2015 ICFPE

The International Conference on
Flexible and Printed Electronics

October 21-23, 2015

Taipei Nangang Exhibition Center,
Taiwan

CORNING

Willow® Glass

The *future* is

flexible

Agenda of Conference

2015 ICFPE
The International Conference on Flexible and Printed Electronics

Day1- Wednesday, October 21, 2015			
Room	504		
10:00-10:20	**ICFPE & IMPACT Joint Openig & Award Ceremony** Conference Chair: Dr. CT Liu, Executive Vice President, ITRI		
10:20-11:10	**Joint Plenary I** - Chung-Chin Hsiao General Manager, Polyera Taiwan Corporation **Wove, the first truly flexible display product**		
11:10-12:00	**Joint Plenary II** - Dipak Chowdhury Division VP, Corning Incorporated, Emerging Innovation Group **Integrated substrate for OLED Lighting**		
12:10-13:30	Lunch		
Room	504b	501	502
13:30-15:15 (Parallel)		**OLED Session I** **[R1]**	**Fine Line Session** **[R2]**
15:15-15:30	Coffee Break		
15:30-17:00 (Parallel)	**Starting from 15:45** **IOT Joint Session**	**OLED Session II** **[R3]**	**Conductive Inks Session** **[R4]**
18:00-20:00	**TPCA Show, IMPACT & ICFPE Reception Party**		

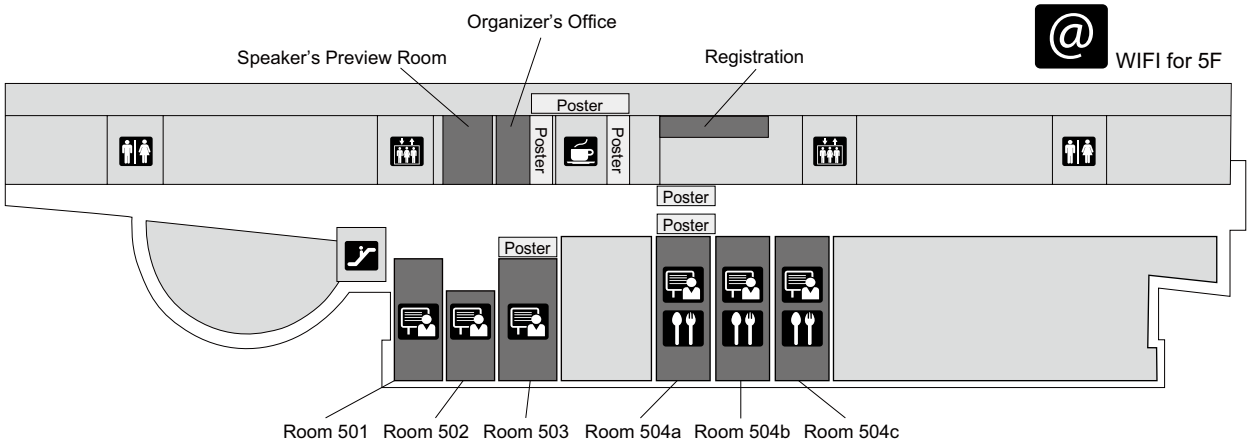
Day2- Thursday, October 22, 2015			
Room	504b+c		
08:30-09:20	**Joint Plenary III** - Hirofumi Matsumoto Fellow/Senior Advisor , Nippon Mektron, Ltd. **FPC Marketing and Technology Trend for "Wearable" and "IoT/M2M"** **- FPC Technologies for "the future" -**		
09:20-10:10	**Joint Plenary IV** - E. Jan Vardaman President, TechSearch International, Inc., **Packaging Trends for Wearable Medical Electronics**		
ROOM	504b	501	502
10:30-12:30 (Parallel)		**Sensors Session** **[R5]**	**TFT Session I** **[R6]**
12:30-13:30	Lunch (ICFPE Poster Session)		
13:30-15:30 (Parallel)		**oe-a Special Session**	**TFT Session II** **[R7]**
15:30-15:45	Coffee Break		
15:45-17:45 (Parallel)	**Wearable Joint Session**	**FPC Session** **[R8]**	**TFT Session III** **[R9]**
18:30-20:30	**Joint Welcome Party @ Ceaser Park Taipei (by invitation)**		

Day3- Friday, October 23, 2015			
Room	504b+c		
08:30-09:20	**Joint Plenary V** - Kee Hyun Shin CEO, Toba **RAM (R2R Additive Manufacturing): Platform Business for Flexible Devices**		
09:20-10:10	**Joint Plenary VI** - Yasumitsu Orii Senior Manager, IBM Research Tokyo **Challenge of Packaging Technologies in the era of Cognitive Computing**		
ROOM	503	501	502
10:30-12:30 (Parallel)	**Display Session** **[R10]**	**Photovoltaics I** **[R11]**	**Roll to Roll Session** **[R12]**
12:30-13:30	Lunch		
13:30-15:15 (Parallel)	**Transparent Substrates** **[R13]**	**Photovoltaics II** **[R14]**	

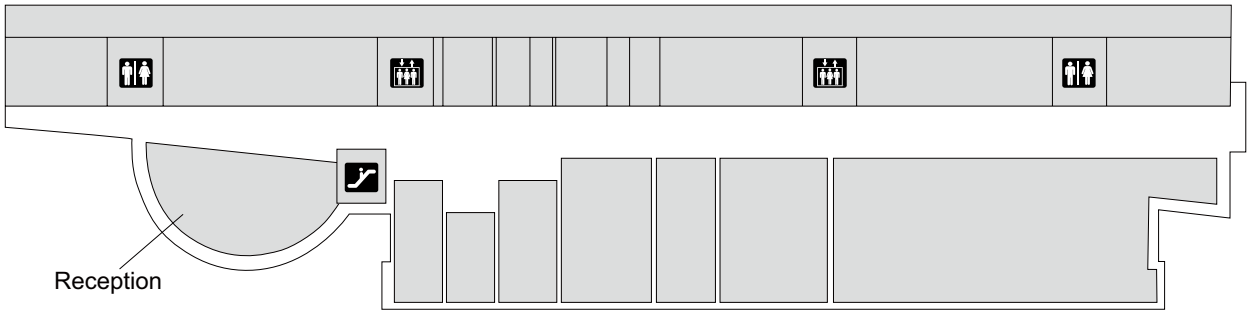
Access the conference proceeding through: https://icfpe.itri.org.tw/Reg/PaperDownload.aspx

Floor Plan

5F ICFPE 2015



3F Reception



1F

TPCA Show 2015

| EAssembly | Green Tech | PCB | Thermal | Flex & Printed |

Conference Room

Dining Room (Conference Attendees Only)

Coffee Break

WiFi

POSTER SESSION

Conference Chair

CT Liu	Executive Vice President, ITRI	Taiwan

Technical Program Committee

Chair

Chain-Hsu Hsu	National Chiao Tung University	Taiwan

Co-Chair

Jupiter Hu	Industrial Technology Research Institute	Taiwan
An Jung Chung	Korea Printed Electronics Association (KoPEA)	Korea
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Chien-Hong Cheng	National Tsing Hua University	Taiwan
Chih-I Wu	National Taiwan University	Taiwan
Clay Shepherd	Research Center for Organic Electronics, Yamagata University	Japan
Fang-Chung Chen	National Chiao Tung University	Taiwan
Hoo-Jeong Lee	School of Advanced Materials Science and Engineering, Sungkyunkwan University	Korea
Hsin-Fei Meng	National Chiao Tung University	Taiwan
Jae-won chung	Department of Mechanical Engineering, Korea University, Seoul	Korea
Ji-Bin Horng	Industrial Technology Research Institute	Taiwan
Jin-soo Noh	Dept. of Electronic Eng., College of Elec-Info Eng., Chosun University	Korea
Jwo-Huei Jou	National Tsing Hua University	Taiwan
Kenjiro Fukuda	Research Center for Organic Electronics, Yamagata University	Japan
Ken-Tsung Wong	National Taiwan University	Taiwan
Luhai Li	Beijing Institute of Graphic Communification	China
Mei-Rurng Tseng	Industrial Technology Research Institute	Taiwan
Shinichi Nishi	Konica Minolta	Japan
Shu-San Hsiau	National Central University	Taiwan
Stephan Kirchmeyer	Heraeus Precious Metals GmbH	Germany
Takao Someya	University of Tokyo	Japan
Tsuyoshi Sekitani	Osaka University	Japan
Tzung-Fang Guo	National Cheng Kung University	Taiwan
Xiachang Zhang	Changzhou Institute of Printed Electronics Industry	China
Yanlin Song	The Institute of Chemistry, Chinese Academy of Sciences	China
Youji Ushijima	The National Institute of Advanced Industrial Science and Technology (AIST)	Japan
Yuh-Zheng Lee	Industrial Technology Research Institute	Taiwan
Yu-Tai Tao	Academia Sinica	Taiwan
Zheng Cui	Suzhou Institute of Nanotech, Chinese Academy of Sciences	China

2015 ICFPE Conference
Welcome from Conference Chair
Dr. CT Liu, Executive Vice President, ITRI

On behalf of the ICFPE committee, we are delighted to welcome you to the 2015 International Conference on Flexible and Printed Electronics to be held on October 21- 23 in Taipei, Taiwan.

Since the first ICFPE in 2009, this event has taken place in Taiwan, Japan, Korea, and China. Over the years, it has continued to grow in many aspects. This year, we are committed to offering our sponsors and attendees another fruitful conference for the information exchange in industry breakthroughs.

Further to the technological advances in recent years, consumers are fostered to have more compact and lighter electronic devices. They have shown a growing awareness for energy efficiency and CO_2 emission reduction. Taiwan's electronics industries will inevitably have to upgrade their technologies that produce lighter products and require less energy in the manufacturing process. In contrast to conventional technologies, flexible electronics is advantageous in its manufacturing process that allows more changes and is cost-effective in production. The market believes that flexible electronics is set to dominate the business development in the years to come. In conjunction with the TPCA Show and the IMPACT Conference, which is the only platform in Taiwan that covers material, circuit boards, and packaging and testing, this year's ICFPE anticipates to bring informative programs and networking platform to all of your participations.

It is again our great honor and pleasure to welcome you for attending the conference. We sincerely hope that you will enjoy an excellent meeting and warm hospitality here in Taiwan.

Sincerely,

CT Liu, Ph.D.
Executive Vice President, ITRI
Conference Chair of 2015 IMPACT & ICFPE

General Information

The 2015 International Conference on Flexible and Printed Electronics is celebrating its 6th anniversary of bringing together leading experts worldwide to present a wide range of topics relevant to the most up-to-date development in flexible and printed electronics.
In addition, the 2015 TPCA Show, which is composed of fundamental elements – PCB manufacturing, materials and equipment – to downstream fields such as electronic assembly, surface finishing, IC packaging, thermal management, green technologies, will also be held at the same venue simultaneously. The collaboration between the conference and the show is to promote the latest research results and manufacturing technology of flexible and printed electronics.

About Conference

- Date: October 21 (Wed) - October 23 (Fri), 2015
- Venue: Taipei Nangang Exhibition Center, Taiwan
- Exhibition : TPCA Show 2015
- Co-located Conference: IMPACT 2015

Registration Desk

Reception desk is located on 5th floor of Taipei Nangang Exhibition Center. Please check in andget proceedings in reception desk from 8:00 to 17:00.

Organizer Office

Room 521 is organizer's office on the 5th floor of Taipei Nangang Exhibition Center.

Speaker Preview Room

The preview room for all speakers is located at Room 521 on the 5th floor of Taipei Nangang Exhibition Center. All speakers are advised to provide your update presentation slides or check your file in advance there.
Open Hour:

8:00-17:00	October 21-23

Poster Session

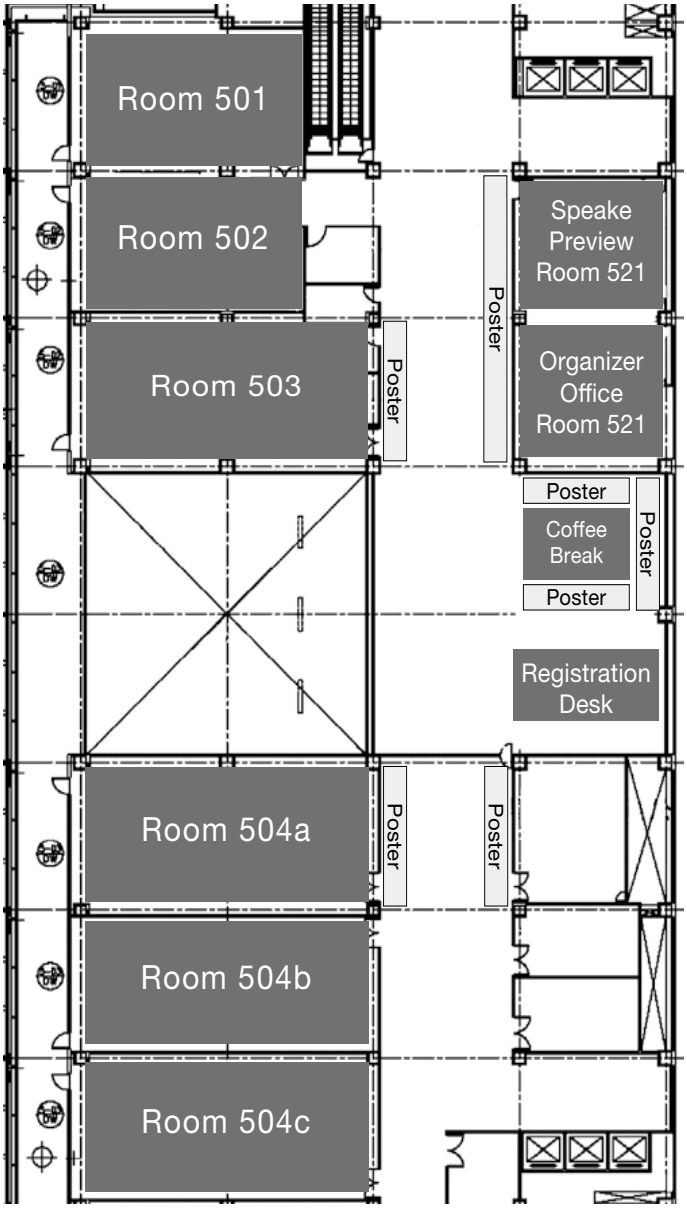
Poster session is located on the 5th floor of Taipei Nangang Exhibition Center.
Day2: October 22 12:30 - 13:30

Internet Access

Wireless internet is provided on 5th floor of Taipei Nangang Exhibition Center for free.

Lunch Provided

All registered attendees can get your lunch with your name badges at "Coffee Break" Area.
Date: October 21-23, 2015
Time: 12:30-13:30



TPCA Show, IMPACT & ICFPE Reception Party

(Taiwanese Cuisine Buffet)
Attendee: All IMPACT/ ICFPE conference attendees and TPCA Show visitors
Date: October 21, 2015 (18:00-20:00)
Venue: 3F, Taipei Nangang Exhibition Center

IMPACT & ICFPE Joint Welcome Party

Note: By invitation only
Time: October 22, 2015 (18:30-20:00)
Venue: 3F of CAESAR PARK TAIPEI (No. 38, Sec. 1, Zhongxiao W. Rd., Zhongzheng Dist.,Taipei City, 100, Taiwan)
Invited Guest:
Plenary Speakers, Invited Speakers, VIP, Sponsors, Session Chairs, Outstanding Paper Award Winners and Committee Members

Identification

Badges are required for admittance to all sessions, lunchex and TPCA Show Reception Party. Please bring it with you all the times.

Conference Venue

Conference rooms will be located on the 5th floor of Taipei Nangang Exhibition Center.

Conference Venue Map

TWTC Nangang Exhibition Hall Transport & Parking Information

Parking Lots :

- P1 TWTC Nangang／620 Parking spaces
- P2 Taiwan Fertilizer C2 Parking Lot／352 Parking spaces
- P3 Taiwan Fertilizer C3 Parking Lot／768 Parking spaces
- P4 Taiwan Fertilizer C4 Parking Lot／82 Parking spaces
- P5 MRT Neihu Depot Parking Lot／584 Parking spaces ／During Exhibition Periods
- P6 Xingzhong Parking Tower／647 Parking spaces／ NT$30 (per hour)／24HR

P Underground Parking
P Parking Lot
Entrance / Exit
Directions to TWTC Nangang

The parking fee above is for reference only

Transport Information :

1. Shuttle Bus Stop (Pick-up / Drop-off)
2. Bus Stop
3. Taxi Drop-off
4. Small Vehicle Drop-off
5. B1 Taxi Pick-up
6. Underground Parking Entrance
7. MRT Shuttle Bus Stop (to MRT Nangang Station)

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Hotel Information

To enjoy the discount for ICFPE conference attendees, please book your hotel right away and make further follow up confirmation with the hotel.

HOTEL	Discount Price	TEL	Location
天閣酒店 - 台北信義 The Tango Hotel	Deluxe Single: NT$4,050 Deluxe Twin: NT$4,050	886-2-25288000	捷運永春站旁 Near Yongchun MRT Station
太平洋商旅 Pacific Business Center	Business Room: NT$4,450+10% Business Room: NT$4,750+10%	886-2-87802000 ext.3305	捷運信義安和站旁 Near Xinyi Anhe MRT Station
兄弟大飯店 Brother Hotel	Standard Single: NT$2900 Twin Room: NT$4000	886-2-27130567	捷運南京東路站旁 Near Nanjing East Road MRT Station
古華花園飯店 Hotel Kuva Chateau	Executive Single: NT3,000+10% Deluxe Twin: NT3,350+10%	886-3-2812626	Taoyuan City
台北凱撒大飯店 Caesar Park Hotel	Single Room: NT$3,800+10% Twin Room: NT$4,100+10%	886-2-23115150 ext. 2337, 2420	台北車站旁 Near Taipei main station
台北馥敦飯店 - 南京館 Taipei Fullerton Hotel - Nan-Jing EAST	Deluxe Room: NT$3,700+10% Executive Deluxe: NT$4,100+10%	886-2-27635656 ext.8162	至南港展覽館車程約 15 分 15 mins to Nangang Exhibition Hall by car
台北馥敦飯店 – 復南館 Taipei Fullerton Hotel - SOUTH	Superior Single: NT$3,630 Superior Twin: NT$3,630	886-2-27031234	捷運大安站旁 Near Daan MRT Station
台北馥華商旅 - 南港館 Forward Hotel - Nangang	Standard Room: NT$3,225	886-2-66156788	捷運南港軟體園區旁 Near Nangang Software Park MRT Station
國賓大飯店 The Ambassador Hotel	Executive Single: NT$4,700+10%+5% Executive Twin: NT$5,400+10%+5%	886-2-21002100 ext.2284	捷運雙連站旁 Near Shuanglian MRT Station
富信大飯店 FUSHIN Hotel	Deluxe Single: NT$3,000+10% Deluxe Twin: NT$3,300+10%	886-2-26416422 ext.5502	接駁車 5 分鐘至南港展覽館 5 mins to Nangang Exhibition Hall by Shuttle Bus
福容大飯店 Fullon Hotel Taipei	Superior Room: NT$4,000 (1 breakfast) Superior Room: NT$4,500 (2 Breakfasts)	886-2-27011239 ext.376 886-2-27019266	大安森林公園捷運站旁 Nearby Daan Park MRT Station
維多麗亞酒店 Grand Victoria Hotel	Deluxe Single: NT$5,600+10%+5% Deluxe Twin: NT$6,200+10%+5%	886-2-85020000 ext. 2322	捷運劍南路站旁 Near Jinnan Rd. MRT Station
麗湖大飯店 City Lake Hotel	Deluxe Single: NT$3,060+10% Deluxe Twin: NT$3,360+10%	886-2-26342136	捷運葫洲站旁 Near Huzhou MRT Station

CC Hsiao

Head of Display Development
General Manager
Polyera Corporation, Taiwan

Topic: Wove, the first truly flexible display product

Wednesday, October 21
Time: 10:20-11:10
Room:504

Abstract
Wove brings digital content into the material world, making it something you can wear.
It's a canvas for people to make, share and wear whatever they want, combining the beautiful and useful in entirely new ways. Digital goes material. That's wove.

