Devices

**Thursday, December 8**

**9:00 - 9:10**

**Kagawa International Conference Hall  
Opening**

**Opening Remarks**

**9:00**

*M. Nakamoto, Topical Session Chair*

**9:10 - 10:45**

**Kagawa International Conference Hall**

### **MEMS1: Displays and Optical Devices (1)**

Chair : W. I. Milne, Univ. of Cambridge, UK

Co-Chair : S. Sugiyama, Ritsumeikan Univ., Japan

**MEMS1 - 1: *Invited* Three Dimensional Optics**

**9:10**

*G. Barbastathis, G. N. Nielson\*, C. W. Wong\*\*  
MIT, USA*

*\*Sandia Nat. Labs., USA*

*\*\*Columbia Univ., USA*

We have been investigating a class of 3D optical elements where a base-band modulation of the index of refraction is imposed on a spatial carrier. When the index modulation is weak, we refer to these elements as "volume holograms." The resulting controllable shift variance results in depth selectivity which we have exploited for optical slicing. 3D optical elements with high index contrast where the modulation is purely periodic are referred to as "photonic crystals." In this paper, we overview the physics of 3D optics, emphasizing new means of controlling the spatial and spectral response; then we describe in more...

**MEMS1 - 2: *Invited* Silicon-Based Micro/Nanomechanics for**

**9:35**

**Nanoengineering**

*T. Ono*

*Tohoku Univ., Japan*

This paper reports on recent development of micro instrumentations based on advanced silicon technologies for nanoengineering and nanoscience. Demonstration of some miniaturized and integrated micro/nanomechanics, including four-terminal microprobes, optical bow-tie probes, nanomechanical sensors, multiprobe for future high-density data storage, and carbon nanotube mechanics and carbon nanotube electron sources for electron emission devices, are presented.

**MEMS1 - 3: *Invited* MEMS Technologies for Micro Optics - From  
10:00 Fiber Optic Communication to Display -**

*H. Toshiyoshi\*\*,\*\*, H. Fujita\**

*\*Univ. of Tokyo, Japan*

*\*\*Kanagawa Ac. of Sci. & Tech., Japan*

We report our recent research accomplishment in the field of optical MEMS (microelectromechanical systems) using the silicon micromachining technologies for both commercial-level product and laboratory-level research and development. Fiber optic VOA (variable optical attenuator) has been commercially released through close collaboration with industrial partner. Besides fiber optics, we also have target in the consumer electronics such as image projection displays using MEMS optical spatial light modulators. This paper also covers MEMS color pixels that could be potentially used to develop flexible electronic papers or posters.

**MEMS1 - 4 Nanostructure for Fast Bend Transition in Liquid  
10:25 Crystal  $\pi$ -Cells Fabricated by Nanoimprint  
Technology**

*H. Kikuchi, K. Machida, H. Sato, T. Murashige,*

*H. Fujikake, F. Sato*

*NHK, Japan*

A novel geometric structure for achieving a fast and uniform splay-to-bend transition in a liquid crystal (LC)  $\pi$ -cell is proposed. In order to obtain the fast and uniform bend transition, we formed a nanostructure in  $\pi$ -cell fabricated by applying room-temperature nanoimprint lithography (NIL) process. This novel LC device has quick, stable transition from splay-to-bend orientation under low-driving voltage. This NIL process can be applicable to the fabrication of display panel to achieve a uniform bend pixel distribution and a fast bend transition.

----- Break -----

11:00 - 13:00

Kagawa International Conference Hall

**MEMS2: Fundamental Mechanism and Materials**

Chair : G. Barbastathis, Massachusetts Inst. of Tech., USA

Co-Chair : T. Ono, Tohoku Univ., Japan

**MEMS2 - 1: *Invited* Normally Closed Microgrippers Based on  
11:00 Diamond Like Carbon/Ni Bimorph and Diamond Like  
Carbon/Metal/Polymer Trimorph Structures**

*W. I. Milne, J. K. Luo, R. Huang, J. H. He, Y. Q. Fu,  
A. J. Flewitt, S. M. Spearing\*, N. A. Fleck  
Univ. of Cambridge, UK  
\*Univ. of Southampton, UK*

Multi-finger, normally-closed microgrippers made from a bilayer of a metal and diamond-like carbon (DLC) or a trilayer of a polymer, metal and DLC have been analysed, simulated and fabricated. Temperatures of ~700 K are necessary to open Ni/DLC bimorph structures. Microgrippers made from an SU8/DLC bilayer or SU8/Al/DLC trilayer have also been fabricated, and fully closed microcages with diameters of ~40  $\mu\text{m}$  have been obtained. Using SU8 reduces the opening temperature of these devices to only ~400 K.

**MEMS2 - 2: *Invited* New Progress of Integration and Fusion in  
11:25 MEMS**

*S. Sugiyama  
Ritsumeikan Univ., Japan*

MEMS (Micro Electro Mechanical Systems), the micro integrated systems of sensors, actuators, and controlling circuits on a silicon chip are widely anticipated in a number of future industrial applications. MEMS function as the active devices processing a wide variety of signals, including: physical (electrical, mechanical, optical, magnetic), chemical, biological, etc. In this paper, the current situation and future prospects about applications of multi-cellular integration, multi-axis integration, mechanism integration, fusion of MEMS and IT, and MEMS process technology are presented.

**MEMS2 - 3 Ultrasmall In-Plane Wavelength Filter in Two-  
11:50 Dimensional Hetero Photonic Crystals**

*H. Takano, B.-S. Song\*, T. Asano\*, S. Noda\*  
Matshushita Electric Works, Japan  
\*Kyoto Univ., Japan*

Highly efficient channel drop operation of an ultra-small in-plane wavelength filter in a two-dimensional photonic crystal slab is presented, using a device consisting of two photonic crystal slabs with different lattice constants. A drop operation with efficiency of more than 80% is experimentally demonstrated, significantly higher than the limit of 25% for conventional devices. It will contribute to various optical filtering and switching applications.

