The 9th

Asian Symposium on Advanced Materials (ASAM-9)

Proceedings

5-8 November 2025
Haeundae Central Hotel
Busan, Republic of Korea

부산대학교
PUSAN NATIONAL UNIVERSITY

PIONEER
부산대학교 국립대학육성사업

생산기술연구소
Research Institute of Industrial Technology

HiC
휴머노이드 후각디스플레이센터

Dear friends and colleagues：

On behalf of the organizing committee of the 9th Asian Symposium on Advanced Materials (ASAM-9), it is with great pleasure that we welcome you to the ASAM-9 here in dynamic Busan, Korea.

Since the successful hosting of the ASAM-1, which was held at Far Eastern National University in Vladivostok, Russia, from October 1~4, 2007, the symposium has taken place every two years in various Asian countries and Russia, including China (2009), Japan (2011), Taiwan (2013), Korea (2015), Vietnam (2017), China (2019) and Russia (2023) with an increasing number of participants and a growing diversity of research outcomes.

This year, the symposium will be held at the Haeundae Central Hotel, Busan, Korea, from November 5~8, 2025. It will serve as a platform for diverse group of researchers, scientists, engineers, and industry professionals from around the world including Asian regions.

Your participation will enrich the discussions and share innovative ideas that can drive our collective efforts towards sustainable solution.

We sincerely hope to welcome your active participation in ASAM-9, and look forward to meeting you in Busan, Korea.

Ildoo Chung

Chairperson of the ASAM-9
Pusan National University, Korea

General information

Conference venue

Haeundae Central Hotel, 33, Haeundaehaebyeon-ro 298beon-gil, Haeundae-gu, Busan, Korea

Registration desk opening hours

November 5) 10:00 ~ 18:00

November 6 & 7) 8:00 ~ 18:00

- The registration fee includes a conference bag with a program booklet, tea/coffee at the venue, lunch, welcome reception, banquet and short excursion.

- Both credit card and cash payments will be accepted at the registration desk on site at the conference venue.

- The name tag provided at registration must be worn at all times during all conference sessions and events.

Lunch

Lunch is included in the registration fee and will be available from 12:00–13:00 on November 6, and from 11:25–12:30 on November 7.

Wi-Fi

Free Wi-Fi is available at the symposium site.

Social Events and Others

Welcome Mixer: November 5, 18:00 at 3F Grand Hall
Banquet: November 7, 18:00 at 3F Grand Hall

Excursion around Busan for participants

A free guided tour program for participants is scheduled on November 7 from 14:00 to 17:30 (After poster session)

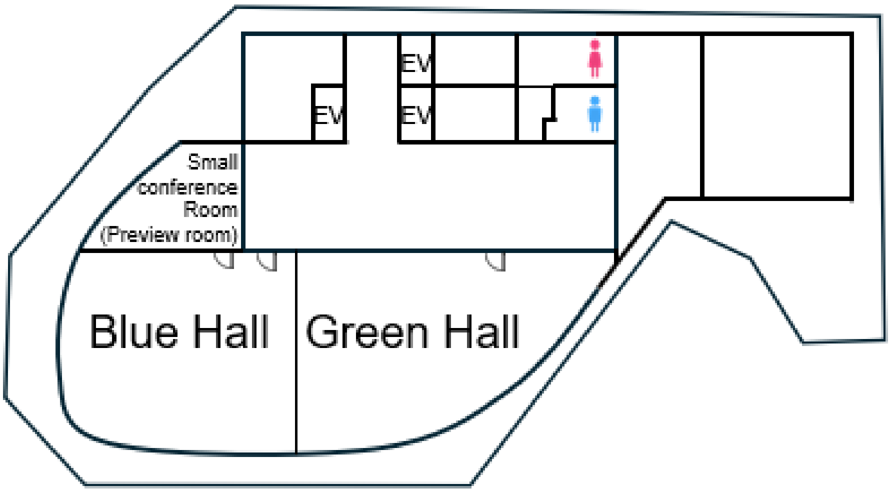
Tour Course : Departure from Haeundae Central Hotel (November 7 at 14:00) → Haedong Younggungsa Temple, Jukseong Catholic Church and Cheongsapo Daritdol Skywalk (14:00 – 17:00) → Back to the Conference venue

* The time back to the conference venue may be subjected to the traffic jams, due to Friday afternoon rush hour.

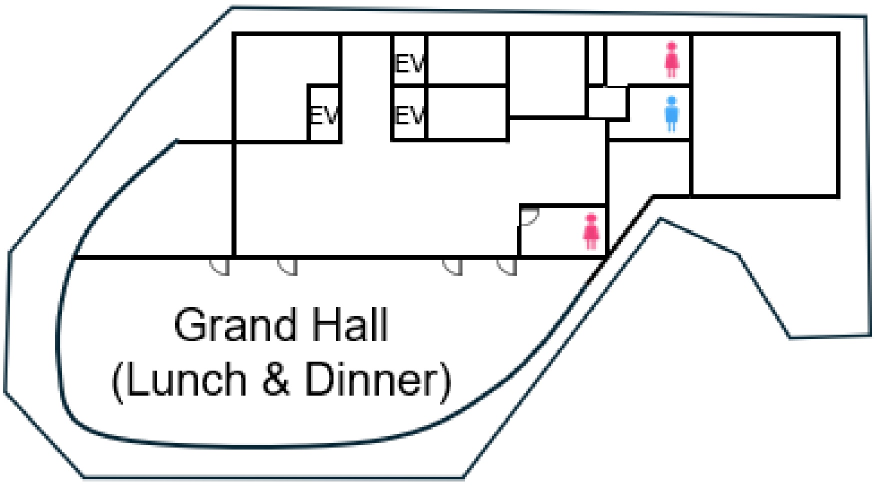
To Presenters: You are kindly requested to bring your presentation files on a USB drive and save them to the conference laptop before your session.

Presentation Location Guide

2F



3F



5F

Getting Here

- ***From Gimhae Airport***

The closest airport is Gimhae International Airport (PUS). The drive to Haeundae takes approximately 1 hour and 20 minutes from the airport. We recommend either taking a taxi (about 30,000 KRW) or using a ride-share service like Uber.

By Bus: Take Bus 307 from Gimhae Airport → Get off at Grand Chosun Hotel Busan → Walk to the hotel

- ***From Busan station***

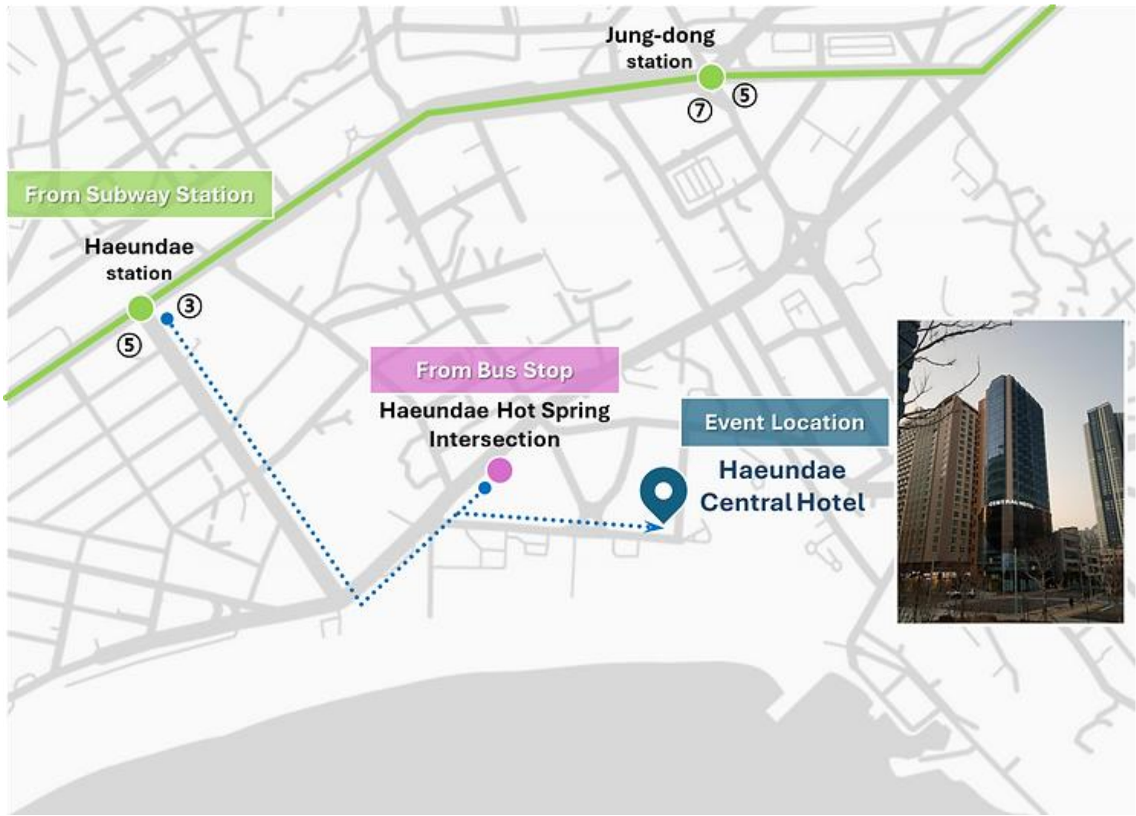
The drive to Haeundae takes approximately 40 minutes from the Busan station. We recommend either taking a taxi (about 20,000 KRW) or using a ride-share service like Uber.

By Subway: Take Line 1 from Busan Station → Transfer to Line 2 at Seomyeon Station → Get off at Haeundae Station (Exit 3 or 5) → Walk to the hotel

By Bus:

1) Take Express Bus 1003 from Busan Station → Get off at Haeundae Hot Spring Intersection (~45 min) → Walk to the hotel

2) Take Express Bus 1001 from Busan Station → Get off at Haeundae Station (~52 min) → Walk to the hotel



Information for presenters

Oral Presentations

Presentations will have the following durations.

Plenary lectures are 40 min including discussion (35 min talk + 5 min discussion)

Keynote lectures are 30 min including discussion (25 min talk + 5 min discussion)

Invited lectures are 20 min including discussion (15 min talk + 5 min discussion)

Oral presentations are 15 min including discussion (12 min talk + 3 min discussion)

Presenters are requested to bring their presentation files on a USB drive. The lecture room is equipped with a PC that supports PowerPoint (ppt, pptx) and PDF formats. Please make sure to check your equipment before the beginning of your session to avoid unpleasant surprises. **We kindly ask all presenters to save and test their files on the lecture room PC before the break time preceding their session.**

Poster Presentations

The posters should A0 size (841x1189 mm) in vertical orientation. The poster boards will be marked with the number according to the poster list. Authors may mount their posters starting from 10:00 on the day of presentation, and all posters must be in place by 12:30. You are welcome to contact the conference assistants on site.

All posters must be removed immediately after the presentation and no later than 14:30. Any posters remaining on display walls after 14:30 will be removed and directly disposed.

Digital submission of poster files is not required. Authors should bring the printed posters directly to the conference on the day of presentation.

***Best Young Speaker Awards (below 40) and Best Poster Awards will be conferred for the papers presented at the symposium in order to stimulate young researchers. The award ceremony will be held at the banquet on November 7th (Friday), 2025.**

Committee

Organizing Committee

Honorary Chairperson:

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Prof. Supason Wanichwecharungruang (Chulalongkorn University, Thailand)
Prof. Limin Wu (Fudan University, China)
Prof. Dongyuan Zhao (Fudan University, China)

Program

Day 1 – November 5 (Wednesday)

Opening remark : 5F Seminar Room at 12:20 – 12:30 (Prof. Ildoo chung / Chair: Suk-kyun Ahn)

Oral session(Plenary/Keynote/Invited/Oral) : 5F Seminar Room & 2F Blue Hall at 12:30 – 18:00

Welcome Mixer : 3F Grand Hall at 18:00 – 20:00

* Coffee break 13:50 – 14:10/16:10 – 16:30

Day 2 – November 6 (Thursday)

Oral session(Plenary/Keynote/Invited/Oral) : 5F Seminar Room & 2F Blue Hall at 9:00 – 18:00

* Lunch : 3F Grand Hall at 12:00 – 13:00

* Coffee break 10:40 – 11:00/14:10 – 14:30 **(with group photo)**/15:40 – 16:00

Day 3 – November 7 (Friday)

Oral session(Plenary/Keynote/Invited/Oral) : 5F Seminar Room & 2F Blue Hall at 9:00 – 11:25

Poster session : 3F Grand Hall at 12:30 – 14:00

Excursion : Tour Course - Departure from Haeundae Central Hotel (November 7 at 14:00) → Haedong Younggungsa Temple, Jukseong Catholic Church and Cheongsapo Daritdol Skywalk (14:00 – 17:00) → Back to the Conference venue

* The time back to the conference venue may be subjected to the traffic jams, if any, around the time(rush-hour of the Friday afternoon)

Banquet & Closing : 3F Grand Hall at 18:00 – 21:00

* Lunch: 3F Grand Hall at 11:25 – 12:30

* Coffee break 10:10 – 10:30

Day 4 – November 8 (Saturday)

Special Symposium in Honor of Prof. C. -S. Ha (in Korean) : 3F Grand Hall at 8:30 – 10:00

Oral session (Invited/Oral): 3F Grand Hall at 10:00 – 11:35

* Lunch (Prof. Ha’s Group only) 11:35 – 13:00

*A half-day special symposium to honor the scientific contributions of Professor Chang-Sik Ha, a pioneer in polymer science is scheduled to be held in Korean on Saturday, November 8, 2025.