Dipak Chowdhury

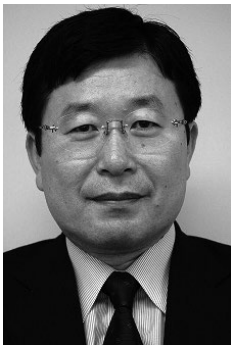
Division VP,
Corning Incorporated, Emerging Innovation Group

Topic: Integrated substrate for OLED Lighting

Wednesday, October 21
Time: 11:10-12:00
Room:504

Abstract
The current challenge for OLED lighting adoption is cost, which can be reduced with a low cost integrated substrate that also provides high light extraction efficiency, as already outlined by Department of Energy analysis. Based on our flexible 100 μm thick Corning® Willow® Glass, we have developed an integrated substrate that enables 2x (40%) light extraction while providing the best possible transparent barrier for long lifetime OLED lighting panels. This flexible substrate will also enable one of the key desired attribute for the next generation lighting panels – conformability. Conformable panels that are low cost and highly efficient in extracting light from the OLED structures will enable possibilities that designers can now only imagine today. Because of the flexible nature of Willow Glass, we are able to make this integrated substrate for panel makers in a roll-to-roll process, significantly lowering manufacturing cost. We believe this efficient and low-cost integrated substrate will reduce the panel cost and drive market adoption for OLED lighting faster than today's analysts expect.

Hirofumi Matsumoto



Fellow/Senior Advisor,
Nippon Mektron, Ltd.

Topic: FPC Marketing and Technology Trend for "Wearable" and "IoT/M2M"
- FPC Technologies for "the future"-

Thursday, October 22
Time: 8:30-9:20
Room:504b+c

Abstract
The search and development of the new FPC market are getting important to avoid current overemphasis of Smartphone applications. At present, "Wearable" and IoT/M2M" are regarded as to be the candidates for new FPC market. As the future FPC technologies that are applicable to these new market, "Stretchable FPCs", "Biodegradable FPCs", and "FPCs with a built-in Sensor (or Flexible Tactile Sensors)" are introduced.

E. Jan Vardaman

TechSearch International, Inc.

Topic: Packaging Trends for Wearable Medical Electronics

Thursday, October 22
Time: 9:20-10:10
Room:504b+c

Abstract
Wearable electronics in not a new concept for implantable devices and hearing aids, new products to enable digital healthcare age are emerging. Some of these products are focused only on health and fitness; others deal with critical care and the control of life threating conditions. New products are expected to collect data, transmit and/or process information and this connectivity is referred to as Internet of Things IoT or as Cisco calls it the "Internet of Everything". This connectivity for digital health care products is enabled by the use of an increasing number of MEMS and sensors, as well as some form of RF device. How are these devices packaged for each application? How do package, assembly, and reliability requirements differ for each product category? No single package dominates this sector today, but increased cost sensitivity will place greater demands on package and assembly decisions for future applications. This presentation examines these trends and the implications for a growing number of products.

Kee Hyun Shin

CEO
Toba

Topic: RAM (R2R Additive Manufacturing): Platform Business for Flexible Devices

Friday, October 23
Time: 8:30-9:20
Room:504b+c

Abstract

A megatrend of the flexible devices in our daily life including mobile, wearable, and flexible devices has brought issues of handling and manufacturing of flexible substrates on which smart functionalities might be embedded. The concept of RAM (Roll-to-roll Additive Manufacturing) technology of Toba will be introduced with its characteristics as a platform business model in the area of barrier films, transparent conductive films, OLED light and Display. Key technologies of RAM will be introduced for platform business. Some examples of platform business with RAM technology will be presented in the area of plating, coating, printing, and CVD.

Yasumitsu Orii

Senior Manager
Science & Technology, IBM Research Tokyo

Topic: Challenge of Packaging Technologies in the era of Cognitive Computing

Friday, October 23
Time: 9:20-10:10
Room:504b+c

Abstract

Cognitive computing has capability of machine learning, recognition and proposal. It is essential to make human life more rich, more productive and more intelligent. For the realization of the cognitive, IBM researchers are trying to mimic human brain architecture. To computationally emulate brain structure interconnected with ten billion neurons and hundred trillion synapses, much further high-density packaging structure is required not only device evolution. At an early-stage development, fine pitch I/O interconnects in several micron order are required, which have a need for innovative bonding, soldering and encapsulation technologies. Furthermore, much denser interposer which provide lower latency and higher bandwidth between chip to chip connects are required for 2.5D and 3D configurations.

Wednesday, October 21, 13:30 – 15:15
Room 501 (5F)

Session R1: OLED Applications and Lighting

Session Chair: Junyou Pan (TCL Corporate Research, China)

13:30 Invited Talk

R11 Rollable, foldable and stretchable displays

Jan-Laurens P.J. van der Steen
Research Scientist,
Holst Centre/TNO, The Netherlands

Abstract

To make lightweight, unbreakable, portable displays, thin plastic substrates are preferred as they give maximum mechanical flexibility. In comparison to liquid crystal (LC) displays, flexible active matrix organic light emitting diode (AMOLED) displays offer superior optical image quality, particularly when flexed. However, the emergence of ultra-flexible AMOLED displays bring new technological requirements, including the need for a TFT backplane that is sufficiently reliable upon bending and preferably does not change its electrical performance when mechanically strained, the demand for ultrathin, high-quality thin-film barriers to protect the OLED from moisture ingress, and ultimately the integration of the components mentioned above on ultrathin plastic substrates that can be temporarily bonded on a rigid glass carrier. In this presentation we give an update on our work on rollable, foldable and stretchable displays. The emphasis will be on the mechanical aspects.

14:00

R12 Transparent blue organic light emitting diodes with n-type graphene as top cathodes

Jung-Hung Chang[1], Ting-An Ku[1], Wie-Ting Chen[1], Shiang-Jiuan Yan[1], Chih-I Wu[2]
National Taiwan University, Taiwan

Graphene, a carbon monolayer with honeycomb lattice structure, is one of the most fascinating materials due to its outstanding physical properties, such as mechanical, electronic, and optical transmittance. This conductive thin film has a strong potential to be transparent electrodes in organic electronic devices with excellent conductivity and highly transparent properties. In the past few years, many groups have already demonstrated the resilience of graphene-based organic photoelectrical devices to replace the commercially available ITO electrodes. With p- doped grapheme as anode transparent substrates, not only organic light emitting diodes (OLEDs) can achieve high luminous efficiencies but also organic solar cell can achieve high efficiency. However, it still lacks for reliable methods to fabricate an n-doped graphene cathode for OLEDs. P-type doped graphene with new polymer-free transfer method has been shown up in our previous report, however, n-type doped graphene as cathode for OLEDs is achieved for the fit time. This polymer-free transfer method provides an efficient way to modify the work function and sheet resistance of graphene to be used as electrodes for organic devices. With n-doped multilayer graphene used as top cathodes, all-solution processed transparent OLEDs could be fabricated without any vacuum process. The results show that graphene electrodes can be used in a wide variety of organic optoelectronics with more efficient doping and simple transfer techniques.

14:15

R13 Fabrication and Integration of Flexible LED Lighting Module

Sheng-Che Chiou, Ai-Sen Liu, Chang-Hsieh Wu, Chia-Tai Kuo, Ming-Hsun Hsieh, Chyi-Ming Leu*, Kuo-Chan Chiou*, Chun-Wei Su*, Wei-Han Hsiao*
Epistar Corporation, Taiwan
*Industrial Technology Research Institute, Taiwan

The flexible lighting system is very difficult to realize by LED, since die attach with flex under reflow temperature is much higher than the softening point of flex. On the other hand,the optical design without external diffuser sheet makes it impossible to achieve uniform light distribution. Therefore, there are only few make demonstrated flexible lighting system by OLED technology. This work successfully implemented the embedded LED chips (ELCs) with batwing design on hybrid Flex with nano-silver wire for printing circuitry. Moreover, the rollable feature enables it to be potentially fabricated by R2R process in volume production.

14:30

R14 R2R fabrications and Opto-electrical Performances of Flexible OLEDs

Takashi Minakata, Mitsuru Tanamura, Yasuhiro Mitamura, Akira Sugimoto, Yukito Yada, Masahiro Yamashita, Yoshiko Ohzu
CEREBA, Japan

Flexible OLEDs have been fabricated using the fully R2R process and influence of fabrication conditio on opto-electrical performance of flexible OLEDs have been evaluated. We have studied defects growth on light emission area caused by moisture permeation both across gas-barrier layer on film and along adhesive from sealed edge, respectively. Strong correlation between moisture permeation performance of substrate or adhesive and defect growth was confirmed. In addition, measurements on optical performance of flexible OLEDs in curved state are performed.

14:45

R15 Fabrication ultra-high barrier films by ICP-PECVD for thin film encapsulation

Wenming Su, Fei Fei, Mihun Song Zheng Cui*
Suzhou Institute of Nano-Tech and Nano-Bionics, China

The rapid development of organic electronics is leading to a number of promising devices in the area of energy sources and conservation (e.g., display, lighting and solar cells). One obstacle to this development is the susceptibility of these devices to water vapor and oxygen, which are well known to cause rapid degradation in many organic electronic devices. In order to guarantee the minimum lifetime needed for various applications, high barrier performance encapsulation materials and structures must be developed and researched. However, due to the limitation of technology and equipment, there is a dearth of necessary studies interiorly.

15:00

R16 Solution-Based Processing and Stamping For Organic Light-Emitting Diodes

Apisit Chittawanij, Yu-Sheng Tsai, Yang-Ching Lin and, Fuh-Shyang Juang
National Formosa University, Taiwan

In this paper, one demonstrate a simple and reliable stamping technique for fabricating multi-solution process flexible white SM-OLEDs. The structure is ITO/ PEDOT:PSSpin-coating 26DCzPPy: FIrpic:Hex-Ir(phq)$_3$tamping TPBi/LiF/Al. Poly(di-methyl silane) (PDMS) stamp is used for transferring 1,3,5-tris (N-phenylben zimidazol-2-yl) benzene (TPBi). A fully solution-based process is successfully established to efficiently fabricate white SM-OLEDs. At the current deity of 10 mA/cm^2, luminance of 892 cd/m2 and current efficiency of 8.9 cd/A, and CIE coordinate (0.33, 0.37) were obtained.

Wednesday, October 21, 13:30 – 15:15
Room 502 (5F)

Session R2: Fine Line Printed Technologies for Electronics Applications
Session Chair: Fang-Chung Chen, National Chiao Tung University, Taiwan

13:30 Invited Talk

R21 Fine line solution for printed electronics
Ohra Sakata
General manager,
Seria corporation, Japan

Abstract
Gravure offset printing is the right solution which can make very fine pattern. This printing method achieve to make thin lines like L/S=20/20 (μm) or independent 3 (μm) lines. In this talk, I will present technical tricks and traps of gravure offset to realize the mass production of PE products and introduce some applications using gravure offset. Furthermore I provide a brief introduction to the other fine printing method including new concept screen printing.

14:00

R22 Reverse-Offset Printed Organic Transistors with Submicron Channel Length
Kenjiro Fukuda[1,2], Yasunori Takeda[1], Yudai Yoshimura[3], Tomoko Okamoto[3], Yoshinori Katayama[3], Daisuek Kumaki[1], Shizuo Tokito[1]
[1]Graduate School of Science and Engineering, Yamagata University
[2]Japan Science and Technology Agency (JST), Japan
[3]DIC Corporation, Japan

Printing technology offers great potential in the manufacturing of large-area thin film electronics with low costs. However, conventional printing methods lack the throughout and patterning resolution required to produce channel lengths for printed electronic devices with a high degree of integration and circuit density, as well as high operating frequencies. Here we report on printed organic thin-film transistor (TFT) devices with submicron (0.6 μm) channel lengths (L), for which the source and drain electrodes are fabricated by employing a scalable reverse-offset printing method with high patterning resolution.

14:15

R23 Development of Adhesion Contrast Planography for Rapid-prototyping of Single Micrometer-sized Silver Conductive Patterns
Yasuyuki Kusaka, Hirobumi Ushijima
National Institute of Advanced Industrial Science and Technology, Japan

One requirement in printed electronics is the high-variatiolow-volume production of various devices. To achieve this, a rapid and inexpeive alternative to conventional reverse offset printing and gravure offset printing is required, especially for devices with high-resolution patterning. Herein, we propose a new planography-based offset printing method called adhesion contrast planography that enables to fabricate silver conductive lines with up to 5 μm resolution. In the proposed printing protocol, an adhesive latent image produced on a silicone surface by UV exposure was exploited for patterning. We investigated the patterning mechanisms of our methods by focusing on adhesion contrasts of the silicones and thickness on the ink layer.

14:30

R24 Printing Fine-Line Metal Mesh Structure as Touch-Sensitive Electrode using Gravure Offset Printing Technology for Touch Sensor

Yu-Ming Wang, Wei-Yuan Chen, Kai-Jun Wang, Ming-JyhChang, Sheng-Yu Lin, Wen-Tung Hsu, Ta-Hsin Chou
Industrial Technology Research Institute, Taiwan

This paper focuses on the integrated development of gravure offset printing process to print a fine-line metal mesh structure with the properties of low sheet resistance and high optical transmission. Two key components of reducing copper ink and laser-ablation gravure plate are integrated and used in the process to enhance the printing quality and yield. The results show that the printed OLS metal mesh touch sensor owing the properties of linewidth ~7.1 um sheet resistance 6.7 Ω / □, transmission 89% and multi-touch function.

14:45

R25 A study on the stabilization of pattern width in the gravure off-set printing

Ga Eul Kim[1,2], Yong Ho Jeon[2], Shin Kwon[1], Moon Gu Lee*[2]
KIMM, Korea, South
Ajou University, Korea, South

Recently, the gravure off-set printing has emerged as a method of the mass production of the printed electronic devices with low-cost. The gravure off-set printing consists of two processes such as off and set processes. Firstly, in the off process, the printing ink is transferred from engraved pattern to the blanket roller. Secondly, in the set processes, the transferred ink in the blanket roller is transferred to the target substrate. Printing quality is affected by the swelling occurred by the blanket roller because of the solvent absorption in the blanket roller. The swelling causes a failure of the printed pattern. To prevent the failure of the printed pattern, the swelling control facility was fabricated by using drying process.

15:00

R26 Controllable polymer transfer by bio-inspired anisotropic fibers: toward direct writing nano-thin micro-patterns

Huan Liu*, Qianbin Wang, Lei JiangHuan Liu*, Qianbin Wang, Lei Jiang
Beihang University, China

Dynamic wetting in fibrous systems offers versatile solution for not only living strategies of biological organisms but practical applications. In these systems, liquid transfer along or within fibers are the essential process both in micro- and macro-scope, but hard to proceed in a controllable manner. Here, we demonstrate that the Chinese brush, an important tool for the traditional Chinese calligraphy and painting, enables manipulating low viscosity ink liquid in a well-controlled manner: large mass ink loading, and the steady, uniform and continuous ink transfer onto the substrate. We show that the array of the freshly emergent hairs with unique anisotropic multi-scale structures, featured by the tapered architecture with conical tip enveloped by oriented micro-meter scaled squamae, is responsible for the liquid manipulation of Chinese brush. Inspired by controllable liquid transfer of Chinese brush, we developed model devices with double- and multi- parallel hairs that allows for direct writing microlines with 10 μm resolution and nanometer-thick, millimeter-wide thin films, respectively, with well defined profile and uniform distribution on diverse substrates. We envision that the smart liquid transfer of Chinese brush will shed light on the novel template-free fabricating of organic functional materials based devices.

Wednesday, October 21, 15:45 – 17:45
Room 504b (5F)

Joint Session: IoT [All Invited Talks]

Session Chair: Albert Lan

15:45
JS1: The Impact of IoT on Packaging and Assembly: Challenges and Opportunities
E. Jan Vardaman
President, TechSearch

16:15
JS2: SiP Solutions for Wearable Devices and IoT (Internet of Things)
JiaYang Chen
SPIL Deputy Director, Engineer Center

16:45
JS3: Wearable Electronics & Big Data Drive a New Paradigm; High Volume/High Mix Manufacturing
Charles E. Bauer
Senior Managing Director TechLead Corp.

17:15
JS4: Enabling new ways of manufacturing – Intel IoT Vision, Practices and Challenges ahead
Richard Chuang
Intel

Wednesday, October 21, 15:30 – 17:00
Room 501 (5F)

Session R3: OLED Applications and Lighting

Session Chair: Takashi Minakata, CERBA, Japan

15:30 Invited Talk

R31 Highly Efficient Exciplex-based OLEDs

Ken-Tsung Wong
Professor,
National Taiwan University, Taiwan

Abstract

The excited states with small ΔE_{ST} suitable for thermally activated delayed fluorescence (TADF) can be achieved by the formation of exciplex via intermolecular charge transfer between physically blended electronic donor and acceptor molecules. The physical properties of exciplex can be manipulated by the judicious combination of hole-transporting (HT) and electron-transporting (ET) materials. In this conference, our efforts of developing new HT and/or ET materials for generating efficient exciplexe OLEDs will be reported. In addition, the applications of exciplex as host material for highly efficient OLEDs and a new strategy for giving high efficiency (> 10%) pure fluorescence white OLED will also be presented.

