



2014 춘계학술대회 연구논문 초록집

PROCEEDINGS

The Polymer Society of Korea

2014. 4. 9 [Wed] - 11 [Fri] 대전컨벤션센터
Annual Spring Meeting



한국고분자학회
The Polymer Society of Korea



대전광역시
DAEJEON METROPOLITAN CITY

DIME 대전마케팅공사

cathode buffer layer can have a significant impact on the efficiency and stability of OPVs.

3PS-237 이윤지

Synthesis and Characterization of Naphtho[2,1-b:3,4-b']dithiophene-based Polymers
이윤지, 김유진[†], 장재열, 이재열, 이지상, 최효정, 김윤희[†], 권순기, 박찬연[†] 경상대학교; [†]포항공과대학교

A series of p-type polymers, Naphtho[2,1-b:3,4-b']dithiophene derivatives (NDT) were designed and synthesized. The polymers with another acceptor units were synthesized by Stille coupling reaction. The naphtho[2,1-b:3,4-b']dithiophene unit of the polymer main chain enhances charge carrier mobility by extending π -conjugation length and rigidly enforced coplanar structure. NDT-based polymers investigated their TFT characteristics.

3PS-238 이은광

Graphene-ruthenium complex hybrid photodetectors with ultrahigh photoresponsivity
이은광, Xien Liu, 오준학[†] 울산과학기술대학교; [†]울산과학기술대학교, 포항공과대학교
The maximum responsivity of a pure monolayer graphene-based photodetector is less than 10 mA W⁻¹. Here, we report a graphene hybrid photodetector functionalized with a photoactive ruthenium complex that shows an ultrahigh responsivity and a photoconductive gain under incident optical intensity of the order of milliwatts. This responsivity is two orders of magnitude higher than the precedent best performance of graphene-based photodetectors under a similar incident light intensity. Upon functionalization with a 4-nm-thick ruthenium complex, monolayer graphene-based photodetectors exhibited pronounced n-type doping effect due to electron transfer via the metal-ligand charge transfer (MLCT) from the ruthenium complex to graphene. The ultrahigh responsivity is attributed to the long lifetime and high mobility of the photoexcited charge carriers. Our approach is highly promising for improving the responsivity of graphene-based photodetectors.

3PS-239 이재현

Blue Emission Color Control Using Highly Efficient Blue Materials as Emitting Layer by Co-Deposition Method

이재현, 김수강, 신현규, 박종욱[†] 가톨릭대학교

In previous paper, we reported new high performance blue emitting materials, 9,10-bis(3',5'-diphenylbiphenyl-4'-yl)anthracene(TAT) and 4-(1'(3',5'-diphenylbiphenyl-4'-yl)anthracen-9-yl)-N,N-diphenylaniline (TATA) which have electroluminescence (EL) maximum values of 443nm and 469nm. OLED devices were fabricated and characterized by co-deposited emitters of TAT and TATA with different ratio. EL maximum wavelength was changed from 443nm to 469nm. Further data will be discussed in presentation.

3PS-240 이정준

Enhancement of Efficiency and Air stability in Polymer Solar Cell with Modified PEDOT/PSS Buffer Layer using Polymeric Additives

이정준, 김중현[†], 이승환, 박훈교, 조원석, 이진종[†] 연세대학교; [†]마시건 대학교

In most of the bulk heterojunction (BHJ) OSCs, poly(4-styrene sulfonate)-doped poly(3,4-ethylenedioxythiophene (PEDOT:PSS) is widely used as hole transport layers (HTL). However, PEDOT:PSS accelerates the degradation of OSCs due to its highly hygroscopic and acidic nature. To solve this problem, PEDOT:PSS was modified to have a resistance from water using polymeric additive. As a results, power conversion efficiency(PCE) increased from 2.51% to 3.30% by 31% and half-life times also increased around 3 times. The electrical and morphological properties of modified PEDOT:PSS was analyzed by X-ray photoelectron spectroscopy(XPS), Kelvin probe, 4-point probe meter and atomic force microscopy(AFM) respectively. This method is very simple on the production process and shows a lot of applicability in various organic electric device such as OPV, OLED, OTFT etc.,.

