The 15th International Conference on Flexible and Printed Electronics (ICFPE2025)

2025 ICFPE
The International Conference on Flexible and Printed Electronics

Book of Abstracts

September 17-19 2025
Institute of Science Tokyo
& Kuramae Kaikan
Tokyo, Japan

ICFPE2025 Program Special & Regular Sessions
September 17 (Wed)

Opening Remark　　　　　　　　　　Kuramae Hall
11:00-11:10
Conference Chair: Prof. Takaaki Manaka
Institute of Science Tokyo, Japan

Plenary　　(Chair Prof. Baba)　　　　Kuramae Hall
11:10-12:00　PL-1
Sustainable High-Throughput Foundry for Sticker-Like Computer via Roll-to-Roll Gravure Printing System
Gyoujin Cho[1,2,3]
[1]Department of Intelligent Precision Healthcare Convergence, Sungkyunkwan University, Republic of Korea
[2]Department of Biophysics and Institute of Quantum Biophysics, Sungkyunkwan University, Republic of Korea
[3]Engineering Research Center for Developing R2R Printed Flexible Computer, Sungkyunkwan University, Republic of Korea

Lunch

Special session 1 (Prof. Pandey)　　　　Kuramae Hall
Recent Development in Functional Optoelectronic Devices and Systems
13:00-15:00
13:00　S1-I1 (invited)
Synergistic Interface Engineering of NiOx/Perovskite Heterojunction via Multifunctional Organic Molecule for Efficient and Stable Inverted Solar Cells
Das Adhikari, R.[1], Baishya, H.[1], Patel, M. J.[2], Yadav, D.[2], Iyer, P. K.[1,2]
[1]Centre for Nanotechnology, Indian Institute of Technology Guwahati, India
[2]Department of Chemistry, Indian Institute of Technology Guwahati, India
13:30　S1-I2 (invited)
TBD
Vipul Singh
Indian Institute of Technology Indore, India

14:00 S1-O1

PFO-DBT/PCBM Blend-Based High-Performance OFETs for Optoelectronic Applications

Sidhi G Ramer[1], I. A. Palani[2], Shyam S. Pandey[3], Vipul Singh[3]

[1]Molecular and Nanoelectronics Research Group (MNRG), Department of Electrical Engineering, IIT Indore, India

[2]Department of Mechanical Engineering, IIT Indore, India

[3]Graduate School of Life Science and Systems Engineering, Kyushu Institute of Technology, Japan.

14:20 S1-O2

An investigation on the performance of Quaternary NiTi-SMA Bimorph Integrated Optical Fiber Sensor

Navneet Chouhan[1,2], Nandini Patra[2], I. A. Palani[2] and Vipul Singh[1]

[1]Molecular and Nano-Electronics Research Group, Indian Institute of Technology, India

[2]Mechatronics and Instrumentation Lab, Indian Institute of Technology, India

14:40 S1-O3

Unraveling the role of charge carrier mobility for the fabrication of OFET-based integrated sensing devices

Harshita Rai, Kshitij RB Singh, Shyam S. Pandey

Graduate School of Life Science and System Engineering, Kyushu Institute of Technology, Japan

Break

Special session 2 (Prof. Kitamura) Kuramae Hall

Smart, Wearable, and Flexible Sensor Devices

15:10-17:10

15:10 S2-I1 (invited)

Wearable Respiration Sensor Fit on Skin and Fine Patterning Technique Using Flexible Film

Minoru Sasaki

Toyota Technological Institute, Japan

15:40 S2-I2 (invited)

Organic Floating-Gate Transistors for Printed Nonvolatile Optoelectronic Memory and Image Sensor Applications

Takashi Nagase[1,2]

[1] Department of Physics and Electronics, Osaka Metropolitan University, Japan

[2] The Research Institute for Molecular Electronic Devices, Osaka Metropolitan University, Japan

16:10 S2-I3 (invited)

Development of a Chemiresistive Sensor Based on Metal-Oxide-Semiconductor Nanostructures for Wearable Detection of Ions in Solutions

Yoshinari Kimura

Department of Finemechanics, Graduate School of Engineering, Tohoku University, Japan

16:40 S2-O1

RF-Controlled Resistance Modulation in Ag2Te Films for Neuromorphic Electronics

Jun Yamasawa, Yuta Tsuchihashi, Toshihiro Nakaoka

Sophia University, Japan

16:55 S2-O2

Skin-Adhesive Organic Transistors for Long-Term Wearable Electronics

Chika Okuda, Takao Someya, Tomoyuki Yokota

The University of Tokyo, Japan

Regular session 1 (Prof. Baba) Royal Blue Hall

13:00-14:30

13:00 R1-I1 (invited)

Laser-Induced Conductive Patterns on Flexible and Eco-Friendly Substrates

Ying-Chih Liao

Department of Chemical Engineering, National Taiwan University, Taiwan

13:30 R1-O1

Fabrication of Transparent Heater using Inkjet - Printed sacrificial layer

Kyung-Tae Kang[1], Dong Yeol Shin[1], Chaewon Kim[1], Yoon Jae Moon[1], Kunsik An[2]

[1]Autonomous Manufacturing & Process R&D Department, Korea Institute of Industrial Technology (KITECH), Korea

[2]Department of Mechanical Engineering, Sejong University, Korea

13:45 R1-O2

Selective Semiconducting Carbon Nanotube Extraction with Cellulose Acetate

Kazuhiro Yoshida[1], Daichi Suzuki[2], Yoshiyuki Nonoguchi[1]

[1]Kyoto Institute of Technology, Japan

[2]Sensing Technology Research Institute, AIST, Japan

14:00 R1-O3

A Hybrid Inkjet Printhead with Piezo and EHD Technology for 200 cP Viscosity Ink Ejection

Eunyoung Lee, Inho Na, Choongmoo Shim, Jongphil Choi, Youngjoon Han, Youngjun Jo, Chaerim Park, Juhyeon Park, Ju Young Park, Yoomin Lee, Jaewoo Joung, Jaeyong Choi

ENJET Co.,LTD, Republic of Korea

14:15 R1-O4

Plasma-Enhanced g-C_3N_4/BC-Derived LIG Electrodes for AChE Assisted Pesticide Detection

Saranvignesh Alagarsamy, Ying-Chih Liao

Department of Chemical Engineering, National Taiwan University, Taiwan

Break

Special session 4 (Prof. Kajii) Royal Blue Hall

Analysis and Electronic and Optical Materials for Future IoT

15:10-17:10

15:10 S4-I1 (invited)

Ultrathin Photonic Devices and Integrated Systems for Bio-Interfacing

Kenjiro Fukuda

The University of Osaka, Japan

15:40 S4-I2 (invited)

Light intensity dependence of equivalent circuit parameters of organic photovoltaic cell: Evaluation with Bayesian estimation

Kazuya Tada

University of Hyogo, Japan

16:10 S4-I3 (invited)

Organic Luminescent Radical Materials for Organic Electronics

Ken Albrecht

Institute for Materials Chemistry and Engineering, Kyushu University, Japan

16:40 S4-O1

Effect of buffer layer insertion at the interface between the printed ZnOx electron transport layer and the emissive layer for application to printed light-emitting devices

Yuki Nagase[1], Hirotake Kajii[1], Maowei Huang[1], Shintaro Toda[2], Masahiko Kondow[1]

[1]Graduate School of Engineering, The University of Osaka

[2]ULVAC-The University of Osaka Joint Research Laboratory for Future Technology, Japan

16:55 S4-O2

Electrical Polarization Characteristics of AC-driven Insulated Organic Electroluminescent Devices with Printed Inorganic/Organic Hybrid Ferroelectric Dielectric Film Towards the Application in Non-Volatile Optical Memory

Hirotake Kajii, Yuto Takayama, Hinata Kimura, Masahiko Kondow

The University of Osaka, Japan

OE-A session (Dr. Klaus Hecker) Bldg W9, W933 Lecture Room

Flexible and Printed Electronics: Materials, Production, and Applications

presented by OE A at ICFPE 2025, Tokyo, Japan

13:00-17:10

13:00 OE-A-1

Flexible and printed electronics enabling innovation and industrialization

Klaus Hecker, Raswanth Sendhil Sasikala

OE-A, Germany

13:20 OE-A-2

3D Kirigami lighting enable by 2D printed electronics

Peter Rensing[1], Razvan Petre[1], Matjaž Milfelner[2], Peter Bancken[3], Corne Rentrop[1,4], Hylke Akkerman[1]

[1]Holst Centre – TNO, The Netherlands

[2]TECOS Slovenia, Slovenia

[3]Signify Netherlands B.V., The Netherlands

[4]TracXon B.V., The Netherlands

13:40 OE-A-3

Organic photovoltaic cells and modules for harvesting indoor light to power IoT devices – upscaling and long-term stability

Sadok Ben Dkhil

Dracula Technologies, France

14:00 OE-A-4

Electroactive polymers for flexible and printable innovative sensors and actuators

Tong Huang[1], Mickael Pruvost[2]

[1]Arkema KK, Japan

[2]Arkema, France

14:20 OE-A-5

Fully printable biosensors enabled by biofunctionalized 2D-material based inks

Sina Azad[1], Frank Nüesch[1,2], Jakob Heier[1]

[1]Laboratory for Functional Polymers, Swiss Federal Laboratories for Materials Science and Technology (Empa), Switzerland

[2]Institute of Materials Science and Engineering, Ecole Polytechnique Fedérale de Lausanne (EPFL), Switzerland

14:40 OE-A-6

Empowering Scalable Innovation in Functional Surfaces

Fabien Resweber

Armor Smart Films, France

Break

15:10 OE-A-7

Advanced screen-printing process for functional textiles

Paul Brook

Interlink Electronics Inc., The United States of America

15:30 OE-A-8

Additive manufacturing platform for freeform 3D microelectronics and packaging

Darragh Walsh, Jeroen Sol, Sophie Suijdendorp, Hylke Akkerman

Holst Centre/TNO, Eindhoven, The Netherlands

15:50 OE-A-9

Scaling up organic photovoltaics: The path to industrial mass production of integrated PVs in buildings & agriculture

Stergios Logothetidis[1,2], A. Theodosiou[1]

[1]Organic Electronic Technologies P.C. (OET), Greece

[2]Nanotechnology Lab LTFN, COPE-Nano Center of Excellence, Aristotle University of Thessaloniki, Greece

16:10 OE-A-10

Expanding the boundaries of printed electronics for volume manufacturing of PCB-replacements

Ashok Sridhar

TracXon B.V., The Netherlands

16:30 OE-A-11

Why reliability is a crucial element to scale printed flexible electronics products

Wolfgang Mildner[1,2]

[1]MSWtech, Germany

[2]LOPEC, Germany

16:50 OE-A-12

Crossing the Chasm: The role of AI in optimizing Flexible Electronics Performance and Manufacturing

Wolfgang Mildner

Bayflex, Germany/The United State of Aemerica

September 18 (Thu)

ICFPE Keynote (Chair Prof Iino) Kuramae Hall

10:00-10:50 KL-1

Software defined functions – Opportunities for Printed Electronics

Alain Schumacher

IEE S.A., Bissen, Luxembourg

Break

Special session 7 (Prof. Kimura) Kuramae Hall

Intelligent Textile-based Devices

11:00-12:30

11:00 S7-I1 (invited)

Cellulose Nanofiber/Poly(acrylic acid)-based Hydrogel for Colorimetric Biomarker Sensors

Nichaphat Passornraprasit[1], Tatiya Siripongpreda[2], Sumalee Ninlapruk[3], Juan P. Hinestroza[4], Nadnudda Rodthongkum[1], Pranut Potiyaraj[1]

[1]Faculty of Science, Chulalongkorn University, Thailand

[2]Faculty of Environment and Resource Studies, Mahidol University, Thailand

[3]Office of Atoms for Peace (OAP), Thailand

[4]Department of Human Centered Design, Cornell University, United States

11:30 S7-I2 (invited)

Thermally-drawn microelectronic fibers as intelligent textile interfaces

Yuanyuan Guo[1,2,3]

[1]Frontier Research Institute for Interdisciplinary Sciences (FRIS), Tohoku University, Japan

[2]Graduate School of Biomedical Engineering, Tohoku University, Japan

[3]Graduate School of Medicine, Tohoku University, Japan

12:00 S7-I3 (invited)

Flexible and Stretchable Devices for Smart Textiles

Atsushi Takei, Taiki Nobeshima, Yusuke Komazaki, Yasuyuki Kusaka

Sensing Technology Research Institute,

National Institute of Advanced Industrial Science and Technology, Japan

Lunch

Special session 8 (Prof. Hasegawa) Kuramae Hall

Crystal Engineering and Charge Transport in Organic Semiconductors

13:30-15:30

13:30 S8-I1 (invited)

Monolayer organic transistors: from fabrications to applications

Paddy K. L. Chan

Department of Mechanical Engineering, The University of Hong Kong, China

14:00 S8-O1

Control of Carrier Injection in Bottom-Gate Bottom-Contact-Type Single-Crystal Organic Transistors

Keito Murata[1], Shinji Tsuchida[1], Satoru Inoue[2], Toshiki Higashino[3], Tatsuo Hasegawa[1]

[1]University of Tokyo, Japan

[2]Yamagata University, Japan

[3]National Institute of Advanced Industrial Science and Technology (AIST), Japan

14:15 S8-O2

Formation of mixing-induced polar molecular order and carrier transport in piezoelectric organic semiconductors

Kiyoshi Nikaido[1], Seita Kuroda[1], Satoru Inoue[2], Tatsuo Hasegawa[1]

[1]The University of Tokyo, Japan

[2]Yamagata University, Japan

14:30 S8-I2 (invited)

High-Performance, Robust Organic Semiconductors

Toshihiro Okamoto[1,2]

[1]Institute of Science Tokyo, Japan

[2]CREST, JST, Japan

15:00 S8-O3

Nitrogen-Containing Perylene Diimides with Cyclohexyl-Type Side Chains for n-Type Organic Semiconductors

Shohei Kumagai[1], Eiji Fukuzaki[1], Hiroyuki Ishii[2], Jun Takeya[3,4], Toshihiro Okamoto[1,4]

[1]Institute of Science Tokyo, Japan

[2]University of Tsukuba, Japan

[3]The University of Tokyo, Japan

[4]CREST, JST, Japan

15:15 S8-O4

Role of Substituted Alkyl Chains in Layered Organic Semiconductor Crystals: mono-Cn-BTNT

Satoru Inoue[1], Toshiki Higashino[2], Kiyoshi Nikaido[3], Mutsuo Tanaka[4], Seiji Tsuzuki[3], Sachio Horiuchi[2], Hiroyuki Matsui[1], Reiji Kumai[5], Tatsuo Hasegawa[3]

[1]Yamagata University, Japan

[2]AIST, Japan

[3]The University of Tokyo, Japan,

[4]Saitama Institute of Tech., Japan

[5]KEK, Japan

Regular session 2 (Prof. Iino) Royal Blue Hall

11:00-12:15

11:00 R2-O1

Nanomaterials-Enabled Functional Wearables for Sustainable and Intelligent Healthcare

Po Kang Yang

Department of Biomedical Sciences and Engineering, National Central University, Taiwan

11:15 R2-O2

Controlled Alignment of Organic thin films for flexible and efficient phototransistor application

Radhe Shyam[1,2], Takaaki Manaka[2], Rajiv Prakash[1]

[1]Department of Electrical and Electronics Engineering, Institute of Science Tokyo, Japan

[2]Indian Institute of Technology (BHU) Varanasi, India

11:30 R2-O3

Maskless Ultra-Precise Dispensing: Micro-Manufacturing for Flexible and Printed Electronics

Filip Granek, Piotr Kowalczewski

XTPL SA, Poland

11:45 R2-O4

A Flexible and Recyclable Biomechanical Sensor Design based on Triboelectrification

Shih-Min Huang, Po-Kang Yang

Department of Biomedical Sciences and Engineering, National Central University, Taiwan

12:00 R2-O5

Silent Speech Interface Using Soft EMG Sensors with Deep Learning

Yuta Kurotaki[1,2], Reitaro Yoshida[2], Shunsuke Yamakoshi[1], Yutaka Isoda[1], Tamami Takano[1], Yuji Isano[1], Yusuke Miyake[2], Kentaro Kuribayashi[2], Hiroki Ota[1]

[1]Yokohama National University, Japan

[2]Pepabo Research and Development Institute, GMO Pepabo, Inc., Japan

Lunch

Special session 10 (Prof. Yokokura and Prof. Shimada)　Royal Blue Hall

Crystallization and Self-Organization in Flexible, Organic, or Printed Electronics

13:30-15:30

13:30　S10-I1 (invited)

Structural and Electronic Characterization of　Single-crystalline Organic Semiconductors and These Interfaces

Yasuo Nakayama

Department of Pure and Applied Chemistry, Tokyo University of Science, Japan

13:55　S10-I2 (invited)

Solution-Processed Organic Thin-films Growth on Hf0.5Zr0.5O2 Gate Insulators Toward Printed Memory

Nobuya Hiroshiba[1], Kazuto Koike

Osaka Institute of Technology, Japan

14:20　S10-I3 (invited)

Real-time analysis of vacuum-deposited organic thin-film growth using quartz crystal microbalance

Ryosuke Matsubara

Shizuoka University, Japan

14:45　S10-I4 (invited)

Spontaneous Orientation Polarization of Natural Polar Molecules

Kouki Akaike

National Institute of Advanced Industrial Science and Technology, Japan

15:10　S10-O1

Crystal Structure and Transistor Characteristic of T-shaped Novel π-conjugated Molecules

Suo Jeon[1], Seiya Yokokura[1,2], Hiroki Waizumi[1,2], Toshihiro Shimada[1,2]

[1]CSE, Hokkaido University, Japan

[2]ENG, Hokkaido University, Japan

Poster session: Kuramae Hall, Gallery

15:40-17:30

（Poster presentation core time: 15:40 - 16:35 odd number, 16:35 - 17:30 even number）

P-01 Soft Three Dimensional shape electronic technology

Kuga Kato, Tatsuhiro Takahashi, Tadahiro Furukawa

Yamagata University, Japan

P-02 Silver Nanowires–Elastomer materials for Low-Voltage-Driven Stretchable Transistors with Artificial Synapses and Printing Process Applications

Shu-Wei Hsiao, Pei-Tun Liao, Wen-Ya Lee

National Taipei University of Technology, Taiwan

P-03 All-Solution-Processed CsPbBr3 Quantum Dot Light-Emitting Diodes on Flexible Paper Substrates

Wen-Cheng Su[1], Chang-Syuan Wang[1], Tsung-Che Wang[1], Yu-Chi Hu[1], Wen-Chen Tseng[1], Chiashain Chuang[1], Ji-Lin Shen[2], and Dung-Sheng Tsai[1]

[1]Department of Electronic Engineering, Chung Yuan Christian University, Taiwan

[2]Department of Physics, Chung Yuan Christian University, Taiwan

P-04 Theoretical and Experimental Analysis of Quantum Dot Color Conversion Films for display application

Kinza Batool[1], Youngji Lim[2], Kyoungwon Park[2], Bum-Joo Lee[1]

[1]Department of Flexible and Printable Electronics, Jeonbuk National University, Republic of Korea

[2]Display Research Center, Korea Electronics Technology Institute (KETI), Republic of Korea

P-05 Rational Design of Layered Heterostructures for Multifunctional Sensing Systems

Hsin-Yu Kuo, Po-Kang Yang

Department of Biomedical Sciences and Engineering, National Central University, Taiwan

P-06 A Multifunctional Stretchable Sensor For Rehabilitation Application

I Chun Ha, Po Kang Yang

Department of Biomedical Sciences and Engineering, National Central University, Taiwan

P-07 Understanding the Charge Transport in Interlayer-based Charge Generation Layers by Impedance Spectroscopy Coupled Equivalent Circuit Simulation

Akeem Raji[1], Somi Park[1], So-Young Boo[1], Eun-Jeong Jang[2], Jaeyong Park[1], Woon-Ha Lee[1], Si-Eun Park[1], Seonghwan An[1], Jonghee Lee[1], Jae-Hyun Lee[1]

[1]Department of Creative Convergence Engineering, Hanbat National University, South Korea

[2]Department of Electronic Engineering, Hanbat National University, South Korea

P-08 Mechanistic Insights into MoO_3 Interfacial Layer Functionality for Non-Precious Electrodes in Organic Semiconductors

Jin Xu, Yu Maeda, Kanta Hatano, Yu Satou, Kenshin Oyamatsu, Ryousei Matsumoto, Norio Onojima

University of Yamanashi, Japan

P-09 Temperature-Tunable Chirality in Chiral Perovskite Thin Films via Dimensional Phase Transition

Feng Wei, Takaaki Manak, Dai Taguchi

Institute of Science Tokyo, Japan

P-10 Drying Effects on Surface Morphology and RF Characteristics of Inkjet-Printed Coplanar Waveguides

Jun Ho Yu[1], Sung-min Sim[2], Jung-Mu Kim[2], Sang-Ho Lee[1]

[1]Korea Institute of Industrial Technology, Korea

[2]Jeonbuk National University, Korea

P-11 Simultaneous Laser-Assisted Inkjet Printing for Uniform Silver Micro-Lines

Iseok Sim[1,2], Kwon Yong Shin[1], Heuiseok Kang[1], Jun Young Hwang[1], Seung-Jae Moon[2]

[1]Korea Institute of Industrial Technology, Republic of Korea

[2]Department of Mechanical Convergence Engineering, Hanyang University, Republic of Korea

P-12 Wavelength-Controlled Chirality Inversion in Circularly Polarized Photopolymerization of Polydiacetylene

Hongfei Sun, Taishi Noma, Dai Taguchi, Takaaki Manaka

Institute of Science Tokyo, Japan

P-13 Glucose Sensor Application using W-doped VO_X Thin Films Prepared by Chemical Solution Deposition

Aoi Yamamoto, Yuichi Hirofuji, Kazuto Koike, Nobuya Hiroshiba

Nanomaterials Microdevices Research Center, Graduate School of Engineering,

Osaka Institute of Technology, Japan

P-14 Electrical power transmission from triboelectric generators utilizing molecular orientational disordering as power source

Dai Taguchi, Taishi Noma, Takaaki Manaka, Mitsumasa Iwamoto

Institute of Science Tokyo, Japan

P-15 Humidity-controlled measurement system for evaluating triboelectric generators using dipolar energy

Ryunosuke Sakakibara, Taishi Noma, Dai Taguchi, Takaaki Manaka

Institute of Science Tokyo, Japan

P-16 Spectroscopic Reflectometry for Evaluating Orientational Order Parameter of Polymer Semiconductor Films Oriented by Floating Film Transfer Method

Keito Toyama, Taishi Noma, Dai Taguchi, Takaaki Manaka

Institute of Science Tokyo, Japan

P-17 Evaluating thermally stimulated de-trapping current from Al/polyethylene/ITO devices for electrical power sources

Souta Takahashi, Taishi Noma, Dai Taguchi, Takaaki Manaka

Institute of Science Tokyo, Japan

P-18 Sulfur Vacancy Induced Ultra-low Schottky Barrier Height in Electrochemically Exfoliated MoS_2 FETs

Jaehyoung Park[1], Juntae Jang[1], Seongmin Ko[1], Jongeun Yoo[1], Kyungjune Cho[2], Takhee Lee[1]

[1]Department of Physics and Astronomy, Seoul National University, Korea

[2]Soft Hybrid Materials Research Center, Korea Institute of Science and Technology, Korea

P-19 Investigation of Bulk Photovoltaic Effect in Chiral-Polar Perovskites

Taishi Noma[1,2]

[1]Center for Emergent Matter Science (CEMS), RIKEN, Japan

[2]School of Engineering, Institute of Science Tokyo, Japan

P-20 Attempt of New Photoelectron Yield Spectroscopy Measurement Using Kelvin Probe

Hideichiro Kamimura[1], Masahiro Ohara[2], Hisao Ishii[1]

[1]Chiba University, Japan

[2]Shinshu University, Japan

P-21 Synthesis and electron transport properties of n-type semiconducting polymers consisting of two types of acceptors

Takashi Seki, Waner He, Atsushi Isobe, Tsuyoshi Michinobu

Department of Materials Science and Engineering, Institute of Science Tokyo, Japan

P-22 Synergistic Plasmonic-Thermoelectric Enhancement in Semiconducting Carbon Nanotubes for Infrared Light Detection

Kazuhiro Yoshida[1], Masayuki Ishihara[1], Daichi Suzuki[2], Yoshiyuki Nonoguchi[1]

[1]Kyoto Institute of Technology, Japan

[2]Sensing Technology Research Institute, AIST, Japan

P-23 Metal-Ion Coordinative Parylene Thin Films for OLED

Yugo Ogata, Yu Kitazawa, Mutsumi Kimura

Department of Chemistry and Materials, Faculty of Textile Science and Technology & Research Initiative of Supra-Materials, Shinshu University, Japan

P-24 Development of Electro-Active Parylene Thin Layers with Oxadiazole Derivative

Sora Miyauchi, Yu Kitazawa, Mutsumi Kimura

Faculty of Textile Science and Technology, Shinshu University, Japan

P-25 Material transformation for effective use of wood extracts using organic photocatalysts

Akito Yokoyama[1], Koushi Usuda[1], Mashiro Nakano[1], Md. Shahiduzzaman[1,2], Tetsuya Taima[1,2], Takahiro Yamaguchi[1], Makoto Karakawa[1,2]

[1]Natural Science and Technology, Kanazawa University, Japan

[2]Nanomaterial Research Institute (NanoMaRi), Kanazawa University, Japan

P-26 Polymeric Conductive Adhesive-Based Ultrathin Epidermal Electrodes for Long-Term Monitoring of Electrophysiological Signals

Keonuk June, Ju Hwan Shin, Ji Yeong Choi, Hyesu Choi, Tae-il Kim

School of Chemical Engineering, Sungkyunkwan University (SKKU), Republic of Korea

P-27 Enhanced Stability and Gating Efficiency in Mixed Molecular Transistors

Donguk Kim[1], Hyemin Lee[1], Minwoo Song[1], Jongwoo Nam[1], Changjun Lee[1], Jaeyong Woo[1], Juntae Jang[1], Minsu Jeong[2], Hyeonwoo Yeo[2], Ryong-Gyu Lee[2], Eunje Park[3], Hyeonmin Choi[3], Yong-Hoon Kim[2], Keehoon Kang[3], Takhee Lee[1]

[1]Department of Physics and Astronomy, Seoul National University, Korea

[2]School of Electrical Engineering, Korea Advanced Institute of Science and Technology (KAIST), Korea

P-28 Radiation-Engineered Silicon Proton Filters for Microbial Fuel Cell Applications

Zanyu Wang, Seongjib Cho, Eunju Lim

Department of Convergent Systems Engineering, Dankook University, Korea

P-29 Alicyclic Diamine-Modified Polyimides with Enhanced Flexibility and Optical Properties for Flexible Display Cover Windows

Se Hui Jo[1], Hyuck-Jin Kwon[1], Jun Hwang[2], Chill Won Lee[1]

[1]Department of Chemistry, Dankook University, Republic of Korea

[2]Department of Foundry Engineering, Dankook University, Republic of Korea

P-30 Design and Synthesis of a Novel Mono-Functional Acrylate with Carboxylic Groups for Enhanced Flexible Display Optically Clear Adhesive

Yu Na Jeong, Suk-Min Hong, Chil Won Lee

Department of Chemistry, Dankook University, Republic of Korea

P-31 High-Performance Phototransistor based on In-Situ Core/Shell Perovskite-MoS_2 Heterostructure

Sunggyu Ryoo[1] , Jinwoo Sim[1], Joo Sung Kim[2], Tae-Woo Lee[2], Kyungjune Cho[3], Keehoon Kang[2], Takhee Lee[1]

[1]Department of Physics and Astronomy, Seoul National University, Korea

[2]Department of Materials Science and Engineering, Seoul National University, Korea

[3]Convergence Research Center for Solutions to Electromagnetic Interference in Future-Mobility, Korea Institute of Science and Technology, Korea

P-32 Novel method for reducing contact resistance using liquid crystal properties independent of electrode material

Hiroki Nakano, Hiroaki Iino

Institute of Science Tokyo, Japan

P-33 Fabrication of n-channel organic transistor and invertor using liquid crystalline organic semiconductor

Tatsuki Kanebako, Shun Takamaru, Hiroaki Iino

Institute of Science Tokyo, Japan

P-34 Ortho-Fluorine Substituted Triphenylamine-Based Hole Transport Materials for Stable Perovskite Solar Cells: Influence of Planar Versus Non-Planar Linkers

Telugu Bhim Raju, Toshinori Matsushima

Carbon Neutral Research Center (MCI-CNRC), International Institute for Carbon-Neutral Energy Research (WPI-I2CNER), Kyushu University, Japan

P-35 Enhanced Performance in Perovskite Solar Cells with Aggregation-Controlled Double-Layer SnO_2

Dai Semba[1], Telugu Bhim Raju[1], Zhanglin Guo[1,2], Toshinori Matsushima[1,2]

[1]WPI-I2CNER, Kyushu University, Japan

[2]CESD, WPI-I2CNER, Kyushu University, Japan

P-36 Surface Plasmon Resonance-Enhanced Photoelectrochemical Flexible Sensor Using Doped PEDOT:PSS Thin Film with Gold Nanoparticles

Charin Seesomdee, Sachiko Jonai, Kazunari Shinbo, Akira Baba

Graduate School of Science and Technology, Niigata University, Japan

P-37 Point-of-Care Wireless DNA Sensing for CGG Repeat Detection in Fragile X Syndrome

Jinhwa Park[1,2,+], Eman Alzamer[2,+], Younsu Jung[1], Seongryeong Kim[1,2], Kiran Shrestha[1], Gyoujin Cho[1,2]

[1]Department of Biophysics, Institute of Quantum Biophysics and Research Engineering Center for R2R Printed Flexible Computer, Sungkyunkwan University, Republic of Korea

[2]Department of Intelligent Precision Healthcare Convergence, Sungkyunkwan University, Republic of Korea

[+]The first authorship is shared equally by J. P. and E. A.

P-38 Bio-Incorporated Gravure (Big) Printed Health Endangered Area Test (Heart) Chips: Big-Heart Chips

M. Zhang[2], I. Shrestha[2], S. Y. Kim[1], K. Shrestha[1], P. Sharma[2], G. J. Cho[1,2]

[1]Department of Biophysics, Institute of Quantum Biophysics, Sungkyunkwan University, South Korea

[2]Department of Intelligent Precision Healthcare Convergence, Sungkyunkwan University, South Korea

P-39 Evaluation of Electrodeposited Polypyrrole Thin Film Utilizing a Hybrid Sensor of Surface Plasmon Resonance and Quartz Crystal Microbalance

Ryu Obuchi, Reaksmey Ek, Kohei Hashimura, Yasuo Ohdaira, Akira Baba, Kazunari Shinbo

Niigata University, Japan

P-40 Portable Sensing-Driven Smart Helper Device: Personalized, Rehabilitation-Oriented Assistive Technology

Jeyeon Kim[1], Wonkeon Hwang[1], Yeonji Oh[2], Gunoh Jung[1], Yeongeun Byeon[1], Junghyun Lee[1], Jungsuk Kim[1]

[1]Gachon University, South Korea

[2]Cellico Research and Development Laboratory, South Korea

P-41 Liquid Crystal-Based Beam Diffraction Devices and Their Applications

Jun Do[1],Woochan Na[1], Eunju Lim[2], Kanghee Won[1]

[1]Department of Information Display, Kyung Hee University, Korea

[2]Department of Science Education/Convergent Systems Engineering, Dankook University, Korea

September 19 (Fri)

Plenary (Chair Prof Taguchi) Kuramae Hall

10:00-10:50 PL-2

Electronic Structure and Molecular Orientation of Amorphous Organic Films Studied by UV Photoemission Spectroscopy and Kelvin Probe

Hisao Ishii

Chiba University, Japan

Break

Special session 13 (Prof. Matsuhisa) Kuramae Hall

Stretchable Electronic Devices

11:00-12:30

11:00 S13-I1 (invited)

Ultraflexible Organic Optoelectronic Devices for Skin-compatible Electronics

Sungjun Park

Ajou University, Korea

11:25 S13-I2 (invited)

Electrochemical Biosensing Interface Engineering for Continuous Biomarker Monitoring Systems

Jayoung Kim

Department of Medical Engineering, College of Medicine, Yonsei University, South Korea

11:50 S13-I3 (invited)

Monitoring, Manipulating and Mimicking Motor Systems

Pingqiang Cai[1,2]

[1]Nanjing University, China

[2]Nanjing Drum Tower Hospital, China

12:15 S13-O1

Softness-perceptive e-skin

Atsushi Nitta, Yoshiki Kondo, Haruki Nakamura, Naruhito Seimiya, Kuniharu Takei

Hokkaido University, Japan

Lunch

Special session 13 (continue) (Prof. Matsuhisa) Kuramae Hall

Stretchable Electronic Devices

13:30-15:30

13:30 S13-I4 (invited)

From Stretchable Polymer to Soft Neuromorphic Electronics

Wen-Ya Lee

Department of Chemical Engineering & Biotechnology, National Taipei University of Technology, Taiwan

13:55 S13-I5 (invited)

Molecular Dipole Engineering of Polymer Semiconductors for Stretchable Electronics

Chien-Chung Shih

Department of Chemical and Materials Engineering National Yunlin University of Science and Technology, Taiwan

14:20 S13-O2

A stretchable hole transport layer for high-frequency, soft diodes

Aki Hiraoka, Siyuan Liu, Hugo Laval, Byunghun Oh, Naoji Matsuhisa

Research Center for Advanced Science and Technology/ Institute of Industrial Science, The University of Tokyo, Japan

14:35 S13-O3

Highly reliable stretchable hybrid devices combining stretchable materials and rigid electronic elements

Yuji Isano[1], Maika Takaya[1], Yuta Kurotaki[1,2], Ryosuke Matsuda[1], Yusuke Miyake[2], Tamami Takano[1], Yutaka Isoda[1], Tomoki Hamagami[1], Kentaro Kuribayashi[2], Hiroki Ota[1]

[1]Yokohama National University, Japan

[2]GMO Pepabo, Inc., Pepabo R&D Institute, Japan

14:50 S13-I6 (invited)

Design and Synthesis of Stretchable and Self-healing Polymers for Electronic Skin Applications

Ho-Hsiu Chou[1,2,3]

[1]Department of Chemical Engineering, National Tsing Hua University, Taiwan

[2]College of Semiconductor Research, National Tsing Hua University, Taiwan

[3]Photonics Research Center, National Tsing Hua University, Taiwan

15:15 S13-O4 Armband-type Hand Motion Capture System Integrating sEMG and IMU Sensors

Shusuke Yamakoshi[1], Yuji Isano[1], Yuta Kurotaki[1,2], Tamami Takano[1], Yutaka Isoda[1], Hiroki Ota[1]

[1]Yokohama National University, Japan

[2]GMO Pepabo, Inc., Pepabo R&D Institute, Japan

Special session 15 (Prof. Hasegawa) Royal Blue Hall

Crystal Simulation and Crystal Engineering of Organic Semiconductors

11:00-12:30

11:00 S15-I1 (invited)

Structure-Property Relationships in Thienoacenes for Improved Transport Properties

Guillaume Schweicher

Laboratoire de Chimie des Polymères, Faculté des Sciences, Université Libre de Bruxelles (ULB), Belgium

11:30 S15-O1

A plot of quadrupole moments in organic semiconductors as a phase diagram of the crystal structures

Takehiko Mori

Institute of Science Tokyo, Department of Materials Science and Engineering, Japan

11:50 S15-O2

Step-by-Step Molecular Arrangements Optimization Approach for Crystal Structure Prediction and Energy Potential Map Analysis

Ryota Ono[1], Seiji Tsuzuki[1], Satoru Inoue[2], Tatsuo Hasegawa[1]

[1]University of Tokyo, Japan

[2]Yamagata University, Japan

12:10 S15-O3

Flip-Flop Dynamics in Smectic Liquid-Crystal Organic Semiconductors Revealed by Molecular Dynamics Simulations

Hiroyuki Matsui[1], Tomoka Suzuki[1], Antonio De Nicola[2], Satoru Inoue[1,3], Tomoharu Okada[1], Tatsuo Hasegawa[3], Giuseppe Milano[4]

[1]Yamagata University, Japan

[2] CINECA, Italy

[3] The University of Tokyo, Japan

[4]University of Naples Federico II, Italy

Lunch

Special session 16 (Dr. Higuchi) Royal Blue Hall

Recent Progress on Nonvolatile Display Devices

13:30-15:30

13:30 S16-I1 (invited)

Electronic Tile as Energy-Efficient Reflective Display Units for Walls and 3D Structures

Makoto Omodani[1,2], Hiroyuki Yaguchi[1], Hisae Oba[1]

[1]Tokyo Denki University, Japan

[2]Tokai University, Japan

14:00 S16-I2 (invited)

Recent Progress on Electrochromic Devices Using Metallosupramolecular Polymers

Masayoshi Higuchi

National Institute for Materials Science (NIMS), Japan

14:30 S16-O1

Data-Driven Design of High-Performance Electrochromic Devices

Aiwei Zhao[1,2], Dines Chandra Santra[1], Kenji Nagata[1], Junya Sakurai[1], Masahiko Demura[1], Masayoshi Higuchi[1,2]

[1]National Institute for Materials Science, Japan

[2]Graduate School of Information Science and Technology, Osaka University, Japan

14:45 S16-O2

Synthesis and Characterization of Ru/Zn-Based Metallosupramolecular Polymer with Electrochromic and Electrofluorochromic Properties

Tingwei Zhang[1,2], Satya R. Jena[1], Masayoshi Higuchi[1,2]

[1]National Institute for Materials Science, Japan

[2]Osaka University, Japan

15:00 S16-I3 (invited)

Digital information which is invisible under visible light but detectable under infrared light

Shuichi Maeda, Suzuto Takebayashi, Hayate Akagi

Tokai University, Japan

Regular session 3 (Prof Taguchi) Bldg W9, W933 Lecture Room

11:00-12:15

11:00 R3-O1

Synaptic Transistor Memory Using DPP-based Polymer and Biomass Additive

Waner He[1], Zhen Feng[1], Qun-Gao Chen[2], Chu-Chen Chueh[3], Wen-Ya Lee[2], Tsuyoshi Michinobu[1]

