E11

Organic and Hybrid Materials for Photovoltaic and Optoelectronic Devices

ICPST-43 (2026)

The 43rd International Conference of
Photopolymer Science and Technology

June Wed 24, 2026 13:30 - 15:25
Room C [Arcrea Himeji, Room 407]

E11. Organic and Hybrid Materials for Photovoltaic and Optoelectronic Devices

E11-1-1

Molecular Control of 1D Polaron Delocalization Driving High Mobility in Indacenodithiophene Copolymers

Christine Luscombe [1]

[1] Okinawa Institute of Science and Technology

Indacenodithiophene (IDT)-based conjugated polymers have been attracting much interest for having good charge mobility despite lacking long range order. Poly(indacenodithiophene-co-benzothiadiazole) (p(IDT-BT), which serves as a benchmark, exhibits remarkably low energetic disorder and high hole mobility even in a near-amorphous microstructure. This high performance is traced to its planar backbone, which fosters substantial intrachain polaron delocalization. Macroscopic charge transport is completed by sparse but efficient interchain contacts between acceptor units, effectively "stitching" the material together.1 A reduction in backbone planarity, as seen in poly(indacenodithiophene-co-benzopyrollodione) (p(IDT-BPD)), has a dramatic effect, increasing static energetic disorder and reducing monomer-to-monomer electronic coupling. This disruption forces charge carriers to become severely localized onto single IDT donor units. This result confirms that intrachain delocalization and efficient interchain coupling are paramount providing a generalized structural design principle for high-performance pi-conjugated semiconductors.

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E11-1-2

Improvement of efficiency and stability of ultraflexible emerging photovoltaics toward wearable applications

Kenjiro FUKUDA [1]

[1] The University of Osaka

By utilizing extremely thin substrates, emerging photovoltaics such as organic and perovskite solar cells can have extremely thin total film thicknesses. This allows for extremely lightweight solar cells with power generation per unit weight exceeding 10 W/g, and also provides excellent flexibility against bending. In this presentation, we will introduce our latest efforts to improve the efficiency and stability of such ultra-thin next-generation solar cells.

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E11-1-3

Sheet-type image sensor for biomedical imaging and sensing

Tomoyuki Yokota [1]

[1] The University of Tokyo

We have developed a sheet-type image sensor that enables high-resolution and high-speed reading. This sheet-type image sensor can take the high-resolution image of fingerprints and veins used for biometric authentication. In addition, the same sheet-type image sensor can measure the pulse wave which is one of the vital signs, and its distribution. The developed sheet-type image sensor is fabricated by densely integrating a high-efficiency readout circuit using an active matrix of a low-temperature polysilicon thin film transistor and a photodetector that uses a highly efficient organic semiconductor as a photosensitive layer. The resolution of the image sensor achieves 508 dots per inch (dpi) required for fingerprint authentication, and the organic photodetector consists of bulk hetero structure organic layer which has high photosensitivity to near infrared light with a wavelength of 850 nanometers (external quantum efficiency of 50% or more). It is easy to integrate the sheet-type image sensor into equipment and attach it to curved surfaces due to the thickness of the polymer base material is 10 micrometers, and the total thickness of the sheet-type image sensor is 15 micrometers.

Evaluation of vein and fingerprint images taken by this sheet-type image sensor showed that the contrast difference of the veins was less than 5% compared to images using a general CMOS image sensor. We confirmed that the conformable image sensor has high image quality equivalent to that of conventional CMOS image sensors. Since the sheet-type image sensor is thin and bendable, it can be easily integrated into wearable devices, and it is possible to measure health condition and perform biometric authentication at the same time.

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E11-1-4
Charge Transfer Interface for Novel Optoelectronic Devices

Seiichiro Izawa [1]

[1] Institute of Science Tokyo

At the donor/acceptor interface of organic semiconductors, charge separation and recombination occur, which are central processes in the photoconversion of organic solar cells. The charge transfer (CT) state, which exists as an intermediate, greatly influences the conversion efficiency of organic solar cells, and therefore, research to clarify its properties has been actively conducted. On the other hand, we have utilized the CT state as a precursor, transferring its energy to the triplet excited state of luminescent materials, and further inducing light emission through triplet-triplet annihilation, thereby realizing novel principles for photon upconversion and organic light-emitting diodes with ultra-low turn-on voltages.

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E11-1-5

Electroluminescent Photoresists: Extending Moore’s Law to Full-Color OLEDs

Shao-Wei Lo [1]

[1] ETH Zurich

We present a molecular design strategy that integrates efficient electroluminescence with photoresist functionality, realizing the long-sought electroluminescent photoresists (ELPRs). Using atom transfer radical polymerization (ATRP), we construct star-branched polymers that spatially isolate thermally activated delayed fluorescence (TADF) emitters within a protective shell, enabling crosslinking without exciton quenching. This ELPR platform yields a record external quantum efficiency (EQE) of 13.3% and direct patternability down to 110 nm via UV and E-beam lithography. The resulting ELPRs exhibit exceptional robustness and CMOS process compatibility, establishing a versatile “Functional Photoresist” platform for high-resolution, monolithically integrated organic optoelectronic and photonic devices.