Professor Ha's former students, postdoctoral researchers, collaborators, and friends will celebrate his scientific contributions to polymer science over the past 40 years, as well as his 70th birthday.

Time Table

Program

Time
8:00 - 9:30
9:30 - 10:30
10:30 - 11:30
11:30 - 12:30
12:30 - 13:30
13:30 - 14:30
14:30 - 15:30
15:30 - 16:30
16:30 - 17:30
17:30 - 18:30
18:30 - 20:00

Nov. 5 (Wed.)		
10:00 – 12:20	Registration	
12:20 – 12:30	Opening Remark	
Place	5F Seminar room	
12:30 – 13:10	(PL 1) Kohzo Ito (Japan)	
13:10 – 13:50	(PL 2) Yury Shchipunov (Russia)	
13:50 – 14:10	Coffee break	
14:10 – 14:40	(KL 1) Dongyuan Zhao (China)	
14:40 – 15:10	(KL 2) Michel Wong Chi Man (France)	
15:10 – 15:40	(KL 3) Toyoko Imae (Taiwan)	
15:40 – 16:10	(KL 4) Sang-Young Lee (Korea)	
16:10 – 16:30	Coffee break	
Place	5F Seminar room	2F Blue Hall
16:30 – 16:50	(IL 1) Takashi Miyata (Japan)	(IL 4) Gözde Kabay (Germany)
16:50 – 17:10	(IL 2) Jong S. Park (Korea)	(IL 5) Heejoon Ahn (Korea)
17:10 – 17:30	(IL 3) Ji-Hun Seo (Korea)	(IL 6) Chae Bin Kim (Korea)
17:30 – 17:45	(OL 1) Anjali Nagapadi Preman (Korea)	(OL 3) Grigory B. Veselov (Russia)
17:45 – 18:00	(OL 2) Sofia D. Afonnikova (Russia)	(OL 4) Zirui Lv (China)
Place	3F Grand Hall	
18:00 – 20:00	Welcome Mixer	

Nov. 6 (Thu.)		
8:00 – 9:00	Registration	
Place	5F Seminar room	
9:00 – 9:40	(PL 3) Rigoberto Advincula (USA)	
9:40 – 10:10	(KL 5) Atsushi Takahara (Japan)	
10:10 – 10:40	(KL 6) Ken Terao (Japan)	
10:40 – 11:00	Coffee break	
Place	5F Seminar room	2F Blue Hall
11:00 – 11:20	(IL 7) Myung-Han Yoon (Korea)	(IL 10) Chie Kojima (Japan)
11:20 – 11:40	(IL 8) Jinn P. Chu (Taiwan)	(IL 11) Jaejun Lee (Korea)
11:40 – 12:00	(IL 9) Dowon Ahn (Korea)	(IL 12) Young-Rae Cho (Korea)
Place	3F Grand Hall	
12:00 – 13:00	Lunch	
Place	5F Seminar room	
13:00 – 13:40	(PL 4) Zhiyong Tang (China)	
13:40 – 14:10	(KL 7) Alexei Khokhlov (Russia)	
14:10 – 14:40	Group Photo Coffee break	
14:40 – 15:10	(KL 9) Hyun-jong Paik (Korea)	
15:10 – 15:40	(KL 10) Youngkyoo Kim (Korea)	
15:40 – 16:00	Coffee break	
Place	5F Seminar room	2F Blue Hall
16:00 – 16:20	(IL 13) Yuji Higaki (Japan)	(IL 16) Kyu Hyun (Korea)
16:20 – 16:40	(IL 14) Thai Hoang (Vietnam)	(IL17) Tran Dinh Thang (Vietnam)
16:40 – 17:00	(IL 15) Hongzhi Liu (China)	(IL 18) Jeong Jae (JJ) Wie (Korea)
17:00 – 17:15	(OL 5) Yuji Shibasaki (Japan)	(OL 9) Shin-ichi Yusa (Japan)
17:15 – 17:30	(OL 6) Suraj Kishan Aswale (Korea)	(OL 10) Joonwoo Park (Korea)
17:30- 17:45	(OL 7) Su Jeong Heo (Korea)	(OL 11) SeungWoo Jung (Korea)
17:45 – 18:00	(OL 8) Cecilia Adena (Taiwan)	(OL 12) Kyeong-Seok Oh (Korea)

Nov. 7 (Fri.)		
8:00 – 9:00	Registration	
Place	5F Seminar room	
9:00 – 9:40	(PL 5) Sei Kwang Hahn (Korea)	
9:40– 10:10	(KL 11) Jin-Woo Oh (Korea)	
10:10 – 10:30	Coffee break	
Place	5F Seminar room	2F Blue Hall
10:30 – 10:50	(IL 19) K.S.V Krishna Rao (India)	(IL 21) Shangru Zhai (China)
10:50 – 11:10	(IL 20) Yang H. Yun (USA)	(IL 22) Yong-Zhu Yan (China)
11:10 – 11:25	(OL 13) Sivagangi Reddy Nagella (Korea)	(OL 14) Donghee Shin (Korea)
Place	3F Grand Hall	
11:25 – 12:30	Lunch	
12:30 – 14:00	Poster session	
14:00 – 18:00	Excursion	
Place	3F Grand Hall	
18:00 – 21:00	Banquet & Closing Ceremony	

Nov. 8 (Sat.)	
Place	3F Grand Hall
8:30 – 10:00	Special Symposium in Honor of Prof. Chang-Sik Ha (in Korean)
	Registration
10:00 – 10:20	(IL 23) Sung Soo Park (Korea)
10:20 – 10:35	(OL 15) Hyun Kyo Kim (Korea)
10:35 – 10:50	(OL 16) Hoon Hwang (Korea)
10:50 – 11:05	(OL 17) Soon Joon Chung (Korea)
11:05 – 11:20	(OL 18) Byeon Tae Yang (Korea)
11:20 – 11:35	(OL 19) Ki Yol Ahn (Korea)
11:35 – 13:00	Lunch

DAY 1 (Nov. 5, Wed)

5F Seminar Room

(Chair : Ildoo Chung)

(12:30 - 13:10)

Plenary Lecture 1

Kohzo Ito

University of Tokyo, Japan

“Slide-Ring Materials for Circular Economy”

(13:10 - 13:50)

Plenary Lecture 2

Yury Shchipunov

Russian Academy of Sciences, Russia

“Nano/microfibrillated Cellulose Aerogels. Green Renewable Materials for Advanced Technology and Ecology”

-- *Coffee Break (13:50 – 14:10)* ------------------------------------

(Chair : Sang-Young Lee)

(14:10 - 14:40)

Keynote Lecture 1

Dongyuan Zhao

Fudan University, China

“Supra-Assembly of Functional Mesoporous Materials for the Energy Applications”

(14:40 - 15:10)

Keynote Lecture 2

Michel Wong Chi Man

Centre National de la Recherche Scientifique(CNRS), France

“Synthesis of structured silsesquioxanes”

(Chair : Yury Shchipunov)

(15:10 - 15:40)

Keynote Lecture 3

Toyoko Imae

National Taiwan University of Science and Technology, Taiwan

"Size Effect by Atomic Clusters on Chemocatalysis and Photocatalysis"

(15:40 - 16:10)

Keynote Lecture 4

Sang-Young Lee

Yonsei University, Korea

"Redesigning Polymer Electrolytes: Chemistry Beyond PEO"

-- *Coffee Break (16:10 – 16:30)* -----------------------------------

5F Seminar Room

(Chair : Dongyuan Zhao)

Invited Lectures

(16:30 - 16:50) IL-1, **Takashi Miyata** (Kansai University, Japan)
Dynamic Polymer Materials: Designing Crosslinks for Advanced Functions

(16:50 - 17:10) IL-2, **Jong S. Park** (Pusan National University, Korea)
Flexible Electrochromic Energy Storage Devices Featuring Viologen Ion Gels

(17:10 - 17:30) IL-3, **Ji-Hun Seo** (Korea University, Korea)
Solid state polymer electrolytes with dynamic mechanical bond for enhanced ionic conductivity

(Chair : Jong S. Park)

Oral Presentations

(17:30 - 17:45) OL-1, **Anjali N. Preman**, Suk-kyun Ahn* (Pusan National University, Korea)
Better together: Integrating adhesion and ion conductivity in composite binders for high-performance silicon anodes

(17:45 - 18:00) OL-2, **Sofia D. Afonnikova** (Boreskov Institute of Catalysis SB RAS, Russia)
Multicomponent alloys as catalysts for the production of carbon nanofibers and metal carbon composites

2F Blue Hall

(Chair : Toyoko Imae)

Invited Lectures

(16:30 - 16:50) IL-4, **Gözde Kabay** (Karlsruhe Institute of Technology (KIT), Germany)
A Simple Approach for Real-time Hydogelation Monitoring

(16:50 - 17:10) IL-5, **Heejoon Ahn** (Hanyang University, Korea)
High-Performance Stretchable Zinc-Ion Micro-Batteries Enabled by PEDOT and Zinc-Ion Co-Intercalated Vanadium Oxide Nanofibers

(17:10 - 17:30) IL-6, **Chae Bin Kim** (Pusan National University, Korea)
A General Approach to Compatibilizing Mixed Plastics through Dynamic Boronic Ester Bond Formation

(Chair : Heejoon Ahn)

Oral Presentations

(17:30 - 17:45) OL-3, **Grigory B. Veselov** (Boreskov Institute of Catalysis, Russia)
Preparation of Nickel-containing Carbon Xerogels and Their Properties

(17:45 - 18:00) OL-4, **Zirui Lv**, Dongyuan Zhao* (Fudan University, China)
Hierarchical Engineering of Single-Crystalline Mesoporous Metal-Organic Frameworks with Hollow Structures

DAY 2 (Nov. 6, Thu)

5F Seminar Room

(Chair : Suk-kyun Ahn)

(9:00 - 9:40)

Plenary Lecture 3

Rigoberto Advincula

University of Tennessee, Knoxville/ORNL, USA

"AI/ML in 3D Printing High Performance Polymer Materials and Synthesis"

(9:40 - 10:10)

Keynote Lecture 5

Atsushi Takahara

Kyushu University, Japan

"Surface and Interfacial Chemistry of Environmental Degradation of Polymers"

(Chair : Rigoberto Advincula)

(10:10 - 10:40)

Keynote Lecture 6

Ken Terao

Osaka University, Japan

"Molecular Conformation and Intermolecular Interactions of Linear, Cyclic, and Branched Polymers in Solution"

-------------------------------------- *Coffee Break (10:40 – 11:00)* --------------------------------------

5F Seminar Room

(Chair : Youngkyoo Kim)

Invited Lectures

(11:00 - 11:20) IL-7, **Myung-Han Yoon** (Gwangju Institute of Science and Technology, Korea)
Self-Supporting Hydrogel Nanofiber Meshes for Directional Neuronal Network Growth

(11:20 - 11:40) IL-8, **Jinn P. Chu** (National Taiwan University of Science and Technology, Taiwan)
Semiconductor-based Highly-Ordered Nanostructure Arrays: Fabrication and Application

(11:40 - 12:00) IL-9, **Dowon Ahn** (Pusan National University, Korea)
Visible light 3D printing to access the next generation soft materials

2F Blue Hall

(Chair : Byeong Guk Jeong)

Invited Lectures

(11:00 - 11:20) IL-10, **Chie Kojima** (Institute of Science Tokyo, Japan)
Relation between hydration and tumor accumulation in biocompatible dendrimers

(11:20 - 11:40) IL-11, **Jaejun Lee** (Pusan National University, Korea)
Mechanochemical Engineering of Soft and Hybrid Materials Using Laser-Induced Shockwaves

(11:40 - 12:00) IL-12, **Young-Rae Cho** (Pusan National University, Korea)
Advanced Eco-Friendly Clad Metals: Property Evaluation and Emerging Industrial Applications

--- *Lunch (12:00 – 13:00)* ---

5F Seminar Room

(Chair : Liu Hongzi)

(13:00 - 13:40)

Plenary Lecture 4

Zhiyong Tang

National Center for Nanoscience and Technology, China

“Application of Metal-Organic Frameworks in Electrocatalytic Oxygen Evolution”

5F Seminar Room

(Chair : Jeong Jae (JJ) Wie)

(13:40 - 14:10)

Keynote Lecture 7

Alexei Khokhlov

Lomonosov Moscow State University, Russia

"Life Cycle of Polymer Materials: Scientific vs Emotional Approach"

------------------------------- *Coffee Break & Group Photo (14:10 – 14:40)* -------------------------

(Chair : Zhiyong Tang)

(14:40 - 15:10)