**MEMS2 - 4 Pressure Balanced Electrostatic Micro-Valve for Miniaturized Pneumatic Systems**  
12:10

*Y. Nishijima, H. Kawada, T. Ishida, H. Harada  
Matsushita Elec. Works, Japan*

A miniaturized electrostatic micro-valve with a novel pressure balanced structure was proposed and fabricated for the demands of control devices for miniaturized air actuators that can work in relatively high pressure pneumatic applications. The fabricated micro-valves can be arranged in array structure and have potential applications in smell mixing device or pneumatic Braille-display. The micro-valve was prepared using MEMS technology, which makes On/Off actuation against the pressure of 0.7MPa and the volume flow rate of the valve reached to 0.2L/min.

**MEMS2 - 5L White Color Flat Field Emission Lamps for High Quality General Lighting**  
12:30

*M. Nakamoto, H. Kominami, Y. Nakanishi, Y. Takigawa,  
Y. Ohgi, H. Hiraki\*, M. Haba\*  
Shizuoka Univ., Japan  
\*Dialight Japan, Japan*

Extremely large luminous flux, uniform luminance, and high luminous efficacy white color flat field emission lamps (FELs) have been proposed and developed by the insight of high quality general lighting, by the usage of newly developed low acceleration voltage high luminance white color phosphor and carbon nanowall (CNW) field emitters, to realize high quality general lighting.

**MEMS2 - 6L Blackboard-Type Display Compatible with Large Area MEMS**  
12:40

*R. Shigematsu, A. Higo, H. Toshiyoshi, H. Fujita  
Univ. of Tokyo, Japan*

We propose a new type of an electronic re-writable blackboard that keeps the trace of finger-drawn strokes using the bitmap of scattering light from segmental membrane. Images can be erased entirely or partially by releasing voltage or pulling back the membrane with magnetic force, respectively. Thanks to the simplicity of the device structure and principle, the proposed display has scalability to an oversized board that could be made by printing or embossing.

**MEMS2 - 7L A High Fill-factor Comb-driven XY-stage with Topological Layer Switch Architecture**  
12:50

*K. Takahashi\*\*, M. Mita\*\*\*, H. Fujita\*, H. Toshiyoshi\*\*,  
\*Univ. of Tokyo, Japan  
\*\*Kagawa Ac. Of Sci & Tech., Japan  
\*\*\*Japan Aerospace Exploration Agency, Japan*

We present a novel design of comb-driven double-gimbal XY-stage actuators for a 2D optical micro lens scanner, which has been realized for the first time by topologically separating the actuator elements in two layers: all the electrical parts (electrodes and interconnections) are in the SOI (Silicon-on-Insulator) layer, while the mechanical parts (suspensions, frame, and XY-stage) are in the substrate. The XY-stage moved 19  $\mu\text{m}$  in the X and Y direction independently.

----- Break -----

14:00 - 15:25

Kagawa International Conference Hall

**MEMS3: Imaging and Sensors**

Chair : J. M. Kim, Samsung Adv. Inst. of Tech., Korea  
 Co-Chair : H. Toshiyoshi, Univ. of Tokyo, Japan

**MEMS3 - 1: Invited A 500 dpi Optical Image Sensor Using a Short Channel a-Si:H TFT**

*S. H. Kim, S. H. Park, Y. D. Nam, H. J. Kim, S. M. Hong,  
 J. H. Hur, J. Jang  
 Kyung Hee Univ., Korea*

We developed a 500 dpi image sensor on glass with 256 x 300 pixels. The switching and sensor devices are amorphous silicon thin-film transistor. The TFT with a channel length of 2  $\mu\text{m}$  exhibited a field effect mobility of 0.4  $\text{cm}^2/\text{V}\cdot\text{s}$ , a threshold voltage of 4 V and on/off current ratio higher than  $10^7$ . A 500 dpi image sensor with 2  $\mu\text{m}$  channel TFTs for switching and sensor was demonstrated with an amorphous silicon.

**MEMS3 - 2 Infrared Light Source Made of Nanocrystalline Porous Silicon**

*T. Hatai, H. Uemi, T. Ichihara, T. Komoda, N. Koshida\*  
 Matsushita Elec. Works, Japan  
 \*Tokyo Univ. of A&T, Japan*

A novel infrared light source based on a nanocrystalline porous silicon (nc-PS) is fabricated. The nc-PS effectively prevents heat dissipation from a thin film heater formed on nc-PS. In spite of the large heater size, this device shows fast response and wide temperature modulation. This device can be used as a thermal image generator for operation test of an infrared camera because the heater layer has no floating structure and can be formed into a matrix pattern.

**MEMS3 - 3 New Ultrasonic Image Sensing by Nanocrystalline Porous Silicon Ultrasonic Emitter Combined with a Condenser Microphone Array**

*K. Tsubaki, H. Yamanaka, K. Kitada, T. Komoda,  
 N. Koshida\*  
 Matsushita Elec. Works, Japan  
 \*Tokyo Univ. of A&T, Japan*

Ultrasonic three-dimensional image sensing in air has been demonstrated using an impulse acoustic emission from nanocrystalline porous silicon (nc-PS) device as a probing signal. Due to a completely flat frequency response in a wide range, an ideal impulse probe signal can be generated with no reverberations, in contrast to the case of conventional piezo-electric transducers. In combination with a MEMS-type condenser microphone array, different several objects are successfully picked up three-dimensionally at once.