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E11-2-1

Charge carrier dynamics of Sn^{4+} based halide perovskite nanocrystals

Yasuhiro Tachibana [1] [2]，Chathurika Kottahachchige [1]

[1] RMIT University，[2] The University of Osaka

Metal halide perovskite has recently attracted considerable attention as one of promising materials to be applied for optoelectronic devices owing to their low cost preparation process and attractive optical properties. However, these applications have been investigated by employing toxic lead halide materials, since they have so far shown the highest performance, and no alternative metal has not been identified to replace them. Employing high toxic lead will impede commercialization of lead halide perovskite devices. In this presentation, we will demonstrate synthesis of size and shape controlled Sn(4+) based perovskite nanocrystals. We will characterize photo-induced charge carrier dynamics for synthesized nanocrystals.

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E11-2-2

Lead-Free Double Perovskite Quantum Dots for Next-Generation Optoelectronics

Qing SHEN [1], Shikai Chen [1], Yongge Yang [1]

[1] The University of Electro-Communications

Lead-free halide double-perovskite quantum dots (QDs) offer an environmentally friendly platform for broadband and white-light emission, yet their LED applications remain limited by low photoluminescence quantum yields and inefficient charge transport. Here we report Sb/Mn co-doped Cs2NaInCl6 QDs combined with short-chain ligand engineering. The dual-doping strategy enables near-unity PLQY and stable white emission, while short-chain ligands improve film conductivity and carrier injection, leading to LEDs with the highest reported external quantum efficiency for double-perovskite QD devices.

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E11-2-3

Interfacial Defect Passivation via Carboxylic Acid-Functionalized Fullerene for Efficient Tin-Based Perovskite Solar Cells

Inseob Noh [1], Hyung Do Kim [1], Hideo Ohkita [1]

[1] Department of Polymer Chemistry, Kyoto University

Interfacial engineering is pivotal for mitigating the substantial voltage losses often observed in tin (Sn)-based perovskite solar cells. In this study, we employed a carboxylic acid-functionalized fullerene derivative (C_{60}-COOH) to modify the TiO_2/perovskite interface. We hypothesized that the carboxyl moiety would chemically anchor to the TiO_2 surface to passivate defects, while the fullerene core would facilitate electron extraction. Our experimental results confirm that this interfacial modification effectively reduces surface trap density and suppresses nonradiative recombination at the interface. Consequently, the modified Sn-based perovskite solar cells exhibited a marked improvement in open-circuit voltage, increasing from 0.43 to 0.51 V, and achieved an enhanced power conversion efficiency from 3.58 to 5.75%. These findings highlight the effectiveness of functionalized fullerenes in managing interfacial defects and optimizing device performance.

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E11-2-4

Formation kinetics of polymer films probed by aggregated-induced emissive molecules

Hinata Tamada [1], Hyung Do Kim [1], Yamamoto Shunsuke [1], Ohkita Hideo [1]

[1] Grad. Sch. of Eng., Kyoto Univ.

Conjugated polymers are widely used as materials for organic optoelectronic applications such as solar cells and organic thin-film transistors. Interestingly, blending them with insulating polymers has been reported to enhance their hole transport properties; however, the underlying mechanism remains still unknown. Since phase separation in polymer blends is generally driven by differences in solidification rates, this study focuses on the solidification kinetics of the component polymers. We developed a novel method to monitor these kinetics in real-time by employing aggregation-induced emission (AIE) molecules, which act as sensitives probes for molecular motion during film formation.

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E11-3-1

Molecular Engineering of C-Shaped ortho-Benzodipyrrole-based A-D-A type Acceptors for High-Performance Organic Solar Cells

Yen-ju Cheng [1]

[1] National Yang Ming Chiao Tung University

The high-performance Y6-based nonfullerene acceptors (NFAs) feature a C-shaped A-DA'D-A-type molecular architecture with a central electron-deficient thiadiazole (Tz) A' unit. We designed and synthesized a new A-D-A-type NFA, termed as CB16, having a C-shaped ortho-benzodipyrrole-based skeleton of Y6 but with the Tz unit eliminated. When processed with non-halogenated xylene without using any additives, the binary PM6:CB16 devices display a remarkable power conversion efficiency (PCE) of 18.32%, surpassing the performance of the corresponding Y6-based devices. The C-shaped A-DNBND-A skeleton in CB16 and the Y6-series NFAs constitutes the essential structural foundation for achieving exceptional device performance. Elucidating the structure-property-performance relationships of A-DA'D-A-type NFAs paves the way for the future development of structurally simplified A-D-A-type NFAs. In this talk, the following main-core and side-chain molecular engineering of the CB-based A-DNBND-A structure for developing a new class of structurally simplified A-D-A-type NFAs and understanding structure-property-performance relationship and their applications will be discussed. Effects of fluorinated/brominated/methylated ortho-benzodipyrrole-based acceptors on charge recombination, energy loss and efficiency of organic photovaltaics have been carefully investigated.