[1]Department of Materials Science and Engineering, Institute of Science Tokyo, Japan

[2]Department of Chemical Engineering and Biotechnology, National Taipei University of Technology, Taiwan

[3]Department of Chemical Engineering, National Taiwan University, Taiwan

11:15 R3-O2

Exploring Intramolecular Triplet–Triplet Annihilation Upconversion by Double Sensitization

Aoi Haraguchi[1], Kenichi Goushi[2], Shoma Sasaki[1], Chihaya Adachi[1,3]

[1]Center for Organic Photonics and Electronics Research (OPERA), Kyushu University, Japan

[2]Department of Applied Quantum Physics & Nuclear Engineering, Kyushu University, Japan

[3]International Institute for Carbon Neutral Energy Research (I^{2}CNER), Kyushu University, Japan

11:30 R3-O3

Structural variation in semiconducting polymers for organic photovoltaics

Kyohei Nakano, Yumiko Kaji, Keisuke Tajima

RIKEN center for emergent matter science (CEMS), Japan

11:45 R3-O4

Operating lifetime dependent on electron injection layer for inverted blue exciplex upconversion-type OLEDs

Kenta Usui, Masahiro Morimoto, Shigeki Naka

University of Toyama, Japan

12:00 R3-O5

Fabrication of Flexible Organic Thin Film Transistors Using Liquid Crystalline Organic Semiconductor Ph-BTBT-10 and Application to Image Sensor Pixels

Issei Suzuki, Hiroaki Iino

Institute of Science Tokyo, Japan

Closing Remark & Award Ceremony Kuramae Hall

15:40-15:55

Conference Chair: Prof. Takaaki Manaka

Institute of Science Tokyo, Japan

Kuramae Hall (Kuramae Kaikan)	Royal Blue Hall (Kuramae Kaikan)	W933 Room (Science Tokyo, Bldg W9)
17 September (Wednesday)		
Registration (10:00-17:00)		
Registration		
Opening remark 11:00-11:10 T Manaka		
Plenary Lecture 11:10-12:00 PL-1 Gyoujin Cho		
Lunch	Lunch	Lunch
Special session 1 Recent Development in Functional Optoelectronic Devices and Systems Organizer: S S Pandey (Kyushu Inst Technol) 13:00-15:00 S1-I1 P K Iyer S1-I2 V Singh S1-O1 S G Ramer S1-O2 N Chauhan S1-O3 H Rai	Regular Session 1 13:00-14:30 R1-I1 Y-C Liao R1-O1 K-T Kang R1-O2 K Yoshida R1-O3 J Choi R1-O4 S Alagarsamy	OE-A Session Flexible and Printed Electronics: Materials, Production, and Applications OE-A-1 K Hecker OE-A-2 H Akkerman OE-A-3 S B Dkhil OE-A-4 T Huang OE-A-5 S Azad OE-A-6 F Resweber
break	break	break
Special session 2 Smart, Wearable, and Flexible Sensor Devices Organizer: M Kitamura (Kobe Univ) 15:10-17:10 S2-I1 M Sasaki S2-I2 T Nagase S2-I3 Y Kimura S2-O1 J Yamasawa S2-O2 C Okuda	Special session 4 Analysis and Electronic and Optical Materials for Future IoT Organizer: H Kajii (Osaka Univ) 15:10-17:10 S4-I1 K Fukuda S4-I2 K Tada S4-I3 K Albrecht S4-O1 Y Nagase S4-O2 H Kajii	OE-A Session (continue) Flexible and Printed Electronics: Materials, Production, and Applications OE-A-7 P Brook OE-A-8 D Walsh OE-A-9 S Logothetidis OE-A-10 A Sridhar OE-A-11 W Mildner OE-A-12 W Mildner

18 September (Thursday)

Registration (9:30-17:00)

Kuramae Hall (Kuramae Kaikan)	Royal Blue Hall (Kuramae Kaikan)	W933 Room (Science Tokyo, Bldg W9)
OE-A Keynote 10:00-10:50 KL-1 A Schumacher		
break		
Special session 7 Intelligent Textile-based Devices Organizer: M Kimura (Shinshu Univ) 11:00-12:30	Regular Session 2 11:00-12:15	
S7-I1 N Passornraprasit S7-I2 Y Guo S7-I3 A Takei	R2-O1 P-K Yang R2-O2 R Shyam R2-O3 F Granek R2-O4 S-M Huang R2-O5 Y Kurotaki	
Lunch	Lunch	
Special session 8 Crystal Engineering and Charge Transport in Organic Semiconductors Organizer: T Hasegawa (Univ Tokyo) 13:30-15:30	Special session 10 Crystallization and Self-Organization in Flexible, Organic, or Printed Electronics Organizer: S Yokokura (Hokkaido Univ) & T Shimada (Hokkaido Univ) 13:30-15:30	
S8-I1 P K L Chan S8-O1 K Murata S8-O2 K Nikaido S8-I2 T Okamoto S8-O3 S Kumagai S8-O4 S Inoue	S10-I1 Y Nakayama S10-I2 N Hiroshiba S10-I3 R Matsubara S10-I4 K Akaike S10-O1 S Jeon	
break		
Poster session 15:40-17:30		
18:00-20:00 Dinner Venue: Tsubame Terrace, Science Tokyo		

19 September (Friday)		
Registration (9:30-10:30)		
Kuramae Hall (Kuramae Kaikan)	Royal Blue Hall (Kuramae Kaikan)	W933 Room (Science Tokyo, Bldg W9)
Plenary Lecture 10:00-10:50 PL-2 Hisao Ishii		
break		
Special session 13 Stretchable Electronic Devices Organizer: N Matsuhisa (Univ Tokyo) 11:00-12:30	Special session 15 Crystal Simulation and Crystal Engineering of Organic Semiconductors Organizer: T Hasegawa (Univ Tokyo) 11:00-12:30	Regular session 3 11:00-12:15
S13-I1 S Park S13-I2 J Kim S13-I3 P Cai S13-O1 A Nitta	S15-I1 G Schweicher S15-O1 T Mori S15-O2 R Ono S15-O3 H Matsui	R3-O1 W He R3-O2 K Goushi R3-O3 K Nakano R3-O4 K Usui R3-O5 I Suzuki
Lunch	Lunch	
Special session 13 (continue) Stretchable Electronic Devices Organizer: N Matsuhisa (Univ Tokyo) 13:30-15:30	Special session 16 Recent Progress on Nonvolatile Display Devices Organizer: M Higuchi (NIMS) 13:30-15:30	
S13-I4 W-Y Lee S13-I5 C-C Shih S13-O2 A Hiraoka S13-O3 Y Isano S13-I6 H-H Chou S13-O4 S Yamakoshi	S16-I1 M Omodani S16-I2 M Higuchi S16-O1 A Zhao S16-O2 T Zhang S16-I3 S Maeda	
Closing remark and Award Celemony 15:40-15:55 T Manaka		

17 September (Wednesday)

PL-1 (Plenary)

Sustainable High-Throughput Foundry for Sticker-Like Computer via Roll-to-Roll Gravure Printing System

Gyoujin Cho*[1,2,3]

[1]Department of Intelligent Precision Healthcare Convergence, Sungkyunkwan University, 2066, Seobu-ro, Jangan-gu, Suwon-si, Gyeonggi-do, 16419, Republic of Korea

[2]Department of Biophysics and Institute of Quantum Biophysics, Sungkyunkwan University, 2066, Seobu-ro, Jangan-gu, Suwon-si, Gyeonggi-do, 16419, Republic of Korea

[3]Engineering Research Center for Developing R2R Printed Flexible Computer, Sungkyunkwan University, 2066, Seobu-ro, Jangan-gu, Suwon-si, Gyeonggi-do, 16419, Republic of Korea

*Corresponding: gcho1004@skku.edu

Abstract

In this presentation, I would like to deliver three key design principles towards integrating large-scale TFTs in the roll-to-roll gravure (R2Rg) printing method.[1,2] By identifying that the critical challenges towards realizing a full-scale, printed foundry lies in minimizing the topology variations in printed dielectric layers, overcoming current limits in overlay printing registration accuracy (OPRA), and bridging the lack of process design kit (PDK) for printed TFTs, we are able to, for the first time, demonstrate a proof-of-concept R2Rg printing foundry by fully printing flexible 4-bit processors with *p*-type and *n*-type single-walled carbon nanotube-based TFTs without the aid of conventional fabrication methods (Figure 1).

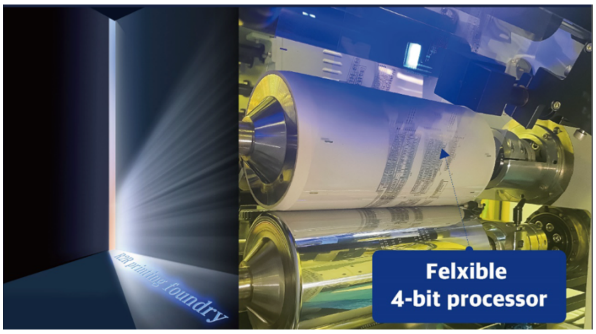

Figure 1. Concept image of R2R printing foundry.

References

[1] S Parajuli, et al. Tailoring threshold voltage of R2R printed SWCNT thin film transistors for realizing 4 bit ALU. *NPJ Flexible Electronics* 8 (1), 78, 2024

[2] H. Park, et al. The first step towards a R2R printing foundry via a complementary design rule in physical dimension for fabricating flexible 4-bit code generator. *Adv, Electron. Mater.* 6 (12), 2070051, 2020.

S1-I1 (invited)

Synergistic Interface Engineering of NiO_X/Perovskite Heterojunction via Multifunctional Organic Molecule for Efficient and Stable Inverted Solar Cells

Das Adhikari, R.[1], Baishya, H.[1], Patel, M. J.[2], Yadav, D.[2], *Iyer, P. K.[1,2]

[1]Centre for Nanotechnology, Indian Institute of Technology Guwahati, Guwahati-781039, Assam, India

[2]Department of Chemistry, Indian Institute of Technology Guwahati, Guwahati-781039, Assam, India

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Abstract

The performance of inverted perovskite solar cells (PSCs) is critically influenced by the buried heterojunction formed between the nickel oxide (NiO_X) hole transport layer (HTL) and the perovskite absorber.[1] Despite its widespread use, NiO_X suffers from several intrinsic limitations, including energy level mismatches, poor conductivity, and undesirable redox interactions with the perovskite layer.[2, 3] These issues often result in suboptimal charge extraction, increased interfacial non-radiative recombination, and compromised power conversion efficiency (PCE) and operational stability.[4] To address these challenges, we introduce a multifunctional organic molecule as a bifacial defect passivator to precisely engineer the NiO_X/perovskite interface. The molecule is strategically designed with acidic, cyano, and fluorinated groups that effectively passivate surface defects on NiO_X, thereby enhancing the Ni^{3+}/Ni^{2+} ratio, improving hole extraction, and aligning energy levels with the perovskite layer.[5] These functional moieties also provide active sites that facilitate homogeneous perovskite nucleation at the buried interface. On the opposite end, a guanidinium-based group interacts with unreacted residual PbI_2, promoting the formation of a low-dimensional perovskite phase. This interfacial phase contributes to defect passivation and enhances crystallinity, resulting in reduced non-radiative recombination and stabilized perovskite films. Moreover, the organic interlayer acts as a chemical buffer layer that mitigates detrimental redox reactions between $Ni^{\delta+}$ and the perovskite, further improving interface integrity. The combined bi-directional functionality of the molecule enables simultaneous optimization of both the NiO_X and perovskite sides of the interface. As a result, the modified inverted PSCs achieve PCEs exceeding 24% and exhibit remarkable thermal and operational stability, even without encapsulation. This study presents a versatile interface engineering strategy that leverages the synergistic roles of multifunctional groups to enhance the performance and durability of PSCs.

References

[1] R. Das Adhikari, M. J. Patel, H. Baishya, D. Yadav, M. Kalita, M. Alam and P. K. Iyer, *Chem. Soc. Rev.*, 2025, **54**, 3962–4034.

[2] X. Yang, D. Luo, Y. Xiang, L. Zhao, M. Anaya, Y. Shen, J. Wu, W. Yang, Y.-H. Chiang, Y. Tu, R. Su, Q. Hu, H. Yu, G. Shao, W. Huang, T. P. Russell, Q. Gong, S. D. Stranks, W. Zhang and R. Zhu, *Adv. Mater.*, 2021, **33**, e2006435.

[3] R. Garai, R. K. Gupta and P. K. Iyer, *Acc. Mater. Res.*, 2023, **4**, 560–565.

[4] H. Baishya, R. D. Adhikari, M. J. Patel, D. Yadav, T. Sarmah, M. Alam, M. Kalita and P. K. Iyer, *J. Energy Chem.*, 2024, **94**, 217–253.

[5] R. Das Adhikari, H. Baishya, M. J. Patel, D. Yadav and P. K. Iyer, *Small*, 2024, **20**, e2404588.

S1-I2 (invited)

2025 International Conference on Flexible and Printed Electronics (ICFPE)

Vipul Singh
Indian Institute of Technology Indore, India

S1-O1

PFO-DBT/PCBM Blend-Based High-Performance OFETs for Optoelectronic Applications

Sidhi G Ramer[1], I. A. Palani[2], Shyam S. Pandey[3]and Vipul Singh[3*]
[1] 1Molecular and Nanoelectronics Research Group (MNRG), Department of Electrical Engineering, IIT Indore, 453552, Madhya Pradesh, India.
[2] Department of Mechanical Engineering, IIT Indore, 453552, Madhya Pradesh, India.
[3] Graduate School of Life Science and Systems Engineering, Kyushu Institute of Technology, 2-4 Hibikino, Kitakyushu, Fukuoka 808-0135, Japan.
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Abstract

Fabricating organic thin films with highly aligned chains exhibiting notable optical and electrical anisotropy is desirable for efficient planar devices to improve organic field-effect transistors (OFET) performance. This study demonstrates significant enhancements in the device parameters of OFETs utilizing the oriented thin films of poly 2, 7-(9, 9-dioctylfluorene)- alt- 4,7- bis (thiophen-2-yl) benzo- 2,1,3- thiadiazole (PFO-DBT)/ [6,6]-phenyl-C61-butyric acid methyl ester (PCBM) blend processed via R-FTM. OFETs were constructed on Si/SiO_2 substrates modified with an ultrathin layer of CYTOP to enhance the device performance. The blended polymer thin film OFET displayed a superior charge carrier mobility (μ) of 9.4×10^{-3}cm^2/V-sec and an I_{on}/I_{off} of 3×10^3, significantly outperforming its pristine counterpart, which exhibited a μ of 5×10^{-3}cm^2/V-sec and an I_{on}/I_{off} of 2×10^3. These outcomes emphasize the potential of R-FTM in the development of high-performance OFETs, specifically intended for white light sensors.

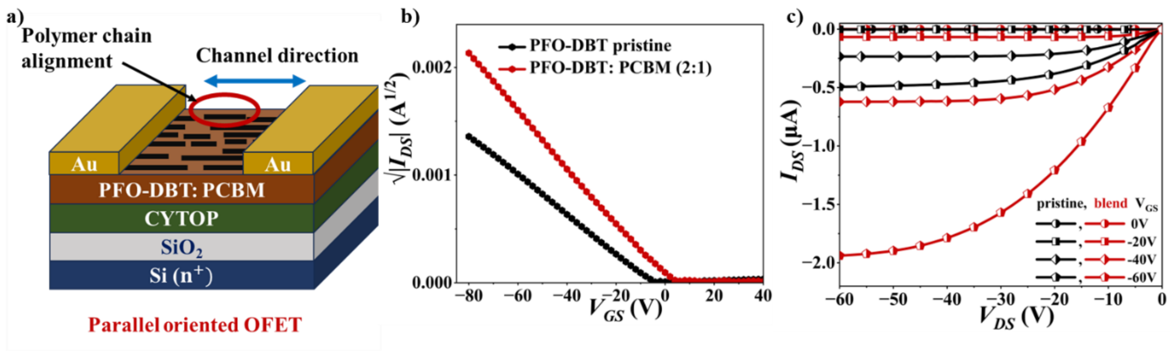

Figure 1. a) Schematic diagram, b) transfer and c) output characteristics of the pristine PFO-DBT and PFO-DBT: PCBM (2:1) blended thin film based OFETs.

References

[1] M. Pandey, S. S. Pandey, S. Nagamatsu, S. Hayase and W. Takashima, Thin Solid Films 619, 125 (2016).

[2] S. G. Ramer, K. V. Gaurav, I. A. Palani, Y. Ando, S. S. Pandey and V. Singh, Synth Met 312, 117869 (2025).

[3] A. S. M. Tripathi, N. Kumari, S. Nagamatsu, S. Hayase and S. S. Pandey, Org Electron 65, 1 (2019).

S1-O2

An investigation on the performance of Quaternary NiTi-SMA Bimorph Integrated Optical Fiber Sensor

Navneet Chouhan[1,2], Nandini Patra[2], I. A. Palani[2*] and Vipul Singh[1*]
[1] Molecular and Nano-Electronics Research Group
[2] Mechatronics and Instrumentation Lab
Indian Institute of Technology, 452020, India
*Corresponding: navneet.24ncs@gmail.com

Abstract

Optical fiber sensors (OFSs) offer a reliable, real-time temperature monitoring solution. Shape Memory Alloy (SMA)-bimorph integrated optical fiber sensor provides an intensity modulation-based sensing technique. The macro-bend in the optical fiber structure results in attenuation of the optical signal initially; however, bimorph expansion upon heating provides a linear increase in it. This work compares the performance of the Ternary NiTi SMA integrated OFS with the that the quaternary NiTi SMA-based bimorph composition. The Quaternary composition chosen was Ni(44)-Ti-Cu(5)-Al(1) while the ternary composition was Ni(40)Ti-Cu(10). The addition of Al resulted in the refinement of the grain structure along with an increase in the crystallinity as confirmed from the XRD results, hence, the better Shape memory effect. Quick resistivity changes were alo observed with reduced hysteresis. All these improvements in material properties resulted in better response towards temperature sensing. An improved martensitic sensitivity was recorded ~24 mV/°C while for the austenite phase ~30 mV/°C. Around 50% enhancement was observed in response as compared to the ternary composition. Therefore, the addition of Al resulted in enhanced linearity with improved temperature response integrated bimorph optical fiber structure, however with reduced temperature range.

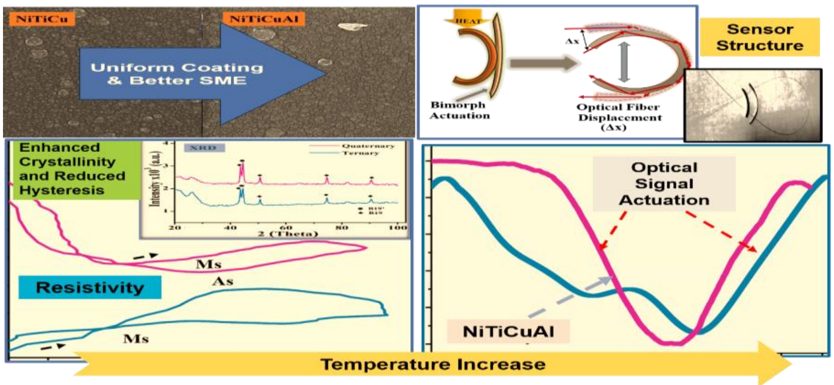

Figure 1. The FESEM, XRD, Resistivity plot of NiTiCu and NiTiCuAl; Optical signal actuation of ternary and quaternary SMA bimorph integrated OFS

References

[1] N. Chouhan et. al., IEEE Sensor Letters, 2025.

[2] N. Patra et. al., Sensors and Actuators, 2024.

S1-O3

Unraveling the role of charge carrier mobility for the fabrication of OFET-based integrated sensing devices

Harshita Rai*, Kshitij RB Singh, and Shyam S. Pandey
Graduate School of Life Science and System Engineering, Kyushu Institute of Technology, 2-4, Hibikino, Wakamatsu, Kitakyushu 808-0196, Japan
*Corresponding: harshitarai30@gmail.com

Organic field effect transistors (OFETs), owing to their switching behavior in response to the applied gate voltage, have shown tremendous potential to be used as transduction elements for advanced and miniaturized sensing devices[1]. The evolution of OFETs as transducers in sensing systems has primarily focused on architecture and probe engineering, often overlooking the intrinsic role of charge carrier mobility (μ) on sensing performance. Device architecture engineering, as well as optimizing the transducer performance, is highly desired for the fabrication of high-performance integrated sensing systems. Thus, this study investigates the impact of OFET's μ on sensing via extended-gate systems and employs device engineering to create an integrated and reusable sensor.

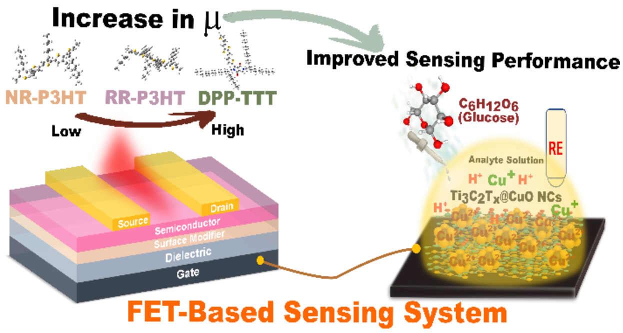

Fig.1. *OFETs architecture and sensing response outcome.*

For understanding the impact of μ on sensing parameters, OFETs were fabricated using different conjugated polymers (CPs), namely NR-P3HT, RR-P3HT, and DPP-TTT, for attaining varied μ. For this, thin films were fabricated using in-house developed floating film transfer method (FTM) to improve film quality and μ[2]. The obtained result reveals that the μ of DPP-TTT (2.6×10^{-1} $cm^2/V\cdot s$) was highest and that of NR-P3HT ($7.2x10^{-3}$ $cm^2/V\cdot s$) was lowest. The sensing of glucose using these transducers suggests that sensing performance was controlled by charge carrier μ (**Fig. 1**).

Efforts towards further miniaturization were directed using DPP-TTT exhibiting the highest μ, and the OFETs were fabricated utilizing Indium-tin-oxide (ITO) coated glass as the gate electrode, and polyvinyl phenol (PVP) as a gate dielectric. Lastly, on the opposite end of the ITO, Glucose Oxidase (GOx)@ZnCoO and silver (2 mm) were deposited as a sensing probe and reference electrode, respectively. This fabricated integrated sensing system depicted a rapid response of 10s, which could be attributed to the compact device architecture as well as the high μ of OFET (6.4×10^{-1} $cm^2/V\cdot s$). The fabricated sensing device was found to be highly selective and stable up to 100 cycles.

References

[1] Yui Sasaki et al., *Sensors Actuators B Chem.*, **382**, 133458 (2023).

[2] Tripathi et al., *Appl. Phys. Lett.*, **112**, 123301 (2018).

S2-I1 (invited)

Wearable Respiration Sensor Fit on Skin and Fine Patterning Technique Using Flexible Film

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Toyota Technological Institute, Japan
*Corresponding: mnr-sasaki@toyota-ti.ac.jp

Abstract

For the noninvasive bio-sensors, the skin becomes the attractive place. Since the skin is the interface between the inside and outside of the living things. And, for detecting the good signal from the inside, the sensor device should fit the skin allowing the movement. So, the flexible devices are attractive.

Here, the following 2 topics are described. (1) The respiration sensor using the conductive textile as the electrode fit on the skin measuring the capacitance built across the skin. Figure 1(a) is the schematic drawing. The capacitance measured is constructed below the skin[1]. (2) The new fine patterning technique using the flexible film, which consists of the polyvinyl alcohol (PVA) and photoresist layers. By patterning the photoresist before bending and pasting on the sample, the fine pattern can be obtained on 3D samples[2].

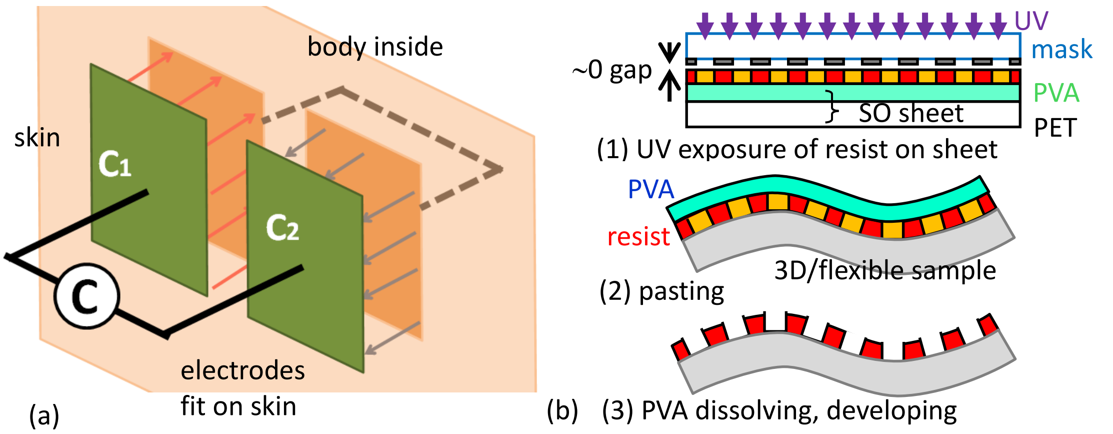

Figure 1. Schematic drawings of (a) the wearable respiration sensor fit on the skin and (b) fine patterning technique using the flexible photoresist film.

The sheet (named SO sheet) which consists of PVA layer and PET sheet is from Aicello Corporation.

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S2-I2 (invited)

Organic Floating-Gate Transistors for Printed Nonvolatile Optoelectronic Memory and Image Sensor Applications

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Abstract

Exploring the optical memory characteristics of organic field-effect transistors (OFETs) with floating-gate structures offers an effective approach for developing flexible and printed nonvolatile memory devices with a large memory window, as well as image sensors with high photoresponsivity. In our studies, solution-processable floating-gate OFET memories have been developed using top-gate/bottom-contact OFETs with polymer semiconductor layers and vertical phase separation in solution-processed polymer–small-molecule composite films for forming organic semiconductor floating gates composed of TIPS-pentacene molecules [1-3] (Fig. 1(a)). Floating-gate OFETs using polythiophenes, such as P3HT and PBTTT, as the semiconductor layer exhibit a large threshold voltage shift of over 30 V under blue LED light illumination only when a positive gate voltage is applied due to the storage of photogenerated electrons in the TIPS-pentacene floating gates (Fig. 1(b)). Such feature enables the realization of solution-processable organic image sensor arrays with built-in memory functionality (Fig. 1(c)), leading to enhanced photoresponsivity. Further, OFET memories with organic floating-gate layers show a large dependence of drain current on the intensity of red LED light as a result of the emergence of short-term synaptic plasticity under red light illumination (Fig. 1(d)), enabling pre-processing functions for image sensors, such as contrast enhancement and noise reduction, as reported by Zhou et al. [4].

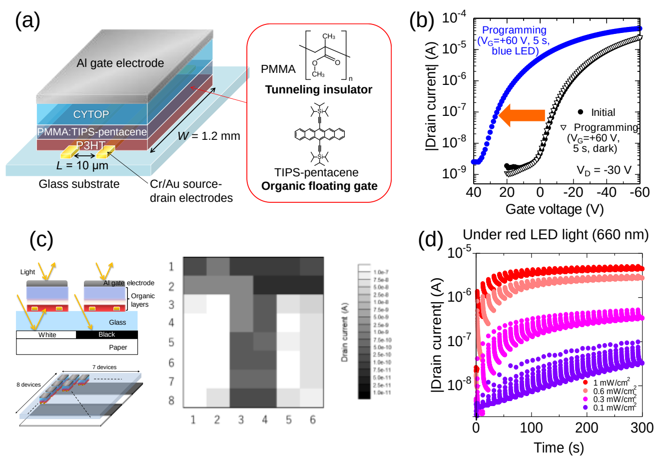

Figure 1. (a) Structure of a solution-processable floating-gate OFET memory. (b) Transfer characteristics of a P3HT-based OFET memory with a PMMA:TIPS-pentacene (80:20) floating-gate layer, measured after programming under blue LED light illumination and erasing in the dark. (c) Black-and-white image pattern reproduced from the recorded drain currents of a P3HT OFET memory array. (d) Light-intensity-dependent drain current of the P3HT OFET memory under repeated programming under red LED light illumination.

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Acknowledgements

This work was supported by the Mazda foundation, the Futaba research grant program, Kansai Research Foundation for Technology Promotion, and JSPS KAKENHI (Grant Nos. JP20K21007, JP21H04564, JP24K00931, and JP24K01330).

S2-I3 (invited)

Development of a Chemiresistive Sensor Based on Metal-Oxide-Semiconductor Nanostructures for Wearable Detection of Ions in Solutions

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Abstract

Flexible and compact sensors that detect ion species in body fluids and industrial wastewater are required for health and environmental protection [1]. Compared to conventional ion sensors such as ion chromatography and ion-sensitive field-effect transistors, chemiresistive metal-oxide-semiconductor sensors have attracted attention for routine monitoring applications because of their advantages of simple measurement and ease of miniaturization. In this study, chemiresistive sensors based on ZnO nanostructures were fabricated by heating Zn foils and depositing Ag electrodes (Fig. 1(a)) for detecting ions in solutions. The resistance of the sensor changed during exposure to and removal of the ionic solutions from the sensor's surface between the electrodes [2]. The ZnO sensors exhibited excellent repeatability in the bent state (in convex and concave directions) for Cl^- and Na^+ solutions (Fig. 1(b)). Furthermore, principal component analysis, using sensing performance for K^+ and Ca^{2+} solutions, suggested identifiability of ion species in the ZnO sensors (Fig. 1(c)) [3]. This information could provide new strategies for realizing high-performance wearable ion sensors.

This work was supported by JSPS KAKENHI grant Number 25K17651.

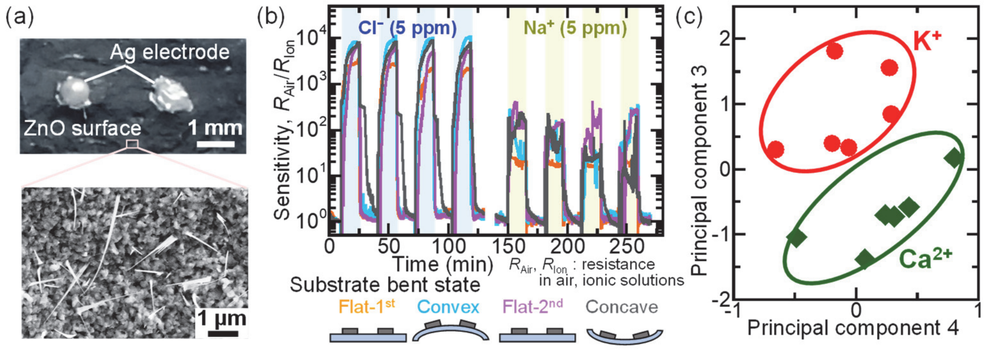

Figure 1. (a) Optical and scanning electron microscope images of a ZnO sensor. (b) Dynamic responses of the sensor in different bent states. (c) Principal component analysis results.

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S2-O1

Exploring RF-Controlled Resistance Modulation in Ag_2Te Films for Neuromorphic Electronics

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Analog resistance modulation in solid-state memory devices has attracted increasing attention, particularly for neuromorphic computing, where multiple stable conductance states emulate synaptic plasticity. Concurrently, research in radio-frequency (RF) flexible electronics is advancing toward compact wireless systems with high-frequency functionality for wearable sensors, conformal antennas, and soft robotics. While these fields have evolved separately, growing interest is emerging in their convergence, as integrating memory and RF functionality on flexible platforms could support reconfigurable signal processing in compact and wearable devices.

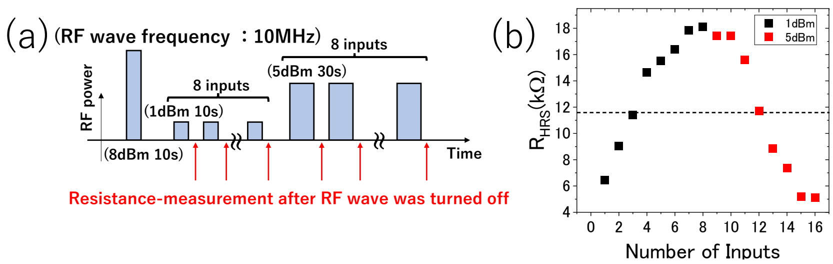

Fig.1 (a) Measurement sequence for evaluating RF-induced resistance change. After each RF pulse was turned off, the device resistance was measured using voltage pulses. (b) Resistance evolution of the HRS under repeated RF pulse inputs, measured using the method in (a). Dashed lines represent the resistances before RF inputs.

This study explores multilevel resistance modulation in a solid-state memory device using polycrystalline monoclinic Ag_2Te thin films. The films were deposited by RF magnetron sputtering and integrated between planar electrodes on a SiO_2/Si substrate using standard photolithography techniques. Initial I–V characterization used a triangular waveform (±0.5 V), followed by pre-conditioning with a single 10-second, 8 dBm RF pulse at 10 MHz applied via ground–signal–ground probes. RF pulses at 10 MHz were then applied at two power levels: 1 dBm for 10 seconds and 5 dBm for 30 seconds each [Fig. 1(a)]. After each RF input, the device was reset to a high resistance state (HRS) by a RESET pulse, and the resistance was measured at −0.02 V. The device exhibited distinct resistance behaviors depending on RF power. At 1 dBm, resistance progressively increased with repeated inputs. In contrast, 5 dBm inputs induced a gradual resistance decrease from the elevated state created by prior 1 dBm pulses [Fig. 1(b)].

Although the current device is built on a rigid substrate, the intrinsic ductility of Ag_2Te-based alloys—particularly $Ag_2Te_{1-x}S_x$, which exhibits metal-like flexibility—suggests potential for future integration into flexible platforms. These results provide a foundation for the advancement of RF-tunable memory systems, with potential relevance to future integration into compact, reconfigurable neuromorphic electronics for wearable and adaptive applications.

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S2-O2

Skin-Adhesive Organic Transistors for Long-Term Wearable Electronics

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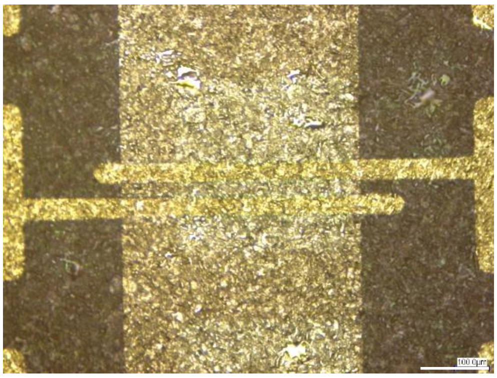
Abstract

Skin electronics offer a promising platform for non-invasive monitoring of vital signs in future healthcare, nursing, and sports applications. A critical component is the integration of on-skin adhesive transistors, which enable signal amplification near the body [1] and the construction of sensor arrays for spatial data collection [2]. While transistors on ultrathin plastic [1] or elastomeric substrates [2] have been developed to achieve conformal skin attachment, maintaining stable contact over extended periods remains a challenge due to limited substrate wearability. Here, we report organic thin-film transistors (OTFTs) fabricated on a 10 μm-thick commercial skin adhesive tape. Owing to the gas-permeability, stretchability, adhesiveness, and mechanical robustness, the tape could be continuously worn for more than two weeks in daily life without delamination. The OTFTs fabricated on this substrate exhibited reasonable performance, demonstrating the potential of this approach for long-term, skin-conformal electronics.



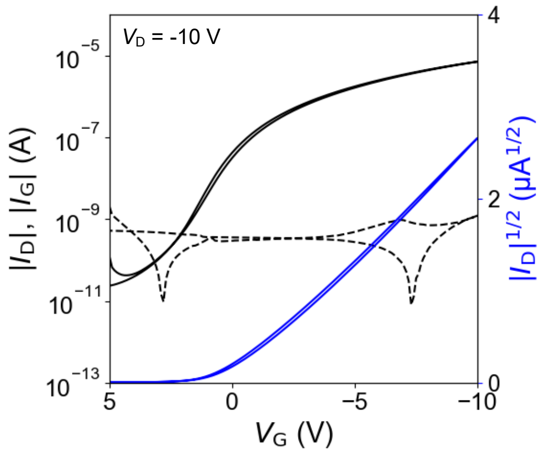


Figure 1. (left) Microscopic image of fabricated organic thin-film transistors OTFT on skin adhesive tape (scale bar: 200 μm), (right) the transfer characteristics of the OTFT.

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R1-I1

Laser-Induced Conductive Patterns on Flexible and Eco-Friendly Substrates

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Abstract

The demand for sustainable and cost-effective materials in biosensing is growing, especially for real-time and portable health monitoring. However, conventional electrode fabrication methods often require multiple processing steps and use non-renewable materials. This reliance raises environmental concerns and limits scalability. In this study, a green approach is developed to directly transform biodegradable bacterial cellulose (BC) into conductive carbon thin films using CO_2 laser-induced carbonization under ambient conditions for biosensor fabrication. Bacterial cellulose (BC) a biopolymer generated by specific bacteria, features a highly porous, nanoscale fibrous structure along with notable mechanical strength and biocompatibility. These properties make it a highly versatile material for biomedical applications. The laser-induced carbonization process leverages these unique structural features of BC, converting it into a conductive carbon matrix suitable for electrochemical applications. This one-step technique involves the precise application of a CO_2 laser, which locally heats the BC, breaking down organic components and rearranging carbon atoms to create conductive graphitic structures.

This approach integrates key functional components directly into the bacterial cellulose (BC) matrix, enhancing conductivity and sensor performance without the need for complex post-treatment steps. The resulting laser-induced carbonized BC electrodes exhibit excellent mechanical flexibility and maintain stable conductivity under bending conditions, making them highly suitable for flexible electronics. In addition to forming reliable conductive pathways, the printed patterns function effectively as electrodes for the selective, reproducible, and stable detection of glucose and lactate. The streamlined laser carbonization process enables efficient fabrication while supporting real-time biomarker sensing in actual sweat samples. Moreover, biodegradability testing shows that the printed material degrades completely within 28 days in soil without any adverse effects. Overall, BC-based conductive patterns represent a sustainable, portable, and cost-effective solution for printed electronics, highlighting the promise of laser-induced carbonization in advancing high-performance materials for flexible electronic technologies.

