한국기계연구원 주요사업/일반사업, 협동연구사업(KM3000)의 연구비 지원으로 수행되었습니다.

3PS-266 전수민

Group III–V Semiconducting Nanocrystals For Hybrid Display Materials

전수민, 디 박, 이광섭† 한남대학교

As the current workhorse CdSe quantum dots have been well developed for display related applications. CdSe is environmentally restricted and has little future in industry. Group III–V semiconductors are attractive as they are less toxic than the II–VI analogues and show comparable luminescence properties with II–VI semiconductors. Among III–V semiconductors, InP has attracted much interest as a direct gap material with a band gap of 1.27 eV, which is suitable for getting visible emission in the quantum confinement regime. Chemical synthesis of InP/ZnS core/shell semiconducting nanocrystals or quantum dots (QDs) are well known. In this work we are describing the synthesis of InP/ZnS core/shell type NCs in various emission range in combination with various techniques to increase their quantum yield.

3PS-267 전수지

Preparation and Synthesis of novel acceptor–donor–acceptor type conjugated molecules for organic solar cells

전수지, 박상혁† 공주대학교

Solution-processed organic photovoltaic (OPV) devices offer a cost-effective approach to future renewable energy technology. However, there are still obstacles to accomplish high power conversion efficiencies (PCE) in OPVs because of the mismatch between the solar spectrum and the spectra of the organic materials used in active layer. To overcome this absorption limitation, synthesizing new low band gap materials is essential to improve PCE of organic solar cells. To this aim, three low band gap molecules consist of D (electron-donating unit) and A (electron-accepting unit) alternative structure were newly designed and synthesized. In this work, we have prepared A–D–A type small molecules with low bandgap, and their optical and electrochemical properties along with their application to actual OPV devices were investigated.

3PS-268 정민우

Effect of Side Alkyl Chain on Molecular Crystallinity in Small Molecule OTFTs and OPVs

정민우, 김봉수† 한국과학기술연구원

We synthesized a series of acceptor–donor–acceptor type small-molecules named Si1TDPP-EE and Si1TDPP-EE-C6. Si1TDPP-EE consist of dithienosiloe (Si) as donor and diketopyrrolopyrrole (DPP) as acceptor to have both optimal energy levels for exciton separation and planarity for close molecular packing and high carrier transport. In Si1TDPP-EE-C6, we introduced (2-hexyl)thiophene at the each end of Si1TDPP-EE for crystallinity increase. Si1TDPP-EE and Si1TDPP-EE-C6 exhibited electrochemical band gaps of 1.61 eV and 1.67 eV. In 2D-GIXD, Si1TDPP-EE-C6 showed higher crystalline ordering than Si1TDPP-EE. We found this increase of crystallinity affected the organic thin film transistor significantly. But this fact affect OPV performance adversely. This result demonstrates that a side alkyl chains induce crystallinity increase, while in molecules:$PC_{60}BM$ blends molecules can't have nano-scale phase separated channel.

3PS-269 정영식

Fabrication and Characterization of Fluorinated Polynorbornenes Transparent Substrate for Organic Light Emitting Devices (OLED)

정영식, 조훈정, 서덕진, 하창식† 부산대학교

Our polymer substrates were synthesized and polymerized *via* ring opening metathesis polymerization (ROMP). These polymer substrates were transparent with high thermally and mechanical stability. Polynorbornene polymer were synthesized with various amine by monofluoromethlyphenyl group and difluoromethlyphenyl group and phenyl group. The ring opening metathesis polymerization (ROMP) of norbornene dicarboximide derivatives(MFMPhNDI, DMFPhNDI and PhNDI) bearing phenyl groups was carried out with well-defined vinylidene ruthenium catalyst. This catalyst is highly active for the polymerization of norbornene dicarboximide derivatives. All of the prepared polymers have high average-transmittance from 400 to 800 nm Their glass transition temperatures were detected at temperatures over 200 °C.The another properties of polymers were investigated by GPC, TGA, WXRD, AFM, UV-Vis, FT-IR, AFM, etc.

3PS-270 정은숙

Spontaneous Phase Separation of Zinc Oxide (ZnO) Interfacial Layer in Bulk Heterojunction Polymer Solar Cells

정은숙, 유병관, 여준석, 김동유† 광주과학기술원

The interfacial layers in Polymer solar cells (PSCs) are necessary for high performance because it is useful to match the energy level between electrode and active layer. Thus the multiple structures of PSCs are required, however, these structures are not favorable to roll-to-roll processes and need additional cost of production. In this study, the active layer and electron transport layer (ETL) were simultaneously deposited with vertical phase separation. The zinc oxide (ZnO) was selected as ETL. The zinc acetate solutions were mixed in blended active solution of poly(3-hexylthiophene (P3HT) and [6,6]-phenyl-C_{61}-butyric acid methyl ester (PCBM). To analyze the phase separation, atomic force measurement, secondary ion mass spectroscopy and contact angle were measured. These results showed that the zinc atoms were vertically phase-separated due to difference of surface energy and density. These devices had similar performance compare to the device made by conventional method.