16:00

R32 Enabling high-efficiency organic light-emitting diodes with a cross-linkable electron confining hole transporting material

Yu-Ting Su[1], Tsung-Han Li[1], Jwo-Huei Jou[1]*
[1]National Tsing Hua University, Taiwan

Wet-process enables flexible, large area-size organic devices to be fabricated cost-effectively via roll-to-roll manufacturing. However, wet-processed devices often show comparatively poor performance due to the lack of solution-process feasible functional materials that exhibit robust mechanical properties. We demonstrate here a cross-linkable material, 3,6-bis(4-vinylphenyl)-9-ethylcarbazole (VPEC), to facilitate the injection of hole and meanwhile effectively confine electron to realize. Most importantly, the VPEC not only works for devices containing low band-gap red or green emitte, but also for the counterpart with high band-gap blue emitter.

16:15

R33 Synthesis and Application of Organic Materials Based on Excited-state Intramolecular Proton Transfer (ESIPT)

Prof. Sanghyuk Park
Kongju National University, Korea, South

Synthesis and properties of novel excited-state intramolecular proton transfer (ESIPT) materials, recently developed in our group, are described. Highly efficient ESIPT reaction, achieved in polyquinolines, polybenzoxazoles, and oxadiazole and imidazole derivatives possessing an intramolecular tautomerizable hydrogen bond, has been investigated theoretically and experimentally. It is demonstrated that unique properties arising from the ESIPT process (large Stokes'-shift, no self-absorption, and easy population inversion, etc.) make it possible to produce advanced polymer devices for lasing, optical storage, and electroluminescence.

16:30

R34 Optical Properties of Two-Dimensional ZnO Array Generated by Template

Xiu Li, Yanfang Xu, Meijuan Cao, Luhai Li
Beijing Institute of Graphic Communication, China

In this study, a single layer and a large area polystyrene microspheres mask, with 300, 600, 800and 1100nm in diameter have been prepared, and then the radio-frequency (RF) magnetron sputtering technique is adopted to deposit ZnO thin films on the templates. The optical properties of ZnO films on polystyrene microspheres template has been investigated.

16:45

R35 Blue-hazard free candle light-style OLED with fluorescent tube efficacy

Meenu Singh, Sudhir Kumar, Jwo-Huei Jou
National Tsing Hua University , Taiwan

Numerous studies report blue light possess a potential hazard to the retina of human eyes, secretion of melatonin and artworks. We demonstrate here a blue-hazard free illumination source on the basis of organic light emitting diode. With the use of multiple complementary phosphorescent green, orange-red, yellow, and sky-blue emitters, the sensationally warm candle light-style emission is proven to be also drivable by electricity. The candlelight-style OLED can serve as a good measure for general lighting. It should also be suitable as the lighting for museums and galleries, by noting many ancient artworks to have actually been done under the light of oil lamps or candles. To be energy-saving, highly efficient candlelight emission is demanded. The device shows, at 1,000 cd m−2 for example, an efficacy of 75.8 lm W−1 , an external quantum efficiency of 26.4%, with a 77 spectrum resemblance index and 2,284 K color temperature. The high efficiency may be resulted because of four crucial factor, namely selection of high quantum yield phosphorescent emitters, host molecules facilitating an effective host-to-guest energy transfer, high mobility electron transporting material to enable effective carrier injection balance, and employment of charge carrier generation layer.

Wednesday, October 21, 15:30 – 17:00
Room 502 (5F)

Session R4: Conductive Inks and Pastes

Session Chair: Hoo-Jeong Lee, Sungkyunkwan University, Korea

15:30 Invited Talk

R41 Rapid sintering of nano metal ink for printed electronics application using a laser in air Environment

Kyung-Tae KANG
Director, Center for Advanced Printed Electronics
Korea Institute of Industrial Technology, Korea, South

Abstract

Nano silver and copper particles have been used in form of a colloidal ink for printed or flexible electronics applications. In order to achieve flexible electronics, low temperature processable polymers are preferred as a printing substrate. However, the printed metal particles should be sintered usually by heat to have a high electrical conductivity which can be affected by grain size, porosity, oxidation and removal of nanoparticle capping materials. In this presentation, laser sintering will be explained as a feasible nano metal particle sintering technique for flexible or printed electronic. Effects of grain size and porosity of nano silver ink also will be described. For nano copper ink, effect of oxidation will be discussed.

16:00

R42 Fast near-infrared sintering of nano-silver conducting ink for printed electronics

Weibing Gu, Zheng Cui
Suzhou Institute of Nano-Tech and Nano-Bionics, CAS, China

Near infrared sintering technology is one of alternative sintering approaches for conductive ink, which can reduce the processing time to a few seconds, while achieving similar or better conductivity values compared to conventional thermal sintering. In this paper, nano-silver ink was used and then heat treated by hot-air oven and near infrared equipment (Heraeus Noblelight). In comparison to thermal annealing by hot-air oven, NIR sintering results in higher conductivity which resistivity is as low as 2.78 uΩ·cm only for 8 seconds irradiation.
The resistivity is only 1.6 times than that of bulk silver. SEM micrographsshow that the particles are full sintered by NIR and formation signal crystal. We also fabricated a function circuit on PET substrate by screen printing, and then sintered with NIR. The results show that the circuit conductivity is good and the substrate is not damaged.

16:15

R43 Low-Temperature Progressive Sintering for Inkjet-Printed Copper Nanoparticles

Hui-Ju Chan, Bo-Cin Huang, Cheng-Yao Lo
National Tsing Hua University, Taiwan

Progressive sintering combining near infrared (NIR) and inteive pulse light (IPL) was proposed with optimized process parameters to satisfy low-temperature and efficiency requirement for inkjet-printed copper (Cu) nanoparticle in this work. Unlike other IPL proposals, this progressive sintering reduced the resistivity of Cu mainly during NIR itead of IPL, leaving the sintered metal film intact without cracks and delaminations from the substrate. A 24% bulk conductivity was achieved with this proposal.

16:30

R44 Inkjet Printed Graphene/Au-PEDOT:PSS Layers for Electrochemical Sensing

Chakrit Sriprachuabwong, Anurat Wisitsoraat, Decha Dechtrirat and Adisorn Tuantranont
National Electronics and Computer Technology Center, Thailand

A novel graphene/gold-poly(3,4-ethylenedioxythiophene): poly(styrene-sulfonate)(GP/Au-PEDOT:PSS) nanocomposite was synthesized by electrolytic exfoliation and in-situ polymerization methods. The GP/Au-PEDOT:PSS composite was then modified on screen printed carbon electrodes (SPCE) by inkjet printing technique. The formation of GP/Au-PEDOT:PSS nanocomposite was confirmed by Raman spectroscopy and X-ray diffraction (XRD). Cyclic voltammetric response of GP/Au-PEDOT:PSS modified electrode towards ferri/ferro cyanide ($Fe(CN)6^{3-/4-}$) showed relatively sharp and high redox peaks with low background current at low redox potential compared with Au-PEDOT: PSS modified and unmodified electrodes, indicating that GP increases the number of electro-active sites and electrochemical activity for Au-PEDOT:PSS composite. Therefore, the inkjet-printed GP/Au-PEDOT:PSS electrode is a promising candidate for advanced electrochemical sensing applications.

16:45

R45 Thermal conductive materials containing copper nanowires

Da young Choi, *Sang-Ho Kim
Kongju National University, Korea, South

The heat generated by an intensive arrangement in such a compact devices becomes the main reasons of life time and device performance issues. Thermal conductive adhesive (TCA) is important thermal interfacing materials used between the heating element and heat proof plate. It generally consists of polymer resin, hardener and metal particles such as Au, Ag, Cu, Ni and Al. In order to improve thermal conducting properties of TCA, we have applied copper nanowires. Bisphenol-A-diglycidyl ether (DGEBA), triethylene tetraamine(TETA) and copper nanowires was used as polymer, hardener and metal, respectively.Thermal conductivity of TCA containg Cu nano materials was studied of as a function of Cu nano wire length and the concentration.

Thursday, October 22, 10:30 – 12:15
Room 501 (5F)

Session R5: Sensors

Session Chair: Yu-Tai Tao, Academia Sinica, Taiwan

10:30 Invited Talk

R51 Flexible and Printed Organic TFT Devices and Integrated Circuits for Biosensor Applications
Shizuo Tokito
Distinguished Professor
Yamagata University, Japan

Abstract
Printable materials and fully printed organic TFT devices have been developed and applied to integrated circuits for use in biosensors. Printed CMOS inverter circuits were produced that demonstrated good response characteristics with a high gain at 10V operation. Three-stage ring oscillator and D-flip flop circuits based on CMOS inverters were also successfully fabricated. In addition, ultra-thin printed OTFT devices fabricated on parylene-C film substrates exhibited excellent bendability and compressibility and were employed in biosensor applications.

11:00

R52 Printed Graphene Electrochemical sensor
Adisorn Tuantranont
Thailand Organic and Printed Electronics Innovation Center, Thailand

Our recent research on printed graphene sensor, which covers synthesis, fabrication, characterization and applications of graphene based electrochemical sensors are presented. Graphene is synthesized by electrolytic exfoliation method and used to produce graphene-PEDOT:PSS conductive ink that has been applied for various electrochemical sensing applications. Graphene-PEDOT:PSS modified SPCE is demonstrated highly sensitivity and selectivity for detections of glucose, salbutamol and glutathione. Furthermore, graphene prepared by electrolytic exfoliation is combined with copper phthalocyanine-polyaniline and employed to modified SPCE for selective electrochemical sensing of ascorbic acid.

11:15

R53 Highly Stretchable Silver Fluoropolymer Composite Directly Printed on Textile
Hanbit Jin, N. Matsuhisa, T. Yokota, K. Takashima, M. Nakajima, I. Amimori, T Someya
University of tokyo, Japan

Recently, there has been strong interest in stretchable electronics to meet the technological demands of modern society such as wearable electronics. Here, we describe printing method of stretchable conductor which is needed for wearable sensor network. We produced highly stretchable conductor composed of silver particles and fluoroelastomer and it was directly printed on textile by stencil printing. Stretchable conductor printed on textile can be stretched over 200%, maintaining resistance less than 2 Ω/cm. And this method enabled ECG measurement from ordinary sport wear. We expect our highly stretchable and printable ink can provide new design opportunities for wearable health care system.

11:30

R54 Detection of Mercury (II) Ion in Water using an Extended-gate Type Organic Field Effect Transistor Functionalized with a Dipicolylamine Derivative

Tsuyoshi Minami, Yui Sasaki, Tsukuru Minamiki, and Shizuo Tokito
Yamagata University, Japan

The electrical detection of mercury (II) ion (Hg2+) in aqueous media was achieved by an organic field effect transistors (OFET). The fabricated OFET possesses an extended-gate electrode functionalized by an artificial receptor (i.e. dipicolylamine), which shows a selective response to Hg2+ even in the presence of large excess amounts of interferent Na+. OFETs could be fabricated on low-cost plastic film substrates using printing technologies, meaning that OFETs can potentially be applied to practical heavy metal ion sensor devices in the near future.

11:45

R55 Elastomeric thin pressure sensor using silver nanowires embedded PDMS with a simple double layer structure

Hakyung Jeong, Sungsik Park, Janghoon Park, Youngwook Noh, Dongjin Lee
Konkuk University, Korea, South

Pressure sensor is more important component in optoelectronic and electronic device. It is applied to wearable device for human being, flexibility and light-weight are required. In this paper, fabricated thin flexible pressure sensor using silver nanowire for sensing the changes the current by increasing the force. The advantage of this process is a cheap and simple because of double layers. Pressure sensor made by interdigitated pattern silver ink and silver nanowires on the PDMS. As a result, the pressure sensor is linearly increased the current along applied force. Furthermore the restoration of sensor is good through the point-type of graph in the 1 Hz frequency. Thus, it can made pressure sensor that high sensitivity and restoration by simple and cheap process.

12:00

R56 Inkjet-printed Graphene-PEDOT/PSS Antenna for RFID Application

Assawapong Sappat[1], Chakrit Sriprachuabwong[1], Tanom Lomas[1], Apisak Worapishet[2] and Adisorn Tuantranont[1]
[1]Thailand Organic and Printed Electronics Innovation Center
National Electronics and Computer Technology Center, National Science and Technology Development Agency, Thailand
[2]Mahanakon University of Technology, Thailand

In this work, transparent UHF antenna based on inkjet-printed graphene-PEDOT/PSS is designed and simulated for radio frequency identification (RFID) application. The antenna structure was patterned by inkjet printing of graphene-PEDOT/PSS conductive ink synthesized by a simple one-step electrolytic exfoliation process. The graphene-PEDOT/PSS antenna was designed based on an RFID λ/2 structure to operate at a resonant frequency of 860 MHz. The polyethylene terephthalate (PET) was chosen as a substrate. The design was simulated with finite-element software, namely Advanced Design System. The results show that the inkjet-printed graphene-PEDOT/PSS antenna can effectively be received and transmitted a radio frequency. The tag read range is 73 cm from RFID reader.

Thursday, October 22, 10:30 – 12:30
Room 502 (5F)

Session R6: Thin Film Transistor Circuits (TFTI)

Session Chair: Kazuhiro Kudo, Chiba University, Japan

10:30 Invited Talk

R61 Flexible Electronic Paper for Rail-type Electronic Shelf Driven by Fully Printed Organic TFT

Manabu Ito
Manager,
Toppan Printing, Japan

Abstract

Flexible organic TFT arrays are fabricated by fully printed method for electronic paper. Taking advantage of flexible feature, electronic paper with extra-wide aspect ratio of 1:60, whose size is 15 mm by 900 mm is demonstrated. This novel electronic paper can be applied to rail-type ESL (Electronic Shelf Label). Moreover, our rail-type ESL is bended with the curvature radius of 50 mm in order to improve the visibility of users. Flexibility expands the degree of design, which is the great advantage compared to conventional rigid display.

11:00

R62 Development of Printed Transistors and Logic Gates on PET substrate

Ta-Ya Chu, Heping Ding, Neil Graddage, Christophe Py, Afshin Dadvand, Hiroshi Fukutani, Stephen Lang, Ye Tao
National Research Council Canada, Canada

We will present a compreheive study of inkjet-printed organic semiconductors, dielectrics, and silver electrodes for use in organic thin-film transistor (TFT) fabrication. Functional inverters, logic gates and ring oscillators have been fabricated on PET substrate using 3-layer-printed OTFTs. A voltage gain up to 15 V/V has been achieved on the printed inverter at a bias voltage of 15V. Four different logic gates (NOR, NAND, OR and AND) have been fabricated. Relatively small variations in mobility and current were obtained from a large quantity of printed transistors. The printing and measurements were carried out under ambient conditions without any encapsulation or inert atmosphere protection, which fully demonstrates the stability of our printed electronic devices.

11:15

R63 A Printed Small Antenna on High Dielectric Nanopaper Composite for Flexible and Wearable Electronics

Tetsuji Inui[1], Hirotaka Koga[2], Masaya Nogi[2] and Katsuaki Suganuma[2]
[1]Graduate School of Engineering, Osaka University, Japan
[2]The Institute of Scientific and Industrial Research, Japan

Antennas are essential components for the transmission and reception of radio waves as information signals. In the recent trend of wearable electronics, antennas need to be small and flexible. In this study, high-k and flexible paper composites with the k value up to 730 at 1.1 GHz were successfully prepared by mixing a small amount of conductive silver nanowires with insulating cellulose nanofibers, allowing the miniaturization of the antennas by about a half as compared with the conventional paper and plastic substrates. This miniaturized flexible paper antenna is expected as a wireless communication device for future wearable electronics.

11:30

R64 Customization Technology and Tools for Building Printed Circuits

Jordi Carrabina, Mohammad, Mashayekhi, Manuel Llamas, Simon Ogier, Tim Pease, Mäntysalo Matti, Laurila Mika-Matti, Lluís Terés
Universitat Autònoma de Barcelona, Spain

The implementation of printed circuits is currently under extensive investigation. Organic Thin Film Transistor (OTFT) design and fabrication improvements with promising electrical behavior useful for building logic gates have been presented [1-12]. Further investigations have led to design and fabrication of stable semi-custom application specific printed electronic circuits such as pre-defined standard cell components and libraries [13] and gate arrays [14]. In order to increase the overall performance, stability and scalability of printed electronic circuits and systems, physical layout design of the components and interconnections as well as material and printing technologies must be improved and optimized

11:45

R65 Fabrication of Hybrid Organic-Inorganic Complementary Inverter at Low Temperature

Heajeong.Cheong, Kazunori Kuribara, Shintaro Ogura, Manabu Yoshida, Hirobumi Ushijima, Nobuko Fukuda, Sei Uemura
AIST, Japan

We fabricated organic-inorganic complementary inverters composed of dinaphtho [2,3-b:2',3'-f], thieno [3,2-b] thiophene (DNTT) and indium-gallium-zinc-oxide (IGZO) as p- and n- semiconducto, respectively. An IGZO film was fabricated using solution process at 200°C for 5 min. The DNTT was deposited using thermal evaporation. We observed hybrid complementary inverters that at a supply voltage of 30 V show a high gain of 58V/V. These results revealed that the IGZO prepared by solution process at a low temperature can be as an n-type channel of an inverter circuit.

12:00

R66 Influences by Repeated Uniaxial Mechanical Strain on Flexible Polycrystalline Thin Film Transistors

Bo-Wei Chen[a], Ting-Chang Chang[b,c], Yu-Ju Hung[a], Shin-Ping Huang[a],Tien-Yu Hsieh[b], Ming-Yen Tsai[a], Po-Yung Liao[b], Tai-Jui Wang[d], Wu-Wei Tsai[d], Tsu-Chiang Chang[d], Bo-Yuan Su[d]
[a]Department of Photonics, National Sun Yat-Sen University,Taiwan
[b]Department of Physics, National Sun Yat-Sen University, Taiwan
[c]Advanced Optoelectronics Technology Center, National Cheng Kung University, Taiwan
[d]Industrial Technology Research Institute, Taiwan

This letter investigates the effect of repeated bending of flexible p-channel low-temperature polycrystalline-silicon thin-film transistors (LTPS TFTs) employing an ultra-low-temperature process (<673 K). Experimental results reveal that interface state density (Nit) and grain boundary trap deity (Ntrap) after 10,000 width-axis tensile strain bending iterations are more pronounced than after equivalent width-axis compressive strain bending. Extracted interface and grain boundary traps both increase, which elevates trap assisted leakage. Furthermore, the bending distorts the Si–Si bonds in the poly-silicon film, which causes more significant NBTI degradation because strain-induced weak Si–Si bonds can react with dissociated H during NBTI stress.

