E6
Nanoimprint

ICPST-43 (2026)

The 43rd International Conference of Photopolymer Science and Technology

June Fri 26, 2026 09:30 - 10:30
Room C [Arcrea Himeji, Room 407]

E6. Nanoimprint

E6-1-1
Hydroxypropyl Methylcellulose-Based pH-Responsive Microneedle Sensor for Food Spoilage Detection

Misaki Oshima [1], Mayu Morita [1], Hiryu Hayashi [1], Mano Ando [1], Momoka Kamada [1], Rika Tsutakawa [1], Mao Nakagawa [1], Naoto Sugino [2], Yoshiyuki Yokoyama [3], Satoshi Takei [1]

[1] Toyama Prefectural University, [2] SANKO GOSEI LTD., [3] Toyama Industrial Technology Research and Development Center

A pH-responsive microneedle sensor composed of hydroxypropyl methylcellulose and red cabbage pigment was developed for food spoilage detection. Fabricated by high-fidelity nanoimprint lithography, the sensor exhibited clear color changes with pH variation. Puncture tests on refrigerated yellowtail confirmed reliable penetration and color changes at the needle tips, demonstrating detection of internal biochemical changes. This technology enables visual freshness assessment and may improve food safety and reduce food loss.

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E6. Nanoimprint

E6-1-2
Moth-eye nanostructured surface with patterned superhydrophilic regions on a superhydrophobic background

Takuto Wakasa [1], Jun Taniguchi [1]

[1] Tokyo University of Science

Inspired by a desert beetle that harvests water from fog, we fabricated a surface with a superhydrophobic moth-eye structure throughout, where patterned circular regions feature superhydrophilic moth-eye patterns. Using photolithography and UV-NIL, hydrophilic regions were patterned on a moth-eye mold, then a fluorinated UV-curable resin was applied and demolded. Surface free energy was evaluated via contact angle measurements using water, diiodomethane, and ethylene glycol. Results showed that reducing the hydrophilic area fraction by ~20% increased surface free energy by 26–56%, demonstrating that surface wettability can be tuned by controlling the hydrophilic-to-hydrophobic area ratio.

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E6. Nanoimprint

E6-1-3
Fabrication of ceramic micropatterns using solvent-soluble UV-curable resins

Jun Taniguchi [1], Fujii Itsuki [1], Wakasa Takuto [1], Osaki Takeshi [2], Okado Yukio [2]

[1] Tokyo University of Science, [2] Toyo Gosei Co., Ltd.

Micropatterning of ceramics has become necessary to increase the surface area of fuel cells. Ceramics are hard materials, so they are difficult to process using cutting or lasers. To solve this problem, a micropattern was formed on a substrate using a solvent-soluble UV-curable resin, and this pattern was used as a guide to fill in a ceramic powder slurry. After firing at a low temperature, the UV-curable resin was dissolved, successfully forming a ceramic micropattern.

E7

Strategies, Materials, and Processes for Advanced Packaging, MEMS, and Flexible Devices

ICPST-43 (2026)

The 43rd International Conference of Photopolymer Science and Technology

E7. Strategies, Materials, and Processes for Advanced Packaging, MEMS, and Flexible Devices

E7-1-1 (Invited)
Advanced Microelectronic Packaging Trends Using Photosensitive and Non-Photosensitive Polymers

Takafumi Fukushima [1]

[1] Tohoku University

Recent advances in microelectronic packaging increasingly rely on both photosensitive and non photosensitive polymers to achieve fine-pitch interconnect on RDL interposers, enhanced reliability, and chiplet integration with heterogeneous devices and materials. Photosensitive polymers enable high resolution patterning for RDLs, microvias, and (fan-out) wafer level packaging, supporting continued scaling beyond Moore’s law limitation. Non photosensitive polymers provide superior mechanical stability, dielectric performance, and thermal reliability for large area and high power applications. This talk reviews the latest material innovations, processing strategies, and integration approaches that leverage the complementary advantages of these polymers, highlighting emerging trends in chiplet architectures, hybrid bonding/temporary bonding, and high density, low loss interconnect technologies.