3PS-241 이정호

Synthesis of lactam-based conjugated polymers: Siloxane terminated solubilizing side chains with bithiophene and biselenophene

이정호, 이상면, 양창덕[†] UNIST

Recently, Bao et al. demonstrated the effectiveness of siloxane terminated solubilizing groups as side chains in and isoindigo-containing polymer with bithiophene PI12T-Si. Besides, Jian Pei et al. reported the research of 2-octyl-dodecyl alkylated isoindigo based polymer with many counter parts, and among them the bithiophene polymer PI1DDT showed the best mobility. In the line of this work, we hear in report siloxane isoindigo polymer consistently biselenophene as a counter part, and its transistor is in depth investigated. In comparing with analog isoindigo bithiophene polymer.

3PS-242 이정훈

Diketopyrrolopyrrole-based small molecules for BHJ solar cells

이정훈, 강효진, 양창덕[†] 울산과학기술대학교

An easily accessible DPP-based small molecules with different alkyl chain have been synthesized by a simple and efficient route.

3PS-243 이정희

A Study of Crystallization Variation of Polymer Dielectrics on Charge Trapping Behavior in Organic Field-Effect Transistors

이정희, 이희정[†] 한밭대학교

유기재료를 반도체로 사용하는 유기박막트랜지스터(organic field-effect transistors, OFETs)에서 절연체 특성은 threshold voltage(V_{th}), mobility, hysteresis 등과 같은 소자성능에 큰

영향을 끼친다. 고분자 절연체의 다양한 특성 중에서 Polymer 결정성과 절연체내의 charge trapping과의 상관관계에 대한 연구는 현재 부족한 실정이다. 본 연구에서는 고분자 절연체의 crystallization 정도가 charge trapping에 미치는 영향을 정확하게 확인하고자 한다. 이를 위해 대표적인 polymer 물질인 poly(methyl methacrylate) (PMMA)의 결정도를 tacticity를 통해 제어하였다. 실험결과 고분자 절연체의 결정화도와 charge trapping에 대한 체계적인 이해가 이루어졌고, 절연체의 결정화도가 높을수록 current decay의 감소와 소자안정성이 증가함을 확인하였다. 또 고분자의 두께에 변화를 주어 deep-trap에 의한 charge trapping을 증명하였다.

3PS-244 이주한

Surface plasmon resonance of simple solution-processed silver nanoparticles in AC Driven Polymer Electroluminescence Device

이주한, 박철민[†], 조성환 연세대학교 신소재공학과

Surface plasmons are collective oscillations of free electrons in a metal at an interface with a dielectric. The coupling effect between excitons and surface plasmons, which is caused by the overlap of the local electromagnetic field of excitons in the emissive layer and surface plasmons, leads to significant radiative emission through effective energy transfer in polymer LEDs (PLEDs). The AC driven surface Plasmon resonance was used between fluorescent polymers with simple solution-processed silver nanoparticles. We demonstrated an extremely high brightness of solution-processed polymer AC EL device with brightness of approximately 15,000 cd m⁻² for yellow.

3PS-245 이지현

Synthesis of Novel Low-bandgap Polymer Containing Fluorinated Benzoimidazole for Polymer Solar Cells

이지현, 김원준, 진영음[†] 부경대학교

A new donor-acceptor conjugated polymer (PBDT-DFBI), which consists of difluoro-alkyl benzoimidazole electron-acceptor unit and an electron-donor segment of alkoxy substituted benzo[1,2-b:4,5-b']dithiophene (PBDT), was synthesized according to palladium catalyzed the Stille coupling reaction. The resulting copolymer was characterized by TGA, GPC, UV-vis absorption spectroscopy and cyclic voltammetry measurements. PBDT-DFBI good thermal stability and poor solubility in common types of organic solvents. The polymer based on benzoimidazole units show λ_{max} at 365 ~ 508 nm. With a highest occupied molecular orbital (HOMO) energy level around -5.20 eV, these polymers exhibit a narrow bandgap of 1.75 ~ 1.87 eV.

3PS-246 이진용

Synthesis and Photovoltaic Properties of Benzo[1,2,4]oxadiazole-Based Copolymer Containing Fluorinated Benzene as Weak Electron Donating Unit for Polymer Solar Cells

이진용, 조재용, 조원석[†] 서울대학교 재료공학부

1,4-Di(thiophene-2-yl)benzene (DTB), which is a phenyl compound flanked with thiophene, was synthesized via a simple synthetic route and utilized as a weak electron-donating unit in D-A type copolymer for lowering the HOMO of the copolymer. A copolymer (PDTBDTBT) was synthesized by reacting DTB with 4,7-di(thiophen-2-yl) benzo[c][1,2,5]thiadiazole (DTBT). Fluorination of benzene moiety between thiophene (F2DTB) was carried out for further lowering the HOMO energy level of the copolymer due to the strong electron-withdrawing property of fluorine. When the F2DTB is used as an electron-rich unit for conjugated copolymers (PF2DTBDTBT) which exhibits a deep HOMO energy level of -5.5 eV, the PSCs fabricated from PF2DTBDTBT exhibit a high V_{oc} , leading to a promising PCE.