12:15

R67 Impact of Uniaxial Mechanical Strain on Flexible a-IGZO Thin Film Transistors

Bo-Wei Chen[a], Ting-Chang Chang[b,c], Yu-Ju Hung[a], Shin-Ping Huang[a],Tien-Yu Hsieh[b], Ming-Yen Tsai[a], Po-Yung Liao[b], Tai-Jui Wang[d], Wu-Wei Tsai[d], Tsu-Chiang Chang[d], Bo-Yuan Su[d]
[a]Department of Photonics, National Sun Yat-Sen University, Taiwan
[b]Department of Physics, National Sun Yat-Sen University, Taiwan
[c]Advanced Optoelectronics Technology Center, National Cheng Kung University, Taiwan
[d]Industrial Technology Research Institute, Taiwan

This letter investigates the impacts of mechanical strain on flexible back-channel-etched amorphous In-Ga-Zn-O (a-IGZO) thin film transistors fabricated on a polyimide substrate. The flexible thin film transistors were exposed to mechanical tension or compression stress with bending radius of 30mm. Device parameters such as threshold voltage, carrier mobility and sub-threshold swing were extracted from drain current-gate voltage characteristics. Also, the strain-induced trap state generation and distribution of density-of-state within the energy gap were investigated utilizing capacitance-voltage measurements. By investigating the transfer as well as output characteristics of devices, variations in threshold voltage were discovered, while none were found for carrier mobility or trap states. Such phenomena indicate that the molecular bonding structures are altered after mechanical strain. Furthermore, strains are applied along both the device channel width and length directions to clarify the strain effect on electrical instability.

Thursday, October 22, 13:30 – 15:30
Room 501 (5F)

Specail Session: oe-a [All Invited Talks]

Session Chair: Dr. Klaus Hecker, OE-A

13:30

SS1 Polymer Touch Panels for Flexible Displays
Stephan Kirchmeyer
Head of Marketing, Business Line Display & Semiconductor
Heraeus Deutschland GmbH & Co. KG, Germany

Abstract

Common touch sensors use films sputtered with indium tin oxide. The recent progress in PEDOT polymers and the new etch technology enables flexible and 3D shaped all polymer touch sensors. In a joint project with ITRI 6” flexible PEDOT touch panels on a thin PI film were fabricated combining the invisible patterning process with ITRI’s FlexUp™ technology.

14:00

SS2 Photonic Curing for Thinner Displays
Stan Farnsworth
Vice President Marketing,
NovaCentrix Corporation

Abstract

Photonic curing has been established as effective for processing high-temperature inks on low-temperature substrates. In this presentation, photonic curing will be shown to facilitate thinner display structures. Additionally, the significance of simulation modelling will be shown for optimizing substrate thickness.

14:30

SS3 Stretchable/flexible device

Sei Uemura
Researcher/Dr.
National Institute of Advanced Industrial Science and Technology/Flexible Electronics Research Center, Japan

Abstract

We developed the stretchable wiring made from conductive fibers and applied it to a stretchable pressure sensor. An elastic pressure sensor sheet, which is sensitive to pressure in the vertical direction and insensitive to elongation in the horizontal direction was also successfully developed by using the stretchable wiring and elastomer films. As an application example, the sensor sheet was demonstrated as a shoe insole pressure sensing system and the sensor system could detect a pressure distribution from soles to adapt to its deformation.

15:00

SS4 Roll-to-roll hybrid manufacturing offer high potential for wearable and health

Antti Kemppainen
Key Account Manager
VTT Technical Research Centre of Finland

Abstract

Roll to roll manufacturing can be used to print circuits and components in high throughput repeatable manner. Combining that with roll to roll pick and place assembly process cost efficient highly automatized manufacturing process for hybrid flexible electronics can be developed. Especially, by use bare silicon die components high flexibility and very low thickness is achieved in in hybrid electronics. This enables rewinding after assembly and therefore further processing in roll format. Post processing typically for skin attachable patches or diagnostics is lamination, for plastic integrated elastomer integration over-molding. Hybrid electronics is most competitive benefits in cases where thin flexible for factor is necessity, but component integration density cannot be increased due to form limitations. This is very typical in wearable and health sensor systems that need to be flexible enough for convenient skin contact or flexible, light weight and robust enough to be integrated to cloths or accessories.

Thursday, October 22, 13:30 – 15:30
Room 502 (5F)

Session R7: Thin Film Transistor Circuits (TFT II)

Session Chair: Kyung-Tae KANG, Korea Institute of Industrial Technology, Korea, South

13:30 Invited Talk

R71 Printed thin-film transistors using inorganic electronic inks

Zheng Cui
Professor
Suzhou Institute of Nanotech, Chinese Academy of Sciences, China

Abstract

Semiconductor inks based on single-walled carbon nanotubes and IGZO oxide materials have been developed. Thin-film transistors were fabricated by printing the two inorganic inks as the channel materials. The printed TFTs have demonstrated high mobility and low process temperatures. Inverters and ring oscillators have been made using the TFTs, as well as simple circuits for driving OLED.

14:00 Invited Talk

R72 POLYMER SEMICONDUCTOR MATERIALS: STRUCTURE, SOLVENTS AND SUBSTRATES

Mingqian He
Sr. Research Associate
Corning, USA

Abstract

We have developed a series of tetrathienoacene-DDP based polymers for organic field effective transistor (OTFT) applications. Here we would like to report some of the fundamental study results which include material structures, solvent effects and substrates. A variety of solvent combinations can show very different electronic properties. By adjusting the side-chain design, different levels of processability can be achieved. The entire OTFT fabrication process can be done under 200°C. This allows transistors to be fabricated and function on Gorilla glass (strengthened ion containing glass).

14:30

R73 Stacked Complementary Logic Circuits with Low-Voltage Operation using Printed Organic Thin-Film Transistors

Yasunori Takeda, Kazuaki Kakita, Hidetaka Shima, Yasuhiro Yoneda, Yasuhiro Tanaka, Masashi Mamada, Kenjiro Fukuda, Daisuke Kumaki, Shizuo Tokito
Yamagata University, Japan

In this study, we fabricated complementary logic inverter circuits with a stacked structure using printed electrode and semiconductor layers. We have succeeded in modifying and optimizing the electrode surface conditions for both the p-type and n-type, respectively. Furthermore, by using and in n-type device with a top-gate, bottom-contact structure, we were able to achieve excellent electrical properties. As a result, we have demonstrated OTFT integrated circuits such as ring oscillators and flip-flop circuits that can be driven at low voltages.

14:45

R74 Flexible CMOS Circuits Based on Printed P-type and N-type Carbon Nanotube Thin-Film Transistors

Xiang Zhang[1,2], Wenya Xu[1], Weiwei Xu[1], Jianwen Zhao[1]*, Zheng Cui[1]
[1]Printable Electronics Research Centre, Suzhou Institute of Nanotech and nano-bionics, Chinese Academy of Sciences, PR China
[2]School of Materials Science and Engineering, Shanghai University, Shanghai, PR China

In this paper, we presented a new and effective method to print flexible CMOS logic circuits, as well as using low temperature ALD technique to tune the charge carrier types. Two different sc-SWCNT inks (i.e., PFOBT and DPP sorted sc-SWCNT inks) were selectively deposited in the device channels by drop casting or aerosol jet printing, and then 50 nm thickness of HfO_2 thin film were deposited on top of SWCNT thin films by ALD technique at 120°C. After that, top-gate electrodes and interconnects were printed by aerosol jet printing. Printed top-gate SWCNT TFTs showed p-type and n-type on PET substrates when using PFOBT and DPP sorted sc-SWCNTs as channel materials, respectively. Both of them show excellent electrical properties with on/off ratio of ~10^5 and mobility of ~15 $cm^2V^{-1}s^{-1}$. CMOS inverter consisting of one p-type TFT and one n-type TFT exhibited a maximum voltage gain of 9, 12, 15, 22 and 23 at V_{dd} of 0.5, 0.75, 1, 1.25 and 1.5 V, respectively. A 3-stage ring oscillator has been fabricated and achieved oscillation frequency of 0.9 kHz at V_{dd} of 2V.

15:00

R75 High performance low temperature printed IGZO thin film transistors and circuit application

Zheng Chen*, Meilan Xie, Teng Zhou, Zheng Cui
Suzhou Institute of Nano-Tech and Nano-Bionics (SINANO), Chinese Academy of Sciences, China

High performance printed indium gallium zinc oxide thin film transistors (IGZO-TFTs) are prepared at annealing temperature as low as 300°C, with different dielectrics and electrodes. The devices exhibit mobility in the range of 1-5cm^2/Vs and high on-to-off ratio of more than 106. Furthermore, the printed IGZO-TFTs were used to construct inverters, showing typical inverter characteristics.

15:15

R76 Fine Patterning of Inkjet-Printed Silver Nanoparticle Ink and its Application to Organic Thin-Film Transistors

Daisuke Kumaki, Yoshimasa Goto, Atsushi Harada, Emi Shiga, Kenjiro Fukuda, Shizuo Tokito
Yamagata University, Japan

We have demonstrated the fine patterning of silver electrodes in organic TFT (OTFT) devices using a newly developed silver (Ag) nanoparticle ink and inkjet printing equipment. The silver nanoparticle ink was optimized for high-resolution patterning using inkjetprinting. A very stable discharge with no nozzle clogging was observed by using the developed ink. The patterned silver nanoparticle traces on a Cytop® layer showed line widths of 20 μm and a low resistivities of 7 μΩcm at a sintering temperature of 120°C. By using this Ag nanoparticle ink, we successfully fabricated an organic transistor with a very short channel length of 10 μm, achieving a field-effect mobility of 0.6 cm^2/Vs.

Thursday, October 22, 15:45 – 17:30
Room 501 (5F)

Session R8: Flexible Printed Circuit (FPC)

Session Chair: C.T. Lee, National Cheng Kung University, Taiwan

15:45 Invited Talk

R81 Flexible transparent conductive films

Sang-Ho Kim
Professor
Kongju National University, Korea

Abstract

To fabricate Ag nanowire-based TCF, the nanowires are wet-coated onto a transparent polymer films and dried below 150°C. Since the drying temperature is not high enough to make chemical bonding between nanowires, they usually stayed as weak physical bonding and fixed by surrounding binder polymers. The weak wire-wire junctions sometime become loose upon the very serious bending of TCF films. (e.g. bending radius <0.3 mm) Therefore, the wire-wire junction needs to be stabilized upon such serious bending to make truly flexible electronic devices. In this report, I'd like to mention few issues to stabilize the wire-wire junctions by flash white light combined with deep UV irradiation.

16:15 Invited Talk

R82 Photonic solution for roll to roll production of printed copper on plastics used in manufacture of high density Interconnect (HDI) Circuits

Saad Ahmed
Director of Engineering
Xenon Corporation, USA

Abstract

Use of high intensity pulsed light for sintering conductive metal inks has significant benefits for Roll to Roll processing of Flexible Printed Circuits. One application of this technology is in the manufacture of high density interconnects requiring thin copper laminates on PI, where the scope exists for replacing the vacuum deposition phase for the formation of copper layers only a few microns thick A full end to end process has been demonstrated with a Xenon Pulsed Multi Lamp System for Roll to Roll production and proves to be a not only a cost effective solution but also an enabling technology.

16:45

R83 Novel Laser Induced Metallization for Three Dimensional Circuit by Spray Method

Min-Chieh Chou, Tune-Hune Kao, Meng-Chi Huang, Wen-Hua Zhang, Wei-Yu Li, Tzi-Huei Lai
Industrial Technology Research Institute, Taiwan

A novel laser induced metallization (LIM) is developed for 3 dimensional circuit. A special laser-activatable solution is firstly sprayed on top of the substrate, followed by laser structuring and the electroless plating. The metal patterns can be transferred from the CAD data on almost any complex surface. LIM has small linewidth (30 μm) and much more flexibility on the substrate choosing. For example, the substrate can be plastic, glass, or ceramic. In addition, the laser-activatable solution on top of the substrate also plays a role of the insulator. As a result, the multilayer patterns can be made by simply repeating the spray method on the same surface. Moreover, since this method is capable of making patterns layer-by-layer, the capacitors and inductances can be direct integrated with the circuit design. In this report, a 2G/3G/4G (all-in-one) antenna is tested by using our spray method. The return loss reaches the 3:1 VSWR standard, and the radiation efficiency is larger than 60% within the operation frequency.

17:00

R84 Fabrication of Flexible Printed Circuit by Gravure Offset Printing Technique

Cheng-Yi Shih[1], Sheng-Feng Chung[1], Ching-Chih Wei[1], Shu-Yi Chang[1], Shih-Ming Lin[1], Cheng-Ta Ko[1], Shu-Man Li[1], Shinn-Juh Lai[1], Jui-Feng Hung[1], Ohra Sakata[2], Keiichi Abe[2], Su-Tsai Lu[1]
[1]Electronics and Optoelectronics Research Laboratories, Industrial Technology Research Institute, ITRI, Taiwan, R.O.C.
[2]Komori Machinery Co., Ltd., Japan

Flexible printed circuit boards are the popular electronic devices due to their flexibility, downsizing ability and movable properties. Conventional printed circuit using photoresist and lithography method that requires a five-step operation to pattern a metal trace. However, it belongs to a complicated process and it does not meet the requirement of high pattern density and rapid cycle time. An alternative for FPC manufacturing process is developed using a combination of gravure offset printing and electroless plating, results in a simplified metal patterning process with a line width 18 μm.

17:15

R85 Roll-to-roll printing and photonic sintering of nano silver and nano copper conductive inks for fabrication of flexible circuits

Xingye Zhang, Haiyan Wang, Shuo Wang, Yanlin Song
Institute of Chemistry, Chinese Academy of Sciences, China

Printed electronics is an emerging area of research that promises large markets due to the ability to fabricate a variety of devices on flexible substrates using high-throughput printing approaches. In our group, nano silvecopper powder and conductive ink/paste were produced in large scale, flexible circuits were manufactured through roll-to-roll digital inkjet or screen printing approach. In detail, roll-to-roll printing of RFID antenna on Teslin film and roll-to-roll photonic sintering of the printed traces were our focused research this year, the results shows the potential of this technology in the the application of flexible circuits especially in RFID antenna and various cell phone antenna.

Thursday, October 22, 15:45 – 17:45
Room 504b (5F)

Joint Session: Wearable Electronics [All Invited Talks]

Session Chair: Shizuo Tokito, Yamagata University, Japan

15:45

JS1 Thin-film electronics for smart applications

Tung-Huei Ke
Senior researcher
Imec, Belgium

Abstract

Future smart living will be connected. Perceptive systems will interface people with their environment in an intuitive and natural way, with invisible boundaries between electronics and objects (at work, at home, in transport, etc.). As connectivity becomes ubiquitous in our lives, electronic intelligence will penetrate an increasing number of everyday objects. The Internet of Things will start evolving into the Internet of Everything. The speed and extend of this evolution will depend on the availability of functional electronic components that can be seamlessly introduced in a variety of objects at acceptable cost. To make this happen, innovation is needed at all levels, from the basic technology to integrate low-cost disposable connectivity in every-day objects, to the system and software aspects of the globally interconnected objects.

16:15

JS2 Printed Sensors and Carbon Nanomaterials -Toward the Tipping Point for Commercialization

Ryan Giedd
Director of device engineering and development
Brewer Science, USA

Abstract

Printed electronics manufacturing continues to attract much industry attention due to its appealing potential for highly scalable, low-cost, and high-volume manufacturing capabilities for high-value electronics applications. Printing of electronic components also enables the addition of features that were previously unattainable, such as integration of sensors and electronics onto 3-D surfaces, printing directly on curved and 3-D surfaces, and printing of circuitry and functional elements on flexible and stretchable substrates. Key innovations in both process and material research continue to happen, making printed electronics manufacturing ubiquitous for electronics and sensor applications.

In this paper, we present an overview of the key advances made in carbon nanomaterials research and printing technologies that are crucial in accelerating the adoption of these nanomaterials as primary functional materials in various sensor applications for serving a variety of markets from consumer electronics to biomedical devices. The materials cover a full gamut of printed carbon materials, namely, nanotubes, graphene, fullerenes, conductive polymers, optical materials, and encapsulants, to make a fully printed device.

Carbon nanomaterials have excellent conducting or semiconducting properties depending on the structure. Moreover, ambient conditions in the immediate vicinity of the nanomaterials and the physical condition of the printed mat alter the electrical properties, thereby creating excellent sensing capability for various physical and chemical factors. We have created an array of fully printed transducers for sensing temperature, humidity, strain, and volatile organic compounds with a variety of carbon nanomaterials. These fully printed devices have a flexible form factor and offer ultrafast response times on the order of milliseconds.

Several advances have also been made in creating composites using CNTs for flexible and stretchable electronics. With improvements in printing techniques and chemistries for composites, we have created stretchable conductors that elongate along multiple axes without flaking or loss of adhesion. These unique materials have the ability to pave the way for a new future for wearable electronics.

16:45

JS3 5 Don’ts from the “Connected” Peak

Hsin-Dar, Lee
General Manager
Pervasive Displays Inc., Taiwan

Abstract

Connected Devices (M2M, IOT, quantified self, connected home, etc.) are trending/peaking concepts transitioning through the peak of inflated expectations in Gartner’s 2015 Hype Cycle. What it means to hardware companies is that the “connected” market, our next big potential markets is more fantasy than reality.

Pervasive Displays is a company faced with the tall task of selling e-Paper displays to the connected world. This talk is intended to share “lesson learned” with other hardware, technology driven companies with the hope that others can benefit from our experience.

17:15

JS4 Application Opportunities for Electrophoretic Paper-like Displays.

Keisuke Hashimoto
Corporate Fellow
E Ink Holdings, Japan

Abstract

Electrophoretic paper-like display (ePaper) was commercialized in 2004 as eBook reader (eReader). The eReader market has been growing ever since. With the unique characteristics of ePaper including sun-light readability, low power, reading comfort (friendliness to eye), etc., new applications beyond eReader have been realized for mobile, office and outdoor applications. EPaper products are considered as green devices. For example, an eReader device can easily hold over 1,000 books, and each charge can last over 1 month. This talk will show latest technical and application trends of ePaper, and its future opportunity.