June Thu 25, 2026 09:20 - 11:25
Room B [Arcrea Himeji, Small Hall]

E7. Strategies, Materials, and Processes for Advanced Packaging, MEMS, and Flexible Devices

E7-1-2 (Keynote)
Advanced Packaging – 3D System on Chip Partitioning and Chiplets

Andy Miller [1]

[1] IMEC

Advanced Packaging combines 3D partitioning and Chiplet Technology and is viewed as being one of the key technology enablers for continued scaling and extending Moore's Law. In this talk we will discuss how 3D Partitioning is enabled, leading to the different technology blocks which must be developed to complete the system level scaling of advanced devices. These technology blocks lead to multiple constructions utilising concepts such as hybrid bonding, Interposers, Fine Pitch ReDistribution Layers (FP-RDL) and micro bumping to name a few.

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E7. Strategies, Materials, and Processes for Advanced Packaging, MEMS, and Flexible Devices

E7-1-3 (Invited)
Advanced materials for high performance semiconductor packages

Takao Sakuma [1]

[1] Ajinomoto Co., Inc.

Semiconductor package substrates, driven by continuous advances in semiconductor chips, stacking technologies, and the growing demand for high-capacity and high-speed communication, are required not only to increase in size but also to deliver enhanced functionality, including high reliability and low transmission loss. Ajinomoto Build-up Film^{TM} (ABF^{TM}) has been widely used as an insulating material in multilayer package substrates owing to its excellent insulation reliability, thickness uniformity, and compatibility with the semi-additive process (SAP). In this work, various ABF^{TM} materials are presented, focusing on their physical properties, key features, and application potential.
Meanwhile, co-packaged optics (CPO) is gaining increasing attention as a key enabling technology for next-generation high-performance computing systems and switch ASICs for AI servers, where low-loss and highly reliable package substrates play a critical role. The close integration of optics and electronics in CPO architectures provides a viable pathway toward reduced power consumption and increased bandwidth density. Polymer optical waveguides and adhesive materials are promising technologies for advanced optical interconnects, particularly in CPO architectures requiring low optical loss, high integration density, and design flexibility. In this presentation, the properties and potential applications of polymer optical waveguides and adhesive materials are also discussed.

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E7. Strategies, Materials, and Processes for Advanced Packaging, MEMS, and Flexible Devices

E7-1-5

<1 micron Lines and Vias in Polymer Dielectrics Using Novel Photodefinable Hardmask

Yu Kambe [1], Forrest Etheridge [1], Thomas McCune [1], Marissa Tranquilli [1], Mehr Unnisa Zaheer [1], Alexis Miranda [1], Rui Peng [1], Danielle Chamberlin [1]

[1] NanoPattern Technologies, Inc.

To meet the roadmap for redistribution layer (RDL) resolution, patterning 1-micron lines/vias in polymer dielectrics is essential, but impractical with current photoimageable materials below 2 microns. NanoPattern Technologies, Inc. has developed a photodefinable hardmask that achieves 1-micron features in 4-micron thick polymer dielectric layers using conventional lithography and dry etch.

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E7. Strategies, Materials, and Processes for Advanced Packaging, MEMS, and Flexible Devices

E7-2-1 (Invited)
JOINT2: Advancing Package Evaluation — Development Progress and Technical Challenges

Sadaaki Katoh [1]

[1] Resonac Corporation

Resonac launched the Packaging Solution Center in 2018 as an R&D hub providing one-stop packaging solutions, and in October 2021 established the co-creative evaluation platform JOINT2 with leading partners to accelerate development of advanced materials, equipment, and substrates for 2.xD and 3D packages. As higher-density integration requires finer wiring pitch, smaller vertical interconnects, and larger package sizes, we have been developing advanced vertical and lateral interconnect technologies and evaluating fabrication and reliability for extremely large 2.5D packages. This presentation summarizes the achievements of JOINT2 and the key technical challenges identified through these activities.

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E7. Strategies, Materials, and Processes for Advanced Packaging, MEMS, and Flexible Devices

E7-2-2
Novel photosensitive polyimide(PSPI) for next generation advanced packaging

Takahiro Shimizu [1], Makiko Irie [1], Kazuaki Ebisawa [1], Ryoma Michinobu [1], Ko Ueno [1]

[1] TOKYO OHKA KOGYO CO., LTD.