3PS-271 정의혁

The π-extended isoindigo-based low bandgap polymer for high-performance polymer solar cells

정의혁, 조원호† 서울대학교

Recently, low bandgap conjugated polymers have attracted considerable attention for polymer solar cells (PSCs). The desirable design directions for the polymers are that those should have deep HOMO energy levels, broad absorption and balanced crystallinity. Isoindigo, (*E*)-1*H*,1'*H*-[3,3']biindolylidene-2,2'-dione, which is one of the indigoid natural organic dyes is a symmetrical molecule containing two indolin-2-one units. Those contribute towards strong electron-withdrawing characteristic and planar π-conjugated structure of the molecule. Furthermore, isoindigo-based organic materials have broad absorption spectra, high extinction coefficients, and very deep HOMO energy levels which are closely related to open circuit voltage for PSCs. In this work, we present highly π-extended isoindigo-based alternating conjugated copolymer with 6.5% PCE. To the best of our knowledge, its photovoltaic performance is the best value reported to date for PSCs using isoindigo-based polymers.

3PS-272 정재웅

Semi-crystalline Random Conjugated Copolymers with Panchromatic Absorption for Highly Efficient Polymer Solar Cells

정재웅, 조원호† 서울대학교

Extension of light absorption of the conjugated polymer is one of the most important factors for enhancement of power conversion efficiency of polymer solar cells (PSCs) because the limited absorption of most conjugated polymers leads to lower current density. An effective approach to extend light absorption is synthesis of copolymers composed of at least two different chromophores with complementary absorption range. To broaden light absorption range and thus enhance the efficiency of PSCs, we synthesized random copolymers consisting of DPP and isoindigo as co-electron deficient units in D-A type copolymer. The random copolymers exhibited both broad light absorption and low-lying HOMO levels. Furthermore, predominant face-on orientation of random copolymers on substrate is beneficial for charge transport in device. Combination of excellent optoelectrical properties and favorable molecular orientation renders the random copolymer a promising candidate for active layer material in PSCs.

3PS-273 정지은

Diketopyrrolopyrrole (DPP)-Based Low-Band Gap Polymers for OTFTs and OPVs

정지은, 김혜민, 김은아, 백남섭[1], 강재욱[2], 김태동† 한남대학교; [1]한국전자통신연구원; [2]한국기계연구원

Recently diketopyrrolopyrrole (DPP)-based conjugated polymers have extremely fascinated as semiconducting materials for organic light emitting diodes (OLEDs), organic thin film transistors (OTFTs), and organic photovoltaics (OPVs). The DPP-based polymers have been shown to exhibit efficient luminescence, good field-effect charge transport, and small band gaps due to DPP core's electron deficient nature. Here we present the synthesis and detailed characterization of new low band-gap copolymers derived from DPP units containing 3,5-di-tert-butylbenzyl groups. The polymer has shown ~1% of power conversion efficiency (PCE) with ambipolar characteristics. Their thermal, optical, and electrochemical properties are also described.

3PS-274 제민경

Highly directional alternate direct n and p-channel for organic field-effect transistors and complementary ambipolar inverter

제민경, 표승문† 건국대학교

High performance ambipolar OFET and an inverter were fabricated by successive depositions of 6,13-bis(triisopropylsilylethynyl)pentacene (TIPS-pentacene) and copperhexadecafluorophthalocyanine ($F_{16}CuPc$). Ordered crystalline microwires of TIPS-pentacene were grown using solution processed capillary tube method and $F_{16}CuPc$ layer by using thermal evaporation method. We report a unique device architecture, in which $F_{16}CuPc$ was deposited on and in between the ordered crystalline microwires of TIPS-pentacene results the formation of highly directional alternate direct n and p-channel between source and drain. More than 90% ambipolar characteristics were achieved for the device consisting thick microwires and 140nm F16CuPc as active layer's materials. The device exhibited ambipolar mobilities with 3.38×10^{-3} cm^2/Vsec for hole and 1.35×10^{-4} cm^2/Vsec for electron, respectively. Further, air stable ambipolar inverters comprising two ambipolar OTFTs with a gain up to 8.0 is also demonstrated.