**MEMS3 - 4      A Novel Noise Reduction Technique for the  
15:05            Uncooled Infrared Image Sensor with the Bulk-  
                     Micromachined Pixels**

*H. Honda, I. Fujiwara, Y. Iida, K. Shigenaka, S. Uchikoga  
Toshiba, Japan*

We have developed an uncooled (thermal) infrared image sensor with a read-out circuit that can calibrate the substrate temperature variation in every frame period. We use two types of pixels, a bulk-micromachined infrared detection pixel and a non-bulk-micromachined reference pixel, to null out the effect of the substrate temperature. The difference of the signals from the two yields just the component of infrared radiation.

----- Break -----

15:45 - 17:00

Kagawa International Conference Hall

**MEMS4: Displays and Optical Devices (2)**

Chair :            J. Jang, Kyung Hee Univ., Korea  
Co-Chair :        T. Komoda, Matsushita Electric Works, Japan

**MEMS4 - 1: *Invited* Nano and Display Technologies**

**15:45**            *J. M. Kim*  
*Samsung Advanced Inst. of Tech., Korea*

No abstract was submitted.

**MEMS4 - 2      Flexible Transparent Display by Plastic MEMS**

**16:10**            *Y. Taii\*, A. Higo\*, H. Fujita\*, H. Toshiyoshi\*\*,\*\**  
*\*Univ. of Tokyo, Japan*  
*\*\*Kanagawa Ac. of Sci. & Tech., Japan*

This paper reports a new flexible transparent image display based on the MEMS technology of plastic materials. A pair of thin PEN (polyethylene naphthalate) films with evaporated metal reflectors are laminated into a Fabry-Perot interferometer, and a transparent color is made by electrostatically tuning the gap. Thanks to the flexibility of the PEN films, the display could operate even when placed on a curved surface

**MEMS4 - 3      Femtosecond-Laser-Induced Periodic Structures on  
16:30            SiO<sub>2</sub> Surface with Copper Coating**

*K. Tanaka, Y. Izawa\*, M. Kubo, M. Fujita\*\*, M. Nakai\*,  
T. Norimatsu\**

*Matsushita Elec. Works, Japan*

*\*Osaka Univ., Japan*

*\*\*ILT, Japan*

Femtosecond lasers can be used for forming the nano-sized periodic structure on the surface of fused silica. However, the processing control range is narrow and unstable due to the nonlinearity of the multiphoton absorption process. By coating the surface with a thin metallic film, we found that the periodic structure can be formed easily below the ordinary ablation threshold for fused silica. It is also possible to improve and control the processing quality.

**MEMS4 - 4L    Color Gamut Improvement for Field Emission  
16:50            Displays**

*Y. Hatano, K. Iida, Y. Kato, K. Kokubu, Y. Iguchi  
Sony, Japan*

We will report improved performance of phosphor screens optimized for field emission display's (FED's) operating conditions. Factors which influence the visual qualities of FED will be discussed including dead layer voltage in phosphor screen as well as accelerating voltage for FED operation. And also, we have successfully developed high resolution FED panel (19.2" SXGA), which performs the premium visual properties applying these technologies and nano-Spindt type emitter technology.

**Author Interviews**

17:30 - 18:30

**IDW '06**

International Display Workshops

Dec. 6 – 8, 2006

Convention Hall Ohmi, Otsu Prince Hotel  
Otsu, Japan

<http://idw.ee.uec.ac.jp>

# Topical Session on Accumulation and Imaging Technique of Optical Information

Tuesday, December 6

13:30 - 15:00

ANA Hotel Clement Takamatsu Hiten 2

## AIT1: AIT(1)

Chair : M. Ishikawa, AIST, Japan  
Co-Chair : T. Kunimoto, Tokushima Bunri Univ., Japan

### AIT1 - 1: *Invited* Imaging by Laser-Excited THz Pulses

13:30

*M. Hangyo, M. Tani, H. Kitahara  
Osaka Univ., Japan*

No abstract was submitted.

### AIT1 - 2: *Invited* Ultrafast and High Efficient Image Processing Using Novel Coherent Control Technique

14:00

*N. Tsurumachi\*, S. Furue\*\*,\*\*\*, K. Komori\*\*,\*\*\*,  
S. Nakanishi\*, H. Itoh\*  
\*Kagawa Univ., Japan  
\*\*AIST, Japan  
\*\*\*CREST-JST, Japan*

It is necessary to find nonlinear optical materials with high optical nonlinearity and fast response for the future practical application of optical imaging. For this purpose, we propose to apply a novel coherent control method to one-dimensional photonic crystal structure with nonlinear optical materials which can enhance the nonlinear optical effect such as optical phase conjugation. This coherent control technique, which uses an area-regulated laser pulse sequence, that is available even for inhomogeneously broadened systems such as quantum dots ensemble or dye-doped polymer.

### AIT1 - 3: *Invited* Imaging of Dynamical Localized Excitations in Coupled MEMS Oscillator Arrays

14:30

*M. Sato, A. J. Sievers\*  
Kanazawa Univ., Japan  
\*Cornell Univ., USA*

Vibrational excitations in coupled MEMS arrays are visualized to study nonlinear localized modes in discrete lattices. Tips of cantilevers are imaged on a 1-D CCD camera. The brightness of the image depends on the oscillation amplitude of the cantilever so that a distribution of amplitudes in the array can be recorded as a function of position and time. Nonlinear localized excitations known as intrinsic localized modes become visible experimentally.