With advances in packaging technologies, multilayer and fine pitch RDL have become key trends. PSPI for photo imageable dielectric are required to have low residual stress, low shrinkage and high resolution while maintaining high reliability. In this work, by adopting a partially closed ring structure in the polymer, we achieved low residual stress and shrinkage and maintained other properties. In addition, we obtained high resolution by optimizing photoreactivity through formulation. We will present the evaluation results and discuss their applicability.

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E7. Strategies, Materials, and Processes for Advanced Packaging, MEMS, and Flexible Devices

E7-2-3

Extreme Copper Wiring via Etch Control – A Simulation Study with Atomistic Resolution

Sanjay Malik [2], Arsenios Gkourras [3], Karim Huet [3], Antonino La Magna [1]

[1] Istituto per la Microelettronica e Microsistemi (CNR-IMM), [2] SCREEN SPE U.S.A., [3] SCREEN SPE Germany GMBH

Ultrahigh density packaging architectures are designed to achieve extremely fine interconnects enabling high I/O counts, enabling faster data transmission and efficient power management to meet growing demands of AI and high-performance computing. Next-generation interconnects require ultrafine traces beyond current 2 µm / 2 µm limits, creating major challenges. This study explores a fabrication scheme for extreme copper wiring where ultrafine traces are formed via a wet etch process into a thin film of titanium nitride. We report a simulation study with atomistic resolution of a unique wet etch process enabling ultrafine copper traces by eliminating seed layer removal steps.

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E7. Strategies, Materials, and Processes for Advanced Packaging, MEMS, and Flexible Devices

E7-2-4

Development of reactive molecular dynamics for cross-linked polymer networks

Minoru Hoshino [1], Masaru Yamasaki [1], Ryohei Kondo [1], Yoshitomo Ishiguro [1], Yohei Okoda [1], Kunpei Yamada [1]

[1] Resonac Corporation

Understanding and predicting cross linked network structures in polymers are essential for controlling their thermomechanical and photosensitive performance. However, experimentally clarifying these network structures and their underlying mechanisms remains challenging. In this work, we developed reactive molecular dynamics capable of generating and analyzing cross linked networks based on predefined reaction schemes. The method was applied to several epoxy resin systems to compute key material properties, including glass transition temperature and elastic modulus. By analyzing the resulting network structures, this study elucidates their relationships with these properties and demonstrates the effectiveness of simulation based structural analysis for polymer design.

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E7. Strategies, Materials, and Processes for Advanced Packaging, MEMS, and Flexible Devices

E7-3-1 (Invited)

Reaction Layer Formation Mechanism at Transition Metal/Polyimide Interfaces: Correlation with Adhesion.

Yugo Kubo [1], Koji Kuramochi [1], Yuichi Sonohara [1]

[1] Sumitomo Electric Industries, Ltd.

In the field of semiconductor packaging, significant attention is focused on the interface state between metals such as copper and organic insulators like polyimide. This presentation focuses on the two points: 1. The correlation between reaction phase formation at the transition metal/polyimide interface and adhesion, 2. Atomic and molecular level temporal changes at the Cu/polyimide interface under high-temperature storage conditions.

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E7. Strategies, Materials, and Processes for Advanced Packaging, MEMS, and Flexible Devices

E7-3-2

Development of Next-Generation Photoresist Materials for Advanced Semiconductor Packaging

Kazuki Sato [1], Satoka Mizuishi [1], Daisuke Ojima [1], Atushi Kubo [1]

[1] TOKYO OHKA KOGYO CO., LTD.

With the rapid advancement of high-performance applications such as artificial intelligence (AI), next-generation semiconductor packaging technologies are facing increasing demands for higher integration density and enhanced performance.
Photoresists play a crucial role in enabling high-performance advanced packaging manufacturing. Key technical challenges include scaling the feature size of redistribution layers (RDL) to below 2 μm, as well as forming high aspect ratio (AR) Cu pillar structures. Additionally, the semiconductor industry is increasingly shifting toward environmentally friendly practices by adopting sustainable materials to reduce environmental impact.
In particular, RDL scaling is progressing not only wafer level but also panel level, requiring further sophistication in exposure technologies. While conventional i-line steppers using mercury lamps remain mainstream, exposure systems employing h-line laser sources are gaining traction, contributing to the diversification and flexibility of exposure methods.
Under this circumstance, to address these challenges, we have developed two types of chemically amplified positive-tone photoresists that are free of per- and polyfluoroalkyl substances (PFAS), aiming to meet such semiconductor industry trend. Photoresist A, designed for RDL applications, is compatible with both i-line and h-line exposure systems and has successfully demonstrated the formation of fine patterns with a Line/Space resolution of 0.9/0.9 μm.
Furthermore, Photoresist B, developed for tall Cu pillar structures exceeding 200 μm in height, addresses the conventional issue of insufficient resolution through utilizing a novel resin system to overcome conventional resolution limitations. It effectively mitigates pattern deformation and bottom residue during post-development patterning, achieving an aspect ratio greater than 1:10.
These results represent a significant advancement in materials technology, simultaneously addressing the three critical requirements of miniaturization of RDL-wire, high AR formation of Tall Cu Pillar, and environmental sustainability in next-generation semiconductor packaging. The details of these findings are presented in this paper.