Thursday, October 22, 15:45 – 17:30
Room 502 (5F)

Session R9: Thin Film Transistor Circuits (TFT III)

Session Chair: Manabu Ito, Toppan Printing, Japan

15:45 Invited Talk

R91 New materials for truly flexible oxide TFT backplane and AMOLED application

Hsing-Hung Hsieh,
Director
Polyera Taiwan Corporation, Taiwan

Abstract

Flexible and wearable displays are very attracting opto-electronic devices, yet thin-film transistors (TFTs) with high good electrical characteristics and mechanical flexibility are essential to develop this new technology. We have developed the new hybrid oxide TFT technology which couple oxide TFTs with proprietary Polyera organic gate insulator (OGI). With the thermally-stable and photo-patternable Polyera OGI, our hybrid oxide TFTs show groundbreaking performance compared to the reported literatures. Finally we demonstrated a 5 inch flexible AMOLED based on oxide TFTs with Polyera OGI, showing both electrical function validity and excellent mechanical flexibility.

16:15

R92 Conversion of Printed Carbon Nanotube Thin-film Transistors from P-type to N-type for High-performance CMOS Inverters

Jianwen Zhao*, Long Qian, Wenya Xu and Zheng Cui
Printable Electronics Research Centre, Suzhou Institute of Nanotech and nano-bionics, CAS, China

Here, we report a facile and valid method to selectively produce n-type SWCNT thin-film transistors using zirconium (IV) acetylacetonate. The threshold voltages of n-type SWCNT TFTs could be tuned accurately by controlling the concentration of zirconium(IV) acetylacetonate or the printing process. SWCNT CMOS inverte were also cotructed on flexible and rigid substrates via aerosol jet printing method. The printed CMOS inverters showed high gain (up to 22), large noise margin (up to 80% 1/2 V_{dd}) and subnanowatt power consumption at the applied voltage of only 1 V. 16:30

16:30

R93 Silicon nanopillar-templated vertical field effect transistor using organic semiconductor as channel material

Chi Chih Ho[a,b,c], Ding Chi Huang[a] and Yu Tai Taoa*
[a]Institute of Chemistry, Academia Sinica, Taiwan.
[b]Nano Science and Technology Program, Taiwan. International Graduate Program, Academia Sinica, Taiwan and National Tsing Hua University, Taiwan
[c]Department of Engineering and System Science, National Tsing Hua University, Taiwan

Arrays of silicon nanopillar (SiNP) were used as scaffold to prepare a vertical organic field-effect transistor (VOFET) using benzothienobenzothiophene (BTBT) as the conducting channel. Uniform films were obtained by simple melting process, giving a typical transistor characteristic with low operating voltage.

16:45

R94 Selective Electrospray Deposition Method for Step-Edge Vertical-Channel Organic Transistor Circuits

Kazuhiro Kudo, Hiroshi Yamauchi and Masatoshi Sakai
Chiba University, Japan

We proposed a new selective electrospray deposition (SESD) method for integrated circuits. In this SESD method, the electric fields are applied between the nozzle and selected patterned electrodes, i.e., gate lines fabricated on a master substrate. The SESD method can be applied to fabricate n- and p-channel complementary field-effect transistors (FETs) because of the selectivity of the direct patterning process without the need for masking during the deposition. Step-edge vertical-channel FETs with submicron channel length based on p- and n-type semiconducto were fabricated by the SESD method and have measured basic FET characteristics.

17:00

R95 Solvent-free and Low Temperature Printing by Ultrasonic Welding Method

T. Sasaki, T. Ko, S. Yamaguchi, J. Hayashi, Y. Yamazaki, M. Sakai, H. Yamauchi, Y. Okada, Y. Sadamithu, S. Shinamura, K. Kudo
Graduate School of Engineering, Chiba University, Japan

In this study, we tried to form C8-BTBT (Dioctylbenzothienobenzothiophene, m.p. 126.5°C) active layer of organic field effect transistors (OFET) on flexible substrates by ultrasonic welding, which is widly used to weld thermoplastics parts by local frictional heat generated from ultrasonic vibration without raising temperature of whole volume. It was demonstrated that C8-BTBT thin films were fabricated between polyethylene terephthalate (PET, heat-resistant temp. ~110°C) films by ultrasonic welding without damaging PET films, contact electrodes, and gate insulating layers. We succeeded in fabricating OFET having field effect mobility of 0.14 cm^2/Vs.

17:15

R96 Control of Crystallinity of Zone-cast Semiconductors in Binary System

Yongjin Jo, Mijung Lee
Kookmin University, Korea, South

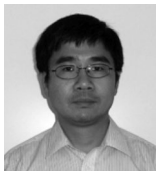
In recent extensive study of organic thin film transistorsocc (OTFTs), organic semiconducto (OSCs) have shown great potential for transparent and flexible electronic applications produced with low cost and in large area. Small molecule blends and multicomponent systems are introduced to fulfill the properties of OSCs in optoelectronic system with easy and inexpeive. Here, 6,13-bis (triisopropylsilylethynyl)pentacene (TIPS-pentacenePEN) and polystyrene are blended to form semiconducting layer by zone casting to produce aligned OSCs. We varied ratio of TIPS-pentacene PEN and polystyrene ratio and observed the improved field effect mobilities mobility compared with pure OSC layer. These results demonstrate that varied ratio effects on the crystallinity of TIPS-pentacene PEN and enhanced properties are from metastable state.

Friday, October 23, 10:30 – 12:00
Room 503 (5F)

Session R10: Flexible Displays

Session Chair: Jwo-Huei Jou, National Tsing Hua University, Taiwan

10:30 Invited Talk



R101 Printed Display Technology in Mainland China

Junyou Pan
Deputy Chief Engineer
TCL Corporate Research, China

Abstract

After decades of being technology follower in display industry, the local TV or panel makers in China are now in position to take lead in the next generation technology. Both central government and local government, like Guangdong province, put high emphasis on this technology area. In line with this, the TCL group has made an ambitious plan on printed display technology. In this paper, the project roadmap is outlined, covering the cooperation through the whole supplier chain, from material, equipment, process development and panel integration. The printable OLED and QLED are both included.

11:00

R102 Fabrication of Flexible Display on Polyimide Substrate Using Air-stable Inverted Organic Light-Emitting Diodes

Genichi Motomura, Mitsuru Nakata, Yoshiki Nakajima, Tatsuya Takei,Toshimitsu Tsuzuki, Hirohiko Fukagawa, Hiroshi Tsuji, Takahisa Shimizu, Yoshihide Fujisaki, Toshihiro Yamamoto
JAPAN BROADCASTING CORPORATION (NHK), Japan

An oxide thin-film transistor (TFT) driven flexible display on transparent polyimide substrate using air-stable inverted organic light-emitting diodes (iOLEDs) was fabricated. The indium-tin-zinc-oxide (ITZO) TFT backplane was directly fabricated on the polyimide substrate. The ITZO was also used as the electron injection layer (EIL) in the iOLEDs to obtain higher efficiency and simplify the fabrication process. The fabricated panel could be easily peeled off from the glass carrier substrate due to the SiO2 release layer. The luminance of the iOLED using ITZO as the EIL was higher than that of the conventional iOLED at the same voltage. Dark spots were barely observed in the iOLED display encapsulated with barrier film .

11:15

R103 Spatial and Directional Photometric Properties of a Curved AMOLED Display

Shau-Wei Hsu, Zong-Ying Chung
CMS, ITRI, Taiwan

This work studies spatial and directional photometric properties of a curved AMOLED display by a method based on directional imaging photometric measurements and near-field analyses. By output white, red, green and blue full images to the display, the dependences of tri-stimulus values on vertical photometric angle, photometric azimuth and surface coordinates were carried out and investigated. The major parts of the tri-stimulus values are found well fitted with exponential function of cosine of vertical photometric angle. The approximately independences on photometric azimuth and surface coordinates indicate that the sample is nearly isotropic and uniform.

11:30

R104 Optimizing Electron Injection Layer to Improve Performance of Green Quantum Dots Light-Emitting Diodes

Hoang-Tuan Vu[1], Hsin-Chieh Yu[1], Chun-Yuan Huang[2,*] and Yan-Kuin Su[1,*]
[1]Institute of Microelectronics, Department of Electrical Engineering and Advanced Optoelectronic Technology Center, Taiwan.
[2]Department of Applied Science, National Taitung University, Taiwan.

A novel efficient and air-stable electron injection layer (EIL) of cesium azide (C_sN_3) was compared with conventional ones including CsF, Cs_2CO_3, LiF and without EIL in type-II green quantum dot light-emitting diodes (QLEDs) with both organic electron and hole transport layers. Via directly decomposing to pristine cesium (Cs), the low-temperature evaporated CsN3 provided a better interfacial energy level alignment without damaging the underneath organic layer. Coequently, the current efficiencies of 7.45 cd/A was achieved in the CsN_3-QLEDs consisting of colloidal QDs at 544 nm, which was 310% (at 10 mA/cm^2) improvement over the LiF- devices. Moreover, the light turn-on voltage in CsN_3-devices significantly decreased ~ 5.5 V in comparison with LiF-devices.

11:45

R105 Flexible Reliability Certification of Color Filter on Flexible Substrate

Kuo-Chang Lee, Kai-Sheng Shih, Yi-Shou Tsai, Fiona Chao, Yu-Chun Lin,
Display Technology Center, Industrial Technology Research Institute,

To realize the flexible display application, the reliability of 6-inch 266ppi color filte (CFs) on flexible substrate was tested. Both of adhesion of CF material on flexible substrate and bending test were performed.

Friday, October 23, 10:30 – 12:15
Room 501 (5F)

Session R11: Photovoltaics and Batteries (I)

Session Chair: Ken-Tsung Wong, National Taiwan University, Taiwan

10:30 Invited Talk

R111 Silver nanowire-based transparent conductive films: improvement of electrical conduction

Hoo-Jeong Lee
Professor
Sungkyunkwan University, Korea

Abstract

This study proposes a novel method of improving the electrical conductivity of silver nanowires (NWs)-networked films for the application of transparent conductive electrodes. We applied Cs-added TiO2 (TiO2:Cs) nanoparticles onto Ag NWs, which caused the NWs to be neatly welded together through local melting at the junctions, according to our transmission and scanning electron microscopy analyses. Systematic comparison of the sheet resistance of the samples reveals that these welded NWs yielded a significant improvement in conductivity. OLED devices, fabricated by using the NW film planarized via embedding the wires into PMMA, demonstrated device performance was comparable with the reference sample with indium tin oxide electrode.

10:45

R112 Design on Demand for Large Area Polymer Solar Cells.

Mélodie Chaperon, Anthony Barbot, Florence Ardiaca, Matthieu Manceau and Solenn Berson
CEA, LITEN, Department of Solar Technologies, France

Thanks to their unique combination of attractive features, PSCs (Polymer Solar cells) have drawn a tremendous research interest over the last decade. To a very large extent, PSCs were prepared via a combination of slot-die coating and screen-printing while less attention has been paid to inkjet printing or laser patterning. Being both digital techniques, they are an elegant solution to manufacture customized devices for better integration within mobile electronic devices and Internet of Things applications. The two processes were studied to elaborate flexible PSCs and finally square or round modules were elaborated with efficiencies above 4% over the active area.

11:00

R113 The Next Great Leap Forward in Power Technology – To be powered by Organic Photovoltaics

Phoebe Tan, C.W. Ko, C.C. Hsiao
Raynergy Tek Incorporation, Taiwan

The advances in Oganic Photovoltaics (OPVs) of rising from 2.5% to 11% for the past decades has received enormous commercial interests of various market segments ranging from consumer electronics to building integrated facade to automotive. One of the key advances of OPVs to date is the development of novel photoactive materials with tailored energy levels and solubility, enabling OPVs technology to meet the industrial mass production capability. Here, we report on a high performance solution processable polymer semiconductor (PV2000) with certified power convention efficiency of 10.36% and has demonstrated exceptional processability such as robustness in various roll to roll coating process, air stability as well as outstanding lifetime performance under light soaking test.

11:15

R114 Porphyrin-Incorporated 2D D-A Polymers with over 8.5% Polymer Solar Cell Efficiency

Yi-Hsiang Chao[a], Jyun-Feng Jheng[a], Jhong-Sian Wu[a], Kuan-Yi Wu[a], Shih-Hao Peng[a], Ming-Chi Tsai[b], Chih-Li Wang[b], Yen-Ni Hsiao[b], Ching-Yao Lin[b,*] Chien-Lung Wang[a,*] and Chain-Shu Hsu[a,*]
[a]Department of Applied Chemistry, National Chiao Tung University, Taiwan,
[b]Department of Applied Chemistry, National Chi Nan University, Taiwan,

A novel D-A copolyme were developed by utilizing pyrene-modified porphyrin as complementary light-harvesting unit (LHU). It was found that adding proper amount of the LHU increased light absorption in the 400-500 nm region, rendering the porphyrin-incorporated D-A copolymer panchromatic light absorber. Voc-Jsc trade-offs commonly seen in many D-A polyme were not found in this work. This is attributed to the presence of the LHUs increasing the Jsc without sacrificing the Voc and FF of the polymer solar cells (PSCs). Thus, 8.0% PCE was observed for the Polymer:PC71BM single-junction PSCs. Significantly, 8.6% PCE was achieved when a C-PCBSD cathodic interlayer was introduced to suppress leakage current.

11:30

R116 Development of Spray Coating Process for Organic Thin-Film Photovoltaic Device

Tatsuo Mori[1], Takuya Morimoto[2], Xiaoling Ma[2], Yoshinori Kobayashi[3], Hiroki Akenaga[3],Yoshiyuki Seike[3], Keiji Miyachi[3], Takao Nishikawa[4]
[1]Department of Electrical Engineering, Aichi Institute of Technology, Japan
[2]Department of Electrical Engineering and Computer Science, Nagoya University, Japan
[3]ASAHI SUNAC Corporation, Japan
[4]Center for Regional Collaboration in Research and Education, Japan

We report the fabrication of organic photovoltaic devices (OPV) by the spray coater, rCoater. This spray coater can control many spray by a spray gun, carrier gas, etc. We fabricated the organic photovoltaic devices based on P3HT:PCBM by rCoater. The PV properties of the optimized spray-coated specimen are better than those of the spin-coated specimen. The improvement of properties is thought to be caused by the specific film morphology of spray-coared layer.

12:00

R117 Towards Fully Solution-processed Organic Solar Cells--A Facile Strategy for Graphene Anode and Cathode

Jan-Kai Chang, Jeih-I Taur, Chih-I Wu
National Taiwan University, Taiwan

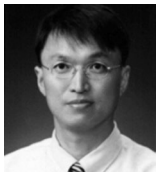
An in situ doping process with polymer-free transfer for graphene has been demonstrated, allowing residue-free graphene with tunable work function. The proposed scheme for doped graphene is compatible with arbitrary substrates including the delicate organic thin films; meanwhile, the doped graphene/dopant intercalation stacks were systematically investigated via photoemission and Raman spectroscopy to gain light into their electronic structure and corresponding e-ph coupling, respectively. This is in addition to the detailed studies on doping-dependent optical and electrical properties, i.e., transmittance, sheet conductivity and surface morphology. Work functions from 3.25 eV to 5.10 eV for such doped graphene sheets developed a more energy-favorable band alignment that facilitates carrier extraction when mounted with organic solar cells, enabling graphene anode and cathode for transparent electrode applications. In this way, a semi-transparent, high performance organic photovoltaic cell obtained via fully solution process can be achieved based on the incorporation of graphene anode and cathode. Therefore, the proposed facile strategy of vacuum-free process benefits the fabrication of photovoltaic cells to reach a time-saving, low-cost, large-area processing technology.

Friday, October 23, 10:30 – 12:15
Room 502 (5F)

Session R12: R2R manufacturing and application (Roll to Roll I)

Session Chair: Antti Kemppainen, VTT Technical Research Centre of Finland

10:30 Invited Talk



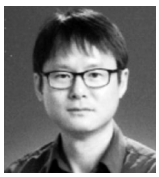
R121 Fully Roll-to-Roll Gravure Printed Thin Film Transistor Based Electronic Devices for IoT

Gyoujin Cho
Professor
Sunchon National University, Korea

Abstract

For the realization of IoT, fully printed thin film transistors (TFTs)-based costless wireless communication tool, sensor arrays and signage will be key elements since everything needs to have wireless communication tool, sensor and signage to communicate each other. As a consequence of developing the costless devices for IoT application, I would like to show the way of fabricating the costless RF-sensors and TFT-backplane arrays of active matrix through a continuous roll-to-roll (R2R) gravure printing process. In this presentation, I would like to show the details of R2R gravure system to print versatility of fully printed TFT-based flexible devices for the realization of IoT.

11:00 Invited Talk



R122 Reverse Offset Printing Process and Equipment for Ag Mesh Pattern

Taik-Min Lee
Head of Dept. of Printed Electronics
KIMM, Korea

Abstract

Conventionally, the indium tin oxide has been mostly used for transparent electrode. However, conductivity of ITO is not sufficient for large area devices. In this work, the mesh pattern using Ag nano ink was printed on PET substrate by reverse off-set printing system. The printed Ag mesh patterns were sintered using a flash light sintering system at room temperature and under ambient condition. This study introduces a roll printing process based on interface separation, which transfers ink 100% by using the interface separation mechanism. This method is effective in controlling the line width and thickness of patterns, and is capable of printing fine lines and thin films of excellent surface roughness. We were able to print line widths of approximately 1 □m, the thickness of the printed patterns were uniform and controllable. We think this study will allow us to take a step towards the realization of various devices by using the printing method.

11:30

R123 One-Step Roll-to-Roll Printing for Ultra-Fine Line Technology

Sheng-Feng Chung[1,*], Cheng-Yi Shih[1], Shu-Yi Chang[1], Shih-Ming Lin[1], Yu-Jay Wei[1], Ohra Sakata[2], Keiichi Abe[2], Su-Tsai Lu[1]
[1]Electronics and Optoelectronics Research Laboratories, Industrial Technology Research Institute, ITRI, Taiwan, R.O.C.
[2]Komori Co., Ltd., Japan

The innovation of ITRI's roll-to-roll (R2R) fine line technology and Komori's gravure off-set printing capability are utilized to study the direct printed conductive line for touch panel. Without photolithography process, a 3 μm-width finest line and a 1mm-width widest line can be formed at the same time, called one-step printing. Compared to conventional manufacturing process, one-step printing provides an effective and cost saving method to fabricate touch panels as well as other electronic devices.