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E11-3-2

Alkyl Substituent Effects on Cyclopentadithiophene-Based Non-Fullerene Acceptors

Tomokazu Umeyama [1], Sakura Nishihara [1], Kenta Yamada [1], Mizuki Goto [1], Ryogo Hara [1], Wataru Suzuki [1]

[1] University of Hyogo

The influence of alkyl substituents on the cyclopentadithiophene (CPDT) unit was investigated for A–D–A′–D–A-type non-fullerene acceptors composed of difluorinated 1,1-dicyanomethylene-3-indanone as the terminal acceptor unit (A), CPDT as the donor unit (D), and a quinoxaline derivative as the central acceptor unit (A′). 1H NMR spectral analysis suggested that the branching structure of the alkyl chains modulates the torsion angle of the conjugated backbone.

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E11-3-3

Development of Multipodal Hole-Collecting Monolayer Materials for p-i-n Perovskite Solar Cells

Minh Anh Truong [1]

[1] Institute for Chemical Research, Kyoto University

As high-performance hole-collecting monolayer materials for perovskite solar cells, we developed several multipodal molecules bearing multiple anchoring groups that can chemically adsorb onto conductive electrode substrates. These multipodal monolayer materials enable precise control of molecular orientation on the substrate and their interactions with the perovskite layer, outperforming conventional materials. In this presentation, our molecular design concept, characterization as well as device evaluation will be introduced in detail.

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E11-3-4

Light-induced ESR analyses of PEAI-passivated perovskite solar cells

Liqi Liu [1], Yizhou Chen [1], Atsushi Sato [1], Kazuhiro Marumoto [1 2 3]

[1] Department of Materials Science, University of Tsukuba, [2] OIQSST, University of Tsukuba, [3] TREMS, University of Tsukuba

Perovskite solar cells (PSCs) show great potential for further performance improvement, yet the microscopic role of interfacial modifiers remains unclear. In this work, electron spin resonance (ESR) spectroscopy was employed to investigate PSCs incorporating phenethylammonium iodide (PEAI) at the perovskite/electron transport layer interface. ESR measurements under one-sun illumination reveal signals originating from BCP-related gap states and migrated electrons in $PC_{61}BM$. Continuous illumination induces a decrease in the $PC_{61}BM$ signal without PEAI, whereas the signal remains stable with PEAI, indicating that PEAI introduces an interfacial energy barrier that suppresses electron migration and enhances device stability.

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E11-4-1

Green- and Near-Infrared-Selective Organic Solar Cells: Materials Design and Agrivoltaic Application

Yutaka IE [1]

[1] The University of Osaka

Wavelength-selective organic solar cells (OPVs) were developed to harvest specific regions of sunlight for power generation. Such OPVs can be directly installed on agricultural greenhouses, enabling electricity generation over large cultivated areas without adversely affecting crop growth. In this study, new organic semiconductor materials selectively responsive to green and near-infrared light were developed. In addition, for green-light-selective materials, meter-scale module fabrication was investigated, and crop growth under the transmitted light environment was evaluated.

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E11-4-2

Fullerene Acceptors for Efficient Charge Separation in Photocatalytic Hydrogen Evolution

Tsubasa Mikie [1], Kenta Tanaka [1], Kazuki Kohzuki [2], Hideo Ohkita [2], Itaru Osaka [1]

[1] Hiroshima University , [2] Kyoto University

In this study, we report on fullerene acceptors (FAs) engineered to promote intermolecular π–π interactions and extend the π-electron network, thereby inducing efficient charge separation and photocatalytic hydrogen evolution. Covalent integration of a bithiophene moiety bearing a dicyanoindanone terminal group onto the fullerene core simultaneously affords a rigid molecular framework and strong visible-light absorption through intramolecular donor–acceptor interactions. As a result, the designed FA exhibits a markedly enhanced hydrogen evolution rate compared with PCBM, underscoring intermolecular π–π interaction engineering as an effective strategy for advancing FA-based single-component organic photocatalysts.

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E11-4-3

Molecular Orientation and Degradation in Non-Fullerene Organic Solar Cells

Kazuhiro Marumoto [1 2 3]

[1] Dep. Mater. Sci., Univ. of Tsukuba, Japan, [2] OIQSST, Univ. of Tsukuba, Japan, [3] TREMS, Univ. of Tsukuba, Japan

This research investigates the degradation of PM6:Y6 organic solar cells using ESR spectroscopy and DFT calculations. We discovered that simulated solar irradiation significantly increases the face-on ratio of both PM6 and Y6 molecules. Crucially, this orientation shift is light-induced rather than a simple thermal effect. This structural change promotes aggregation and phase separation, leading to exciton quenching and the subsequent decline of short-circuit current density and open-circuit voltage. Consequently, light-induced molecular reorientation is identified as a primary cause of operational instability in these high-efficiency devices.