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E7. Strategies, Materials, and Processes for Advanced Packaging, MEMS, and Flexible Devices

E7-3-3

High Aspect Ratio Cu Pillar Formation on 310 × 310 mm Panel Using Novel Dry Film Resists and Digital Lithography

Hajime Furutani [2], Ksenija Varga [1], Lisa Berger [1], Tobias Zenger [1], Masayuki Kishino [2]

[1] EV Group, [2] Asahikasei

With the rapid scaling of AI server package sizes, fan-out panel-level packaging (FO PLP) has attracted increasing attention, particularly the transition from wafer-based processes to 310 mm × 310 mm panels. This paper reports the evaluation of thick dry film resist (DFR) processes using digital lithography for FO PLP applications. Using a 120 µm-thick DFR, via patterns with aspect ratios of 1:3 and 1:4 were successfully resolved on panel substrates, achieving CD uniformity within ±4%. High-aspect-ratio Cu pillars were subsequently fabricated based on these vias, demonstrating the feasibility of digital lithography-based DFR processes with
digital lithography technology for advanced FO PLP.

E8

Polyimides and High Thermally Stable Resins

ICPST-43 (2026)

The 43rd International Conference of Photopolymer Science and Technology

June Thu 25, 2026 13:00 - 14:20
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E8. Polyimides and High Thermally Stable Resins

E8-1-1
Molecular Design and Property Prediction of Sterically Confined Melt-Processable Phenylethynyl-Terminated Oligoimides for High-Temperature Fiber-Reinforced Plastics

Ki-Ho Nam [1], Jung Min Bae [1], Gyeongho Bae [1], Yeonho Jeong [1], Yeyeong Han [1], Jaedoo Nam [1], Seohyeon Lee [1], Yunbi Lee [1], Junheon Lee [1]

[1] Kyungpook National University

Polyimides are high-performance polymers widely employed in aerospace and electronics due to their excellent thermal and mechanical properties. Phenylethynyl end-capped polyimides (PETIs) were developed to improve processability by controlling molecular weight, yet their rigid backbones and strong interchain interactions still limit melt-processability. To address this, structural modifications using bulky moieties have been investigated. In this study, phenylethynyl end-capped oligoimides were synthesized by varying the molar ratios of cage-structured adamantane-1,3-diamine and 3,4'-oxydianiline. The incorporation of adamantane units disrupted chain packing, increased free volume, and enhanced melt flow behavior. The thermal and rheological properties of the resulting oligoimides were systematically compared, demonstrating that backbone engineering using sterically hindered diamines offers a promising route to improve the processability of high-performance thermosetting polyimides.

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E8. Polyimides and High Thermally Stable Resins

E8-1-2
Water Vapor Permeability in Polyimide Materials during Hybrid Bonding

Kai Ishigami [1], Kota Nomura [1], Masaya Jukei [1], Yugo Tanigaki [1], Takenori Fujiwara [1], Yu Shoji [1], Hitoshi Araki [1]

[1] Toray Industries, Inc.

Hybrid bonding (HB) is attracting increasing attention for high density packaging. However, previous studies have reported that water is generated in inorganic dielectric materials during the HB process, leading to void formation. To address this issue, polyimide materials are considered promising candidates for dielectric layers of HB because of their higher gas permeability compared with inorganic materials. In this paper, we confirmed that even when water is generated in polyimide materials, it can be released through the film. These results indicate that void free polymer based HB can potentially be achieved.

