●

Antonio Facchetti

Yueh-Lin Loo Perepichka Igor Perepichka Dmitrii

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18680322139 feizhang@pku.edu.cn

18565790920 heyw@pku.edu.cn

13692275586 zhaochb@pku.edu.cn

13713595527 wyuting@pku.edu.cn

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8:35-8:50	Antonio Facchetti	Northwestern University	Elastic Semiconductors for Mechanically Flexible Organic Transistor Architectures
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17:05-17:15	Molecular and Nano Effects on Organic Charge Trapping Transistor Memory
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17:25-17:35	Controllable Aggregation of Conjugated Polymer Monolayer: from Field-Effect Transistors to Integrated Circuits
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13:55-14:10		Solution-Grown Organic Single-Crystalline Heterojunctions
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15:10-15:25		Tuning the transport properties of D-A conjugated polymers by optimizing the substituents: ADFT study
15:25-15:45		
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16:25-16:35		Phosphorus-Containing Semiconducting Materials for Optoelectronic Applications
16:35-16:45	Mingfeng Wang	-Conjugated semiconducting molecules □ 7□ □ □ □ □ applications
16:45-16:55		
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17:15-17:25		The wettability control of interface for high-performance organic thin-film transistors by soluble insulating polymer films
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10:15-10:25	Carbon Based Integratable Soft Thin Film Transistors
10:25-10:35	
10:35-10:45	Electrolyte-gated Organic Transistor for Optoelectronic Applications
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08		High-capacity and multi-bit non-volatile memory with the double floating gate
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11		Study of hysteresis in organic thin film transistors based on NDI derivatives
12		Mn^{2+} Doped All-inorganic Lead-Free Cs2PdBr6 for Near Infrared Photodetector
13		Synthesis, Properties, and Thin-Film Transistors of Indolo[3,2-b]carbazole
14		□ □ □ □ □ -Stacks of Hexabenzoperylenes
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18		High quality wafer-scale Graphene & Boron Nitride on large monocrystalline copper by CVD method
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20		Design, synthesis and properties of two new integrated optoelectronic anthracene derivatives
21		OFET
22		Enhanced Performance in Doped Micro-Nano Porous Organic Thin-Film Transistors
23		Inverted Annealing Enhanced Performance of Organic Thin-Film Transistors and Phototransistors Based on 2-(4-dodecylphenyl) [1]benzothieno[3,2-b]benzothiophene
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26		Solution Processed Centimeter-scale Highly-aligned Organic Single-crystal Arrays for High-performance Organic Field-effect Transistors
27		
28		High n-channel Mobility and Transport Kinks in C60 Field Effect Transistor with Phosphonic Acid Interfacial Layers
29		

38	Application of organic/inorganic nanocomposites in piezoresistive sensors
39	Wide Band Gap Pyromellitic Diimides for Photo Stable n-Channel Thin Film Transistors
40	Single-Crystal Organic Field-Effffect Transistors of Dibenzofuran (DBF) linked BTBT
41	Thermal Stable Organic Thin Film Transistors Based on Tetracene
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13796634967 wangyueyi@pku.edu.cn

18516991291 chenwl0302@pku.edu.cn

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wang-tao@pku.edu.cn

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18680322139 feizhang@pku.edu.cn

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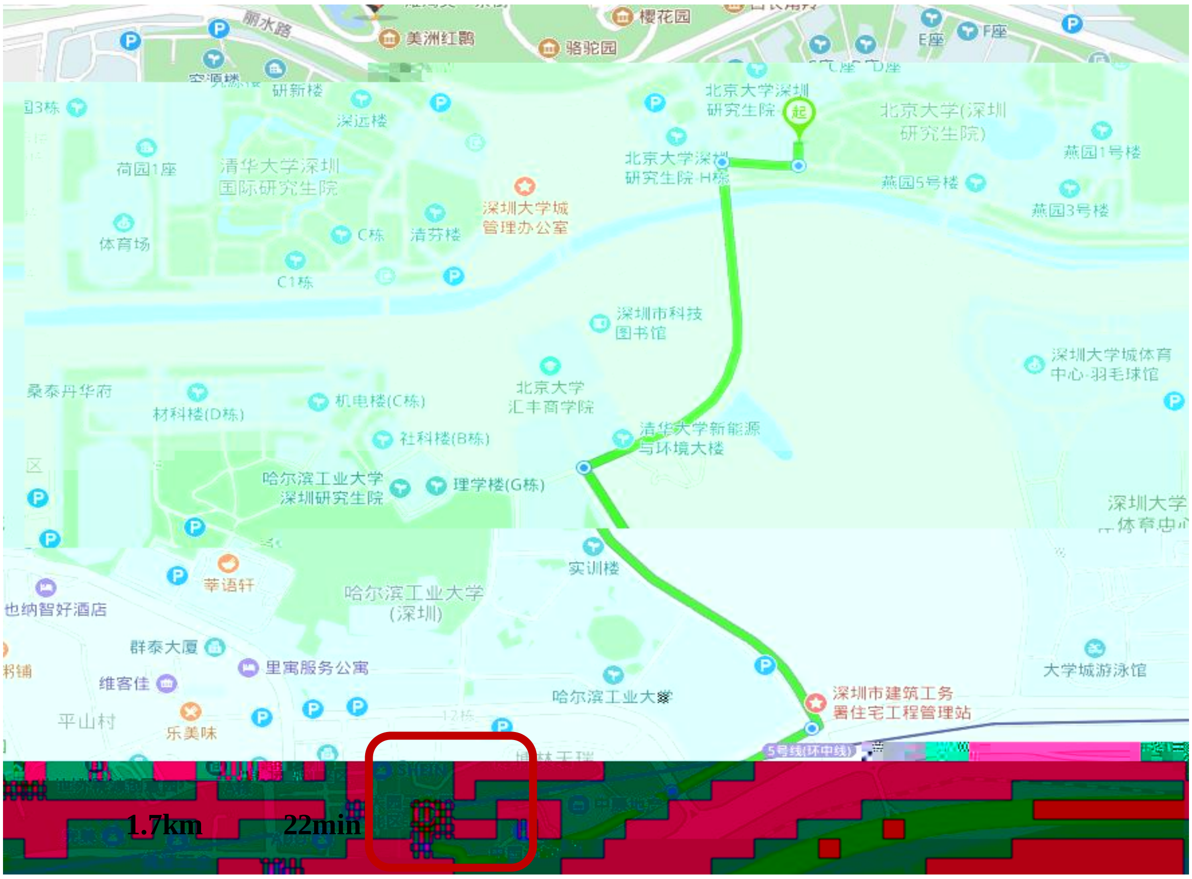

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Recent Advances in Flexible Optoelectronics

AN Zhongfu[1], CHAO Jie[2], CHEN Runfeng[2], CHEN Yonghua[1], FAN Quli[2], HUANG Ling[1], HUANG Xiao[1], HUO Fengwei[1], LAI Wenyong[2], LI Lin[1], LIU Juqing[1], SUN Huibin[1], WANG Jianpu[1], WANG Lianhui[2], WANG Nana[1], XIE Linghai[2], ZHAO Qiang[2], LIU Xiaogang[3], YU Ting[3], ZHANG Hua[3], and HUANG Wei[1,2,3,*]

[1] Key Laboratory of Flexible Electronics (KLoFE) & Institute of Advanced Materials (IAM), Nanjing Tech University (NanjingTech), 30 South Puzhu Road, Nanjing 211816, China

[2] Key Laboratory for Organic Electronics and Information Displays (KLOEID) & Institute of Advanced Materials (IAM), Nanjing University of Posts & Telecommunications (NUPT), 9 Wenyuan Road, Nanjing 210023, China

[3] Institute of Flexible Electronics (IFE), Northwestern Polytechnical University (NPU), 127 West Youyi Road, Xi'an 710072, China

E-mail: iamwhuang@nwpu.edu.cn

In the past decades, organic optoelectronics has made great progress both in fundamental studies and commercial applications because of their excellent properties, such as solution processable, flexible, low-cost and able to be made at large area. Our recent work is devoted to the development of high-performance organic semiconductors for flexible electronics and optoelectronics. We will present our recent advancement on rational molecular design of organic semiconductors for light-emitting diodes, lasers, memories, chemo-/biosensors, and latest research results about ultralong organic phosphorescence, light-emitting perovskites and color display technologies.

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Biography

HUANG Wei is Academician of Chinese Academy of Sciences (CAS), Russian Academy of Sciences (RAS), Academy of Engineering and Technology (ASEAN), Asian Pacific Academy of Materials (APAM), and Pakistan Academy of Sciences (PAS). He is Deputy President & Provost of Northwestern Polytechnical University, and an eminent scientist in the area of organic/plastic optoelectronics and flexible electronics. Academician Huang is one of the earliest and most renowned scientists in the field of organic optoelectronics and plastic electronics. Since early 1990s, he has focused on the frontier areas in organic optoelectronics which developed from Physics, Chemistry, Materials Science, Life Science, Electronics, and Information Science & Technology based interdisciplines. Academician Huang has established the principal framework for organic optoelectronics, achieved high-performance and multi-functionalization organic semiconductors, boosted the commercialization and industrialization of scientific and technological achievements, enabling him the founder and pioneer of organic optoelectronics and flexible electronics in China. In the area of organic optoelectronics and flexible electronics, he has made a large amount of systematic and innovative achievements and has published more than 760 papers as the first author or corresponding author in *Nature*, *Nature Materials*, *Nature Photonics*, *Nature Nanotechnology, Nature Communications, Advanced Materials, Journal of the American Chemical Society,* etc, with over 73,000 citations and an h-index of 123. He has held over 360 patents which are granted in USA, Singapore, and China, etc. Additionally, Academician Huang has published several books, such as *Organic Electronics, Bio-optoelectronics*, etc.

Elastic Semiconductors for Mechanically Flexible Organic Transistor Architectures

Antonio Facchetti

[1] Northwestern University 2145 Sheridan Road, Evanston IL, 60208 USA

*Email: a-facchetti@northwestern.edu

In this presentation we report the development of novel semiconductors, as well as thin-film engineering, for flexible organic transistors. In particul -
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mechanical stress, demonstrating that polymer backbone composition is more important that film degree of texturing. Furthermore, by fabricating polymer/polymer blends by shear techniques, it provides a new avenue to enhance charge transport and achieve excellent mechanical robustness, which is further increased by modification of th)
enhancing mechanical flexibility and tune charge transport. These devices can better sense analytes, intercalate ions, and be doped.

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Biography

Antonio Facchetti is a co-founder and currently the Chief Technology Officer of Flexterra Corporation. He is also an Adjunct Professor at Northwestern University. He has published more than 480 research articles, 13 book chapters, and holds more than 130 patents. He received the ACS Award for Creative Invention, the Giulio Natta Gold Medal of the Italian Chemical Society, the team IDTechEx Printed Electronics Europe Award, the corporate Flextech Award. He is a Fellow of the National Academy of Inventors, MRS, AAAS, PMSE, Kavli, and RSC Fellow. He was selected among the "TOP 100 MATERIALS SCIENTISTS OF THE PAST DECADE (2000-2010)" and recognized as a Highly Cited Scientist by Thomson Reuters.

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*Email: miaoqian@cuhk.edu.hk

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*Email: haoli.zhang@lzu.edu.cn

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*Email: apafyan@polyu.edu.hk

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*Email: guoxg@sustech.edu.cn

Imide-functionalized arenes are excellent building blocks for constructing high-performance n-type organic and polymeric semiconductors due to their strong electron-withdrawing capability and good solubilizing ability. However, development of such arenes is highly challenging due to the synthetic barriers and the accompanying steric hindrance. Herein, various ladder-type imide-functionalized arenes up to 5 imide groups and 15 rings are successfully synthesized and characterized. Due to their unique physicochemical properties and compact structures, these imides are highly suitable for developing novel acceptor-acceptor (A-A) type homopolymers, which show well-tailored frontier molecular orbital (FMO) energy levels and film morphologies. Moreover, two imide-functionalized thiazoles, DTzTI and DTzI, are also invented, which enable access to a series of A-A homopolymers, donor-acceptor (D-A) copolymers, and donor-acceptor-acceptor (D-A-A) copolymers, showing distinct acceptor loadings in backbone and widely tunable FMO energy levels. When incorporated into organic thin-film transistors (OTFTs), the A-A type homopolymers exhibit unipolar n-type transport characteristics with the highest electron mobility > 3 cm^2 V^{-1} s^{-1}. Notably, all homopolymers do not show undesirable kink in transfer curves, thus avoiding mobility overestimation. The deep-lying FMO levels result in greatly suppressed off-currents (I_{off}s) of 10^{-10} - 10^{-11} A and remarkable on-current/off-current ratios ($I_{\mathrm{on}}/I_{\mathrm{off}}$s) of 10^7 - 10^8 in transistors, which are critical for practical applications. In addition to imide group, another strong electron-withdrawing group, i.e. cyano, is also introduced to polymers, which also show highly promising device performance in n-type OTFTs,

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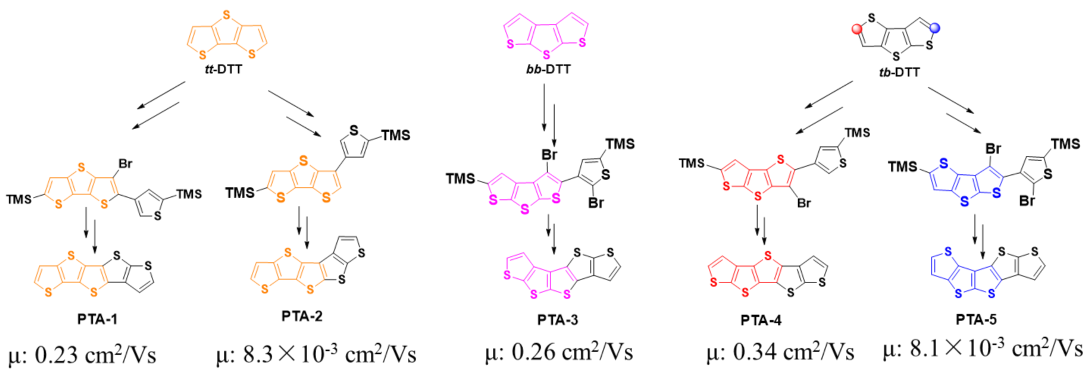

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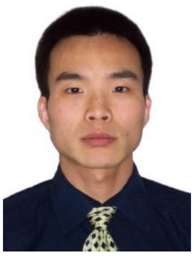

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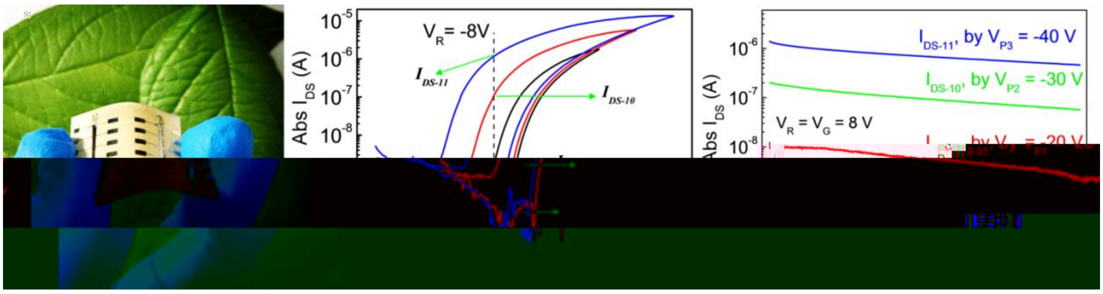

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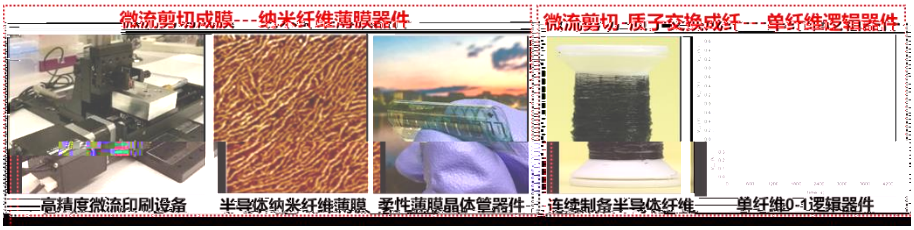

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Interfacial Effects & Physics of Molecular Crystalline Semiconductors under Two-Dimensional Limit

Yun Li

[1] School of Electronic Science & Engineering, Nanjing University, Nanjing 210093

*Email: yli@nju.edu.cn

To achieve the sustainable advancement in organic electronics, elucidating the intrinsic microscopic motion of charge carriers and realizing functional organic devices with superior optoelectronic characteristics are of significant importance. Recently, we proposed techniques for efficient fabrication of ultrathin molecular crystalline semiconductors. Thus, a revolutionary opportunity to study and even utilize their unique interfacial effects under a two-dimensional limit, to directly examine related influences on the charge transport, and to achieve devices with high performance, is offered. For instance: 1) an interfacial flat-lying molecular monolayer has the buffering effect to reduce the interaction from the dielectric layer, thus narrowing the trap distribution near the HOMO level. 2) the interfacial vdW interaction is studied to be utilized for controlling the self-assembly of small-molecule semiconductors, and large-area mono- & bilayer 2D molecular crystals are fabricated for their applications in high-performance transistors. 3) the interfacial templating effect is presented from a spin-coated molecular monolayers for enhancing the device performance. 4) ultralow energy consuming ferroelectric organic transistor memories are achieved by virtue of very efficient charge injection and low operation voltage due to the ultrathin thicknesses of functional layers. 5) ultrathin crystalline semiconducting layer can well shorten the exciton diffusion length, thus leading to a much fast response speed as in a UV phototransistor.