11:45

R124 Fully roll-to-roll gravure printed thin film transistor (TFT) based-active matrix for a tactile sensor application

Junfeng Sun, Wookyu Lee, Hyunmo Koo, Gyoujin Cho*
Department of Printed Electronics Engineering,Sunchon National University, Korea, South

For the first time, 20 × 20 thin film transistors (TFTs)-based active matrices with 9.3 dpi along 15 m PET roll was successfully printed by utilizing R2R gravure printing system, and we obtained a device yield above 99%. Based on the R2R printed 20 × 20 TFT-based active matrices, the tactile sensor application was carried out. The resulting TFT active matrix-based tactile sensor was demonstrated by loading "L"-shape or finger touching. In the near future, this sensor can be wirelessly interconnected to smartphones as a surveillance sheet or carpet.

12:00

R125 Design of experiment for optimization of tunable printing conditions in roll-to-roll gravure printing process for sub-30μm multi line printing

Jongsu Lee, Kee-Hyun Shin, Dongjin Lee
Konkuk university, Korea, South

In this study, three criteria to evaluate the printability of micro scale pattern considering various printing defects are proposed: continuity, average width, and degree of local smudging. Using the criteria, the printability of micro

multi line by the tunable printing conditio such as tension, velocity, and pressures for nipping and doctoring were evaluated numerically. Finally, optimal value of the each tunable factor was obtained by Box-Behnken design of experiment. Under the optimal conditions, sub-30 μm multi-line which has below 1% of widening was obtained.

Friday, October 23, 13:30 – 15:15
Room 503 (5F)

Session R13: Conductive and Transparent Ultra-Thin Substrates

Session Chair: Zheng Cui, Suzhou Institute of Nanotech, Chinese Academy of Sciences, China

13:30 Invited Talk

R131 Silver nanowire electrodes for flexible electronics

Haekyoung Kim
Professor
Yeungnam University, Korea

Abstract

Random silver nanowire (AgNW) networks have been regarded as promising candidates to replace indium tin oxide (ITO) because of their attractive electrical, thermal, and optical properties. In contrast to common conductive materials with a dense thin film structure, AgNW networks are comprised of a three-dimensional (3D) hollow framework in which individual nanowires are connected to each other to establish an electrical pathway.9,10 This structure allows the AgNW network film to simultaneously exhibit transparency, conductivity, and mechanical flexibility. However, its high roughness limits its use in many applications since Ag NWs produce randomly formed 3D hollow frameworks because of their intrinsic wire characteristics [1]. The general roughness values of Ag NWs electrode are similar to the diameters of the wires (60–100 nm) which cause shorting of devices and a hazy appearance. In order to apply Ag NW TCE to electronic deviceswith thin active layers, approaches to reduce surface roughness while maintaining high transparency and electrical performance have been studied from various perspectives. In this study, the surface roughness of Ag NW electrodes was dramatically reduced by transferring Ag NW electrode to the flexible PET film on which a highly transparent organic functional layer, poly (N-vinylpyrrolidone) (PVP), was simply coated. The application of Ag NW electrode to devices will be discussed.

14:00

R132 Silver Nanowire-Based Transparent Heating Film

Hyun ji Jang, *Snag-Ho Kim
Kongju national university, Korea, South

Transparent heating film (THF) is used as a refrigerator, defrosting and glasses such as defrosting purposes. Indium tin oxide (ITO) or fluorine doped tin oxide (FTO) is used in conventional THF. But there are limits to the application due to relatively high sheet resistance and low flexibility. In this study using silver nanowire (AgNW) as substitute material and fabricated silver nanowire heating film (SNWHF). The heater surface was protected by the passivation. By applying a voltage to the thermal properties were studied.

14:15

R133 Flexible Transparent Conductive Films Combining Flexographic Printed Silver Grids and CNTs Films

Lixin Mo, Jun Ran, Yi Fang, Qingbin Zhai, Luhai Li
Beijing Institute of Graphic Communication, China

A high-performance ITO-free transparent conductive film (TCF) has been made by combining high resolution flexographic printed Ag grids with carbon nanotubes (CNTs) film. The Ag grids printed with flexography has a 20 μm line width at a grid interval of 400 μm. The Ag grids/CNTs hybrid film exhibits excellent overall performances, having a typical sheet resistance of 14.8 Ω/□ and 82.6% light transmittance at room temperature. This means 23.98% reduction in sheet resistance and only 2.52% loss in transmittance compared to pure Ag grids. Analysis with SEM indicates that the CNTs coating improves the conductivity of the Ag grids by interconnecting the silver nanopartices and by filling areas between the Ag grids. The hybrid film may fully satisfy requirements of different applications, e.g. used as the anode of polymer solar cells (PSCs). The J-V curve shows that the power conversion efficiency of the PSCs using the Ag/CNT anode is 2.73%, which is much higher than that of the Ag grids having the PCE of 0.61%.

14:30

R134 Copper Particle Assisted Graphene Composite as Transparent Electrode

Tsung-Chin Cheng, Kuo-You Huang, Ang Sheng Chou, Cheng-Feng Yue, Chih-I Wu*
National Taiwan University, Taiwan

For flexible electronic applications, like display or touch panel[1], Graphene is one of the choices in transparent electrode due to its electrical, mechanical and chemical properties. This paper presents graphene growth by chemical vapor deposition (CVD) which is composited of copper particle in the thermal CVD process in the same process.

14:45

R135 Electrical and Optical Characterization of Electrospun Al-doped Zinc Oxide Nanofibers

Yu-Yu Cho, Changshu Kuo
National Cheng Kung University, Taiwan

Nanostructured aluminum-doped zinc oxides (AZO) have attracted much attention for both scientific and industrial applications due to the advantages of the optimized electrical conductivity and the optical traparence. Here, ultrathin AZO nanofibers are fabricated via an electrospinning technology, and the resulting materials showed low sheet resistance and high optical transparency in the visible wavelength. A low sheet resistance of 190 ohm sq-1 at 84.2 % transparency is identified upon the 2 at. %-doped AZO nanofibers. These results demonstrated the promising electric and optical properties of the electrospun AZO nanofibers, suitable for the uses as conductive and transparent ultra-thin substrates.

15:00

R136 Hydrothermal growth of zinc oxide nanowires on flexible substrate based on roll-to-roll slot-die coated uniform zinc acetate seed layers

Janghoon Park, Sungsik Park, Jongsu Lee, Hakyung Jeong, Youngwook Noh, Hwijae Kang, Eung Jin Kim, Kee-Hyun Shin, Dongjin Lee
Konkuk University, Korea, South

Roll-to-roll (R2R) slot-die coating is widely known that can be used to estimate layer thickness and capable to obtaining a uniform coating film. In this study, we introduce the zinc oxide nanowires (ZnO NWs) hydrothermal growth based on R2R slot-die coating of Zn acetate seed layer. The proposed method was increase the precursor reaction with seed layer by obtains the uniform and less coated layer thickness. This technique could be applied to large area ZnO NWs film and its applications.

Friday, October 23, 13:30 – 14:15
Room 501 (5F)

Session R14: Photovoltaics and Batteries (II)

Session Chair: Tatsuo Mori, Aichi University, Japan

13:30

R141 Water Washing Improving the Conductivity of Flexography Printed ITO-Free Transparent Electrode for Polymer Solar Cells

Yi Fang, Yanfang Xu, Shiqi Zhu, Luhai Li
Beijing Institute of Graphic Communication, China

We report a simple method to obtain high conductivity transparent electrode by flexography printing and water washing, then fabricated ITO-free polymer solar cells based on poly(3-hexylthiophene) (P3HT) and [6, 6]-Phenyl C61 butyric acid methyl ester (PC60BM). The printed silver pattern of square and hexagon shapes show considerable sheet resistance decrease by water washing. The poly(3, 4-ethylenedioxythiophene) poly(styrenesulfonate) (PEDOT:PSS) was coated on the transparent electrode as the anode modification layer. The confocal laser scanning microscope (CLSM) shows the morphological changes of the two silver pattern after water washing and the PEDOT:PSS coating. The hexagon grid based polymer solar cell exhibit a higher power conversion efficiency of 0.37% than the square grid based device, owing to the lower surface resistance and higher transparency.

13:45

R142 Screen Printed Flexible Supercapacitor Electrodes Based on Active Carbon

Yaling Li, Mengru Ding, Fuyan Zhao, Ruili He,Shan Kang, Luhai Li
Beijing Institute of Graphic Communication, China

A facile method was provided to prepare supercapacitor electrodes with screen printing technology. The silver conductive ink was printed onto PET substrate and then dried at 120 oC for 30 min. The silver electrode was used as current collector. The active carbon paste was screen printed onto the above current collector and then dried at 120 oC overnight. The printed electrode area is 6.25 cm2. The symmetric supercapacito were fabricated with two pieces of the electrode and PVA-H2SO4 gel as a separator. Cyclic voltammetry (CV), galvanostatic charge/discharge (GCD) and electrochemical impedance spectroscopy (EIS) measurements were obtained using an electrochemical workstation. The results show that the flexible supercapacitor fabricated with the printed electrode has large specific capacitance. The largest specific capacitance is 0.28 mF cm-2 at scan rate of 5 mV s-1.

14:00

R143 Enhanced performance of perovskite based solar cells by interfacial charge transfer complex in Electron transport layer

Jun-Ho Bae, Sae-Mi Park, Jin-Mun Yoon, Seok-In Na
Chobuk National University, Korea, South

Organic-inorganic hybrid perovskite solar cells (PeSCs) have attracted much attention over the past few years because of high absorption coefficient, efficient excition dissociation, and long carrier diffusion length properties. [1] To date, efficiencies of PeSCs improved dramatically from 4 to over 20% in just few years by control the morphology and crystallization of perovskite films and interfacial engineering of hole or electron selective layers (HSL, ESL).[2] Compared with the former, investigatio on interfacial engineering of PeSCs have been less explored despite of the possibility for a dramatic efficiency enhancement via tuning charge-collection property. In particular, modifications of ESLs are less studied due to a difficulty in finding a suitable n-doping material. However, we found one of n-doping material for ESLs. In this study, we investigated the ESL effect by n-doping material. As a result, with the aid of added ESL device efficiencies were dramatically improved more than 12%.

POSTER SESSION

Time: Oct 22, 12:30-13:30
Venue: 5F, Taipei Nangang Exhibition Center, Taipei, Taiwan

AS017
Fine Silver Nanoparticles Lines Prepared by Microcontact Printing
Zhiqing Xin, Shili Liu, Xiu Li, Yi Fang, Lixin Mo, Yaling Li and Luhai Li
BIGC, China

The width of conductive lines is crucial for transparent electrodes. However, traditional printing techniques cannot meet the demands for line width. Here, we introduce a new method based on transferring silver nanoparticles by microcontact printing (μCP) to prepare fine conductive wires. Silver nanoparticles ink was transferred from resource substrate to target substrate using PDMS stamp with line patterns of 10 μm width and space. The pressure imposed on the stamp was significant for the quality of lines during the μCP process. Transferred lines were conductive after baking. The technology can be used to create fine conductive pattern .

AS020
Printed Ag electrode with uniform and low resistivity by optimized sintering process
Lu Zhou, Wenming Su, Dongyu Zhang
Printable Electronics Research Centre, Suzhou Institute of Nanotech and nano-bionics, Chinese Academy of Sciences, China

The sintering process of printed nano-silver electrode was investigated and optimized. A relatiohip between sintering condition and the performance of printed Ag electrodes can be summarized by compare the variation of morphology and resistivity. Under the optimized sintering condition, a batch of printed Ag electrodes with uniform and the lowest resisitivity can be achieved. This result could be very interesting and useful for the mass production of printed Ag electrode.

AS039
Printed Hysteresis-free N type Carbon Nanotube Transistors Using Polymer Sorted Sc-SWCNT Inks
Wenya Xu, Jianwen Zhao*, Zheng Cui
Printable Electronics Research Centre, Suzhou Institute of Nanotech and nano-bionics, CAS, China

In this work, we developed a method to print top-gate n-type SWCNT TFTs using polymer sorted sc-SWCNTs as channel materials and atomic layer deposition (ALD) of HfOx thin films as dielectric layers. Printed n-type TFT showed high mobility (up to 31.6 cm2/V-1s-1) and ooff ratio of ~104 with low operating voltage and free hysteresis. The linear behaviour of the output characteristics at low Vds for the n-TFT suggests perfect Ohmic contact and barrier-free injection of electro at the source contact. The reason for the polarity conversion from p-type to n-type is probably attributed to the positive fixed charge in the HfOx layer. Furthermore, printed top-gate SWCNT TFTs showed high stability since ALD of HfOx thin films can act as an encapsulation layer.

AS059
Synthesis of Quaternary Ammonium Magnetic Porphyrins and Potential Applications in Dye Sensitized Solar Cells
Zhicheng Sun, Shuying Chen, Guangwen Bin, Hao Ai, Pengcheng Li, Luhai Li*
Beijing Institute of Graphic Communication, China

The porphyrin sensitize in Dye sensitized solar cells (DSCs) played important roles of light absorption and carrier traport. In view of the natural photosynthesis function of porphyri, a series of porphyrin compounds with special structures as the sensitize were synthesized and characterized. The synthesized magnetic ionic ammonium metalloporphyri with tetrabromoferrate(III) as paramagnetic anio {TMPyPC8(FeBr4)4} constitute more conjugation structures, which absorb light over the visible range and impacts on the interfacial back electron transfer process.

AS060

Synthesis and Characterization of 2-Naphthol and Thiazole-based Excited-state Intramolecular Proton Transfer (ESIPT) Molecules for Fluorescent Zinc Sensors

Jaeyoung Jeoung, Youngbeom Seo, Sivaraman Somasundaram and Sanghyuk Park*
Kongju National University,Korea, South

Zinc ion plays important roles in human physiopathology. Development of seitive and noninvasive ion sensing technique is important to trace free zinc ions. However, most of the attention has been focused to detect free zinc ions using typical structure of a fluorescent zinc sensors which is composed of a conventional fluorophore and a well-known zinc-specific sensor. In this work, we have designed and synthesized novel sensing materials based on ESIPT process, which results in the formation of two tautomeric forms in the excited state of the probe, normal and tautomer forms are very successful for the design of probes with dual fluorescence. Naphthol and thiazole-based HNT1 and HNT2 were synthesized, and selective and ratiometric Zn2+ sensing was investigated.

AS062

Aqueous Based Cu Nanoparticle Ink for Highly Conductive patterns on Polyimid film

Beyong-Hwan Ryu*, Youngmin Choi, Sunho Jeong†, Su Yeon Lee†, Yeong-Hui Seo†,
Yejin Jo†, Eui Duk Kim‡, and Seok Heon Oh‡
†Device Materials Research Center, Korea Research Institute of Chemical Technology, Korea
‡Nano R&D Group, Hanwha Chemical Research & Development Center, Korea

Ink-jet printing process based on functional ink containing metal nanoparticles has been considered as one of emerging technologies. The functional materials play important role in the large-area and low-cost processing techniques for the printable electronics, such as printable display and photovoltaic applications. As far as metal nanoparticle ink, there is a need for environmental-friendly preparation of Cu nano ink and its application to ink-jet printing process. We tried to prepare the Cu nanoink for inkjet printing to open the new processing paradigm of low-cost and eco-friendly F/PCBs by direct digital printing. The fine pattern with high conductivity at low processing temperature is necessary.

The patterning behaviors were affected by contact angle of Cu nanoink on a substrate and concentration of Cu nanoink. We focused on investigating the rate of water to miscible dispersion medium of Cu nanoink in terms of contact angle, surface tension and viscosity of aqueous based Cu nanoink, which resulted in physical properties of Cu pattern of line width, microstructure and conductivity. It was confirmed that the 40~60 wt% Cu nanoink could be prepared, with the line width of < 40 □ and resistivity of ~ 10uΩ cm at 300°C for 1h. We also found that the aqueous based Cunano ink was stable for 3 months.

AS067

Micro-machined multi-function silicon nozzles fabrication for thin film printing to make OLED lighting

Kwon-Yong Shin, Mingyu Kang, Myong-Ki Kim, Dug-Hyung. Sung,
Kyungtae Kang, Kwan-Hyun Cho and Sang-Ho Lee
KITECH, Korea, South

Recently, a micro-machined multi-function silicon (Si) nozzles printing system is suggested as an alternative thin film printing method for organic light emitting diode (OLED) devices. Due to the direct writing feature, nozzle printing technology has many advantages in terms of maskless process, less waste of material, ultra-thin film fabrication, patterning on non-planar substrate or flexible substrate and possibility of printing on massive area in a short time using multi-head module. Several researches successfully demonstrated printed OLED displays by nozzle printing. This study introduces fabrication of multi-function Si nozzle and investigation of flow rate and solution injection time for a continuousjet coating process. Thin film of PEDOT:PSS was coated on ITO-coated glass substrate and OLED lighting device was fabricated by combining a continuous-jet coating process and a thermal evaporation process as a feasibility test for OLED device manufacturing process. We performed Si deep reactive ion etching process after definition of the desired patterns with thick photoresist etch masks to fabricate the micro Si nozzles. The fabricated

Si nozzle was coated with fluorocarbon film to obtain non-wetting surface to prevent spreading of ink solution on the nozzle surface during jetting. Figure 1 shows the nozzle fabrication process. Jetting behavior of diluted PEDOT:PSS solution was instigated by using the micro Si nozzles under different flow rate and injection time. We coated the thin film of PEDOT:PSS on ITO/glass substrate for OLED lighting using micro-machined silicon nozzles. In the case the thin film coating of PEDOT:PSS on ITO/glass substrate, its thickness uniformity was ±9% at average thickness= 68.56 nm. To test the feasibility of continuous-jet coating process, OLED lighting device was successfully fabricated by continuous-jet coating of PEDOT:PSS and thermal evaporation of HTL,EML, ETL and EIL.

AS083

Enhanced performance in green and red perovskite light-emitting diodes by microcavity using distributed Bragg reflector

Kwon-Yong Shin[1], Mingyu Kang[1], Myong-Ki Kim[2], Dug-Hyung. Sung[2], Kyungtae Kang[1], Kwan-Hyun Cho[1] and Sang-Ho Lee*[1]
[1]Korea Institute of Industrial Technology, Ansan, Korea
[2]DEVICEENG, Asan, Korea

Organometal halide perovskite materials have attracted considerable interest of solar cell community due to their superior properties such as high carrier mobility, long exciton diffusion length and high absorption efficiency. However, as a light emitter, they also have unique advantages such as high purity color generation property with narrow spectral width and easy color tunability that can be achieved by simply adjusting the bandgap[1]. Furthermore their solution-processability will be helpful to extend this technology to large area roll-to-roll process. Recently, room temperature perovskite light-emitting diodes (PELED) were demotrated, but their performances were not sufficient, yet. In this work, we applied distributed Bragg reflector (DBR) microcavity structure to red and green perovskite LED to increase the electronic coupling for better color purity and achieved improved performances.