----- Break -----

15:10 - 16:40

ANA Hotel Clement Takamatsu Hiten 2

**AIT2: AIT(2)**

Chair : M. Hangyou, Osaka Univ., Japan  
 Co-Chair : N. Tsurumachi, Kagawa Univ., Japan

**AIT2 - 1: Invited Novel Properties of Luminescent Quantum Dots and Their Application to Nano-Sensors**

15:10

*M. Ishikawa*  
*AIST, Japan*

Photoluminescence (PL) intermittency was examined for single CdSe quantum dots (QDs) synthesized at 75 °C. The PL intensity of single CdSe QDs fluctuated on a subsecond time scale. The subsecond PL fluctuations, the average of which was 213 ms, are different from “on” and “off” PL blinking generally observed for QDs fluctuating on second to minute time scale. From previous reports, we attribute the subsecond PL intensity fluctuations to a high-density distribution of homogeneous surface trap states.

**AIT2 - 2: Invited Spectroscopy-Tomography of Living Single-Cells**

15:40

*I. Ishimaru*  
*Kagawa Univ., Japan*

We propose spectroscopy-tomography of living single-cells to measure slight changes in proteins in the cell. We can obtain the cross-sectional images of the microsphere with a diameter of 10 μm. The distribution of the internal submicron-defect in the microsphere can be analyzed. And to correct the center of rotation, we propose the image processing that uses the normalized correlation function as estimated value. The vague internal defect becomes to be distinguished by this proposed method.

**AIT2 - 3: Invited Dynamics of Fine Structures of Elongating Neuron Revealed with New Type of Polarized Light and Phase Contrast Microscopy**

16:10

*K. Katoh, T. Otaki\**  
*AIST, Japan*  
*\*Nikon, Japan*

No abstract was submitted.

**Author Interviews**

18:20 - 19:20

## Wednesday, December 7

15:00 - 17:00

Exhibition Hall

**Poster AITp: AIT(3)****AITp - 1 Non-Uniformity Effects and Illumination Criterions for Biomedical Images**

*C. R. Ou<sup>\*,\*\*,\*\*</sup>, R. Her<sup>\*\*</sup>, R. Tzeng<sup>\*\*</sup>, C. H. Chen<sup>\*\*</sup>,  
R. Chang<sup>\*\*\*</sup>, C. -J. Chang<sup>\*\*\*\*,\*\*\*\*\*</sup>*

*\*Hsiuping Inst. of Tech., Taiwan*

*\*\*LEXM Res., Taiwan*

*\*\*\*Central Taiwan Univ., Taiwan*

*\*\*\*\*Tri-Service General Hospital, Taiwan*

*\*\*\*\*\*Tsu-Chi Univ., Taiwan*

In this article, the effects of non-uniformity to the medical images will be discussed. A microscopic Q value is implementing to define the images qualities for the illumination system. The criterion that connects the macroscopic contract ratio and the Q value is established.

**AITp - 2 Activity Evaluation of Chick Dorsal Root Ganglion Cell with Continuous Microscopic Images**

*H. Shimizu, T. Wakimoto, K. Yamakawa  
Kagawa Univ., Japan*

Dorsal Root Ganglion cells of a chick embryo were cultured and the extension movement of the nerve axon and the filopodia at the growth cone was estimated with continuous microscopical images. The axon and filopodia elongated actively in L-15+ NGF solution containing L-Fructose, their activity in the solution containing Allitol seemed to be almost the same as in the reference solution.

**AITp - 3 Effect of D-Allose on Fibroblast**

*M. Maeda, K. Mitani, H. Shimizu  
Kagawa Univ., Japan*

A research was carried out for the purpose of examining the effect of rare sugar on fibroblast cell. The fibroblast is cultivated in a culture solution L-15 and basic Fibroblast Growth Factor with or without D-Allose. The activity of the fibroblast cell was observed by microscopy. We found D-Allose inhibits the function of b-FGF.

**IMID / IDMC 2006**

Aug. 22 – 25, 2006

Daegu, Korea

## Topical Session on Novel Imaging Devices and Systems

Thursday, December 8

13:30 - 15:05

Sunport Hall Takamatsu Small Hall 1

### IDS1: Novel Imaging Devices and Systems (1)

Chair : S. Kawahito, Shizuoka Univ., Japan

Co-Chair : T. Aoki, Shizuoka Univ., Japan

**IDS1 - 1:     *Invited*   Extremely High-Resolution Camera System  
13:30           with Four 1.25-in. 8M-pixel CMOS Image Sensors**

*K. Mitani, H. Shimamoto, T. Yamashita, R. Funatsu  
NHK, Japan*

A compact camera system has been developed for a 4000-scanning-line ultra-high-definition video system nicknamed "Super Hi-Vision" for future broadcast services conveying a strong sense of reality to the viewer. The camera uses four 1.25-inch 8M-pixel CMOS digital imagers and the diagonal pixel shifting method in a 4-pickup system. A 5x zoom lens and a signal processing system with a function for real-time lateral chromatic aberration correction have also been developed for the system.

**IDS1 - 2:     *Invited*   Progress of ISIS (In-situ Storage Image  
13:55           Sensors) Mounted in Ultra-High-Speed Video  
                  Cameras**

*T. G. Etoh, H. Maruyama\*, H. Ohtake\*, K. Tanioka\*  
Kinki Univ., Japan  
\*NHK, Japan*

In 2001, an ultra-high-speed video camera of 1,000,000 fps was developed by Etoh et al. The camera equipped with a specially-designed CCD image sensor, "ISIS", the in-situ storage image sensor with a linear CCD storage area attached to each pixel. The progress of the ISIS-camera family for this five years is summarized with their potential applicabilities.

**IDS1 - 3:     *Invited*   Development of Camera System Capable of  
14:20           Taking Pictures with High-Fidelity Colors**

*T. Ejaz, T. Horiuchi, T. Yokota, G. Ohashi, Y. Shimodaira  
Shizuoka Univ., Japan*

A set of three optical filters was designed, and a camera system was developed using these filters in order to capture high-fidelity colors within the gamut of vision. Photographs of the macbeth chart, and 18 pieces of clothing samples of various colors were taken. The measured tristimulus values of the objects were compared with those of the images captured by the camera. The average color difference,  $\Delta E_{ab}$ , was found to be 1.85.