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*E-mail: hujianyong@snnu.edu.cn

(NDTI) LUMO (–4.0 eV) π π [1] NDTI (PNDTI-TV PNDTI-NDT PNDTI-V PNDTI-BTz PNDTI-NTz) NDTI (NDTI-BBT NDTI-BNT NDTI-BTE NDTI-BPE NDTI-B2PdE NDTI-B4PdE NDTI-B2Az NDTI-B6Az) (Fig.1) LUMO (< –4.0 eV) HOMO n FET[2,3]

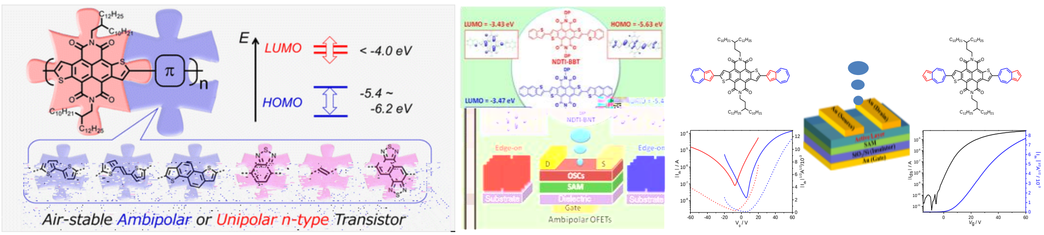

Fig 1. NDTI-integrated polymers (left) and NDTI-derived triad-type molecules (middle and right).

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*Emails: gaoxu@suda.edu.cn; wangsd@suda.edu.cn

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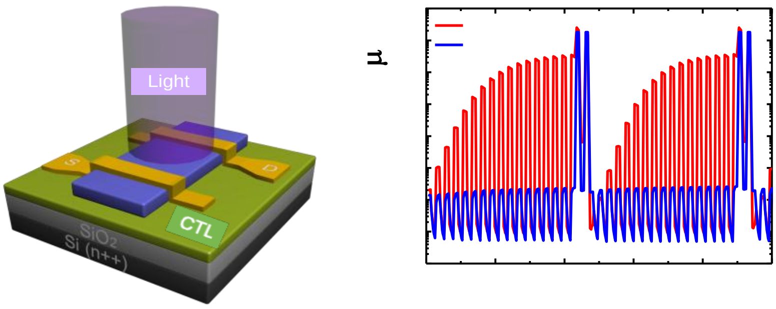

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3 Center for Materials, Architectures and Integration of
Nanomembranes (MAIN),TU Chemnitz, Chemnitz 09126, Germany
4 Institute for Integrative Nanosciences, Leibniz IFW Dresden,
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*Email: zhufeng@ciac.ac.cn

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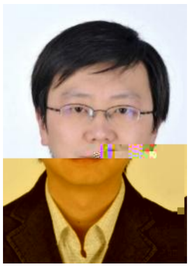

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Carbon nanotube based high performance and low power CMOS devices

Lian-Mao Peng

Department of Electronics, Peking University, Beijing 100871, China

Email: lmpeng@pku.edu.cn / Phone:86 10 62764967

Carbon nanotube (CNT)-based electronics has been considered one of the most promising candidates to extend Si complementary metal-oxide-semiconductor (CMOS) technology, which will soon meet its performance limit. In particular CNTs have been investigated for various electronic and optoelectronic device applications, such as sub-10nm CMOS devices which outperform that of state-of-the-art Si based CMOS devices in both speed and power consumption, as well as idea material for monolithic optoelectronic integration with complementary MOS-compatible signal processing circuit.

Prototype device studies on individual CNTs revealed that CNT based devices have the potential to outperform Si CMOS technology in both performance and power consumption. With a well-designed device structure and in combination with graphene, we showed that high-performance top-gated CNT FETs with a gate length of 5 nm can be fabricated. A scaling trend study revealed that sub-10 nm CNT CMOS FETs significantly outperform Si CMOS FETs. In particular, the 5 nm CNT FETs approach the quantum limit of FETs and involve only approximately one electron per switch. The contact length of the CNT CMOS devices has been scaled down to 25 nm, and the smallest CMOS inverter yet reported with a total pitch size of 240 nm is demonstrated. These results show that CNT CMOS technology has the potential to substantially outperform that of Si when approaching the quantum limits of a binary logic switch and to extend mainstream CMOS technology in the post-Moore era [1].

Significant progress has also been made in fabricating carbon nanotube low-power devices. An efficient way to reduce the power is to lower the supply voltage V_{DD}, but this voltage is restricted by the 60 millivolts per decade thermionic limit of subthreshold swing (SS) in FETs. A Dirac source (DS) with a much narrower electron density distribution around the Fermi level than that of conventional FETs was recently proposed and demonstrated using CNT to reduce SS [2]. In particular, a DS-FET with a carbon nanotube channel provided an average SS of 40 millivolt per decade over four decades of current at room temperature and high device current. When compared with state-of-the-art Si 14-nanometer node FETs, a similar I_{on}

Nano-Carbon Imides: Precise Synthesis and Applications

Zhaohui Wang

Key Laboratory of Organic Optoelectronics and Molecular Engineering, Department of Chemistry, Tsinghua University, Beijing, 100084, P. R. China

E-mail: wangzhaohuis@mail.tsinghua.edu.cn

Nano-carbon imides, especially extended rylene imides are attracting ever-increasing academic attention with aiming at seeking desirable functionality for various optoelectronic devices. The readily derivative nano-carbon skeleton combining easily modifiable imide chains results in a variety of robust materials with intense absorbance

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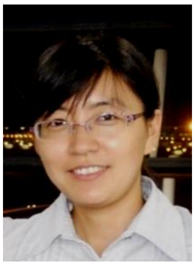

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Perovskite LEDs: High Efficiency and High Brightness

Jianpu Wang[1]

[1]*Key Laboratory of Flexible Electronics (KLOFE) & Institute of Advanced Materials (IAM), Jiangsu National Synergetic Innovation Center for Advanced Materials (SICAM), Nanjing Tech University*

iamjpwang@njtech.eud.cn

Solution-processed light-emitting diodes (LEDs) are attractive for applications in low-cost, large-area lighting sources and displays. Organometal halide perovskites can be processed from solutions at low temperatures to form crystalline direct-bandgap semiconductors with intriguing optoelectronic properties, such as high photoluminescence yield, good charge mobility and excellent color purity. In this talk, I will present our effort to boost the efficiency of perovskite LEDs to a high level which is comparable to organic LEDs. More importantly, organic LEDs are difficult to maintain high efficiency at high current densities due to their excitonic nature and low charge mobilities. Low temperature solution-processed perovskite LEDs demonstrate remarkably high efficiency at high current densities, suggesting unique potential to achieve large size planar LEDs with high efficiency at high brightness.

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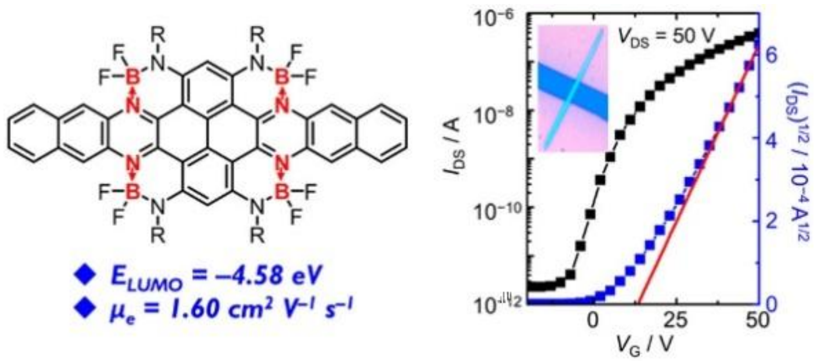

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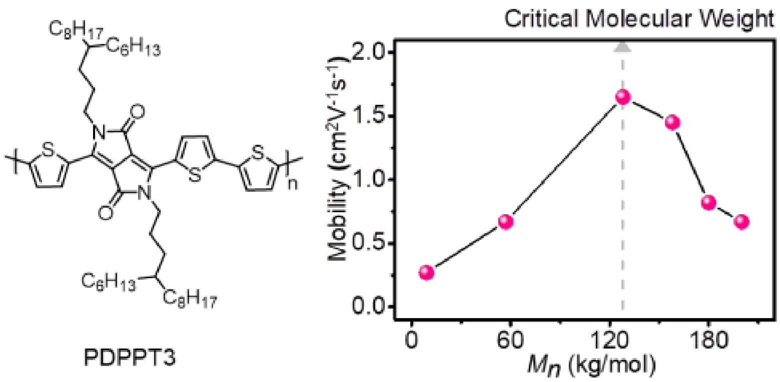

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图 1. 以茚满二酮为端基醌式化合物的合成

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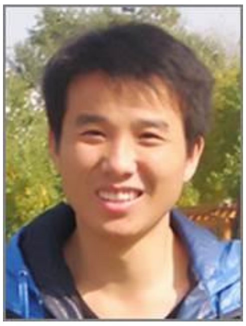

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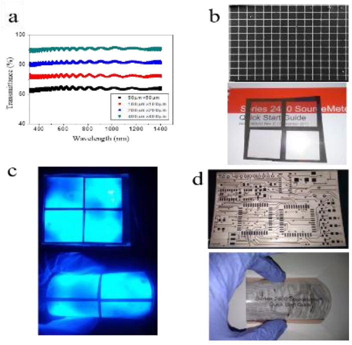

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*Email: gcshan@buaa.edu.cn

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Coherent charge transport in two-dimensional conjugated polymeric crystal

Yuan Tian( )[1,3] Huanli Dong( )[1] Wenping Hu( )[1,2,*] Daoben Zhu( )[1]

[1] Beijing National Laboratory for Molecular Sciences, Key Laboratory of Organic Solids, Institute of Chemistry, Chinese Academy of Sciences, Beijing 100190, China

[2] Tianjin Key Laboratory of Molecular Optoelectronic Sciences, Department of Chemistry, School of Sciences, Tianjin University, Tianjin 300072, China

[3] School of Physics and Electronics, Hunan University, Changsha 410082, China

*Email: huwp@tju.edu.cn

Two-dimensional (2D) polymeric crystals are highly attractive for i) clarifying charge transport mechanism of conjugated polymers, ii) enriching the family of 2D materials, and iii) advancing their application in high performance device and circuit of plastic electronics. Here, a kind of novel, atomic thin, centimeter-sized scale, 2D conjugated polymeric (2DCP) crystals are demonstrated to approach these targets. Coherent charge transport, Hall-effect in diffusion regime and positive magnetoconductance due to weak localization are found for the first time in such 2DCP crystals. These results indicate that such high quality 2DCP crystals provide an ideal platform for new physics and device beyond conventional polymer thin films.

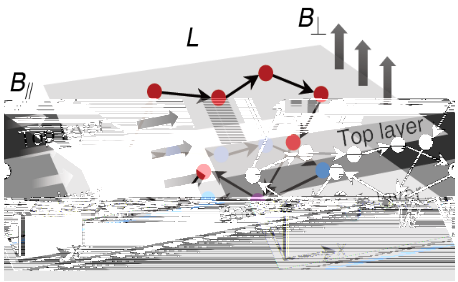

Figure 1. A possible closed-loop charge carrier trajectory in bilayer 2DCP crystals [1].

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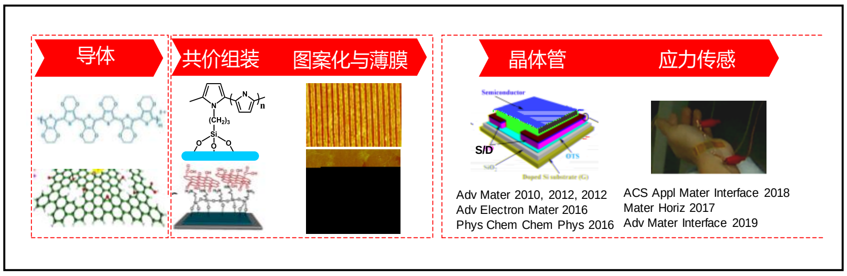

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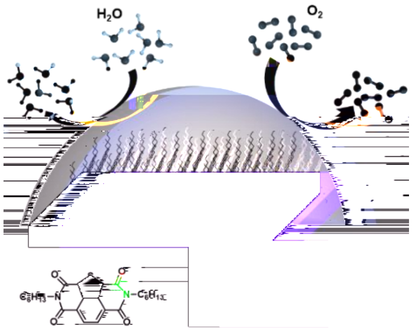

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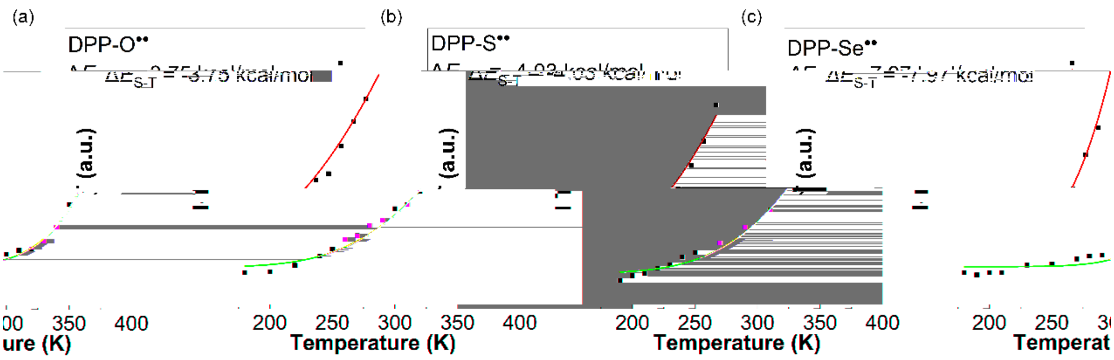

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Molecular and Nano Effects on Organic Charge Trapping Transistor Memory

Linghai Xie[1,*], Yang Yu[1], Haifeng Ling[1], Linyi Bian[1], Qihao Ma[1], Mingdong Yi[1], and Wei Huang[1,2,*]

[1] *Centre for Molecular Systems and Organic Devices (CMSOD), Key Laboratory for Organic Electronics and Information Displays & Institute of Advanced Materials (IAM), Nanjing University of Posts & Telecommunications, Nanjing 210023 (China).*

[2] *Shaanxi Institute of Flexible Electronics (SIFE), Northwestern Polytechnical University (NPU), 127 West Youyi Road, Xi'an 710072, Shaanxi, China.*

E-mail: iamlhxie@njupt.edu.cn; iamwhuang@nwpu.edu.cn

Molecular charge trapping is the key physical process in organic transistor memory for data storage that dominate various parameters such as writing/erasing voltage, memory window, on/off ratio, response spend and retention time as well as endurance. As a result, it is very important to explore the structure-property relationship for the guideline of rational design of molecular electrets. Herein, we talk about the molecular and nano effects on charge trapping and memory performance.

We are developing new molecular materials and materials engineering approaches towards high-performance and functional memory systems, including topological nano-molecule (grids & polygrids), organic nanostructures (nanosheets & arrays). Starting from the stable steric hindrance molecular structure, the hierarchical design and regulation of molecular structure, nanostructure and thin films are carried out, and series of stable wide-bandgap memory media are developed. We found that the alkyloxy group is not favorable for the charge storage if molecular structure without alkyloxy have enough film-forming capability. Steric bulk can tune the charge trapping kinetics via the pi-interrupted linkage with sp^3 carbon that can protect charge from the relaxation with the longer retention time regarding the controlled models. Nanogrids are high-performance charge trapping elements for multibit memory. Pi-stacked polystyrene is promise matrix with the role of tunneling layers for small-dipole SFX-TCN as charge trapping elements. The nanocolumn effect was first explored for improvement of response speed and data retention. With the p-n junction, the charge can be stored at the interface in the active semiconducting layers.