Keynote Lecture 9

Hyun-jong Paik

Pusan National University, Korea

"Chain-End Functionalized Polymers via Radical Polymerization"

(15:10 - 15:40)

Keynote Lecture 10

Youngkyoo Kim

Kyungpook National University, Korea

"Organic Neuromorphic Transistors Based on Water-Processable Polymeric Hysteresis Nanolayers"

------------------------------------ *Coffee Break (15:40 – 16:00)* ------------------------------

5F Seminar Room

(Chair : Myung-Han Yoon)

Invited Lectures

(16:00 - 16:20) IL-13, **Yuji Higaki** (Oita University, Japan)
Aqueous Microphase Separation Induced by Coacervation of Zwitterionic Polymers

(16:20 - 16:40) IL-14, **Thai Hoang** (Institute for Tropical Technology, Vietnam)
Novel friendly environmental coatings contain Ag-Zn/zeolite, nano Cu2O,
and polysiloxane matrix used in seawater

(16:40 - 17:00) IL-15, **Hongzhi Liu** (Shandong University, China)
Silsesquioxanes-based Functional Materials for Sustainable Development

(Chair : Dowon Ahn)

Oral Presentations

(17:00 - 17:15) OL-5, **Yuji Shibasaki*** (Iwate University, Japan)
Nano composite of bio-based poly(arbutin) with silver nanoparticle

(17:15 - 17:30) OL-6, **Suraj Kishan Aswale**, Hyun-jong Paik* (Pusan National University, Korea)
Engineering Polymer Topologies for Tunable Properties
: Insights from Characterization to Application

(17:30 - 17:45) OL-7, **Su Jeong Heo**, Dong Gi Seong*, (Pusan National University, Korea)
Wax-Enabled Multifunctional Glass Fiber-Reinforced Polymer Composites:
Self-Healing, Self-Lubrication, and Enhanced Mechanical Performance

2F Blue Hall

(Chair : Chie Kojima)

Invited Lectures

(16:00 - 16:20) IL-16, **Kyu Hyun** (Pusan National University, Korea)
The Extensional Rheological Properties of Biodegradable Blends
: PLA/LDPE and PHA/LCB-PLA Blends

(16:20 - 16:40) IL-17, **Tran Dinh Thang** (Industrial University of Ho Chi Minh City, Vietnam)
Polycaprolactone/Xanthan Gum/Chrysophanol Biomaterials: Preparation, Characterization, Drug Release, and Bioactivities

(16:40 - 17:00) IL-18, **Jeong Jae (JJ) Wie** (Hanyang University, Korea)
Rapid Yet High Amplitude Collective Oscillation of Magnetic Micropillar Arrays

(Chair : Jaejun Lee)

Oral Presentations

(17:00 - 17:15) OL-9, **Shin-ichi Yusa*** (University of Hyogo, Japan)
Polyion Complex (PIC) Micelles Composed of Random Copolymers

(17:15 - 17:30) OL-10, **Joonwoo Park**, Jaejun Lee* (Pusan National University, Korea)
Programmable Micropatterns via Photomask Mediated Laser-Induced Shockwave Spallation

(17:30 - 17:45) OL-11, **SeungWoo Jung**, Dong Gi Seong* (Pusan National University, Korea)
Transformable Hybrid Fiber-Reinforced Polymer Fabricated Using Multi-Resin Dispensing

(17:45 - 18:00) OL-12, **Kyeong-Seok Oh**, Sang-Young Lee* (Yonsei University, Korea)
Conflicting entropy-driven zwitterionic dry polymer electrolytes for scalable High-energy all-solid-state batteries

DAY 3 (Nov. 7, Fri)

5F Seminar Room

(Chair : Chang-Sik Ha)

(9:00 - 9:40)

Plenary Lecture 5

Sei Kwang Hahn

POSTECH, Korea

“Smart Biomedical Materials and Devices for Theranostic Applications”

(9:40 - 10:10)

Keynote Lecture 11

Jin-Woo Oh

Pusan National University, Korea

“Humanoid Electronic Nose and Tongue Technologies: Neural Network-Based AI Systems for Revolutionary Digital Healthcare”

-- *Coffee Break (10:10 – 10:30)* ------------------------------------

(Chair : Thai Hoang)

Invited Lectures

(10:30 - 10:50) IL-19, **K.S.V. Krishna Rao** (Yogi Vemana University, India)
New Opportunities in Sustainable Nano-Polymeric Materials for Treatment of Cancer

(10:50 - 11:10) IL-20, **Yang H. Yun** (University of Akron, USA)
Nanoparticles Made from the Polymer L-Tyrosine Phosphate and VEGF
Receptor Genes Normalize Hypertension in Pregnancy

Oral Presentations

(11:10 - 11:25) OL-13, **Sivagangi Reddy Nagella**, Chang-Sik Ha* (Pusan National University, Korea)
Synthesis of Low-Dielectric Poly(ether-imides) Derived
from a Bio-Based Novel Diamine

2F Blue Hall

(Chair : Tran Dinh Thang)

Invited Lectures

(10:30 - 10:50) IL-21, **Shangru Zhai** (Dalian Polytechnic University, China)
Natural Lignin-based Environmental Functional Materials with Improved Performance

(10:50 - 11:10) IL-22, **Yong-Zhu Yan** (Hainan University, China)
Preparation and Properties of Electromagnetic Interference Shielding Polymer Composites with Extreme Environment Resistance

Oral Presentations

(11:10 - 11:25) OL-14, **Donghee Shin**, Beomjin Jeong* (Pusan National University, Korea)
Sorting-free Carbon Natnotube Channel Synaptic Transistor for Simple and Facile Fabrication Process

DAY 4 (Nov. 8, Sat)

Special Symposium in Honor of Prof. Chang-Sik Ha (Presented in Korean)

3F Grand Hall

(Chair : Jinho Ryoo)

Invited Lectures

(10:00 - 10:20) IL-23, **Sung Soo Park** (Dong-Eui University, Korea)
Nanohybrid Materials Based on Polymers and Periodic Mesoporous Organosilicas

(Chair : Sung Soo Park)

Oral Presentations

(10:20 - 10:35) OL-15, **Hyun Kyo Kim** (Pusan National University, Korea)
Interfaces in Polymer Composites

(10:35 - 10:50) OL-16, **Hoon Whang** (Pusan National University, Korea)
Recent Advances in Polymer Film Coating

(10:50 - 11:05) OL-17, **Soon Joon Chung** (Pusan National University, Korea)
Polymers for Automobile

(11:05 - 11:20) OL-18, **Byeong Tae Yang** (Pusan National University, Korea)
Polymer Blends and Their Processing

(11:20 - 11:35) OL-19, **Ki Yol Ahn** (Pusan National University, Korea)
Polyimide Films and Their Hybrids

Poster Presentations

(Nov. 7th, Fri, 12:30-14:00)

3F Grand Hall

PS-01 A Highly-Ordered Close-Packed Metallic Nanotube Array for Surface-Enhanced Raman Scattering (SERS) Applications

Chun-Wei Chang, Ting-Hao Chang, Alfreda Krisna Altama, Jun-Ting Wang, Jinn P. Chu*, National Taiwan University of Science and Technology, Taiwan

PS-02 Octahalogen-substituted Metal Phthalocyanines and Hybrid Materials Based on Them: Structural Features and Sensor Properties

Klyamer Darya*, Kamdina Tatiana, Ivanova Victoriia, Sukhikh Aleksandr, Basova Tamara, Nikolaev Institute of Inorganic Chemistry Siberian Branch of Russian Academy of Sciences, Russia

PS-03 Styrene Butadiene Rubber (SBR) Prepared by Ab initio Emulsion Polymerization Using Macro-RAFT Agent

Dongjun Lee, Seongyoon Kim, Hyun-jong Paik*, Pusan National University, Korea

PS-04 Poisson-like Living Chain Isolation in ATRP-Synthesized Block Copolymers

Eujin Bae, Hyun-jong Paik*, Pusan National University, Korea

PS-05 Compression-Induced Vertical Alignment of Liquid Crystal Elastomers via the Smectic Phase

Hyeonji Seok, Kyeong-wan Kim, Suk-kyun Ahn*, Pusan National University, Korea

PS-06 Liquid Crystal Elastomers with Enhanced Reprocessability via Exchangeable Networks

Yebin Choi, Suk-kyun Ahn*, Pusan National University, Korea

PS-07 Architectural Control and Rheological Properties of Long Chain Hyperbranched Polystyrene Synthesized via Sulfoxide-Functionalized ATRP

Hyerim Kim, Dongwoo Kim, Minchan Kim, Kyu Hyun*, Hyun-jong Paik*, Pusan National University, Korea

PS-08 High-Temperature Creep-Resistant and Reprocessable Epoxy Adhesive Based on Disulfide-Linked Covalent Adaptable Networks

Jaehong Park, Jaehyeok Lee, Chae Bin Kim*, Pusan National University, Korea

PS-09 Light-Driven Tunable Adhesion in Donor-Acceptor Stenhouse Adduct Functionalized Polymer Networks

Minkyeong Gwon, Siwoo Kim, Kyungwon Seo, Woojin Noh, Hyosung An, Jaejun Lee*, Pusan National University, Korea

PS-10 One-Pot Free Radical Polymerization: Thermal Activation of a Dual-Functional Initiator for Block Copolymer Synthesis

Seunghyeon Lee, Seoyoung Lee, Minji Kim, Yerin Jang, Heungbae Jeon*, Hyun-jong Paik*, Pusan National University, Korea

PS-11 Stretch-Driven Thermal Conductivity Modulationin Emulsion-Templated Porous Vitrimers

Seungjae Shin, and Chae Bin Kim*, Pusan National University, Korea

PS-12 Coordination Geometry-Controlled Shock Wave Energy Dissipation in Metallosupramolecular PDMS Networks

Seungrae Cho, Hyemi Lee, Sieun Je, Juho Lee, Suwon Ba, Tae Ann Kim, Jaejun Lee*, Pusan National University, Korea

PS-13 Photoinduced Shape-Fixation and Reconfiguration of Soft Microarchitectures in Covalent Adaptable Networks

Yeomyung Yoon, Hojun Moon, Woongbi Cho, Dongwook Lee, Sohdam Jeon, Jeong Jae Wie, Chae Bin Kim*, Pusan National University, Korea

PS-14 Microphase Separation of Phosphocholine-Cholinephosphate Diblock Copolymers in Aqueous Solutions

Yuki Matsui, Yasuhiro Eguchi, Yuji Higaki*, Oita University, Japan

PS-15 Horizontal Lithium Electrodeposition on Atomically Polarized Monolayer Hexagonal Boron Nitride

Cheol Heo, Seung-Hyeok Kim, Sang-Young Lee*, Yonsei University, Korea

PS-16 Glass Fiber Reinforced Plastic Embedded with Silica-Coated Hollow Glass Microspheres for Enhanced Thermal Insulation in Liquid Hydrogen Storage

Dahee Cho, Dayoung Kim, Sumin Heo, Dong Gi Seong*, Pusan National University, Korea

PS-17 Lithium-ion battery with metal oxide-coated polyolefin separators - terpolymer binder approach

Dahyeon Park, Sooyong Lee, Jihyeon Kim, Hwajeong Kim, Youngkyoo Kim*, Kyungpook National University, Korea

PS-18 Exploring Thermoelectric Properties of Hybrid Films Based on Conducting Polymers

Deepu Murukadas, Woongki Lee, Chanbin Park, Hwajeong Kim, Youngkyoo Kim*, Kyungpook National University, Korea

PS-19 Smart photonic contact lens to control the function of smart glasses

Dong Chul Cho, Sang Bea Shin, Sei Kwang Hahn*, POSTECH, Korea

PS-20 Thermally Conductive and Stable Organic PCM Composites Enabled by Segregated Filler Architectures

Donghun Lee, Chae Bin Kim*, Pusan National University, Korea

PS-21 Composition-Controlled Network Formation in Reactive Polyacrylate Binders for High-Performance Silicon Anodes

Gihun Lee, Seungwoo Lee, Hyerin Kang, Suraj Aswale, Suk-kyun Ahn* Hyun-jong Paik*, Pusan National University, Korea

PS-22 Crystalline and Stable Hierarchical Porous Conjugated Organic Framework as an Ideal Platform for Electrosynthesis

Hongfei Wu, Feng Li*, Dongyuan Zhao*, Fudan University, China

PS-23 Comprehensive Investigation of Anti-solvent Free Processed CsPbI2Br Perovskite Thin Films

Ji Hee Song, Siyeon Seo, Hyo Jung Kim*, Pusan National University, Korea

PS-24 Transparent PEDOT:PSS/MXene Thin-Film Heater with Enhanced Conductivity and Joule Heating Efficiency via Trifluoroacetic Acid Treatment

Jihwan Ju, Beomjin Jeong*, Pusan National University, Korea

PS-25 Stretchable MXene/Silver Nanowire (MXAg) Electrodes for Biophotonic Applications of Stretchable Light-Emitting Diodes