**IDS1 - 4                    Adaptive Image Enhancement Using Image Feature  
14:45                        Extraction for Mobile System**

*J. S. Kim, B. Y. Kim, S. W. Kim, W. H. Choe\*, M. H. Lee,  
J. T. Kim, C. S. Choi  
Samsung Elect., Korea  
\*Samsung Advanced Inst. of Tech., Korea*

In this paper, a new algorithm and circuit of an adaptive image enhancement technique for mobile display system is proposed. This algorithm efficiently enhances luminance of original image using image feature extraction without color distortion and realizes real time enhancement of motion image without flicker. This circuit is implemented in the LCD Driver IC of QVGA resolution with only 10,000 gates and 0.5 mW power consumption.

----- Break -----

15:20 - 17:00

Sunport Hall Takamatsu Small Hall 1

**IDS2: Novel Imaging Devices and Systems (2)**

Chair :                    K. Mitani, NHK, Japan  
Co-Chair :                N. Egami, NHK, Japan

**IDS2 - 1:            *Invited* CMOS Time-of-Flight Range Image Sensors**

15:20                    *S. Kawahito  
Shizuoka Univ., Japan*

Recent developments of time-of-flight (TOF) image sensors are reviewed. Using charge domain operation, range resolution of 1mm can be achieved. The resolution is explained by the photon shot noise in the region of sufficient light level. As an example of the TOF range image sensor, the results of the implementation of a QVGA-size CMOS TOF range image sensor are presented.

**BANQUET**

Wednesday, December 7  
19:00 – 21:00  
at Hiten (3F)  
ANA Hotel Clement Takamatsu

See page 9 for details

**IDS2 - 2: 15:45**     ***Invited* Characteristics of Active-Matrix HEED (High-Efficiency Electron Emission Device) and Its Application to Image Sensing**

*K. Sakemura, R. Tanaka, T. Nakada, N. Negishi, Y. Okuda, H. Satoh, A. Watanabe, T. Yoshikawa, K. Ogasawara, M. Nanba\*, S. Okazaki\*, K. Tanioka\*, N. Egami\*, A. Kobayashi\*\*, N. Koshida\*\*\**

*Pioneer, Japan*

*\*NHK, Japan*

*\*\*Hamamatsu Photonics, Japan*

*\*\*\*Tokyo Univ. of A&T, Japan*

An active-matrix HEED with scanning driver circuits was developed for an ultra-highly sensitive compact HARP image sensor. The HEED arrays with 256×192 pixels were fabricated as an image pickup beam source for the HARP target in combination with conventional MOS planar technology. The prototyped device operates well as a high-sensitivity image sensor with a sufficient resolution. The way towards ultrahigh-sensitivity and high-definition compact image sensing has been opened by active-matrix HEEDs.

**IDS2 - 3: 16:10**     ***Invited* Photoconductive Properties of Organic Film onto CMOS Readout Circuit**

*S. Aihara, T. Watabe, N. Egami, M. Kubota, K. Tanioka, N. Kamata\*, D. Terunuma\**

*NHK, Japan*

*\*Saitama Univ., Japan*

We have been studying photoconductive properties of organic films to develop a new type of solid-state image sensor without color separation optical systems. As a step toward this goal, the photoconductive properties of an organic film on a CMOS readout circuit were measured. The signal output voltage based on signal charges generated by the organic film was clearly observed, showing great potential for the development of high-resolution prism-less color cameras.

**IDS2 - 4: 16:35**     ***Invited* Photon Counting Type X-Ray Imager with Energy Distinction**

*T. Aoki, Y. Ishida, Y. Makino, G. Ohashi, Y. Tomita\*, H. Morii, J. Temmyo, Y. Hatanaka\*\**

*Shizuoka Univ., Japan*

*\*Hamamatsu Photonics, Japan*

*\*\*Aichi Univ. of Tech., Japan*

Photon counting type X-ray imager with energy distinction function was developed. This device was operated by photon counting mode for high-sensitivity, energy-discrimination (in order to color-like imaging) for a photon, and actual counts of incident X-ray photon compare with conventional X-ray imaging device, such as X-ray CCD, X-ray I.I. which are driven by current integrated mode. Moreover, the imager could be applied for X-ray CT, because the imager operated under the high-incident condition by micro-focus X-ray source tube.

**Author Interviews**

17:30 - 18:30

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SANYO EPSON IMAGING DEVICES CORPORATION  
SED Inc.  
Seiko Instruments Inc.  
SEMI Japan  
Semiconductor Energy Laboratory Co., Ltd.  
Sharp Corporation  
Sony Corporation  
Sumitomo Chemical Co., Ltd. Tsukuba Research Laboratory  
Technology Research Association for Advanced Display Materials (TRADIM)  
Thomson Corporate Research Tokyo  
Tokki Corp.