R1-O1

Fabrication of Transparent Heater using Inkjet-Printed sacrificial layer

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Abstract

Transparent heaters became popular for anti-fog window shields and side-view mirrors of automobiles, ships, airplanes etc. Many kinds of transparent electrodes have been used for transparent heaters. The printed electronics techniques such as an inkjet printing have been applied to manufacture transparent electrodes.

In this presentation, the polymeric sacrificial layer deposition technique by an inkjet printer to manufacture transparent electrodes and transparent heaters was introduced. The periodically printed sacrificial layer dots by inkjet printing on a thin aluminum film were introduced to form transparent electrode with perforated metal pattern after ultrasonic punching.

It was investigated that the narrow metal region of the perforated pattern is efficient to generate Joule heating using the multi-physics simulation. The relationship between electrical and thermal properties is investigated by adjusting the spacing of holes in the aluminum grid.

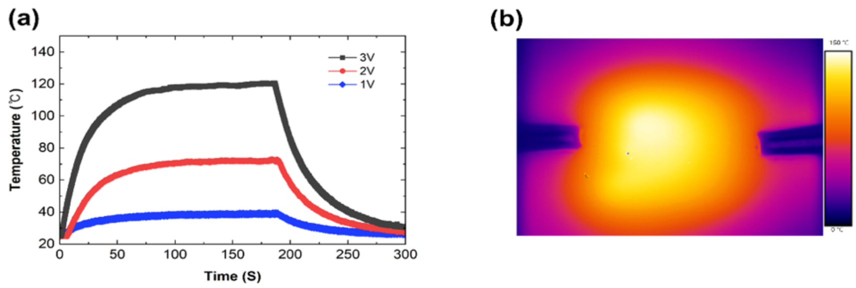

Figure 1. The performance of transparent heater with 75um inkjet-printed drop distance, (a) temperature profile with applied voltage of 1, 2 and 3V, (b) Thermal camera image.

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R1-O2

Selective Semiconducting Carbon Nanotube Extraction with Cellulose Acetate

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The post-synthetic extraction of semiconducting carbon nanotubes (CNTs) using hydrophobic polymers is advantageous for achieving high purity, crystallinity, and yields over other purification methods. However, this process requires anhydrous hydrophobic solvents, making it difficult to develop practical processes such as scale-up and continuous flow with acceptable reproducibility. Herein, we present a method for the purification of semiconducting CNTs; this method tolerates environmental impurities such as water in polar organic solvents.[1]

We used cellulose acetate (CA) as a dispersant and ethyl lactate as a solvent, based on our previous method.[2] UV-Vis-NIR absorption spectroscopy revealed negligible absorption of metallic CNTs (arc discharge, mean diameter of 1.4 nm), in contrast to non-selective, aqueous Pluronic F127 dispersion (Fig. 1(a)). Unlike conventional extraction methods which require dehydrated solvents,[3] the CA-assisted extraction demonstrated excellent selectivity even in the presence of water (Fig. 1(b)). Therefore, CA-assisted dispersion is considered a robust and efficient way for selectively extracting semiconducting CNTs in organic solvents. The semiconducting CNTs obtained here exhibited notable switching performance in their electric double-layer transistors (on–off ratio of ~1.5×10^5) and a large thermoelectric power factor (235 $\mu W\,m^{-1}\,K^{-2}$). These results further confirm the excellent semiconducting performance derived from the selective extraction of semiconducting CNTs.

(a) (b)

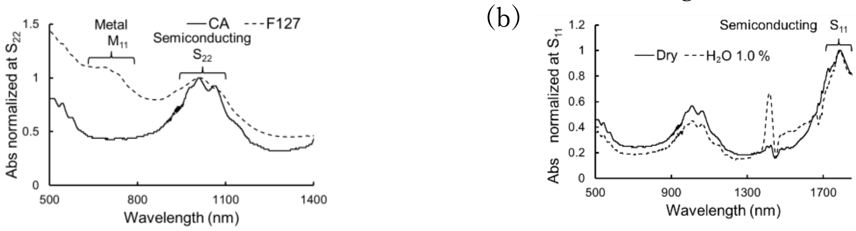

Figure 1. Absorption spectra of (a) F127- and CA-assisted SWNT dispersion, (b) CA-assisted SWNT dispersion in the presence of water.

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R1-O3

A Hybrid Inkjet Printhead with Piezo and EHD Technology for 200 cP Viscosity Ink Ejection

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Abstract

Inkjet printing is based on piezo printing offers high precision and eliminates the need for mask fabrication, making it attractive for applications in printed electronics such as displays, biomedical devices, and PCBs[1]. However, its use is generally limited to low-viscosity inks(typically <20 cP), which restricts its broader adoption in other manufacturing processes and limits the use of various functional materials [2].

In this study, we present hybrid inkjet printhead(Model: EHDison-H16) that combines piezo and EHD(ElectroHydroDynamic) printing mechanisms for overcoming limitatons of conventional inkjet printing.

The EHDion-H16 is 16 nozzle(100npi) MEMS-based drop-on-demand head with heating functions(Fig. 1(a)). Stable jetting was achieved across a wide range of ink viscosities, including silver(Ag) ink as shown in Fig 1(b). Notably, a high-viscosity ink(200 cP) in room temperature, which cannot be printed using piezoelectric actuation alone, was successfully ejected by simultaneously applying piezo and EHD voltages at a working distance exceeding 1 mm. These results demonstrate that the EHDison-H16 effectively addresses key limitations of traditional inkjet printing and enables the use of high-viscosity functional inks in applications such as printed electronics, displays, and semiconductor manufacturing.

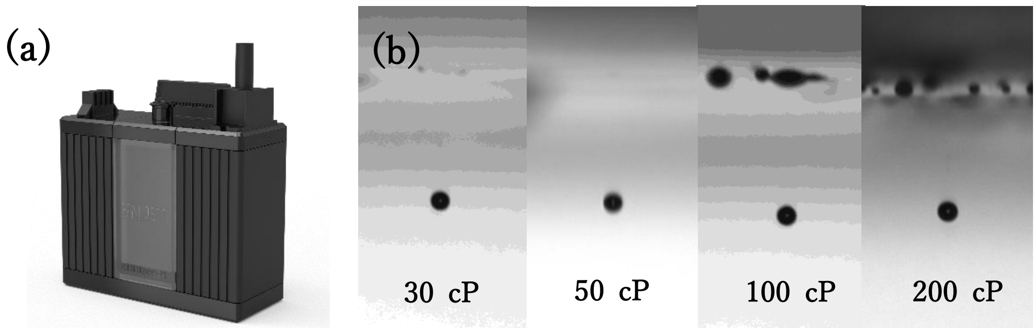

Figure 1. (a) EHDison-H16 head, (b) Jetting images by ink viscosity

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R1-O4

Plasma-Enhanced g-C_3N_4/BC-Derived LIG Electrodes for AChE-Assisted Pesticide Detection

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Abstract:

A sustainable biosensor platform was developed through the strategic integration of natural precursors, surface modification, and ambient-condition processing. Bacterial cellulose (BC), chosen for its biodegradability and structural purity, was first functionalized with matcha extract to enhance its carbonization potential. Nitrogen-rich graphitic carbon nitride (g-C_3N_4) was then incorporated to introduce electronic functionality and nitrogen doping capacity. To further activate the surface and promote uniform dispersion of g-C_3N_4, the composite was treated with low-temperature plasma, creating defect sites favorable for graphitic conversion. Laser-induced graphene (LIG) formation was subsequently achieved using CO_2 laser irradiation, producing porous, conductive films with interconnected carbon networks. Silver nanoparticles (AgNPs) were deposited to boost electrocatalytic properties, and acetylcholinesterase (AChE) was immobilized to impart selective recognition of organophosphate pesticides via enzyme inhibition.

The resulting AChE@Ag@N-LIG biosensor demonstrated high sensitivity, excellent selectivity, and strong operational stability under voltammetric analysis. This multi-step, yet chemical-free and eco-compatible process offers a practical route toward high-performance, flexible electrochemical sensors. The work underscores the feasibility of combining natural dopants, mild plasma activation, and laser patterning to develop biodegradable sensing devices suited for environmental and agricultural diagnostics.

S4-I1 (invited)

Ultrathin Photonic Devices and Integrated Systems for Bio-Interfacing

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Abstract

Extreme thinness in electronics reduces weight, enhances comfort, and improves mechanical robustness against bending by minimizing strain. This allows thin and stretchable devices to be attached to dynamic surfaces, such as body joints, driving research into ultra-thin and stretchable organic solar cells. Furthermore, these lightweight and flexible properties offer greater design freedom for various applications.

We are focusing on the improvement of performance/stability of ultrathin electronic devices, including self-adhesive electrodes [1], organic photovoltaics [2] and organic photodetectors [3], and developing integration technologies of such ultrathin devices for practical applications [4,5]. Such devices and integrated systems can be conformable to biological surfaces with minimal discomfort, enabling future biology-machine interfaces.

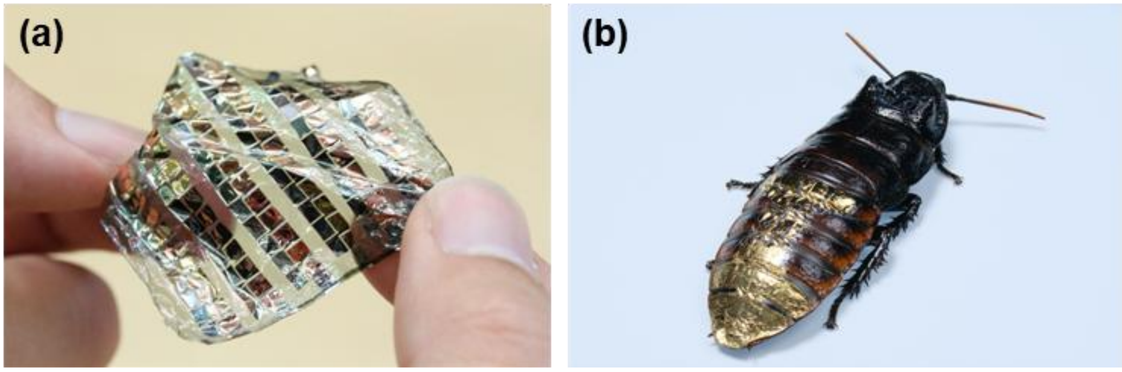

Figure 1. Ultrathin electronic devices (a) organic solar cell modules, (b) self-adhesive electrodes conforming to an insect body surface.

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S4-I2 (invited)

Light intensity dependence of equivalent circuit parameters of organic photovoltaic cell: Evaluation with Bayesian estimation

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Organic solar cells, including perovskite-type devices, are attracting attention not only for grid-connected outdoor photovoltaic applications but also as maintenance-free power sources for IoT devices. An equivalent circuit model that accurately reproduces the current–voltage characteristics of a solar cell is useful for understanding its performance under various load conditions. In the era of solid-state lighting, indoor light environments have become highly diverse. Therefore, to fully exploit the power generation potential of organic solar cells under all possible lighting conditions, it is beneficial to develop an equivalent circuit model that accurately reflects the dependence on light intensity.

When estimating equivalent circuit parameters from experimentally obtained current–voltage characteristics, nonlinear least-squares estimation is commonly used. However, the results often vary depending on the choice of initial values, making it difficult to determine a unique parameter set for a given experimental curve. This issue is particularly evident in the diode ideality factor n, as shown in Fig. 1, where even when n is fixed at significantly different values, the experimental curve can still be reasonably reproduced by adjusting the remaining parameters. This ambiguity can result in discontinuities in the estimated light intensity dependence of certain parameters. [1]

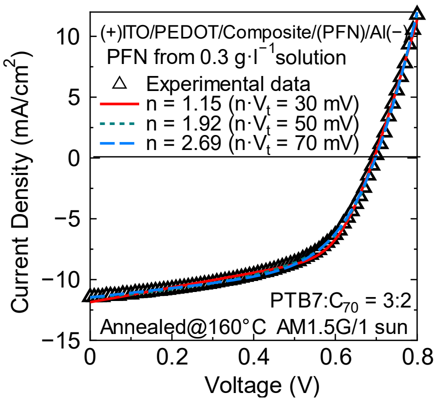

Figure 1: Example of fitting the experimental current-voltage curve of an organic solar cell with the ideal factor n of the diode fixed at various values with least squares.

Recently, the author proposed a Bayesian estimation approach that enables the derivation of full distributions for the parameter estimates. [2][3] This method provides a more robust interpretation of uncertainty and yields a relatively smooth light intensity dependence on equivalent circuit parameters.

Acknowledgements

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S4-I3 (invited)

Organic Luminescent Radical Materials for Organic Electronics

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Luminescent radicals are garnering attention as fourth-generation luminescent materials for OLED applications and other fields, such as bioimaging and quantum sensing. TTM (tris(2,4,6-trichlorophenyl)-methyl) radicals are the most popular luminescent radicals but suffer from low photostability. The attachment of donor molecules, such as carbazole, can enhance photostability.[1] This radical is applicable as an emitting material for OLEDs (Organic light emitting diodes).[2] The electrical excitation of doublet emitters in OLED devices is expected to form 100% doublet excitons, and all of the excitons can be harvested without the spin-flip process.

TTM radicals are known to have poor photostability, but we have assumed that the photostability of the carbazole-TTM system is dominated by the stability of the carbazole cation radical; i.e., modifying the carbazole unit will lead to controlling both the photostability and the luminescent property. Here, we report a series of carbazole-TTM dyads with π -extended carbazole donors (Figure 1 left), together with the dendronized TTM radical (Figure 1 right) and their applications in OLED devices.[3,4]

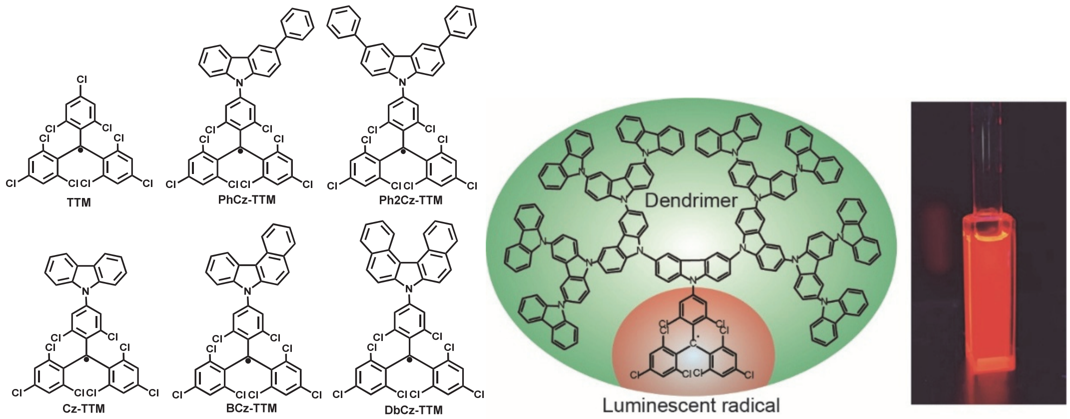

Fig. 1 (Left) Structure of TTM radical with π-extended carbazoles. (right) Chemical structure and photo of the PL in cyclohexane of carbazole dendronized TTM radical.

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S4-O1

Effect of buffer layer insertion at the interface between the printed ZnO_x electron transport layer and the emissive layer for application to printed light-emitting devices

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Abstract

In printed light-emitting devices, it is necessary to form an appropriate electron transport layer. In this study, we investigated the insertion of a buffer layer to suppress degradation of the emissive layer from high-temperature annealing treatment during the formation of a coated ZnO_x electron transport layer using the sol-gel method, to improve the light-emitting characteristics of the device.

For the fabrication of polymer light-emitting diodes (PLEDs) as shown in Fig. 1, the yellow-green emissive fluorene-type polymer F8BT was used as the emissive layer, and a metal chelate compound $Zr(acac)_4$ [1], which was insoluble in ZnOx precursor solution, was used as the buffer layer. EL intensity in PLED with $Zr(acac)_4$ was larger than that in PLED without $Zr(acac)_4$, as shown in Fig. 2. It means that the improvement in the current efficiency of PLED by inserting a buffer layer was achieved. Next, we investigated the characteristics of printed quantum dot (QD)LEDs with cadmium-free InP/ZnSe/ZnS QD patterned emissive layer, which was formed by electrophoretic deposition. As shown in Fig. 3, the yellow-green emission based on QD exhibits higher color purity and narrower half-width EL spectrum, compared to F8BT devices.

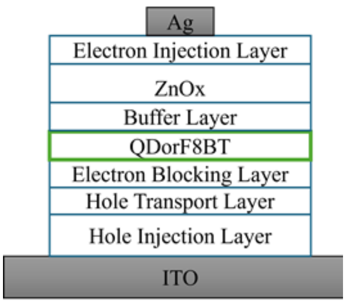

Figure 1. Typical device structure with and without buffer layers

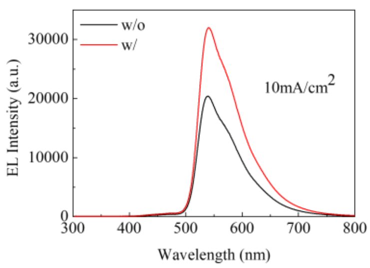

Figure 2. EL spectra of F8BT devices (W/O and W/)

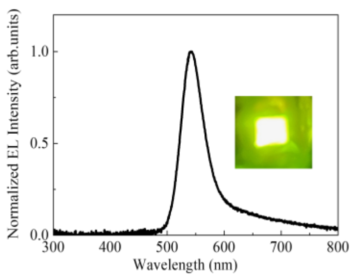

Figure 3. EL spectrum of QD device (W/)

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Acknowledgement: This work was partially supported by JSPS KAKENHI Grant Number 25K01264.

S4-O2

Electrical Polarization Characteristics of AC-driven Insulated Organic Electroluminescent Devices with Printed Inorganic/Organic Hybrid Ferroelectric Dielectric Film Towards the Application in Non-Volatile Optical Memory

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Abstract

Alternating current (AC) -driven organic electroluminescent device (ACEL) exhibits the unique device architecture in which an emitting layer is separated with an insulator from the electrode, which offers novel design freedom. The applied AC field assists in the formation of excitons and light generation. The operating voltage of ACEL can be lowered by using a high permittivity insulating layer. The capacitance of the dielectric layer is one of the crucial factors to improve the characteristics of ACEL.

We demonstrated the AC-driven insulated organic electroluminescent device with inorganic /organic hybrid dielectric film mirror to realize all-solution processed polymer electroluminescent devices with one-dimensional photonic crystal microcavity structures. [1,2] Polyvinylidene Fluoride Derivative is a promising material for the easy fabrication of thin films by spin-coating. A poly(vinylidene fluoride-trifluoroethylene), P(VDF-TrFE), which is one of ferroelectric, and fluorine-based polymers exhibits both low refractive index at the optical frequency, and high permittivity at the low frequency for ACEL operation. Its ferroelectricity originated from molecular dipoles associated with positively charged hydrogen atoms and negatively charged fluorine atoms. For both P(VDF-TrFE) film and multilayer films consisted of inorganic copper(I) thiocyanate, CuSCN and P(VDF-TrFE), typical *D-E* hysteresis loops were observed. Under the controlled bias, the hysteresis of EL emission intensity was also obtained for the ACEL with semiconductor mirror incorporating conductive polymer PEDOT:PSS, as shown in Fig. 1. The different electrical polarization direction of the P(VDF-FrTE) layer results in different emission intensities. We also discuss the optical and electrical properties of dielectric film mirrors to improve the characteristics of ACELs.

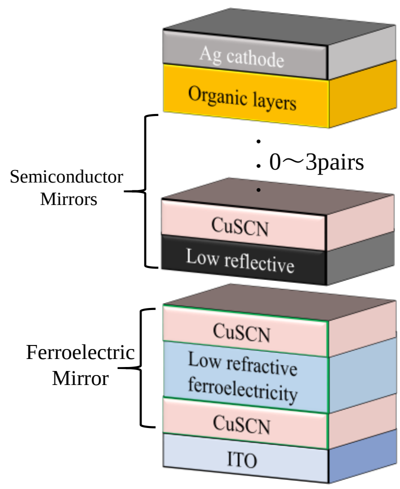

Fig. 1. Typical device structure

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OE-A-1

Flexible and printed electronics enabling innovation and industrialization

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Abstract
Thin, light, flexible and robust are the key characteristics of printed electronics, which can be seamlessly integrated into a wide range of products. Flexible and printed electronics enables new applications in a variety of industries, including automotive, consumer electronics, healthcare, printing/packaging and smart buildings, as well as its growing presence in the Internet of Things (IoT) - in short, "electronics everywhere". At the same time, there is a growing need for sustainable and circular electronics due to its quantities but also specifics of conventional electronics. Flexible and printed electronics enable more sustainable electronics by using new materials and processes, as well as through their lightweight nature.

This presentation provides an overview of the OE-A Roadmap and discusses the technologies and applications that combine the expertise of over 100 members from across the value chain.

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OE-A-2

3D Kirigami Lighting enabled by 2D Printed Electronics

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Abstract

Origami, the traditional Japanese art of paper folding, and *kirigami*, which incorporates cutting, have inspired a wide range of applications—from Miura-folded maps and robotic grippers to deployable solar sails and origami-based architecture.

2D (hybrid) printed electronics enable low-cost, large-area 2D circuit fabrication on flexible plastic substrates using sustainable additive methods. By incorporating kirigami-inspired cuts into the layout, flat electronic sheets can transform into functional 3D structures. However, this requires co-design of circuitry and cutting patterns. Sharp folds with conductive traces are prone to failure due to high strain; therefore, additional cuts must be strategically placed to reduce stress in critical areas.

Standalone thin plastic foils are often too fragile for many real-world applications. As part of the European project *3DoP - Optimization of Production by 3D Printing*, we have developed methods to embed flexible 3D kirigami LED circuits into rigid plastics using sequential thermoforming and injection molding. To avoid stress during shaping, the unfolded 3D PET structures are laser scanned and converted into digital models, which are then 3D printed via laser sintering to create custom molds.

This presentation outlines the integration of additive manufacturing with kirigami electronics, and demonstrates the embedding of complex 3D LED designs into rigid plastic components to produce robust, functional electronic products.

Figure 1. Close-up photograph of a folded LED lighting foil with a hexagonal structure.

OE-A-3

Organic photovoltaic cells and modules for harvesting indoor light to power IoT devices – upscaling and long-term stability

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The growing demand for scalable fabrication of high-efficiency organic photovoltaic (OPV) cells and modules is becoming increasingly evident, particularly in the context of indoor applications. Indoor organic photovoltaics (IOPV) represent a promising energy harvesting solution for powering Internet of Things (IoT) devices, owing to their flexibility, reliability, and high power density under low-light conditions. With billions of IoT devices expected to be deployed in the coming years—many of which will operate within indoor environments—there is a critical need for custom-designed, conformable photovoltaic systems that can adapt to the diverse form factors of devices such as environmental sensors, smart tags, and health monitors.

In this context, inkjet printing has emerged as a particularly attractive technique for the scalable production of flexible OPV cells and modules. This digital, additive manufacturing method enables precise material deposition, minimal waste, and unprecedented freedom in design and geometry, making it ideal for producing PV devices tailored to a wide range of shapes and applications.

Here, we address the key challenge of translating laboratory-scale processes into industrial-scale manufacturing for the realization of fully inkjet-printed, high-efficiency IOPV cells and modules. To highlight the unique advantages of inkjet printing, we demonstrate custom-shaped OPV modules integrated into various IoT devices, enabling autonomous operation without the need for batteries or connection to the electrical grid. This work underlines the potential of inkjet-printed IOPVs as a viable power source for the next generation of smart, connected indoor devices.

OE-A-4

Electroactive polymers for flexible and printable innovative sensors and actuators

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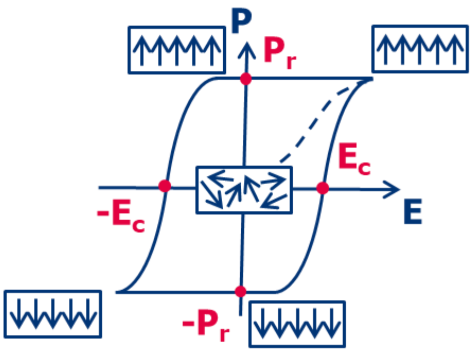
Abstract

At Arkema we produce and provide a series of electroactive polymers, which is called Piezotech®. These fluoropolymers [1] exhibit unique electroactive properties such as piezoelectric, pyroelectric, electro-strictive, and electrocaloric properties, etc. We divided these materials into 2 ranges based on the different chemical structures. One is Ferroelectric Copolymer FC. The other is named as Relaxor ferroelectric Terpolymer RT. In this presentation, both types of materials will be introduced with the development examples that carried out in our partners.

Piezotech FC copolymer, which is copolymerized with VDF and TrFE, shows an excellent piezoelectric and pyroelectric thanks to the high ratio of β-crystal after being annealed. Therefore, FC copolymer is an ideal material for acoustic, touch, strain, impact sensors. The famous application of FC copolymer is that it is used in ultrasonic finger printing sensor in most smart phones. Moreover, with the inverse piezoelectric effect, it gives mechanical motion/feedback within the electric field, which provide a possibility of fabricating actuator or film type speaker.

Piezotech RT terpolymer, which is copolymerized with VDF, TrFE and one more additional monomer. Because the additional monomer improves the mobility of dipoles, RT terpolymer gives a unique relaxor ferroelectric property. Within electric field, it gives higher striction comparing with FC copolymer. This property makes RT a possible to be a actuators.



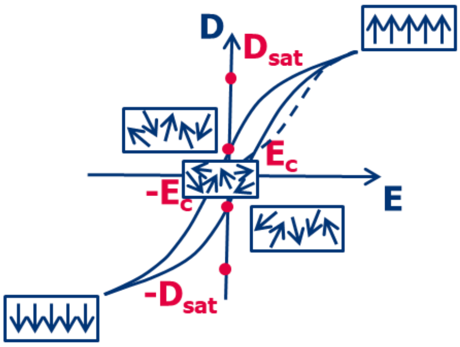


Figure 1 (left). Electric field-Polarization hysteresis curves of Piezotech FC.

Figure 2 (right). Electric field-Displacement hysteresis curves of Piezotech RT.

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OE-A-5

Fully Printable Biosensors Enabled by Biofunctionalized 2D-material-based Inks

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Abstract

The widespread adoption of biosensors for affordable and accessible home healthcare is currently limited by complex and costly manufacturing processes. Leveraging the low cost and scalability of printed electronics, this research presents a novel platform for the fabrication of fully printed biosensors. We have developed an innovative and directly printable biofunctionalized ink using a highly conductive and water-processable graphene derivative. This enables the one-step production of specific chemiresistive sensors. Owing to the unique properties of additive-free 2D-material-based inks, biological buffer solutions can be used as carrier solvents for ink formulation, preventing biomolecule denaturation. As a proof of concept, we have demonstrated a highly sensitive urea sensor capable of operating in complex media, highlighting the advantages of our biofunctionalized inks. This breakthrough in functional ink formulation eliminates the need for complex post-printing biofunctionalization and opens the door to a broad range of biosensing applications and lays the foundation for the large-scale production of affordable biosensors for healthcare and environmental monitoring.

OE-A-6

Empowering Scalable Innovation in Functional Surfaces

Fabien Resweber[1]
[1] Business Developer / ARMOR SMART FILMS

Abstract

Armor Smart Films, a subsidiary of the ARMOR Group, is a trusted industrial partner specializing in the development and industrialization of functionalized surfaces. Our mission is to deliver accurate innovation—where precision, efficiency, and relevance converge to meet the real needs of our clients and the industry.

We combine deep expertise in formulation, coating, and printing technologies with robust industrial capabilities, enabling a seamless transition from lab-scale prototyping to large-scale manufacturing. Our facilities include dedicated labs, pilot lines, and roll-to-roll and sheet-to-sheet platforms, ensuring scalability and reliability.

We offer a full-service approach:

- Testing and characterization
- Custom liquid formulation development
- Pilot and industrial-scale coating/printing
- Tailored design and integration support

A key area of expertise lies in printed electronics, with electroactive technologies, particularly P(VDF-TrFE) copolymers from Arkema Piezotech®. These materials offer superior piezoelectric properties, thermal stability, and mechanical robustness, making them ideal for Sensors, Haptic interfaces, Energy harvesting, Medical instrumentation…

The presentation will explore in greater detail our technological capabilities, from advanced formulation and functional printing and coating of electroactive materials, as well as our industrial infrastructure designed to support seamless upscaling—from lab to mass production.

OE-A-7

Advanced screen-printing process for functional textiles

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Abstract

Wearable devices and smart textiles incorporating flexible sensors and electronic circuits are finding increasing application in Consumer, Industrial and Health/Wellness markets. The underlying technology to accomplish these is the ability to produce highly conductive circuits, sensors of different modalities, and interface components, on a variety of substrates. My presentation will share an advanced printing technology that utilizes specialized conductive inks, often based on silver or carbon, that are printed on to transfer films and subsequently heat-pressed onto textiles or other substrates. Unlike traditional circuit manufacturing, this process offers a cost-effective, low-CapEx, lightweight and scalable alternative for promoting ubiquitous sensing, while solving the usual limitations related to adhesion, durability and electrical performance. Via real-life application examples, the presentation will exemplify the nuances and advantages of this unique approach.

OE-A-8

Additive Manufacturing Platform for Freeform 3D Microelectronics and Packaging

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Abstract

Additive manufacturing of electronics is an emerging technology at the intersection of 3D printing and printed electronics [1]. Holst Centre's novel 3D microelectronics manufacturing platform uniquely combines direct imaging lithography and additive manufacturing technology. The platform utilizes a foil coating process which leverages the high resolution and throughput afforded by direct imaging lithography with the design freeform of 3D printing. Using a Visitech LUXBEAM® DMD-based illumination system, our system can produce structural and electrical features down to 10 μm, enabling the creation of highly interconnected 3D microelectronic circuits. A microelectronic demonstrator to enable endoscopic ultrasound imaging (shown below in Figure 1), developed in collaboration with Philips™ within the EU-funded AMPERE project, will be presented. The demonstrator is designed to be attached on top of a catheter medical device without affecting the catheter functionality. There is therefore significant form factor requirements, with several bare die chips needing to be interconnected on a 1 mm-wide ring. The demonstrator includes bare die ASIC (350 μm wide, 50 μm thick) and capacitive micromachined ultrasonic transducer (CMUT) chips with 50 μm bond pads (90 μm pitch) which are embedded and interconnected using the novel printing platform.

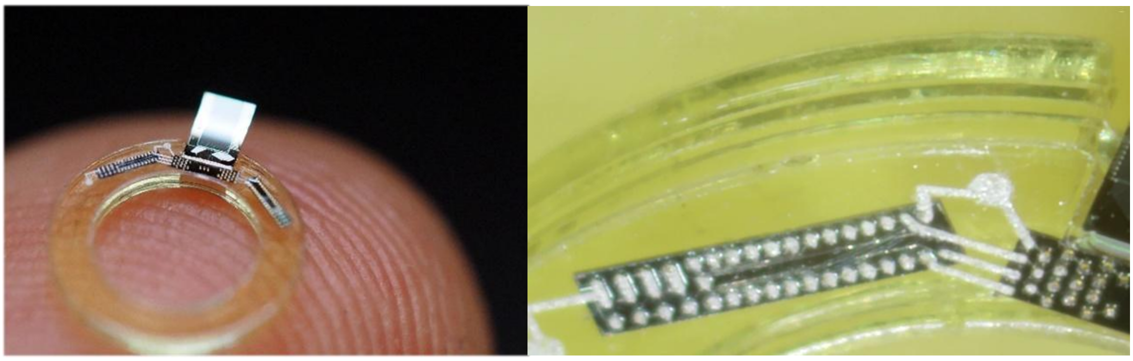

Figure 1. 3D printed microelectronic demonstrator to facilitate endoscopic ultrasound on a catheter tip. (Left) Isometric view of manufactured demonstrator on a finger tip. (Right) Isometric view of printed silver-based interconnects (90 μm pitch) on an ASIC chip.

References

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OE-A-9

Scaling up organic photovoltaics: The path to industrial mass production of integrated PVs in Buildings & Agriculture

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Abstract
Organic photovoltaics (OPVs) are revolutionizing our future by enabling limitless generation of electricity from the sun from all surfaces. Flexible OPVs offer unprecedented advantages in terms of lightweight, capability for digital design and color aesthetics, cost-effectiveness in fabrication, semi-transparent with tunable optical transparency, and a high potential for recyclability, contributing to the Green Transition. These advantages can enable their rapid integration in Buildings, Greenhouses, Urban Infrastructure, Automotive, portable devices, etc. Nevertheless, the integration of semi-transparent OPVs in buildings and urban infrastructure and pedestrian cooling is still far from being widely adopted.

In this presentation, we describe the innovations of the Horizon Europe Flex2Energy project (www.flex2energy.eu) that will revolutionize the renovation and construction wave of the EU's building industry by introducing novel Integrated OPV (IPV) products for energy positive buildings. Flex2Energy develops a unique automatic production line for sustainable manufacturing of printed IPVs with a power higher than 90W/m2, and a cost of less than 150 €/m2. It will demonstrate and validate IPVs in energy efficient buildings, automotive and agriculture industries with minimum environmental and landscape impact and it will deploy a complete market strategy to bridge the gap between the PV and building sectors in Europe and internationally. Also, it will demonstrate the huge potential of OPVs for applications in pedestrian & building infrastructures by controlling spectral transmission, UV protection, reducing temperature, shading, with huge benefits in saving energy for cooling and personal health. The project is coordinated by Organic Electronics Technologies (OET) and the consortium consists of 17 expert partners that include 6 SMEs and 5 Industries and 2 Industrial Associations. Flex2Energy will make Europe a pioneer in automated sustainable manufacturing of IPVs and its successful achievement in the production of advanced photovoltaic for applications in buildings, automotive, sustainable agriculture, smart cities, etc.

In addition, we will provide an overview of the innovations in zero-defect large-scale manufacturing of printed OE nanomaterials and devices, by robust intelligent in-line metrology tools and methodologies that can measure and analyze in real-time the nanoscale thickness, opto-electronic properties and potential defects over large areas.

OE-A-10

Expanding the boundaries of printed electronics for volume manufacturing of PCB-replacements

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Abstract

The current printed circuit board (PCB) technologies are typically subtractive, and score low on sustainability metrics. Furthermore, they are limited in their suitability for roll-to-roll (R2R) manufacturing, which is a key requirement for the IoT revolution currently taking place. Printed electronics is seen as a key enabler for IoT devices, encompassing applications such wearables, logistics track-and-trace, structural health monitoring, smart buildings, etc. One of the key limitations in today's printed electronics is the lack of a high-throughput and robust vertical interconnect access (VIA) production process. As a consequence, the complexity of circuitry enabled by printed electronics lags considerably in comparison with circuitry produced through traditional lithography (etching) techniques. This is one of the primary reasons why double-sided printed electronics are also rare.

TracXon has developed and patented a high-speed, R2R-compatible VIA production process that could enable printed electronics to replace traditional PCBs for, e.g., IoT applications. TracXon is building what is likely the first dedicated VIA filling machine that is compatible with existing R2R as well as S2S printing lines in the industry. The main objective behind this development is to enable double-sided and high-density printed electronics, thereby closing the gap with traditional PCB techniques in terms of complexity of the circuitry.

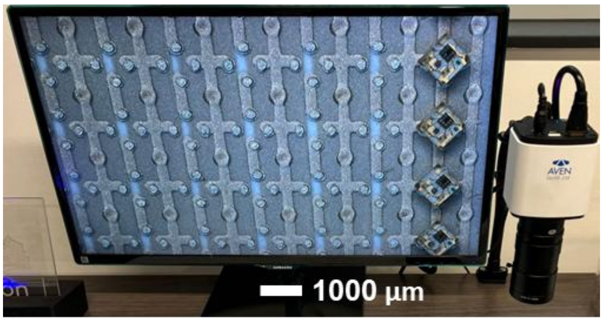

Figure 1. Double-sided printed circuitry with printed VIAs.

OE-A-11

Why reliability is a crucial element to scale printed flexible electronics products

Wolfgang Mildner
MSWtech
General Chair LOPEC

Printed and flexible electronic products are the result of extensive research and the convergence of multiple enabling technologies. While prototypes and first-generation products have been successfully demonstrated over the past years, an increasing number of solutions are now approaching market readiness—bringing with them the urgent need for scalable manufacturing.

This presentation will explore the critical role that reliability plays in enabling the transition from lab-scale innovation to industrial-scale production. Reliable data is essential at every stage of this journey: from component-level performance, through manufacturing process parameters, to the long-term behavior of products and systems under environmental stress and accelerated aging conditions.

A robust digital representation of reliability data enables modeling, simulation, and predictive analytics for scaled production processes. The talk will outline key data requirements, practical tools (2), and system-level concepts that support reliable upscaling.

Use cases from sensors, flexible heating elements (1), and emerging photovoltaic applications (3) will illustrate how reliability strategies are being applied to support commercialization and long-term performance

1) MSWtech
2) BayflexSolutions
3) SolarTAP an Helmholtz initiative

18 September (Thursday)

ICFPE Keynote and abstract

Dr. Alain Schumacher

CTO, IEE S.A., Luxembourg

Alain Schumacher holds a PhD in Physics with a strong background in the field of thin film physics and technologies from the University of Kaiserslautern, Germany.
Ever since Alain joined IEE in 2000, he has been working in different functions, across many divisions, grew into the company and influenced growth of the company, too. Today he holds the position as CTO and is a member of the Executive Committee at IEE S.A.
Alain's story with the Printed Electronics world spans across many years of passionate research, strategy, evaluating new technologies and systems, supporting operations, and finally, creating valuable, strong connections with various partners. As a member of the OE-A board, Alain Schumacher took over the Chair of the Board of Directors in 2025. Thus, he is well placed to bring his experience and visions into the printed electronics world.
IEE has been leading the way in innovative sensing solutions and electronics manufacturing services for automotive, building management & security, Health Tech and beyond, since 1989. When it comes to automotive safety, IEE has equipped > 500 millions of cars all over the world and continues to do so. Alongside its roadmap, IEE targets to build a wider, more diverse, and future-proof reality in which printed electronics continue to play a critical role in helping citizens lead a better, safer and more comfortable life.