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E8. Polyimides and High Thermally Stable Resins

E8-1-3
Synthesis of Silicon-Containing Hydrocarbon-Based Polymers Exhibiting Low Dielectric Loss for High-Frequency Communication Applications

YUKA AZUMA [1], Riku Takahashi [1], Natsuko Sashi [1], Kan Hatakeyama [1], Yuta Nabae [1], Ririka Sawada [1], Shinji Ando [1], Teruaki Hayakawa [1]

[1] Institute of Science Tokyo

Next-generation communication systems require materials with low dielectric loss at high frequencies to achieve high-speed and large-capacity data transmission. In this study, silicon-containing hydrocarbon-based polymers were designed and synthesized by hydrosilylation polymerization. The obtained polymers showed excellent thermal stability, with 10% weight-loss temperatures above 400℃. Dielectric measurements demonstrated very low dielectric constants and loss tangents. These superior dielectric properties are attributed to reduced molecular polarity and suppressed water absorption resulting from the introduction of silicon units into the hydrocarbon backbone.

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E8. Polyimides and High Thermally Stable Resins

E8-1-4

Bulky Substituent Effects on High-Frequency Dielectric Properties of Poly(ether sulfone)s and Polyimides

Kentaro Sone [1], Hayato Maeda [1], Riku Takahashi [1], Kan Hatakeyama [2], Yuta Nabae [1], Teruaki Hayakawa [1]

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

With the advancement of next-generation communication technologies, low dielectric loss polymers are required. In this study, aromatic polymers with bulky substituents were designed to tune free volume and chain mobility, aiming to suppress orientational polarization and dielectric relaxation. Four bisphenol monomers bearing bulky substituents were synthesized and subsequently polymerized with bis(4-fluorophenyl) sulfone to obtain poly(ether sulfone)s. Polyimides were also synthesized from the corresponding dianhydrides. The resulting polymers exhibited excellent thermal stability ($T_{d\text{-}5\%}$ > 380 ℃) and reduced dielectric constant (D_k) and dielectric loss (D_f) at 40 GHz, particularly for the polymer bearing 4-cyclohexylphenoxy groups (D_k = 2.49, D_f = 0.0036).

E9

Nanobiotechnology

June Fri 26, 2026 09:30 - 12:00
Room B [Arcrea Himeji, Small Hall]

E9. Nanobiotechnology

E9-1-1
Programmable Biomembrane Nanoparticles for Functional Biointerfaces

Yoshihiro Sasaki [1], Ryosuke Mizuta [1], Kazunari Akiyoshi [3], Eisuke Kanao [2], Yasushi Ishihama [2]

[1] Graduate School of Engineering, Kyoto University, [2] Graduate School of Pharmaceutical Sciences, Kyoto University, [3] Graduate School of Medicine, Kyoto University

Biomembrane nanoparticles provide a versatile strategy for constructing functional biointerfaces by integrating inorganic nanoparticle cores with dynamic lipid bilayers. Here, we propose a programmable design concept for biomembrane nanoparticles based on a density-gradient lipid-layer penetration method, which enables uniform single-bilayer formation independent of particle size or lipid composition. Single-particle analyses confirm highly homogeneous membrane coverage across particle populations. Importantly, the fluid lipid interface allows post-fabrication functional programming through controlled lipid composition and cell-free reconstitution of membrane proteins. This platform enables tunable cell–nanoparticle interactions and biointerface functions, positioning biomembrane nanoparticles as programmable nanobio-systems beyond conventional surface-modified nanomaterials.

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E9. Nanobiotechnology

E9-1-2

Host-Dependent Anti-Metastatic Effects of Carbon-ion Radiation Therapy Combined with Dendritic Cell Immunotherapy

Liqiu Ma [1], Kensuke Osada [1], Takashi Shimokawa [1]