In this process, breakthroughs have been made in principle ds), The nn gece v (eakt)7(h(um)5(pol)5(e -7(i)e)3(e4(i)5b)5(p

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Controllable Aggregation of Conjugated Polymer Monolayer: from Field-Effect Transistors to Integrated Circuits

Mengmeng Li*

Key Laboratory of Microelectronic Devices and Integrated Technology, Institute of Microelectronics, Chinese Academy of Sciences, Beijing 100029, China

*Email: limengmeng@ime.ac.cn

In spite of their great potentials in bottom-up organic electronics, it is challenging to fabricate conjugated polymer monolayer field-effect transistors due to intricate crystallization and film formation of conjugated polymers.[1-3] Here, we demonstrate transistors based on a single molecular layer of a conjugated polymer. The resulting polymer monolayer transistors are highly reproducible and exhibit field-effect mobilities reaching 3 $cm^2 V^{-1} s^{-1}$. The high performance is attributed to the strong interactions of the polymer chains present already in solution leading to pronounced edge-on packing and well-defined microstructure in the monolayer. The high reproducibility enables the integration of discrete unipolar polymer monolayer transistors into inverters and ring oscillators. Real logic functionality has been demonstrated by constructing a 15-bit code generator in which hundreds of self-assembled polymer monolayer transistors are addressed simultaneously. Our results open prospective pathways for bottom-up organic electronics.

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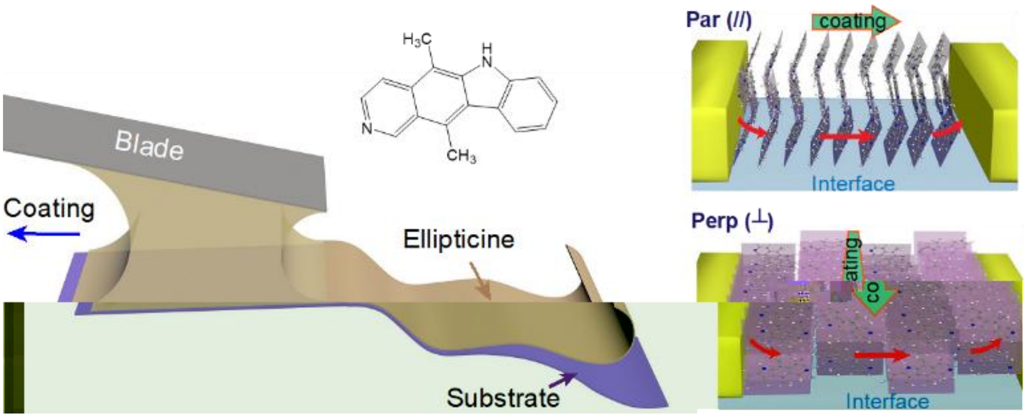

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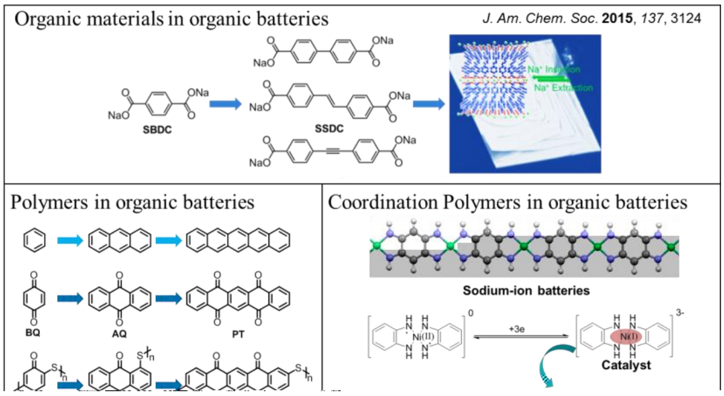

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Enhancing FET performance through co-doping or modification

Qichun Zhang[1]

School of Materials Science and Engineering, Nanyang Technological University (NTU), 50 Nanyang Avenue, Singapore 639798, Singapore.

E-mail: QCZhang@ntu.edu.sg. Website: http://www.ntu.edu.sg/home/qczhang/.

Abstract

In this talk, I will present three strategies (the replacement of O with S, Cocrystal, and doping) in my research to enhance the FET performance of the existed materials including NDI, PEDOT and DTPTP.

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Dr. **Qichun Zhang** is an Associate Professor at the School of Materials Science and Engineering and at Nanyang Technological University, Singapore. His research focuses on conjugated rich carbon materials and applications. Currently, he is an associate editor for J. Solid State Chemistry, Advisory board members of Materials Chemistry Frontiers, Chemistry - an Asian Journal, Journal of Materials Chemistry C, and Inorganic Chemistry Frontiers. He also is a fellow of the Royal Society of Chemistry. In 2018 and 2019, he has been recognized as one of highly-cited researchers (top 1%) in cross-field in Clarivate Analytics. Till now, he has published more than 330 papers (H-index: 68) and 4 patents.

Flexible Polymer/Nanoparticle Memristors

Jianyong Ouyang

Department of Materials Science and Engineering, National University of Singapore, Singapore 117576

*Email: mseoj@nus.edu.sg

Electronic devices with resistive switches can be used as memory devices. They are considered as the next-generation hardware for artificial intelligence (AI). Resistive switches have been observed on devices with a polymer film embedded with nanoparticles between two electrodes. These devices have advantages of low fabrication cost and high mechanical flexibility of the active layer. They can be important units in next-generation electronic systems, such as wearable electronic and transient electronic systems. However, the resistive switches are insensitive to the interfaces between the active layer and electrodes for early devices with the nanoparticles capped with oxides or saturated organic ligands.

The interface between two electronic materials usually plays a pivotal role for the electrical behavior of electronic devices. Here, I would like to present polymer:nanoparticle devices with resistive switches sensitive to the interface between nanoparticles and electrodes. When nanoparticles capped with conjugated organic ligand and two different metals are used as the electrodes, the resistive switches are asymmetrical. The resistive switch from low current to high current takes place only along one polarity, and the reversal switch occurs only along the opposite polarity. The electrical behavior, materials effect and mechanism for the resistive switches will be presented and discussed.

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Achieving non-fullerene organic solar cells with near 17% efficiency

He Yan

Department of Chemistry

Hong Kong University of Science and Technology

Organic solar cells (OSCs) are flexible, semi-transparent and environmentally friendly devices which can be installed in areas where silicon panels are not suitable (such as glass windows on buildings). Conventional OSCs are based on fullerene acceptors as a key component. However, fullerene-based OSCs can only achieve modest efficiency of 12% at best, due to their large voltage loss (above 0.8V), and poor device stability.

Recently, there has been a major revolution in the OSC field, as researchers developed many high-performance non-fullerene acceptors that can overcome the limitation of traditional fullerene acceptors and open a new era for the OSC field. One of the unique features of non-emerging non-fullerene OSCs is the surprisingly small voltage losses of the devices (~ 0.5V). Since 2016, our team at HKUST has developed a range of non-fullerene systems that can simultaneously generate high photocurrent (near 100% yield) with small voltage losses (first published in Nature Energy). Moreover, we have recently achieved record-breaking OSCs based on a state-of-the-art non-fullerene acceptor, achieving an unprecedented efficiency of 16.7% in single-junction OSC device. Our work clearly indicate that OSCs have the potential to reach the high efficiency of inorganic solar cells.

Our results show that the key factor is the long charge transfer life-time that allows for efficient charge separation despite of a small energy offset. In the other aspect, we study structure-property relationship of high-performance donor and non-fullerene acceptor materials and reveal the key structure features that enable highly efficient non-fullerene organic solar cell devices with over 16% efficiency. With these understandings of mechanism and structure-property relationship, it is feasible to further increase the efficiency of organic solar cells to the range of 18 to 20% in near future.

Unique Optoelectronic Properties of Molecularly-Thin Organic Semiconductor Films

Beilei Sun[1], Xin Xu[1], Zefeng Chen[1], and Jianbin Xu[1,2], Xiran Wang[3]

[1]Department of Electronic Engineering and Materials Science and Technology Research Center, The Chinese University of Hong Kong, Shatin, NT, Hong Kong, Hong Kong SAR, China

[2]Institute of Advanced Electronic Materials, Shenzhen Institutes of Advanced Technology, Xi Li Town, Nan Shan District, Shenzhen, China

[3]School of Electronic Science and Engineering, Nanjing University, Nanjing, Jiangsu, China

Keywords: two-dimensional, optoelectronics, organic semiconductors, *J*-aggregation

Organic semiconductor (OSC) is of scientific and technological significance for optoelectronic application, since they have numerous advantages over their inorganic counterparts. Here we interrogate the optoelectronic properties of organic semiconductors in two dimensional limits. We find that the PTCDI-C_{13} can form high-quality monomolecular layer with *J*-aggregation on *h*-BN substrate. Very strong light emission with a narrow bandwidth down to 10 nm is observed in the monolayer PTCDI-C_{13} film. Beyond the first molecule layer, the multilayer PTCDI-C_{13} crystal on BN is dominated by *H*-aggregation. Different from the h-BN substrate, only *H*-aggregation film is found from PTCDI thin films on SiO_2 substrates. This monolayer *H*-aggregation film provides an idea platform for exploring the intrinsic carrier transport properties because the crystal cracks and step edges, which widely exist in the bulk crystal, can be excluded in the monolayer film. We find that the monomolecular PTCDI-C_{13} film exhibits a high mobility anisotropy ratio up to ~80, which is one order of magnitude higher than those reported previously from bulk single crystals of organic semiconductors, and highly consisted with theoretical result. Hopping mechanism with an activation energy $k_B T_0$ ~30 meV is also observed in monomolecular PTCDI-C_{13} film.

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Jianbin XU

[1] [2,*]

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[2] School of Materials Science and Engineering, Nanyang Technological University, 50 Nanyang Avenue, 639798, Singapore

Email: yanghui2018@tju.edu.cn

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Understanding the processing parameters of meniscus guided coating method for OFET fabrications

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Email: pklc@hku.hk

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*Email: hpchen@fzu.edu.cn

Integrating transistor and display pixels into light emitting transistor (LET) is anticipated to optimize the active matrix display, which would significantly reduce the number of transistors in pixel drivers and the space occupied by the transistors simultaneously. In this work, a novel vertical quantum-dot light emitting transistor (VQLET)

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*Email: lzhqiu@hfut.edu.cn

We reported an effort to improve the sensitivity and selectivity of organic-transistor sensors using porous polymer film. A facile and controllable phase-separation route using polymer semiconductor blends for fabricating microporous semiconductor films is proposed. The microporous film-based gas sensor exhibited excellent selectivity to ammonia with a detection limitation of 0.5 ppm, a high sensitivity of over 800 at 10 ppm NH_3, and response / recovery time of few seconds. We also demonstrated a sensor modified with molecularly imprinted polymer (MIP), a porous film with empty cavities complementing the analyte molecules in terms of size, shape and functionality, for specifically recognizing ascorbic acid (AA). The MIP sensor exhibited excellent specific recognition ability to AA which could avoid the interference of other structurally similar compounds, such as aspartic acid, glucose, uric acid and glycine.

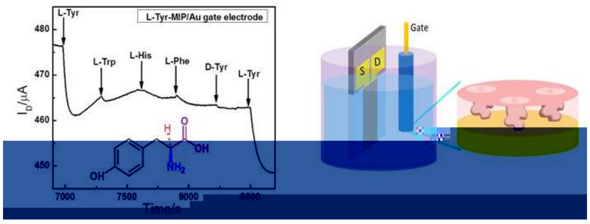

图 1. Schematic diagram and performance of MIP-OECT device

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Tailoring Aggregation Structures of Molecular Materials by Crystal Engineering

[1] [2] [2,*]

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*Email: zhenyg@iccas.ac.cn, huwp@tju.edu.cn

Crystal engineering including polymorph control and co-assembly is one of important strategies to tailor aggregation structures to improve the optoelectronic properties of molecular materials.[1] Herein, we report the controllable growth of different crystal phases of organic semiconductors, i.e. pentacene[2], thienoacene (BDTDT)[3], phthalocyanine derivatives (TiOPc)[4] as well as porphyrins[5] through polymorph induction of surface nanogrooves, solution supersaturation, vapor transport temperature gradient or protonic acid.

Fig 1. Schematic tailoring packing structures of molecular materials.

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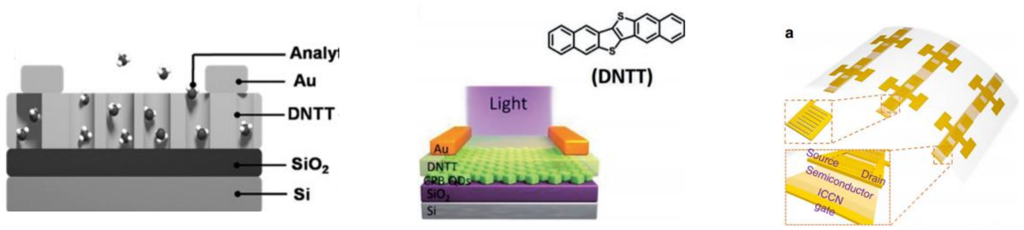

图 1.

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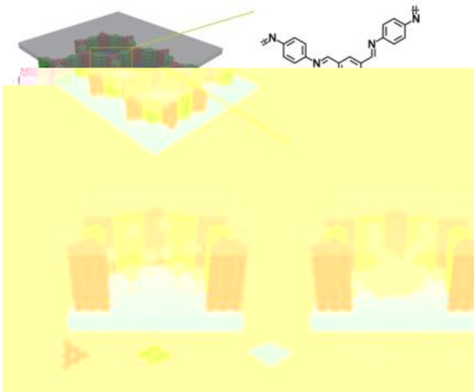

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Solution-Grown Organic Single-Crystalline Heterojunctions

Hanying Li

Department of Polymer Science and Engineering, Zhejiang University, Hangzhou 310027, P. R. China.

*Email: hanying_li@zju.edu.cn

Organic heterojunctions are widely used in electronics and well ordering in the molecular packing inside the heterojunctions is highly desired. However, it is still challenging to interface organic single crystals to form single-crystalline heterojunctions. In this work, two novel methods will be introduced to describe how to prepare, from solutions, single-crystalline heterojunctions. On one hand, organic single-crystalline planar heterojunctions are grown in a single step from a mixed solution of p-type and n-type molecules. Based on crystallization of six organic semiconductors from a droplet on a substrate, two distinct crystallization mechanisms have been recognized in the sense that crystals form at either the top interface between the air and solution or the bottom interface between the substrate and solution. The preference for one interface rather than the other depends on the semiconductor-substrate pair and, for a given semiconductor, it can be switched by changing the substrate, suggesting that the preference is associated with the semiconductor-substrate molecular interaction. Furthermore, simultaneous crystallization of two semiconductors at two different interfaces to reduce their mutual disturbance results in the formation of bilayer single crystals interfaced together for organic heterojunctions. On the other hand, single crystals are prepared in organogels of a typical conjugated polymer. Instead of pure crystals, crystals containing the gel nanofibers are obtained. Essentially, nanofiber networks are incorporated into growing crystals and penetrate through the crystals, resulting in a crystal/gel-network interpenetrating composites. Based the two types of single-crystalline heterojunctions, charge transport and charge transfer process are studied. Hence, by demonstrating these two solution methods for the preparation of single-crystalline heterojunctions, this work should greatly harvest the highly ordered organic crystalline materials for high performance electronics.

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*Email: ljiang@iccas.ac.cn

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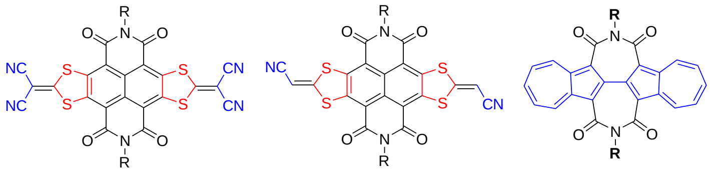

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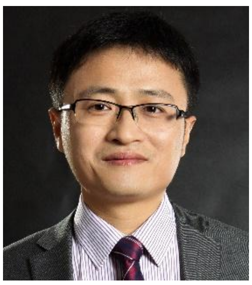

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CMOS D-A 2DPP 2PT F 9 $cm^2V^{-1}s^{-1}$, 6 $cm^2V^{-1}s^{-1}$

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Tuning the transport properties of D-A conjugated polymers by optimizing the substituents: A DFT study

Yishan Wang[1], Wanying Huang[1], Wei Hao[2], Hu Zhao[3], Shuzhou Li[2], Jia Zhu[1]*

[1]College of Chemistry, Key Laboratory of Theoretical & Computational Photochemistry of Ministry of Education, Beijing Normal University, Beijing 100875, P. R. China

[2]School of Materials Science and Engineering, Nanyang Technological University, 50 Nanyang Avenue, 639798 Singapore

[3]Department of Physics, Beijing Normal University, Beijing 100875, P. R. China

*E-mail: zhu.jia@bnu.edu.cn

Donor-acceptor (D-A) polymers have attracted extensive attentions because of their tunable transport polarity and promising potential in the application of high mobility electronic devices.[1,2] Here, we have designed a series of PDPP-TVT based D-A conjugated polymers with different substituent groups (i.e. -F, -CN, -NH_2, -OH, -CF_3, -$COCH_3$ and -@ [illegible]-positions of thiophene and explored the effects of substituents on their charge injection and transport properties by employing density functional theory. Ionization Potentials (IPs), Electron Affinities (EAs), and HOMO/LUMO energy levels followed by charge injection barriers of the PDPP-TVT polymers were calculated to evaluate their charge injection properties. The results show that -F and -CN can significantly improve the planarity of backbone, which can facilitate the charge transport. Secondly, electron donating groups contribute to increased HOMO and lowered IP, thus improving the hole injection capacity, while electron withdrawing groups are helpful to electron injection. Thirdly, narrowest band gap as well as smallest difference between IP and EA of PDPP-TVT-CN suggests that it is an excellent candidate for ambipolar device. Furthermore, the calculations of intra-chain and inter- [illegible] % [illegible] properties. Our theoretical results indicate that -NH_2, -OH and -F are helpful to enhance intra-chain hole transport of D-A polymers, while -H and -F can enhance the intra-chain electron mobilities. Besides, -NH_2, -$COCH_3$ and -CF_3 benefit to balance hole and electron transport along the backbone. Inter-chain mobilities results indicate that -CN can greatly improve inter-chain hole transport and PDPP-TVT-CN has balanced hole and electron mobilities along the stacking direction. Our findings show that substituents on conjugated backbone can significantly regulate the molecular as well as electronic structure, and ultimately play an important role in charge injection and transport. More importantly, the incorporation of appropriate substituents is an effective strategy to balance hole and electron injection as well as transport properties and thus contributing to obtain promising candidates of ambipolar electronic devices.