E12

Fundamentals and Applications of Biomimetics Materials and Processes

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E12. Fundamentals and Applications of Biomimetics Materials and Processes

E12-1-1

Microstructure-induced petal effect on hierarchical ceramic surfaces fabricated by multi-step imprinting

Daigo Kamioka [1], Shotaro Manabe [1], Natsuki Tsushima [1 2], Fujio Tsumori [1]

[1] Kyushu University, [2] Tokyo University

This study demonstrates the bio-inspired petal effect—high water adhesion with superhydrophobicity—on sintered alumina surfaces fabricated via multi-step imprinting. A hierarchical surface of 50 μm macro-waves and 2 μm micro-lines exhibited this effect. Notably, 2 μm single-scale patterns showed lower contact angles than flat surfaces, contradicting conventional geometric models. We attribute this anomaly to “microstructure-induced pinning”, where the increased exposure of grain boundaries creates localized hydrophilic defects in the hydrophobic coating. This highlights the impact of geometric structures and micro-defects on wettability, providing a crucial foundation for developing durable functional surfaces.

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E12. Fundamentals and Applications of Biomimetics Materials and Processes

E12-1-2

Mechanical Entrainment of Oscillatory Transport Dynamics in Physarum polycephalum: Toward Biomimetic Rhythm-Responsive Systems

Fujio Tsumori [1]， Nako Okamoto [1]， Natsuki Tsushima [1 2]

[1] Kyushu University， [2] The University of Tokyo

Periodic mechanical stimulation can modulate biological dynamics through temporal structure. In this study, we examined frequency-dependent entrainment of pulsation rhythms in Physarum polycephalum under periodic compressive stimulation of an agar substrate. Time-lapse imaging and spectral and phase analyses showed that, although final growth changed little, stimulation around 80–90 s/cycle shifted dominant pulsation frequencies toward the stimulus frequency and reorganized phase synchrony. These results suggest that periodic compression tunes oscillatory transport dynamics in a living network, providing a bioinspired basis for rhythm-responsive soft systems and future biomimetic design.

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E12. Fundamentals and Applications of Biomimetics Materials and Processes

E12-1-3

Ray-Tracing Analysis of Optical Functions in Leaf-Inspired Internal Structures

Fujio Tsumori [1]， Rinnosuke Mori [1]， Natsuki Tsushima [1 2]， Masamitsu Ishibashi [1]， Eiji Gotoh [1]

[1] Kyushu University， [2] The University of Tokyo

Plant leaves exhibit hierarchical internal structures that enable efficient light management under variable illumination. In this study, we analyzed leaf-inspired internal geometries using X-ray CT-derived models and ray-tracing simulations to clarify biomimetic optical design principles. Tissue-level analysis showed that a shade-leaf epidermis with convex morphology maintained relatively high transmission over a broad range of incident angles. Cell-level analysis using simplified Sun and Shade palisade models revealed two contrasting strategies: configuration-dependent optical switching in the Sun model and robust light capture in the Shade model. These results provide a biomimetic perspective for understanding and designing angle-responsive optical surfaces.

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E12-1-4

Water-Developable Negative Photoresist Material for UV Lithography Exhibiting Inclusion Effects Using Cyclodextrin Derivatives

Hiryu Hayashi [1], Momoka Kamada [1], Rika Tsutakawa [1], Misaki Oshima [1], Mayu Morita [1], Mao Nakagawa [1], Yuna Hachikubo [1], Satoshi Takei [1]

[1] Toyama Prefectural University

A water-developable negative photoresist was developed by functionalizing methyl-β-cyclodextrin with acrylic groups. Microfabrication using an underlayer achieved a minimum line width of 7 µm at the sencivity of 30 J/cm^2 .Evaluation of inclusion capability showed a distinct reduction in guest molecule absorption peaks upon exposure. By eliminating organic solvents, this eco-friendly material provides a sustainable alternative for high-resolution patterning, offering significant potential for biocompatible applications where toxicity must be minimized.

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E12-1-5

Sustainable Micro-Pattering Using Hyaluronic Acid-Based Water-Developable Negative Photoresist

Momoka Kamada [1], Hiryu Hayashi [1], Rika Tsutakawa [1], Misaki Oshima [1], Mayu Morita [1], Mao Nakagawa [1], Yuna Hachikubo [1], Satoshi Takei [1]

[1] Toyama Prifectual University

To address the demand for eco-friendly lithography processes that exclude hazardous solvents, the patterning performance of a hyaluronic acid-based negative photoresist was investigated. Methacrylated hyaluronic acid was employed to enable UV-induced crosslinking and subsequent development in pure water. This approach yielded fine line patterns with a minimum width of 1 µm at an exposure dose of approximately 0.4 J/cm^2. Furthermore, a swelling ratio of less than 2% was recorded, demonstrating high resolution and stability compared to previously reported biopolymer resists.