[1] National Institutes for Quantum Science and Technology

Carbon-ion radiation therapy achieves excellent local tumor control; however, distant metastasis remains a major obstacle to improving patient survival and quality of life. To address this issue, combination strategies integrating carbon-ion radiation therapy with dendritic cell (DC)–based immunotherapy have been proposed, yet their general applicability across different tumor types and host immune backgrounds remains unclear. In this study, we evaluated the anti-metastatic efficacy of carbon-ion radiation therapy combined with DC immunotherapy in multiple syngeneic mouse tumor models. Significant suppression of lung metastasis was observed in osteosarcoma and lung carcinoma models in C3H/He and C57BL/6J mice, whereas no anti-metastatic effect was detected in colon carcinoma models in BALB/c mice. In vitro analyses further demonstrated that carbon-ion–irradiated tumor cells activated immature DCs derived from C3H/He and C57BL/6J mice in a dose-dependent manner, while DCs from BALB/c mice remained unresponsive. Mechanistic investigations revealed that the therapeutic outcome was primarily determined by host immune polarization (Th1- or Th2-dominant responses), rather than tumor type itself. These findings highlight the host-dependent nature of carbon-ion radiation–DC combination therapy and provide a rationale for immune-based patient stratification to optimize anti-metastatic cancer treatment.

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E9. Nanobiotechnology

E9-1-3
Design of Peptide-Mimetic Bioactive Polymers Targeting Biomembranes

Kazuma Yasuhara [1]

[1] Nara Institute of Science and Technology

Biological membranes are dynamic interfaces composed of lipid bilayers and membrane proteins. Inspired by membrane-active peptides and proteins, we have developed amphiphilic polymers that modulate membrane properties and induce biological activities. This presentation highlights two classes of membrane-active polymers: synthetic antimicrobial polymers that disrupt bacterial membranes, and amphiphilic polymers that spontaneously fragment lipid bilayers to form lipid nanodiscs.

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E9. Nanobiotechnology

E9-1-4

Evaluation of microneedle devices for biosensor applications

Yukihiro Kanda [1 2], Takehara Hiroaki [1 2], Ichiki Takanori [1 2]

[1] Innovation Center of NanoMedicine, [2] The University of Tokyo

Microneedles made from biodegradable polymer materials are gaining attention as minimally invasive medical devices that safely access the body. Recent researches have also advanced the application of these needles as biosensors by embedding different materials at their tips. However, challenges remain in application as sensor devices of microneedles, as exemplified by the difficulty in balancing measurement functionality with insertion capability. In this study, the functionality of microneedle devices aimed at application in biosensors was evaluated.

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E9. Nanobiotechnology

E9-1-5

Engineering Injectable Hyaluronic acid Hydrogels with Tunable Dioxazaborocane Crosslinking enables and Immunostimulatory CpG Delivery

Debabrata Palai [1 2], Kevin Barthelmes [1], Mao Hori [1], Takuya Katashima [3], Akira Matsumoto [1 3]

[1] Department of Organic Biomaterials, Institute of Science Tokyo, [2] Joining and Welding Research Institute, The University of Osaka, [3] Department of Materials Engineering, The University of Tokyo

A new class of injectable hydrogels has been developed by tuning the chemical structure of dioxazaborocane (DOAB) crosslinkers grafted onto hyaluronic acid. Small substituent changes enabled precise control of gelation times, ranging from seconds to several hours, while maintaining excellent injectability and biocompatibility. Rheological studies revealed that substituent-dependent crosslinker reactivity governs the viscoelastic transition of the network. The hydrogels also displayed excellent biocompatibility and molecular diffusion properties. Using oligo-CpG as a model immunostimulatory drug, the system exhibited a rapid initial release (60–70% within 24 h) followed by sustained release over several days, demonstrating its potential as a versatile platform for minimally invasive drug delivery.

E10

Photopolymers in 3-D Printing/ Additive Manufacturing

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E10. Photopolymers in 3-D Printing/ Additive Manufacturing

E10-1-2

Photothermally responsive hydrogel microrobots fabricated by multi-material two-photon lithography

Shusuke Iwano [1], Shogo Oishi [1], Masaru Mukai [1], Shoji Maruo [1]

[1] Yokohama National University

Recently, research on microrobots using 4D printing technology has made great progress. In particular, soft microrobots remotely actuated through photothermal heating have attracted considerable attention. However, the deformation modes and structural complexity of conventional microrobots remain limited because they are typically fabricated from a single material. To address this limitation, we fabricated a series of multi-material microrobots using our uniquely developed multi-material two-photon lithography technique. These microrobots are actuated by the contraction of a photothermally responsive hydrogel. Through localized laser heating, we successfully demonstrated faster and more sophisticated motions than conventional single-material models.