AS089

Planar organohalide perovskite photovoltaic cells

Uisik Kwon[1], Duc Cuong Nguyen[1], Jong-Hyeon Park[1], Seung-Joo Kim[1], Soonil Lee[1], Deaho Lee[2], Hui Joon Park[1]*
[1]Division of Energy Systems Research, Ajou University, Korea
[2]Department of Mechanical Engineering, Gachon University, Korea

Organolead halide perovskites have been highlighted as efficient light harvesters for photovoltaic (PV) cells due to their superior properties, such as high charge-carrier mobility and absorption efficiency, and manufacturability. Furthermore, due to their ambipolar transport behavior, various organic semiconductor materials such as 2,2′,7,7′-tetrakis(N,N-p-dimethoxy-phenylamino)- 9,9′-spirobifluorene (spiro-MeOTAD), phenyl-C_{61}-butyric acid methyl ester (PCBM) and poly(3-hexylthiophene-2,5-diyl) (P3HT) can be utilized as charge transport layer. Among them, poly(3,4-ethylenedioxythiophene)-poly(styrenesulfonate) (PEDOT:PSS) has been widely used as hole transport layer in a planar heterojunction (PHJ) perovskite photovoltaic cells, showing impressive power conversion efficiency (PCE) of 14%[1,2]. However, it is considered as a source of device degradation due to its water-born and acidic nature, which seriously impacts the long-term stability of the perovskite PV devices. In this work, PHJ perovskite PV cells using solution-processed NiO nanoparticles as a hole transport layer were demonstrated, and the best PCE around 9% was achieved. We expect that nanoparticle-based NiO layer can be utilized to produce high performance perovskite PV cells having better stability.

AS092

Improving the printability of CMD(Cross Machine Direction) micro line with Design of roll pattern

BeomSoon Kim[1,2], Kyung Pil Kim[1,2], Jea-Min Kim[1,2] and Sung Lim Ko[1,2]
[1]Department of Mechanical Design and Production Engineering, Konkuk University, Korea
[2]KU-VTT joint research centre, Konkuk Univ., Korea

It's big issue for researchers to print micro fine line in any direction. Especially, thick micro pattern is supposed to be printed for electrode which has low resistance and is required for electronic device like flexible printed circuit

board(FPCB). But It's not easy to printed micro fine line in cross machine direction because of affection of doctor blading. So the affection of doctor blading is mentioned and the way to improve the printability of micro pattern in cross machine direction, designing the roll pattern in this study.

AS093

The Effect of dopping using tetrafluorotetra-cyanoquinodimethane as a Hole Transport Layer in Polymer Solar Cells

Jun Hyeok Lee†, Inchan Hwang‡, Mijung Lee†
†Department of Advanced Materials Engineering, Seoul Korea
‡Departmentof Electronic Materials Engineering, Seoul Korea

Polymer solar cells (PSCs) have attracted interest due to their potential to be manufactured lighter, more flexible and low cost as an alternative energy-harvesting device. In the last decade, the development of PSCs continues to show progresses. We investigate the effect of p-type doped graphene layers using solution process by surface modification with tetrafluorotetra-cyanoquinodimethane (F4TCNQ) when they are used as HTLs for improved power conversion efficiency (PCE). We confirm the increment solar cell parameters resulting in the increment of carrier concentration. Also we can conclude that electron transfer occurs between the F4TCNQ and the P3HT, which results in the formation of mobile carriers and charge-transfer complexes, reduces the resistance at the organic interface and enhances the performance of device.

AS096

Analysis printing feature of microfluidic channel on paper substrate using gravure printing

Kyungpil Kim, Beomsoon Kim, Jae-Min Kim and Sung Lim Ko
Konkuk University, Korea, South

Normally paper-based microfluidic devices have been fabricated by using ink jet printing, wax printing, photolithography. But there are disadvantages for mass production such as cost, speed and waste of materials. In detail, Ink jet printing and wax printing are too slow to fabricate compared with gravure printing because that need to use small droplet and wax should be printed with heat and long time to be absorbed to paper. In this study, basic experiment is carried out for cheap and mass production using different pattern depth, composition ratio, molecular weight of ink on filter paper.

AS102

Key Parameters of Fully R2R Gravure Printed TFT-Active Matrix for E-Paper Application

Joonghyun Park, Wookyu Lee, Junfeng Son, Hyunmo Koo, Sanggyun Jung and Gyoujin Cho*
Department of Printed Electronics Engineering, Sunchon National University, Korea

For demonstrating a way of R2R gravure printed TFT-AM, 10 ppi of 20 x 20 TFT-AM was designed and fully printed along 15 m of plastic film The device yield was about 98 % with ± 19 % variation of threshold voltage (Vth). To test the feasibility of R2R printed TFT-AM, key parameters such as acceptable ranges of on-off ratio, switching speed, operation voltage and stability were extracted by laminating E-paper on the printed TFT-AM and will be introduced in this presentation with a scalability factor for manufacturing TFT-AM using all R2R gravure

AS103

Experimental analysis of tension variation on the thermal deformation of flexible substrate in roll-to-roll additive manufacturing process

Hyijae Kang[1], Janghoon Park[2], Jongsu Lee[2], Jongjin Kim[2], Sooseong Park[1], Hyogeun Gil[1], Hyunkyoo Kang[4], Kee-Hyun Shin[1,3,*]
[1]School of Mechanical Eng., Konkuk Univ., Seoul, South Korea
[2]Dept. of Mechanical Design and Production Eng., Konkuk Univ., Seoul, South Korea
[3]Flexible Display Roll-to-Roll Research Center, Konkuk Univ., Seoul, South Korea
[4]Technisch Universität Chemnitz, Chemnitz, Germany

Nowadays, roll-to-roll additive manufacturing (RAM) process attracting interested to substitute for the conventional subtractive manufacturing based on photolithography technique. RAM based fabrication system have an advantage such as high throughput, cost effective, and eco-friendly. RAM system is flexible body linked system; it has a special feature that controls the tension. Therefore, the tension is the most significant process parameter can cause the several defects such as register error, breaks, wrinkle and so on. In the previous research, tension model and control method have been studied in industrial scale systems.In RAM process, there are several disturbances of tension, not only the mechanical vibration and eccentricity, but also the temperature change is the most effective disturbance on tension variation. In printing process included RAM system, the substrate must pass through the dryer in a specific time to dry the printed surface, thus, the tension will be changed. In this study, the tension behavior in thermal atmosphere was analyzed at a cotant operating tension.

AS106

Analysis of printability of micro-scale patterns by shape of engraved pattern

Jongjin Kim[1], Jongsu Lee[1], Janghoon Park[1], Kihak Sung[1], Kee-Hyun Shin[2,3]*
[1]Dept. of Mechanical Design and Production Eng., Konkuk Univ., Seoul, Korea;
[2]School of Mechanical Eng., Konkuk Univ., Seoul, Korea;
[3]Flexible Display Roll-to-Roll Research Center, Konkuk Univ., Seoul, Korea

In gravure printing process, the characteristics of ink and substrate, and printing conditio such as tension, velocity and etc. are affect the quality of printed patter. Thus far, many researches for optimization of the aforementioned factors have been reported. However, there is a few study about the quality of printed pattern by the shape of depth of engraved patter. In this study, it was analyzed the effect of shape of depth of engraved patter in the gravure printing roll on printability. Fit, it was compared the amount of wiped out ink after doctoring (Fig. 1)

AS110

Flexible High Potential Thin Film Zinc-Air Battery by Screen Printing Technique

Sira Suren, Phenfar Benjapongvimon, Soorathep Kheawhom
Chulalongkorn University, Thailand

A flexible thin film zinc-air battery by screen printing technique was developed. Mixture of Zn powder, ZnO, and Bi_2O_3 was used as the anode electrode. Types of cathode electrodes (carbon paper and carbon black) were investigated. Batteries using carbon paper and carbon black provided open-circuit voltage at 1.44 and 1.45 V, respectively. Both batteries were tested by continuously bending so that their lengths decreased from 3 cm to 1 cm while discharging at 0.15 mA/cm^2. Throughout the bending test, both batteries could provide voltage at 1.23 V. Battery using carbon black showed a little longer discharging time. Energy deities observed from batteries using carbon black and carbon paper were 682 and 323 Wh kg-1, respectively.

AS112

Fabrication of projected capacitive flexible touch panel based on double-sided printing process

Youngwook Noh[1], Sungsik Park[1], Janghoon Park[1], Hakyung Jeong[1], Dongjin Lee[2,3,*]
[1]Department of Mechanical Design and Production Engineering, Konkuk, University, Seoul, South Korea
[2]School of Mechanical Engineering, Konkuk University, South Korea
[3]Flexible Display Roll-to-Roll Research Center, Konkuk University, South Korea

Projected capacitive touch technology is being used in the touch panel. It is mounted on all smartphone by excellent touch sensitivity and response time. The principle is that electric field is formed between two electrodes applying alternating current (AC) voltage. If the finger is close to this point, the electric field between the electrode and the finger is formed and the electric field between two electrodes is decreased. Touch panel fabricated by arranging this with X-Y axis. Conventional touch panel has been produced on dielectric film by attaching two indium tin oxide (ITO) films patterned electrodes. To manufacturing low cost flexible touch panel, new fabrication technique was proposed by using double-sided printing technology.

AS117

Silver grid/PEDOT:PSS transparent conducting electrodes for flexible organic light emitting diodes application

Keum-Jin Ko, Jae-Wook Kang*
Chonbuk National University, Korea, South

The flexible electronics has been known as an alternative technology for the realization of the next generation electronics applications specifically inorganic light emitting diode (OLED) device. Flexible OLED based on transparent conducting electrodes (TCEs) with high transparency, flexibility, and conductivity in order to replace indium tin oxide (ITO) were still the main challenging issues. In addition, surface roughness is also play an important role for reduction of device shortage. In this work, solution processed the poly(3,4-ethylenedioxythiophene):polystyrene sulfonate (PEDOT:PSS) and Ag grid was employed for the fabrication of flexible TCEs substrate. As a result, thef lexible TCEs exhibit high transparency (transmittance > 80 % at 550 nm),high conductivity (sheet resistance: ~40 ohmq.) and low surface roughness (rms roughness: ~0.36 nm).

AS118

Development of donor-acceptor type-based low band gap polymer for highly efficient polymer solar cells

You Sun Lee, Yong Jin Noh, Seok In Na*
Chonbuk National University, Korea, South

Recently, the bulk heterojunction-based polymer solar cells have received significant attention due to their potential for low-cost, large area, mechanical flexibility, solution processability, light weight, and roll-to-roll manufacturing. In recent years, the polymer solar cells have shown dramatic increase of efficiency up to ~ 9% as a result of development of novel low band gap polymer [1,2], because the device characteristics such as fill factor, open-circuit voltage, short-circuit current deity are highly dependent on donor polymer properties. Therefore, the development of donor polymer based on low band gap properties could be highly desirable for the realization of high-efficient polymer solar cells. In this work, we demonstrated the highly efficient polymer solar cells using novel low band gap polymer as donor materials in the photoactive layer. Also, the effect of low band gap polymer on the device parameter such as fill factor, open-circuit voltage, and short-circuit current deity all investigated. As a result, power conversion efficiency of an optimum polymer solar cells with low-band gap polymer showed more than 7%.

AS120

Graphene-copper mesh based flexible transparent electrodes

Dabin Son[1,2], Jae-Wook Kang[2,*], and Sang Hyun Lee[1,*],
[1]Institute of Advanced Composite Materials, Korea Institute of Science and Technology (KIST), South Korea
[2]Department of Flexible & Printable Electronics, Chonbuk National University, South Korea

High-quality graphene grown by chemical vapor deposition(CVD) method is a promising for industrial applications.[1,2] However, there are a number of processes including synthesis ofgraphene, polymer coating/removing for the transfer to an arbitrary substrate and a chemical etching to remove the metal.[3] Especially the high-purity catalytic metal imposes high material and process cost. The electrical conductivity of CVD-graphene is still not enough to use for electrodes in solar cells and LEDs.[4] These problems hinder the practical applications of graphene as electrodes. Here we report a facile approach to fabricate high conductive flexible electrodes using CVD-graphene. After growth of graphene, the copper foil used as catalytic metal was selectively etched to form a mesh-type electrodes and then embedded into polymer matrix. Figure 1 shows Raman spectrum of the graphene-copper mesh hybrid electrode reveals the existence of graphene overall surface. The effects of external strain on the conductivity of the hybrid electrode and optical properties will be discussed.

AS121

Low band gap donor materials of new polymer based on BDT-TPD copolymer for Polymer solar cells

Chul Moon Choi, Li-Xing, You Hyun Seo, Myoung Hoon Lee and Seok-In Na
Department of Flexible and Printable Electronics
Chonbuk National University

The bulk-heterojunction polymer solar cells have been attracted increasing attention due to their potential such as low cost, light weight, flexibility and solution-precoessability for next-generation renewable energy devices. Among the main components of PSCs, donor polymer have been considered as a key component for high-efficient solar cells, because their light absorption, charge carrier mobility, energy level, solubility, and band-gap properties have the influence on all cell-parameters such as short-circuit current deity, open-circuit voltage, and fill factor.[1] Herein, we introduce a novel BDT-based polymer materials with a a hydrophobic 4-octylphenyl group and a hydrophilic c – 4(2,5,8,11 tetraoxatridecan-13-yloxy)phenyl group as low band-gap donor for high-performance polymer solar cells and also investigate the effects of side chai of BDT-based polyme on device-performance.[2] The device with BDT-based polymer materials used as donor materials in PSCs exhibited the excellent power conversion efficiency of 5.81%.

AS122

Control of the wavelength dispersion by photo-reaction of New Reactive Mesogens

Ah-young Jo[1], and Myong-Hoon Lee[1,2,*]
[1]Dept. Of The Graduate School of Flexible and Printable Electronic, Chonbuk National Univ., Korea
[2]Dept. of BIN Fusion of Technology, Chonbuk National Univ., Korea

LCs are self-organizational material. These optical rotaional property leads to LCD's dominant development in display industrial. But when the light goes through LC molecules, the double refraction of light will occur in a transparent, Birefrigence. This can be big problem because of light leakage and screen distortion induced from phase retardation. So we synthesized New Reactive Mesoge to solve these problems through control of wavelength dispersion in accordance with change of wavelength. An axis-selective UV light absorption by photo-reaction moieties of RM gives the anisoptropy to LCs and then induce the generation of optical anisotropy.

AS123

Synthesis and polymerizable of New chiral dopants for Cholesteric LC Application.

Dasom Han, Kyundo park, and Myong-Hoon Lee
The Graduate School of Flexible and Printable Electronics, Chonbuk National University., South Korea.

Cholesteric liquid crystals draw great attention due to their potential in various application as key materials for display. They have a helical molecular orientation which is induced by a chiral dopant molecules mixed with nematic liquid crystals. Therefore, the development of highly efficient chiral dopant is most important helical twisting power and decant solubility in organic solvents as well as general nematic liquid crystals.

AS125

Aqueous conductive ink Based on SWCNT dispersed by Water-Soluble Conducting Polymer

Min-jae Lee, Jae-min Shim and Myong-Hoon Lee
The Graduate School of Flexible and Printable Electronics, Chonbuk National University, South Korea

We are researching the CNT dispeion and conductive ink manufacturing through a new polymer synthesis of PANBUS(poly anilino N-butylsulfonate). Recently, the printed electronics technology directly printing the pattern of electronics circuit is noted as the method manufacturing electronic circuit.The conductive ink is being researched as the main material for using printed electronics technology. The polymer conductive ink is capable of junction at a lower temperature and it is excellent in workability.Therefore, we have been researching the CNT ink for stable dispeion of carbon nano-tube and for application as conductive ink.

AS128

Influence of PEIE in ZnO-nanoridges as Efficient Electron Transporting Layer in Inverted Type Organic Solar Cells

Riski Titian Ginting[1], Won Yong Jin[1], Jae-Wook Kang[1,*]
[1]Graduate School of Flexible and Printable Electronics, Chonbuk National University, South Korea

In this work, various device configuration was fabricated employing relatively thin layer of PEIE onto indium tin oxides (ITO)/ZnO nanoridges structure which served as an efficient electron transporting layer. Based on the current density-voltage (J-V) characteristics, PEIE/ZnO-R device exhibits higher photovoltaic performance as compared to the ZnO-R/PEIE device, which mainly attributed due to the suppression of oxygen defect at the surface of ZnO as supported by XPS results. Additionally, the improvement of the short circuit density with PEIE/ZnO-R device can be assigned to the increment of charge carrier mobility as further confirm by charge extraction linearly increasing voltage (photo-CELIV) measurements.

AS129

Flexible Fibrous Electrodes based on Metal Embedded Transparent Conducting

Won-Yong Jin, Il Cheol Jeon, Jae-Wook Kang
Chonbuk National University, Korea, South

In this report, the novel architecture of fully solution processed OSCs based on Fibrous shape ultra-thin transparent conducting electrodes (TCEs) was composed of the stripe patterned Ag metal sub-electrodes embedded into flexible UV-curable polymer substrate. The fabricated TCEs able to achieve high transparency (transmittance > 70%; 550 nm), highly conducting (sheet resistance ≈ 20 Ω/ □), and high flexibility (bending radius ≈ 0.5 mm) electrodes with ultra-smooth surface (rms roughness ≈ 0.4 nm). This device active layer consists of the low-band gap polymer blend with PCBM. In addition, based on J-V characteristics, it is found that the photovoltaic performance only slightly changes even after being bend at low bending radius.

AS130

Triphenylamine and Benzothiadiazole-based D-A-A' and A'-A-D-D-A-A' Type Small

Sivaraman Somasundaram, Suzy Jeon and Sanghyuk Park
Department of Chemistry, Kongju National Univeristy, Korea.

Utilization of small-molecule based organic photovoltaic (OPV) devices has received strong attention due to their easy preparation, purification, and batch-to-batch resemblance in properties. In this work, a series of soluble benzothidiazole and triphenylamine containing molecules were synthesized, and their application to organic photovoltaic devices was studied. The absorption spectra demonstrated that the absorption wavelength of the small molecules could be tuned dramatically by extension of molecular structure from donor(D)-acceptor(A)-acceptor(A') to A'-A-D-D-A-A' sequences. Due to the intramolecular energy transfer from the acceptor to donor and vice versa in D-A structures in prepared molecules, the maximum emission wavelengths were red-shifted gradually with the increase of chain length. Bulk heterojunction type solar cell devices were fabricated by using the small molecules as donors and PCBM as acceptor (2:1), gave maximal Voc of the photovoltaic cells of 0.59 V and the power conversion efficiencies of the devices were measured 0.776 % under the illumination of AM1.5, 100 mW/cm^2.