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E12-2-1
Study of the High-intensity Reflection Structure that used the Speckle Exposure Method

ATSUSHI SEKIGUCHI [1 3]， Iwaoka Tomoki [2]， Hiroshi Kobayashi [2]， Toshiyuki Horiuchi [2]， Hirai Yoshihiko [3]， Masaaki Yasuda [3]

[1] Litho Tech Japan Corporation， [2] Tokyo Denki University， [3] Osaka Metropolitan University

Cases have been reported of pedestrians being injured when they collided with vehicles while walking at night. While having pedestrians wear reflectors can help, drivers must often be quite close before the reflected light becomes visible, because the reflector does not have a structure that generates high-intensity reflections. We therefore considered using lithography technology to create a reflection structure that can generate high-intensity reflections visible from greater distances. Specifically, we developed a high-intensity reflection structure by using a photoresist with controlled molecular weight distribution and performing speckle exposure. We applied an F-2 resist with controlled molecular weight distribution onto an Si substrate and performed speckle exposure and development. The structure obtained was irradiated with white LED light to observe the reflections. The results indicated success in creating a structure that reflects light with high intensity. Additionally, we performed theoretical verification by carrying out simulations of the molecular size and reflectivity, the results of which are also reported here.

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E12-2-2

Hydro- and Oleophobic Properties of Neanurinae (Collembola)

Satoru Tachibana [1], Seiya Nishikawa [1], Takeshi Ito [2]

[1] Kyoto University, [2] Kansai University

Springtails are attracting attention biologically and technologically for their omniphobic properties. However, the function of the surface of Neanurinae (Collembola: Neanuridae) with rougher surface structures remains insufficiently investigated. Neanurinae species are arthropods approximately 2 mm in length inhabiting the topsoil and have many microscopic ridges which cover the entire body. This study examined the surface properties of Neanurinae, *Deutonura frigida*, to obtain fundamental information for engineering applications. The results suggest hydrophobicity and oleophobicity, raising expectations for high-performance surfaces.

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E12-2-3

Formation of Double-Roughness Structures on PS/PMMA Blend Film Surfaces Using Atmospheric-Pressure Low-Temperature Plasma

Masashi Yamamoto [1]， Ayumu Takada [1]， Soma Tanaka [1]， Atsushi Sekiguchi [2 3]

[1] National Institute of Technology, Kagawa College， [2] Litho Tech Japan Corporation， [3] Osaka Metropolitan University

This study examined the formation of double-roughness structures, inspired by natural hierarchical surfaces, on PS (polystyrene) / PMMA (poly(methyl methacrylate)) blend film surfaces using atmospheric-pressure low-temperature plasma (APLTP). Leveraging phase separation between the two polymers, micro- and nanoscale structures were formed in their respective domains. The static water contact angle reached approximately 100°. The combination of polymer blending and APLTP technique provides a practical and scalable approach to biomimetic surface formation.

E13, J1

Surface Treatment and Functionalization of Polymer Surfaces

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E13, J1. Surface Treatment and Functionalization of Polymer Surfaces

E13-1-1

Raman-Spectra-Based Five-Peak Deconvolution for Predicting Micro-scratch Critical Load of Diamond-Like Carbon Films

Yoshihisa Osano [1], Tatsuyuki Nakatani [1]

[1] Okayama University of Science, [2] Mitsubishi Pencil Co.,Ltd.

A Raman spectral data–driven optimization approach was extended from density prediction to the more complex property of adhesion in diamond-like carbon (DLC) films. Five-peak deconvolution analysis of Raman spectra revealed correlations between carbon structure and the critical delamination load determined by micro-scratch testing, providing insights into delamination behavior. Partial least squares (PLS) regression enabled effective prediction of critical delamination load when delamination was governed by the internal structure of the DLC film and the DLC/interlayer interface. In contrast, when delamination shifted to the interlayer/substrate interface, incorporation of additional descriptors representing interface properties became necessary. These results demonstrate that the proposed approach is effective within specific delamination-mode regimes and is particularly suitable for efficient optimization of deposition conditions in the early stages of process development.

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E13-1-2

流動電位法によるDLC成膜したチューブ内面の等電点測定

shinsuke kunitsugu [1]，達行 中谷 [2]，裕一 今井 [3]

[1] 岡山県工業技術センター，[2] 岡山理科大学フロンティア理工学研究所，[3] ストローブ株式会社

交流高電圧プラズマCVD法により、小径・長尺チューブ内壁へのDLC成膜が可能となって以来，人工血管やカテーテルなど医療用チューブ材料への応用検討が進められている。生体材料表面の電位がゼロとなる等電点は，生体内での細菌付着やタンパク質吸着を支配する極めて重要な指標である。しかし，これまでチューブ内面に成膜したDLC膜の等電点を直接測定した報告はない。本研究では，流動電位法を用いてチューブ内腔面に成膜したDLC膜の等電点を直接測定し，さらに各種プラズマ処理による等電点の変化を評価した結果について報告する。

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E13, J1. Surface Treatment and Functionalization of Polymer Surfaces

E13-1-3

Fabrication of Photo-adhesive Materials Using a Bifunctional Dipyridyldisulfide-derived Methacryl Monomer and a Reducer