3PS-275 조동준

Organic Thin Film Transistor with Photo-polymerizable Liquid Crystalline Oligothiophene Semiconductor

조동준, 이몽룡, 손은호, M. Heeney[1], 송기국† 경희대학교 영상정보소재기술연구센터; [1]Imperial College London, U.K.

반도체 특성의 reactive mesogen 물질을 이용하여 유기박막트랜지스터(OTFT)를 제조할 때, 액정 상 reactive mesogen 분자들의 배열을 조절 한 후 광 반응을 하게 되면 일정하게 배열된 유기반도체 분자들의 필름을 얻을 수 있다. 이와 같이 유기반도체 분자들의 배열 상태를 조절할 수 있는 OTFT 소자를 제조하게 되면 유기반도체 분자 배열이 OTFT 전기적 성능에 미치는 영향을 상세하게 이해할 수 있으리라 본다. 본 연구에서 사용한 reactive mesogen 유기반도체 물질은 다섯 개의 thiophene ring으로 이루어져 있으며 양 말단에 광중합이 가능한 oxetane 그룹을 가지고 있다. 이 reactive mesogen 물질의 액정 특성을 DSC와 편광현미경으로 관찰하였고, UV-Vis과 FTIR spectrometer를 이용하여 분자들의 배향을 조사하였으며, OTFT 소자를 제작하여 유기반도체 분자의 배열 방향에 따른 OTFT 소자의 전기적 특성을 분석하였다.

3PS-276 조미영

π-Conjugated polyelectrolytes as an interfacial layer for polymer solar cells: conformation of polyelectrolytes

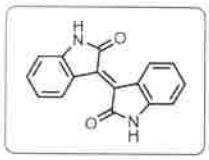
The π-Extended Isoindigo-Based Low Bandgap Polymer for High-Performance Polymer Solar Cells

정의혁, 조원호*

서울대학교 재료공학부

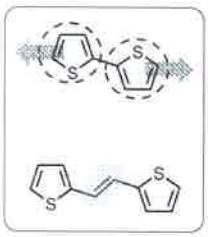
Introduction

❖ Advantages of isoindigo for high efficient organic solar cells



- Two lactam rings with strong electron withdrawing property
  ⇒ *Deep HOMO energy levels*
- Highly planar π-conjugated structure
  ⇒ *High hole mobility of OFETs*

❖ Features of conjugated polymer with thienylvinylene (TVT)



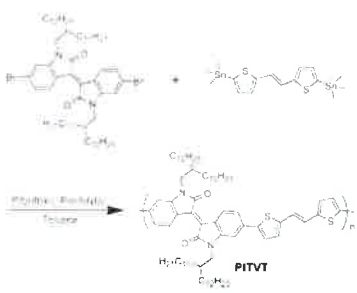
- Alleviation of steric hinderance on successive aromatic rings
  ⇒ *Enhanced polymer coplanarity*
- Promotion of closer intermolecular distance
  ⇒ *More increased charge-carrier transporting characteristics*

Objectives

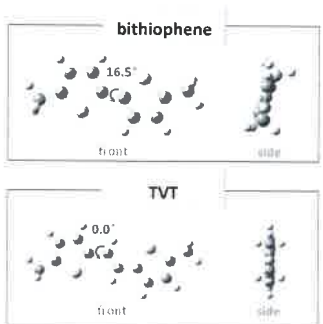
- **For high efficient polymer solar cells, synthesis of alternating low bandgap copolymer with isoindigo and thienylvinylene and characterization of photovoltaic properties of the polymer**
- **For well-developed morphology of active layer, optimization through control of binary solvents with good solvent and poor solvent for the polymer**

Results

❖ Synthesis of PITVT

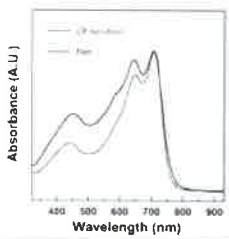


❖ DFT calculation

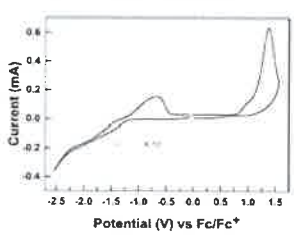


❖ Optical and electrochemical properties of the polymer

◆ UV-vis absorption spectra



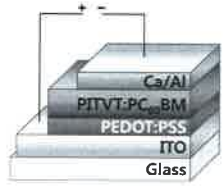
◆ Cyclic voltammogram



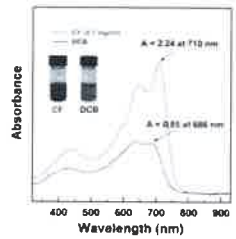
Polymer	M_n (kg mol^{-1})	PDI	Absorption λ_{max} ($CHCl_3$) (nm)	Absorption λ_{onset} (film) (nm)	E_g^{opt} (eV)	E_g^{ec} (eV)	LUMO (eV)	HOMO (eV)
PITVT	74.6	1.46	710, 644, 451	771	1.61	2.03	−3.61	−5.64