AS132

One-pot synthesized hierarchical mesoporous SnO_2 sphere for enhanced photovoltaic applications

Eun Chong Kim, Jung Tae Park*
Department of Flexible and Printable Electronics, Chonbuk National University, South Korea

In this paper, we have demonstrated the development of hierarchical mesoporous SnO_2 spheres via a facile solvothermal reaction with graft copolymer as a structure-directing agent for photovoltaic studies. And, graft copolymers were synthesized via ATRP. The om-SnO_2 IF layer were utilized as a buffer layer in ssDSSCs with solid state electrolyte and the influence of the material structure on photovoltaic performance was also investigated. The photovoltaic devices based on hierarchical mesoporous SnO_2 spheres were fabricated and characterized in detail by measuring the FESEM, EF-TEM, XRD, BET, BJH, reflectance, IPCE, IMPS/IMVS, JV, and UV-vis spectroscopy.

JP029

Durability evaluation of inkjet printed conductive lines

Akane Tanaka[1], Masaya Nogi*[2], and Katsuaki Suganuma[2]
[1]Uematsu Printing Co. Ltd., Toshima-ku, Tokyo, Japan
[2]Institute of Scientific and Industrial Research, Osaka University, Ibaraki, Osaka, Japan

One of the attractive printed electronics technologies is a direct printing of fine conductive patter on flexible substrates. In this study, comb patter were inkjet-printed on a flexible substrate using a silver nanoparticle ink. The conductivity of printed patter were measured under high temperature (85°C) and high humidity (85% RH). After high temperature and humidity test, the comb patter were observed by a microscope. In this presentation, we will discuss about the mechanism of electrochemical migration of the printed patter.

JP078

Thermally Stimulated Current Study for Analysis of Spontaneous Polarization of Electrospun Poly(DL-lactic Acid) Fibrous Film

*Taiki Nobeshima[1], Yuya Ishii[2], Heisuke Sakai[3], Sei Uemura[1], Manabu Yoshida[1]
[1]National Institute of Advanced Industrial Science and Technology, Flexible Electronics Research Center, JAPAN
[2]Toyohashi University of Technology, JAPAN
[3]Japan Advanced Institute of Science and Technology, JAPAN

We found that a racemic poly(lactic acid) (PDLLA) fibrous film prepared by the electrospinning method exhibits invee-piezoelectric-like behavior. To study whether a spontaneous polarization in the electrospun film resulted in the piezoelectric-like effect, the thermally stimulated current (TSC) measurements without a poling treatment was conducted. As a result, the electrospun PDLLA film exhibits some TSC peaks by relaxation of its spontaneous polarization. The polarization would come from the strong electric field applied to the PDLLA polymer solution used in the electrospinning approach.

JP101

Polarized FT-IR Strudy of Electrospun Poly(DL-lactic Acid) Fibrous Film

*Heisuke Sakai[1], Yuya Ishii[2], Taiki Nobeshima[3], Sei Uemura[3], Hideyuki Murata[1]
[1]School of Materials Science, Japan Advanced Institute of Science and Technology, JAPAN
[2]Department of Electrical and Electric Information Engineering, Toyohashi University of Technology, JAPAN
[3]Flexible Electronics Research Center, National Institute of Advanced Industrial Science and Technology, JAPAN

Recently, we have found that the electrospun Poly(DL-lactic acid) (PDLLA) fibrous films show the piezoelectric-like behavior, where the films were applied to the sensors and the actuato. However, the origin of the piezoelectric-like behavior of the fiber is not clear. In this paper, In this study, we investigate the polymer chain alignment iide the electrospun PLA fibe by mea of the polarized FT-IR spectroscopy. The discussion on the polymer chain orientation iide the fiber and the application of the PLA fibrous film will be presented.

TW007

Deposition of a-SiOC:H Thin Films Using an Atmospheric Pressure Plasma System

Jui-Mei Hsu[a], Jhih-Ren Lin[a], Chih-Chiang Weng[a], David Dasher[b], Jiangwei Feng[c]
[a]Industrial Technology Research Institute, Taiwan, R.O.C.
[b]Sullivan Park, Corning Inc , USA
[c]Corning Research Center Taiwan, Taiwan, R.O.C.

We developed an atmospheric pressure (AP) plasma system for thin film deposition, which is suitable for flexible substrates and roll- to-roll coating process. a-SiOC:H materials were deposited using tetramethylsilane (TMS) and oxygen as the precuo. Modulus and the chemical structure of deposited films were analyzed using nanoindention and Fourier-traform infrared spectroscopy (FT-IR). The results show that a-SiOC:H film properties can be easily engineered to different modulus/hardness and chemical structure using AP plasma.

TW012

Synthesis Green and Yellow Iridium (III) Complexes for Organic Light emitting Diodes

Cheng-An Wu, Meng-Hao Chang, Pang-Chi Huang, Jin-Sheng Lin, Mei-Rurng Tseng
Industrial Technology Research InstituteTaiwan

New tris-cyclometalated iridium (III) complexes, with different substituents in the phenyl ring of ligands, were successfully synthesized and characterized. In this paper, innovative substituents' influence on the photophysics and electroluminescentdevice were verified.

TW021

OLED Fabrication by Using a Novel Planar Evaporation Technique

Ming-Ting Hsiao[1], Fu-Ching Tung[1], Jwo-Huei Jou[1,*]
[1]Department of Materials Science and Engineering, National Tsing Hua University, Taiwan

OLED fabrication is suffering from high material wasting during deposition. To improve, we have developed a novel thin-film deposition system with a planar source loadable with any premetered solvent-mixed organic compounds, plausibly with no component number limitation. We hence demonstrate experimentally, along with a Monte Carlo simulation, in the report the feasibility of using the technique to deposit on a large area-size substrate various organic materials with a relatively high material utilization rate coupling with high film uniformity. Specifically, nonuniformity of less than ±5% and material utilization rate of greater than 70% have been obtained for the studied films.

TW026

Organic Photovoltaic Devices for Indoor Applications

Shun-Shing Yang and Fang-Chung Chen
National Chiao Tung University Taiwan

In this presentation, we evaluated the potential of organic photovoltaic devices (OPVs) for indoor low power applications. The light source for evaluating the performance of OPVs under indoor illumination conditio was a fluorescent tube. Two different polymer blends were used as the photoactive layers. We have found that the devices fabricated with an electron donor featuring a higher lowest unoccupied molecular orbital exhibited better performance due to its higher photovoltage.

TW034

Organic Photovoltaic Devices Prepared with a Low-Band-Gap Polymer for Low Light Applications

Zong-Chun Hsieh and Fang-Chung Chen*
National Chiao Tung University Taiwan

In this work, the device performance of organic photovoltaic devices (OPVs) prepared with a low-band-gap (LBG) polymer was studied under illumination from two artificial light sources indoor. We have found that the power conversion efficiency of the OPV under 600 lux illumination could achieve a high power conversion efficiency of ca. 14%.

TW053

Enabling high efficiency phosphorescent OLEDs using solution-process feasible molecular host

Snehasis Sahoo[a], Sudhir Kumar[a], Daiva Tavgeniene[b], Saulius Grigalevicius[b], Jwo-Huei Jou[a,*]
[a]Department of Materials Science and Engineering, National Tsing-Hua University, Taiwan
[b]Department of Polymer Chemistry and Technology, Kaunas University of Technology, Lithuania

Solution-process feasible organic light-emitting diodes (OLEDs) are key to realize cost effective, high throughput, large area fabrication of high quality flat panel displays and solid state lightings. In this study a carbazole based host material 2-[4-(carbazol-9-yl)butyloxy]-9-[4-(carbazol-9-yl)butyl]carbazole (4) is synthesized. Resultant host material shows high triplet energy, matching energy levels, and possess high solubility in common organic solvents at room

temperature. When doped with a green phosphorescent emitter fac tris(2-phenylpyridine)iridium (Ir(ppy)3), host 4 containing device shows an external quantum efficiency of 14.1% and power efficiency of 51 lm W -1 at 100 cd m -2 or 11.1 and 30.3 lm W -1 at 1,000 cd m -2. The high efficiencies may be attributed to the host possessing an effective host-to-guest energy transfer. The facile synthesis, excellent solubility in common organic solvents, outstanding film integrity and high triplet energy come together to eure that the compound 4 may be a promising host material for wet-process phosphorescent OLEDs.

TW056

Electrolyte Film-free Electrochromic Devices Based on Bilayer WO3/NiO Structures

Ta-Huang Sun, Min-Chuan Wang, Der-Jun Jan
Physics Division, Institute of Nuclear Energy Research, Taiwan.

The bilayer electrochromic (EC) devices are deposited on glass substrate without any electrolyte film by sputtering. We demonstrate that optical transmittance of bilayer EC devices consisting of WO3/NiO with or without activation process can be controlled through application of an electric field. Spectral, electric, and structural studies suggest that this EC phenomenon is induced by electric-field excitation in the films, electron injection into the metal oxide, which becomes negatively charged, and subsequent formation of metallic particles, which absorb and/or scatter visible light.

TW061

Polymer Solar Cells Prepared with Photoexfoliated Fluornated Graphite as Cathode Buffer Layer

Wai-Chen Lin, Hung-Wen Hsu, and Fang-Chung Chen
National Chial Tung University, Taiwan

We discovered that UV radiation upon the fluorinated graphite (FG) dispeion in N-methyl-2-pyrolidone could facilitate the exfoliation of FGS. From the analysis of the images obtained, the average thickness of the FGSs was about 3 nm, which was thinner than that of the nanosheets prepared using conventional sonication approach. The as-prepared inverted polymer solar cells exhibited an open circuit voltage of 0.53 V, a short circuit current deity of 10.22 mA cm-2 and a fill factor up to 53.7%., resulting in a power conversion efficiency (PCE) of 2.91%.

TW070

Silver Networks Based on Electrospun Poly(Methyl Methacrylate) and Silver Trifluoroacetate as Transparent Conducting Films

Hung-Tao Chen, Hsiu-Ling Lin, Pei-Ying Hsieh, Changshu Kuo, In-Gann Chen
National Cheng Kung University, Taiwan

Silver networks with high transmittance (>80%) and low sheet resistance (<300 ohmq.) were prepared via a polymer-assisted electrospinning technique and several post treatments, including thermal, electromagnetic and chemical processes. Nonaqueous media containing poly(methyl methacrylate) (PMMA) and silver trifluoroacetate (STA) were formulated as polymemetal electrospinning precursor. Nanofibers randomly deposited on substrates formed a plane scaffold, which served as the raw material for silver networks. Post treatments at low temperature not only reduced the STA precuo to silver nanoparticles (Ag NPs), but also triggered connection of the Ag NPs into a one-dimeional (1D) domain. Silver fibe formed continuous conducting networks on the substrate surface. The sheet resistances and optical transmittance of these silver networks revealed strong correlatio with the original STA/PMMA ratios and with the silver network morphologies. The material fabrication was carefully investigated, and the surface plasmon resonances (SP), fiber morphologies, and electrical and optical properties as well as bending reliability of the products were examined.

TW098

Effect of side-chain bulkiness on the OTFT and OPV performance of two dimensional conjugated polymers based on 5,6-difluoro-benzo-2,1,3-thiadiazole and quarterthiophene units

Shih-Hao Peng[a], Cheng-Tai Yang[a], Chih-Li Wang[b], Ching-Yao Lin[b] and Chain-Shu Hsua
[a]Department of Applied Chemistry, National Chiao Tung University, Taiwan, R.O.C
[b]Department of Applied Chemistry, National Chi Nan University, Taiwan, R.O.C

In this presentation, perylene, dithienylbenzothiadiazole (DTBT), porphyrin-pyrene and diporphyrin-pyrene were introduced to the side chai of poly(5,6-diffluoro-benzothiadiazole-alt-quaterthiophene)(PTh4FBT).Four random copolyme, ie, PTh4FBT-PERY, PTh4FBT-DTBT,PTh4FBT-PorPy and PTh4FBT-DPorPy were synthesized. The effect of side chain bulkiness on the optoelectronic properties of the obtained polyme were measured by UV,CV and X-ray diffraction. This performance in the organic thin film transistor and organic solar cell was evaluated. The OFET devices based on PTh_4FBT-PERY, PTh4FBT-DTBT, PTh4FBT-PorPy and PTh4FBT-DPorPy show the great mobility respectively. More over, the device performance of PTh_4FBT-PERY is superior than the other devices.

TW108

Effect of Surface Organosilanization on Promoting the Adhesion of Conducting Polymer Thin Films on Polydimethylsiloxane Substrates as Flexible Transparent Electrodes

Pen-Cheng Wang[1], Priyadharsini Karuppuswamy[1,2], Kuan-Hsun Li[1], Li-Hung Liu[1], Hung-Lun Liao[1], Ray-Wen Hsu[1]
[1]Department of Engineering and System Science, National Tsing Hua University, Taiwan
[2]Nano Science and Technology Program, Taiwan. International Graduate Program, Academia Sinica and National Tsing Hua University

Optimized method for fabricating robust conducting polymer thinfilms on surface-treated poly(dimethylsiloxane) via in situpolymerization of aniline yielded substrates with the potential to beused as all-polymer transparent electrodes in flexible electronicsdevices.

TW133

Donor-Acceptor Polymer-based Nonvolatile Memory

Chien Lu[1], Yun-Ching Peng[2], Wen-Ya Lee[2]* and Wen-Chang Chen[1]
[1]Department of Chemical Engineering, National Taiwan University, Taiwan
[2]Department of Chemical Engineering, National Taipei University of Technology, Taiwan

Nonvolatile organic transistor-typememory has attracted great attention due to its features, including flexibility, low cost and large area fabrication. In general, the organictransistor-type memory devices requires multi-layer structure consisting of a chargestorage layer and a charge transport layer. However, the multilayer structure causescomplex fabrication process. Therefore, to simplifying the device structure, we demonstrate a single-layer memory device using donor (D) -acceptor (A)conjugated copolyme. By using different donor and acceptor moieties, e.g.thiophene, selenophene, quaterthiophene, qunioxaline, benzothidiazole, and diketopyrrolopyrrole(DPP), the influence of the D-A chemical structure on the memory behavior hasbeen systematically investigated. The D-A copolymer-based devices showed large memory windows (> 50V), long retention time (> 105 s), highoff current ratios (> 105) and fast switching time. Furthermore, the write-read-erase-read (WRER) cycles can be operated over 200 cycles, indicating stable flash-type memory behaviors. This study demonstrates the D-A polymer materials provide a new strategy for the material design ofnext-generation nonvolatile flash memory applications.

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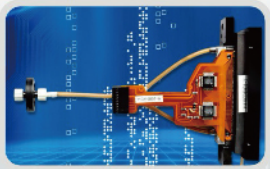

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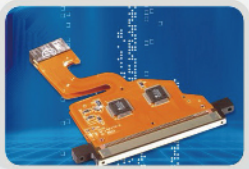

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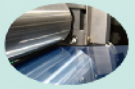
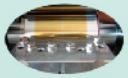

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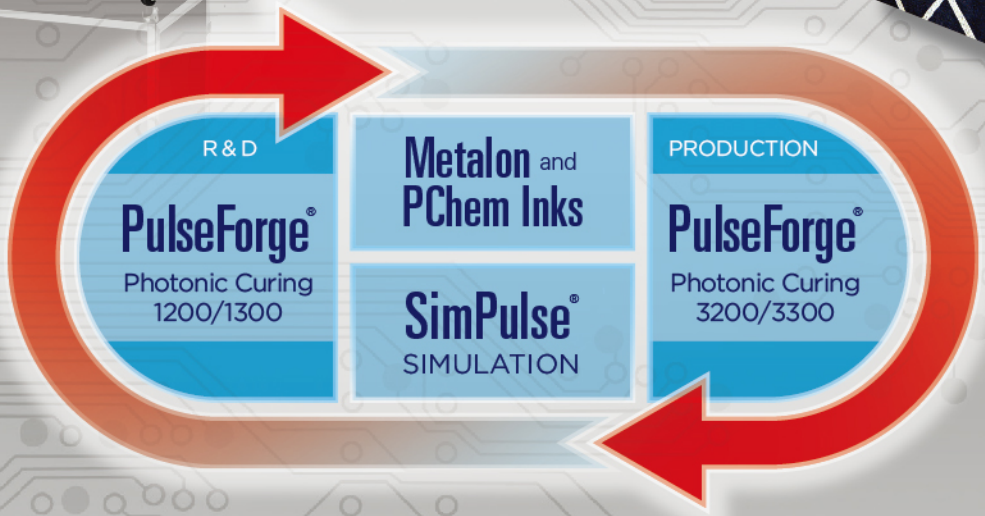

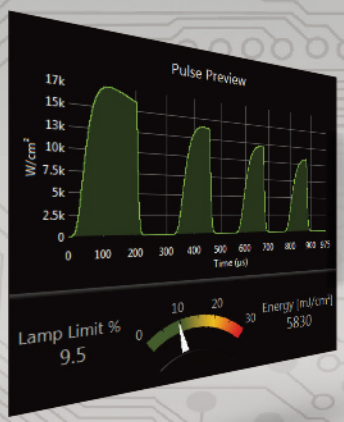

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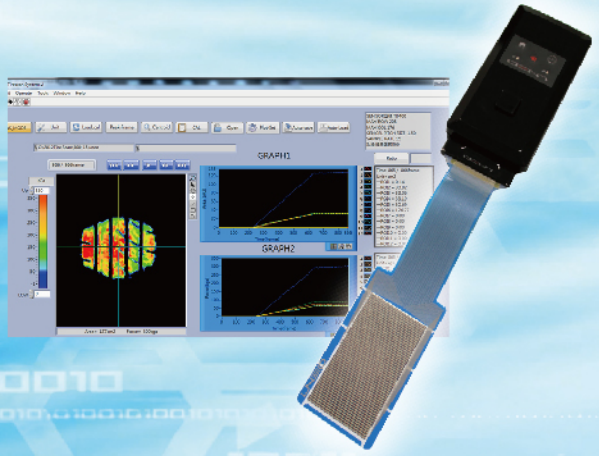

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NOVACENTRIX

JCA

PERVASIVE DISPLAYS

Polyera

SOLVAY

善营 SHINING

環球水泥股份有限公司 Universal Cement Corporation

XENON

Co-located Event

TPCA Show 2015

iMPACT International Microsystems, Packaging, Assembly Conference Taiwan

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＊本會議榮獲經濟部國際貿易局「推動國際會議及展覽在台辦理計畫」補助。