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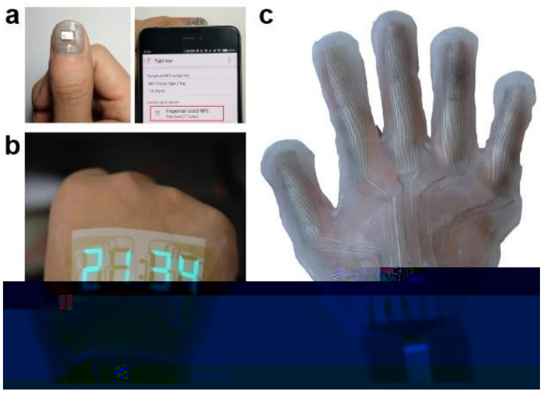

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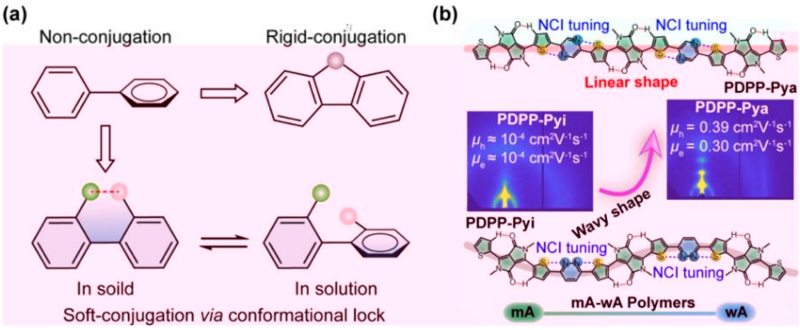

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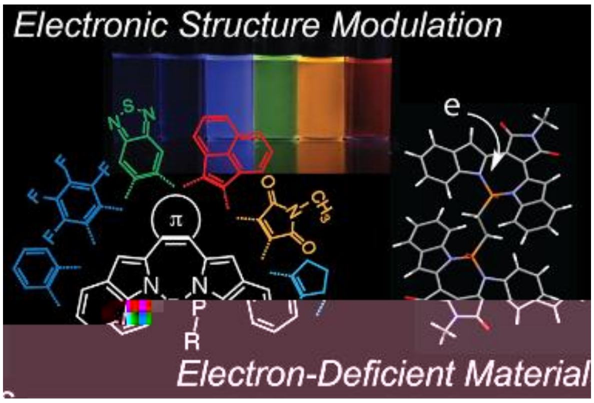
Phosphorus-Containing Semiconducting Materials for Optoelectronic Applications

Yi Ren [1,*] Kai Yang[1] Yueh-Lin Loo[2*]

[1] School of Physical Science and Technology, Shanghai Tech University, Shanghai 201210, P.R. China.
[2] Department of Chemical and Biological Engineering and Princeton New Jersey 08544, United States

*Email: renyi@shanghaitech.edu.cn

Designing new organic semiconducting materials (OSMs) have been playing important roles for advancing high performance organic optoelectronic devices.[1] Diverse organic chemistry has been explored to fine-tune both chemical structures and optoelectronic properties of OSMs. We and others have demonstrated that incorporation of main-group elements (B, N, P, S) can effectively fine tune optoelectronic properties of OSMs.[2] However, incorporating of main-group elements into OSMs generally involves harsh reaction conditions, less selective reactivity, and low reaction yields. In this presentation, we will discuss our recent efforts on how to use phosphorus-nitrogen chemistry to build the new semiconducting materials. Compared to the previous synthetic protocols, our method show highly desirable characteristics, such as high selectivity, high reaction yield, mild reaction conditions. Finally, we investigated their optoelectronic properties in devices. The preliminary results show that these new semiconducting materials are very promising candidates in applications of organic optoelectronic devices.



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synthesis to applications

Mingfeng Wang*

School of Chemical and Biomedical Engineering, Nanyang Technological University, 62 Nanyang Drive, 637459, Singapore

*Email: mfwang@ntu.edu.sg

π-Conjugated molecules and polymers have emerged as key materials for next generation of printable flexible electronic devices such as sensors, light-emitting diodes, field-effect transistors, solar cells, and more recently bioelectronics. Most of the π-conjugated molecules and polymers have been synthesized through conventional coupling methods such as Suzuki coupling and Stille coupling, both of which involve the tedious C-H activation using organometallic reagents that suffer from their high flammability, high toxicity and poor stability.

In this presentation, I will first present our recent efforts towards synthesis of a variety of π-conjugated small molecules and polymers under the scheme of C-H direct arylation as a new atomically efficient and ecologically

synthesis of π-conjugated molecules and polymers in fewer steps, no need of C-H bond preactivation and without involvement of stannyl toxic reagents. The second part of this presentation will address the emerging applications of these π-conjugated polymers, including organic field-effect transistors (OFETs), photovoltaic devices, and photoconductive neural stimulation.

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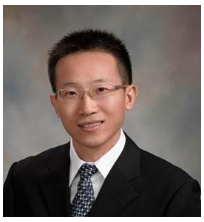

Mingfeng Wang is currently a Nanyang Assistant Professor in the School of Chemical and Biomedical Engineering at Nanyang Technological University, Singapore. He received his B.Sc. degree in Chemistry at Jilin University in 2001, followed by his M.Sc. degree in Polymer Chemistry and Physics under the supervision of Prof. Xi Zhang. In 2004, he joined Prof.

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Polymer Chemistry and Materials in 2009. Then he was awarded with a Postdoctoral Fellowship supported by the Natural Sciences and Engineering Research Council of Canada (NSERC), and moved to Prof.

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Biomedical Engineering at Nanyang Technological University in 2012. His current research focuses on polymeric materials with bioinspired structures and advanced functions for optoelectronic and biomedical applications.

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*Email: huangguang_liu@jnu.edu.cn

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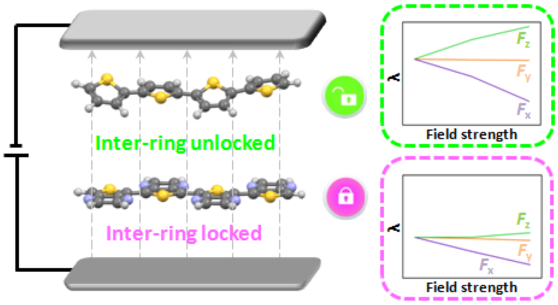

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Scanning Kelvin probe microscopy, SKPM

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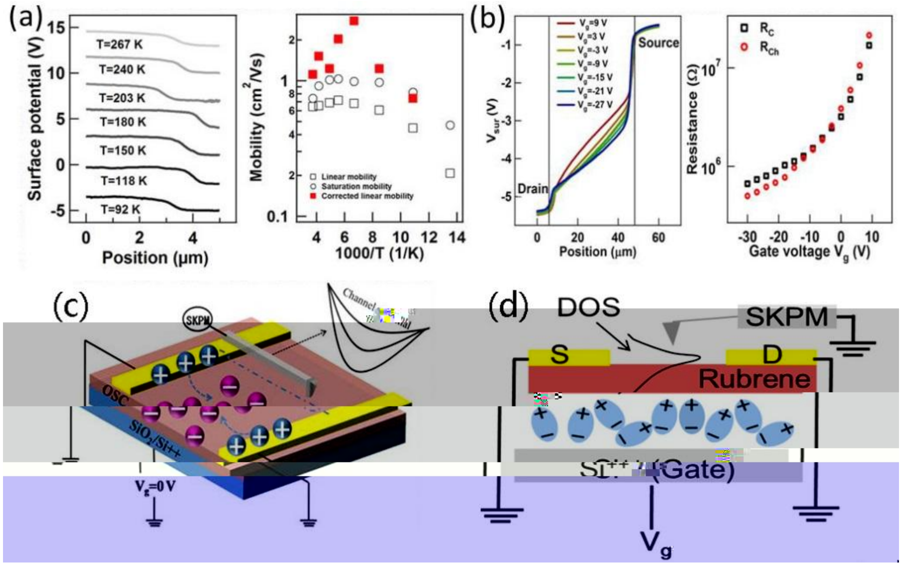

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The wettability control of interface for high-performance organic thin-film transistors by soluble insulating polymer films

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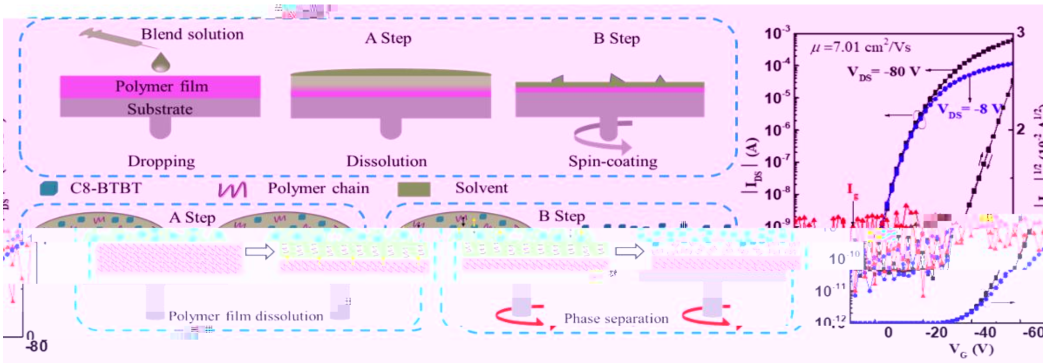
Email: jinhua_li@hubu.edu.cn

Organic small molecule semiconductors have higher carrier mobility compared to polymer semiconductors, while the actual performances of these materials are susceptible to morphological defects and misalignment of crystalline grains.[1-2] Here, a new strategy is explored to control the crystallization and morphologies of solution-processed small organic molecule semiconductor 2,7-dioctyl[1]benzothieno[3,2-b][1]benzothiophene (C8-BTBT) by using soluble polymer films to control the wettability of substrates. Different from the traditional surface modification method, the dissolved polymer alters the state of semiconductor solution, which in turns changes the crystallographic morphologies of the semiconductor films. By controlling the solubility and thickness of the polymer modification layers, it is possible to regulate the grain boundary and domain size of C8-BTBT films, which determines the performances of OTFTs. It is expected that this new modification method will be applicable to high-performance OTFTs based on other small molecular semiconductors and dielectrics.



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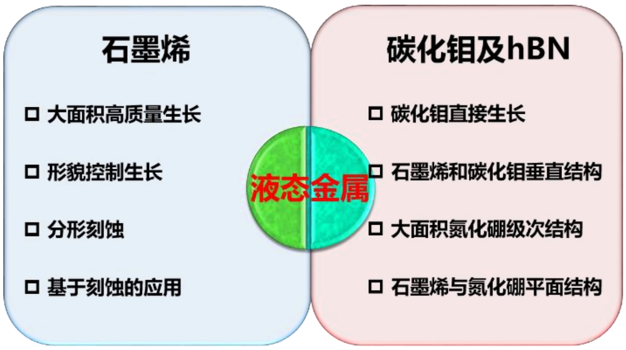

图 1. 液态铜上单晶二维材料的生长

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*Email: jianpei@pku.edu.cn

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Editorial Board Chair

Novel Metal Oxide Thin Film Transistor

Miao Xu[1,2], Hua Xu[2], Min Li[2], Jianhua Zou[2], Hong Tao[2], Lei Wang[1,2], Junbiao Peng[1]

[1] State Key Laboratory of Luminescent Materials and Devices, South China University of Technology, Guangzhou, China [2]Guangzhou New Vision Opto-Electronic Technology Co., Ltd, Guangzhou, China

Keywords: thin film transistor; metal oxide; Praseodymium doping; transparent display

Rear earth element-doped indium zinc oxide (Re:IZO) has been employed as the channel layer of thin film transistors (TFTs). The TFTs with Re doping exhibited a remarkable suppression of the light induced instability. A negligible photo-response and remarkable enhancement in negative gate bias stress under illumination (NIBS) were achieved in the Re:IZO TFTs. Meanwhile, the Re:IZO TFTs showed reasonable characteristics with a high field effect mobility of 18.4 cm^2/Vs, SS value of 0.15 V/decade, and I_{on}/I^{off} ratio of 10^9. A prototype of fully transparent AMOLED display was successfully fabricated to demonstrate the potential of Re-doping TFTs applied in transparent devices.

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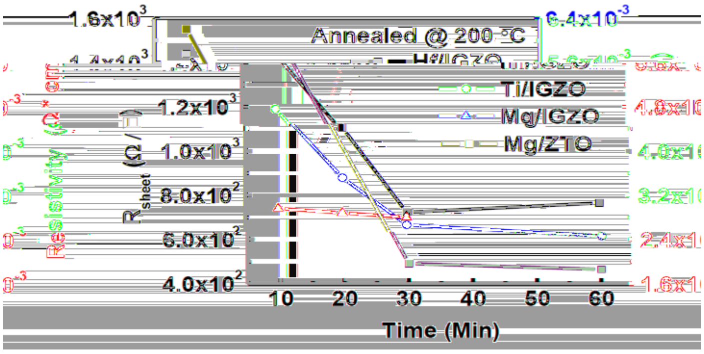
*Email: zhangsd@pku.edu.cn



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*Email: jiezhang@jiangnan.edu.cn

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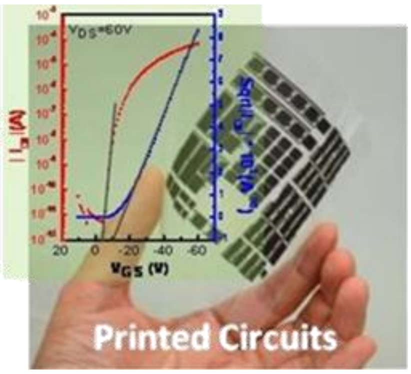

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Email: dicha@iccas.ac.cn

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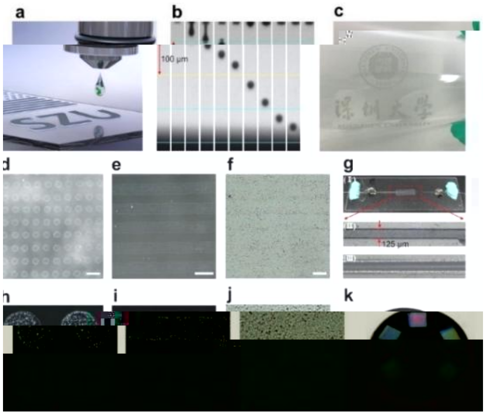

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Carbon Based Integratable Soft Thin Film Transistors

Min Zhang*, Chunhui Du, Ziwei Zhang, Qiuyue Huang, Jiaona Zhang, Qinghua Wang, Haoxuan Jiao
School of Electronic and Computer Engineering, Peking University, Shenzhen, China
Tel.:86-755-26032482, *E-mail: zhang.min@pku.edu.cn

Internet-of-Things, human-machine interface, advanced displays and wearable electronics are proposing more requests and challenges on soft thin film transistors (TFTs) recently years. For high-speed low-power applications, driving capability and operation voltage of TFTs are focused. For soft systems, flexibility, rollability, stretchability, and transparency are more critical. At the same time, device repeatability, uniformity, and reliability are required. To address these requirements and challenges, we have built up an advanced carbon-based soft thin film transistor platform. In this platform, with carbon nanotubes (CNTs) as channel and electrodes, organic and inorganic soft material as gate dielectric, we have realized intrinsically flexible all-carbon TFTs, high-mobility low-power transparent rollable all-carbon TFTs, and high-mobility high-stretchability all-carbon TFTs. Besides, we have combined the advantages of carbon nanotubes with the general a-IGZO platform to realize carbon nanotube embedded enhanced a-IGZO TFTs for high drivability.Integrating every low-dimensional flexible layer into a flexible or stretchable device is a compelling challenge to realize all-flexible transistors. We have also proposed new solutions for these flexible integrations, including photolithography incorporated filtration, hydrophilization, low temperature annealing process for flexible devices, and organic based dielectric processing. The platforms with the realized devices provides promising solutions for future electronics.