❖ Photovoltaic performance of the polymer

◆ Device structure



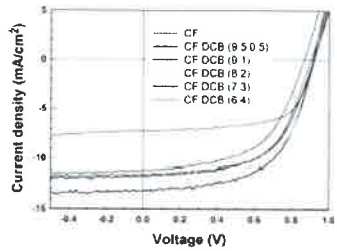
◆ Solubility of PITVT in CF, DCB

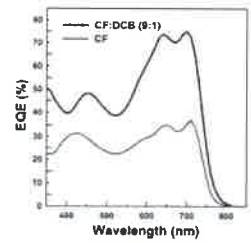


CF: Good solvent

DCB: Poor solvent (0.04 mg/ml)

◆ Device optimization via solvent control



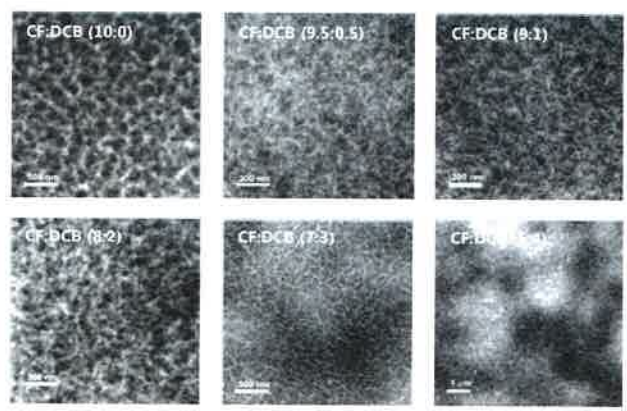


Solvent ratio (CF:DCB, v/v)	V_{OC} (V)	J_{SC} (mA/cm²)	FF	PCE (%)
10:0	0.92	7.19	0.66	4.33
9.5:0.5	0.87	11.01	0.54	5.18
9:1	0.91	13.15	0.59	7.09
8:2	0.92	12.41	0.58	6.66
7:3	0.92	11.61	0.58	6.21
6:4	0.90	11.44	0.60	6.18