TOKYO CATHODE LABORATORY CO., LTD.  
Tokyo Electron Limited  
TOKYO OHKA KOGYO CO., LTD.  
TOPPAN PRINTING CO., LTD.  
Toshiba Matsushita Display Technology Co., Ltd.  
TOYO Corporation  
TOYOTA INDUSTRIES CORPORATION  
Ube Material Industries, Ltd.  
ULVAC, Inc.  
ZEON CORPORATION

#### **IDW/AD '05 SECRETARIAT**

c/o Inter Group Corp.  
Toranomom Takagi Bldg.,  
1-7-2 Nishi-shinbashi, Minato-ku,  
Tokyo 105-0003, Japan

#### **LIST OF EXHIBITORS (as of October 31, 2005)**

AIXTRON K.K.  
Aomori Support Center for Industrial Promotion  
CYBERNET SYSTEMS CO., LTD.  
CHUO PRECISION INDUSTRIAL CO., LTD.  
FUTEC INC.  
Hitachi, Ltd.  
HORIBA, Ltd.  
Keisoku Giken Co., Ltd.  
MEIRYO TECHNICA CORP.  
Nishida Lab., The University of Tokushima  
NITTOH KOGAKU K.K.  
Nordson Asymtek K.K.  
OPTO DESIGN, INC.  
Opto Science, Inc.  
Otsuka Electronics Co., Ltd.  
Plastic Logic Ltd.  
RSoft Design Group, Inc.  
Sanayi System Co., Ltd.  
SEIKO ELECTRIC CO., LTD.  
SHINTECH Inc.  
Suzuki Yasoji Lab., TOKAI University  
Tokki Corp.  
Toray Research Center, Inc.  
TOYO Corp.

**Funds for the conference are furnished in part by the following organizations:**

- The Murata Science Foundation
- Kagawa Prefectural Government
- Takamatsu Convention & Visitors Bureau (Takamatsu City)

## **EVENING GET-TOGETHER WITH WINE**

Monday, December 5  
18:00 – 20:00  
Main Hall Foyer (3F),  
Sunport Hall Takamatsu  
(Sponsored by Merck Ltd., Japan)

See page 9 for details

## **EXHIBITION**

12:00 – 18:00 Tuesday, Dec. 6  
9:00 – 18:00 Wednesday, Dec. 7  
9:00 – 18:00 Thursday, Dec. 8  
9:00 – 14:00 Friday, Dec. 9  
Small Hall 2 (5F)  
Sunport Hall Takamatsu

Free admission with your registration name tag.

## **BANQUET**

Wednesday, December 7  
19:00 – 21:00  
at Hiten (3F)  
ANA Hotel Clement Takamatsu

See page 9 for details

## **Outstanding Poster Paper Awards**

Friday, December 9  
12:20 – 13:30  
(after Takamatsu Festival)  
Tamamo (3F),  
ANA Hotel Clement Takamatsu

See page 8 for details

## **Takamatsu Festival**

Takamatsu Folk Entertainment  
Friday, December 9  
12:20 – 13:30  
(before Outstanding Poster Paper Awards)  
Tamamo (3F),  
ANA Hotel Clement Takamatsu

See page 9 for details

## **IDW '06**

International Display Workshops

Dec. 6 – 8, 2006  
Convention Hall Ohmi, Otsu Prince Hotel  
Otsu, Japan

<http://idw.ee.uec.ac.jp>

## **PDP International Forum '05**

10:00 - 15:30, Saturday, Dec. 10

History Museum (5-min walk from IDW venue)

Meet Prof. Don Bitzer, the inventor of PDP, at the luncheon with wine. Join discussion on "how to dominate the TV world" with internationally well-known scientists. Everyone is welcome.

inquiry: [pdp-forum@townsend.ee.uec.ac.jp](mailto:pdp-forum@townsend.ee.uec.ac.jp)