Fig 1. Carbon based advanced TFTs for advanced displays.

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Biography

Min Zhang is an Associate Professor of Electronic and Computer Engineering in Peking University Shenzhen Graduate School and a Vice-Director of Thin Film Transistor and Advanced Display Lab. She received her B.S. and M.S. degrees from Department of Microelectronics □ □

[1] [1] [1,*]

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*Email: zhouh81@pkusz.edu.cn

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Electrolyte-gated Organic Transistor for Optoelectronic Applications

[1,*]

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*Email: hhxu@szu.edu.cn

Electrolyte-gated organic transistor (EGOT), which possesses the advantages of low-voltage and low-cost, have drawn extensive attentions. Here, we will report our recent progresses on EGOT optoelectronic devices. Firstly, we will introduce the charge modulation spectroscopy to in-situ probe the charge transports at the electrolyte/organic semiconductor interface. By correlating the impedance spectroscopy and gating-voltage dependence of the mobility, we show that the large disordered regions of the organic layers will cause significant electrochemical doping effects at the electrolyte/organic semiconductor interface, resulting in strong carrier-ion interactions as well as deep trap states. These fundamental works will help us to design high-performance EGOT optoelectronic devices. Next, we will introduce our recent work on EGOT devices for photodetection and optical modulation applications. We will introduce a flexible, low-voltage and highly-sensitive photodetector based on the EGOT structure with an ionogel/AgNW electrolyte gate. The device exhibits high responsivity of 7.5×10^5 A·W^{-1} and ultrahigh sensitivity (~7.5×10^5) . Moreover, as the bending radius is reduced as small as 2 mm, the sensitivity remains in the level of 10^5. Finally, we will introduce a flexible and efficiency-enhanced hybrid optical modulation transistor (h-OMT) based on the EGOT in which organic semiconductors are blended with silver nanoparticles (AgNPs). As a results, the device exhibits unipolar transport and ultra-high on-off ratio of ~4.8×10^6 in a small voltage range of ~2 V. Using charge modulation reflection spectroscopy, we demonstrate that the device shows a broad spectral response from 400 nm to 2000 nm and maximum optical modul □ □ . 2□" □ □: 452□)3-fold of magnitude higher than that of the device without AgNPs. Our work provides the possibility of EGOT devices for constructing novel optoelectronic systems in the future.

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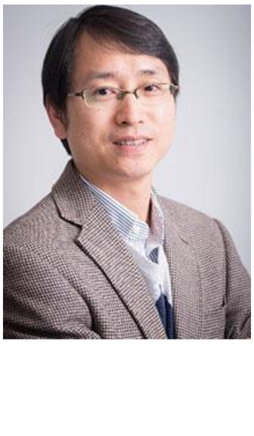
Large-scale Precise Patterning of Organic Micro/Nano-Crystals for High-Performance Transistors

Jiansheng Jie*

Institute of Functional Nano & Soft Materials (FUNSOM), Soochow University, Suzhou 215123,

Email: jsjie@suda.edu.cn

Small-molecule organic micro/nanocrystals (OMNCs) have unique properties that can complement or rival their counterpart inorganic semiconductor nanocrystals, like flexibility, versatility, and tunability in electronic and optical properties. They are identified to be prospective system to construct new-generation low-cost flexible, stretchable and wearable electronic and optoelectronic devices. However, the scale-up of OMNCs for technological applications is difficult because their growth orientation and location are usually stochastic in nature. The alignment and patterning of OMNCs at desired locations are prerequisite for their device applications in practice. In this talk, we will introduce our recent advances in the large-area alignment and patterning of ordered OMNCs for high-performance optoelectronic devices. A highly efficient yet simple method that combines surface micro/nano-structured templates and conventional organic coating techniques, such as spin-coating, dip-coating, and blade-coating, was developed to produce organic micro/nanowire arrays at designated locations. This strategy enables wafer-scale fabrication of organic nanowire arrays with ultrahigh accuracy, reliability, and flexibility. Besides the single-component OMNCs, single-crystalline organic p-n heterojunction microbelt arrays were successfully fabricated through a surface-energy controlled stepwise crystallization approach. Moreover, fluid dynamics numerical simulation was utilized to understand the underlying mechanisms for the alignment and patterning of OMNCs. Our work opens up the opportunities for future high-performance, low-cost organic electronic and optoelectronic devices.



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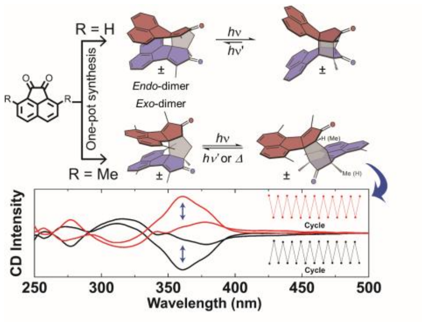

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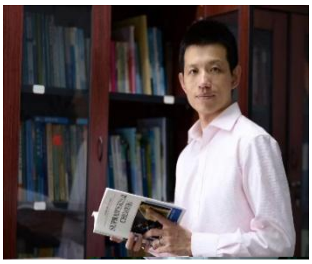

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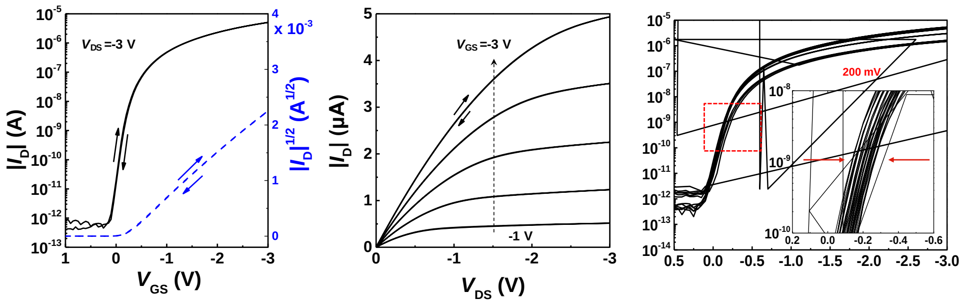

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*Email: dengwei@suda.edu.cn, jsjie@suda.edu.cn

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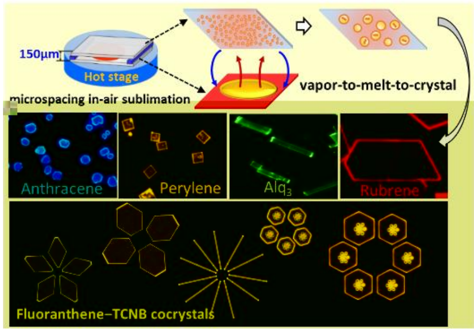

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*Email: weixiafang@iccas.ac.cn

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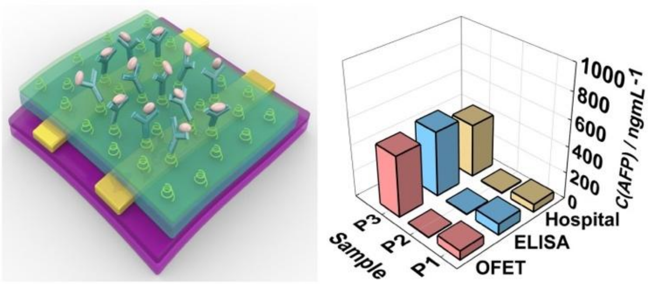

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Substituents effect on charge injection and transport properties of PDPP-TVT based D-A conjugated polymers: A DFT study

Yishan Wang[1], Wanying Huang[1], Wei Hao[2], Hu Zhao[3], Shuzhou Li[2], Jia Zhu[1]*

[1]College of Chemistry, Key Laboratory of Theoretical & Computational Photochemistry of Ministry of Education, Beijing Normal University, Beijing 100875, P. R. China
[2]School of Materials Science and Engineering, Nanyang Technological University, 50 Nanyang Avenue, 639798 Singapore
[3]Department of Physics, Beijing Normal University, Beijing 100875, P. R. China
*E-mail: zhu.jia@bnu.edu.cn

Donor-acceptor (D-A) polymers attract much more attention because of their tunable transport polarity and

pJ

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*Email: yli@nju.edu.cn, qijingwang@nju.edu.cn.

Fe-OFET

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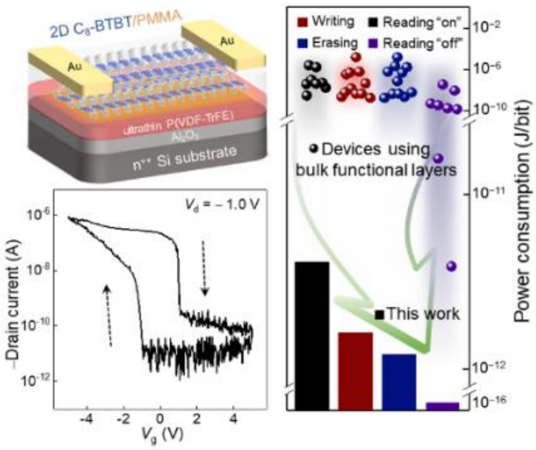
[3]

pJ ~1.2 pJ/bit;

~1.6 pJ/bit; ~1.9 pJ/bit ~0.2 fJ/bit

0.1%



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1996– 2019

High-performance and multi-bit organic field-effect transistor memory with the molecular double-floating-gates

Qihao Ma[1], Yang Yu[1], Keyang Cao[1], Yun Guo[1], Mingdong Yi[1], Linyi Bian[1], Haifeng Ling[1,*], Linghai Xie[1,*], and Wei Huang[1,2,*]

[1] Key Laboratory for Organic Electronics and Information Displays; Institute of Advanced Materials Nanjing University of Posts and Telecommunications; Nanjing 210023, China
[2] Shaanxi Institute of Flexible Electronics; Northwestern Polytechnical University; 4. 4/)@
7 = 8iamlhxie@njupt.edu.cn; iamwhuang@nwpu.edu.cn

Compared with the traditional memory based on inorganic materials, organic field-effect transistor (OFET) memory have attracted great attention because of their advantages of low cost, excellent flexibility, solution processability and low-temperature processing. Among them, the floating-gate memory based on OFET structure has controllable and isolated charge storage sites, which can be as a promising way to achieve high-performance and multi-bit memory. [1,2]

In this work, we used the organic small-molecule material G_4 blending with C_{60} to fabricate a molecular double-floating-gates OFET memory. The G_4 can effectively distribute the aggregation of C_{60}, which makes trapping-charges difficult to escape, and compared with pure rough C_{60} film, the blending films have very smooth surface. In addition, G_4 itself has strong charge trapping ability, which can enhance storage density. Consequently, the memory devices had a very high performance, the memory with the blending ratio 10:2 (G_4:C_{60}) has achieved a

[1] [2] [2] [1] [1,*] [2] [1,*]

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[2] 92 300072.
*Email: yanhou.geng@tju.edu.cn, yang.han@tju.edu.cn

OTFTs
OTFTs

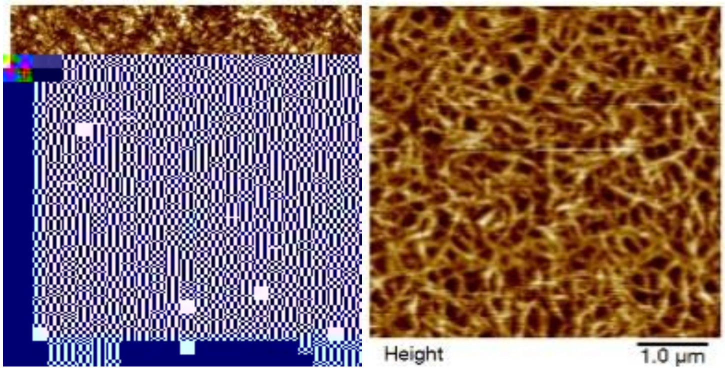
OTFTs
DPP
PDPPT3-HDO DPP

* *

135 300350

*Email: yanhou.geng@tju.edu.cn, yang.han@tju.edu.cn

DPP [1] PDMS PDMS PDMS 50% COS 40% 80% DMA FOE AFM X (GIWAXS) OFETOFET



1. AFM DPP /PDMS

[1] Wang, Z.; Geng, Y. et al. , A Simple Structure Conjugated Polymer for High Mobility Organic Thin Film Transistors Processed from Nonchlorinated Solvent. *Adv. Sci.* **2019**, DOI:10.1002/advs.201902412.

NDI

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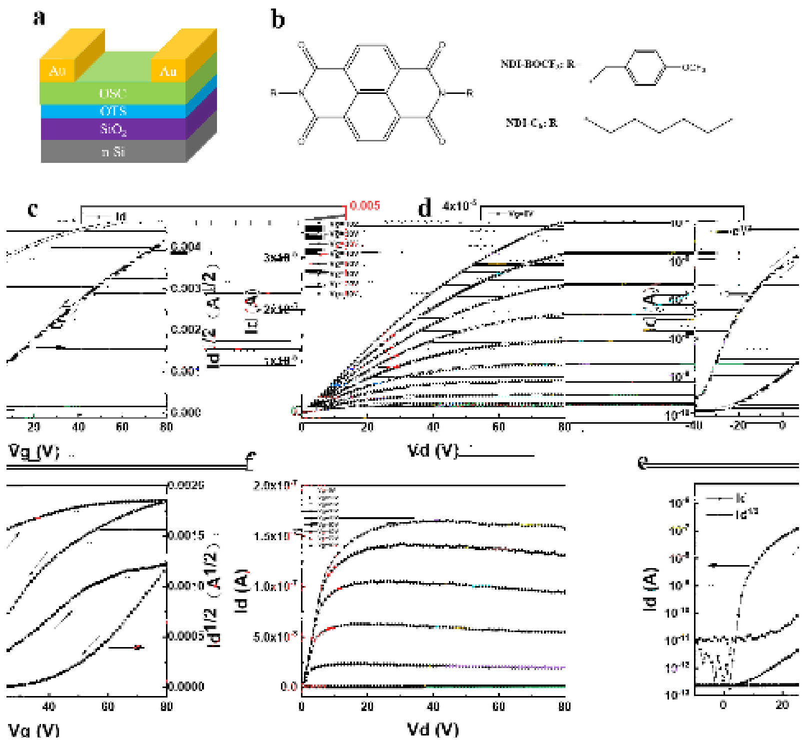
*Email: menghong@pku.edu.cn

OFETs OFETs
NDI NDI- BOCF3 ND-C6 n TFT
NDI

NDI-BOCF3 NDI-C6
NDI-BOCF3 OTS/SiO2
n



1. a) b) NDI- BOCF3 ND-C6 c) NDI- BOCF3 d) NDI-C6 e) NDI- BOCF3 f) NDI-C6

[1] Changbin Zhao, et al, Study of hysteresis in organic thin film transistors based on NDI derivatives, submitting,

2018

Mn^{2+} Dop

Synthesis, Properties, and Thin-Film Transistors of Indolo[3,2-*b*]carbazole

Mengna Zhao[1] Binghao Zhang[1] Qian Miao[1,*]

[1] Department of Chemistry, the Chinese University of Hong Kong,
Shatin, New Territories, Hong Kong, China
*Email: miaoqian@cuhk.edu.hk

Indeno[1,2-*b*]fluorene has been intensively studied as organic semiconductors since the five-membered rings makes the conjugated systems inherently antiaromatic, resulting in high electron affinity and low-lying LUMO energy levels.[1] By replacing the C C double bonds in the five-membered rings of indeno[1,2-*b*

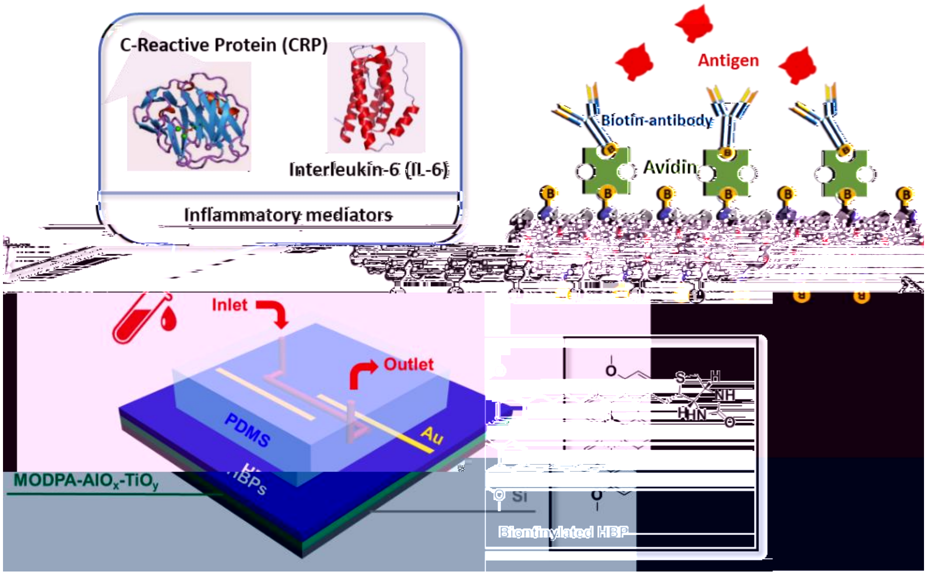
-Stacks of Hexabenzoperylenes

Yujing Wang [1] Qian Miao [1,*]

[1] Department of Chemistry, The Chinese University of Hong Kong, Shatin, New Territories, Hong Kong, China;
*Email: miaoqian@cuhk.edu.hk

One challenge in tailoring organic semiconductors for sensing applications is that the introduction of reactive groups or binding sites usually impairs p-p interactions. To meet this challenge, our group recently discovered that

the solid state, suggested a general platform for OFET sensing by self-assembling into a semiconducting nanosheet. [1,2] This study demonstrates that this platform allows for the quantitative, in situ, and in real time monitoring of bio-affinity reactions between analytes from solution to the surface-immobilized receptors as a bioelectronic sensor. The examples given include the binding of two different antigens (C-Reactive Protein (CRP) and Interleukin-6 (IL-6)) from solution to relative antibodies immobilized on the surface of biotin-functionalized HBP (1a) which has be modified with avidin. The preliminary results show that these bioelectronic sensors have enabled quantitative and highly sensitive detection of different antigens with the increase of electrical current, demonstrating detection capability as low as 5 ng mL^{-1} of concentrated CRP and 50 ng mL^{-1} of concentrated IL-6. The bioelectronic sensor is promising to enable the highly sensitive and selective detection of biological species that are important in medical diagnosis.