Masahiro Furutani [1]，Hayaka Oto [1]

[1] National Institute of Technology, Fukui College

ジピリジルジスルフィド部位を有する2官能メタクリルモノマーを合成した．これを光接着材料として用いる際に2-ヒドロキシメタクリラート，光ラジカル開始剤とともに還元剤を添加し，接着層中に2-メルカプトピリジル基がその場生成するようにした．波長365 nm単色光を用いてガラス基板と各種金属基板との異種材光接着を行い，還元剤の添加効果を確認した．

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E13, J1. Surface Treatment and Functionalization of Polymer Surfaces

E13-2-1

形状補正マスクと円錐ミラーを用いた円筒内面円周一括投影露光

Hiroki Nishigaki [1]，Shotaro Hattori [1]，Kenji Shintani [1]，Kenji Kobayashi [1]，Toshiyuki Horiuchi [1]，Hiroshi Kobayashi [1]

[1] 東京電機大学大学院

円筒試料に円錐ミラーを挿入し、平面マスク上のパターンを反射投影することで、円筒内面の円周方向に一括露光する技術を検討した。円錐ミラーを介して投影するとパターンに円周方向の変形が発生するため、変形を予測して修正した形状補正マスクを設計・試作した。内径14mmのSUS304ステンレス鋼パイプに直径10mm頂角90°の円錐ミラーを挿入して露光した結果、約3mmの円や正方形パターンを形成することができた。

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E13, J1. Surface Treatment and Functionalization of Polymer Surfaces

E13-2-2

Surface Modification of Polystyrene Substrates *via* Non-thermal Atmospheric Pressure Plasma Treatment for Controlling Cell Adhesion

Naoki Doi [1], Kyosuke Miyagawa [1], Yukinori Yamauchi [2], Yasushi Sasai [3], Masayuki Kuzuya [1], Shin-ichi Kondo [1]

[1] Gifu Pharmaceutical University, [2] Matsuyama University, [3] Gifu University of Medical Sciences

Controlling the cell adhesion properties of combustible materials such as polystyrene (PS), which can be mass-produced and disposed of, would contribute to the development of microfluidic devices. In this study, atmospheric remote plasma—a highly operable technique—was employed to introduce hydrophilic groups onto PS substrates. The surface modification and cell adhesion properties of the plasma-treated PS substrates were diligently evaluated. The non-thermal atmospheric pressure plasma was irradiated to unprocessed PS petri dish, which were added to water or 35% (w/v) hydrogen peroxide (H_2O_2) aqueous solution. The water contact angles of PS substrate before and after plasma-irradiation significantly decreased from 75^o to 25^o, imparting hydrophilicity. XPS measurements also revealed that plasma irradiation with 35% H_2O_2 introduced 1.2 times more oxygen atoms onto the PS substrate compared to that of water. Furthermore, the number of adherent cells was controlled in a concentration-dependent manner of H_2O_2. ESR measurements with 5,5-dimethyl-1-pyrroline *N*-Oxide (DMPO) revealed that atmospheric pressure plasma treatment with 35% H_2O_2 could generate 1.5 times more hydroxyl radicals compared to that of water. These results demonstrated that atmospheric pressure plasma irradiation with H_2O_2 would be advantageous for controlling cell adhesion of PS substrates and providing useful insights for the development of a microfluidic device.

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Room D　[Arcrea Himeji, Room 408]

E13, J1. Surface Treatment and Functionalization of Polymer Surfaces

E13-2-3

メカノケミカル固相重合による光応答性高分子ミセルの開発

Shin-ichi Kondo [1], Naoki Doi [1], Yasushi Sasai [2], Yukinori Yamauchi [3]

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メカノケミカル固相により光応答性を有する両親媒性ブロック共重合体を合成した。本ブロック共重合体を用いて高分子ミセルを調製し、その光応答性について評価した。

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Room D [Arcrea Himeji, Room 408]

E13, J1. Surface Treatment and Functionalization of Polymer Surfaces

E13-3-1

Etching and surface modification of organic films by atomic hydrogen annealing

Heya Akira [1], Fujino Yuto [1], Sumitomo Koji [1]

[1] Univ. of Hyogo

Since the etching rate of organic thin films depends on the atomic hydrogen density, organic thin films containing C–C–O bonds were subjected to atomic hydrogen annealing (AHA) to evaluate atomic hydrogen density. Etching and surface modification were analyzed using quartz crystal microbalances. Reduction induced by AHA was confirmed for all organic thin films. Rapid etching occurred in the initial stage (up to ~1800 s), while prolonged treatment (1800–3600 s) led to surface-modified layer formation, reducing reactivity with atomic hydrogen and decreasing the etching rate.