Jonghyeong Cho, Kwanghyeon Park, Sei Kwang Hahn*, POSTECH, Korea

PS-26 Silica Nanoparticles with Second-Scale Room Temperature Phosphorescence and in situ Generated Carbonaceous Defects for Theranostic Applications

Kyurim Lee, Sei Kwang Hahn *, POSTECH, Korea

PS-27 Designing Phase-Change Thermal Interface Materials via Pickering Emulsions and Segregated Filler Networks in Covalent Adaptable Networks

Min Jun Lee, Chae Bin Kim*, Pusan National University, Korea

PS-28 Electrostatic Covalent Organic Frameworks as On-Demand Molecular Traps for High-Energy Li Metal Battery Electrodes

Sejung Oh, Kyeong-seok Oh, Sang-Young Lee*, Yonsei University, Korea

PS-29 Restructuring of Aqueous Electrolytes Using a Soft-acidic/Hard-basic Zwitterion for Low-temperature Anode-free Zn batteries

Seokhyeon Ryu, Hong-I Kim, Sang-Young Lee*, Yonsei University, Korea

PS-30 Enhancement of Stretchable Ferroelectric Capacitor through Amine-Functionalized Graphene Oxide Additives

Seongbo Jang, Beomjin Jeong*, Pusan National University, Korea

PS-31 Additive Engineering for Crystallization and Defect Passivation in Perovskite Solar Cells

Seungbu Han, Kukhyun Jo, Hyo Jung Kim*, Pusan National University, Korea

PS-32 Tuning Mechanical and Electrochemical Properties of ROMP-Derived Copolymer Binders for Silicon Anodes

Seungwoo Lee, Suk-kyun Ahn*, Pusan National University, Korea

PS-33 Additive Engineering Strategies for Commercial Perovskite Solar Cells Exhibiting Superior Moisture and Thermal Stability

Siyeon Seo, Hyo Jung Kim*, Pusan National University, Korea

PS-34 Real-Time Observation of Perovskite Film Stability under Continuous Illumination and Bias

Sungmin Jeon, In-Young Lee, Hyo Jung Kim*, Pusan National University, Korea

PS-35 Stepwise Self-Assembly of Multi-segment Mesoporous Silica Nanobamboos for Enhanced Thermal Insulation

Xirui Huang, Tiancong Zhao*, Dongyuan Zhao*, Fudan University, China

PS-36 Dendrite-Free, Confocal Deposition of Lithium Metal on Electroactive Organic Materials

Ye-Seul Chung, Seung-Hyeok Kim, Sang-Young Lee*, Yonsei University, Korea

PS-37 Environmentally Friendly Processing Of Trichloroethylene On Ni-M (M = Mo, W, Pd) Catalysts Into Carbon Nanofibers For Further Application

Potylitsyna A.R.*, Bauman Y.I., Popov A.A., Shubin Y.V., Vedyagin A.A., Mishakov I.V., Boreskov Institute of Catalysis, Russia

PS-38 P-NIPAM-based Hydrogel for Sustainable Separation of Miscible Liquids

Gibum Kwon*, Gahee Im, University of Kansas, USA

PS-39 TiO_2 Nanohelices Decorated with Homogeneous Au-Core Pd-Shell Nanocatalysts for Selective Toluene Gas Detection

Hanseo Bae, Hyeonwoong Hwang, Sei Kwang Hahn*, POSTECH, Korea

PS-40 Impact of Carbonate Content in CO2-Based Polyols on the Properties of Thermoplastic Polyurethanes

Han-su Lee, Il Kim* and Suk-kyun Ahn*, Pusan National University, Korea

PS-41 Eco-Friendly UV-Curable Acrylic Adhesives with Selective Cleavability Using Lipoic Acid-Derived Crosslinkers

Hyunseok Kim, Rudru Ganga Ratnamma, Ildoo Chung*, Pusan National University, Korea

PS-42 3D Printable Photocurable Dental Composites Based on Catechol-Functionalized Acrylic Polymers

Hyunseok Kim, Chaeyoung Jeon, Ildoo Chung*, Pusan National University, Korea

PS-43 Synthesis of Solution-Processable Borosiloxane Networks as Advanced Flame Retardant Platform

Jieon Kim, Jaejun Lee*, Pusan National University, Korea

PS-44 Recyclable Thermoset Polyurethane Foams with Dynamic β-Amino Ester Networks for Thermal Insulation Applications

Jiyun Han, and Chae Bin Kim*, Pusan National University, Korea

PS-45 Lubricant-Infused Metallic Glass Nanotube Arrays for Enhanced Slippery and Icephobic Surfaces

Man Yun Hsu, Helmi Son Haji, Ting Hao Chang, Jhen De You, Jinn P. Chu, Pakman Yiu*, National Taiwan University of Science and Technology, Taiwan

PS-46 Non-Fluorinated Long Alkyl Acrylates for Water Repellent

Myeong U Jeong, Ildoo Chung*, Pusan National University, Korea

PS-47 Upcycling Polyolefin Waste into Reprocessable Adhesives via Covalent Adaptable Networks

Naon Choi, Chae Bin Kim*, Pusan National University, Korea

PS-48 Synthesis and Intrinsic Anti-Ultraviolet Performance Regulation of Biobased Polythioethers

Qiubo Wang, SeongkuKim*, Yongjiang Laboratory (Y Lab), China

PS-49 Multifunctional Waterborne Anti-Icing Coatings Using a Polarity-Switchable Maleic anhydride Copolymer

Sehui An, Ji Min Lee, Sanghyuk Wooh, Chae Bin Kim*, Pusan National University, Korea

PS-50 Sustainable TPU Designed from CO2-Derived Carbonate Polylols with Tunable Functionality

Soyun Park, Anjali Nagapadi Preman, Il Kim, Suk-kyun Ahn*, Pusan National University, Korea

PS-51 Water-Coatable Acrylonitrile-Maleic Anhydride Copoloymers for Eco-friendly Carbon Fiber Precursors and Flame-Retardant Coatings

Wonjun Lee, Chae Bin Kim*, Pusan National University, Korea

PS-52 Two-Component Binder System of Water Glass and Starch for Iron Ore Pelletization

Aniket B. Gole, Cho Hayoon, Won-Ki Lee*, Pukyong National Univesity, Korea

PS-53 Comparative Study of Drug Encapsulation and Release Kinetics in MOF-808 and ZIF-8

Anastasiia Iazikova, Aleksandr Tomilov, Artem Poryvaev, Matvey Fedin*, International Tomografic Center, Russia

PS-54 Sensing of Bio-Hazardous Species Using Organic Transistor Platforms

Bongmo Kim, Chulyeon Lee, Hwajeong Kim, Youngkyoo Kim*, Kyungpook National University, Korea

PS-55 3D Printed PDRN/GelMA Bioink for Muscle Tissue Engineering

Elif Beyza Demiray, Moon Sung Kang, Iruthaya Pandi Selestin Raja, Hee Jeong Jang, Dongwoo Gi, Dong-Wook Han*, Pusan National University, Korea

PS-56 Wound Management with Zinc Ion-Releasing Gelatin-Based Bioadhesives

Elif Beyza Demiray, Sung Eun Kim, Hee Jeong Jang, Kyung Min Park, Dong-Wook Han*, Pusan National University, Korea

PS-57 Synthesis and Characterization of L-Tyrosine Polyester (LPE) for Drug Delivery Vehicle

Seoyoung Han, Jiun Choi, Ildoo Chung*, Pusan National University, Korea

PS-58 3D Printable PEKK-based Dental Resins Incorporating Multifunctional Groups with Improved Mechanical Properties

Jeongmin Lee, Sujin Kim, Ildoo Chung*, Pusan National University, Korea

PS-59 Poly(ether ketone ketone)-Based Hybrid Resins for Dental 3D Printing

Jeongmin Lee, Sujin Kim, Ildoo Chung*, Pusan National University, Korea

PS-60 Synthesis and Characterization of Biocompatible and Biodegradable L-Lysine Polyurethane (LPU) Nanoparticles for Use in Drug Delivery

Jiun Choi, Soojeong Choi, Ildoo Chung*, Pusan National University, Korea

PS-61 Fabrication and Characterization of Crosslinked Hyaluronic Acid Incorporating Polymerizable Polyrotaxane

Jiun Choi, Rudru Ganga Ratnamma, Ildoo Chung*, Pusan National University, Korea

PS-62 Fabrication of edible sodium alginate-zein based membranes with aligned patterns for cultured meat applications

Kummara Madhusudana Rao, Sung Soo Han*, Yeungnam University, Korea

PS-63 Organic Transistor Sensors for Ultrasensitive Detection of Reactive Oxygen Species

Minjae Kim, Chulyeon Lee, Hwajeong Kim, Youngkyoo Kim*, Kyungpook National University, Korea

PS-64 Synthesis of Acrylic Pressure Sensitive Adhesives Using Supramolecular Movable Cross-linkers with Improved Adhesion Properties

Rudru Ganga Ratnamma, Ildoo Chung*, Pusan National University, Korea

PS-65 Synthesis and Characterization of Slide-ring Polyurethane based on Poly(propylene glycol)-methyl-β-cyclodextrin Polyrotaxane

Rudru Ganga Ratnamma, Jihyun Lee, Ildoo Chung*, Pusan National University, Korea

PS-66 Development of High-Perfomance Photocurable Resin for Dental Applications using Methacrylate-Modified Poly(phenyl sulfone)

Soojung Lee, Jeongmin Lee, Ildoo Chung*, Pusan National University, Korea

PS-67 Microfluidic Sweat Patch Integrated Smartwatch for Non-Invasive Photonic Continuous Glucose Monitoring

Sunah Cheong, Sei Kwang Hahn*, POSTECH, Korea

PS-68 Polydopamine-Coated hBN Segregated Networks for Flame Retardancy and Mechanical and Thermal Properties Reinforcement in CAN Composites

Hyun Ju Kim, Chae Bin Kim*, Pusan National University, Korea

PS-69 Development of a Water-Cooled Heat Dissipation Plate for Electric Vehicle Batteries Using a Polymer Heterojunction Film

Kwang Sun Ahn, Jiun Choi, Ildoo Chung*, Pusan National University, Korea

PS-70 Charge-Trapping Control in Organic Field-Effect Transistors for Memory and Neuromorphic Applications

Jihyun Kim, Taehoon Kim, Chulyeon Lee, Hwajeong Kim, Youngkyoo Kim*, Kyungpook National University, Korea

PS-71 Programming Mechanochromism in Spiropyran-Incorporated Liquid Crystal Elastomers via Direct-Ink-Writing

Kyeong-wan Kim, Tae Ann Kim, Suk-kyun Ahn*, Pusan National University, Korea

PS-72 Programmable Shape-Morphing Textiles from Liquid Crystal Elastomers

In-sun Jeong, Jin-Hyeong Lee, Suk-kyun Ahn*, Pusan National University, Korea

PS-73 Cross-linked hybrid polyimide films for low dielectric applications

Sivagangi Reddy Nagella, Chang-Sik Ha*, Pusan National University, Korea

PS-74 Organic Neuromorphic Transistors Based on Thermally Crosslinked Water-Soluble Polymers

Seungmok Lee, Hwajeong Kim, Youngkyoo Kim*, Kyungpook National University, Korea

PS-75 Covalent Organic Framework based on Multi-Acceptor Planar Structure for Efficient Photocatalytic Production of H2O2

Di Liu, Zhiwei Zhao, Yang Wang*, Fudan University, China

PS-76 PI-based CFRPs Fabricated by a Novel CNTF-assisted Joule Heating Process for Multifunctional Aerospace Applications

Song Hee Kim, Mi Ju Jeong, Dayoung Kim, Dong Gi Seong*, Pusan National University, Korea

PS-77 Infrared-Sensing Organic Phototransistors with Novel Gate Sensing Layers

Yeonwoo Jeon, Chulyeon Lee, Hwajeong Kim, Youngkyoo Kim*, Kyungpook National University, Korea

Plenary Lecture

PL-1 ~ PL-5

Slide-Ring Materials for Circular Economy

Kohzo Ito[1,2*]

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We have developed a novel type of polymeric materials such as slide-ring (SR) materials and pseudo-polyrotaxane (PPR) nanosheet with cyclodextrins (CyDs) for sustainable engineering. In the SR materials, polymer chains are topologically interlocked by figure-of-eight cross-links.[1)] Hence, these cross-links can pass along the polymer chains freely to equalize the tension of the threading polymer chains similarly to pulleys. Recently, we have just reported the stretch induced crystallization of the SR gel, which leads to extremely high toughness and recoverability.[2)] The concept of the slide-ring gel is not limited to cross-linked gels but also includes elastomer[3)], resins[4)], and composites[5)]. Accordingly, it can be applied to wide area such as paints, rubbers, soft actuator, batteries, and so on.[6.7)] The slide-ring materials were used as a key technology to create tough and sustainable polymers for circular economy.