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[1] [1,*] [1,*]

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*Email: guoyunlong@iccas.ac.cn liuyq@iccas.ac.cn

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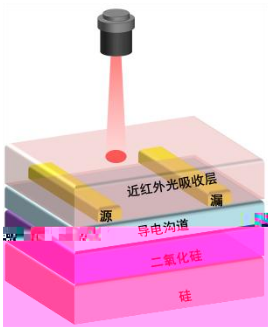

1.

[1] Q. Y. Li, Y. L. Guo, Y. Q. Liu, Exploration of Near-Infrared Organic Photodetectors, Chemistry of Materials, 31, 6359-6379, (2019)

OFET

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[2] 2 100193

*Email: liuyq@iccas.ac.cn

(QBT)

QBT QBT (MQBT)

MQBT 2,2'- BT 3,3'- (2,2'-) (DFBT) 2

(D A) (< 1.20 eV)

PMQBT-DFBT $1.35\ cm^2\ V^{-1}\ s^{-1}$

MQBT QBT

1. OFET

[1] Lei, T.; Xia, X.; Wang, J. Y.; Liu, C. J.; Pei, J., "Conformation locked" strong electron-deficient poly(p-phenylene vinylene)

[1] [1] [1,*] [1,*]

[1] 2 100190

*Email: guoyunlong@iccas.ac.cn liuyq@iccas.ac.cn

OFET AMOLED

10 cm^2 V^{-1} s^{-1} 10^6

OLED

DPP PDVT-C10

o-xylene PDVT-10 20 mg/mL

PDVT-C10 OLED

1. PDVT-10

2015 2018

AMOLED, OFET

High quality wafer-scale Graphene & Boron Nitride on large monocrystalline copper by CVD method

Wenqian Yao[1], Jianing Zhang[2], Bin Wu[*], Yunqi Liu[*]

Beijing National Laboratory for Molecular Sciences, Key Laboratory of Organic Solids, Institute of Chemistry, Chinese Academy of Sciences, Beijing 100190, P.R. China*

Email: yaowenqian@iccas.ac.cn

Graphene has received highly attention since it was prepared by mechanical exfoliation in 2004 by Geim and Novoselov. It has enormous excellent properties in mechanical, thermal, electrical and optical aspects. However, the grain boundaries will severly reduce its physical properties, especially electrical properties. But the electrical properties of graphene can be largely improved by using hexagonal boron nitride (h-BN) as a dielectric layer. Therefore, the synthesis of large-scale monocrystalline graphene & h-BN remains a tricky challenge. Here, we
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XRD and EBSD techniques. Monolayer graphene has been successfully grown on Cu(111) surface. Interestingly, we demonstrated that highly orientated h-BN and continuous film can be also grown on Cu(111) at ambient condition, promising a growing method for high quality dielectric material.

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[1] 2 100190

*Email: guoyunlong@iccas.ac.cn; liuyq@iccas.ac.cn

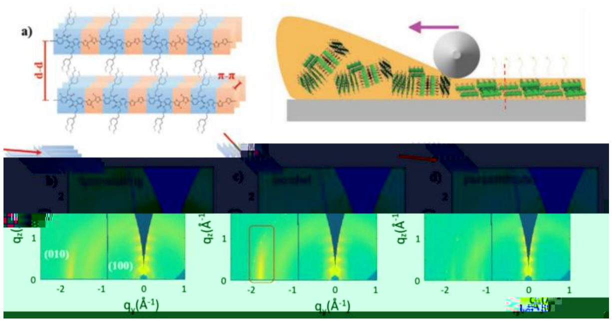
roll-to-roll bar-coating

bar-coating edge-on

Bar-coating ,

5.5 $cm^2\ V^{-1}\ s^{-1}$ 4.5 $cm^2\ V^{-1}\ s^{-1}$ spin-coating 9

Bar-coating



1. a) edge-on PFIBI-BT 2D-GIWAXS , b) spin-coating bar-coating GIWAXS c) d)

1. **J. Chen**#, Y. Jiang#, J. Yang#, Y. Guo,* Y. Liu*, Copolymers of Bis-Diketopyrrolopyrrole and Benzothiadiazole Derivatives for High-Performance Ambipolar Field-Effect Transistors on Flexible Substrates. *ACS Appl. Mater. Interfaces* **2018**, *10*, / 2525 / 2532.

2. Yingying Jiang#, **Jinyang Chen#**, Yunlong Guo,* Wenping Hu,* and Yunqi Liu*. Fast Deposition of Aligning Edge-On Polymers for High-Mobility Ambipolar Transistors. *Adv. Mater*. **2019**, *31*, 1805761.

2017

ACS Applied Materials & Interfaces

DOI:10.1021/acsami.7b16516

201710417872.1 **Advanced Materials**

DOI: 10.1002/adma.201805761

Design, synthesis and properties of two new integrated optoelectronic anthracene derivatives

Dan Liu[1], jie li[2], Chenguang Li[2], Huanli Dong[1*], and Wenping Hu[2*]

[1] Key Laboratory of Organic Solids Institute of Chemistry, Chinese Academy of Sciences, Beijing, 100190

[2]Collaborative Innovation Center of Chemical Science and Engineering (Tianjin)&
Department of Chemistry, School of Science, Tianjin University, Tianjin 300072

*Email: dhl522@iccas.ac.cn, huwp@tju.edu.cn

Anthracene, featuring with high luminescence for crystals (64 %) and □ □%□ □ /□ ^{2} V^{-1} s^{-1}), is believe to be a promising skeleton to obtain high performance optoelectronic semiconductors.[1] We design, synthesis and assembly two anthracene derivatives with the high mobility and efficient solid state emission, 2-(2,2-diphenylethenyl) anthracene (DPEA: by simply introducting the half tetraphenylethene (TPE) AIE unit into the 2-posotion of anthracene with the AIE semiconductor materials)[2] and 1,4-di(anthracen-9-yl)buta-1,3-diyne (DABD: by simply incorporating anthracene units and ethynyl groups with different molecular configurations *via* tuning the crystallization process)[3]. DPEA and the -phase DABD crystals initiates two directions for developing high performance integrated optoelectronic organic semiconductors for potential multifunctional applications.

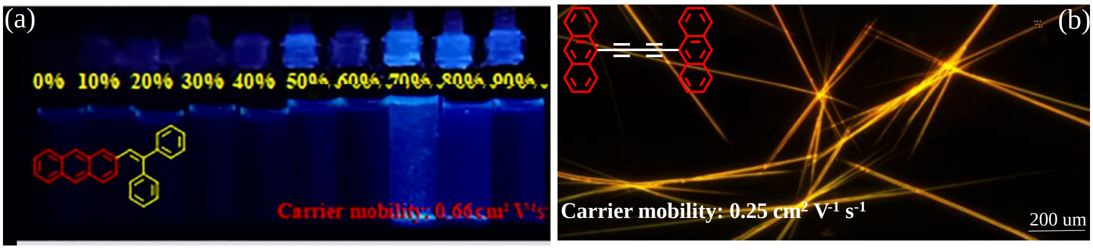


Figure 1. (a) The molecular structure of DPEA, and its AIE property of the fluorescence photographs with mobility. (b) The molecular structure of DABD, the fluorescence microscopy images of DABD crystals with -phase DABD crystals with mobility.

Reference

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[3] Dan Liu, Chenguang Li, Huanli Dong and Wenping Hu. *J. Mater. Chem. C*, **2019**,7, 5925-5930.

Dan Liu □□ □ □at the Institute of Chemistry, Chinese Academy of Sciences. Her current research work is focused on designing, synthesis and characterization of optoelectronic devices based on novel organic semiconductor materials.

OFET

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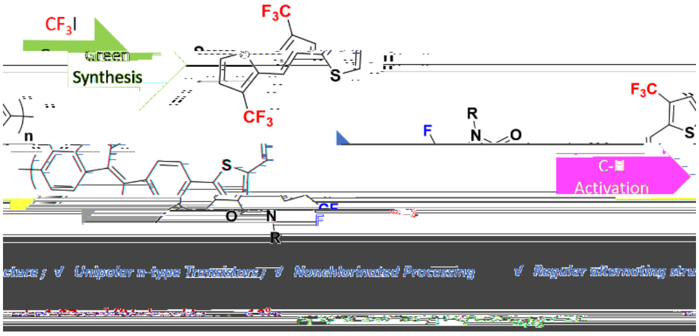
Email: liuyq@iccas.ac.cn

n

(EWGs) [1] - n

CF$_3$TVT Ozawa CF$_3$TVT ( ) CF$_3$ FMO F-H , n $_e$ 1.37 cm^2/(V s) / 10^8 n



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[1] Gao, Y. and Geng, Y. et al. *Adv. Mater.* **2015,** *27*, 6753 6759.

17

Enhanced Performance in Doped Micro-Nano Porous Organic Thin-Film Transistors

Chao He, Yaowu He, Aiyuan Li and Hong Meng*

School of Advanced Materials, Peking University Shenzhen Graduate School, Shenzhen 518055, P. R. China.
*Email: menghong@pku.edu.cn

Molecular doping is an effective method to improve the device performance of organic thin-film transistors. One critical challenge is the disruption of structure order upon doping of highly crystalline organic semiconductors, which significantly reduces the charge carrier mobility. Here, we demonstrate a new method to achieve enhanced performance in solution processed organic thin-film transistors based on C8-benzothieno[3,2-b]benzothiophene (C8-BTBT) via channel doping without disrupting the molecular ordering. Central to the method is the formation of micro-nano porous organic semiconductor thin films via hot spin coating method and blending a proper amount volatile [1]benzothieno[3,2-b][1]benzothiophene (BTBT). Using this method, the charge carrier mobility of C8-BTBT transistors is enhanced twice after doping with 2,3,5,6-tetrafluoro-7,7,8,8,-tetracyanoquinodimethane F_4-TCNQ. Combining UV-vis-NIR absorption and PL spectra, the doping mechanism is identified as partial-charge-transfer induced trap filling.

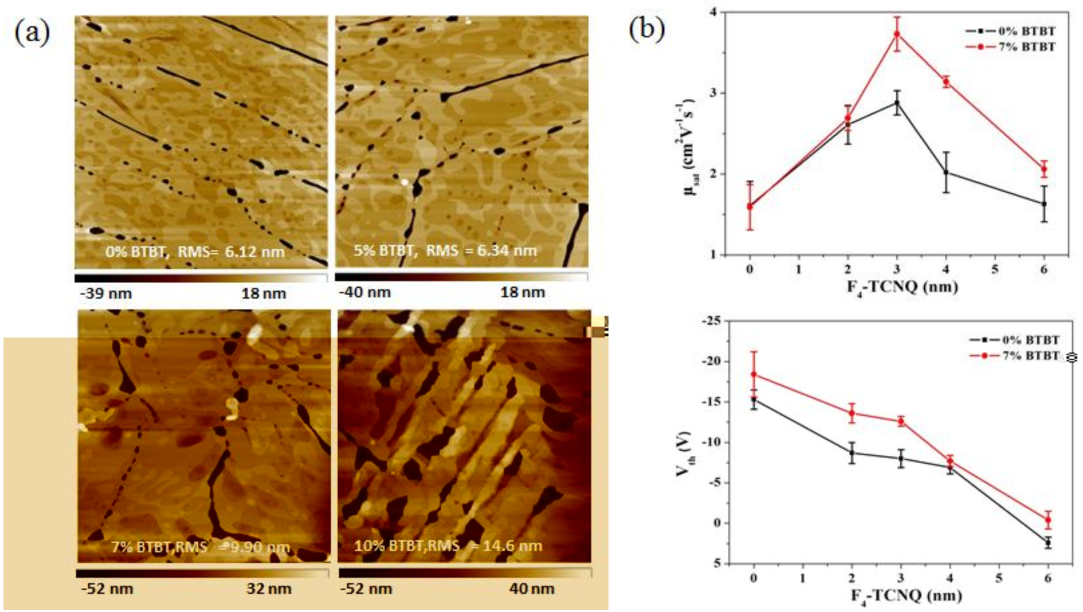

Figure 1. (a) □ □ □% □□/ □ □@5-BTBT thin films with different amount of BTBT, (b) Mobility and threshold voltage of C8-BTBT devices as a function of F_4-TCNQ thickness

Author Introduction

Chao He is currently a research scientist at Peking University Shenzhen Graduate School. His research interests focus on solution-processed organic electronics.

Inverted Annealing Enhanced Performance of Organic Thin-Film Transistors and Phototransistors Based on 2-(4-dodecylphenyl) [1]benzothieno[3,2-b]benzothiophene

Yueyi Wang[1], Yaowu He[1], Aiyuan Li[1], Liangjie Zhang[2,*], Chao He[1,*] and Hong Meng[1]

[1] School of Advanced Materials, Peking University Shenzhen Graduate School, Shenzhen 518055, P. R. China.
[2] Institute of Polymer Optoelectronic Materials & Devices, State Key Laboratory of Luminescent Materials & Devices, South China University of Technology, Guangzhou 510640, P. R. China
*Email: hechao@pkusz.edu.cn

Thermal annealing is an effective process method for regulating the arrangement of liquid crystalline molecules and preparing high performance devices. Although numerous researches have been reported on thermal annealing in) ular packing and arrangement in thin films. Herein, we propose an inverted annealing process to solve this problem, which successfully improves the performance of the organic thin film transistors based on 2-(4-dodecylphenyl) [1]benzothieno[3,2-b]benzothiophene (C12-Ph-BTBT) with ~25% increase in mobility demonstrated compared to conventional annealing. In addition, the photoelectronic properties of C12-Ph-BTBT based phototransistors treated with inverted annealing display a similar improvement, with the highest photoresponsivity increased from 461.6 A/W for conventionl annealed devices to 541.7 A/W under the incident beam intensity of 179.2 uW/cm^2. The main reason for the device improvement is ascribed to the gravity induced alignment of C12-Ph-BTBT molecules due to their soft nature at high temperature. Our results provide an effective way to improve the performance of organic electronics based on liquid crystalline molecules.

Figure 1. (a), (b) Schematic of the OTFTs based on conventional and inverted annealing processes, respectively. (c), (d) Transfer curves of OTFTs.

Author Introduction

Yueyi Wang is currently studying for a master's degree at Peking University, research interests focus on solution-processed organic thin-film transistor.