3PS-247 이진원

Morphology control of bi-planar structured perovskite solar cells

이진원, 김석순[†] 전북대학교 유연인쇄전자전문대학원; [†]군산대학교

Recently, organic/inorganic perovskite (e.g. CH₃NH₃PbI₃) based solar cells have attracted great attention because of high efficiency and simple fabrication process without use of vacuum system. Especially, interests in perovskite/[6,6]-phenyl C₆₁-butyric acid methyl ester (PCBM) planar heterojunction solar cells that can be fabricated by simple solution process at low-temperature of ~100 °C have dramatically increased and performance has been continuously improved up to ~11%. However, the uncontrolled precipitation of the perovskite crystalline inducing large morphological variations results in poor reliability of device performance. In this study, we will discuss structural, electrical, and optical characteristics of solution processed perovskite layers and their effect on the performance.

3PS-248 이치환

Photovoltaic Property of Dye-Sensitized Solar Cell based on Metal-free Organic Photosensitizers

이치환, 정주희, 이윤서, 김재홍, Le Quoc Bao, 한운수[†], 김재홍[†] 영남대학교; [†]대구가톨릭대학교

Dye-sensitized solar cells (DSSCs) have attracted considerable attention on account of their high solar energy-to-conversion efficiencies and low cost processes compared to conventional p-n junction solar cells. Despite potential advantages of their high molar extinction coefficient, convenient, and customized molecular design for their photophysical and photochemical properties, the organic photo-sensitizer still remain rather limited application field mainly because of their lower conversion efficiencies (2~9%) and stabilities, compared to Ru-dyes. In this work, the DSSCs were fabricated with double electron acceptor metal-free organic photo-sensitizer on the phenothiazine framework that was bridged with thiophene moieties. An organic dye with a single electron acceptor was also synthesized for comparison purposes.

**Synthesis and Photovoltaic Properties of Benzothiadiazole-Based Copolymer
Containing Fluorinated Benzene
as Weak Electron Donating Unit for Polymer Solar Cells**

이진용, 조제웅, 조원호

서울대학교 공과대학 재료공학부

1,4-Di(thiophene-2-yl)benzene (DTB), which is a phenyl compound flanked with thiophene, was synthesized via a simple synthetic route and utilized as a weak electron-donating unit in D–A type copolymer for lowering the HOMO of the copolymer. A copolymer (PDTBDBTBT) was synthesized by reacting DTB with 4,7-di(thiophen-2-yl)benzo[c][1,2,5]thiadiazole (DTBT). Fluorination of benzene moiety between thiophenes (F2DTB) was carried out for further lowering the HOMO energy level of the copolymer due to the strong electron-withdrawing property of fluorine. When the F2DTB is used as an electron-rich unit for conjugated copolymers (PF2DTBDBTBT) which exhibits a deep HOMO energy level of -5.5 eV, the PSCs fabricated from PFDTBDBTBT exhibit a high V_{OC} , leading to a promising PCE.



Synthesis and Photovoltaic Properties of Benzothiadiazole-Based Copolymer Containing Fluorinated Benzene as Weak Electron Donating Unit for Polymer Solar Cells



이진용, 조제웅, 조원호*
서울대학교 재료공학부

Introduction

Energy level tuning and planar packing of D-A type materials

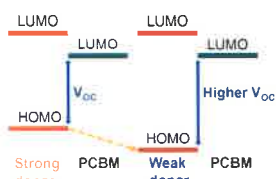
Weak electron-rich units for high V_{OC}



- The highest electronegativity
- Smaller size than other electron-withdrawing groups
→ less steric hindrance

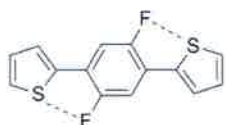


- Electron-withdrawing substituents for weak electron-rich units



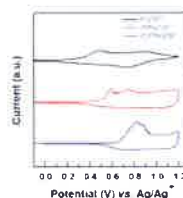
- By introducing weak electron-rich units in conjugated polymers