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E13, J1. Surface Treatment and Functionalization of Polymer Surfaces

E13-3-2

Effect of ortho-Methyl Group of Terminal Phenol of Dissolution Inhibitor on Sensitivity in Chemically Amplified Three-Component Novolac Resists

Katsuaki Takashima [1], Konishi Hidekazu [2], Tanaka Yuichirou [2], Horibe Hideo [1]

[1] Osaka Metropolitan University, [2] ASAHI YUKIZAI CORPORATION

We have developed a three-component chemically amplified novolac resist consisting of a novolac resin, a photoacid generator, and a dissolution inhibitor protected by an acetal group. In the exposed areas of this photoresist, the dissolution inhibitor reacts with acid to form a dissolution accelerator, a phenolic compound. In this study, the acidity of the dissolution accelerator was changed by substituting a methyl group at the ortho position of the terminal phenol of the dissolution inhibitor. The effect of this difference in acidity on the sensitivity of the photoresist was evaluated.

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E13, J1. Surface Treatment and Functionalization of Polymer Surfaces

E13-4-1

Improvement of Microwave Plasma Ignition in High-Pressure Water Vapor Environment

Thiha Kyaw Swar [1], Hnin Thazin Hlaing [1], Hiroki Taniguchi [1], Yamato Hiraoka [1], Khin Si Si Kyaw [1], Takeshi Aizawa [3], Mitsunori Nogawa [3], Yasuhiro Oonishi [3], Hiroshi Sugiyama [4], Fumito Imura [4], Noriko Miura [2], Shinichi Ikeda [2], Shiro Hara [2 4], Tatsuo Ishijima [1], Yasunori Tanaka [1], Yusuke Nakano [1]

[1] Kanazawa University, [2] National Institute of Advanced Industrial Science and Technology, [3] Yonekura MFG. Co., Ltd., [4] Hundred Semiconductors Inc.

Microwave-excited water vapor plasma ashing is a promising environmentally friendly technique for photoresist removal. However, plasma ignition at high pressure (~ 6.8 kPa) is difficult due to the high collision frequency between H_2O molecules and electrons in addition high electron affinity of H_2O. In this study, high voltage was applied to generate primary electrons near the microwave antenna region to assist plasma ignition. Without high-voltage assistance, plasma was not generated, whereas stable plasma ignition with a delay time below 0.4 s was achieved with high-voltage application. These results demonstrate that high-voltage-assisted electron generation effectively enhances microwave plasma ignition under high-pressure water vapor conditions.

E13, J1. Surface Treatment and Functionalization of Polymer Surfaces

E13-4-2

Fluorescence modification of organic nanoparticles via pulsed laser irradiation in the presence of surfactants

Ryohei Yasukuni [1], Daisuke Tominaga [1], Tomosumi Kamimura [1]

[1] Osaka Institute of Technology

Organic nanoparticles (NPs) are promising for organic device applications due to their high reactivity derived from large specific surface areas. In this study, we investigated the effects of surfactant addition on the fluorescence properties of perylene diimide NPs prepared by pulsed laser fragmentation of bulk crystals. While the organic NPs exhibited bulk-like emission in pure water, the presence of surfactants led to molecular-like fluorescence behavior. This change is attributed to the suppression of intermolecular interactions among surface molecules, demonstrating that surfactant addition is an possible strategy for tuning the optical functionalities of laser-generated organic NPs.

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Room D [Arcrea Himeji, Room 408]

E13, J1. Surface Treatment and Functionalization of Polymer Surfaces

E13-4-3

レーザー照射とオゾン水処理を用いたレジスト除去

Yusuke Murakami [1]，沙夢 森下 [1]，大実 片岡 [3]，悠太 朝田 [1]，良平 安國 [1]，政志 吉村 [2]，英夫 堀邊 [3]，共住 神村 [1 2]

[1] 大阪工業大学大学院工学研究科，[2] 大阪大学レーザー研究所，[3] 大阪公立大学大学院工学研究科

レーザー照射によるレジスト除去ではレジストをSiウェハー界面から剥離できる。本研究では、まずレーザー照射によりレジストを部分的なパターンで剥離させる。オゾン水でレジストを除去する場合、通常、最表面から酸化分解される。さらに剥離によりSiウェハーが現れたパターン部分を用いることによりオゾン水で処理での除去速度の向上が可能か検討する。レーザー照射による剥離パターンとオゾン水処理条件の関係について調べる。

E14

Chemistry for Advanced Photopolymer Science

ICPST-43 (2026)

The 43rd International Conference of Photopolymer Science and Technology

E14. Chemistry for Advanced Photopolymer Science

E14-1-1

Photoinitiator-Controlled Photopolymerization of an Ultrathin Transparent Protective Overlayer

Minho Jung [1], Moon Hyun Chung [1], Si Chul Rho [1]

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Photopolymerization is widely used to fabricate functional polymer layers with controlled thickness, uniformity, and optical properties. In this study, we report a photoinitiator-driven photopolymer system designed to form an ultrathin and optically transparent protective overlayer based on a Dual Safety Shield Layers (DSSL) architecture.