KL-1 (ICFPE Keynote)

Software defined functions – Opportunities for Printed Electronics

Dr. Alain Schumacher, CTO, Chair OE-A Board of Directors*

IEE S.A., Bissen, Luxembourg

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* Organic and Printed Electronic Association

Abstract

Printed electronics has always been appealing for innovative applications that challenge conventional methods. Since the first patented forms of flexible and printed electronics emerged in the early 20th century, technology has gradually and imperceptibly crept into our everyday lives, mostly as an almost invisible actor. In combination, with surface-mount technology to form Hybrid Printed Electronics, devices benefit from greater functionality, intelligence, and connectivity while maintaining flexibility, design freedom, affordability, and scalability. Ultimately this pushed the consolidation of printed electronics in many market segments, such as medical & health, automotive and consumer electronics, where it has become indispensable and will remain so. According to the OE-A roadmap, new fields of use are expected to emerge, along with a need for enhanced and more cost-effective systems.

So far, applications have generally been fulfilled by standalone sensors designed for specific functions. Looking forward, the boundaries between hardware and software will continue to blur, so-called software defined sensing solutions will emerge in the future. In fact, by fusing inputs from various sensors, intelligent sensing platforms can efficiently display new or existing functions, whereby digitalization, AI, big data, connectivity & communication as well as edge-computing will play a major role. Owing to advancements in technology, hybrid printed electronics have become integral components in the development of novel, dependable sensor systems.

Figure 1.: IEE’s business - Creating Sensing Solutions for a Better World

S7-I1 (invited)

Cellulose Nanofiber/Poly(acrylic acid)-based Hydrogel for Colorimetric Biomarker Sensors

Nichaphat Passornraprasit[1,*], Tatiya Siripongpreda[2], Sumalee Ninlapruk[3], Juan P. Hinestroza[4], Nadnudda Rodthongkum[1], Pranut Potiyaraj[1]
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[2] Faculty of Environment and Resource Studies, Mahidol University, Thailand
[3] Office of Atoms for Peace (OAP), Thailand
[4] Department of Human Centered Design, Cornell University, United States
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Abstract

Early and non-invasive detection enables timely diagnosis and enhances patient accessibility. In this work, CNF/PAA hydrogel-based colorimetric sensors were developed for detecting sweat urea and urinary sarcosine, biomarkers of kidney disease and prostate cancer, respectively. The 3D hydrogel structure facilitated efficient sample absorption and analyte preconcentration, improving sensing performance and usability. Incorporation of cellulose nanofibers enhanced mechanical strength and structural stability. Enzymatic and coloring reagents enabled colorimetric semi-quantitative detection, while graphene oxide supported precise analysis via laser desorption/ionization mass spectrometry. These hydrogels can be fabricated as patches or integrated with 3D-printed strips, offering a versatile, non-invasive platform for point-of-care diagnostics and potential expansion to other disease biomarkers.

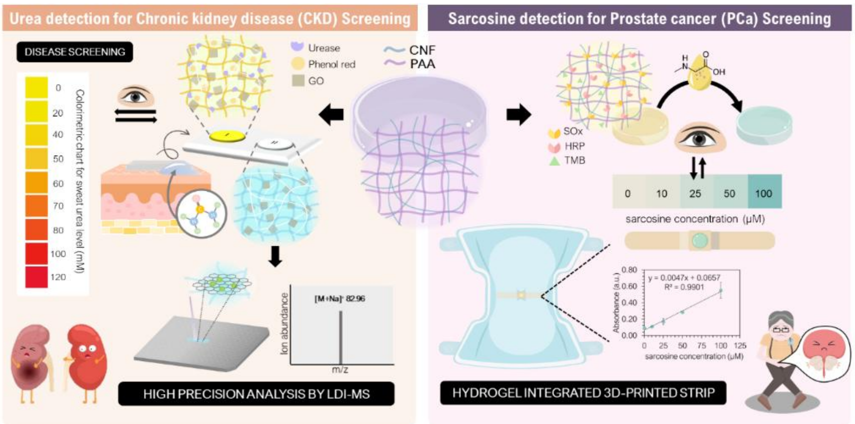

Figure 1. non-invasive CNF/PAA hydrogel colorimetric sensors for disease screening.

References

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S7-I2 (invited)

Thermally-drawn microelectronic fibers as intelligent textile interfaces

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Abstract

The convergence of fiber engineering and flexible electronics is opening new frontiers in textile-based intelligent systems. Our research leverages thermally drawn, multifunctional polymer fibers as a versatile platform for integrating electrical, optical, chemical, and fluidic functionalities into flexible, thread-like devices.

These microelectronic fibers are engineered to perform in vivo neurochemical sensing by incorporating surface-functionalized biosensing layers, such as aptamers, ionophores, and electroactive polymers, directly onto the fiber surface [1–3]. Additionally, we have developed shape-adaptive actuator fibers that dynamically reorient in response to stimuli [4] (PCT/JP2022/17664), and embedded microfluidic channels to enable in-fiber chemical analysis, realizing a lab-in-fiber (LiF) paradigm [5].

Beyond biomedical interfaces, we translate this architecture into wearable textile systems for continuous monitoring of physiological parameters, including sweat metabolites, temperature, and electrolyte balance, offering a promising pathway toward seamless human–machine integration [2,6].

Our approach combines materials innovation with advanced fiber processing, contributing to the next generation of smart textiles that interface directly with biological systems for both healthcare, neuroscience and medical applications.

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S7-I3 (invited)

Flexible and Stretchable Devices for Smart Textiles

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Abstract

Developing electronic devices that can be smoothly and comfortably attached on human bodies is a challenging task in the field of electronics. For attaching electronic devices on three-dimensional shapes such as human bodies, flexibility and stretchability are essentially required, but conventional rigid and flat electronic devices cannot meet the requirement. In addition to flexibility and stretchability, breathability are also essential factors from the perspective of comfortability. For manufacturing a wide variety of flexible and stretchable electronic devices, the use of stretchable structures has attracted attention. In terms of breathability, the development of electronic devices in the form of clothing and fabrics has been energetically studied [1] in recent years.

Here, this report presents a way of fabricating stretchable electronic devices composed of thin films and elastomer and electronic devices in the form of fibers. As shown Fig.1(a), by attaching thin-film electronic devices on elastomer and by forming a wavy structure, the thin film device avoids fracturing under stretch by straightening its wavy structure. As another method, called kirigami structure, thin-film devices with parallel cutting patterns can resist stretching by opening its cutting pattern under stretch. As shown in Fig.1(b), by integrating a kirigami structure with functional elastomer, biaxial stretchable device was achieved. For breathability, a fiber-shape electronic device that can be woven into clothing and fabrics was realized by rolling a thin-film electronic device as shown in Fig.1(c).

This report presents the way of making stretchable and comfortable electronic devices and the applications.

Figure 1. (a)Film/elastomer structure. (b)Kirigami-structure device. (c) Fiber-shape device

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S8-I1 (invited)

Monolayer organic transistors: from fabrications to applications

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Key Words: Monolayer semiconductors, contact resistance, solution shearing, field effect transistors, brain computer interface

In this presentation, my focus will be on high-performance monolayer organic crystals and their application in developing an OFET with a record-breaking current density. The semiconductor material utilized is derived from solution-processable DNTT, and the deposition technique employed is solution shearing. Among the four derivatives tested, the one displaying the best performance exhibited a contact resistance of 25 ohm·cm. The monolayer crystal demonstrates an unprecedented ability to conduct high-density current, reaching up to 19 μA/μm per channel width, which translates to 1.2 MA/cm2 when normalized by the channel cross-section area. This current density significantly surpasses that of previously reported OFETs and is comparable to that of inorganic transistors.

However, operating OFETs at such high current densities inevitably generates significant heat, which can lead to thermal damage, particularly at the metal/organic contact interface. To mitigate this thermal damage, we have found that reducing the voltage pulse width to 10 μs and the duty cycle to 1% still allows the device to function properly. Our research underscores several key findings: (i) monolayer crystals effectively lower contact resistance, (ii) molecularly thin semiconductors remain capable of conducting substantial current, and (iii) effective thermal management is crucial for advancing OFET studies, especially those aiming for outstanding performance.

Building on the significant advancements in monolayer semiconductors, we have developed flexible transistor sensors designed to capture high signal-to-noise ratio electrophysiological signals from the brain. By repurposing these transistors into invasive neural probes and semi-invasive ECoG sensors, our monolayer transistor technology holds great promise for applications in brain-computer interfaces."

S8-O1

Control of Carrier Injection in Bottom-Gate Bottom-Contact-Type Single-Crystal Organic Transistors

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Abstract

Bottom-gate bottom-contact (BGBC)-type organic thin-film transistors (OTFTs) are advantageous for practical applications, as they allow electrode fabrication without damaging the organic semiconductor (OSC) layer. We previously demonstrated high-performance BGBC-type OTFTs exhibiting both high mobility and near-ideal subthreshold switching by coating uniform single-crystalline OSC films onto highly lyophobic fluoropolymer dielectrics such as Cytop [1,2]. To further enhance device performance, it is essential to understand carrier injection characteristics, which remain insufficiently explored due to the complexity of the ternary interface—comprising of the OSC, electrode, and gate dielectric.

Here, we investigate the carrier injection mechanism at this ternary interface by fabricating OTFTs with a variety of OSCs, electrode work functions, and gate dielectric materials, along with short-channel OTFTs on Cytop. Evaluation of device characteristics and contact resistance reveals that higher electrode work functions result in more efficient carrier injection [3], and that gate dielectric properties also have a significant impact [4]. The highest device mobility and steepest subthreshold slope were achieved using PFBT-treated electrodes (with highest work function) in combination with fluorinated polymer dielectrics (Cytop, AF2400) exhibiting low surface energy. These findings suggest that carrier accumulation and trap suppression near the ternary interface are critical for improved injection.

Moreover, we successfully fabricated short-channel OTFTs on Cytop by developing a photolithography-compatible process for this highly lyophobic surface [5]. These results contribute not only to improved device performance but also to a deeper understanding of charge injection physics in organic field-effect transistors.

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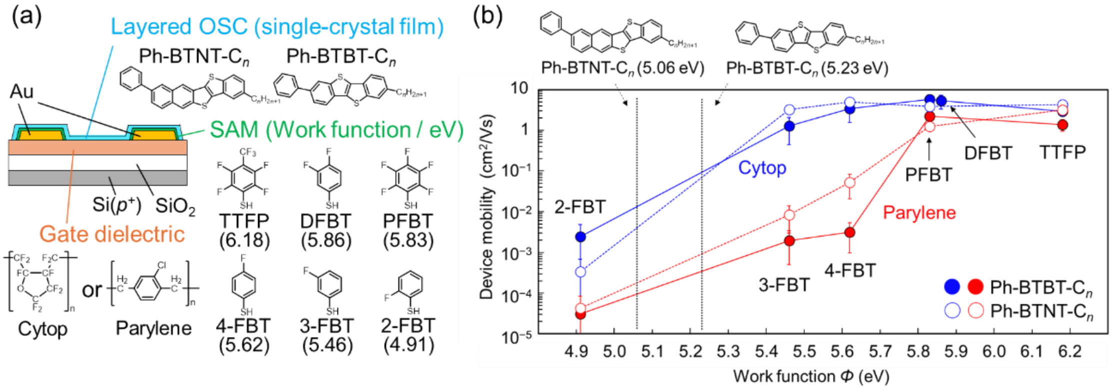

Fig (a) Schematic cross section of the device. (b) Device mobility for various combinations of OSCs, electrode work functions, and gate dielectrics. Vertical dotted lines indicate the ionization energies of Ph-BTBT-C_n and Ph-BTNT-C_n. Cited from Ref. [3].

S8-O2

Formation of mixing-induced polar molecular order and carrier transport in piezoelectric organic semiconductors

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Organic semiconductors (OSCs) composed of π-conjugated cores and alkyl chains naturally form quasi-two-dimensional molecular assemblies, such as layered crystal phases and liquid crystal (LC) phases. Recent studies have shown that the emergence of LC phases promotes the formation of layered crystal structures [1], which affords excellent carrier transport in thin film transistors. We have previously demonstrated that LC phases can facilitate the formation of supramolecular cocrystals from distinct OSC molecules, leading to mixing-induced polymorphic layered crystal phases [2, 3]. Among these diverse crystal structures, polar molecular order is promising for exploring novel functionalities in OSCs, including nonlinear optics, piezoelectricity, and nonreciprocal charge transport. However, achieving polar crystal phases in OSCs remains challenging, as most molecular crystals adopt centrosymmetric structures, and only a limited number of OSCs are known to exhibit polar order [4].

In this presentation, we report the emergence of a polar cocrystal phase achieved by mixing OSCs with similar chemical structures, Ph-BTBT-C_{10} and 4F-Ph-BTBT-C_{10} (Fig. 1a). Structural analysis via X-ray diffraction and optical second harmonic generation reveals that equimolar mixing of these two compounds induces a polar crystal structure (Fig. 1b), despite each material individually crystallizing in a centrosymmetric phase. Furthermore, the crystalline film of the equimolar mixture exhibits piezoelectric response, attributed to in-plane polarization, along with asymmetric *I-V* characteristics and a significant change in resistivity under tensile strain (Fig. 1c, d). Based on these findings, we discuss the molecular arrangements underlying the mixing-induced polar order and elucidate the relationship between piezoelectricity and strain-sensitive carrier transport.

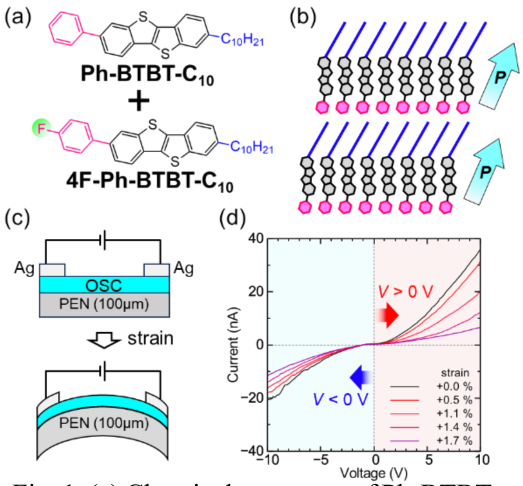

Fig. 1. (a) Chemical structures of Ph-BTBT-C_{10} and 4F-Ph-BTBT-C_{10}. (b) Schematic illustration of the layered crystal structure of the equimolar mixture. (c) Schematic of the two-terminal device configurations. (d) *I-V* characteristics of the equimolar mixture under applied tensile strain.

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S8-I2 (invited)

High-Performance, Robust Organic Semiconductors

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Organic electronics have gained intense attention as organic semiconductor (OSC)-based technology due to their advantages such as being lightweight, mechanically flexible and low-cost compared to the currently used inorganic counterparts. The development of practical OSCs paves the way to next-generation organic-based electronics. Toward this goal, OSCs should meet the following requirements: 1) high carrier mobility, 2) high chemical stability, 3) appropriate solubility in organic solvents for solution processes, and 4) thermal durability for device usage environment. Our group has demonstrated a unique and innovative molecular design strategy for p-type [1-5] and n-type [6-8] OSCs. This paper will make a presentation regarding their synthesis, fundamental properties, aggregated structures, and device evaluation of single-crystalline thin-film-based electronics.

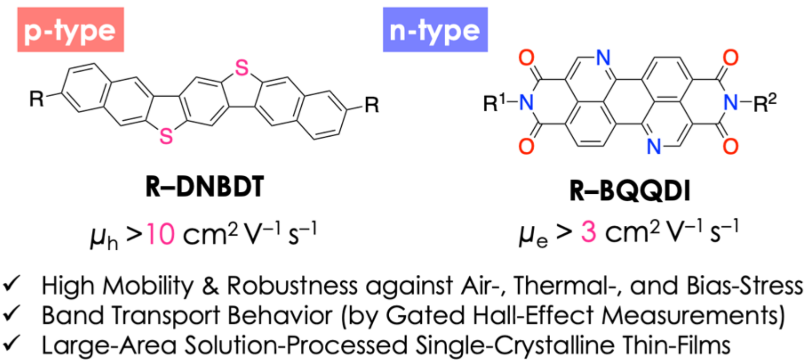

Figure 1. Single-crystalline thin-film electronics based on high-performance, robust OSCs.

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S8-O3

Nitrogen-Containing Perylene Diimides with Cyclohexyl-Type Side Chains for n-Type Organic Semiconductors

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Organic semiconductors (OSCs) are promising for printed and flexible electronics owing to their solubility in organic media and mechanical flexibility. Though, some drawbacks such as low charge-carrier mobilities (mostly <1 $cm^2 V^{-1} s^{-1}$) and instability of the device performances should be tackled. Such issues are particularly concerned with electron-transporting (n-type) OSCs and their thin-film transistor (TFT) applications for organic complementary circuits.

3,4,9,10-Benzo[*de*]isoquinolino[1,8-*gh*]quinoline tetracarboxylic diimides (BQQDIs) have been developed as OSCs promising for the high-performance n-channel TFTs owing to the typical brickwork-type packing structures, low-lying lowest unoccupied molecular orbitals and solution-processable single crystal formations.[1,2] To date, electron mobilities up to 3 $cm^2 V^{-1} s^{-1}$ in air and the band-like electron character has been found with symmetrically phenethyl-functionalized BQQDI (PhC_2–BQQDI).[1,3] Although most of conventional side-chain substituents leads to unbalanced brickwork structures, cyclohexyl substituents can tune the packing structure into a balanced brickwork of Cy_6–BQQDI (Figure 1).[4] While Cy_6–BQQDI shows a low solubility in organic media and thus poor solution processability, substitutions on the cyclohexyl ring could improve the solution processability to afford single-crystal thin films and deeper insights into electron-transport properties of OSCs by linking TFT and theoretical studies.

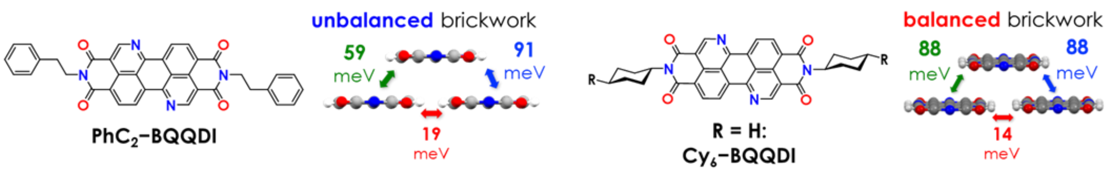

Figure 1. Brickwork packing features of BQQDI derivatives.

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S8-O4

Role of Substituted Alkyl Chains in Layered Organic Semiconductor Crystals: *mono*-C_n-BTNT.

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Abstract

Substitution of rod-like π-conjugated cores with linear alkyl chains is a well-established strategy for developing high-performance organic semiconductors (OSCs), particularly for use in printed organic thin-film transistors (TFTs) [1,2]. It has been shown that self-organized alkyl-chain layers play a crucial role in enhancing layered crystallinity, thereby enabling the formation of well-defined semiconductor – insulator interfaces within the TFT device structures. In particular, one-sided (unsymmetric) substitution of semiconductive π-cores such as benzothienobenzothiophene (BTBT) with alkyl chains facilitates the formation of bilayer-type layered herringbone (*b*-LHB) packing, which significantly improves layered crystallinity. While this strategy is applicable to a wide range of extended π-cores, its implementation has remained limited.

In this study, we focused on *mono*-alkylated benzothieno[3,2-*b*]naphtho[2,3-*b*]thiophene (*mono*-C_n-BTNT) [3], an extended π-core lacking both inversion and mirror symmetry. This unique molecular structure permits four distinct peripheral substitution patterns while maintaining an overall rod-like molecular shape. We systematically examined the effect of alkyl chain length and substitution position on the structure–property relationships of the resulting regioisomers. All four regioisomers exhibited isomorphous *b*-LHB crystal packing with similar intralayer π-core arrangements. However, differences in alkyl chain ordering led to notable variations in crystal stability, solubility, thermal behavior, and TFT performance. Among them, the isomer with alkyl substitution at the most peripheral position formed the most stable packing, and its stability was further enhanced by increasing the chain length. TFTs based on this isomer exhibited high intrinsic field-effect mobility, reaching up to 14 cm²/Vs (Fig.). Based on a comprehensive crystal structure analysis of all derivatives, we discuss the role of alkyl chains in governing the structure–property relationship of layered OSC crystals.

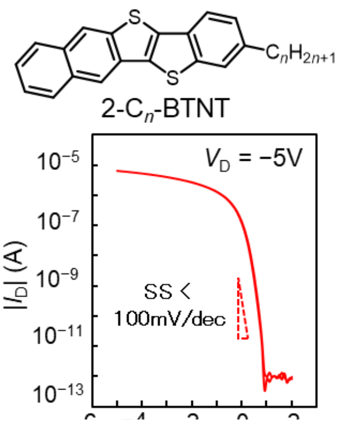

Fig. Chemical structure of 2-C_n-BTNT and the device performance of single-crystal TFT with Cytop as a gate-insulator.

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R2-O1

Nanomaterials-Enabled Functional Wearables for Sustainable and Intelligent Healthcare

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Abstract

With the rapid advancement of the Internet of Things (IoT) and nanosensor networks, self-powered wearable healthcare systems based on functional nanomaterials have garnered significant attention due to their scalability, sustainability, flexibility, and broad applicability.
In this presentation, we will explore the fundamentals, characterization methods, and analytical techniques used to evaluate nanomaterials tailored for self-powered wearable applications. Furthermore, we will discuss design principles and system integration strategies essential for building sustainable and responsive healthcare wearables. Notably, selected case studies will be presented to showcase our recent progress in employing novel layered nanomaterials to develop wearable systems with therapeutic functionalities. This presentation aims to highlight the pivotal role of nanomaterials in shaping the next generation of self-powered, intelligent, and sustainable healthcare systems.

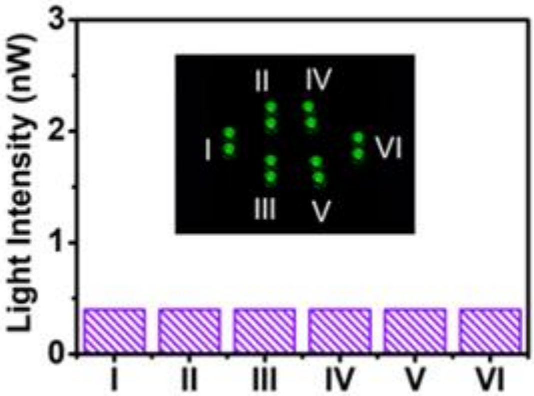

Figure 1. Visualization of Gait Phase Distribution Using an LED Array

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R2-O2

Controlled Alignment of Organic thin films for flexible and efficient phototransistor application

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Abstract

We present a fabrication technique for highly oriented thin films for enhancing the performance of flexible organic phototransistors (OPTs)[1]. Conventional fabrication techniques suffer from the disadvantage of solvent-causing degradation of polymeric gate dielectrics, limiting device scalability and stability. In an attempt to overcome these drawbacks, we used the Unidirectional Floating Film Transfer Method (UFTM) to directly deposit P4T2F-HD semiconductor films on organic dielectric layers without causing damage to them. The higher molecular orientation in the thin films was also confirmed with time-resolved second harmonic generation (TRM-SHG) and corroborated high charge transport efficiency[2]. The optoelectronic features of the fabricated phototransistors exhibited high-quality with 167% sensitivity, 292 A W^{-1} responsivity, and 8.5×10^{13} Jones detectivity under low-intensity illumination (125 $\mu W\ cm^{-2}$). Interestingly, the devices exhibited consistent electrical responses under repeated mechanical deformations, including parallel and perpendicular bending, to exhibit their mechanical stability.

Keywords: UFTM, TRM-SHG, Flexible, Phototransistor.

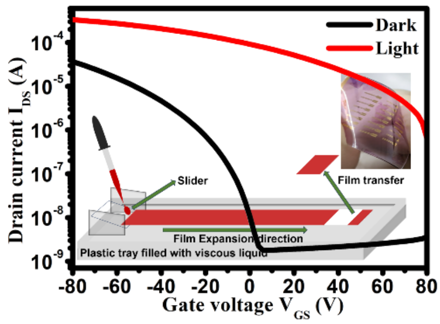

Figure 1. Photocurrent response of the OPT while inset shows the UFTM process and the flexible device image.

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R2-O3

Maskless Ultra-Precise Dispensing: Micro-Manufacturing for Flexible and Printed Electronics

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Abstract

The evolution of flexible and printed electronics requires manufacturing technologies that can produce ultra-fine features with exceptional precision while remaining compatible with various substrate materials and complex 3D geometries. This paper introduces Ultra-Precise Dispensing (UPD) technology, a maskless direct-write printing method that addresses key limitations in current additive manufacturing approaches for flexible electronics.

UPD uses pressure-controlled dispensing of high-viscosity conductive inks (up to 2.5 million cP) through micro-nozzles (0.5-10 μm aperture) to achieve line widths as narrow as 500 nm. The technology operates without electric fields, making it suitable for sensitive electronic components and allowing room-temperature processing on flexible substrates such as polyimide, PET, and hybrid rigid-flex materials. The electrical performance of printed interconnectors reaches 45% of bulk silver conductivity using high metal content inks (up to 85 wt%). It also offers 3D printing capability for conformal deposition on complex topographies and vertical sidewalls.

UPD's maskless operation eliminates costly photolithography steps, reducing manufacturing costs and enabling rapid prototyping for flexible electronics. The additive process minimizes material waste compared to subtractive methods, while the ability to print high-viscosity inks allows for single-pass deposition of thick, highly conductive features. Process integration is simplified through compatibility with standard flexible electronics assembly flows.

UPD technology represents a significant advancement in additive manufacturing for flexible and printed electronics, offering unprecedented resolution, material compatibility, and process flexibility. Its demonstrated capabilities in high-resolution printing, 3D conformality, and diverse substrate compatibility position UPD as an enabling technology for next-generation flexible electronics applications, including wearables, biomedical devices, and smart textiles.

R2-O4

A Flexible and Recyclable Biomechanical Sensor Design based on Triboelectrification

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Abstract

Recently, the development of multi-functional triboelectric nanogenerators (TENGs) with sensing and energy-harvesting capabilities has gained widespread attention.[1, 2] However, insufficient output performance and device sustainability limit their advancement and application. In this study, we prepare a new sulfide-based nanomaterial and further create a nanocomposite for biomechanical sensors.[3, 4] The addition of sulfide-based nanomaterial can effectively increase the triboelectric output.[5] Moreover, we integrated this nanocomposite with nanocellulose to explore its possibility for TENG design, including sustainability, portability, and biocompatibility. Finally, we demonstrate the applicability of this device system in wearable biomechanical sensors.(Fig. 1)

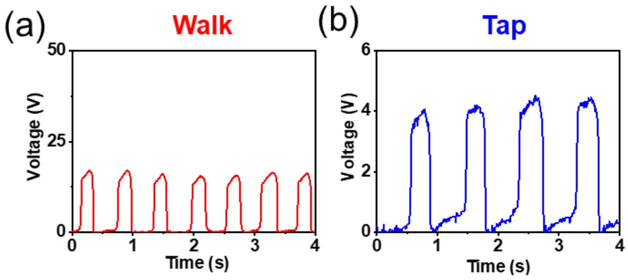

Figure 1. Sensors installed on the (a) finger and (b) foot to sense human motion signal performance.

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R2-O5

Silent Speech Interface Using Soft EMG Sensors with Deep Learning

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Abstract

Silent Speech Recognition (SSR) is a notable technology for noisy environments and situations requiring privacy, but traditional devices have drawbacks such as user burden from constant facial attachment and the risk of privacy breaches [1]. To overcome these issues, this study developed a stretchable, wearable electromyography (EMG) interface that is intentionally operated by the user. Inspired by previous research on using EMG to sense silent speech [2][3], our device acquires EMG signals only when needed, by having the user place the fingertip electrodes on the muscles around their mouth. This approach ensures privacy and security by eliminating the need for constant wear. The use of flexible materials and liquid metal wiring allows for stable signal acquisition, even with complex finger movements.

The system processes EMG signals from four perioral muscles by converting them into Mel-frequency cepstral coefficients (MFCCs) before feeding them into a deep neural network (DNN). This method achieved a high recognition accuracy of up to 94%, a performance also confirmed through t-SNE visualization.

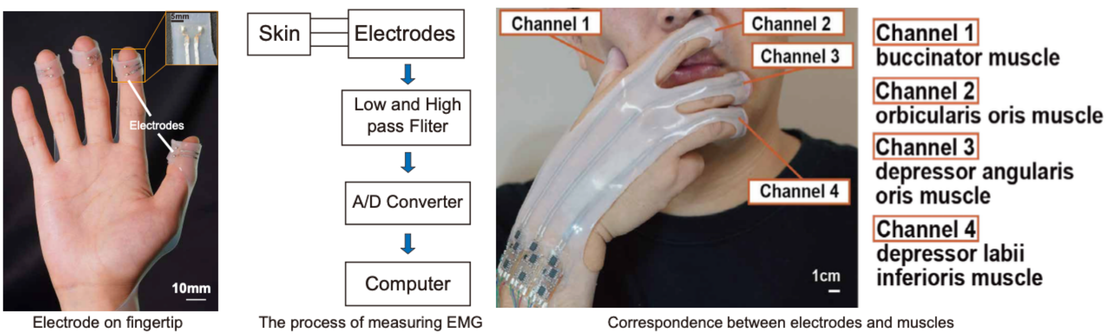

Figure 1. How to use the device electrodes and the flow of EMG processing.

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S10-I1 (invited)

Structural and Electronic Characterization of Single-crystalline Organic Semiconductors and These Interfaces

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Abstract

Opto-electrical performances of organic electronic devices depend fundamentally on the electronic states of molecular semiconducting materials themselves and, even more so, heterojunctions relating to the molecular materials constituting the devices. Although the working mechanisms of the real devices are more or less complex and dynamic with structural disorders and transient electronic processes, ground-state electronic structures of single-crystalline samples are still worth characterizing as simplified systems ideally modeling fundamental aspects in the opto-electronic devices.

The presenter's research group has been engaging in the characterization of organic semiconductor single-crystals and hetero-molecular interfaces built on the molecular single-crystal surfaces. While the photoelectron spectroscopy (PES) measurement, which is one of the most straightforward methodologies for probing the electronic states of matters, is generally uneasy to be applied to bulk molecular solids due to the photoemission-induced charging of the sample, we have demonstrated that this problem can be relieved by the illumination of secondary laser light on molecular single crystal samples during the PES measurements to even unveil their inter-molecular electronic band dispersions [1]. On the other hand, the crystallographic structures of well-defined molecular interfaces built on organic semiconductor single-crystals can also be determined accurately by the surface X-ray diffraction (XRD) measurements using highly intense and directional synchrotron radiation light sources [2]. In this contribution, we will discuss the recent advances in the PES and surface XRD analyses on the single-crystalline organic semiconductors and well-defined hetero-molecular interfaces, including solution-processable molecules for the future application of flexible and printable electronics.

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S10-I2 (invited)

Solution-processed Organic Thin-films Growth on $Hf_{0.5}Zr_{0.5}O_2$ Gate Insulators Toward Printed Memory

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Abstract

While organic field-effect transistor (OFET) memory devices have garnered significant interest in printed electronics, the exploration of their counterparts utilizing oxide-based ferroelectric gate insulators remains limited. This represents a critical research gap, as ferroelectric dielectrics offer the dual advantage of providing non-volatile memory functionality while simultaneously improving transistor performance by lowering the threshold voltage owing to their high dielectric constant relative to that of standard SiO_2. The primary barrier, which has not been extensively addressed, is the deposition of an organic semiconductor layer. The disparate surface energies and interface characteristics of these functional oxides, compared to those of traditional SiO_2 substrates, present a considerable hurdle to achieving uniform, high-quality film growth. Consequently, a systematic investigation of the growth of organic thin films on these functional oxide gate insulators is essential to advance this technology.

This work presents a systematic investigation into the solution-processed growth and structural evolution of two organic semiconductors known for their high mobility ($\geq$1.0 cm^2/Vs): 6,13-Bis(triisopropylsilylethynyl) pentacene (TIPS-Pentacene) [1] and 2-alkyl-7-phenylbenzo[d][1]benzothieno[3,2-b]thiophene (Ph-BTBT-Cn) [2]. These films were grown on Hafnium Zirconium Oxide ($Hf_{0.5}Zr_{0.5}O_2$, HZO) [3, 4], a functional gate insulator selected for its compelling combination of a high dielectric constant (ϵ_r ~20) and stable ferroelectricity in ultrathin films ($\leq$10 nm), which may enable the development of advanced memory devices.

These findings provide fundamental insights into the growth of leading-edge organic semiconductors on HZO surfaces. This foundational knowledge is indispensable for the rational design and optimization of next-generation organic ferroelectric transistors. We envision that this research will pave the way for ultrathin, flexible memory systems and biocompatible electronic interfaces, opening new frontiers for printed electronics.

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S10-I3 (invited)

Real-time analysis of vacuum-deposited organic thin-film growth using quartz crystal microbalance

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Organic semiconductors play an important role in various electronic and optical devices, such as light-emitting diodes, thin-film transistors, and photovoltaics. Achieving high-performance devices requires precise control of the crystal structure in organic thin films, including grain size, morphology, and molecular orientation. In most cases, these structural characteristics are determined during the initial stage of thin-film growth; therefore, elucidating the formation processes at this stage is of critical importance.

Thin-film growth generally proceeds through elementary processes such as adsorption, diffusion, and desorption. Through these processes, stable nuclei form, followed by continued film growth. Understanding these elementary processes is thus essential for controlling the higher-order structures of organic thin films. However, adsorbed molecules or clusters smaller than the critical nucleus are unstable, and conventional ex situ techniques are inadequate for analyzing these processes. This limitation requires in situ investigations of the initial stages of growth.

For this purpose, the quartz crystal microbalance (QCM)—a technique commonly used as a thickness monitor in vacuum deposition—was employed to study the initial growth processes of organic thin films. QCM enables highly sensitive, non-destructive detection of mass changes of molecules adsorbed on the surface of a quartz resonator. For example, in a resonator with a fundamental frequency of 5 MHz, a frequency shift of 0.1 Hz corresponds to an equivalent film thickness of approximately 0.02 nm. This capability allows real-time monitoring of molecular adsorption and desorption processes, irrespective of molecular aggregation. By analyzing the time evolution of the adsorbed mass using simple kinetic models, physical parameters relevant to thin-film growth, such as the mean residence time and adsorption energy of molecules, can be quantitatively determined [1–4]. Furthermore, this approach can be used to distinguish different growth modes, such as layer-by-layer and island growth [2]. In the presentation, an overview of QCM-based studies conducted to date will be introduced.

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S10-I4 (invited)

Spontaneous Orientation Polarization of Natural Polar Molecules

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Spontaneous orientation of polar molecules at electrode interfaces and within organic thin films plays a critical role in optimizing carrier injection in organic electronics and enabling vibrational energy generation by tuning electrode work functions [1] and forming self-assembled electrets [2]. In nature, plants biosynthesize more than 50,000 secondary metabolites, derived from polar precursors, to gain functionalities such as UV protection, antioxidant activity, and cell wall reinforcement. Incorporating these natural polar molecules offers a pathway toward sustainable organic devices.

In this contribution, we report our recent work on the application of natural polar molecules as electrode modifiers and self-assembled electrets (SAEs). We found that caffeic acid (CfA) effectively functions as a work-function modifier for various electrodes [3]. CfA coating universally increases electrode work functions by approximately 0.5 eV due to the formation of interface dipole layers anchored via catechol groups. Enhanced hole injection was demonstrated using simple diode devices [3].

Spontaneous orientation of polar molecules was also observed in thick evaporated films. CfA exhibits a surface potential exceeding 2.5 V at a thickness of 200 nm, arising from the averaged alignment of permanent dipoles within the bulk [4]. Furthermore, vacuum-deposited baicalein (Bai), a bioactive ingredient in traditional Chinese medicines, produces a giant surface potential (GSP) exceeding 10 V at 200 nm thickness [5]. The evaporated Bai film serves as an SAE for vibrational energy generators, exhibiting a non-monotonic depolarization process upon air exposure. In this talk, we will discuss the degradation mechanism of GSP under dark and ambient conditions, as well as strategies to sustain the surface potential without compromising vibrational current output.

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S10-O1

Crystal Structure and Transistor Characteristic of T-shaped Novel π-conjugated Molecules

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[Introduction] Over the past several decades, organic semiconductors have made significant progress, but their performance still remains relatively low, necessitating the development of new high-performance organic semiconductors. In this study, we synthesized a novel π-conjugated molecule, NT (Fig. 1), and crystallized it. The electronic states and charge transport properties of this crystal were investigated using theoretical calculations and FET measurements, revealing that this crystal is a promising p-type semiconductor.

[Experimental] A novel π-conjugated molecule NT was synthesized, purified, and crystallized via sublimation, and its crystal structure was determined by single-crystal X-ray diffraction. The molecular orbitals, reorganization energy, and intermolecular transfer integrals of NT were calculated using Gaussian 16W (B3LYP/6-31G(d,p)). Based on these values, carrier mobility was estimated using a hopping model. A single crystal FET was fabricated as follows. Source and drain electrodes were fabricated directly onto the single crystal obtained by sublimation using carbon paste. A parylene insulating layer was deposited by CVD, and the gate electrode was formed using gold paste to complete the transistor structure.

[Results and Discussion] The crystal structure of NT can be classified as a pitched π-stacking structure (*Pnma* space group), which is similar to that of rubrene. The HOMO level can be estimated to be -5.3 eV, suggesting this crystal is p-type material. The reorganization energy for hole transport and the HOMO-HOMO transfer integral in the face-to-face π-stacking direction were estimated to be 71.8 meV and 96.8 meV (Fig. 2). Based on these values, the carrier mobility was calculated to be 14.6 cm^2/Vs. However, the average mobility of the fabricated single-crystal transistor was 1.2 cm^2/Vs (Fig. 3). The large discrepancy between the theoretical and measured mobilities may be due to contact resistance or molecular motion within the crystal.