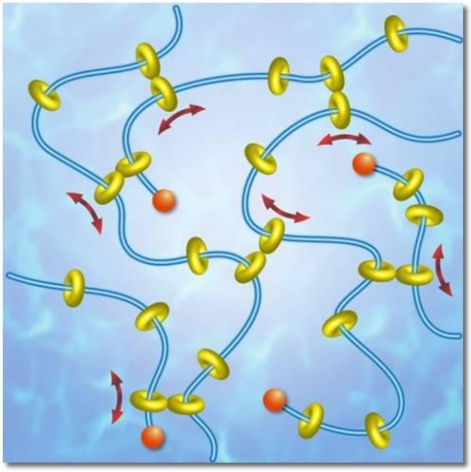

Fig.1. Schematic diagram of Slide-Ring materials.

In this lecture, I will also introduce the results of Japan's flagship national projects, the Moonshot Program and the Strategic Innovation Promotion Program (SIP). While Japan has long boasted world-leading technology in the polymer field, we are now facing a historic turning point due to new international standards for resource circulation. To maintain our global leadership, we believe it is essential to develop and implement circular economy system technologies through collaborative efforts among industry, academia, government, and civil society.

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Nano/microfibrillated Cellulose Aerogels. Green Renewable Materials for Advanced Technology and Ecology

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The first aerogels from nanosized cellulose or nanocellulose were made in 2008, i.e. 17 years ago, but they attract great interest, the study of which is one of the fastest growing areas. Evidence of this can be seen in the annual growth in the number of publications and patents, amounting to 25-30%. Nanosized cellulose has a number of unique advantages, including extraordinary mechanical strength, biocompatibility, biodegradability and inexhaustible renewable resources. Aerogels are used as a convenient matrix for obtaining various materials. Their practically important advantages are low specific gravity (0.1-0.001 g/cm^3), large volume of interconnected macro/mesopores (up to 99.5%) and surface area (50-300 cm^2/g), accessibility of any point in the internal volume. The numerous hydroxyl groups in the cellulose macromolecule and the availability of the entire volume of the aerogel matrix allow its modification – functionalization – by well-developed methods of carbohydrate chemistry, mineralization, attachment of (bio)polymers and their simple incorporation by absorption.

The talk begins from the fabrication of nanosized cellulose, which is still a non-trivial task. The formation of aerogels, if nanocellulose is available, is possible in almost any laboratory. Examples of a number of approaches used for the functionalization of the aerogel matrix are given. These include chemical cross-linking, mineralization by sol-gel chemistry, grafting of (bio)polymers and the introduction of nanoparticles of noble metals, metal oxides, graphene oxide and carbon nanotubes. Superelastic, superhydrophilic, superhydrophobic, electrically conductive, photocatalytic, water- and oil-absorbing, antimicrobial and fire-resistant aerogels, as well as adsorbents for metals and dyes, are considered as examples of functional materials developed in the lab.

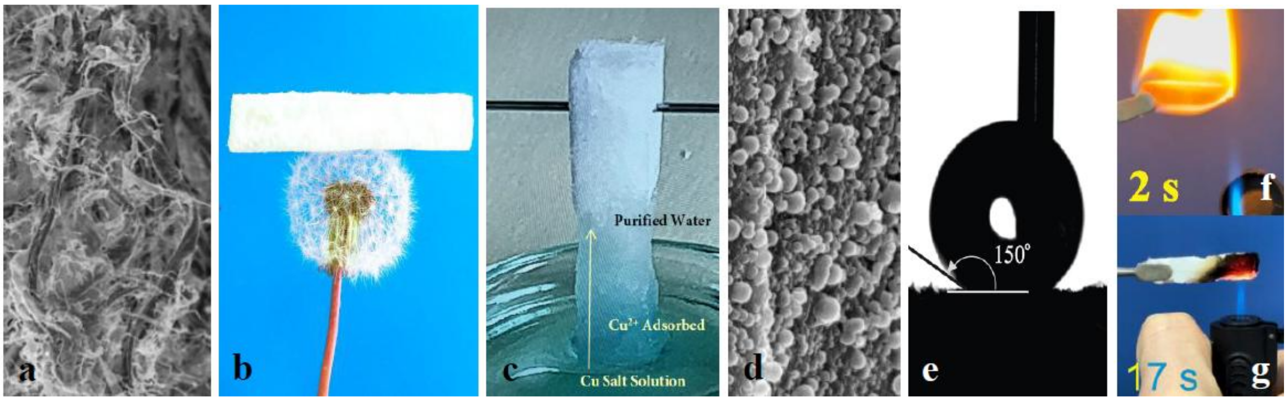

Figure 1. (a) SEM image of aerogel consisting of nano/microfibrils; (b) photo of aerogel; (c) an aerogel bar immersed with its end in a copper salt solution which rises, copper cations are adsorbed and purified water moves higher; (d) the surface of a superhydrophobic aerogel and (e) a drop of water on it; (f) aerogel burning; (g) fire-resistant aerogel.

AI/ML in 3D Printing High Performance Polymer Materials and Synthesis

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Creating and curating new data appends the way we approach materials science. In additive manufacturing (AM), the fabrication of parts and objects with high complexity and high performance is advantageous over other methods. Using polymer nanocomposites enables highly improved properties even with “commodity polymers” that do not need to undergo high-temperature processes or extensive reformulation. With artificial intelligence and machine learning (AI/ML), optimizing the formulation and manufacturing methods is possible. Using sensors capable of a feedback loop mechanism and the ability to use simulation to create digital twins, optimizing properties in record time is possible. Statistical and logic-derived design, including regression analysis, are starting points for designing experiments (DOE) or principal component analysis(PCA) in optimization and analysis vs trial-and-error approaches when working with polymer materials. In this talk, we demonstrate the approaches toward understanding nanostructuring in polymer composites and hierarchical approaches in optimization via AI/ML and other training/learning sets for specific properties and applications, such as 3D printing and flow chemistry reactions. Introducing more sensors (monitoring instruments) in AM processes and real-time ML with online monitoring allows a feedback loop and deep learning (DL) for autonomous fabrication and data analytics.

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Application of Metal-Organic Frameworks in Electrocatalytic Oxygen Evolution

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Green hydrogen is widely regarded as the ideal reducing agent for a sustainable chemical industry, enabling the carbon-neutral production of products like steel, fertilizers, and methanol. However, producing green hydrogen through electrochemical water splitting suffers from energy losses exceeding 40%.[1] A significant portion of this energy loss originates from the oxygen evolution reaction (OER) at the anode. The OER involves a complex four-electron transfer process occurring under harsh oxidative conditions, which complicates the identification of electrocatalysts capable of improving the process's energy efficiency. Consequently, elucidating the fundamental factors governing OER electrocatalyst enhancement represents a major challenge in electrocatalysis. Traditional efforts have focused on optimizing the interaction between OER intermediates and the electrocatalyst surface. Understanding the key parameters influencing OER catalyst activity is therefore crucial for efficient green hydrogen production. Recently, the creation of open metal sites within electrocatalysts has been recognized as a promising approach to boost OER performance.[2,3] Here, utilizing metal-organic frameworks (MOFs) with periodic structures as a model system, we successfully generated open metal sites. These sites serve as highly active adsorption and reaction centers by modifying the attachment modes of ligating atoms or organic linkers to the metal centers (Figure 1), thereby achieving high-efficiency OER.

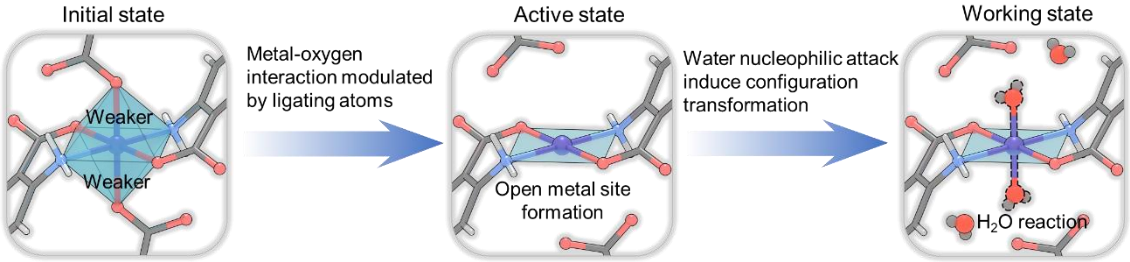

Figure 1. Schematic diagram for undergoing geometry conversion of Co-MOFs in the OER process from the octahedral pristine state to the octahedral working state through the square-planar catalytic state.

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Smart Biomedical Materials and Devices for Theranostic Applications

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Diagnostic and therapeutic devices have been routinely used in the clinic placed at patients' bedsides. However, with the recent progress of nanobiotechnology, a variety of healthcare devices have been investigated for theranostic applications with greatly improved patients' compliance. Here, we developed smart contact lenses and smart wearable devices for both continuous diabetic monitoring and diabetic retinopathy therapy. Smart contact lens could measure tear glucose levels as a non-invasive alternative to the conventional blood glucose tests and deliver drugs from gold coated reservoirs for the treatment of diabetic retinopathy. We also developed a smart NIR light emitting contact lens for the diabetic diagnosis and the treatment of diabetic retinopathy. The retinal vascular hyper-permeability induced by diabetic retinopathy in rabbits was reduced to the statistically significant level by simply wearing the NIR light emitting contact lens. In addition, we developed a smart contact lens to monitor and control the intraocular pressure (IOP) for the treatment of glaucoma. The IOP could be maintained in a controlled manner by the released drug in response to the measured IOP. On the basis of these results, we developed a smart wearable device for highly sensitive glucose monitoring in sweat for clinically feasible diabetic diagnosis. A blue-tooth system could send data wirelessly allowing patients to check their diabetic diagnosis results on the mobile phones. Furthermore, we developed cell-integrated poly(ethylene glycol) hydrogels for in vivo optogenetic sensing and therapy. The real-time optical readout of encapsulated heat-shock-protein-coupled fluorescent reporter cells made it possible to measure the nanotoxicity of cadmium-based quantum dots in vivo. Using optogenetic cells producing glucagon-like peptide-1, we performed light-controlled therapy and obtained improved glucose homeostasis in diabetic model mice. Taken together, we successfully developed smart wearable devices for optogenetic cellular engineering for diagnostic and therapeutic applications. This presentation will provide the current state-of-the-art smart healthcare materials and devices for further clinical applications.

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Keynote Lecture

KL-1 ~ KL-11

Supra-assembly of functional mesoporous materials for the energy applications

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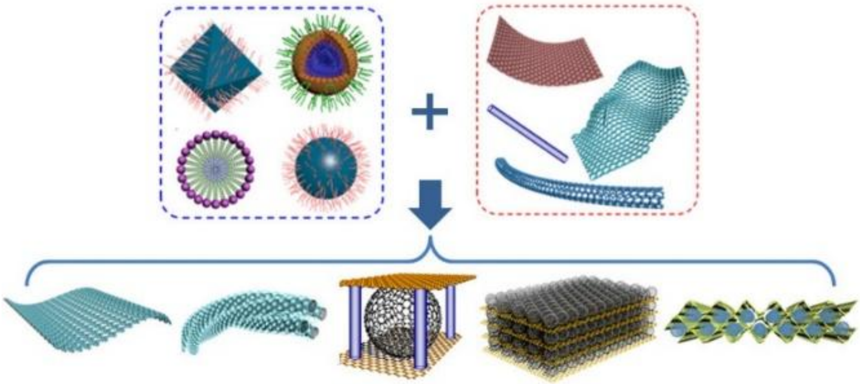
The functional mesoporous materials with pore sizes ranging from 2-50 nm possess unique properties such as high specific surface area, uniform pore size and large pore volume, but also have excellent optical, electrical and magnetic properties of inorganic functional nanoparticles. The functional mesoporous materials can be synthesized by soft-templating method, surfactant assembly process, however, their morphology and mesostructures are difficult to precisely control. In this lecture, we mainly focus the recent progress in the research of molecular aggregate super-assembly regulation, oriented assembly synthesis and the construction of hierarchically-ordered functional mesoporous materials. Based on the new idea of interfacial supra-assembly regulation, we have demonstrated some approaches for the synthesis of ordered functional mesoporous materials with hierarchical mesostructures. We focus on a method for super-assembly using single micelles as mesostructural units. Using this approach, we can precisely prepare a family of novel functional mesoporous materials with hierarchical ordered structures, including uniform nanospheres, hemispheres, polyhedra, two-dimensional (2-D) single-layer nanosheets. These functional mesoporous materials not only have unique and uniform morphology, but also have controllable mesopore structure, high specific surface area, large pore volume and open pore. Based on the interface control, we realized the orientation assembly of functional mesoporous materials, and created the asymmetric dumbbells, gourd, match, shuttlecock, double-leaf dimer (Y-type) multifunctional mesoporous materials for the first time. We will also introduce the applications of functional mesoporous materials in catalyst support (heavy crude oil hydrocracking), electrode materials for lithium-ion batteries, thermal insulation materials, dielectric materials (low-k) and other fields.



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Synthesis of Structured Silsesquioxanes

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The hydrolysis-condensation of organotrialkoxysilanes (Fig. 1, Eq. 1) leads to silsesquioxanes which can be well-defined molecular structures called cages (POSS) or uncompletely condensed polymeric structures. According to the organosilane precursor and to the reaction conditions, several cage compounds can be formed. Thus, with p-styryltriethoxysilane T_8, T_{10}, T_{12} and T_{18} cages could be isolated as pure compounds [1]. These can be post-silylated and hydrolysed leading to POSS units covalently bonded and evenly distributed in a silsesquioxane hybrid network [2,3].