The DSSL architecture represents a sandwich-type photopolymer design in which a functional pigment layer is structurally confined between a polymer substrate and a photopolymerized transparent overlayer. A Type I photoinitiator–based formulation was employed to induce rapid and uniform radical polymerization under UV irradiation, enabling the formation of a continuous protective overlayer without inducing optical haze or surface defects. Photopolymerization performance was evaluated through surface wettability measurements, UV–visible transmittance analysis, and optical inspection. The resulting overlayer exhibited controlled surface characteristics and high visible-light transmittance, demonstrating that efficient radical generation and polymer network development can be achieved even at ultrathin thicknesses. Durability testing further confirmed that the photopolymerized overlayer significantly enhances pigment encapsulation stability by maintaining structural confinement of the pigment layer under simulated use conditions.

This work highlights the role of photoinitiator selection and photopolymerization control in constructing transparent functional polymer layers. The DSSL-based approach provides a versatile photopolymer design strategy for achieving optically invisible yet mechanically effective protective structures in advanced photopolymer systems.

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Room C [Arcrea Himeji, Room 407]

E14. Chemistry for Advanced Photopolymer Science

E14-1-2

Synthesis of cyclic polystyrene via a novel photoinduced ring-expansion polymerization using *3H*-benzothiazol-2-thione as a cyclic initiator

Atsushi Kameyama [1], Tatsuya Osuka [1], Akira Takahashi [2], Sena Hashimoto [1]

[1] Kanagawa University, [2] Institute of Science Tokyo

Ring-expansion polymerization is a useful method for synthesizing cyclic polymers. In this paper, we report photoinduced ring-expansion polymerization of styrene (St) using commercially available *3H*-benzothiazol-2-thione (BTT) as a cyclic initiator for synthesis of cyclic polystyrene. When the photopolymerization of St was carried out using BTT (molar ratio of BTT:St is 1:10) in 1,4-dioxane under irradiation of 365nm-LED (460 W/cm^2 at 365 nm), the conversion of St increased with irradiation time. The structure of the resulting polymer was confirmed by FT-IR and ^{1}H-NMR spectroscopies. MALDI-TOF Mass data proved that the obtained polymer was cyclic polymer containing one BTT moiety.

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E14. Chemistry for Advanced Photopolymer Science

E14-1-3

Sodium Thiophenolate Initiated Polymerization of Methacrylate with Sulfur (S8): High Refractive Index Dual Tone Photoresists.

Xiaofei Qian [1]

[1] Fudan University

A simple and effective strategy for introducing sulfur into polymethacrylate matrix at room temperature has been developed, allowing for the polymerization of a variety of methacrylate derivatives with sulfur. The resulting S-containing polymers performed high refractive index up to 1.8, and when mixed with 3% photo acid generator (PAG), the formulation exhibited as dual tone photoresist and demonstrated excellent patterning capabilities.

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E14. Chemistry for Advanced Photopolymer Science

E14-2-1
Creation of Chiral Molecular Glasses

Hideyuki Nakano [1], Arata Daiki [1], Takeshita Oki [1]

[1] Muroran Institute of Technology

We have been performing studied on the creation of various functional molecular glasses. In the present study, we have newly designed and synthesized chiral molecular glasses. They were found to exhibit circular dichroism not only in solutions but also as amorphous films. They are expected not only to function as novel chiral host materials but also to provide chiral photomechanical materials through hybridization with azobenzene-based molecular glasses.

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E14. Chemistry for Advanced Photopolymer Science

E14-2-2

Photo-thermal Degradation of Stimuli-Sensitive Polymers with Epoxy and Tertiary Ester Moieties

Haruyuki Okamura [1]，Keigo Matsuyama [1]，Kentaro Taki [2]

[1] Osaka Metropolitan University，[2] Kanazawa University

Reducing environmental impact is strogly requiered for the development of composite materials. Generation of gaseous compounds in composite materials has attracted much attention for the application of a circular economy. Degradation of polymers generating bubbles by dual stimulation of ultraviolet light and heat, and near-infrared light and heat have been reported. Poly(1-methyl-1-(6-methyl-7-oxabicyclo [4.1.0]hept-3-yl)ethyl methacrylate) (poly(MOBH), PMOBH) and poly (tert-butyl methacrylate) (poly (tBMA), PtBMA) were reported as polymers generating bubbles by dual stimulation. In this study, decomposition of the copolymer of MOBH and tBMA, P(MOBH-co-tBMA) by dual stimulation of ultraviolet light and heat in the presence of a photoacid generator (PAG) was investigated.

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E14. Chemistry for Advanced Photopolymer Science

E14-2-3

Light- and Heat-Triggered Degradation of Dual-Stimuli-Responsive Polymer Brushes Generating Bubbles with a Photoacid Generator

Haruyuki Okamura [1]，Nogawa Urara [1]，Ohno Kohji [1]，Kentaro Taki [2]

[1] Osaka Metropolitan University，[2] Kanazawa University

Degradation of polymer brushes of dual-stimuli sensitive polymers generating bubbles with a photoacid generator was carried out by irradiation and heating. Polymer brushes of poly(t-butyl methacrylate) having primary or tertiary ester linkages on the surface of substrates were successfully prepared. The degradation of the polymer brushes were successfully occurred by irradiation and heating.