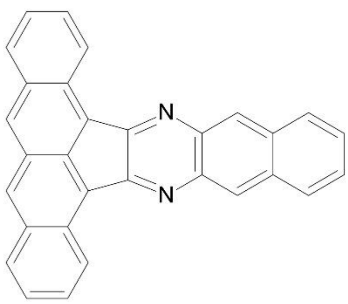

Fig. 1. Molecular structure of NT

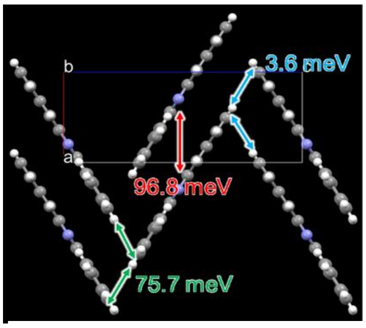

Fig. 2. Transfer integrals of NT

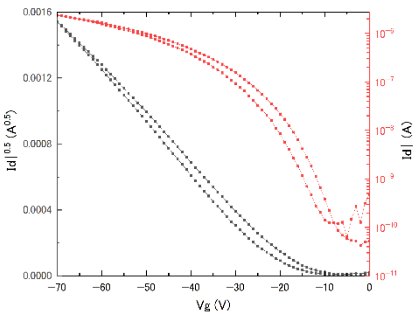

Fig. 3. Transfer curves of OFET

P-01

Soft Three Dimensional shape electronic technology

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1.Introduction

Three dimensional(3D) shape electronics are functional 3D devices integrated with electrical wiring. Due to their design advantages, they are expected to utilize unique products, including automotive, home appliances, and medical and healthcare sectors. We have developed the technology that flat plastic sheet with wiring is deformed 3D shape by vacuum pressure thermoforming. In particular, we studied the relationship between the elongation rate and breakage of the wiring after thermoforming. [1] [2] [3] In this study, we developed soft 3D electronics using transparent soft resin (TSR) as a substrate. Typically, one of the soft substrates is silicone. When silicone was used as a substrate for the thermoforming, the substrate could not keep its 3D shape and reverted to their original form. The glass transition temperature of the TSR is higher than room temperature, therefore the 3D shape of TSR was kept after thermoforming, and soft device was able to be fabricated. Soft devices are comfortable when humans operate or touch products.

2.Experiments and Results

The pattern was printed by screen printing machine with DOTITE XA9521 on a 0.2 mm-thick TSR. DOTITE XA9521 is a stretchable conductive paste and exhibits high resistivity ($2.0\times10^{-4}\Omega\cdot cm$). To solve this issue, we explored optimal annealing methods. A heat resistance of TSR substrate is about 100 °C. Therefore, to enhance conductivity while minimizing thermal stress on the substrate, we applied not only thermal curing using a clean oven but also annealing with XENON flush lump. This approach enabled a significant reduction in electrical resistance. When using only oven curing, the resistance did not decrease, and when using only flush lump, the bottom area of the wiring was not cured enough. In result, the adhesion between the wiring and the substrate was poor.

Table 1. Comparison of volume resistivity

Substrate	transparent soft resin	transparent soft resin
Annealing	100℃40min+ XENON	100℃40min
Thermoforming temperature (℃)	90	90
Volume resistance(Ω・cm)	6.63×10^{-5}	4.03×10^{-4}

A prototype glowing jellyfish device was fabricated using the established annealing conditions and the thermoforming system. This can be illuminated by wireless power supply using the 13.56 MHz frequency band. The wiring pattern was printed on the upper side of TSR, and LED chips were mounted accordingly, shown in Fig.1. To protect wiring from water, a layer of silicone resin was uniformly coated on the upper side. This allowed for stable LED operation underwater could be done. During the thermoforming process, the bottom side was placed in contact with a hemispherical mold shaped like a jellyfish, and the silicone resin was cured after thermoforming. The completed prototype is shown in Fig. 2, where LED illumination was successfully demonstrated in a water tank.

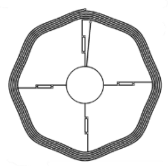

Figure 1. Wiring pattern

Figure 2. Illumination of the glowing jellyfish device

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P-02

Silver Nanowires–Elastomer materials for Low-Voltage-Driven Stretchable Transistors with Artificial Synapses and Printing Process Applications

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Abstract

In this work, we developed a fully stretchable transistor system by Artificial Synapses through an integrated material and process design. We blending silver nanowires (AgNWs) with nitrile butadiene rubber (NBR) to create a highly stretchable and conductive electrode. SEBS was used as the elastic substrate, and the composite was coated onto it.

As a result, the electrode maintained excellent electrical performance, with sheet resistance increasing only from 0.52 to 1.01 Ω/□ under 0% to 100% strain. We applied the elastic electrode in a fully stretchable P-type transistor, using NBR not only as an elastic dielectric but also to solve material compatibility issues. To further improve dielectric stability and mechanical strength, a thiol-ene crosslinking reaction was used.

The resulting device showed good performance, with a charge mobility of 4.48 $cm^2/V\cdot s$ at 0% strain and 0.66 $cm^2/V\cdot s$ under 60% strain, while maintaining an on/off ratio over 10^3. The transistor also exhibited neuromorphic behaviors such as EPSC、PPF、LTP & LTD, and achieved 92.6% accuracy in digit recognition tests.

In the final part, a printing process was employed for each layer of devices, enabling a reduction in device dimensions from 1.5×1.5 cm^2 to 0.35×0.35 cm^2. A 2×2 mini-array was successfully fabricated, it show very good electrical performance (μ = 2.64 $cm^2/V\cdot s$, $I_{on}/I_{off} > 10^3$) and reproducing neuronal properties, thereby validating the scalability and feasibility of this approach for flexible electronics and neuromorphic array applications.

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P-03

All-Solution-Processed $CsPbBr_3$ Quantum Dot Light-Emitting Diodes on Flexible Paper Substrates

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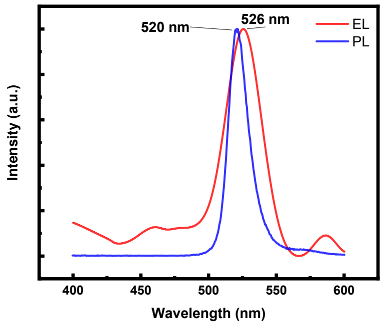
Abstract

This study develops flexible inorganic perovskite quantum dot (QD) light-emitting diodes (LEDs) on paper substrates. $CsPbBr_3$ QDs, chosen for their high fluorescence conversion efficiency, narrow full width at half maximum (FWHM) emission, and compatibility with solution processing, serve as the emissive layer [1]. Paper substrates are low-cost and foldable but suffer from surface roughness, which was mitigated by polymethyl methacrylate (PMMA) pretreatment to enhance device quality.

$CsPbBr_3$ QDs were synthesized via hot-injection and characterized using transmission electron microscopy (TEM), photoluminescence (PL), absorption spectroscopy, and X-ray diffraction (XRD)[2]. $CsPbBr_3$ QD films were fabricated by solution processing, employing silver nanowires (Ag NWs) as both the anode and cathode. This approach was chosen for its simplicity, low cost, and rapid fabrication. Device performance will be assessed through electroluminescence (EL) measurements and $I-V$ characterization, aiming to realize a low-cost, high-efficiency, and flexible paper-based optoelectronic platform for wearable electronics, displays, and lighting.



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P-04

Theoretical and Experimental Analysis of Quantum Dot Color Conversion Films for display application

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Abstract

Quantum dot color conversion films (QDCCFs) have gained prominence in display technologies due to their expanded color gamut and enhanced optical efficiency compared to conventional phosphor or color-filter systems [1]. They are widely adopted as color conversion layers in OLED and micro-LED displays. To investigate the light absorption and conversion behavior of these films, we developed a Beer–Lambert law-based model to predict their light conversion efficiency (LCE) and related optical characteristics. The model incorporates key physical processes, including blue-light absorption by QDs, photoluminescent down-conversion, and partial reabsorption followed by re-emission. For validation, CdSe/ZnS core–shell QDs underwent purification and ligand exchange using BYK-111 and PGMEA for improved dispersion. Photoreactive inks with 20 wt% and 40 wt% QD loadings were formulated and spin-coated into films of varying thickness. Experimental LCE data showed strong agreement with model predictions. Measured LCE values closely matched the theoretical predictions, validating the model's accuracy. This framework provides insight into light–matter interactions and serves as a design tool for optimizing QDCCFs in display technologies.

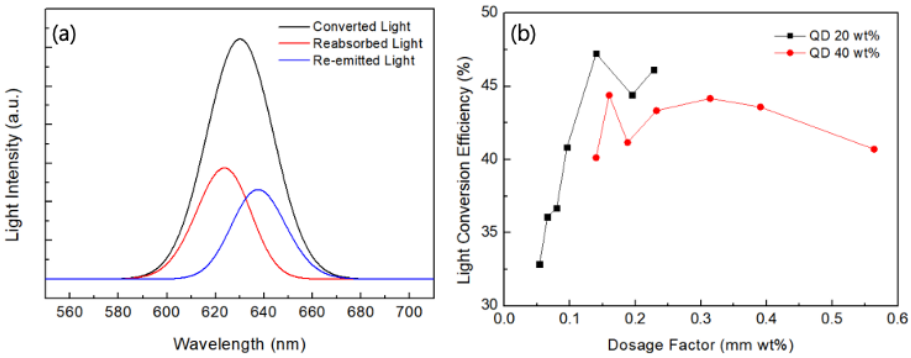

Figure 1. (a) Simulated spectral components of a quantum dot color conversion film (QDCCF), (b) Measured light conversion efficiency (LCE) as a function of the dosage factor (defined as the product of film thickness and QD concentration).

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P-05

Rational Design of Layered Heterostructures for Multifunctional Sensing Systems

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Abstract

In recent years, layered metal dichalcogenides (LMDCs) have attracted considerable attention due to their scalability, structural tunability, and high sensitivity. However, the insufficient output performance remains a major limitation, making the enhancement of piezoelectric properties a significant challenge. Among them, constructing heterostructure is one of the most common methods. In this study, we investigate the piezoelectric properties of heterostructure LMDCs and integrate them into a piezoelectric device to evaluate their output performance. The heterostructure-based piezoelectric device operates as a self-powered sensor capable of capturing physiobiological signals from the human body. Our findings demonstrate that vertical heterostructure holds significant promise for future wearable sensor applications

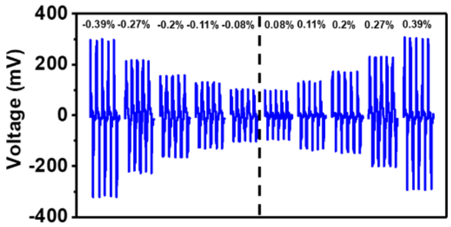

Figure 1. Heterostructure-based strain sensor is achieved.

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P-06

A Multifunctional Stretchable Sensor For Rehabilitation Application

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Abstract

Recently, personalized healthcare monitoring systems have demonstrated great potential in healthcare industry, particularly for the management and prevention of sports injuries. Traditional technologies, such as electromyography (EMG) and magnetic resonance imaging (MRI), are limited by high costs and the inability to provide continuous monitoring, which restrict their further application. On the other hand, wearable electronics have been reported to enable real-time tracking of human motion activity. However, they also face significant challenges, including a limited detection range, sensing functionality, and system sustainability. To overcome these issues, this study introduces a stretchable sensing system based on layered nanocomposites. The proposed nanocomposite material features tunable charge transport properties and can be integrated into an self-powered sensing system to effectively capture human motion patterns. This research highlights the development of a low-cost, self-powered, long-term monitoring, and highly sensitive healthcare monitoring system.

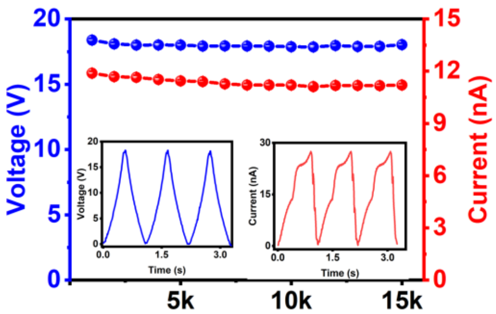

Figure 1. Stability of the sensing outputs.

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P-07

Understanding the Charge Transport in Interlayer-based Charge Generation Layers by Impedance Spectroscopy Coupled Equivalent Circuit Simulation

Akeem Raji[1], Somi Park[1], So-Young Boo[1], Eun-Jeong Jang[2], Jaeyong Park[1], Woon-Ha Lee[1], Si-Eun Park[1], Seonghwan An[1], Jonghee Lee[1] and Jae-Hyun Lee[1,*]
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Abstract

This study investigated the charge generation and operation mechanisms in pristine and aged organic p–n heterojunction charge generation layers (CGLs) with and without an interlayer (IL) using impedance spectroscopy (IS) and equivalent circuit simulations. Figure 1 depicts the simulation results, which revealed that the charge generation efficiency of CGL devices with an IL can be attributed to the lower energy barrier imposed by the IL at the p–n heterojunction and the stability of its molecules after electrical aging[1]. Further investigations providing a clear understanding of the reason behind the stability and efficient operating mechanism in these devices intuitively demonstrated that IS and equivalent circuit simulations can be effectively employed to investigate the electrical stability in multilayered organic devices.

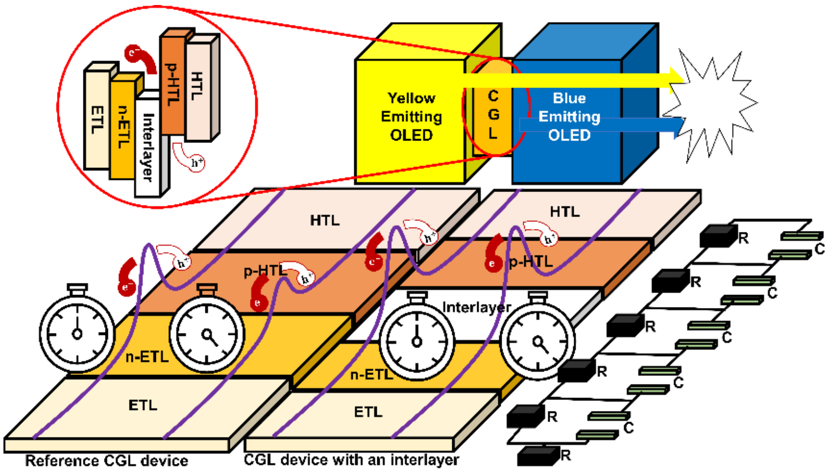

Figure 1. A schematic diagram illustrating the stability and efficient operations in CGL devices with an IL compared with CGL devices without an IL at different conditions.

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P-08

Mechanistic Insights into MoO_3 Interfacial Layer Functionality for Non-Precious Electrodes in Organic Semiconductors

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Abstract

Organic devices offer unique advantages for next-generation lightweight flexible electronics with solution processability. However, the traditional reliance on Au electrodes, which chosen for its favorable work function alignment with organic semiconductor HOMO levels, undermines cost-effectiveness due to the soaring prices. While preliminary studies demonstrate that evaporating a thin (~5 nm) MoO_3 interlayer beneath Al top-contact electrodes enables functional devices [1], the fundamental mechanisms remain unclear. This study specifically investigates: the impact of MoO_3 evaporation on the crystallinity of underlying organic semiconductors, and the potential interdiffusion phenomena at the MoO_3/organic semiconductor interface, which are critical for device performance and stability.

Figure 1 shows Raman spectra of P3HT film with and without MoO_3 evaporation. Raman spectroscopy was employed to analyze crystallinity changes in organic semiconductor films before and after MoO_3 evaporation [2]. The Raman spectra revealed a slight decrease (~4-5 %) in the crystallinity due to MoO_3 evaporation. This quantifies that while MoO_3 evaporation induces some structural perturbation in the underlying organic semi-conductor, the damage is remarkably limited.

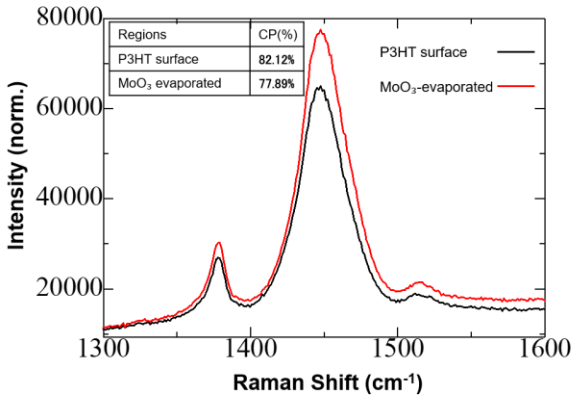

Figure 1 Raman spectra of P3HT film with and without MoO_3 Evaporation.

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P-09

Temperature-Tunable Chirality in Chiral Perovskite Thin Films via Dimensional Phase Transition

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Abstract

Chiral perovskite materials, with their tunable framework structures and diverse embedded organic chiral molecules, are highly regarded in the field of chiral electronics for their excellent photoelectric conversion performance, particularly in applications in circularly polarized light (CPL) detection [1]. However, the mechanism by which the chirality of perovskites can be tuned to respond multi-band CPL remains elusive.

We discovered that the circular dichroism peaks of perovskite films based on lead iodide as the framework and MBA as embedded molecules shift with annealing temperature, while also altering the dimensionality of the crystalline structure. This allows temperature-tunable chirality detection in multi-band CPL. When the annealing temperature is increased from 80° C (the highest CD signal) to 120° C, powder XRD fitting and first-principles calculations reveal that the perovskite film partially shifts from a 2D layered structure to a 1D chain structure (*fig 1*). Furthermore, the wavelength of the CD peak shifts from 500 nm to 400 nm, demonstrating that temperature modulates chirality through changes in crystalline dimensionality. In addition, we also measured the recognition coefficient of the CPL photocurrent of this material. The experimental value of more than 0.52 ensures the reliability of this material as a CPL sensor.

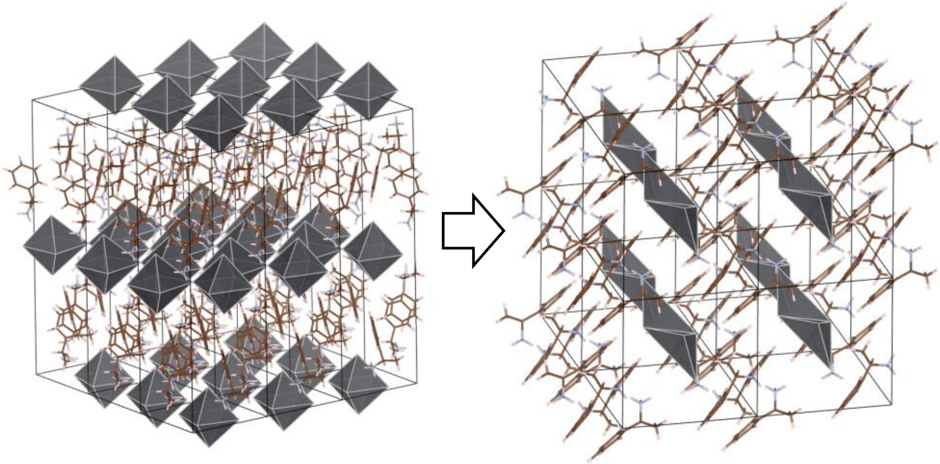

Figure 1. Perovskite crystallization changes from 2D layered structure to 1D chain structure

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P-10

Drying Effects on Surface Morphology and RF Characteristics of Inkjet-Printed Coplanar Waveguides

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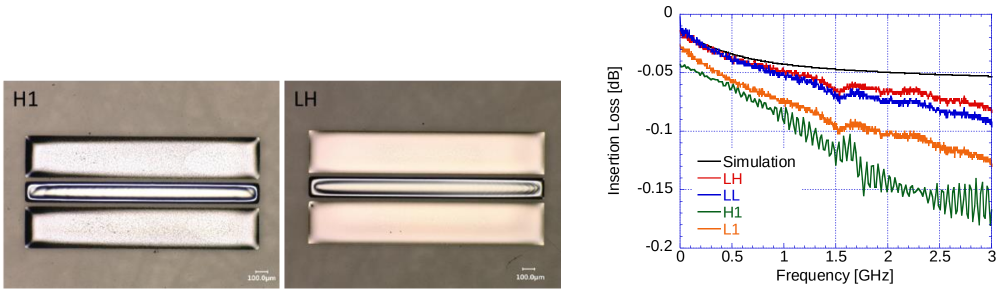
Abstract

We present an optimized fabrication strategy for inkjet-printed coplanar waveguides (CPWs) that enhances RF performance through layer-by-layer sequential drying at varying temperatures. The effects of sequential drying conditions on surface morphology, micro-cavity formation were analyzed using AFM and cross-sectional profile. CPWs dried at low temperature after the first print and at high temperature after the second print exhibited fewer micro-cavities and lower insertion loss. This method offers a practical approach to reducing surface defects and improving the electrical properties of inkjet-printed RF components operating below 3 GHz.



(a) (b)

Figure 1. Inkjet-printed CPW and RF performance under different drying conditions: (a) microscope images, (b) insertion losses.
(L1: 1 print, 45℃; H1: 1 print, 100℃; LL: 2 prints, 45℃ / 45℃; LH: 2 prints, 45℃ / 100℃)

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Acknowledgment

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P-11

Simultaneous Laser-Assisted Inkjet Printing for Uniform Silver Micro-Lines

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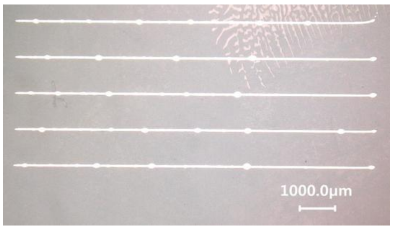
Abstract

The formation of uniform conductive lines has long been considered a critical research objective in printed electronics, as it is essential for miniaturized circuits and reliable electronic devices, such as displays, RFID, sensors, and energy devices. However, instabilities during the printing process can lead to undesirable defects such as breaks or bulges in the printed lines. [1] Moreover, even under optimized process conditions, various disturbances originating from materials and equipment can induce instabilities during the droplet jetting, flight, deposition, spreading, and coalescence stages. To address this challenge, a laser-assisted inkjet simultaneous process was conducted to suppress bulging formation during line printing. The effects of laser intensity and irradiation delay on printing uniformity and bulging suppression were investigated using a laser-assisted inkjet process on various substrates.



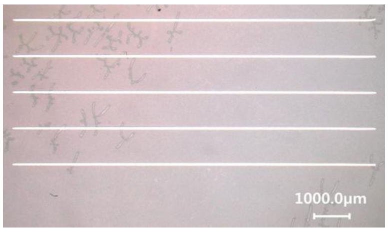


Figure 1. Inkjet only (left) and simultaneous laser-assisted inkjet printing (right) on PEN substrate.

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P-12

Wavelength-Controlled Chirality Inversion in Circularly Polarized Photopolymerization of Polydiacetylene

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Chirality in polymeric materials has attracted considerable attention due to its potential applications in optoelectronic devices and sensors. We have successfully demonstrated the formation of chiral polydiacetylene (PDA) by circularly polarized light (CPL) from achiral diacetylene monomers[1]. However, the mechanism by which CPL introduces chirality is not clear, and the handedness of CPL has been considered to be the main factor in initiating the chirality in the products[2]. Notably, in our experiments, PDA films polymerized under CPL of the same handedness but different wavelengths exhibited opposite circular dichroism (CD) signals. This surprising result suggests that factors beyond the light's chirality — such as the interaction between light wavelength and monomer absorption—may critically influence the chiral outcome of the photopolymerization process.

Without any chiral additives, diacetylene monomer films were irradiated with a mercury–xenon lamp under identical optical power and exposure time. Wavelengths of 254 nm and 280 nm were selected using optical filters, and the incident beam was L-CPL or R-CPL. Irradiation at 254 nm produced a much stronger PDA absorption band at 650~700 nm compared with 280 nm, indicating higher conversion and faster photopolymerization at 254 nm (Figure 1). The CD spectrum (Figure 2) of the PDA film exhibited a signal corresponding to the Cotton effect near the absorption peak. Keeping the handedness of the incident CPL fixed and changing only the wavelength from 254 to 280 nm reversed the CD sign of the product; the sign inversion was observed for both L-CPL and R-CPL. These findings demonstrate that the CPL wavelength plays a decisive role in controlling chiral properties of PDA.

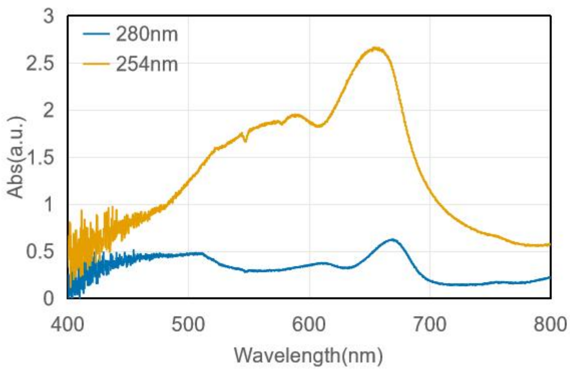

Figure 1. Absorption spectra of PDA films under irradiation at 254 nm and 280 nm

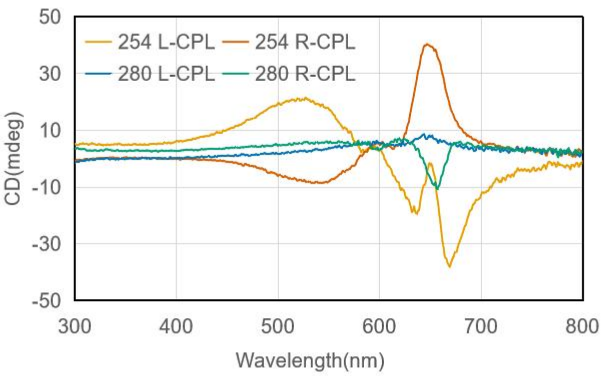

Figure 2. CD inversion by wavelengths of CPL in photopolymerization

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P-13

Glucose Sensor Application using W-doped VO_X Thin Films Prepared by Chemical Solution Deposition

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Abstract

Accurate and sensitive glucose monitoring is crucial for managing diabetes and various biomedical applications. While conventional glucose sensors have made significant advancements, there remains a need for devices offering enhanced sensitivity, stability, and cost-effectiveness. Our previous work demonstrated that vanadium oxide (VO_X) and tungsten oxide (WO_3) thin films exhibit exceptional pH sensitivity, surpassing the Nernst limit [1]. This remarkable sensitivity offers a promising approach for the development of next-generation flexible and/or printable biosensors. Here, silk fibroin (SF) was used to immobilize glucose oxidase (GOD) onto CSD-fabricated VO_X/WO_3 thin films, forming an enzyme membrane. This membrane was then utilized as an extended gate electrode in a prototype extended-gate field-effect transistor (EGFET)-based glucose sensor.

A 300 nm thick titanium (Ti) film was sputter-deposited onto a glass substrate. Then, a W-doped VO_X thin film was formed via CSD. Surface morphology (AFM) and crystallographic analysis (XRD) confirmed a VO_X/WO_3 film comparable to the high-sensitivity pH-sensing films [1]. The VO_X/WO_3 surface was functionalized with a silane coupling agent. A mixture of GOD and 30 wt% SF aqueous solution was drop-cast and spin-coated to form a thin enzyme layer, then ethanol-treated for water insolubility, yielding a stable enzyme-immobilized membrane. The film was then treated with ethanol(80 %, aq) to induce water insolubility, yielding a stable enzyme-immobilized membrane. The Ti layer, functioning as the extended gate electrode, connected to an n-channel MOSFET via a voltage follower circuit. For baseline stabilization, it was immersed with an Ag/AgCl reference electrode in a buffer solution (pH 6.0, 100 mM NaCl). Glucose response was evaluated by immersing the sensor in solutions with varying glucose concentrations. The fabricated sensor exhibited distinct and sensitive responses to different glucose levels, including low concentrations. These results demonstrate the feasibility of using enzyme-immobilized VO_X/WO_3 films fabricated by CSD for high-performance glucose sensing. The detailed discussion will be given in this presentation.

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P-14

Electrical power transmission from triboelectric generators utilizing molecular orientational disordering as power source

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Abstract

Triboelectric generators have been attracting attention as electrical power sources. Electrostatic mono-charges on rubbed two material surfaces have been main sources for power transmission. However, this is not a whole origin for power generation. Polar molecular orientational disordering activated in materials is capable of transmitting electric power [1]. We have proposed physical model behind power transmission through molecular disordering [2,3]. Molecular networks is flexible and is capable of dynamically changing orientational orders by mechanical rubbing. Consequently, low entropy state is established by rubbing. This state is non-equilibrium state, making spontaneous transition into isotropic state during which electrical power is transmitted to external load R. Using the relaxation time τ of polar orientational disordering, electrical polarization P_0 induced by rubbing, and electrostatic capacitance C_s of the rubbed material, this model gives maximized power [2,3]

$$P_m = \frac{1}{\tau}\frac{P_0^2}{4C_s}$$

under matching condition $\tau = C_s R$. The relaxation time τ as indicator of flexibility enhances maximum power meanwhile C_s gives effect on the power as the dimension factor of films.

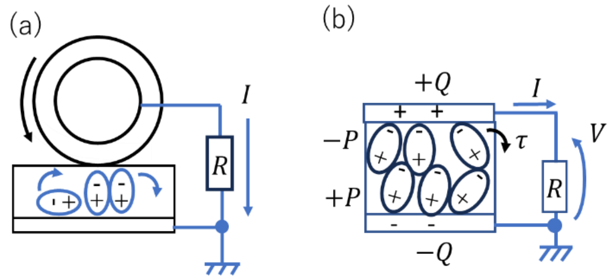

Figure 1. Flexible molecular network gives opportunity that electrical power transmits through molecular orientational disordering. (a) Ordering and disordering of polar molecules during rubbing. (b) Model of power transmission through dipolar depolarization.

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P-15

Humidity-controlled measurement system for evaluating triboelectric generators using dipolar energy

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Abstract

Recently, triboelectric generators have been attracting attention as power source for emerging application such as interactive books [1]. Electrostatic charges have been well utilized in triboelectric generators, however, this is not a whole origin for power source. The material polarization and depolarization induced by rubbing is also candidate for power source. We proposed the model where permanent dipoles in materials are forced orientationally ordered, subsequently transmits power through depolarization [2,3]. In this model, ordering and disordering of polar molecules that are sensitive to environmental conditions such as humidity is key. In this presentation we show I-V measurement system with and without rubbing under stable humidity conditions. The I–V characteristic of the PMDA-ODA (pyromellitic dianhydride-oxydianiline) polyimide measured by using this system is discussed.

Figure 1 shows arrangement of experimental system and the I-V characteristics of the PMDA-ODA triboelectric generator measured under a dry nitrogen atmosphere. In prior to the measurement, the sample was kept in a vacuum for 24 hours. The result showed short-circuit current $I_s = 1.0$ nA, open-circuit voltage $V_s = -173$ V by rubbing with cotton cloth at 100 rpm and 2 mNm.

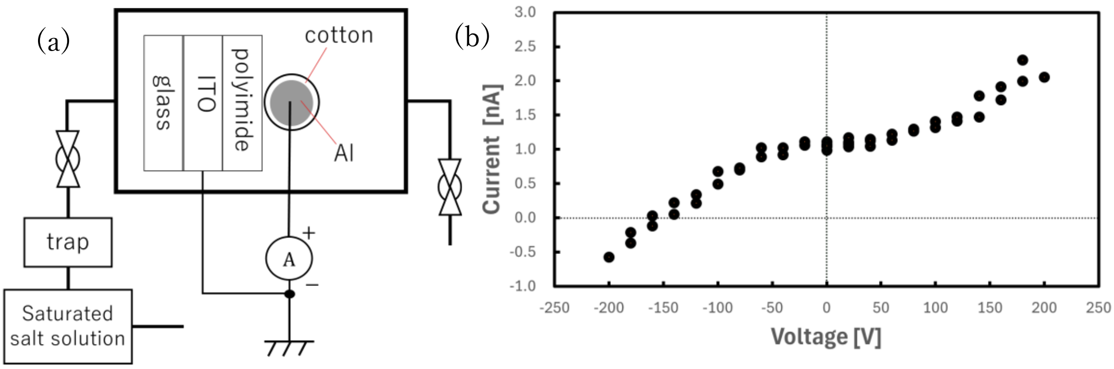

Figure 1. (a) Arrangement of experimental system. (b)I-V characteristic (100 rpm, 2 mNm).

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P-16

Spectroscopic Reflectometry for Evaluating Orientational Order Parameter of Polymer Semiconductor Films Oriented by Floating Film Transfer Method

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Abstract

Carrier mobility of polymer semiconductors has been enhanced with ideas on molecular structures and alignment of polymer chains. For understanding the mechanism of the carrier mobility enhancement, it is crucial to evaluate orientational order of polymers in films. To compare mobility anisotropy and optical absorption anisotropy in terms of the second-order orientational order parameter $S_2 = \langle \frac{3\cos^2\theta - 1}{2} \rangle$, spectroscopic reflectometry is available. In this report, the polarized spectroscopic reflectometry is employed for evaluating orientational order of Poly[2,5-(2-octyldodecyl)-3,6-diketopyrrolopyrrole-alt-5,5-(2,5-di(thien-2-yl) thieno [3,2-b]thiophene)] (DPP-DTT) thin film which is known as the donor-acceptor-type polymer. DPP-DTT/SiO_2/Si samples were prepared by using the floating film transfer method (FTM),[1] and the polarized reflectance spectra were measured. The complex refractive index of DPP-DTT was calculated from the absorbance for multilayer interference calculations. Assuming that the transition dipole is pointing along the main chain axis and oriented with a tilt angle θ from the direction where the polarized absorption is maximized, $S_2 = 0.2$ is estimated by fitting the simulated spectrum to the measurement results.

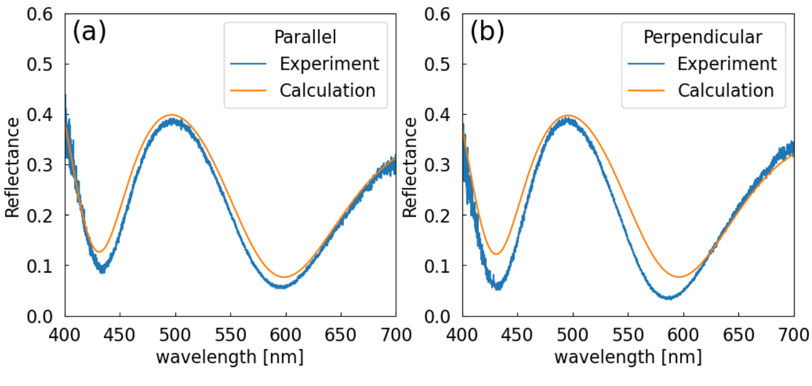

Figure 1. Reflectance spectra of the DPP-DTT/SiO_2/Si sample. Light polarization direction is parallel(a) and perpendicular(b) to the direction in which the thin film is moved during FTM film formation. For this sample, $S_2 = 0.2$ is estimated.

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P-17

Evaluating thermally stimulated de-trapping current from Al/polyethylene/ITO devices for electrical power sources

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Abstract

Thermally stimulated current (TSC) has been employed for evaluating materials and devices [1]. Meanwhile, we have been studying TSCs as electrical power transmission process caused by thermal stimulation. Accordingly, we reported on power transmission from orientational depolarization [2]. Charge de-trapping is also a microscopic origin of TSC. We consider that non-polar polyethylene film would be promising for generating electrical power through thermally stimulated de-trapping current. In this report, we show that the TSC from polyethylene originates from de-trapping. The TSCs of Al/polyethylene/ITO devices were measured as shown in **Figure 1**. **Figure 2** shows the TSC curves obtained with different bias voltages V_b, and two small peaks were observed for both $V_b = +3\ \mathrm{V}$ and $-3\ \mathrm{V}$. The waveforms of $V_b = \pm 3\ \mathrm{V}$ are symmetric around $270\ \mathrm{K}$, while they are asymmetric around $320\ \mathrm{K}$. Presumably, charge injection and subsequent charge-trapping from dissimilar electrodes contributed to this asymmetric waveform. This result suggests that the peak around $320\ \mathrm{K}$ originates from de-trapping.

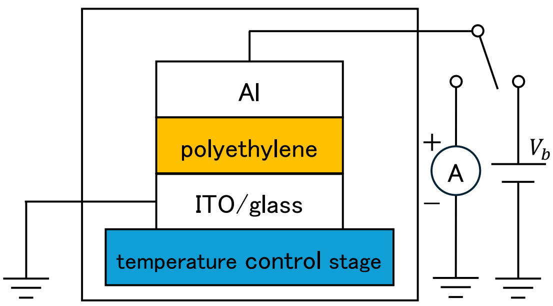

Figure 1. TSC measurement system

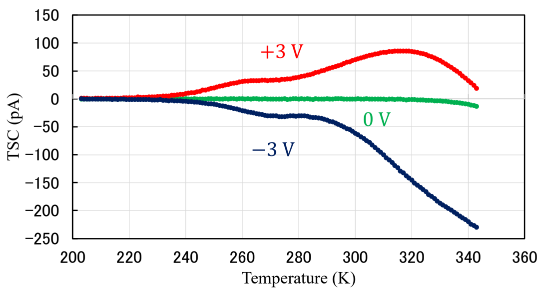

Figure 2. TSC measurement results

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P-18

Sulfur Vacancy Induced Ultra-low Schottky Barrier Height in Electrochemically Exfoliated MoS_2 FETs

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Two-dimensional (2D) materials are considered promising candidates for next-generation electronics beyond silicon. However, the scalable fabrication of large-area devices for industrial applications remains a significant challenge. Among various approaches, electrochemical exfoliation (ECE) has been extensively studied as a viable method for large-scale production [1]. In this study, we investigate the contact properties between ECE-derived MoS_2 and various metals (Fig. 1). Field-effect transistors (FETs) based on ECE-MoS_2 were fabricated using Au, Ti, Cr, and Bi electrodes. The Schottky barrier height (SBH) was extracted using the Richardson equation, and all devices exhibited ultra-low SBHs regardless of the metal work function. This result suggests a strong Fermi-level pinning effect near the conduction band minimum of MoS_2, which is attributed to sulfur vacancies introduced during the ECE process. These findings provide a quantitative understanding of the metal–ECE-MoS_2 interface and highlight the potential of ECE-MoS_2 for high-performance electronic applications.