## **SID 2006**

Society for Information Display  
Symposium, Seminar & Exhibition

June 4–9, 2006

San Francisco, CA, USA

<http://www.sid.org>

## **IMID / IDMC 2006**

Aug. 22 – 25, 2006

Daegu, Korea

## **IDRC**

Sept. 18 – 21, 2006

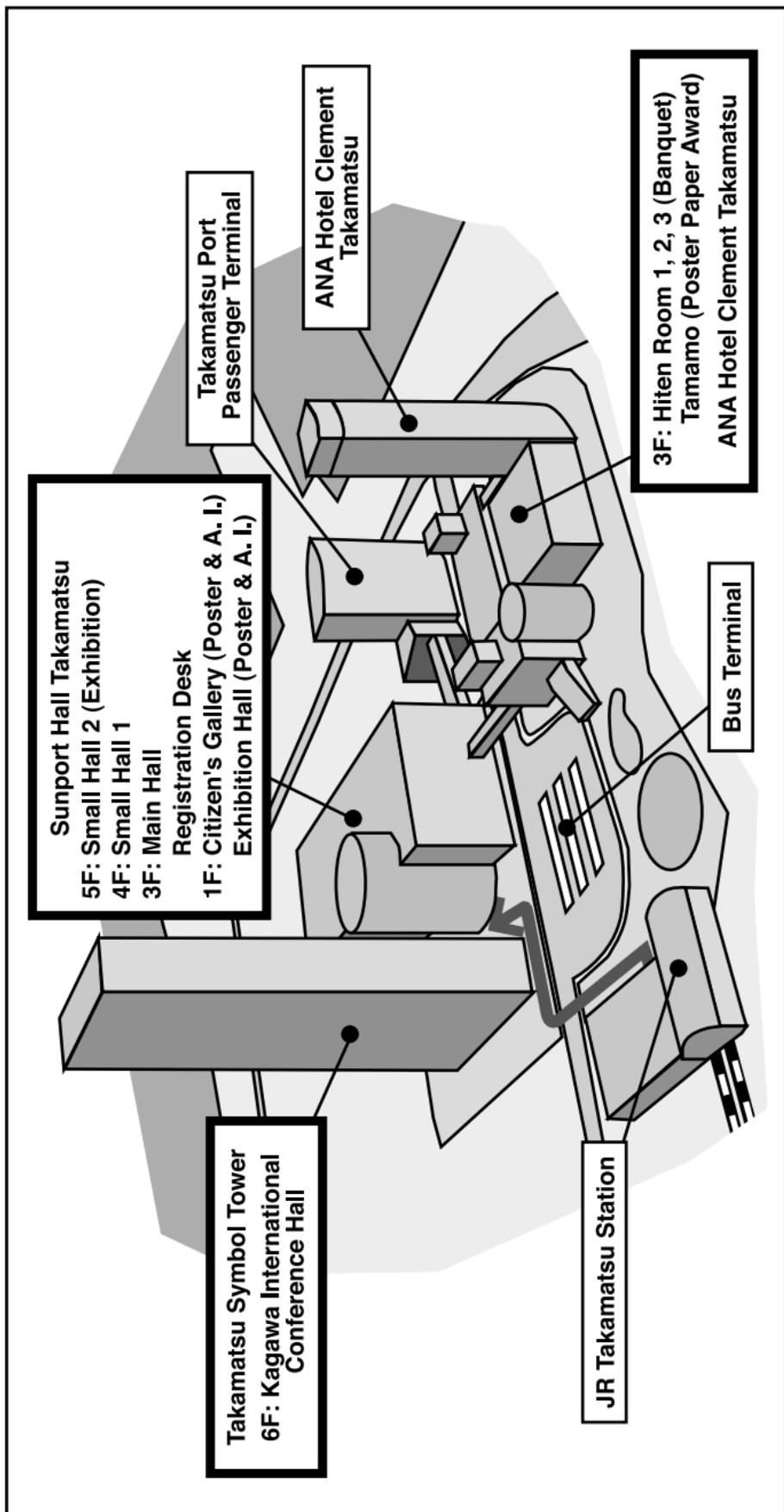
Kent State University

OH, U.S.A.