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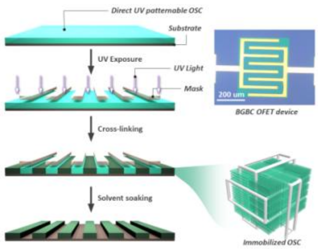
*Email: weidc@fudan.edu.cn

[1]
OSC OSC P
PTDPPTFT4
PTDPPTFT4
PTDPPTFT4
8*8 TFT 100% 1.1 cm^2
V^{-1} s^{-1} 1.64 cm^2 V^{-1} s^{-1} N P(NDI2OD-T2)
PN



1. OSC BGBC OFET

[1] Park, H. W., et al, Universal Route to Impart Orthogonality to Polymer Semiconductors for Sub-Micrometer Tandem Electronics, Advanced Materials, 31, 1901400, (2019)

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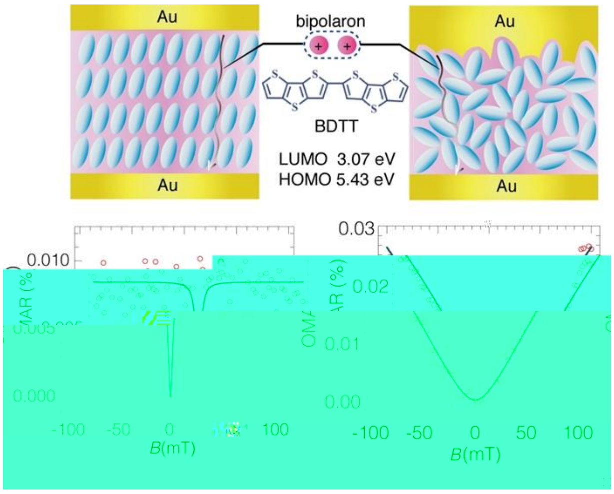
[2] 92 300072
[3] 2 410082
*Email: huwp@tju.edu.cn

OMAR

p BDTT
Au/BDTT/Au



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[1] Shuaishuai Ding, Yuan Tian*, Yang Li, Hantang Zhang, Ke Zhou, Jinyu Liu, Liang Qin, Xiaoxian Zhang, Xiaohui Qiu, Huanli Dong, Daoben Zhu, Wenping Hu*, Organic Single-Crystal Spintronics: Magnetoresistance Devices with High Magnetic-Field Sensitivity, ACS Nano, 13, 9491-9497, (2019)

Solution Processed Centimeter-scale Highly-aligned Organic Single-crystal Arrays for High-performance Organic Field-effect Transistors

Shuming Duan, Xiaotao Zhang, Xiaochen Ren* and Wenping Hu*
Tianjin Key Laboratory of Molecular Optoelectronic Sciences
Department of Chemistry, School of Science, Tianjin University & Collaborative Innovation Center of Chemical Science and Engineering (Tianjin) Tianjin, 300072, China
E-mail: renxiaochen@tju.edu.cn, huwp@tju.edu.cn

Organic single crystal, which exhibits few grain boundary, free defect and long-range order molecular packing, is the key to achieve excellent and uniform characteristics for organic electronics. In practical application, the organic field-effect transistors (OFETs) array must accompany with high performance and small device-to-device variation. However, scalable fabrication of highly aligned organic single crystal arrays is difficult because the lack of control of the nucleation and growth of organic crystals. We report a facile solution printing method to fabricate centimeter-sized highly aligned organic single crystal array with controlled thickness. The OFETs based on organic single crystal array on the different substrates show good devices performance and uniformity. A pseudo-CMOS inverter fabricated based on this method shows high voltage gain and static noise margin over 80%. These demonstrations bring solution printing close to industrial applications and expand its applicability to various printed flexible electronics.

Figure 1. a) POM images of inch-scale single crystalline thin film array on the flexible substrate. The scale bar in the picture is 5 mm. b) Representative transfer I-V curve of patterned single crystalline transistor on flexible substrate before and after bending, inset is OM image of the patterned single crystalline transistor array on flexible substrate. c) The voltage input-output characteristics of the pseudo-CMOS inverter.

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[2] S. Bae, et al, Tailored single crystals of triisopropylsilylethynyl pentacene by selective contact evaporatioy1EMC /P <</y(r)(ll)-3(in)(-)TjEMC /

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*Email: yunfeng.deng@tju.edu.cn

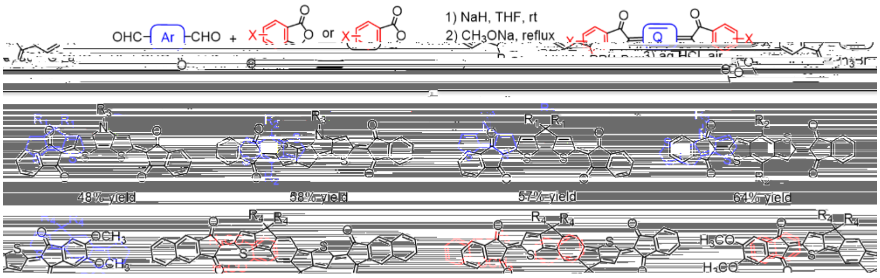
LUMO n

[1]

Wittig Wittig-Horner

[2]

1 > 10^5 L mol^{-1} cm^{-1} LUMO < -4.0 eV OFET n $0.38\ cm^2\ V^{-1}\ s^{-1}$



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2017

High n-channel Mobility and Transport Kinks in C_{60} Field Effect Transistor with Phosphonic Acid Interfacial Layers

SHAN Bowen[1] ZENG Xingwei[1] ZHAO Mengna[1], WANG Yujing[1], MIAO Qian[1,*]

[1] Department of Chemistry, the Chinese University of Hong Kong, Shatin, New Territories, Hong Kong SAR, China

*Email: miaoqian@cuhk.edu.hk

Several cycloalkyl-terminated phosphonic acids have been applied as interfacial Self-assembled monolayer (SAM) of C_{60}-based n-channel field-effect transistors (FET). By careful optimization, vacuum-deposited OTFTs of C_{60} on AlO_x /SiO_2 dielectric modified with 12-Cyclohexyldodecylphosphonic acid (CDPA) exhibited an unprecedentedly high apparent electron mobility, averaging over 30 cm^2 /Vs, and reached 65.2 cm^2 /Vs in the best devices. The unprecedented mobility was attributed to the epitaxial growth of C_{60} film on CDPA SAM layer, confirmed by two-dimensional grazing-incident wide angle X-ray scattering (2D-GIWAXS) and atomic force microscope (AFM) analysis. However, transfer curves used to determine the apparent mobility demonstrated evident non-linear) for the mechanism behind non-linearity, including the gate voltage dependence of contact resistance, and charge injection into deep levels of insulating layers.

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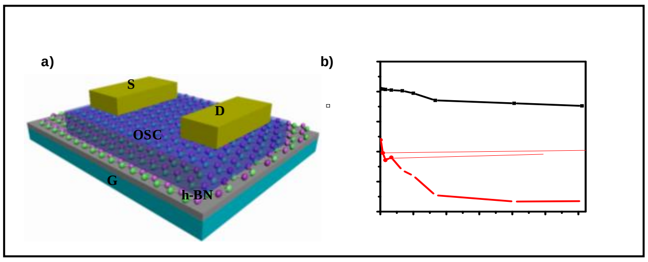
*Email: dcwei@fudan.edu.cn

OFET
OFET
OFET [1]
OFET
PMMA PVA PMMA PVA CYTOP OFET
[2]

h-BN
h-BN h-BN OFET
[3] 2D-BN
2D-BN OFET
OFET 1.29 $cm^2V^{-1}s^{-1}$
2D-BN . 2
2D-BN OFET



1. h-BN OFET

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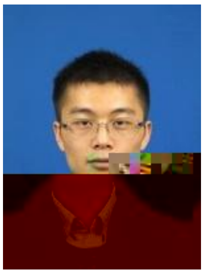

Molecular and low-dimensional structure in organic semiconductor for high-performance chemical sensor

Dapeng Liu Jia Huang*

Interdisciplinary Materials Research Center, School of Materials Science and Engineering, Tongji University, Shanghai, 201804, P. R. China.

*Email: huangjia@tongji.edu.cn

Organic field-effect transistors (OFETs) offer great potential applications in chemical and biological sensing for homeland security, environmental monitoring, industry manufacturing, and medical/biological detection. We report [illegible] -conjugated core structure for OFETs. Alkyl side chains can hinder the diffusion of ammonia into the OSCs layer, which blocks the interaction between ammonia and conducting channel. The result also reveals the relationship between the alky chain and the film thickness in sensitivity control. For the low-dimensional materials, we demonstrated chemical sensors based [illegible] sensitive to chemical analytes. The thickness of the sensing shell can be tuned by controlling the mass ratio of core [illegible]) [illegible] % [illegible]) [illegible]

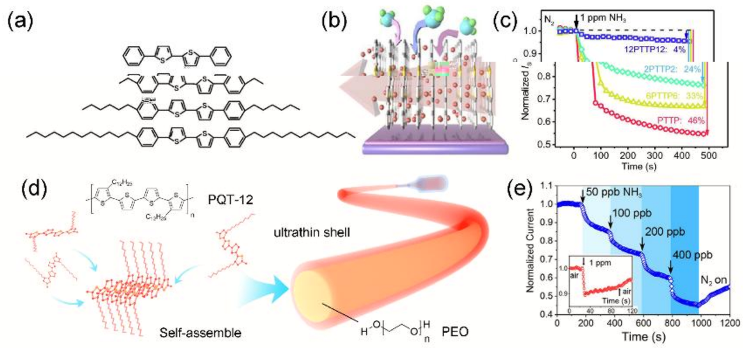

Figure 1. (a) Chemical structure of nPTTPn (0, 2, 6, 12). (b) Schematic diagram of the molecule diffusion. (c) Response to 1ppm NH_3. (d) Electrospinning core-shell nanofiber. (e) Response to ppb level ammonia.

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Dapeng Liu received his bachelo [illegible] Engineering at Tongji University, Shanghai, China. He is currently a PhD student in the School of Materials Science and Engineering, Tongji University. His main research area includes sensors based on organic semiconductor.

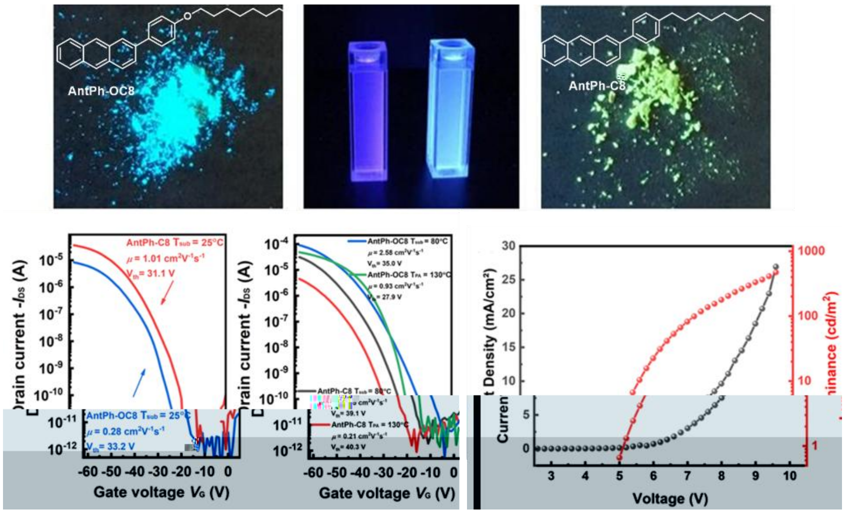
Multifunctional Liquid Crystal Materials Based on Anthracene Derivatives Applied in Optoelectronic Devices

Yunrui Wang[1], *Daqi Fang*[1], *Yaowu He*[1], *Hong Meng*[1*]

[1] School of Advanced Materials, Peking University Shenzhen Graduate School, Shenzhen 518055, People's Republic of China

*Email: menghong@pku.edu.cn

Device integrating is one of the development trends of organic electronics. Under this circumstance, developing novel multifunctional materials is crucial to accelerate the progress of integrated devices such as OLET, OFEW and OEFC. Two liquid crystal (LC) materials, AntPh-OC8 and AntPh-C8, based on the conception of combining LC properties and strong fluorescence, were designed and synthetized. PLQY of AntPh-OC8 and AntPh-C8 were determined to be 40.9% and 37.6%. Highest hole mobility up to 2.59 $cm^2V^{-1}s^{-1}$ was obtained in the OTFT based on AntPh-OC8. Solid-state blue emission of AntPh-OC8 was confirmed in the OLED with a CE of 1.82 cd/A^{-1}. The introduction of side chain played an important role in the modification of charge transporting and photophysical properties for anthracene derivatives.



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Author Introduction

Prof. Hong Meng received his Ph.D. from University of California Los Angeles (UCLA) in 2002. He has been working in the field of organic electronics for more than 20 years. His career experiences including working in the Institute of Materials Science and Engineering (IMRE) at Singapore, Lucent Technologies Bell Labs, DuPont Experimental Station. In 2014, he moved to School of Advanced Materials Peking University Shenzhen Graduate School

[1] [2] [1] [1] [3] [1] [1] [1,*]

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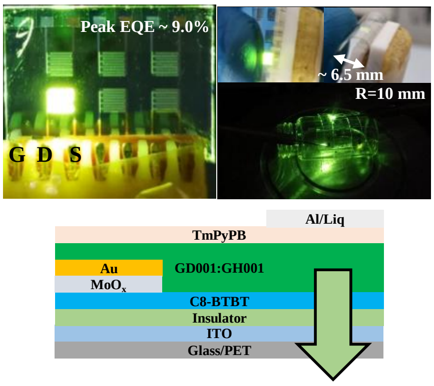
*Email: menghong@pku.edu.cn

(C-PVA) -24 V 14500 cd m^{-2} 9.0% (EQE) (1-) (CYTOP) C-PVA (RH = 70%) 13400 cd m^{-2}, EQE 7.31% CYTOP/C-PVA OLET 8300 cd m^{-2}, EQE 9.01% > 500 cd m^{-2} OLET 6.5 mm



1. OLET

[1] Hongming Chen, et al, Highly Efficient Flexible Organic Light Emitting Transistor Based on High-k Polymer Gate Dielectric, Adv. Opt. Mat., Just Accepted (2019).

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*Email: xrwang@nju.edu.cn, ajavey@berkeley.edu, haibo@nju.edu.cn

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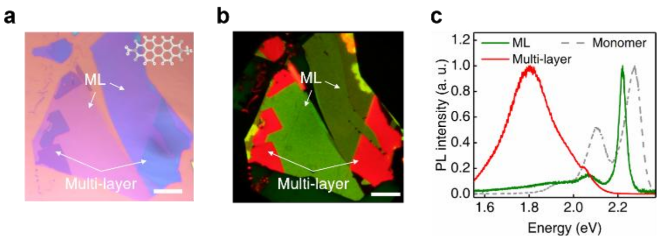

1. Me-PTCDI . a, b, c,

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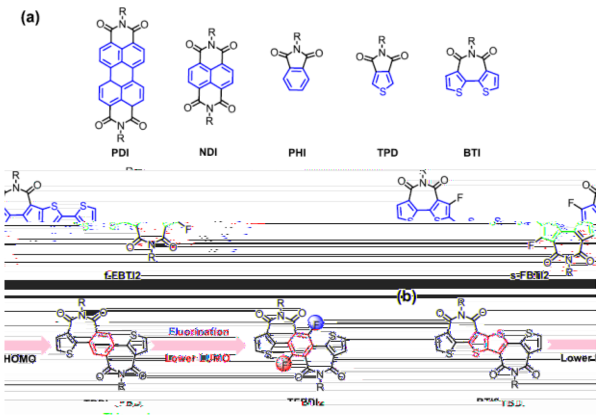
*E-mail: guoxg@sustech.edu.cn

PDI NDI PHI TPD BTI 1a [1] [2] N- BTI (BTI2) [3] BTI2 [3,2-*b*] BTI2 HOMO P- BTI2 TBDI [3,2-*b*] BTI [4] TBDI TBDI TFBDI 1b TFBDI-Br_2 0.10 $cm^2\ V^{-1}s^{-1}$ TFBDI-Se 0.3 $cm^2\ V^{-1}s^{-1}$ TFBDI-Se N-



1. (a) (b) TFBDI

[1] Xugang Guo *et al.* Bithiophene-Imide-Based Polymeric Semiconductors for Field-Effect Transistors: Synthesis, Structure-Property Correlations, Charge Carrier Polarity, and Device Stability. ***J. Am. Chem. Soc.*** . 00)1 2 .1 . 5% . .

[2] Xugang Guo *et al.* Imide- and Amide-Functionalized Polymer Semiconductors. ***Chem. Rev.*** . . 1)561 0 6 / . % .1

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Large-Area 2D Molecular Crystals

Beibei Fu,1 Cong Wang,1 Yantao Sun,2 Yu Wang, 1Fayuan Ge,3 Fangxu Yang,1 Zheyuan Liu,1 Yanfeng Dang,1 Xiaotao Zhang, 1Xiangfeng Shao, 2Rongjin Li,*1 and Wenping Hu1
1. School of Science Tianjin University Tianjin 300072 China
2. State Key Laboratory of Applied Organic Chemistry Lanzhou university, Lanzhou 730000, China
3. State Key Laboratory of Coordination Chemistry School of Chemistry and Chemical Engineering, Nanjing 210023, China
*Email: lirj@tju.edu.cn

Two-dimensional molecular crystals (2DMCs) have attracted considerable attention because of their unique optoelectronic properties and potential applications. Taking advantage of the solution processability of organic semiconductors, solution self-assembly is considered an effective way to grow large-area 2DMCs. However, this route is largely blocked because a precise molecular design towards 2DMCs is missing and little is known about the relationship between 2D self-assembly and molecular structure. Here, a phase separation molecular design strategy towards 2DMCs is proposed and layer-by-layer growth of millimeter-sized monolayer or few-layered 2DMCs is realized. High-performance organic phototransistors (OPTs) were constructed based on the 2DMCs with unprecedented photosensitivity (2.58×10^{7}), high responsivity (1.91×10^{4} A W^{-1}) and high detectivity (4.93×10^{15} Jones). The phase separation molecular design strategy provides a guide for the design and synthesis of novel organic semiconductors that self-assemble into large-area 2DMCs for advanced organic (opto)electronics.