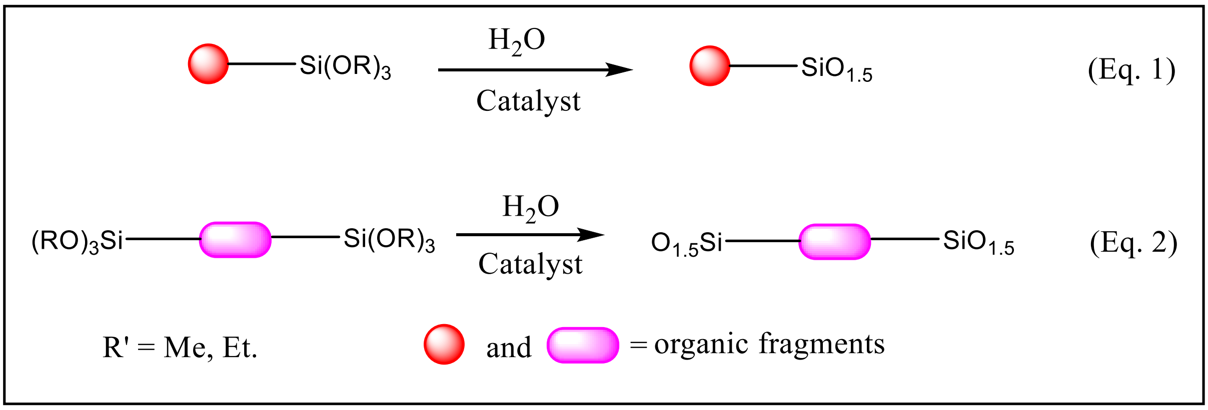

Figure 1. Syntheses of silsesquioxanes and bridged silsesquioxanes.

Moreover, the hydrolysis of organosilane precursors bearing an organic fragment interconnected to several trialkoxysilyl groups produces bridged silsesquioxanes (Fig. 1, Eq. 2). The properties of the resulting hybrid materials can be tuned following the main organic structure (nanostructuring through self-assembly, molecular imprinting/molecular recognition, catalysis, optics, nanomedical applications) [4-8] and also by the silsesquioxane matrix (periodic and uniform porosity, high surface area, etc) [9,10]. My presentation will focus on the syntheses of the size, the structure and the shape of silsesquioxane-based compounds and materials.

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Size Effect by Atomic Clusters on Chemocatalysis and Photocatalysis

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Metals and metal oxides have many uses as chemocatalysts and photocatalysts. In this talk, the effect of size in catalysis is reported.

Metal-relating catalysts range from sub-micro to nano and cluster sizes, and the size depends on the catalytic effect. For example, when ZnO particles become smaller from 14 nm to 1 nm, the rate of the photocatalytic decomposition reaction of formaldehyde is about 5 times faster [1]. A similar size effect has been reported in chemocatalytic reactions, [2,3]. That is, the highest efficiency occurs in so-called atomic clusters of 1 nm or less, due to an increase in the effective reaction surface area of the subdivided particles. In the chemical synthesis of clusters, they must be protected with a stabilizer to avoid the agglomeration of clusters, but this stabilizer often inhibits the activity of cluster. Alternatively, we used the femtosecond pulse laser irradiation to synthesize the bare clusters in physical bottom-up manner [1-3]. Clusters can be sometimes encapsulated in a metal organic framework (MOF) or deposited on a cellulose nanofiber filament [2-6], but the catalytic activity of clusters is not reduced even in these states, because the clusters are distributed as it is in/on these supports.

n-type ZnO exhibits a strong photovoltaic effect similar to TiO_2, but the effect of composites with p-type photovoltaic particle is more efficient than that of the simple p-type photovoltaic particles [7]. The composites of n-type TiO_2 and p-type NiO revealed the higher power conversion efficiency on the dye-sensitized solar cell (DSSC) due to the n-p heterojunction effect [7]. This effect between nanoparticles also occurs in the photolysis of CO_2 gas, but when the heterojunction effect was compared with the efficiency by the size effect of the cluster, the size effect was higher [5]. Incidentally, the photolysis reaction of CO_2 occurs on n-ZnO/p-CuO, but this composite is not effective for DSSC because of differences in catalytic mechanisms.

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Redesigning Polymer Electrolytes: Chemistry Beyond PEO

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Polyethylene oxide (PEO)-based polymer electrolytes, despite decades of research, suffer from inherent drawbacks, including low ionic conductivity at room temperature due to high crystallinity, sluggish segmental motion, and poor salt dissociating capability. These limitations have critically constrained their viability in all-solid-state lithium batteries (ASSBs). In this talk, we present a paradigm shift in polymer electrolyte design that moves beyond the chemistry of PEO. By reengineering ion transport pathways and polymer architectures, we present three distinct strategies: solvent-free single-ion-conducting covalent organic frameworks (COFs) offering directional Li^+ conduction through ordered nanochannels; ionic dimer elastomers (IDEs) that simultaneously deliver high ionic conductivity and mechanical strength, overcoming the long-standing trade-off; and monomer-in-salt systems that promote entropy-driven salt dissociation and decoupled ion transport. These approaches embody a new generation of polymer electrolytes that enable fast, efficient, and stable Li^+ transport under ambient conditions. This work highlights a chemistry-by-design approach to redefine polymer electrolytes beyond PEO for high-performance ASSBs.

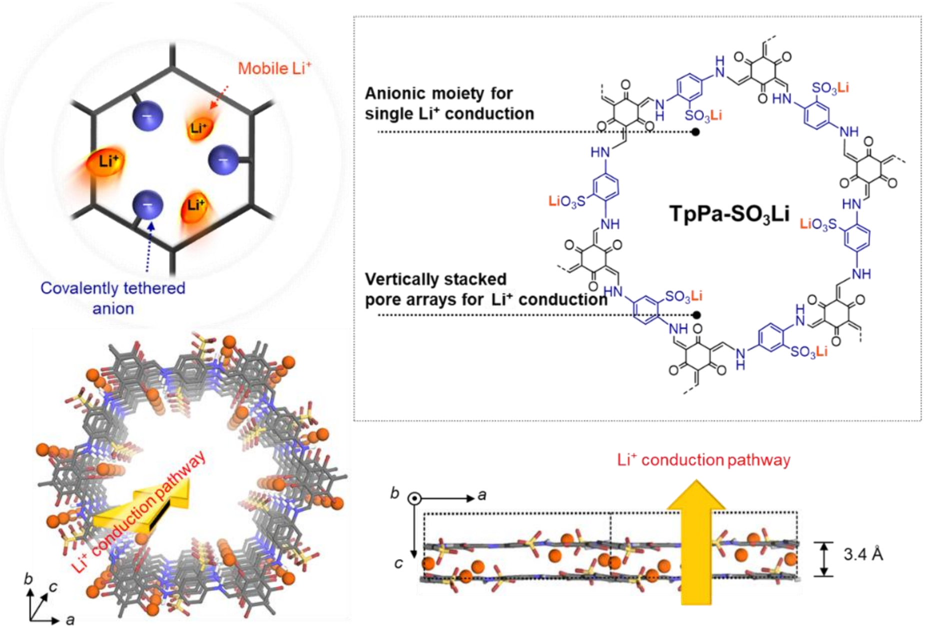

Figure 1. Schematic of solvent-free, single Li+-conducting COF[1].

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Surface and Interfacial Chemistry of Environmental Degradation of Polymers

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Polymers have profoundly influenced modern society, enabling advancements in food preservation, lightweight transportation, electronics, and medical technologies. However, increasing environmental concerns—particularly microplastics (MPs)—have spurred extensive research into polymer degradation and its broader impacts. Addressing the MP challenge requires a deeper understanding of their formation mechanisms, physicochemical properties, and biological effects.

Polymer degradation involves the loss of mechanical integrity, color, and shape due to environmental factors such as heat, light, chemicals, microbial activity, and mechanical stress or electrical stimulation (Figure 1). Degradation can proceed via multiple, often concurrent pathways. **Physical degradation** typically involves fragmentation from mechanical or electrical forces, while **chemical degradation**—often initiated by abiotic processes—leads to changes in molecular structure, reduced molecular weight, new functional groups, and compromised performance. These changes are closely linked to MP formation. In contrast, **biodegradation** offers a sustainable route for polymer breakdown. Biodegradable polymers degrade enzymatically following microbial biofilm attachment. Despite promising developments, achieving materials that balance functional stability during use with efficient post-use degradation remains a major challenge.

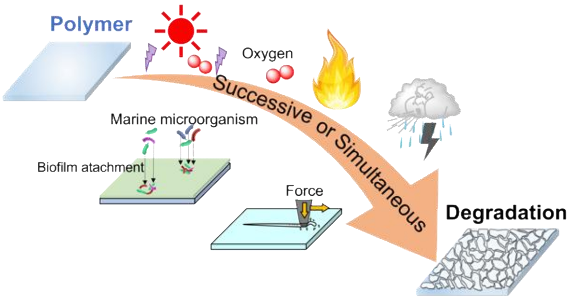

Figure 1. Schematic representation of environmental degradation process of polymeric materials.

Degradation behavior is further influenced by polymer structure. In semicrystalline polymers, amorphous and crystalline regions degrade at different rates—even variations exist within amorphous domains. In multiphase systems such as rubber-modified plastics, the rubbery phase degrades more rapidly than the glassy matrix due to higher molecular mobility and oxygen diffusion. Since degradation typically initiates at the surface, surface composition and morphology are critical to understanding and controlling degradation processes.

This presentation explores key degradation mechanisms—focusing on chemical and biological pathways—while emphasizing the crucial role of polymer surfaces and interfacial science in environmental degradation.

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Molecular Conformation and Intermolecular Interactions of Linear, Cyclic, and Branched Polymers in Solution

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Polymers exhibit strong non-ideality in their solutions due to the large molecular volume relative to their mass. This allows data from dilute polymer solutions to provide accurate information on molecular mass, size, shape, and polymer-to-polymer interactions. Recent advancements in synchrotron radiation small-angle X-ray scattering (SR-SAXS) techniques have enabled precise measurements of polymer structures, including local helical structures, branching, and structural changes driven by intramolecular interactions. In this presentation, I will share findings on polymer morphology and solution interactions obtained through a combination of light scattering, spectroscopy, and SR-SAXS.

The structure and behavior of cyclic and highly branched polymers in solution, along with their chiral separation capabilities on silica, were studied. Amylose carbamate derivatives showed varying rigidity depending on side chain length, with longer side chains providing higher chiral separation abilities. Cyclic amylose displayed weaker separation efficiency compared to linear polymers, emphasizing the critical role of linear polymers in improving performance. Highly branched cyclic dextrin tris (HTPC) dissolved in methyl acetate only at low temperatures, exhibiting LCST-like phase behavior and suggesting specific solvent interactions near bent helices at branching points. Rod-shaped highly branched polymers (HDMBC) were synthesized, revealing the effectiveness of multi-branched structures in chiral separation.

Dilute aqueous solutions of star-shaped branched poly(N-isopropylacrylamide) (sPNIPAM) with temperature-responsive arm chains formed uniform nanoparticles upon heating. Rapid heating produced narrower particle size distributions than slow heating, suggesting spinodal decomposition during the early phase separation process. The high segment density of star-shaped chains facilitated the formation of highly concentrated nanodroplets immediately after aggregation. The charged surfaces of the nanoparticles allowed the formation of stable spherical structures.

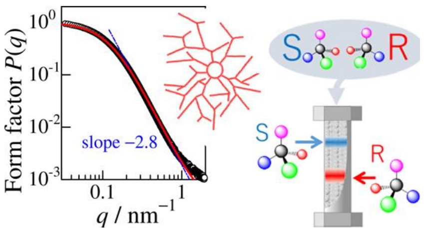

Fig. 1. SAXS data and chiral separation of branched polysaccharide derivative.

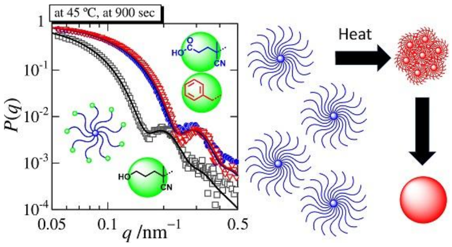

Fig. 2. Nanoparticle formation of star-shaped poly(*N*-isopropylacryl amide) in water.

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Life Cycle of Polymer Materials: Scientific vs Emotional Approach

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Contamination of the environment with polymer waste has recently acquired the features of a global challenge to humanity. During a hundred years of development of polymer science and the polymer industry, about 10 billion tons of waste from used polymer materials have accumulated in the world, which degrade extremely slowly in natural conditions. A particular danger is associated with the pollution of water environments - rivers, lakes, seas and oceans.

To solve this problem, some environmental scientists propose a radical reduction in the global production of polymer materials. This cannot be agreed with, since these materials are an integral part of modern world civilization. Instead, scientists working in the field of polymer science should offer their own approaches that are not associated with reversing global scientific and technological progress.