# MEMO

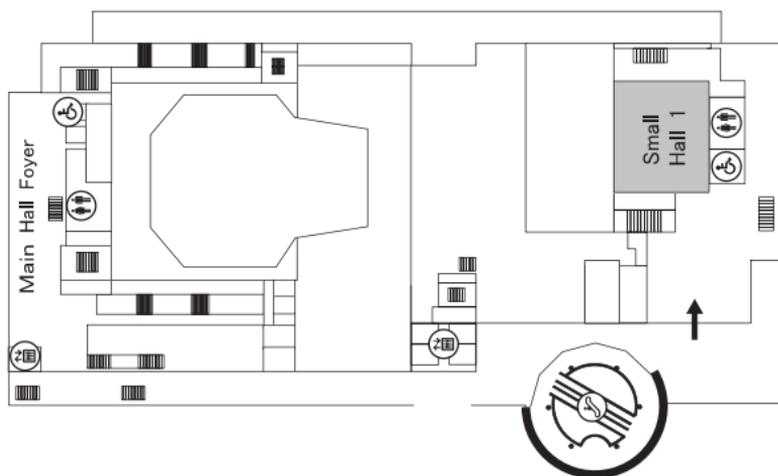


# CONFERENCE SITE (Sunport Takamatsu)



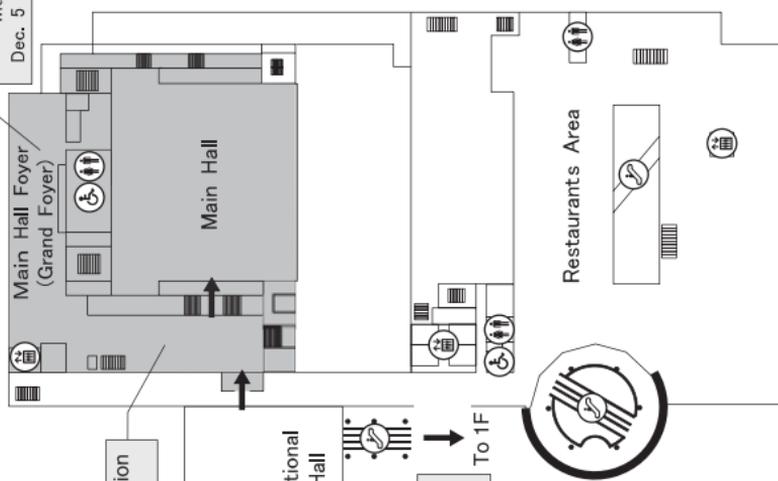
# FLOOR PLAN

## 4F Support Hall Takamatsu

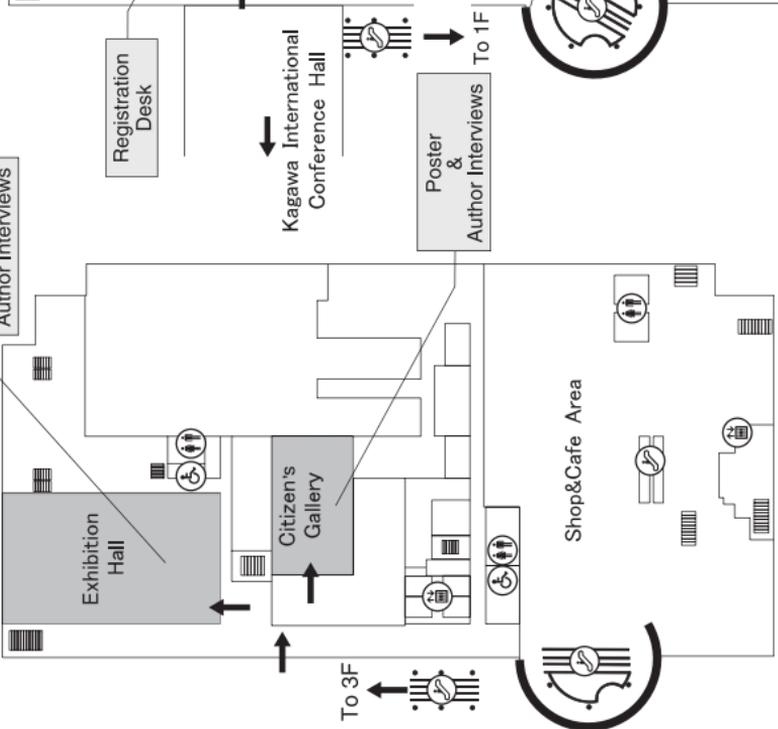


## 3F Support Hall Takamatsu

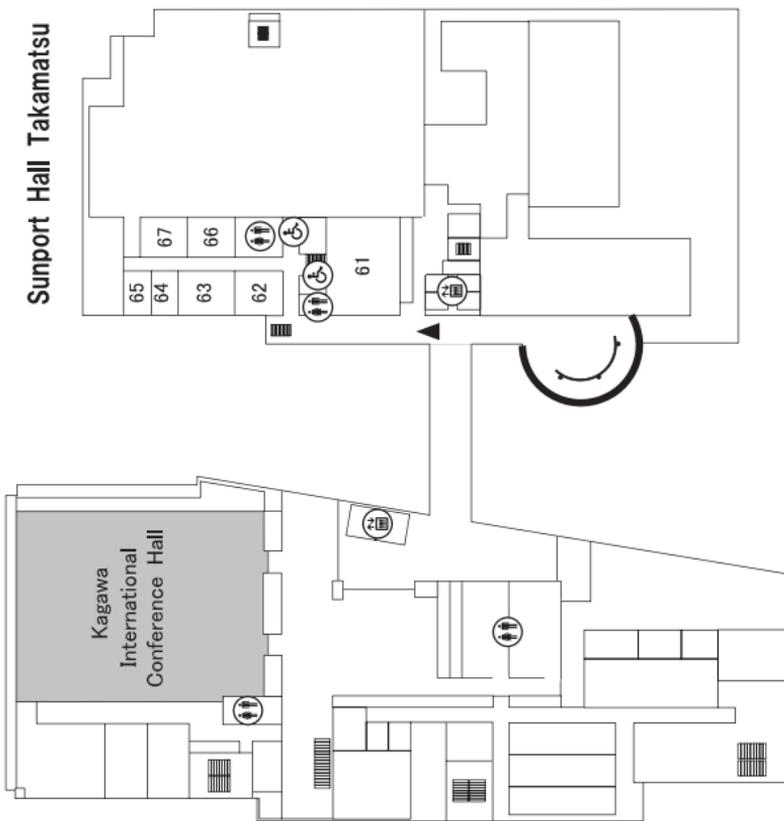
Evening Get-Together  
with Wine  
Dec. 5 18:00-20:00



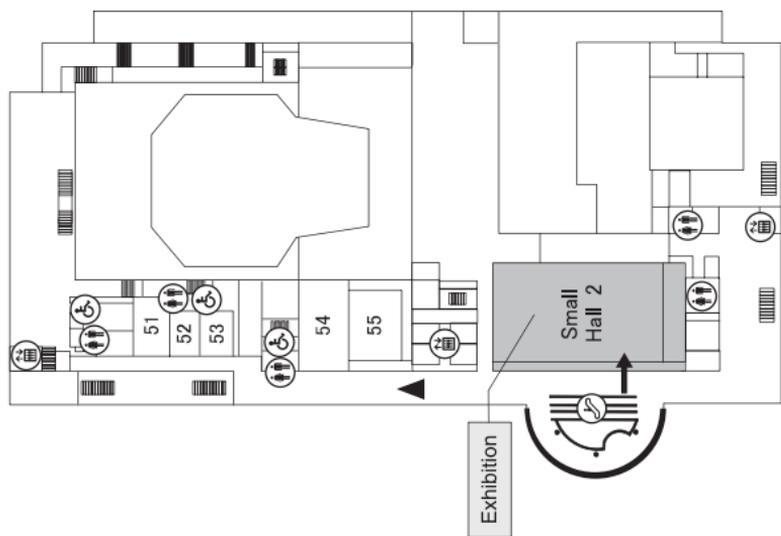
## 1F Support Hall Takamatsu



**6F** Kagawa International Conference Hall



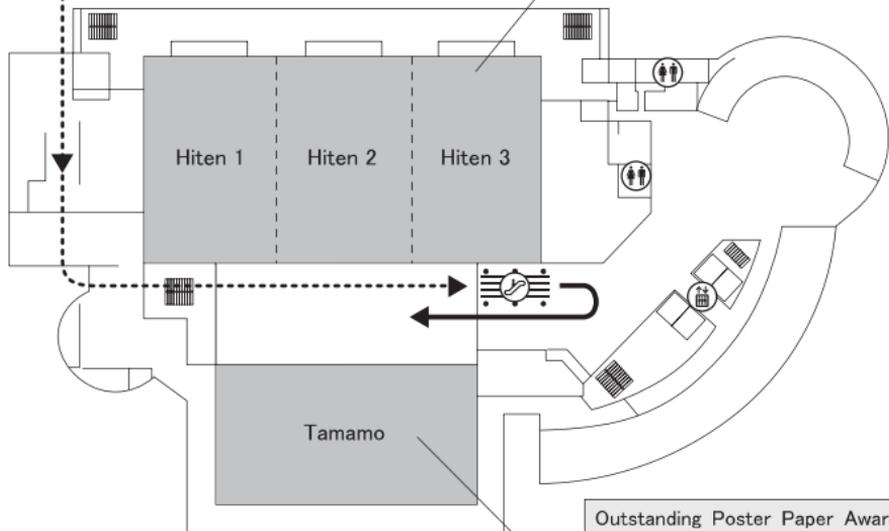
**5F** Sunport Hall Takamatsu



Sunport Hall Takamatsu 2F

**3F** ANA Hotel Clement Takamatsu

Banquet  
Dec. 7 19:00-21:00



Outstanding Poster Paper Awards  
and Takamatsu Festival  
Dec. 9 12:20-13:30

**IDW/AD '05  
FINAL PROGRAM**