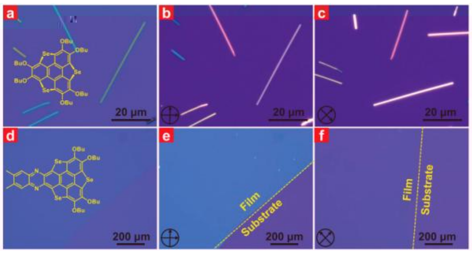

Figure 1. a) OM image of the microribbons of **1**. The inset shows the chemical structure of **1**. b,c) POM images of the microribbons of **1**. d) OM image of a 2DMC of **2**. The inset shows the chemical structure of **2**. e,f) POM images of a 2DMC of **2**.

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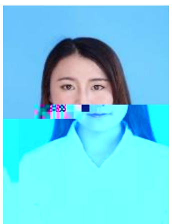
organic field-effect transistors and near-infrared phototransistors *Adv. Mater.* 2018, *30*, 1706260.

About the author



Beibei Fu grew up in Liaocheng, Shandong Province, P. R. China. In 2018, she received her MSC degree from the Department of Chemistry, School of Science, Tianjin University. Since september 2019, she has been a PhD student in the same department (Supervisor: Prof. Wenping Hu). Her interest is in the fields of organic electronics. Currently, she is working on functional electronic devices fabricated by two-dimensional organic crystalline materials.

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Application of organic/inorganic nanocomposites in piezoresistive sensors

Yu Xia[1], Yuan Tian[1*] Zhihui Qin[1*]

[1]School of Physics and Electronics Hunan University, Changsha 410082, China
*Email ytian@hnu.edu.cn , zhqin@hnu.edu.cn

In recent years, with the development of cross-integration in the fields of medicine, machinery, sensors, and intelligent control, the rapid advancement of disability rehabilitation robots in biomedical engineering has been promoted, in which medical equipment has been boosted to be more sophisticated, multifunctional, automated and intelligent.[1] The application of sensors on such robots makes it possible to display various parameters such as pressure, acceleration and etc. in an easy-to-understand form, thus achieving better human-computer interaction. Meanwhile, some organic/inorganic nanocomposites stand out with great potential for the application in piezoresistive pressure sensors due to better mechanical properties and stability. Elective organic/inorganic nanocomposites for piezoresistive sensors are highly expected along with corresponding design towards qualified sensitivity and response time for the foot pressure detection of assisted robots.

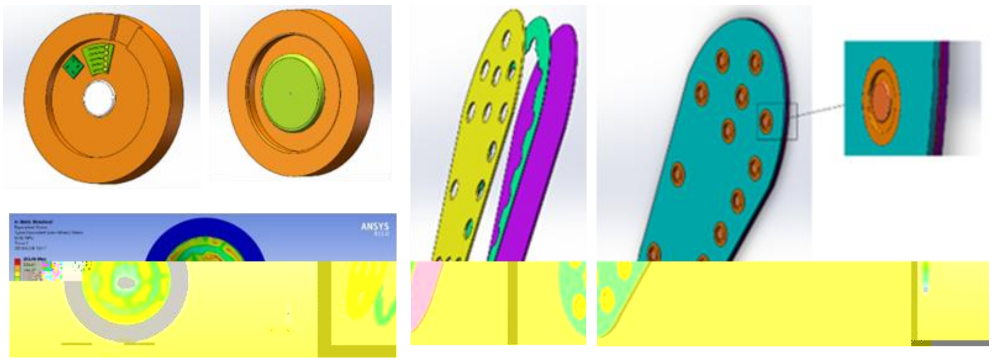

Figure 1. Piezoresistive sensor structure and array layout.

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Wide Band Gap Pyromellitic Diimides for Photo Stable n-Channel Thin Film Transistors

Jianing Wang,[a] Tianchen Fu,[c] Changbin Zhao,[c] Hongtao Yu,[a,c] Dongwei Zhang*[b] and Hong Meng[a,c]

a Key Laboratory of Flexible Electronics (KLOFE) & Institute of Advanced Materials (IAM), Jiangsu National Synergetic Innovation Center for Advanced Materials (SICAM), Nanjing Tech University (Nanjing Tech), 30 South Puzhu Road, Nanjing, 211816, China. E-mail: iamhmeng@njtech.edu.cn

b. The Institute for Solid State Physics, The University of Tokyo, 5-1-5 Kashiwanoha, Kashiwa, Chiba 277-8581, Japan, E-mail: zhangdw@issp.u-tokyo.ac.jp

c School of Advanced Materials, Peking University Shenzhen Graduate School, Peking University, Shenzhen, 518055, China

*Email: iamhmeng@njtech.edu.cn

Organic semiconductors (OSCs) have attracted much attention from both academe and industry in the past few decades due to their diverse applications in organic electronics, including flexible displays, sensors, complementary circuits, etc. The progress in this field has been focused on the molecular design to achieve high charge carrier mobility, which requires densely and periodically molecular packing in their thin films. Up to now, a lot of high @ -extended acenes, heteroacenes and their derivatives for p-type transistors (ref), as well as perylene diimide and naphthalene diimide derivatives for n-type transistors.[1-2] However, it remains a challenge to simultaneous satisfy high mobility and transparency in the visible range within a molecule, which is important for transparent organic field-effect transistors (TOFETs) since it is a fundamental building block in transparent electronics for a variety of applications.

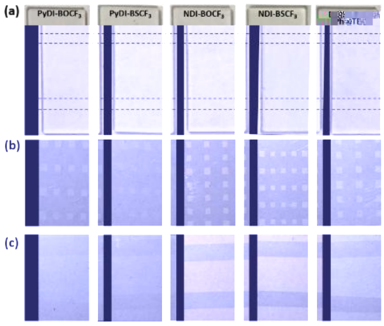

Figure 1. The photographs of 40 nm-thick solid-state thin films of PyDI-BOCF$_3$, PyDI-BSCF$_3$, NDI-BOCF$_3$, NDI-BSCF$_3$ and DPh-BTBT deposited on (a) transparent quartz (the dashed lines represent the area without film) and (b,c) flexible PET substrates.

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Author Introduction

Jianing Wang is currently studying for a master's degree at Nanjing Tech University, is research interests focus on organic thin-film transistor.

Single-Crystal Organic Field-Effffect Transistors of Dibenzofuran (DBF) linked BTBT

Yang He [1], Aiyuan Li [2], Hong Meng*, and Wei Haung*

[1] Nanjing Tech University

[2] Peking University, Shenzhen

*Email: iamhmeng@njtech.edu.cn

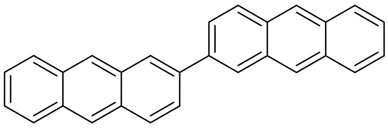
In the field of organic electronics, It s no exception that the organic semiconductor materials based on the thiophene derivatives are the research focus and competitive. in contrast, furan, it has received far less attention, especially the applications of the device. Dibenzofuran (DBF) is one of the aromatic units that widely utilized in organic light-emitting diodes (OLEDs). However, there are few reports on the application of dibenzofuran (DBF) derivatives for the single crystal OTFTs devices. herein, we design and synthesis which combines the promising

Thermal Stable Organic Thin Film Transistors Based on Tetracene

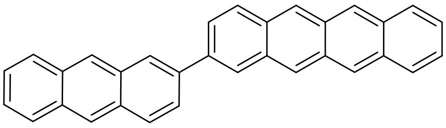
Huinan Yu [1], Chao He [2], Hong Meng [*], and Wei Haung [*]

[1] Nanjing Tech University
[2] Peking University, Shenzhen
*Email: iamhmeng@njtech.edu.cn

Tetracene, one of the polyacene derivatives, shows eminent optical and electronic properties with relatively high stability. To take advantage of the intrinsic properties of the tetracene molecule and explore new semiconductors, herein, we report the design and synthesis of a novel p-channel tetracene derivatives, 2-(anthracen-2-yl)tetracene (TetAnt). Top contact OTFTs were fabricated using this materials as semiconductor layers, with charge mobilities up to 0.79 cm^2 V^{-1} s^{-1}. And 2-anthryl-2-anthracence (2A) was a comparison to research the thermal stability of TetAnt OTFT device, with charge mobilities hold on 0.27 cm^2 V^{-1} s^{-1} at 270 ℃



2Ant



TetAnt

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Author Introduction

Huinan Yu received a BSc in Applied Chemistry from Yancheng Teachers University in 2017 and now a Postgraduate student in Nanjing Tech University co-supervised by Prof. Wei Huang and Prof. Hong Meng. Her research interest is organic semiconductor materials transistors.

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*Email zhenyg@iccas.ac.cn, dhl522@iccas.ac.cn, huwp@tju.edu.cn

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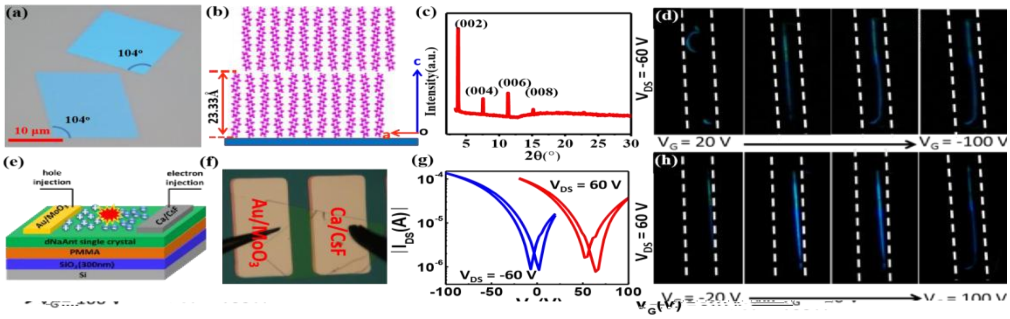

1. a 2,6-DNA b 2,6-DNA c 2,6-DNA XRD e f g d h 2,6-DNA d V_{DS} = -60 V g V_{DS} = 60 V

2,6- 2,6-DNA / 2 ^{2} V^{-1} s^{-1} ~ -10 V 6.88 × 1011 cm ^{2} 2,6-DNA J- 29.2% 2,6-DNA h = 1.10 cm^2 V^{-1} s^{-1}) 54 ^{2} V^{-1} s^{-1} 2,6-DNA [1,2]

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P3HT OFET

OFETs

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3- P3HT 2D 3D

X -

P3HT 3 0.23

P3HT-OFETs

OFETs

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*Email dhl522@iccas.ac.cn,huwp@tju.edu.cn

(OLET) (OFET) (OLED)

OLET OLET OLET 2,6-diphenylanthracene DPA 2,6-di(2-naphthyl) anthracene (dNaAnt) OLET DPA-dNaAnt-OLET p n OLET

OL3(L)20(ET)]T6 EM7(E]T6 P <</MCID 76 >>BDC /C1001

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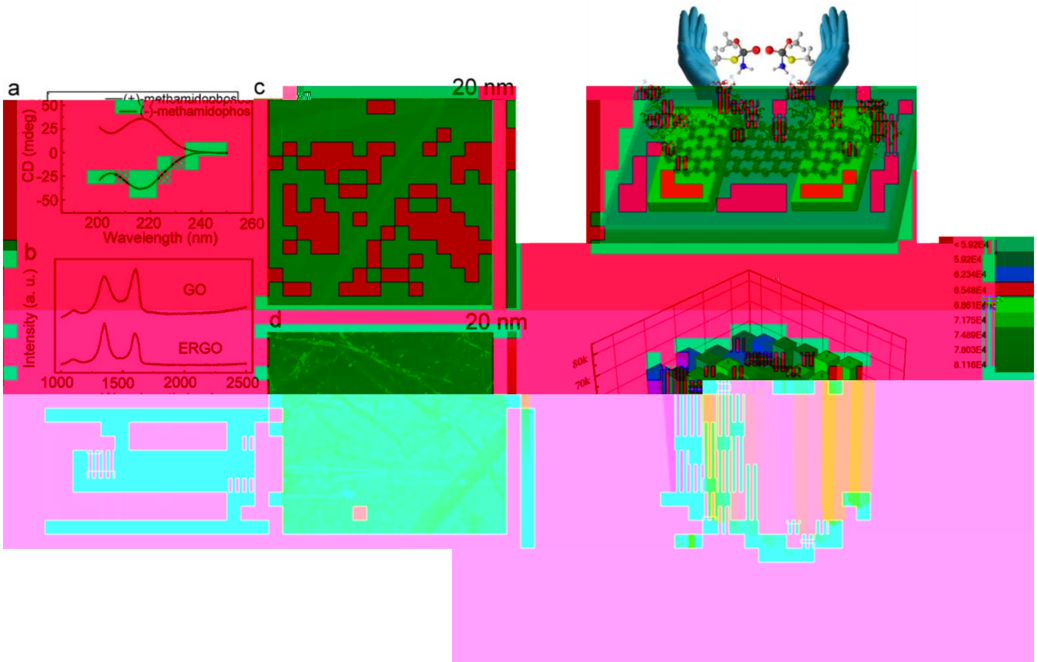
*Email: 851218889@qq.com



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Self-assembled Monolayers Induced Performance Difference in Organic Single Crystal Field-effect Transistors

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[1] 518055

*Email:menghong@pku.edu.cn

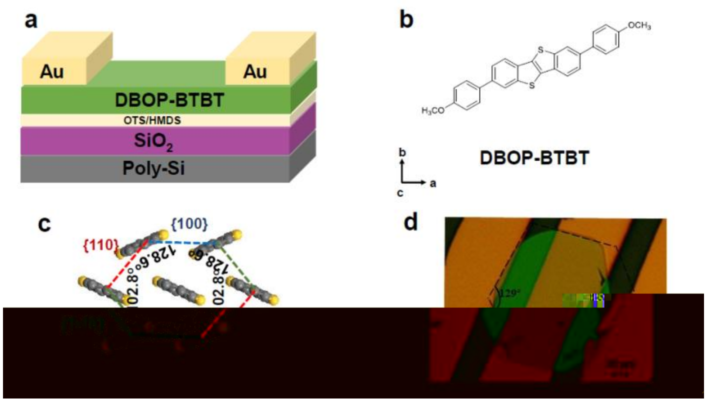
OSCFET

OTS HMDS

HMDS

HMDS 12.9 $cm^2\ V^{-1}\ s^{-1}$

OTS 7.7$cm^2\ V^{-1}\ s^{-1}$



Heterocyclic substituents effects on anthracene-transport performance

Yanan Zhu, Hong Meng*

*Email:menghong@pku.edu.cn

Based on the former work about the influence mechanism of the mobility difference of phenyl and thienyl substituent semiconductors, we have made further exploration towards to design high performance organic thin film transistors. The heterocyclic substituent group effect plays a significant role on materials properties and device performance as well. For theoretical study, simulation of materials property and crystal packing can supply a scientific guidance for materials synthesis in experiments. This time, we have taken the computational methods to design a new material substituent with furan groups which is potential to be used in organic thin film transistors and organic single crystal transistors. The reorganization energy have been calculated and much lower than phenyl substituent (DPAnt) which performs a large mobility as more than 30 cm2V-1s-1. Moreover, the other important parameter, charge transfer integral is larger than DPAnt, which suggested the furan substituent material may get a much better charge transport data. On the whole, the mechanism investigation based on phenyl and thienyl assisted to design a novel materials with furan substituent which is predicted to be an outperformed organic field effect transistors.

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*Email: liay@pkusz.edu.cn

(PVT) 60 nm 2D

[1] 15 $cm^2V^{-1}s^{-1}$

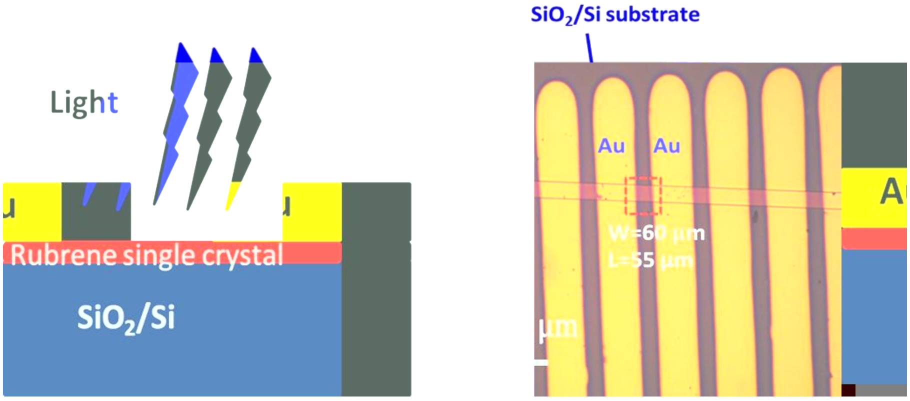
TFT [2]

0.11 mW/cm^2 350 nm 3100 AW^{-1} [3]

+100 V,0.2 s

10000 s -60 V 2s XPS

[4]



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