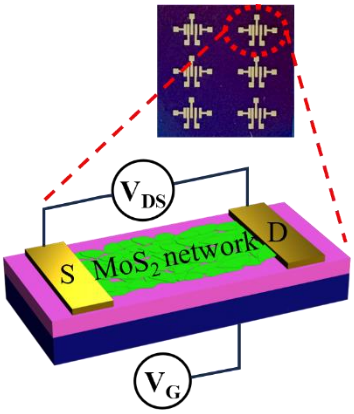

Figure 1. Schematic and optical image of ECE-MoS_2 FETs.

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P-19

Investigation of Bulk Photovoltaic Effect in Chiral-Polar Perovskites

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Abstract

Bulk photovoltaic effect (BPVE) occurs in the bulk of noncentrosymmetric materials, which is intrinsically different from the conventional photovoltaic effect based on p–n junctions [1]. The BPVE is related to several mechanisms such as shift current and circular photogalvanic effect (CPGE) (Figs. 1(a), (b)). Shift current is generated by quantum mechanical effects upon photoexcitation and exhibits ultrafast response and dissipation-less behavior [2]. Recently, shift current has attracted much attention for its potential in photodetector applications. On the other hand, CPGE is generated in materials with spin splitting under irradiation by circularly polarized light [3]. CPGE currents have been measured primarily to investigate spin splitting.

So far, we have investigated shift currents and CPGE currents in chiral-polar materials such as organic–inorganic hybrid perovskites [4] (Fig. 1(c)). In this presentation, I will talk our recent findings on the BPVEs of chiral-polar perovskites.

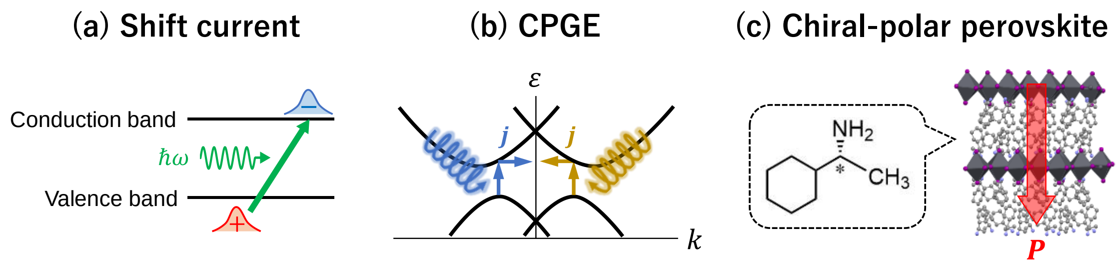

Figure 1. Schematic illustrations of (a) shift current and (b) circular photogalvanic effect (CPGE). (c) The example of chiral-polar perovskites: ((*R*)-(−)-1-cyclohexylethylamine (*R*-CYHEA))$_8$Pb$_3$I$_{14}$.

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P-20 Attempt of New Photoelectron Yield Spectroscopy Measurement Using Kelvin Probe

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Abstract

Photoelectron yield spectroscopy (PYS) is widely used to determine the ionization energy of various organic electronic materials. It is a technique that involves irradiating a sample with light while scanning the wavelength and recording the total photoelectron yield emitted from the sample as a function of the incident photon energy [1]. Despite its broad application, conventional PYS setups lack configurations that enable high-sensitivity measurements under both atmospheric and vacuum conditions. Furthermore, sample charging during measurement presents a significant challenge, particularly for insulating materials.

To enable PYS measurements with high sensitivity under both vacuum and atmospheric conditions, and to accommodate insulating materials, we adopted a method developed by our group known as the Rotary Kelvin Probe (RKP) [2], which measures changes in surface potential. When photoelectron emission occurs, holes are left on the surface of the insulator, resulting in a change in surface charge. By measuring variations in surface potential using RKP during light irradiation, it would be possible to perform PYS measurements.

In this study, we constructed a system that enables surface potential measurements using RKP while sweeping the wavelength of light emitted from a light source and spectrometer. Using this setup, we measured the surface potential of a TPBi thin film under floating potential conditions and evaluated the resulting potential changes to verify the feasibility and effectiveness of PYS measurements with this system.

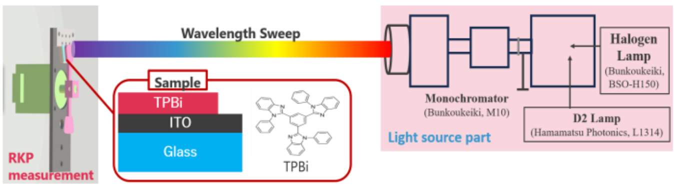

Fig.1: Diagram of our apparatus

Fig. 1 shows the experimental system we made. Monochromatic light from the light source is irradiated onto the sample. The wavelength of this light is swept by the program, and at the same time, the surface potential can be measured by RKP.

In this experiment, TPBi thin film was used as the sample, and the surface potential change ΔV_{cpd} was measured using RKP. The photoelectron yield Y was then calculated using the following equation based on the obtained results.

$$Y \propto \frac{1}{I_{hv}}\frac{\Delta V_{cpd}}{\Delta t} = \frac{1}{I_{hv}}\frac{1}{\Delta t C}\int_{t}^{t+\Delta t} i_{ph}dt$$

Here, I_{hv} is the intensity of the irradiated light at each wavelength, C is the capacitance, ΔV_{cpd} is the surface potential change during Δt seconds, and I_{ph} is the photoelectron current.

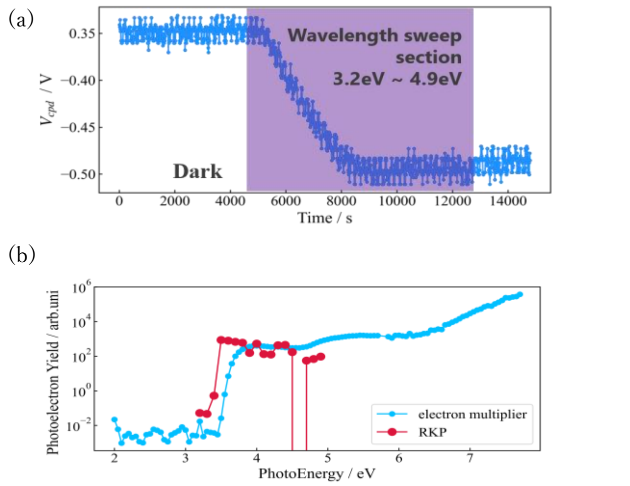

Fig.2: (a) Results of surface potential measurements. (b) PYS spectrum obtained from surface potential change in air. (Blue line is measured with the electron multiplier in vacuum.)

Fig. 2(a) shows the results of surface potential measurements using RKP while performing wavelength sweeping, and Fig. 2(b) shows the photoelectron yield calculated using the above equation and the PYS results measured using the electron multiplier tube method previously performed by our group. From Fig. 2(b), the onset structures of the two spectra at 3.5 eV are almost similar, suggesting that PYS measurements using the surface potential method are feasible.

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P-21

Synthesis and electron transport properties of n-type semiconducting polymers consisting of two types of acceptors

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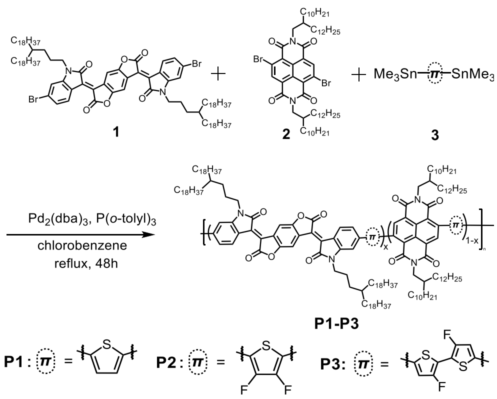
1. Introduction

Organic semiconducting polymers are commonly used as the active layer in organic field-effect transistors (OFETs). These polymers are typically classified as either p-type or n-type, but the development of n-type semiconducting polymers has lagged behind due to challenges such as poor air stability and low electron mobility. N2200, a benchmark n-type semiconducting polymer, offers a promising pathway to improved performance because of its relatively good air stability and electron mobility. Its monomer units based on naphthalenediimide (NDI) derivatives are among the most widely used building blocks for designing n-type semiconductor polymers. In this study, benzodifurandione-based oligo(*p*-phenylenevinylene) (BDOPV) derivatives, known for their strong electron-accepting ability, were employed as alternative building blocks. While BDOPV-based polymers have been reported as excellent materials for n-type OFETs and thermoelectric devices, copolymers combining NDI and BDOPV have not yet been explored. Therefore, three semiconducting polymers incorporating both NDI and BDOPV with varying π-spacers were synthesized and their electron transport properties were systematically evaluated.

2. Results and Discussion

The electron acceptor monomers dibromoBDOPV **1** and dibromoNDI **2** were terpolymerized with π-spacer **3** to afford copolymers **P1** (M_n = 51,000), **P2** (M_n = 5,200), and **P3** (M_n = 68,000) (**Scheme 1**). **P1-P3** possess donor-acceptor type backbones, which exhibit intramolecular charge transfer interactions. Ultraviolet-visible-near-infrared (UV-vis-NIR) spectra revealed that the maximum absorption wavelength (λ_{max}) of the **P2** film was observed at 712 nm, showing a significant blue-shift compared to that of **P1** (743 nm). Cyclic voltammetry (CV) measurements determined the band gaps of **P1**, **P2**, and **P3** to be 1.79 eV, 1.95 eV, and 1.98 eV, respectively. The blue-shift in λ_{max} from **P1** to **P2** was attributed to the increase in the band gaps due to the lowering of the HOMO level caused by the electron-withdrawing fluorine groups introduced in **P2**. Next, Top-contact/bottom-gate (TC/BG) OFETs were fabricated on a highly n-doped Si wafer with 300 nm SiO_2 dielectric layer (**Figure 1**). Semiconducting polymer thin films were fabricated by spin-coating process onto octadecyltrimethoxysilane (OTMS)-treated substrates, and their electron transport properties were evaluated. Under optimized thermal annealing conditions, the electron mobilities (μ_e) of **P1**, **P2**, and **P3**, were measured to be 1.82×10^{-3} cm^2 V^{-1} s^{-1}, 1.35×10^{-5} cm^2 V^{-1} s^{-1}, and 1.16×10^{-2} cm^2 V^{-1} s^{-1}, respectively.



Scheme 1. Synthesis of copolymers.

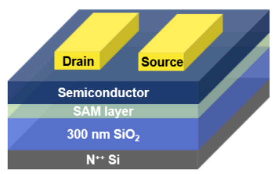


Figure 1. TC/BG OFFT device.

3. Conclusion

Ternary copolymers composed of NDI, BDOPV, and various π-spacers were synthesized, and their electronic transport properties were systematically evaluated. All three copolymers **P1-P3** exhibited electron transport behavior. To further investigate the origin of different electron mobilities, we plan to evaluate the thin film crystallinity of **P1-P3** films.

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P-22

Synergistic Plasmonic-Thermoelectric Enhancement in Semiconducting Carbon Nanotubes for Infrared Light Detection

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Infrared (IR) light detection has a wide range of applications, from molecular fingerprinting to wireless communication. However, developing uncooled, high-sensitivity detectors remains challenging due to low photon energies. Carbon nanotubes (CNTs) are a promising solution because of their plasmon resonance in the infrared region and photothermal voltage generation.[1] Here, we investigate the correlation between the material properties of selectively extracted semiconducting CNTs, including plasmonic resonance, thermoelectric performance, and photodetection behavior.

Semiconducting CNTs (arc discharge, 1.4 nm mean diameter) were selectively dispersed in 0.05 wt% ethylcellulose–tetrahydrofuran.[2] The dispersion was vacuum-filtered onto a membrane and transferred onto a PEN film. For p/n-type PTE sensor fabrication, butanol solutions of potassium hydroxide with benzo-18-crown-6-ether and silver bis(trifluoromethanesulfonyl)imide were used as n- and p-type dopants.[3] Each dopant was manually applied to the CNT film, followed by parylene encapsulation.[4] Visible light (564 THz, 532 nm) and infrared light (2.52 THz) were used to evaluate the PTE response.

We confirmed the formation of p/n-coupled PTE sensors by mapping the two-dimensional PTE response and using infrared spectroscopy. The in-plane p/n-coupled PTE sensor made of semiconducting CNT films exhibited 11 times the sensitivity (0.123 mV W^{-1}) of the film made from as-received CNTs, though the Seebeck coefficient was only four times higher. Because the PTE response depends on the effective Seebeck coefficient and temperature difference, this balance of the plasmonic-thermoelectric effect suggests the presence of additional contributing factors, which may include plasmon-enhanced photothermal conversion and doping-modulated thermal conductivity.

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P-23

Metal-Ion Coordinative Parylene Thin Films for OLED

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Poly(p-xylylene) (parylene) is a paraxylene-based polymer synthesized from the [2,2]*p*-cyclophane (PCP) monomer via chemical vapor deposition (CVD). Parylene has the significant advantage of forming uniform and defect-free thin films by a unique polymerization method called CVD. In our previous research, we have been studying functionalized parylene thin films by introducing various functional groups on parylene, which is intrinsically an electrical insulator material. Inspired by a prior report demonstrating that the coordination of metal ions to dendrimer molecules bearing imine functionalities enhances the performance of organic light-emitting diode (OLED) devices [1], we pursued a related strategy. In this study, we synthesized a novel PCP with an imine side chain and deposited a parylene film 1 using a CVD method, aiming to improve carrier mobility by introducing an imine group. OLED devices using 1 as a hole transport layer were fabricated, and the effect of metal ion coordination to 1 on device performance was investigated.

The polymerization of PCP with an imine side chain by the CVD method resulted in a uniform and defect-free parylene film 1 with a thickness of 16 nm. The ionization potential of 1 was evaluated by a principles of photoemission yield spectroscopy in air and showed a value between that of PEDOT:PSS (hole injection layer) and F8BT (emission layer) (5.47 eV), and furthermore, due to the coordination of Sn^{2+} ions, the value was close to that of PEDOT:PSS (5.18 eV). OLED devices with 1 as the hole transport layer were fabricated and their electrical performance was measured (Fig. 1). In contrast, the coordination of Sn^{2+} ions to 1 lowered the turn-on voltage of the device and improved the luminous efficiency (Fig. 2). The parylene thin film with metal ion coordination ability was obtained, and it was clear that the introduction of metal ions changed the OLED device performance.

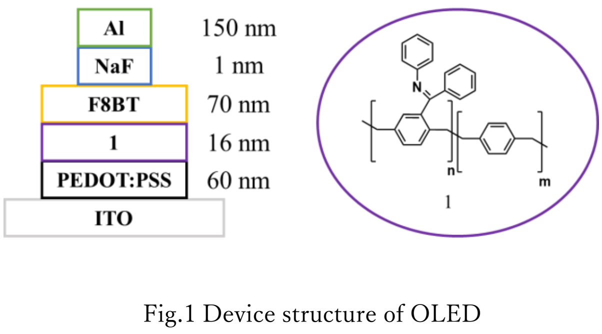

Fig.1 Device structure of OLED

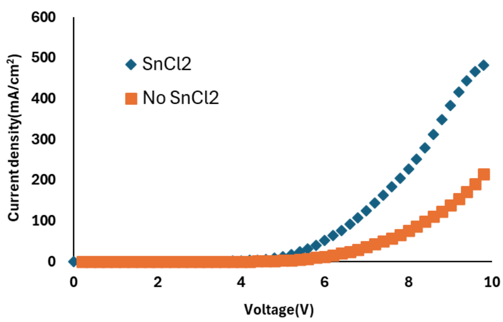

Fig.2 L-V characteristics of the devices

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P-24

Development of Electro-Active Parylene Thin Layers with Oxadiazole Derivative

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Poly(p-xylylene)s (Parylenes:PPXs) are composed of alternating arylene and ethylene units, resulting in a rigid structure that imparts high thermal stability, mechanical strength, and chemical resistance. Parylenes are synthesized via a unique polymerization method known as Chemical Vapor Deposition (CVD). Various parylenes have been prepared by this method form defect-free and uniform films, and their thickness can be easily controlled.

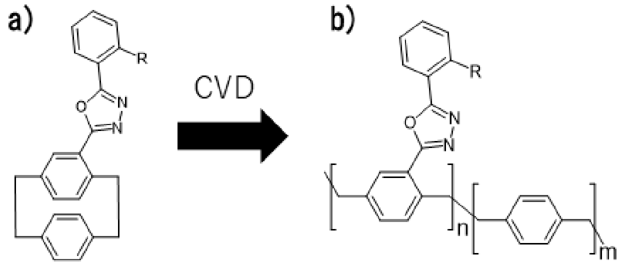

Fig.1 Structure of a) **1**: R=-H; **2**: R=-CH_3 and b) **3**: R=-H; **4**: R=-CH_3.

In our previous report, the electron transporting performance of a parylene layer prepared from compound **1** incorporating oxadiazole derivatives was presented. In this study, we investigated the device performance enhancement of parylene layers by introducing a methyl group into the oxadiazole unit. We synthesized new parylene precursors (compounds **2**). Compounds **1** and **2** (50 mg) were polymerized onto the target surfaces through a chemical vapor deposition (CVD) process. This process included a sublimation furnace temperature of 230 °C and a pyrolysis furnace temperature of 650 °C. The result was the deposition of parylenes (**3** and **4**) onto substrates. The film thickness ranged from 30 to 40 nanometers.

In this study, we fabricated organic electroluminescent (EL) devices using parylene **3** and **4** as the electron transport layers. The device configuration included ITO/PEDOT:PSS (45 nm)/F8BT (55 nm)/3 or 4 (30-40 nm)/NaF (1 nm)/Al (150 nm). The V-L plots of three devices (**3**, **4**, and without parylene) were examined to determine the luminance at 5 V, which was found to be 758, 884, and 17 cd/m^2, respectively. The incorporation of these parylene layers as electron transport layers has been demonstrated to enhance the electroluminescent performance of organic EL devices. Furthermore, an enhancement in luminance was observed for **4** compared to **3**. It was hypothesized that the introduction of an electron-donating methyl group into the oxadiazole derivative would result in enhanced performance.

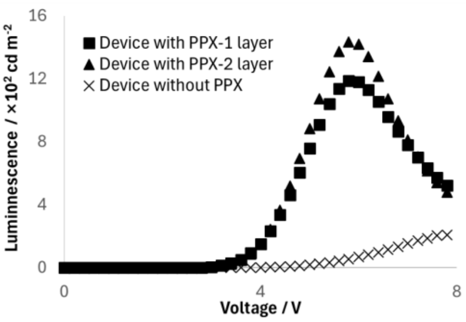

Fig.2 V-L plots of devices with **3** or **4**, and without parylene layer.

P-25

Material transformation for effective use of wood extracts using organic photocatalysts

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Abstract

Lignin is an aromatic polymer that accounts for approximately 20–30% of wood and is the second most abundant biomass resource after cellulose. In the pulp manufacturing process, extracts containing hemicellulose and lignin are obtained, but effective utilization methods have not yet been established, and research continues. We aimed to convert these wood extracts into useful materials. Currently, various methods for converting lignin have been reported[1]. In this study, we selected a photocatalytic method that can proceed solely under light, with mild reaction conditions and short reaction times. In our group's research, we have reported oxidation reactions mediated by charge separation induced by light irradiation using electrode-shaped organic photocatalysts[2]. In this study, we attempted to oxidize and decompose lignin into useful substances using this photocatalyst. As a model experiment, we attempted photocatalytic oxidation reactions using lignin sulfonic acid and confirmed the generation of several useful substances. In cyclic voltammetry measurements, oxidation current was observed when light was irradiated onto the electrode (Fig. 1a). Lignin oxidation decomposition was performed by constant potential measurement under light irradiation (Fig. 1b). Measurements were performed using several model compounds with the same experimental method, and the reaction mechanism of lignin oxidation decomposition was examined.

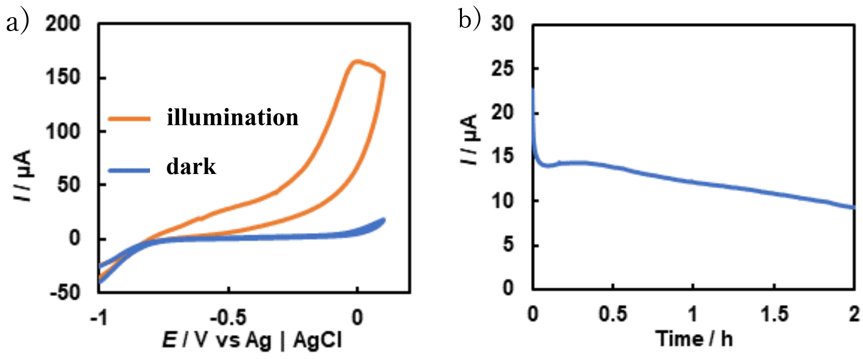

Figure 1. a) CV during light irradiation in dark
b) Constant potential measurement

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P-26

Polymeric Conductive Adhesive-Based Ultrathin Epidermal Electrodes for Long-Term Monitoring of Electrophysiological Signals

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Abstract

Wearable devices and skin-interfaced electrodes are driving the integration of electrophysiology—the study of electrical phenomena in living systems—into daily life. However, continuous and long-term monitoring of biopotential signals remains challenging due to issues related to electrode durability and motion artifacts. To overcome these limitations, we present an ultrathin polymeric conductive adhesive electrode composed of poly(3,4-ethylenedioxythiophene):poly(styrenesulfonate), polyvinyl alcohol, and d-sorbitol (PPd). This electrode offers enhanced adhesion, stretchability, and conformability to the skin. Its mechanical design is guided by theoretical criteria derived from mechanical analysis, enabling stable skin contact and impedance over extended periods. The PPd electrode maintains impedance stability over one week of daily use and demonstrates mechanical durability under repeated deformation. In electromyography (EMG) measurements during high-intensity exercise, the wireless PPd measurement system provides a high signal-to-noise ratio (SNR) even under dynamic motion. Furthermore, in continuous electrocardiogram (ECG) monitoring over a week, the system consistently delivers high-quality signals, validating its robustness and suitability for long-term, real-life applications.

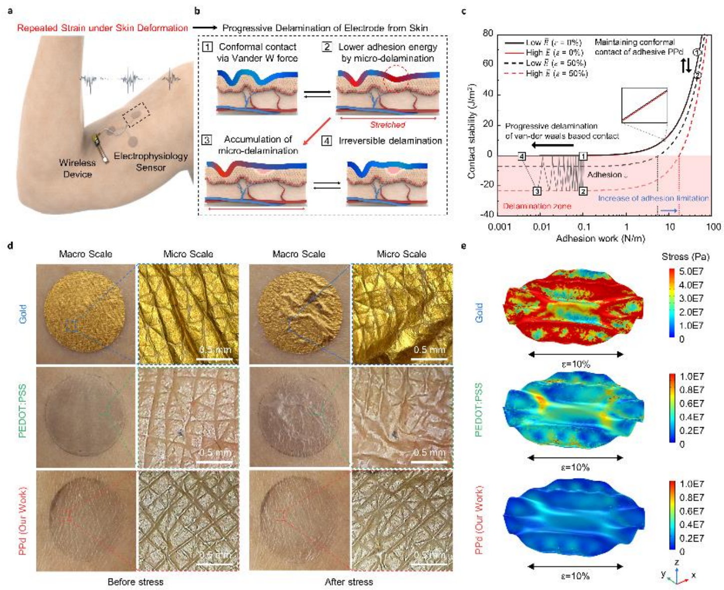

Figure 1. Comparison of conformability between the conductive adhesive PPd electrode and conventional electrodes incorporated in electrophysiology measurement systems.

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P-27

Enhanced Stability and Gating Efficiency in Mixed Molecular Transistors

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Molecular electronics represents a pivotal area of research that enables the continuous scaling down of electronic components. In particular, molecular transistors hold promise for integrating molecule-based functionalities with conventional electronics. However, progress in this field has been hindered by issues such as lack of device stability. In this study, we introduce a mixed-molecule transistor featuring a self-assembled monolayer (SAM) of 16-mercaptohexadecanoic acid (16MHDA) and dodecanethiol (C12) (Fig. 1) [1]. The mixed SAM allows the molecular junction to endure higher voltage bias, broadening the transmission window and delivering on/off ratios that surpass those of single type SAM devices. Additionally, transition-voltage spectroscopy reveals a switch from direct tunneling to Fowler–Nordheim tunneling as gate voltage is swept to negative direction. This change in charge transport mechanism also shows that gate-induced tunneling barrier modulation is greater in mixed SAM transistors compared to single-type SAM transistors, evidencing enhanced gating efficiency. This study offers a path to stable, high-performance molecular transistors.

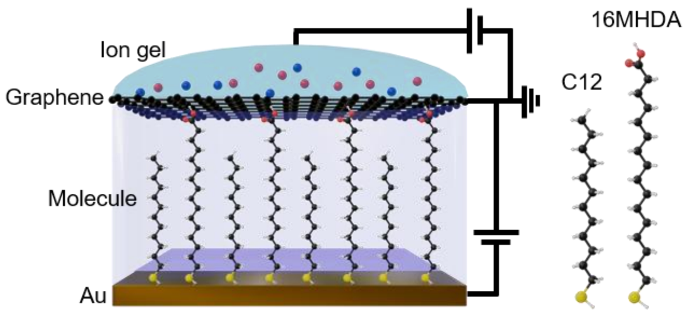

Figure 1. Schematic of the molecular junction with chemical structures of molecules.

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P-28

Radiation-Engineered Silicon Proton Filters for Microbial Fuel Cell Applications

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Abstract

This study presents a fabrication method for proton-selective membranes by forming porous architectures, serving as hydrogen gas filters, within single-crystal silicon substrates [(100) and (111) orientations] using high-energy proton beam irradiation. The resulting membranes were characterized through SRIM-based penetration modeling, pH-dependent diffusion measurements, and complementary analyses[1].

When applied as proton exchange membranes in microbial fuel cells (MFCs), the irradiated silicon substrates exhibited hydrogen ion transport properties comparable to those of Nafion reference membranes, while maintaining stable performance under thermal stress[2]. This straightforward and scalable fabrication approach highlights the potential of radiation-engineered silicon membranes as practical alternatives to Nafion for fuel cells, hydrogen purification, and other electrochemical systems requiring high thermal resilience[3]. These findings open new avenues for radiation-based material engineering, contributing to the development of next-generation hydrogen energy technologies.

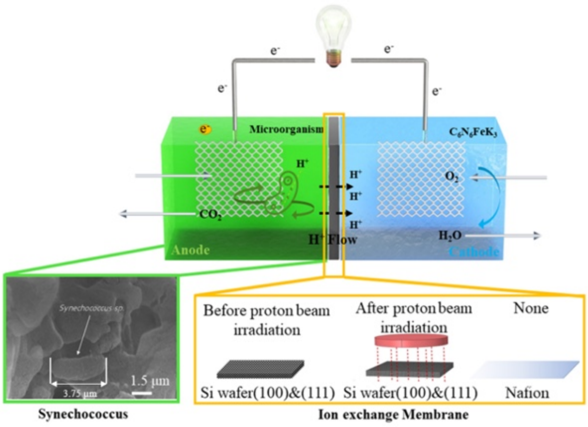

Figure 1. Microbial Fuel Cell Experimental Schematic.

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P-29

Alicyclic Diamine-Modified Polyimides with Enhanced Flexibility and Optical Properties for Flexible Display Cover Windows

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Abstract

Foldable displays require materials that combine optical transparency, mechanical durability, and manufacturing efficiency. While ultra-thin glass (UTG) provides excellent clarity and scratch resistance, its brittleness under small bending radii (1-3 mm) necessitates complex multi-layer protection systems that increase thickness and introduce optical losses from refractive index mismatches. In this study, a single-layer fluorinated polyimide (PI) coating was developed for direct UTG adhesion with precise refractive index matching and enhanced mechanical robustness. The PI was synthesized from 6FDA-TFMB for high transparency and low dielectric constant, incorporating 1,3-bis(3'-aminopropyl)-1,1,3,3-tetramethyldisiloxane (BATMS) for flexibility. Aliphatic crosslinkers (1,3-bis(aminomethyl)cyclohexane (BAC) or bis(aminomethyl)bicyclo[2,2,1]heptane (BBH)) were intcorporated to form three-dimensional networks that effectively disperse bending stress and prevent crack propagation. The optimized coating achieved over 92% transmittance, maintained refractive index deviation less than 0.03 from UTG, and endured more than 20,000 folding cycles without visible cracking or delamination. This integrated approach eliminates multi-layer complexity while reducing interfacial reflections and improving manufacturing yield, demonstrating a scalable solution for next-generation foldable displays.

(a)

Polyimide	Thickness (μm)	Refractive index (632.8nm)	T% Max	YI
6T	18	1.568	92.95	1.30
6T-BATMS(10%)	18	1.540	92.74	1.18
6T-BATMS(20%)	18	1.541	92.21	1.07
6T-BATMS(10%)-(Cl)BAC	19	1.539	92.28	0.98
6T-BATMS(20%)-(Cl)BAC	19	1.541	92.72	0.99
6T-BATMS(10%)-(Cl)BBH	18	1.538	91.26	1.20
6T-BATMS(20%)-(Cl)BBH	19	1.539	91.75	2.20

(b)

Figure 1. (a) Optical properties of 6T-BATMS-(Cl)BAC and 6T-BATMS-(Cl)BBH series and 6T-BATMS series, (b) Folding test of 6T-BATMS(20%) coated on UTG

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P-30

Design and Synthesis of a Novel Mono-Functional Acrylate with Carboxylic Groups for Enhanced Flexible Display Optically Clear Adhesive

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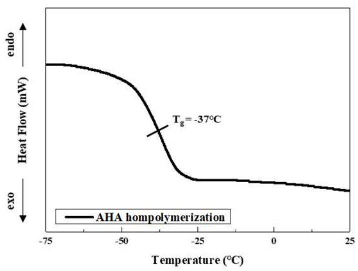
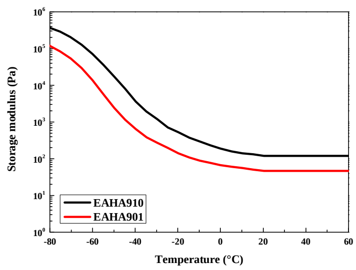
Optically clear adhesive (OCA) plays a crucial role in ensuring stable operation of displays and is widely used. As displays with various form factors have been developed, OCA is required to possess diverse properties beyond its ability to secure components. When external stress is applied to flexible displays, this stress and deformation are transmitted to each component of the display, potentially causing structural instability. Conventional OCA is prone to defects under these conditions due to its low flexibility. Therefore, the recovery and relaxation properties of OCA are essential requirements that must be satisfied to ensure display stability and reliability. Conventional acrylic-based OCA utilizes functional monomers capable of crosslinking and hydrogen bonding, such as acrylic acid (AA), but their high glass transition temperature (T_g) of 105°C reduces flexibility and recovery properties against deformation when used in high concentrations. In this study, to impart functionality and low T_g to acrylic OCA, we synthesized a novel monomer with a T_g of −37°C and carboxylic acid structure, and fabricated OCA utilizing this monomer. As a result, the prepared OCA exhibited low storage modulus and excellent folding resistance of over 100,000 cycles. This indicates that the novel acrylate monomer is suitable for flexible optical display applications.



(a)



(b)

Figure 1. (a) Differential scanning calorimetry (DSC) thermogram of the AHA homopolymerizaiton. (b) Storange modulus of EAHA series for preparing OCA.

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P-31

High-Performance Phototransistor based on In-Situ Core/Shell Perovskite-MoS_2 Heterostructure

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Two-dimensional (2D) transition metal dichalcogenides (TMDCs) are promising materials for various applications, including low-power and optoelectronic devices, due to their atomically thin architecture, tunable band gaps, high on/off ratios, and exceptional electrical properties [1]. In particular, photodetectors fabricated from 2D TMDCs can facilitate the development of flexible devices with high integration density from a materials perspective. Nevertheless, their extreme thinness at the atomic scale results in low light absorption, thereby constraining their sensitivity in photodetection. This study addresses the limitations related to low light absorption by depositing in-situ core/shell perovskite onto the MoS_2 channel, thereby markedly enhancing charge transfer and light absorption efficiency [2]. By subjecting the devices to alternating dark and illuminated conditions and measuring the on and off currents, it was observed that the on/off ratio of the in-situ core/shell perovskite-MoS_2 heterostructure devices increased by a factor of fifty, and the responsivity was enhanced ninefold compared to other MoS_2-based photodetectors [3]. Our research advances the performance of the 2D MoS_2 photodetector through a heterostructure employing core/shell perovskites.

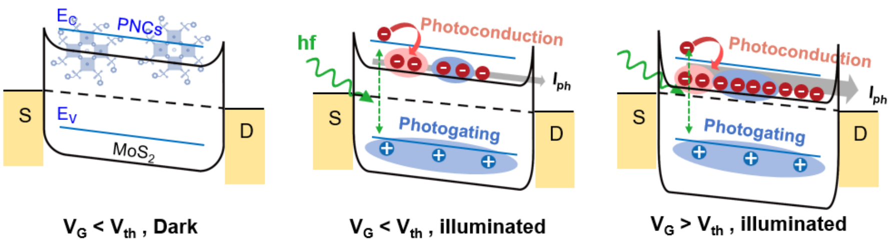

Figure 1. Band diagrams illustrating the operational modes of the perovskite/MoS_2 device.

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P-32

Novel method for reducing contact resistance using liquid crystal properties independent of electrode material

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In organic electronic devices such as organic transistors and organic light-emitting diodes (OLEDs), reducing the contact resistance at the interface between the electrode and the organic semiconductor is critically important. In particular, when using electrode materials that are inexpensive but have a low work function, the injection barrier tends to be large, making contact resistance a serious issue. One possible approach to reduce the contact resistance is heavily doping the interface between the semiconductor and the electrode.

In liquid crystalline organic semiconductor Ph-BTBT-10 (2-phenyl-7-decyl-benzothienobenzothiophene), it has been reported that interfacial doping using the electron acceptor F4-TCNQ (2,3,5,6-tetrafluoro-7,7,8,8-tetracyanoquinodimethane) reduces the contact resistance [1]. Charge transfer from the HOMO level of Ph-BTBT-10 to the LUMO level of F4-TCNQ increases the hole density in Ph-BTBT-10 and generates negatively ionized F4-TCNQ⁻ (Fig. 1(a)). In addition, transient photocurrent measurements have revealed that in the smectic phase, where molecular fluidity is present, both electronic and ionic conduction pathways coexist (Fig. 1(b)) [2].

Based on these findings, it is considered that, after doping a liquid crystalline organic semiconductor with the electron acceptor F4-TCNQ, applying a voltage in the smectic phase enables electric-field-induced sweeping of ionized F4-TCNQ⁻ molecules toward one of the electrodes. This dopant distribution can be fixed by cooling the sample down to the crystalline phase. In this study, we aimed to enhance charge carrier injection by controlling the dopant distribution through voltage application in the liquid crystal phase to reduce the contact resistance.

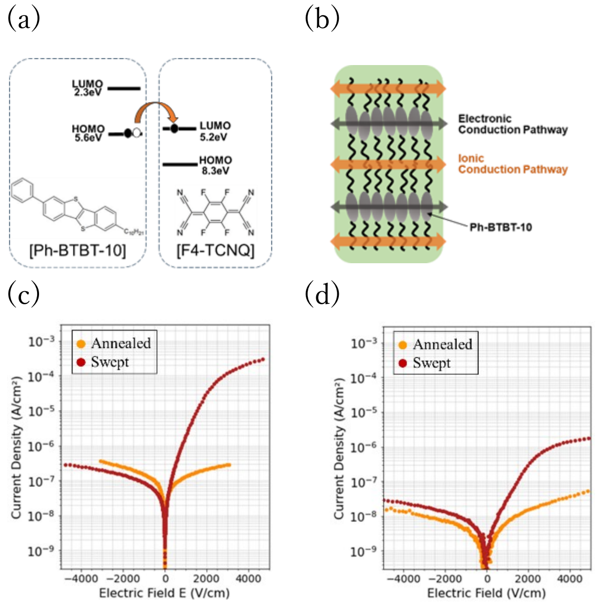

Fig.1 (a) Energy diagram of materials, Ph-BTBT-10 and F4-TCNQ (b) Coexisting electronic and ionic conduction pathways in the liquid crystalline phase (c) logJ-E when using Au electrodes (d) logJ-E when using Cr electrodes

A sandwich-type cell with a thickness of 2 µm was fabricated using two glass substrates with evaporated electrodes. The mixture of Ph-BTBT-10 and 1 % F4-TCNQ was heated to its isotropic temperature and introduced into the cell by capillary action. The cell was then heated to 160 °C (smectic E phase), and a voltage of 10 V was applied for 5 minutes. The sample was subsequently crystallized by slow cooling to room temperature while maintaining the applied voltage. Current density–electric field (J–E) characteristics were evaluated in the range from –1 V to +1 V.

By comparing the J–E characteristics with and without the electric-field-induced dopant sweeping process, we observed that hole injection from the electrode to which F4-TCNQ⁻ was swept resulted in an increase in current density by nearly three orders of magnitude for vertical devices with Au electrodes(Fig. 1(c)), and by nearly two orders for those with Cr electrodes (Fig. 1(d)). These results suggest that the depletion layer was thinned, and the contact resistance was reduced, thereby facilitating charge carrier injection. These results indicate the potential of this novel method for reducing contact resistance that can also be applied to inexpensive electrode materials.

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P-33

Fabrication of n-channel organic transistor and invertor using liquid crystalline organic semiconductor

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Complementary circuits are widely used due to their features such as low power consumption. Organic semiconductors also possess advantages that inorganic semiconductors do not, such as flexibility and low fabrication cost. We previously studied showing that when the liquid crystalline organic semiconductor dialkyl-benzothienobenzothiophene derivative, C10-BTBT, which is originally a p-channel material, is doped with the acceptor tetracyanoquinodimethane derivative, F4-TCNQ, it is converted to charge transfer complex which show an n-channel operation[1]. In this study, we selectively phenyl-BTBT derivative, Ph-BTBT-10, and F4-TCNQ, whose chemical structure are shown in Fig.1 (a), and fabricated an inverter by realizing both p-channel and n-channel transistors on the same substrate. The mobility of the p-channel transistor fabricated with Ph-BTBT-10 thin film is on the order of 1 cm^2/Vs, while that of the n-channel transistor fabricated with charge transfer complex (Ph-BTBT-10)(F4-TCNQ) is on the order of 10^{-3} cm^2/Vs. Therefore, we designed a device structure with W/L =1 and W/L = 1000 for p- and n-channel transistors, respectively, in order to balance the current levels of the p-channel and n-channel transistors. When fabricating both p- and n-channel transistors on the same substrate, the p-channel mobility decreased by an order of magnitude, resulting in the p-channel current being one order of magnitude lower than that of the n-channel as shown in Fig. 1 (b) and (c). Despite this, inverter operation was successfully demonstrated with these devices. Nevertheless, compared to ideal inverter behavior, an issue was observed in which the operating point shifted toward the negative side as shown in Fig. 1 (d).