* PITVT:$PC_{60}BM$ (1:1.5 w:w) / no additive

❖ Morphology of active layers

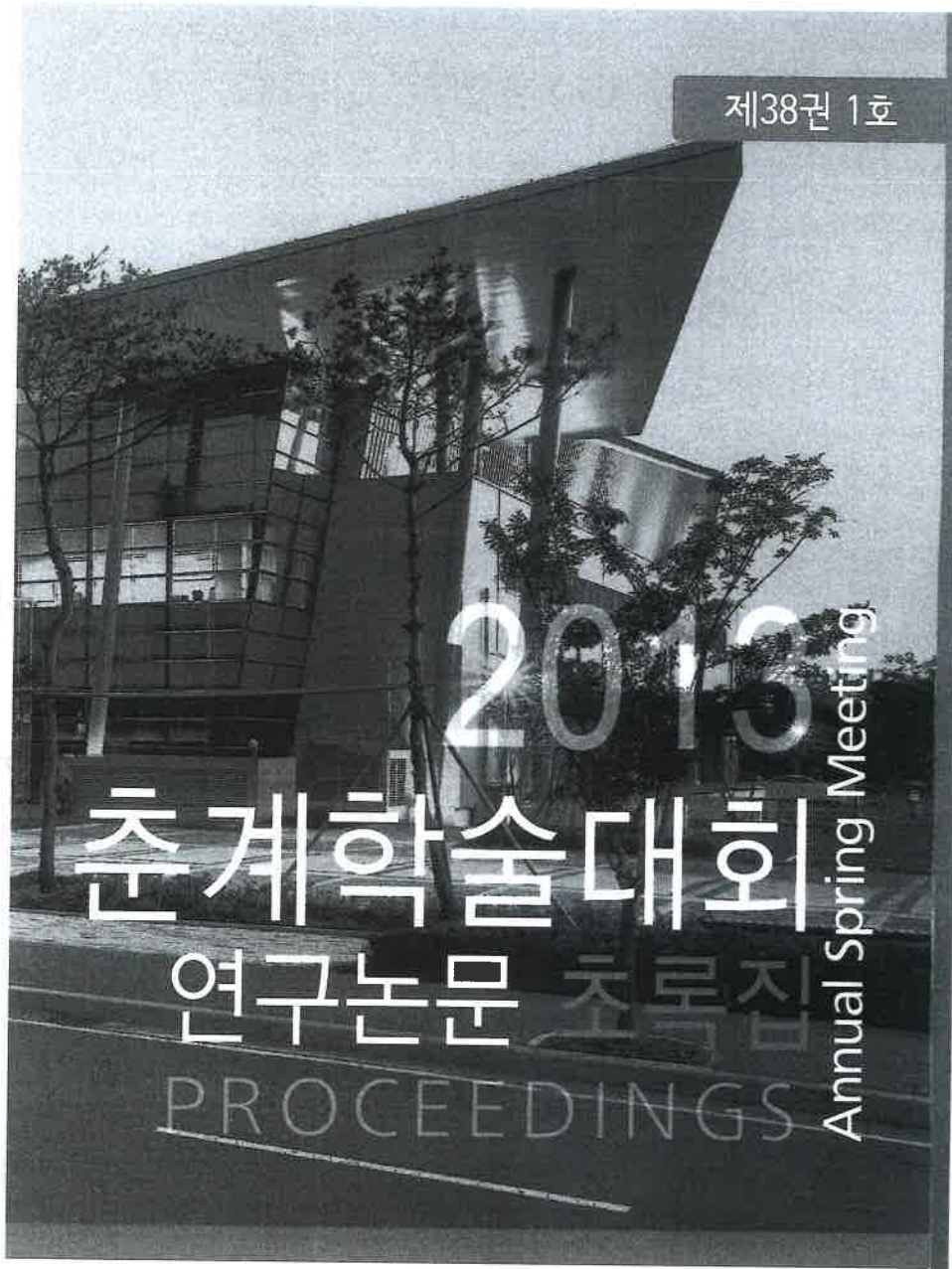
◆ TEM images



Conclusion

- **The π-extended isoindigo-based low bandgap copolymer, PITVT, was successfully synthesized and showed the power conversion efficiency of 7.09% in CF:DCB (9:1 v/v) binary solvent system.**

제38권 1호



2013 춘계학술대회
연구논문 초록집
PROCEEDINGS

Annual Spring Meeting

2013. 4. 11(Thu) - 12(Fri)

한국고분자학회
The Polymer Society of Korea
대전광역시
DAEJEON METROPOLITAN CITY
DIME 대전마케팅공사

일 정 표

4월 11일(목)

시간	행사	장소	비고
08:00–17:30	등 록	1층 로비	
09:00–10:30	**포스터 발표(I)** (좌장: 박재형, 김범준) (1PS–1~1PS–337)	1층 다목적홀	포스터(I) 게시
10:30–11:10	**[기조강연]** (좌장: 장태현) PL–1 고분자 산업의 새로운 르네상스 윤진녕, LG화학	총회장	
11:10–11:50	**[도레이고분자상 수상기념강연]** (좌장: 장지영) PL–2 High Performance Polyimide Dielectrics and Semiconductors: Low–k dielectrics, LC–alignments and Electrical Memories 이문호, 포항공과대학교		
11:50–12:50	**[제 74회 정기총회(춘계)]** 1.개회 2. 2013년도 학회상 시상 3. 회무보고 4. 2012년도 결산승인 5.기타토의 6. 폐회		
12:50–14:00	점 심		
14:00–18:00	초청강연 및 연구논문 발표(I) (초청강연 55편, 구두발표 45편)	각 발표회장	
18:30	간친회및 우수논문발표상 시상	간친회장	

4월 12일(금)

시간	행사	장소	비고
8:00–16:00	등록	1층 로비	
9:00–10:30	**포스터 발표(II)** (좌장: 양성윤, 강영종) (2PS–1~2PS–337)	1층 다목적홀	포스터(II) 게시
10:30–12:30	초청강연 및 연구논문 발표(II) (초청강연 28편, 구두발표 12편)	각 발표회장	
12:30–14:00	점 심		
14:00–16:00	초청강연 및 연구논문 발표(III) (초청강연 28편, 구두발표 12편)	각 발표회장	포스터(III) 게시
16:00–17:30	**포스터 발표(III)** (좌장: 김영진, 가재원) (3PS–1~3PS–337)	1층 다목적홀	