Interactions for planar structure



- Conformational locking to promote π -system coplanarity via F...S interactions

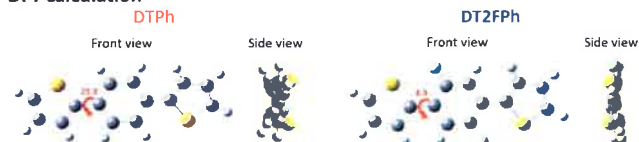
Cyclic voltammograms



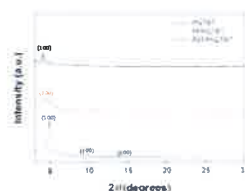
Polymer	HOMO (eV)	LUMO ^[a] (eV)
PQTBT	-5.14	-3.49
PPhQTBT	-5.34	-3.57
P2FPhQTBT	-5.48	-3.76

- ^[a] calculated from the optical bandgap and the HOMO energy level. LUMO = HOMO + E_g^{opt}

DFT calculation

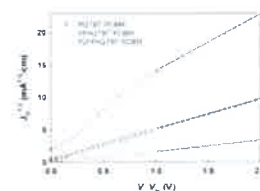


X-ray diffraction data



Polymer	d spacing (nm)
PQTBT	2.08
PPhQTBT	1.97
P2FPhQTBT	1.83

SCLC mobilities



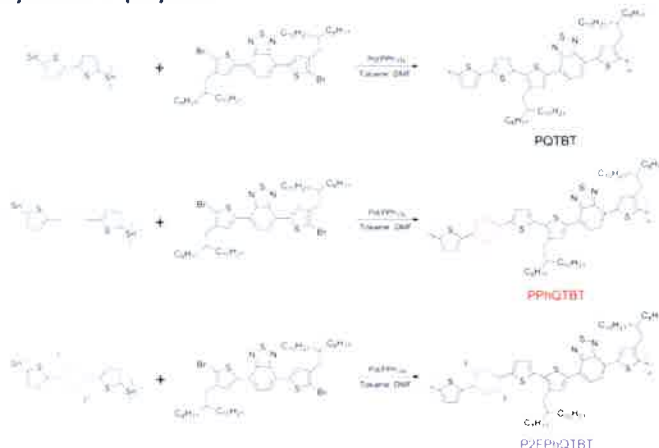
Polymer	μ_n (cm ² /Vs)
PQTBT	8.46×10^{-4}
PPhQTBT	1.09×10^{-4}
P2FPhQTBT	2.37×10^{-3}

Objectives

- To lower the HOMO energy level of the polymers copolymerized with benzothiadiazole (BT) by introducing weak electron-rich units in conjugated polymers
- To investigate the effects of fluorine substitution on conformational change and charge carrier mobility of synthesized polymers

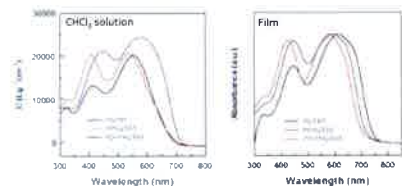
Results

Synthesis of polymers



Characterization of polymers

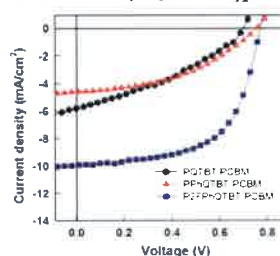
UV visible absorption spectra



Polymer	E_g^{opt} (eV)
PQTBT	1.65
PPhQTBT	1.77
P2FPhQTBT	1.72

Photovoltaic properties and morphology

J-V curves of polymer/PC₇₁BM blend solar cells



Polymer	J_{sc} (mA/cm ²)	V_{oc} (V)	FF	PCE (%)
PQTBT	5.8	0.70	0.35	1.42
PPhQTBT	4.6	0.76	0.43	1.50
P2FPhQTBT	10.0	0.77	0.60	4.62

- Device configuration: ITO/PEDOT:PSS/polymer:PC₇₁BM (1:1)/Ca/Al

TEM images



Conclusions

- Conjugated polymers of BT with weak electron-rich units, PPhQTBT and P2FPhQTBT, are successfully synthesized and show high V_{OC} s of 0.76 V and 0.77 V, respectively.
- Polymers substituted with fluorine atoms exhibits more favorable packing structure to transport free charge carriers than non-fluorinated, which leads to high PCE of 4.62%.