The report will provide an overview of the main areas of scientific research in the field of polymer science, which will ensure the evolution of the polymer industry towards the creation of environmentally friendly production and minimal impact on the environment.

Sorting waste for their subsequent use can only delay littering the environment. Polymer material can be recycled at best several times. Eventually, it will end its life cycle in a landfill or be incinerated. Therefore, the key issues are: (a) thoughtful design of landfills; (b) effective catalysts that prevent air pollution during combustion of polymer materials.

The problem of micro- and nano-plastics (i.e., polymer waste particles smaller than 5 mm) will be discussed separately. The harm from micro- and nano-plastics to living organisms is probably overestimated. Only particles smaller than 5 μm can penetrate the blood, and only objects smaller than 50 nm can pass through cell membranes. In natural aquatic environments, these particles will be covered with a layer of surfactants, so that the immune response to these particles will be similar to that for small dust/sand particles, with which many organisms have coexisted for many millions of years.

Closed-Loop Recycling and Upcycling of Step-growth Polymers

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Engineering plastics based on step-growth polymerization such as poly(ethylene terephthalate) (PET), polyamides (PA), polyurethanes (PU), polycarbonate (PC), and polyimide (PI) comprise ~30% of the global plastic production. Mechanical recycling is available for some of these step-growth polymers (e.g. PET), but that is typically limited to clean, colorless single plastic of those thermoplastic polymers. Chemical recycling via catalytic deconstruction could provide a versatile and efficient path for recycling all these polymers including mixed state, if highly efficient catalyst system is developed [1]. Here, we have developed tailored organocatalysts to enable low energy and versatile depolymerization pathways for step-growth polymers. Our catalyst allows glycolysis of PET, PA, PU, PC, and their multiple mixture at moderate temperature with high yield (Fig. 1A) [2]. A wide range of post-consumer plastics waste, such as bottles, packaging, foams, carpets, etc. is readily deconstructed into monomers or oligomers with high efficiency. We further tailored organocatalyst system to more efficient and deployable system [3]. Moreover, we have developed a path to deconstruct these step-growth polymers to selective length of oligomers. We have utilized those deconstructed building blocks, both monomers and oligomers, to synthesize upcycled polymers, resulting in enhanced properties such as exceptional adhesion (Fig. 1B), and the upcycled polymers can be further deconstructed to reusable building blocks [4, 5]. Such a plastic upcycling path contributes to establishing a new circular economy of polymers. This presentation will update our progress on chemical deconstruction of step-growth polymers and their upcycling toward circularity.

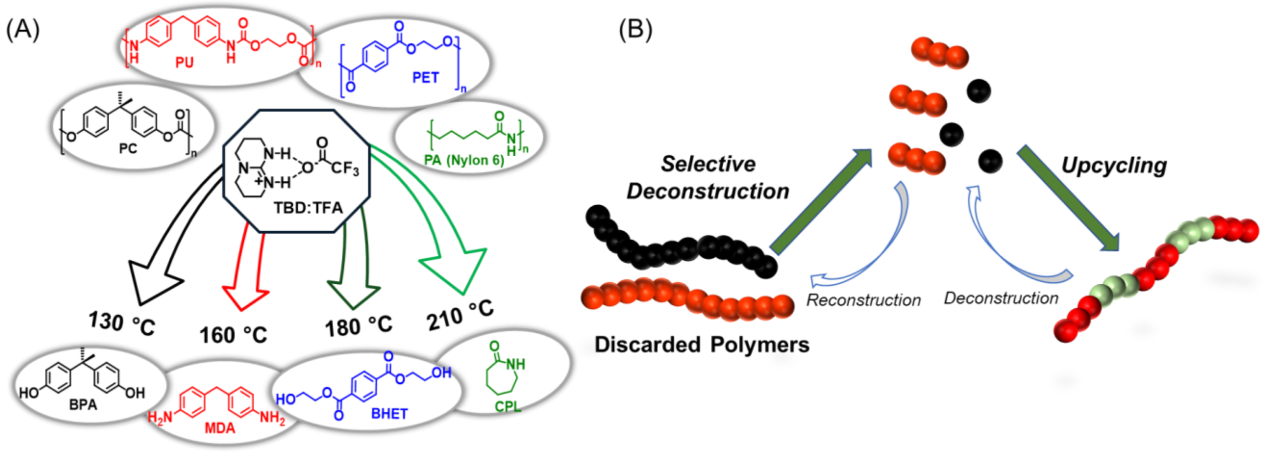

Figure 1. Selective deconstruction of PC, PU, PET, and PA via the TBD:TFA catalyst (A), and Selective deconstruction and upcycling of step-growth polymers (B)

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Chain-End Functionalized Polymers via Radical Polymerization

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Controlling the end groups of polymers is becoming more important in polymer science because these functional ends can significantly influence how the polymers behave and interact with other materials. By carefully designing these chain ends, we can adjust the polymers' properties, improve their self-assembly, and make them more compatible in various mixtures. Reversible Deactivation Radical Polymerization (RDRP) methods—like Atom Transfer Radical Polymerization (ATRP), Reversible Addition–Fragmentation Chain Transfer (RAFT), and Nitroxide-Mediated Polymerization (NMP)—allow us to benefit from both the wide range of monomers available to radical polymerization and the precise control of chain ends typical of living polymerization.

These techniques enable the creation of polymers with well-defined structures and a variety of useful functional groups, which can then be further modified. As a result, we can design smart and advanced materials, such as polymers for drug delivery or stimuli-responsive systems. During this talk, I will explain the fundamental ideas behind synthesizing end-functional polymers using RDRP, with a focus on how we can control molecular weight, polymer architecture, and specific end groups. I will also give examples of how these polymers can be tailored to bond with biomolecules and how we can measure their properties—like molecular weight distribution—to confirm their structure. Finally, I will discuss how these materials may be applied in industry, highlighting their potential to create innovative materials with specialized characteristics.

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Organic Neuromorphic Transistors Based on Water-Processable Polymeric Hysteresis Nanolayers

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Artificial intelligence (AI), based on large language models (LLMs), has emerged as a key technology in the fields of data processing and applications. These generative AI technologies are operated on software platforms, indicative of continuous expansion by advanced coding and data-accessing logics. In contrast, physical AI systems have been relatively positioned far behind generative AIs because their core components are not yet extensively studied and developed, even though conventional devices and motors are used in the apparent robot systems resembling humans. Of various core components for physical AIs such as humanoid robots, neuromorphic devices are recognized as an intrinsic constituent to operate like humans. To date, various neuromorphic devices have been studied using conventional inorganic materials due to well-defined material characteristics and processing conditions. However, a genuine humanoid robot, like a human body, requires soft neuromorphic devices with various features including flexible and stretchable functions. In this regard, organic neuromorphic devices have recently received intense attention due to the potential of organic materials, which can achieve flexibility and softness via molecular structure design. This presentation introduces the basics of neuromorphic devices and demonstrates our recent efforts on organic neuromorphic transistors.

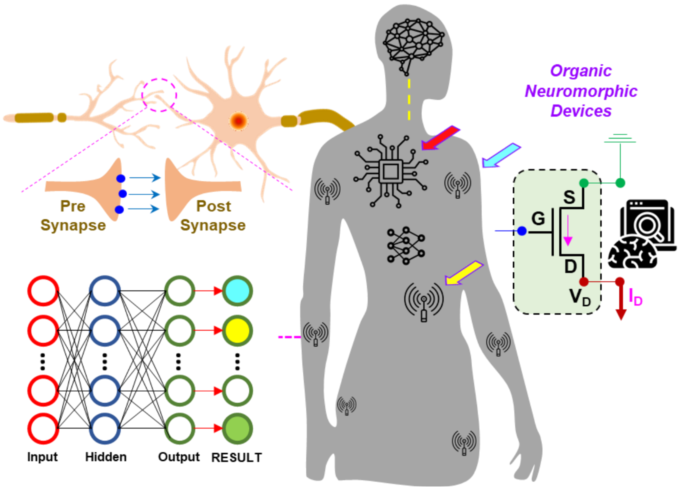

Figure 1. Illustration of a physical AI (humanoid robot) with various organic neuromorphic devices.

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Humanoid Electronic Nose and Tongue Technologies: Neural Network-Based AI Systems for Revolutionary Digital Healthcare

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We introduce an innovative AI-driven humanoid digital healthcare platform grounded in metabolomics and powered by neural network-inspired biomimetic electronic nose and tongue technologies. At the core of this development are M13 bacteriophages engineered to emulate mammalian olfactory receptors with high precision[1,2]. Through this system, our humanoid sensor array—enhanced by deep learning algorithms—analyzes metabolites from diverse human biofluids such as breath, saliva, urine, and serum[3,4]. This analytical versatility enables comprehensive metabolic profiling for disease screening and monitoring, achieving detection sensitivities down to the parts-per-billion range. Beyond digital healthcare, the system's AI-enabled pattern recognition supports applications in hazardous gas monitoring, real-time odor evaluation, and even early-stage fire detection.

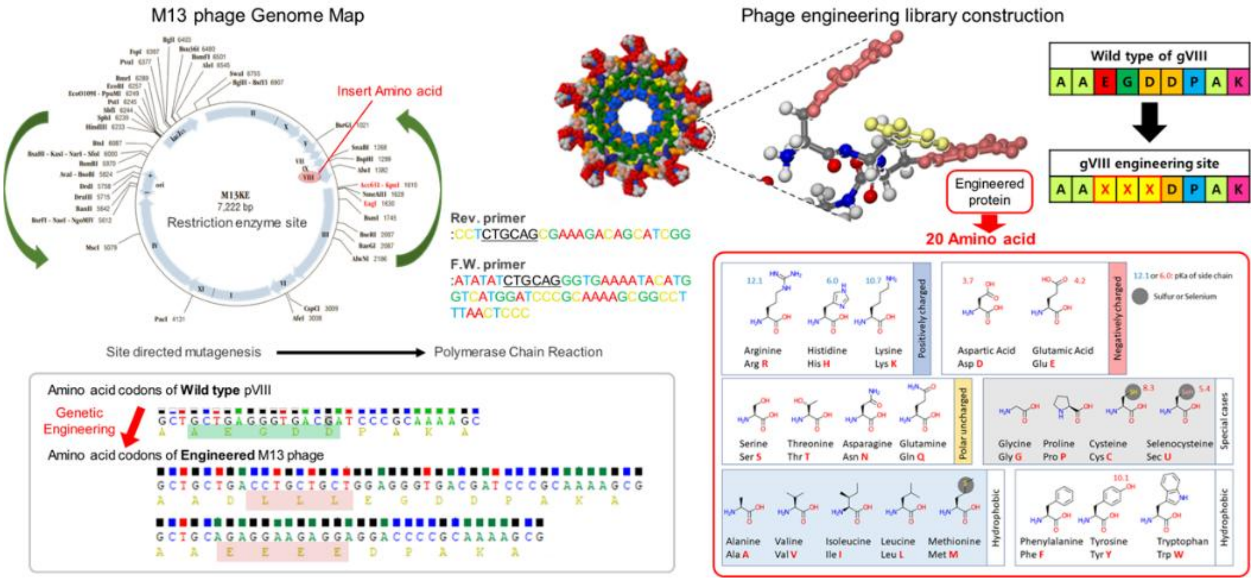

Figure 1 DNA-based M13 bacteriophage pVIII coat protein engineering technology

The unique advantage of our neural network-enhanced M13 bacteriophage platform lies in its genetically engineered pVIII coat protein, which permits the generation of up to 8,000 distinct olfactory receptor types. When integrated with photonic crystal-based signal amplification, synchronized optical acquisition, and advanced AI-powered data processing, this humanoid system delivers unparalleled olfactory sensing performance. Compared to conventional organic or inorganic materials, the bacteriophage-enabled framework vastly expands receptor diversity and boosts overall sensor efficiency, establishing a high-performance biomimetic olfactory platform.

From a medical perspective, this AI-driven humanoid electronic nose addresses urgent challenges in healthcare, notably early lung cancer detection. By capturing and analyzing trace metabolites in exhaled breath through neural network-based classification, the system offers a non-invasive, cost-effective alternative to imaging-based diagnostics. With these capabilities, our humanoid electronic nose and tongue technologies represent a transformative approach for early disease screening and continuous patient monitoring, positioning AI-powered biomimetic sensing as a cornerstone of future digital healthcare and smart medical diagnostics.