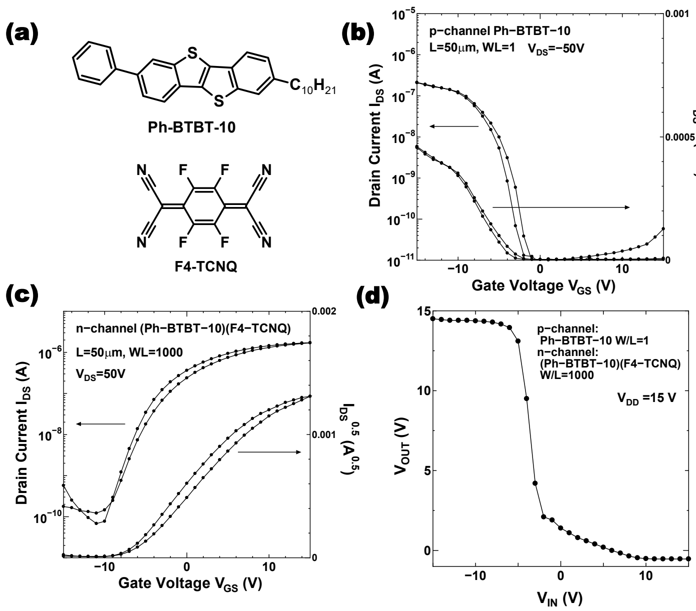

Fig. 1 Inverter characterstics of Ph-BTBT-10 and F4-TCNQ (a) Chemical strutures, (b) and (c) transfer characterstics of p-channel and n-channel transistors, and (d) voltage transfer characteristics of the inverter.

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P-34

Ortho-Fluorine Substituted Triphenylamine-Based Hole Transport Materials for Stable Perovskite Solar Cells: Influence of Planar Versus Non-Planar Linkers

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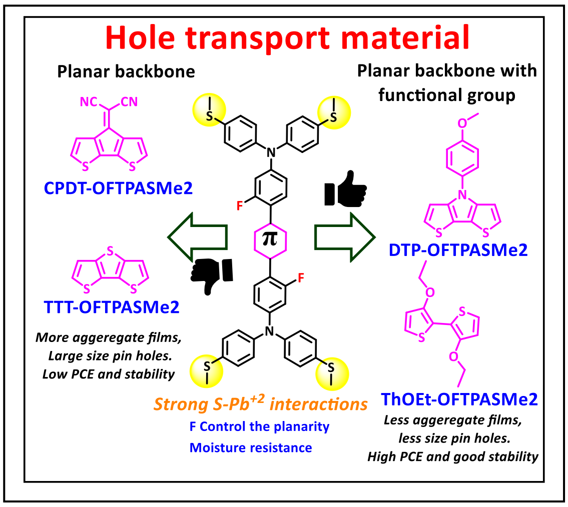
Abstract

The development of stable and efficient hole transporting materials (HTMs) is essential for the commercialization of perovskite solar cells (PSCs). In this study, we introduce four novel HTMs featuring a D-π-D molecular structure. These HTMs have 3-fluoro-*N,N*-bis(4-(methylthio)phenyl)aniline peripheral terminal groups, which are linked with various π-core moieties. Our investigation reveals that altering the π-linkers affects the film morphology of the HTMs, significantly influencing device performance. HTMs with planar backbones, CPDT-OFTPASMe2 and TTT-OFTPASMe2 form films with more voids. In contrast, ThOEt-OFTPASMe2 and DTP-OFTPASMe2 with inhibitory effects caused by ethoxy and methoxy phenyl groups, respectively, prevent film aggregation and result in a pinhole-free morphology. Among the four HTMs, the DTP-OFTPASMe2 HTM emerges as particularly promising, exhibiting an average power conversion efficiency of 18.77%. Subsequent oxygen doping to promote oxidation boosts the efficiency to 21.35% in unsealed devices. These devices are stable in high-humidity conditions for approximately 83 days, underscoring their robust performance



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P-35

Enhanced Performance in Perovskite Solar Cells with Aggregation-Controlled Double-Layer SnO_2

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Employing double-layer SnO_2 is an effective strategy for enhancing the performance of perovskite solar cells (PSCs). This study demonstrates that the annealing temperature of the second SnO_2 layer in the double-layer architecture significantly influences PSC performance. Annealing at 120°C most effectively increases surface roughness of SnO_2 due to enhanced nanoparticle aggregation, which in turn improves electron extraction by enlarging the SnO_2/perovskite interfacial area, leading to higher device efficiency. However, two key challenges, such as poor SnO_2 nanoparticle connectivity and the presence of residual water within the SnO_2 layer annealed at 120°C, were identified. To address these issues, a two-step annealing process was introduced for the second SnO_2 layer in the double-layer architecture—initial annealing at the optimized temperature of 120°C, followed by an additional annealing at 150°C. PSCs incorporating this additionally annealed double-layer SnO_2 with improved nanoparticle connectivity and reduced residual water content exhibited enhanced power conversion efficiency, increasing from 23.0% to 24.8%, and superior operational durability, with efficiency retention improving from 89% to 98% after 300 hours of continuous illumination at 25°C. These findings provide new insights into SnO_2 nanoparticle aggregation within electron transport layers and present a practical approach for simultaneously improving both efficiency and durability in PSCs.

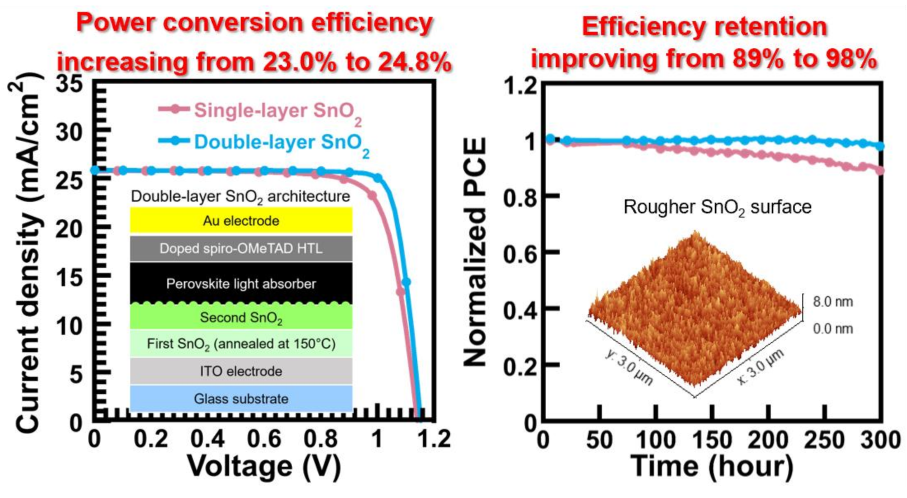

Figure 1. Current density voltage characteristics and operational durability under illumination for PSCs with single-layer SnO_2 and double-layer SnO_2.

P-36

Surface Plasmon Resonance-Enhanced Photoelectrochemical Flexible Sensor Using Doped PEDOT:PSS Thin Film with Gold Nanoparticles

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Abstract

This work introduces a flexible photoelectrochemical (PEC) glucose sensor that integrates a doped poly(3,4-ethylenedioxythiophene):polystyrene sulfonate (PEDOT:PSS) thin film with gold nanoparticles (AuNPs) and a grating-structured gold (Au) electrode on a polydimethylsiloxane (PDMS) substrate [1]. The nanostructured Au electrode supports surface plasmon resonance (SPR) and catalyzes glucose oxidation. To enhance the photoelectrochemical response, AuNPs are deposited on the PEDOT:PSS film, activating localized surface plasmon resonance (LSPR). Both the PEDOT:PSS and AuNP layers are fabricated via electrochemical deposition, with the PEDOT:PSS film maintained in a conductive, doped state. The LSPR effect of AuNPs plays a key role in improving glucose sensing on flexible PDMS, offering potential for adaptable and wearable sensor designs. Furthermore, an Au/PDMS grating structure was engineered to excite grating-coupled SPR, resulting in enhanced detection sensitivity, as evaluated by the limit of detection (LOD). The combination of doped PEDOT:PSS and AuNPs increases charge carrier density and enhances photocurrent under white light illumination [2]. This photocurrent enhancement leads to a lower LOD, confirming the system's effectiveness for light-assisted glucose detection. Flexibility tests involving repeated bending revealed minimal performance degradation, highlighting its promise for practical, flexible biosensing applications.

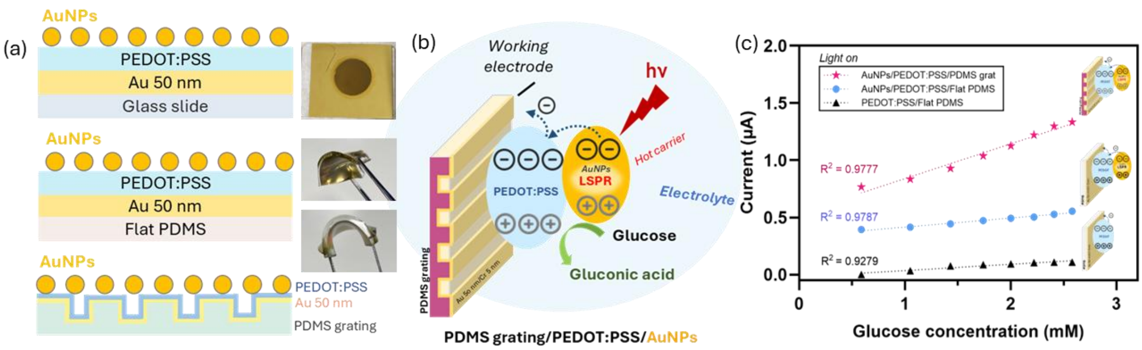

Figure 1. (a) Schematic of the PEC sensor (top: glass, middle: PDMS, bottom: grating-PDMS). (b) PEC glucose sensing mechanism (c) Calibration curve of the flexible sensor in glucose solution.

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P-37

Point-of-Care Wireless DNA Sensing for CGG Repeat Detection in Fragile X Syndrome

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+The first authorship is shared equally by J. P. and E. A.

Abstract

The FMR1 gene plays a critical role in brain development, and its abnormal CGG repetition causes fragile X syndrome (FXS), a commonly inherited form of intellectual disability and a key contributor to autism spectrum disorders, Although PCR and Southern blotting are commonly used together to detect CGG repeat expansions the combined approach remains labor-intensive, time-consuming, and unsuitable for low-cost, point-of-care testing[1]. Here, we introduce a wireless, label-free, and non-contact detection platform that leverages sequence-dependent electrical responses of DNA-containing droplets for the identification of CGG repeat expansions. By allowing electrically active droplets containing nucleic acids to pass over a printed single-walled carbon nanotube (SWCNT)-based transistor coated with an electret layer, we induce sequence-dependent electrical signals without direct contact, labeling, or amplification[2]. This system directly measures the dielectric shift caused by guanine-rich, structurally distinct CGG sequences, distinguishing pathological repeat lengths from normal ones. Our approach removes the need for amplification or optical probes, enabling label-free and rapid detection from minimally processed saliva samples. The droplet-based sensing platform is fully compatible with roll-to-roll printed, low-cost point-of-care-test (PoCT) devices, offering a new direction for early FXS diagnostics that combine physical sensing principles with scalable clinical applicability.

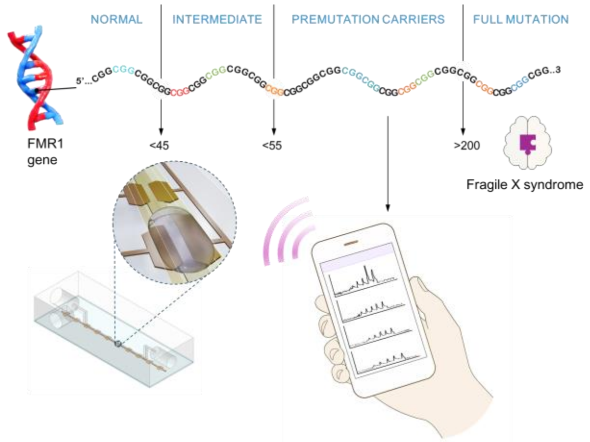

Figure 1. Schematic representation of a non-contact DNA sensing platform for Fragile X Syndrome (FXS) screening based on CGG repeat length.

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P-38

Bio-Incorporated Gravure (Big) Printed Health Endangered Area Test (Heart) Chips: Big-Heart Chips

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Viral infectious diseases have caused great harm to society, the economy, and human health, highlighting the importance of lateral flow assay-like (LFA) point-of-care polymerase chain reaction (PoC-PCR) kits for accurate early infection detection[1]. However, large thermal cyclers and optical fluorescent detection units in conventional PCR devices hinder the development of a disposable, low-cost, and sensitive LFA-like POC-PCR kits[2]. Here, we report the development of a bio-incorporated roll-to-roll (R2R) gravure printed health endangered area test chip (Big-Heart chip), a disposable microfluidic-based PoC-PCR kit with integrated printed Joule heater and cyclic voltammetry to replace a conventional thermal cycler and fluorescence detector, respectively. We fabricate low-cost Big-Heart chips composed of silver-ink-based, self-stabilizing (± 1°C), low-power (0.5 W) Joule heater printed using R2R gravure and room temperature curable PDMS-based microfluidic chip using R2R imprinter at speed of 180 mm/hr costing < 1$ per chip. We complete direct PCR using a 30-cycle serpentine channel microfluidic chip for thermal cycling, detect the reference DNA using printed cyclic voltametric electrodes with a potentiostat chip on a single substrate with a Joule heater using doxorubicin as a probe molecule and an electrochromic display (ECD) as result indicator. We will report a limit-of-detection (LoD) with efficiency using the Big-Heart Chip. Our Big-Heart chip can provide a method to develop LFA-like PCR kits, which can facilitate the rapid detection and prevention of infectious diseases.

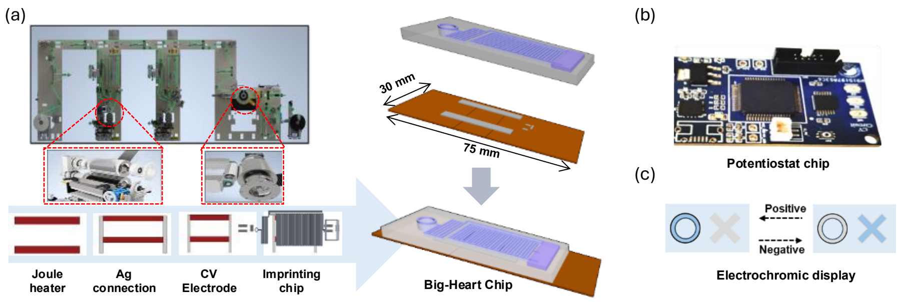

Figure 1. (a) The fabrication and composition of the Big-Heart Chip. (b) The design of potentiostat chip. (c) The detection result by electrochromic display.

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P-39

Evaluation of Electrodeposited Polypyrrole Thin Film Utilizing a Hybrid Sensor of Surface Plasmon Resonance and Quartz Crystal Microbalance

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Surface plasmon resonance (SPR) and quartz crystal microbalance (QCM) are well-known methods for detecting a thin film deposition. SPR can observe changes in refractive index, while QCM can observe changes in mass. Combining of SPR and QCM methods enables complementary measurements for identifying adsorbed molecules and allows for structural evaluations such as thin film swelling or shrinking. Previously, we developed and reported a hybrid sensor combining SPR and QCM for the identification of polyethylene glycol with various degrees of polymerization.[1] In this study, we deposited a polypyrrole (Ppy) thin film by electropolymerization and evaluated the structural changes of the film using this hybrid sensor.

The sensor structure is depicted in Fig. 1. A grating-structured Au thin film was prepared on the quartz surface for use in SPR. The transmission SPR (TSPR) method was employed in this study. A triangular potential wave was applied to the working Au electrode for 20 cycles, and the electrodeposition of the Ppy thin film was carried out. The wavelength of SPR (λ_{SPR}) and the shift in the oscillation frequency of QCM (ΔF_{QCM}) were monitored simultaneously during the deposition process. The kinetic curves for the 1st - 4th cycles and the 17th - 20th cycles are presented in Fig. 2, respectively. The ΔF_{QCM} consistently decreased near the positive potential peak, indicating the deposition of the Ppy film in the regions. Conversely, a redshift and blueshift of λ_{SPR} were observed for the 1st - 4th cycles and the 17th - 20th cycles, respectively. These findings suggest that the SPR method should be used with caution for thin film evaluation. The shrinking and electrochromism of the Ppy film, along with the distribution of the evanescent field on the sensor surface, could lead to thickness dependence.

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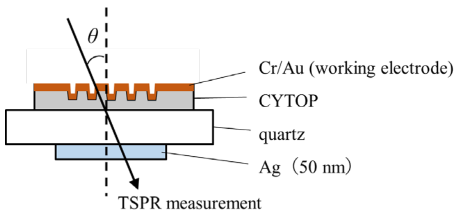

Fig. 1. Sensor structure.

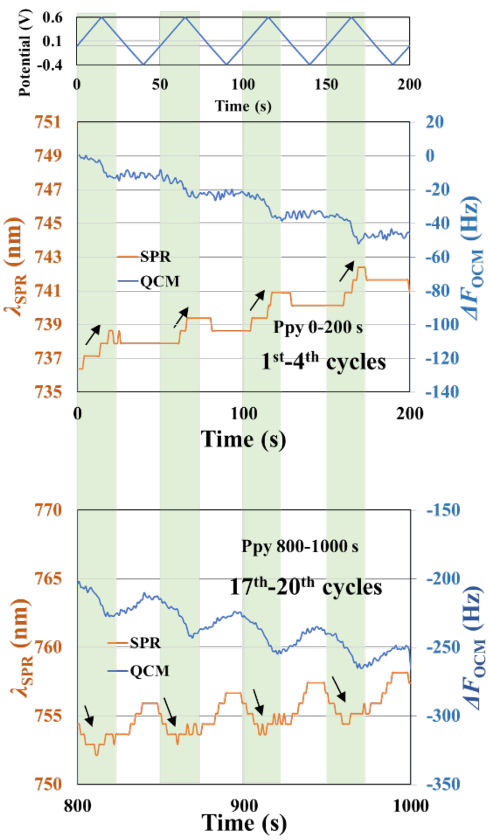

Fig. 2. Response curves of λ_{SPR} and ΔF_{QCM}.

P-40

Portable Sensing-Driven Smart Helper Device: Personalized, Rehabilitation-Oriented Assistive Technology

Jeyeon Kim[1], Wonkeon Hwang[1], Yeonji Oh[2], Gunoh Jung[1], Yeongeun Byeon[1], Junghyun Lee [1], and Jungsuk Kim[1*]

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Abstract

The independent mobility of people with disabilities still relies on canes and Braille blocks, which do not provide proactive and continuous guidance [1]. There is a need for low-cost, infrastructure-free solutions that operate indoors and outdoors and provide predictable guidance in real time. Traditional GPS/AI navigation depends on expensive sensors and computation and performs poorly indoors, whereas classical line tracing is not well adapted to human walking and variable environments [2]. This study presents a Raspberry Pi 5 visual to haptic aid that converts a colored guidance lane into vibration feedback in real time. The camera analyzes a vertically elongated central region of interest (ROI) using hue–saturation–value (HSV) segmentation and compares the red coverage with a threshold ($\theta \approx 0.7$). When the coverage remains above the threshold for approximately 1 second, the device emits 0.12 s vibration pulses at 0.2 s intervals and pauses when alignment is restored. The entire pipeline runs on device in Python; V4L2 camera access, udev (without root privileges), and systemd (auto start) simplify deployment. On highly textured floors, in mixed or ambiguously colored scenes, and under very low illumination, performance may degrade. Mitigation strategies include adaptive threshold and color models, lighting calibration, and selective sensor fusion.

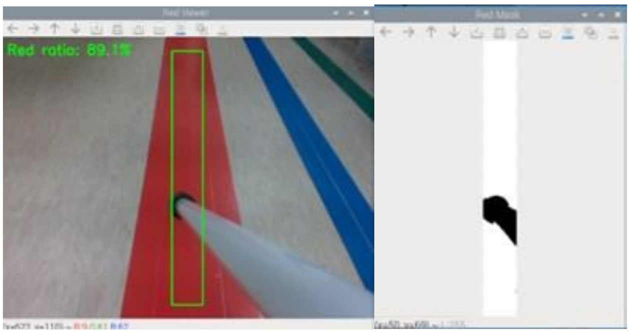

Figure 1. Composite system view of ROI-based red-lane detection and implementation

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P-41

Liquid Crystal-Based Beam Diffraction Devices and Their Applications

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In order to implement a beam steering device to steer light in real time, a transmissive beam deflector using liquid crystal was developed. Using electrically tunable liquid crystals, a virtual prism is formed through changes in phase, and light can be sent in the desired direction in real time through a driving system [1]. A large active area was secured and a beam steering element with a maximum diffraction angle of ±7.7° was implemented at an interval of approximately 0.02° based on the wavelength of 532 nm [2]. The diffraction efficiency was improved by implementing a driving algorithm to overcome the lowered diffraction efficiency at high diffraction angles [3]. Through the above, the position of the user's pupil is tracked through eye-tracking sensors and holographic images are sent in the desired direction, securing a viewing angle approximately 30 times wider than previous one, and applying this to a real-time holographic display [4]. In the future, it can also be applied to possible flat-lens and LiDAR applications.

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19 September (Friday)

PL-2 (Plenary)

Electronic Structure and Molecular Orientation of Amorphous Organic Films Studied by UV Photoemission Spectroscopy and Kelvin Probe

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Abstract

Amorphous organic semiconductor films are widely utilized in electronic devices such as OLEDs. A comprehensive understanding of their electronic states—including HOMO, LUMO, and in-gap states—is essential for constructing energy diagrams that explain device operation. Moreover, controlling molecular orientation is crucial for enhancing device performance. This presentation addresses the following key topics related to these points:

1. **Energy Level Alignment and Band Bending**
We explore the fundamentals of energy level alignment at organic/electrode interfaces, highlighting the influence of HOMO/LUMO tail states and in-gap states. The validity of the Fermi level alignment model is examined through concepts such as intrinsic and pseudo-Fermi levels.
2. **Direct Detection of Weak Electronic States in Organic and Inorganic Semiconductors**
We present examples of detecting weak density of states within the band gap using high-sensitivity UV photoemission spectroscopy (HS-UPS), constant final state yield spectroscopy (CFS-YS), and related techniques [1]. Additionally, we discuss the observation of anion states, exciton fusion, and exciton-anion annihilation processes for OLED materials.
3. **Impact of In-Gap States on Device Performance**
Using HS-UPS, we observed weak DOS in both organic and inorganic films and simulated hole injection and conduction behavior. Our findings demonstrate that shallow states near the valence band edge are critical for understanding hole transport mechanisms [2,3].
4. **Control of Spontaneous Orientation Polarization (SOP) in Polar Films**
SOP in OLED materials significantly affects charge carrier dynamics and device performance. We developed an “intermittent deposition” technique to control SOP by adjusting deposition intervals. Rotary Kelvin Probe measurements confirmed surface potential changes due to molecular relaxation during deposition, enabling modulation of SOP—including polarity switching [5]. We also briefly report SOP control using an instantaneous deposition-rate modulator equipped with a velocity selector [6].

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S13-I1 (invited)

Ultraflexible Organic Optoelectronic Devices for Skin-compatible Electronics

Sungjun Park
Ajou University, Korea

S13-I2 (invited)

Electrochemical Biosensing Interface Engineering for Continuous Biomarker Monitoring Systems

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Abstract

Wearable biosensors represent a promising opportunity to monitor human physiology through dynamic measurements of (bio)chemical markers in bio-fluids such as sweat, tears, saliva, and interstitial fluid in continuous and non-invasive way. Such new platforms can thus offer real-time (bio)chemical information toward a more comprehensive view of a wearer's health, performance, or stress at the molecular level in daily life. Continuous biomonitoring addresses the limitations of traditional invasive blood testing and provides the opportunity for early diagnostic and therapeutic interventions. My talk will focus on developing wearable electrochemical biosensors towards non-invasive health monitoring opportunities and evaluating the potential impact of such wearable point-of-care devices on our daily life and clinical settings. It will cover various types of salivary, sweat and tear fluid based wearable biosensors utilizing mouthguard, tattoo patch, and contact lens form-factors. Significant effort have been made on developing enzymatic electrochemical sensors for continuous metabolite monitoring towards healthcare in daily-life or managing diabetes like chronic disease. Recently, we demonstrated personalization strategy for accurate estimation of blood glucose utilizing non-invasive biofluids. Lastly, the talk will also cover the latest efforts on developing small molecule monitoring wearable sensors, focusing on nanoscale molecularly imprinted polymer via quantum electrochemical detection.

S13-I3 (invited)

Monitoring, Manipulating and Mimicking Motor Systems

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Abstract

Motor systems employ coupled actuation and perception to interact with the environment. On the actuation end, myofibers execute voluntary contraction once triggered by motor neurons locally at the neuromuscular junctions. We developed a cytoadhesion-inspired patch to locally couple the electromechanical signals of forearm muscle, showing exceptional promise in distantly retrieving the amplitude, speed, and strength of hand gestures. On the perception end, visual and haptic inputs are coupled to precisely localize an object through the sensory neurons. Hence, we constructed an artificial neuromuscular junction to fulfil the fusion of visual and haptic signals. Meanwhile, we constructed a low-voltage triggered artificial muscle with power-efficient mechanical outputs, as well as the self-sensing capability. In addition, smart systems that can deliver theragnosis of such motor disorders as early osteoarthritis has been established, by reprogramming mitochondrial metabolism in synovial macrophages upon local injection. In short, the locally coupled monitoring and modulating allows a closer access to the function programmability of motor systems.

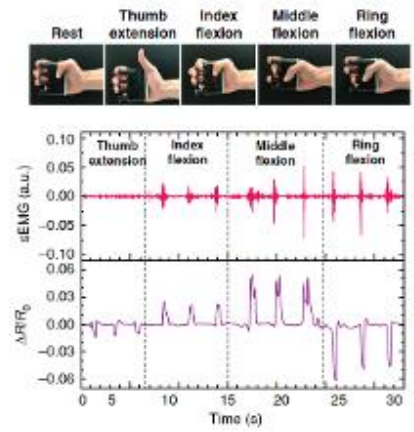

Figure 1. Precise gesture recognition with a locally coupled electromechanical patch

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S13-O1

Softness-perceptive e-skin

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Recently, e-skins integrated with various sensors on a flexible film have attracted significant attention due to their potential applications in robotics and wearable devices. In robotics, many studies have emulated functionalities of human skin, such as tactile pressure perception. However, few have successfully achieved softness detection of objects.

In this study, we present an e-skin composed of six pressure sensors and an echo state network (ESN), which excels at analyzing time-series data. The sensors are aligned in a row. The top electrodes, coated with carbon black (CB), have small dome-shaped structures. When pressure is applied, the top electrodes contact the bottom electrodes, decreasing the initial resistance of ~866.6 kΩ to ~6.2 kΩ under ~1.3 kPa. Since the outputs of the six sensors vary with object softness, softness and applied pressure can be inferred from the resistance values and their spatial distribution.

Experimental measurements revealed that object deformation differs with softness and applied pressure, resulting in distinct pressure distributions across the device. Based on this, we collected data for machine learning and developed ESN algorithms. For both applied pressure and softness detections, the system achieved an accuracy of over 0.9 for softness detection and an average NMSE of 0.0564 for applied pressure detection. Furthermore, to demonstrate the sensor's capabilities, the device was attached to a robot hand, which then grasped various objects (Figure 1). In this demonstration, softness detection accuracy reached 0.987, and the NMSE for pressure detection was 0.00371.

The proposed e-skin, combined with an ESN-based algorithm, accurately estimated both object softness and applied pressure. Its robust performance on a robotic platform underscores its suitability for practical tactile sensing applications.

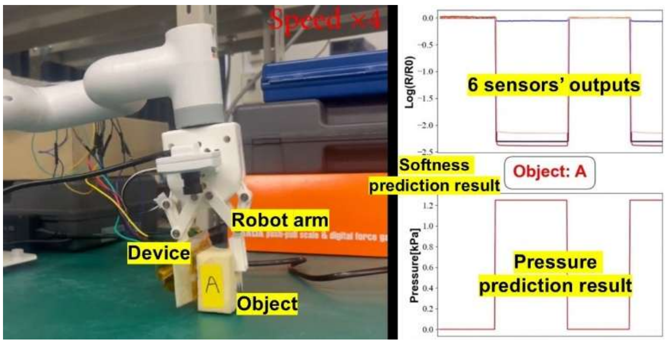

Figure 1. Demonstration of sensor system on the robot arm.

Acknowledgements: This work was partially supported by JST ALCA-Next, JSPS KAKENHI, JST ASPIRE for Rising Scientists, and the Murata Science Foundation.

S13-I4 (invited)

From Stretchable Polymer to Soft Neuromorphic Electronics

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Abstract

The pursuit of electronics that emulate biological systems while offering mechanical compliance drives our research into advanced polymer materials and artificial neural networks. This presentation will show our explorations, beginning with fundamental strategies of stretchable polymer electronics, designing synaptic devices through various material innovations, and culminating in their application in artificial neural networks. Our research starts with a photo-curable stretchable polymer device, where we developed photo-curable stretchable polymer semiconductor blends, forming a semi-interpenetrating polymer network (SIPN) via thiol-ene chemistry. Based on the achievement of stretchable polymer devices, we moved to synaptic devices, initially focusing on ambipolar conjugated polymers and high-k dielectrics. By studying donor-acceptor polymer structures and various crosslinked dielectrics, we successfully demonstrate charge-trapping or ferroelectric-like behaviors, enabling the emulation of key synaptic functions. Finally, we include Li+ ion conductors to the crosslinked dielectrics as a solid-state Li+ electrolyte dielectrics for synaptic transistors and artificial neural networks. These polymer synaptic devices successfully emulate crucial synaptic behaviors with low energy consumption and maintain performance under strain. This comprehensive approach, from material design to device integration, emphasizes the potential of stretchable polymer electronics to create intelligent, adaptable systems for next-generation human-machine interfaces and artificial intelligence.

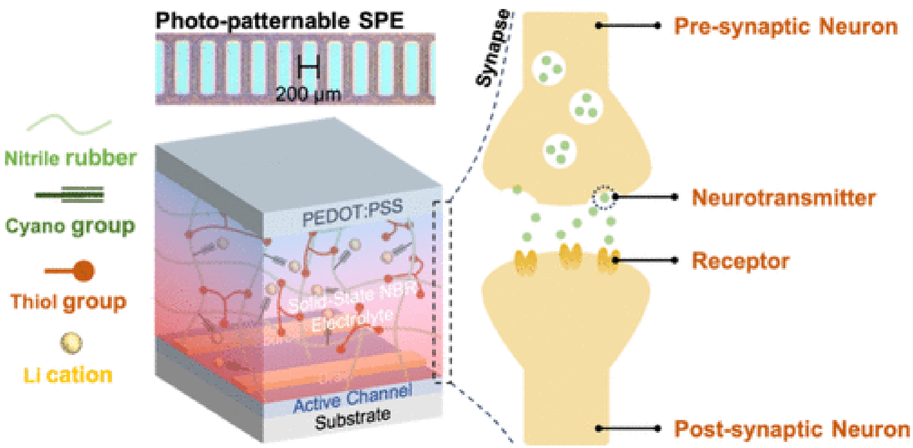

Figure 1. Solid-state Electrolyte Polymer Synaptic Transistor.

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S13-I5 (invited)

Molecular Dipole Engineering of Polymer Semiconductors for Stretchable Electronics

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Abstract

Achieving mechanical stretchability with high electronic properties remains a key challenge in polymer semiconductors. This talk introduces a dipole engineering strategy that uses isomeric linkers with increasing dipole moments to modulate polymer microstructure and address this trade-off. The resulting polymer features a decoupled microstructure, combining reduced long-range crystallinity with intensified short-range aggregation, enabling a 4-fold increase in crack onset strain and a 1.5-fold improvement in field-effect mobility. When applied in organic photodiodes, the material delivers higher quantum efficiency and detectivity, maintaining stable performance under 80% strain. It also improves volumetric capacitance and transconductance in organic electrochemical transistors. These results highlight dipole modulation as an effective approach to simultaneously optimize the mechanical and optoelectronic performance of stretchable polymer semiconductors.

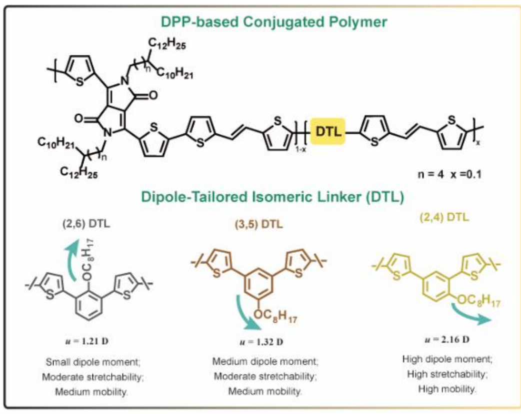

Figure 1. Dipole-tailored isomeric linkers decouple aggregation from crystallinity in conjugated polymers, enabling simultaneous improvements in stretchability and charge transport property.

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S13-O2

A stretchable hole transport layer for high-frequency, soft diodes

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Abstract

Soft and stretchable diodes capable of high-frequency operation enable applications such as wireless power transfer and signal processing[1]. However, the operation frequency of stretchable diodes has been limited to ~10 MHz, which is limited by the lack of stretchable injection layers that can handle high current density.

In this study, we developed a stretchable hole transport layer (HTL) to achieve high-current density stretchable diodes. The HTL was prepared by blending highly conductive PEDOT:PSS with perfluorinated ionomer (PFI)[2]. Additional methanol assisted the uniform mixture and wettability of the solution. The resulting ITO/PEDOT:PSS:PFI/IDT-BT/Au Schottky diodes exhibited a high-current density of 3.1 A/cm^2 at 3 V with negligible hysteresis (Fig. 1a), which is high enough for the operation at 100 MHz. In addition, PEDOT:PSS:PFI showed improved stretchability of 140% although pristine PEDOT:PSS showed stretchability of 30%. Combining stretchable cathode contact will enable 100-MHz stretchable diodes that realize robust wireless communications of soft electronic devices.

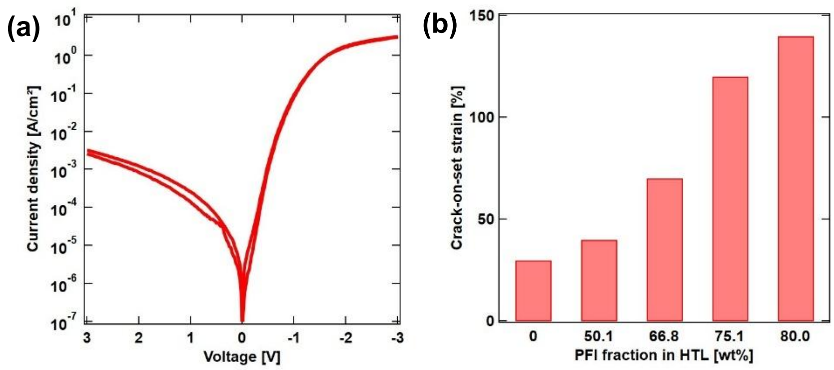

Figure 1. (a) Current density–voltage characteristic of the PFI/PEDOT:PSS mixture containing 80 wt% PFI in solids. (b)The crack-on-set strain

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S13-O3

Highly reliable stretchable hybrid devices combining stretchable materials and rigid electronic elements

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One promising approach for processing information obtained from stretchable devices is machine learning. However, the low repeatability and large individual differences inherent in existing flexible sensors have hindered the collection of consistent training data required for machine learning[1]. Highly stretchable devices incorporating rigid sensors are required to achieve both reliable data collection and high device stretchability.

Here, we developed a stretchable hybrid sensor array capable of measuring inertial data even under 150% elongation by incorporating MEMS inertial sensors with high reproducibility and measurement accuracy into a stretchable silicon rubber substrate. A multi-layer protective structure of polymer with gradually changing rigidity around the hard element was introduced to suppress sudden strain gradients around the high-rigidity area, thereby achieving high deformability(Fig.1a). High-elasticity liquid metal was used for the wiring between sensors to achieve high reproducibility in inertial measurement even under high deformation(Fig.1b). American Sign Language motion data was collected using this device and classification was performed using a deep learning model. As a result, 65 types of sign language, were successfully classified with a 95% accuracy rate(Fig.1c).

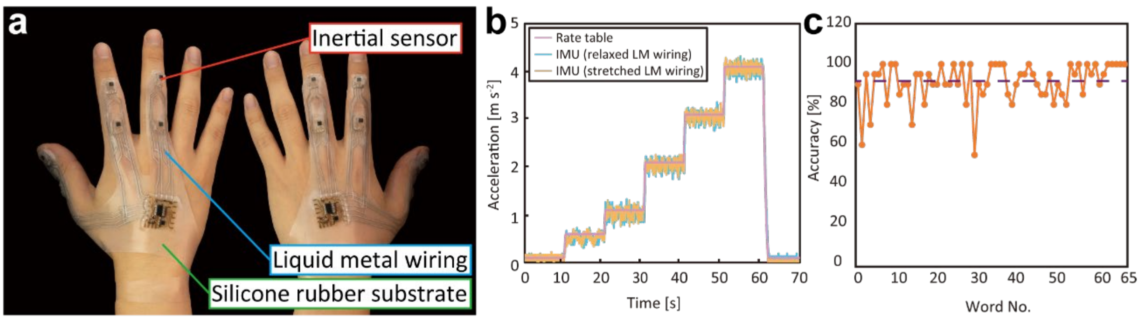

Figure 1. Stretchable hybrid device with rigid components. a, stretchable hybrid device with a multilayer protective layer. b, output from an inertial gyro sensor with relaxed and stretched liquid metal wiring. c, Classification accuracy of 65 words of American sign language using stretchable device and deep learning.