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E10. Photopolymers in 3-D Printing/ Additive Manufacturing

E10-1-3

Development of photo-crosslinkable, micropore-forming bioink for 3D-bioprinting of oriented muscle tissues

Akihiro Nishiguchi [1]

[1] National Institute for Materials Science

Although 3D bioprinting has enormous potential to provide customized constructs for regenerative medicine, bioink formulations for 3D bioprinting often lack interconnected pores for the supply of nutrients and oxygen. Here I will introduce photo-crosslinkable, micropore-forming bioinks for fabricating oriented muscle tissues by 3D-bioprinting. Based on phase separation technology, liquid porogen was embedded into gelatin-based bioinks to form microporous structures. Printing bioinks with shear stress enabled orientation of micropores along the printing direction. Moreover, the porous scaffold exhibited favorable nutrients and oxygen supply to improve cell survival. This approach holds immense potential for creating anisotropic oriented 3D tissue constructs.

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E10. Photopolymers in 3-D Printing/ Additive Manufacturing

E10-2-1
Recyclable anthracene-based photocurable resin for 3D sacrificial molds

Tomomi Aoki [1], Seina Matsubara [1], Wakana Miyadai [1], Masaru Mukai [1], Shoji Maruo [1]

[1] Yokohama National University

Stereolithography is a 3D printing technology capable of producing complex microstructures at high resolution. Recently, techniques for transferring 3D microstructures with high precision using molds formed by stereolithography have garnered attention. In this study, we developed a recyclable mold material that can be photopolymerized and thermally dissolved by utilizing the reversible photodimerization reaction of anthracene. Using this material, 3D molds can be fabricated via two-photon lithography, embedded in PDMS, and then thermally dissolved and recovered in solvent to form 3D microstructures such as microfluidic channels. Since this material is recyclable, it contributes to reducing mold material costs and environmental impact.

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E10. Photopolymers in 3-D Printing/ Additive Manufacturing

E10-2-2
Laser-Based Fabrication of Proteinaceous Microstructures: Recent Advances and Challenges.

Daniela Serien [1], AIST Narazaki [1], Masaki Yumoto [1]

[1] AIST

This talk will provide an overview of laser-based fabrication of microstructures made from protein, highlighting recent advances and ongoing challenges.

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E10. Photopolymers in 3-D Printing/ Additive Manufacturing

E10-2-3

Low-Dielectric, High-Thermal-Stability Poly(divinylbenzene) Structures Fabricated via Stereolithography

Mukai Masaru [1], Shouji Maruo [1]

[1] Yokohama National University

Poly(divinylbenzene) (pDVB) is a rigid, thermally stable polymer, yet its highly crosslinked network renders it infusible and insoluble, hindering conventional melt or solvent processing. Here, we report that, under specified stereolithography conditions, a selected photoinitiator enables direct 3D printing from divinylbenzene monomer, yielding pDVB architectures. The printed parts retain pDVB's intrinsic thermal stability and stiffness, and further exhibit low dielectric constant and loss at relevant frequencies. To our knowledge, this demonstrates a viable processing route for pDVB and indicates potential in high-performance electrical and structural applications.

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E10. Photopolymers in 3-D Printing/ Additive Manufacturing

E10-2-4

Small-scale Soft Actuators and Robots from Photopolymerization of Liquid Crystalline Materials

Hamed Shahsavan [1]

[1] University of Waterloo

The advancement of liquid crystal network (LCN) soft robotics relies on the precise spatiotemporal control of photopolymerization to program anisotropic actuation. While Two-Photon Polymerization (2PP) enables the molecular programming of arbitrary 3D geometries with sub-micron resolution, Digital Micromirror Device (DMD) projection lithography offers a pathway to scalable, high-throughput manufacturing. This study establishes a lithographic framework that bridges the trade-off between the functional precision of 2PP and the production potential of DMD. We present a comparative analysis of LCN actuators fabricated via both methods, explicitly evaluating the fidelity of the director field alignment and the resultant thermomechanical response. We demonstrate that complex biomimetic structures can be achieved at significantly higher production rates using DMD by optimizing the actinic exposure conditions to approximate the voxelated control of 2PP. These results provide a roadmap for upscaling the fabrication of stimuli-responsive soft robots without sacrificing the molecular order required for complex shape-shifting.