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S13-I6 (invited)

Design and Synthesis of Stretchable and Self-healing Polymers for Electronic Skin Applications

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In the past, polymers have been widely used in many fields. Designing the structure of polymers to affect their functions is a crucial topic in academia and industry, which is the core research of our group. In this talk, we will introduce our design strategies of polymer structures for nature-inspired applications, including the application in electronic skin and artificial photosynthesis as follows. Inspired by the human skin, this conformable, stretchable and biodegradable organ formed a remarkable functions for us, such as tactile sensing, temperature sensing, stretchability, and self-healing ability. In this part, we are interested in exploring the field of electronic skin (e-skin) by adopting the polymer molecular engineering, dreaming to mimic the properties of skin, especially in stretchability and self-healing ability, to create novel applications.

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S13-O4

Armband-type Hand Motion Capture System Integrating sEMG and IMU Sensors

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Abstract

Recent advances in hand motion capture have explored the integration of surface electromyography (sEMG) and inertial sensors, particularly using stretchable conductive materials[1][2][3]. However, existing devices face challenges in long-term durability, comfort, and stability during repeated use. In this study, we developed a stretchable armband device that enables reliable, high-precision sensing of sEMG and acceleration signals for daily wear. The device uses rigid metal electrodes for skin contact and liquid metal paste for wiring, achieving both flexibility and electrical stability. All sensing circuits, including power supply, IMU, and sEMG acquisition units, are integrated on a flexible substrate to ensure mechanical stretchability. A hybrid structure of materials with different elastic moduli was applied to reinforce junctions, maintaining stable signal acquisition after more than 30 cycles of wearing. Using the captured multimodal signals, we successfully recognized 26 static fingerspelling gestures and 30 dynamic sign language words with over 90% classification accuracy. This work demonstrates a promising direction for high-functionality wearable interfaces and practical applications of stretchable electronics.

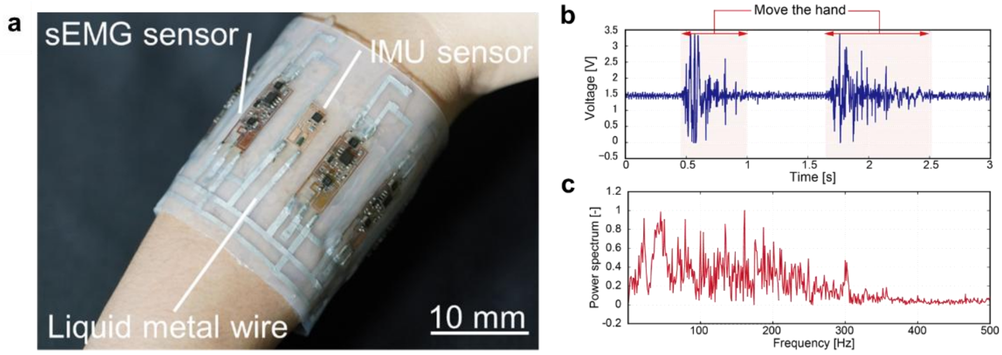

Figure 1: Stretchable hybrid motion capture system integrating sEMG and IMU sensors, showing developed armband device (a), representative sEMG output (b), and frequency-domain (FFT) analysis of recorded signals (c).

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S15-I1 (invited)

Structure-Property Relationships in Thienoacenes for Improved Transport Properties

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In spite of tremendous progress in molecular design, engineering and processing, only few small molecule organic semiconductors (OSCs) have reached charge carrier mobilities (μ) higher than 10 cm^2/Vs, typically with single-crystal devices. However, μ is a material property and not a molecular one. It is thus of paramount importance to take supramolecular order into consideration at all length scales. As recently evidenced, the best OSCs tend to self-organize into large plate-like single-crystals exhibiting a layer-by-layer herringbone packing motif.[1] Moreover, thermal lattice fluctuations cause temporal variations of transfer integrals (J) and impose a transient localization of charges leading to reduced macroscopic μ in these weakly bonded van der Waals solids.[2] We will present recent progress achieved in our group in terms of molecular design and understanding of the impact of thermal energetic disorder: design by theory, crystal engineering, quantum-chemical calculations and evaluation of transport properties in electronic devices.

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S15-O1

A plot of quadrupole moments in organic semiconductors as a phase diagram of the crystal structures

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Abstract
A two-dimensional plot of in-plane quadrupole moments in organic semiconductors provides a "phase diagram" of the crystal structures [1]. The slight positive charges on aromatic hydrogen result in positive quadrupole moments both along the molecular long- and short-axes Q_{xx} and Q_{yy}, and acenes and thienoacenes (red and orange in Fig. 1) have the herringbone (HB) structure. Compounds with electron-deficient rings (blue and violet) have negative Q_{yy}, leading to the stacking structures. Fused thiophenes (pale blue) have a HB-like θ-structure with a large dihedral angle of 130°, constituting a "transition region" between the HB and stacking structures. Compounds with terminal CF_3 and perfluorophenyl groups (yellow and light green) have negative Q_{xx}, forming the stacking structure as well. This is because axial moments ($Q_{xx} = Q_{yy} = -(1/2)Q_{zz}$) on the diagonal line prefer the T-type molecular arrangement, whereas biaxial moments ($Q_{yy} = 0$ and $Q_{zz} = -Q_{xx}$) lead to the stacking structure.

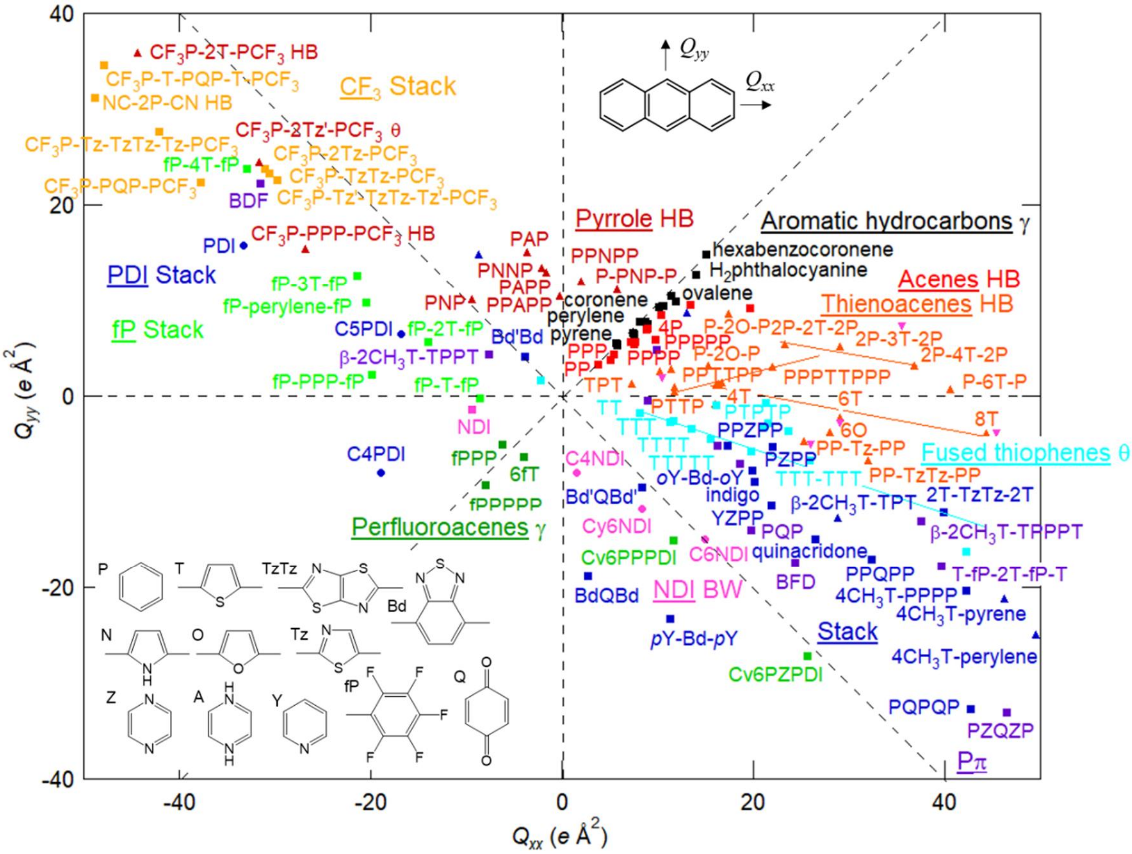

Figure 1. In-plane quadrupole moments Q_{xx} and Q_{yy} (B3LYP/6-31G on Gaussian 16) and the crystal structures indicated by color. PTTP designates benzothiobenzothiophene, and 4T is quaterthiophene.

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S15-O2

Stepwise Quantum Chemical Optimization Approach for Predicting Crystal Structures of Layered Organic Semiconductors

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The electronic properties of organic semiconductors (OSCs) are strongly influenced by their molecular packing motifs, or crystal structures. While recent studies have explored molecular design strategies to achieve high-performance OSCs [1], accurately predicting their crystal structures at the molecular design stage remains a significant challenge. Consequently, the development of high performance OSCs often relies on time-consuming experimental efforts to determine actual crystal structures. Crystal structure prediction (CSP) is therefore expected to accelerate materials development. However, conventional CSP methods do not adequately provide energy potential maps, which are essential for precise controlling molecular arrangements [2].

To address this issue, we focus on the high crystallinity and symmetry of layered OSCs and model their crystal structures using a rational and minimal set of variables. We employ a stepwise optimization approach based on energy potential mapping derived from dispersion-corrected DFT calculations of intermolecular interactions [3]. The model begins with a monomolecular layer, where the short molecular axes are arbitrarily positioned and oriented under glide symmetry, while the long axes remain parallel and unshifted. In the first optimization step, intralayer molecular arrangements are refined by adjusting dihedral angles (2α) and the unit cell parameters (a and b), as illustrated for pentacene in Fig. 1. Further optimization is performed by introducing long-axis inclinations, torsions, and interlayer displacements.

We demonstrate the applicability of this method to a series of polyacenes and mono-alkylated-BTBT derivatives. These OSC molecules form herringbone packing arrangements and exhibit distinct polymorphs, depending on the number of fused rings (in the former) or the alkyl chain length (in the latter). Our method not only accurately reproduces the crystal structures of each polymorph, but also provides insights into the underlying mechanism of polymorph formation.

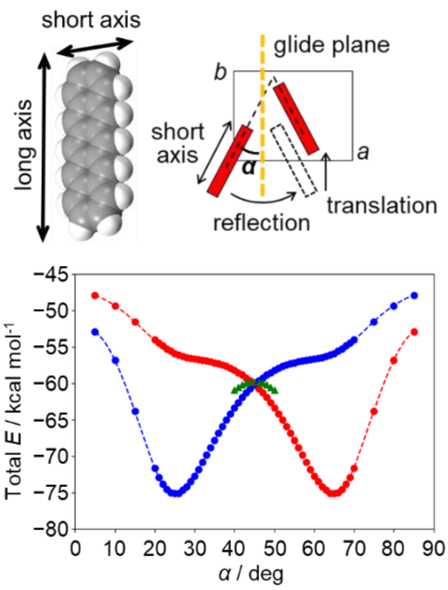

Fig. 1 First step optimization of the intralayer herringbone packing structure of pentacene.

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S15-O3

Flip-Flop Dynamics in Smectic Liquid-Crystal Organic Semiconductors Revealed by Molecular Dynamics Simulations

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Abstract

Smectic liquid crystal (SmLC) organic semiconductors, particularly asymmetrically-substituted BTBT derivatives, exhibit exceptionally high charge carrier mobilities due to their self-organizing layered structures. While the flip-flop motion of molecules—the inversion of molecular long axes—is crucial for phase transitions, its mechanism in polar SmLCs remains poorly understood. We performed fully atomistic molecular dynamics simulations of *p*Tol-BTBT-C$_{10}$ [1], which possesses a polar layered structure where all alkyl chains orient in the same direction (**Figure 1a**). Our simulations successfully reproduced the crystal/SmE/SmB phase transitions at simulated temperatures of 425 K and 495 K, respectively (**Figure 1b**). The SmE phase exhibited herringbone ordering with melted alkyl chains, while the SmB phase showed interlayer diffusion and molecular inversions. Detailed trajectory analysis revealed a unique "lie-down stand-up" mechanism for molecular flip-flop motion in the SmB phase: molecules slide out of their smectic layer, lie horizontally in the interlayer region ($\theta \approx 90°$), then reenter either the original or adjacent layer with inverted orientation (**Figure 1c**). This mechanism, occurring within 1 ns at 510 K, explains molecular inversion in polar SmLCs. Our findings provide fundamental insights into the self-assembly dynamics of high-performance organic semiconductors and their thermal stability.

This work was supported by JST (JPMJCR18J2, JPMJFS2104). The computer resources were offered by “General Project by Research Institute for Information Technology,” Kyushu University.

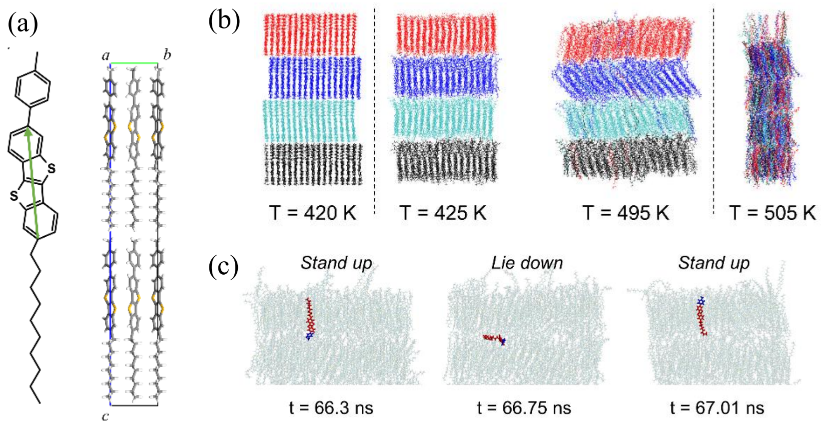

Figure 1 (a) Molecular and crystal structures of *p*Tol-BTBT-C$_{10}$. (b) MD simulation snapshots just below and above transition temperatures. (c) Molecular inversion at 510 K. Red: BTBT and alkyl chain; blue: *p*-tolyl group. [2]

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S16-I1 (invited)

Electronic Tile as Energy-Efficient Reflective Display Units for Walls and 3D Structures

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Abstract

Electronic tiles (e-Tiles) based on electrophoretic e-Paper technology[1)] hold significant promise for large-area, energy-efficient display applications. We prototyped 10 cm x 10 cm e-Tiles and successfully demonstrated a 2 m x 2 m (4 m^2) display constructed from 400 of these units. This 4 m^2 display exhibited remarkably low power consumption of only 4 watts. Beyond planar surfaces, the feasibility of cubic displays was also successfully demonstrated[2)]. Furthermore, the paper reports promising results from durability tests of the e-Tiles.

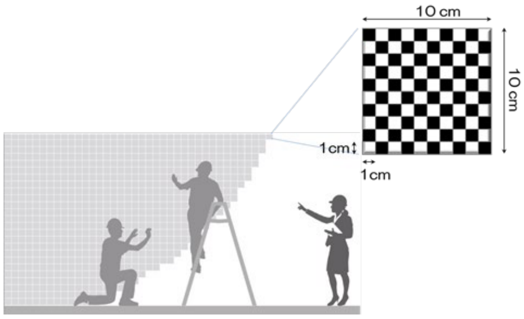


Fig. 1. Concept of the e-Tile.

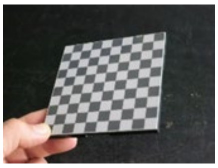


Fig. 2. Prototype of a 10 cm x 10 cm e-Tile.

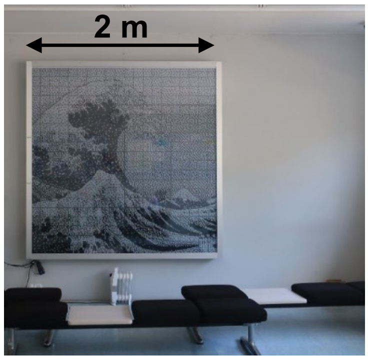
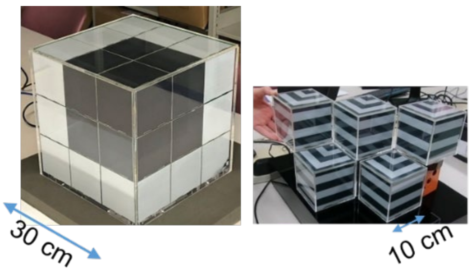


Fig. 3. Large-area 4 m^2 display constructed from 400 e-Tiles.

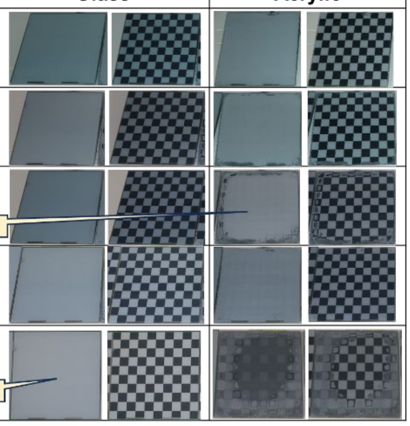


(a) 45 tiles per cubic unit. (b) 5 tiles per cubic unit.

Fig. 4. Cubic displays utilizing e-Tiles.

Table 1. Durability test results for e-Tiles.

Rewriting times [Million times]	Surface layer	
	Glass	Acrylic
0		
10		
18 Degradation		
25		
43 No degradation		



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S16-I2 (invited)

Recent Progress on Electrochromic Devices Using Metallosupramolecular Polymers

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Abstract

Electrochromic (EC) devices with nonvolatile properties are expected to be applied for energy-saving displays and smart windows, because continuous power supply is not necessary to keep both the colored and colorless states.

Various EC materials including WO_3, viologens and π-conjugated polymers have been developed so far, but we focus on metallosupramolecular polymers (MSPs) because of convenient layer preparation on an ITO glass by spray-coating and excellent EC properties. Recent research progress on MSPs is reported in this presentation.

Introduction of two metal ion species in MSPs is anticipated to cause multicolor EC changes, based on the different redox potential between the metal species. We reported multicolor EC properties of MSPs with two or three metal ion species.[1-3] However, it is difficult to introduce two metal ion species precisely in two-dimensional MSPs, so call coordination nanosheets (CONASHs), because very limited metal ion species which can be complexed with organic ligands at room temperature at the water/dichloromethane intreface, are able to be introduced in the CONASH structure. No heating is acceptable in this complexation method, so it is quite hard to include inert metal ions in CONASHs.

To solve the issue, we presented a concept of metalloligands, which have a metal complex moiety. We designed and synthesized metalloligands containing inert metal ions (Os^{2+}/Ru^{2+}), and used them to bind labile ions (Fe^{2+}) at the liquid/liquid interface to construct heterometallic CONASHs (HMCONASHs).[4]

These HMCONASHs possess reversible dual redox activity and exhibit wide absorption and electrochemical windows. Furthermore, HMCONASH films exhibit multicolor EC changes at different voltages, suggesting potential for various applications. This synthetic approach may pave the way for creating CONASHs with diverse structures and functions that are difficult to achieve using traditional synthetic approaches.

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S16-O1

Data-Driven Design of High-Performance Electrochromic Devices

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Abstract

Electrochromic is the reversible change in visible light absorption triggered by voltage[1], with applications in smart windows and low-power displays. Metallo-supramolecular polymers (MSPs) are promising electrochromic materials due to their unique structures. In this research, we introduce materials informatics by selecting several structural factors of MSPs. These were systematically varied using orthogonal design. Machine learning was also applied to model how electrolyte composition affects conductivity and coloration efficiency (CE), aiming to enhance device performance.

Models were implemented in Python (v3.12) using scikit-learn and related libraries.[2] The initial dataset was generated through design of experiments (DoE) methods.[3] Each polymer was synthesized and characterized according to the literature.[4] Experimental results were used to iteratively improve the model. For electrolyte analysis, the electrolyte data in original database was manually extracted from the literatures and used to train a series regression models to evaluate electrolyte influence on conductivity and CE.

In conclusion, Gaussian processes demonstrate high accuracy in predicting the properties of MSPs, especially, one iron-based showed high CE which was confirmed by experiments. While the Ridge regression model shows high accuracy and stability in predicting electrolyte layer properties. In the future, we will extend the application of both models to other performance aspects of electrochromic devices.

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S16-O2

Synthesis and Characterization of Ru/Zn-Based Metallosupramolecular Polymer with Electrochromic and Electrofluorochromic Properties

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Metallosupramolecular polymers (MSPs) are coordination polymers consisting of multidentate chelating ligands with transition metal ions. MSPs with reversible electrochromic (EC) and electrofluorochromic (EFC) properties are expected to be applied to next-generation displays, fluorescent devices, and energy-efficient applications.[1] However, EC/EFC devices using bimetallic MSPs still remain unexplored. To fill this gap, we synthesized a novel Ru/Zn-based MSP (polyRuZn) for advanced optoelectronic devices with EC/EFC switching capabilities.

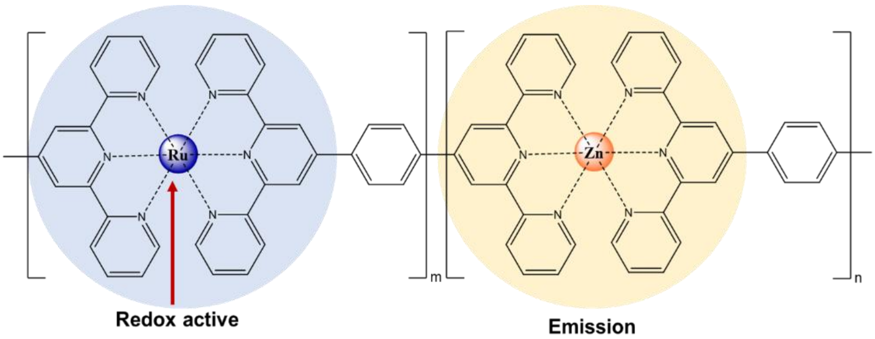

Figure 1. Structure of polyRuZn.

A polyRuZn film on an ITO glass showed stable, reversible EC properties with rapid switching speed and excellent cycling stability. A quasi-solid-state device (QSSD) was also fabricated using polyRuZn which exhibited both reversible EC and EFC properties. In the oxidized state of Ru ions, blue fluorescence was emitted under UV excitation, and subsequent reduction reverted to its original dark hue. Furthermore, we used data science techniques to analyze the EC/EFC behavior of this bimetallic MSP system. 2D device analysis revealed uniform EC/EFC switching behavior across the electrode surface, confirming homogeneous electrochemical processes and robust device performance. In conclusion, this study suggests that the synthesized polyRuZn is a promising functional material for applications in advanced fluorescence-based devices.

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S16-I3 (invited)

Digital information which is invisible under visible light but detectable under infrared light

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Abstract

This paper presents a method for embedding invisible digital information, such as QR codes, onto metallic surfaces using the thin-film interference properties of niobium oxide (Nb_2O_5). The core concept relies on the periodic repeatability of color produced by thin-film interference: specific film thicknesses generate recurring visible colors [1]. Of particular interest is a 90 nm thick Nb_2O_5 layer, which appears nearly achromatic in the visible spectrum and closely resembles the untreated niobium surface, making it effectively invisible to the human eye. However, while this oxide layer is indistinguishable in visible light, it displays significantly different reflectance in the infrared (IR) range. This optical contrast enables the creation of latent images that can only be detected using IR cameras. In the experiment, a QR code pattern was fabricated on a niobium plate using a toner-printed mask and photoresist. The plate was anodized at 35 V in a citric acid solution for 70 seconds, forming a 90 nm Nb_2O_5 layer selectively on the surface. Spectral analysis confirmed minimal reflectance differences in the visible range, but clear contrast in the near-infrared, as shown in Figure 1.

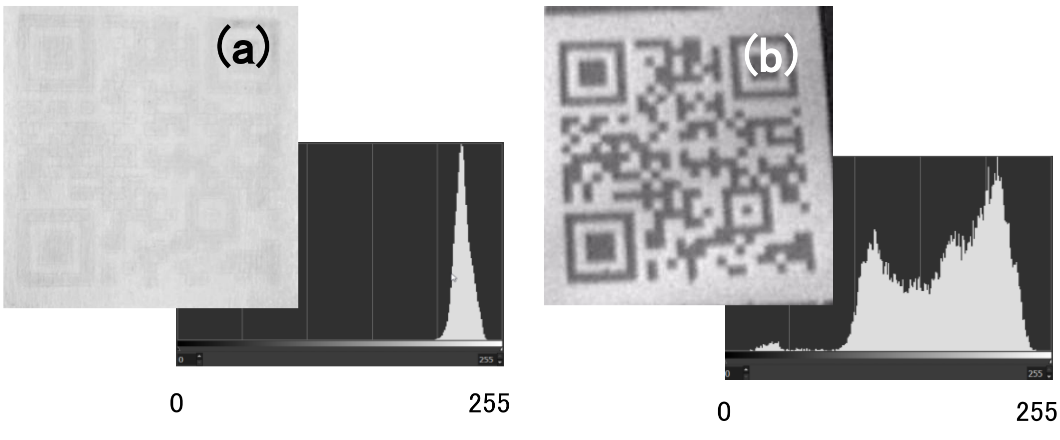

Figure 1 Niobium plate with a latent QR code photographed by a conventional camera(a) and an infrared camera(b), and their histograms.

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R3-O1

Synaptic Transistor Memory Using DPP-based Polymer and Biomass Additive

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Recently, utilizing eco-friendly biomaterials to manufacture "green" organic electronic devices has become increasingly important. Biomass, once considered as waste or used for low-value thermal energy production, is now recognized for its great potential as a sustainable resource. In this study, we investigate the incorporation of a lignin-derived compound, dimethyl 2-pyrone-4,6-dicarboxylate (PDC-DE), into the p-type semiconducting polymer, poly(diketopyrrolopyrrole-thiophene) (PDPP4T), for organic field-effect transistor (OFET) memory device. PDC-DE is synthesized from 2-pyrone-4,6-dicarboxylic acid (PDC), a metabolic product of lignin degradation, and serves as a biomass-derived additive to impart charge-trapping capabilities to the semiconducting polymer matrix. The incorporation of 15 wt% PDC-DE into PDPP4T enhanced charge retention capability and expanded the threshold voltage modulation range. These effects originate from the accessible charge-trapping sites formed by PDC-DE. Unlike OFETs without additives, which exhibited a gradually narrowing memory window due to trap saturation during repeated gate voltage scans, the presence of PDC-DE enabled the memory window to gradually expand during programming/erasing cycles, indicating the presence of field-activated trapping behavior. Finally, the additive enabled the realization of synaptic-like functionalities: measurements of excitatory post-synaptic currents (EPSCs) revealed paired-pulse facilitation and pulse-number-dependent long-term potentiation, closely resembling key features of biological synapses. These findings demonstrate that PDC-DE noy only enhances memory stability but also endows stable neuromorphic characteristics. This approach offers a promising strategy for integrating sustainable material sources with advanced electronic functions in next-generation bio-inspired devices.

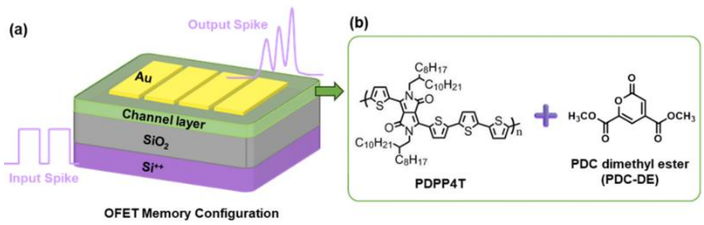

Figure 1. (a) Schematic diagram of OFET memory and (b) chemical structures of the materials used in this study.

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R3-O2

Exploring Intramolecular Triplet–Triplet Annihilation Upconversion by Double Sensitization

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Abstract

Intramolecular triplet-triplet annihilation upconversion (TTU) using dimers composed of two anthracene units has distinct advantages over intermolecular TTU, as it can enable upconversion even in diluted states[1]. However, clear evidence for the occurrence of the intramolecular TTU remains insufficient. In this study, we focus on the double-sensitization mechanism, which is caused by double triplet energy transfer from triplet sensitizers to the dimers[2]. It is a phenomenon inherent in the intramolecular TTU. We provide direct evidence of intramolecular TTU by investigating the dependence of the TTU phenomenon on dimer concentration under conditions where the double-sensitization mechanism is dominant[3].

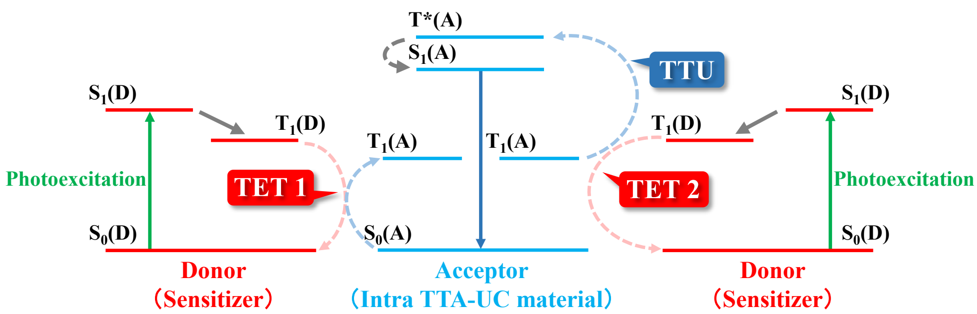

Figure 1. Energy-level diagram of the intramolecular triplet-triplet annihilation upconversion (TTU) by double-sensitization (DS) mechanism. S_0, S_1, T_1, and T* represent the ground state, singlet excited state, triplet excited state, and excited state containing two T_1 states, respectively.

This work was supported by JSPS KAKENHI grant numbers JP24K01572, 23H05406, and JP23K20039.

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R3-O3

Structural variation in semiconducting polymers for organic photovoltaics

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The semiconducting copolymers are widely used as an electron-donating material for organic photovoltaics (OPVs). These copolymers are composed of the two different units, D (donor) and A (acceptor), and are polymerized by a cross-coupling reaction of these units. The ideal cross-coupling reaction gives a perfect alternating polymeric structure like -D-A-D-A-D-; however, in reality, a small amount of homo-coupled part (-D-D- or -A-A-) is present. This non-ideal structure can be structural defects in the polymer main chains and leads to batch-to-batch variation of polymers and reduces electronic device performance.

We have recently developed a new methodology to precisely quantify the ratio of the two units in copolymers using X-ray photoelectron spectroscopy (XPS). The deviation of the ratio from 1:1 indicates the presence of structural defects; thus, the actual defect concentration in the copolymer can be quantified. We evaluated the ratios of the commercially available conjugated polymer donor materials PM6 purchased from different suppliers, and found that PM6 had a slight excess of the D unit in all three samples: the main chain structure of commercially available polymer samples varies depending on the supplier. We tested these PM6s in OPV devices and revealed that the OPV power conversion efficiency decreased with higher concentration of the defects. The decrease in conversion efficiency was mainly caused by a smaller FF, and it was suggested that the transport of charges is affected by the disruption of the main chain structure.

In summary, (1) we developed a method for quantitatively evaluating the unit ratio of conjugated polymers using XPS, and (2) we evaluated the main chain structure of high-performance donor polymers and discussed their influence on solar cell properties. It is empirically known that there are batch differences in conjugated polymer materials that cause the properties to vary from one synthesis lot to another. The general understanding is that the variation in molecular weight is probably the cause. Still, in addition to the molecular weight, the variation in the main chain structure itself may also be a factor.

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R3-O4

Operating lifetime dependent on electron injection layer for inverted blue exciplex upconversion-type OLEDs

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Introduction

Blue is one of the three primary colors and is important for displays. However, blue OLEDs have high emission energy and a short operating lifetime. Further improvement in operating lifetime is required for commercialization. Therefore, the proposed exciplex upconversion-type OLED (ExUC-OLED) has been reported to have a longer lifetime than conventional OLEDs[1]. Inverted OLEDs have improved atmospheric stability compared to control structures[2].

In this study, the inverted blue ExUC-OLEDs were fabricated, and their operating lifetimes and device characteristics were evaluated.

Experiments

The chemical structures of the molecules used are shown in Fig. 1. The inverted ExUC-OLED consists of an indium-tin-oxide (ITO) as the transparent cathode, PEIE or Al (1 nm)/Liq (1 nm) as the electron injection layer, HFl-NDI (50 nm) as the acceptor layer, α,β-ADN (50 nm) as the donor and blue emitting layer, MoO_3 (10 nm) as the hole injection layer, and Al (80 nm) as the anode. PEIE was formed by spin-coating and other materials were formed by vacuum evaporation. In the control device, ITO was used as the anode, followed by MoO_3 (10 nm), α,β-ADN (50 nm), HFl-NDI (50 nm), LiF as the electron injection layer, and Al (80 nm) as the cathode.

Results and discussion

The luminance (L)-current density (J) characteristics show that inverted ExUC-OLED using PEIE has better conversion efficiency than that using Al/Liq (Fig. 2). The maximum luminance of this device was 371 cd/m^2, which was equivalent to that of a control device. In the operating lifetime characteristics, the lifetime until the luminance decreases to 80% of the initial luminance (100 cd/m^2) (LT_{80}) was improved more than 10 times from 21 to 213 hours for the control and inverted structures (Fig. 3). However, emission photographs of the inverted OLEDs show an increase in dark spots in the device using PEIE (Fig. 4). Therefore, the improvement in operating lifetime may be an apparent effect due to the formation of dark spots.

Acknowledgments

This work was supported by JSPS KAKENHI (JP24K00921) and Kato Foundation for Promotion of Science.

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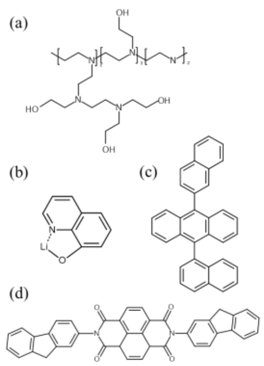

Fig. 1 Chemical structures of (a) PEIE, (b) Liq, (c) α,β-ADN, and (d) HFl-NDI.

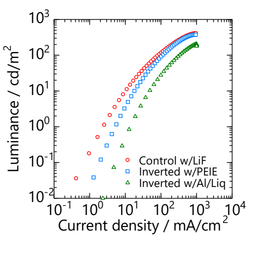

Fig. 2 *L-J* curves of control and inverted ExUC-OLEDs.

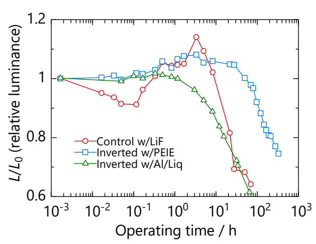

Fig. 3 Operating lifetime measurement of control and inverted ExUC-OLEDs. (w/LiF: 112.5 mA/cm^2, w/PEIE: 175 mA/cm^2, w/Al/Liq: 345 mA/cm^2).

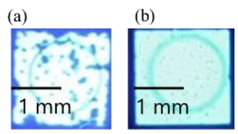

Fig. 4 Emission photographs of inverted OLEDs after LT_{80}. (a) w/PEIE, (b) w/Al/Liq, black circles are marking of the measurement area.

R3-O5

Fabrication of Flexible Organic Thin Film Transistors Using Liquid Crystalline Organic Semiconductor Ph-BTBT-10 and Application to Image Sensor Pixels

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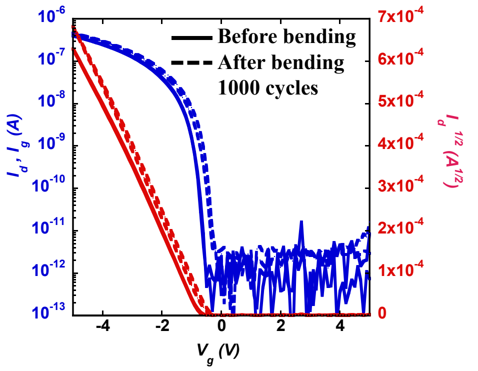
Polyethylene terephthalate (PET) is an economical flexible substrate, but has a low heat resistance temperature of about 150 ℃. We used a liquid crystalline organic semiconductor Ph-BTBT10 as the active layer and a photo-crosslinkable polymer PVCi as gate insulator to fabricate organic thin film transistors (OTFTs) below the heat resistance temperature of PET[1] [2]. The fabricated OTFTs were integrated with organic photo detectors (OPDs) using liquid crystalline $8H_2PC$ and applied to flexible image sensor pixels[3].

Fabricated OTFT shows typical transfer characteristics in saturation region before and after bending 1000 times with a radius of curvature of 1 mm as shown in Fig. 1 (a). The average mobility of 5 devices changed from 0.65±0.41 cm²/Vs to 0.67±0.38 cm²/Vs after bending. Since there was no significant difference in the transfer characteristics before and after bending, the active layer breakage or delamination of each layer were not occurred. The fabricated transistor showed durability for up to 1000 bending cycles. The fabricated OTFTs were integrated with OPDs and used as switching elements in image sensor pixels. Linear photo current response was obtained at light intensities larger than the dark current condition of the OPD and the on-resistance of the OTFT was sufficiently small relative to the OPD (Fig. 1 (b)). The linear dynamic range was calculated to be 51 dB.

(a)



(b)

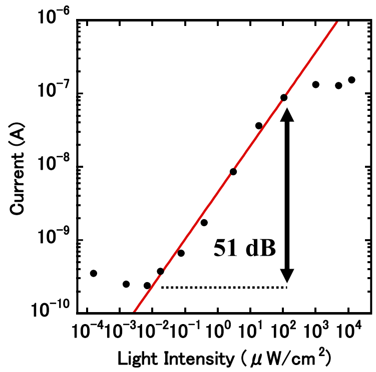


Figure 1. (a) Transfer characteristics of fabricated flexible OTFTs on PET film in saturation region (V_{ds} =-5 V) before and after bending for 1000 cycles with bending radius of 1 mm. (b) Photo current response of fabricated flexible image sensor pixel under 760 nm wavelength light irradiation.

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