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Invited Lecture

IL-1 ~ IL-23

Dynamic Polymer Materials: Designing Crosslinks for Advanced Functions

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Stimuli-responsive polymers represent a compelling class of dynamic materials with broad applicability in the development of cutting-edge sensors, sophisticated drug delivery systems, and innovative cell culture platforms. We has focused on the rational design of diverse stimuli-responsive polymeric materials, including hydrogels, films, particles, and self-assemblies. Our strategy for designing these materials uses a range of dynamic crosslinking mechanisms such as molecular complexation, photodimerization, and polymer chain entanglements. For instance, we engineered biomolecular stimuli-responsive gels that exhibited significant volume changes in the presence of specific target antibodies and tumor markers. This responsiveness is achieved by incorporating biomolecular complexes as dynamic crosslinks, which reversibly dissociate and associate in response to the target biomolecule's presence or absence [1,2]. This paper highlights our recent advancements in the design of dynamic polymer materials through the integration of stimuli-responsive polymer networks, photodimerization, and polymer chain entanglements (Fig. 1). We have developed protein-mimetic gels with dynamic binding sites for target molecules, achieved through molecular imprinting. These gels can regulate the adsorption and desorption of target molecules *via* conformational changes triggered by environmental changes like pH and temperature [3,4]. Furthermore, we fabricated photoresponsive polymer films by combining photodimerizable groups as dynamic crosslinks with poly(dimethylsiloxane), which has a large free volume. This innovative approach enables a novel and facile method for micropatterning *via* UV exposure through a photomask, eliminating the need for solvent-based development [5,6]. When culturing cells on these micropatterned surfaces, we observed preferential cell adhesion, alignment, and proliferation within the unexposed regions, ultimately leading to the formation of cellular patterns. Recently, we proposed a moisture harvesting system using temperature-responsive networks [7] and a universal method for designing stretchable and tough gels [8], which uses polymer chain entanglements as physical crosslinks. Thus, dynamic crosslinks serve as useful tools for engineering dynamic polymer materials with advanced functions, which hold significant promise for various applications.

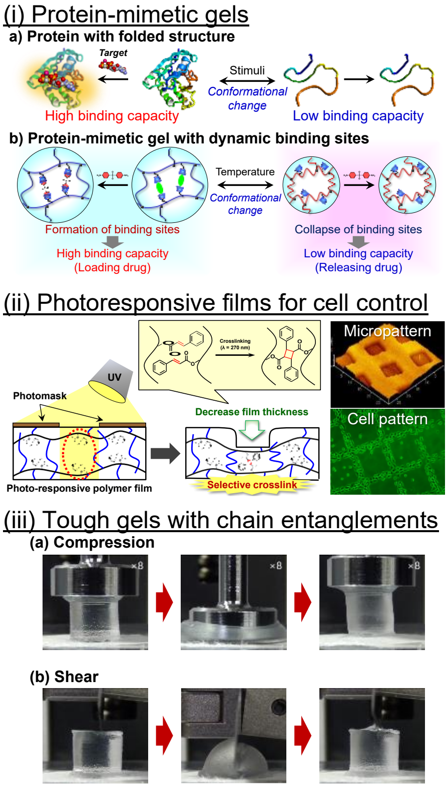

Fig. 1. Dynamic polymer materials with designed crosslinks for advanced functions.

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Flexible Electrochromic Energy Storage Devices Featuring Viologen Ion Gels

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The integration of energy storage and electrochromic technologies is paving the way for innovative multifunctional and flexible electronic systems. In this presentation, we introduce the development of flexible electrochromic energy storage devices (EESDs) utilizing viologen derivatives, which enable simultaneous optical modulation and energy storage. These devices are designed to meet the growing demand for lightweight, adaptable, and optically dynamic components, particularly in wearable electronics and adaptive display technologies.

To enhance redox performance, viologen-based electrochromic ion gels were developed by introducing bulky counter-ions, enabling the viologens to serve dual roles as electrochromic agents and pseudocapacitive charge carriers. To address challenges slow switching and low charge capacity, the several strategies were implemented: (i) electrospun TiO_2 nanofibers, thermally or UV-annealed, acted as ion-selective layers (ISLs) to promote ion transport while maintaining flexibility [1,2]; (ii) IGZO composite electrodes were fabricated with a highly amorphous structure to improve electron mobility and redox activity at the interface [3]; and (iii) carbon nanomaterials were applied as transparent, conductive, and mechanically robust surface coatings to enhance electrode flexibility and stability [4].

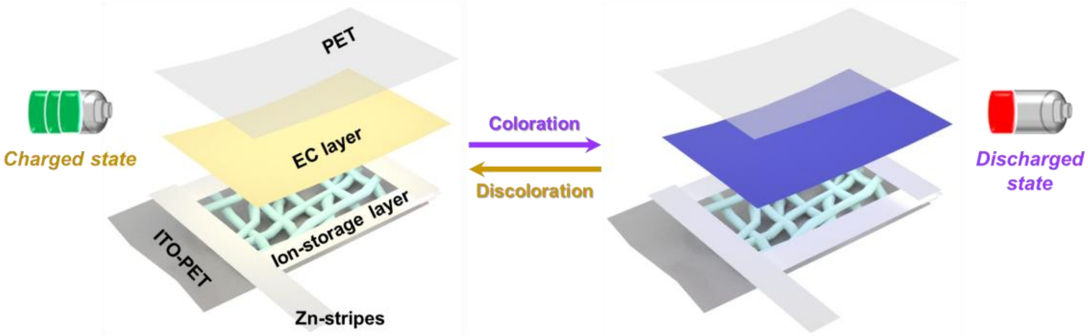

Figure 1. The dual operation mechanism of Zn-based EESDs with a TiO_2 ISL in a charged state (bleached) and discharged state (colored state) [2].

In addition, we briefly cover the most recent EESDs capable of operating in four distinct electrochromic modes and exhibiting visible to near-infrared dual-band energy storage [5].

These works demonstrate durable, flexible, and visually responsive electrochromic energy storage platforms, with promising applications in smart windows, wearable devices, and next-generation display systems.

[1] R. Pal, F. Sun, D. Y. Kim and J. S. Park, *Chem. Eng. J.*, **2024**, *408*, 148191.
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[4] S. Y. Eom, F. Sun, R. Pal, J. Lee, B. Jeong and J. S. Park, *Sol. Energy Mater. Sol. Cells*, **2025**, *288*, 113651.
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Solid State Polymer Electrolytes with Dynamic Mechanical Bond for Enhanced Ionic Conductivity

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The dynamic properties of threaded host molecules in mechanically interlocked polymers (MIPs) has been demonstrated as an important factor for the enhanced ionic conductivity of solid polymer electrolytes (SPEs). Various types of polyrotaxane (PR)-based MIP electrolyte composed of alpha-cyclodextrin and linear poly(ethylene glycol) were synthesized for SPEs. A necklace-like structure of PR-based SPE showed high ionic conductivity ($\sigma = 5.93 \times 10^{-3}$ S cm^{-1} at 25 °C and 1.44×10^{-2} S cm−1 at 60 °C) [1,2] and high Li+ ion transference number (t+ = 0.71). To understand the effect of the molecular mobility on the ion transport behavior, PRs-based MIP electrolytes containing different number of threaded host molecules were designed and synthesized. As a result, the PR-based MIP electrolyte with the lowest inclusion ratio which is expected to show highest molecular mobility exhibits highest ion transportation ability. The dynamic nature of the threaded host molecules in different PRs were characterized by measuring T2 relaxation time using ^{1}H-NMR. As a result, PRs containing lowest host molecules showed the largest T2 relaxation time (0.215 s) [3] and this tendency was very well corelated with ionic conductivity of the PRs-based electrolytes. This highlights the importance of the molecular mobility of MIPs electrolytes in designing solid state polymer electrolytes to enhance the ionic conductivity.

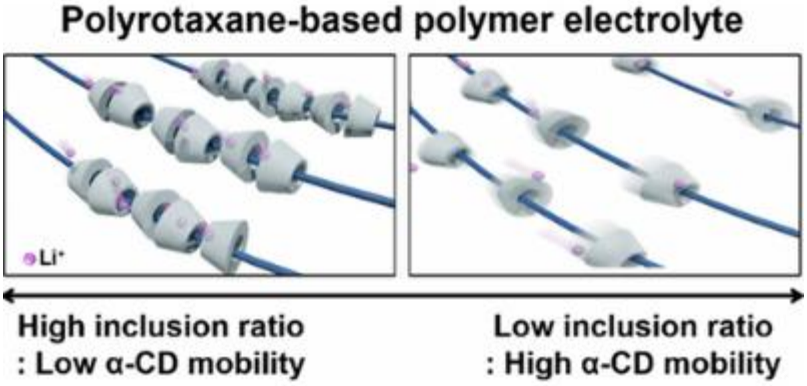

Figure 1. Schematic explanation of enhanced ionic conductivity in PR-based electrolytes composed of different threading ratio of α-CDs.

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[2] B. Kim, M.-C. Sung, G.-H. Lee, et al., *Nano-Micro Letters,* **2025**, 17, 31.
[3] B. Kim, E. Lee, et al., *ACS Macro Letters,* **2024**, 13, 1463.

A Simple Approach for Real-time Hydogelation Monitoring

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Enzymatically cross-linked hydrogels, with their unique ability to offer precise control over gelation kinetics, are a promising avenue for various fields, ranging from material science to pharmaceutical development. However, to fully harness their potential, it is necessary to screen individual enzymatic gelation reactions and analyze the underlying kinetic behavior of the reactants. Traditional hydrogel characterization techniques, while informative, are often resource-intensive and laborious, slowing down research progress in hydrogel development and characterization. To address these challenges, we present an innovative methodology for real-time monitoring of enzymatic hydrogelation using electrochemical impedance spectroscopy (EIS) with interdigitated electrodes (IDEs). The proposed approach's eligibility was tested through the initiation of enzymatic cross-linking of carboxymethyl cellulose-tyramine (CMC-TA) conjugates with horseradish peroxidase (HRP) enzyme in the presence of hydrogen peroxide (H_2O_2) oxidant. By real-time screening the changes in impedance moduli at a single frequency of 3×10^5 Hz, we could distinguish between different gelation trajectories obtained by varying reactant concentrations. This proved to be a sensitive and precise way to study hydrogelation dynamics.

Furthermore, we propose a unique EIS signal interpretation approach that involves placing the conductance data into a modified Michaelis-Menten kinetics equation and extracting reaction constants, such as K_m and k_{cat}, to forecast enzyme kinetic trajectories. This innovative methodology, validated by gold-standard bulk rheology, has proved its potential for fine-tuning hydrogel properties [1].

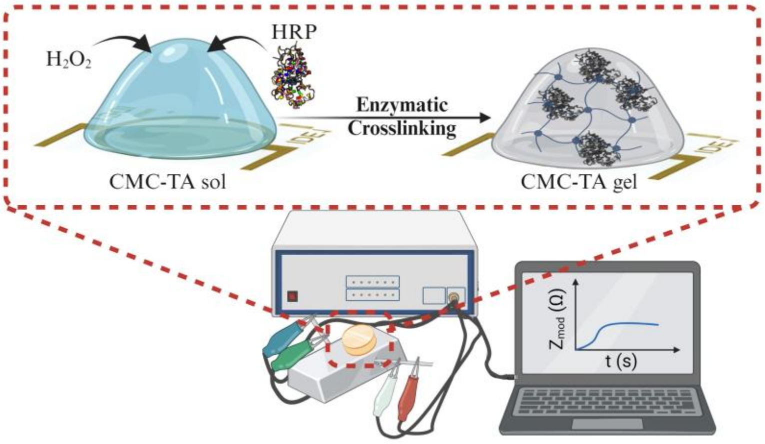

Figure 1. Real-time monitoring of enzymatic CMC-TA hydrogelation via electrochemical impedance spectroscopy (EIS) analysis. CMC-TA sol is crosslinked into a gel through HRP-catalyzed oxidation in the presence of H_2O_2. The gelation process occurs on interdigitated electrodes (IDEs) and is tracked in real time using a potentiostat connected to a computer, which records impedance changes indicative of the sol-to-gel transition.

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Visible light 3D printing to access the next generation soft materials

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Photocuring, the light-driven process of transforming liquid resins into solid objects, has been a cornerstone of 3D printing technology. Traditionally dominated by engineering disciplines, this method has achieved unparalleled build speeds and resolution in additive manufacturing. However, the reliance on high-energy UV light has constrained material options due to degradation and light attenuation issues. This talk introduces groundbreaking chemical innovations that shift the photocuring spectrum from UV to more gentle and adaptable visible wavelengths. This paradigm shift not only enhances material compatibility but also significantly expands the range of printable objects. Our research has yielded novel panchromatic resins, enabling rapid, high-resolution 3D printing using visible light. Furthermore, we've developed new visible light-driven photochemistry techniques. These advancements extend vat photopolymerization capabilities, allowing for the creation of multifunctional, photoresponsive soft materials. This approach opens up exciting possibilities for next-generation soft materials with tunable properties and responsive behaviors.

A General Approach to Compatibilizing Mixed Plastics through Dynamic Boronic Ester Bond Formation

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Growing global environmental concerns have increased the demand for recyclable plastics and more efficient recycling practices. Among various methods, mechanical recycling—the remelting of plastic waste into new products—is considered the simplest and most cost-effective way to recycle waste with a minimal carbon footprint. However, most commodity plastics are not compatible with each other. Therefore, to mechanically recycle mixed plastic waste, a compatibilizer, such as a block copolymer, is often required. However, compatibilizers only work for specific sets of polymers, necessitating the development of new compatibilizers for different polymer mixtures. To address this challenge, we propose a general strategy for compatibilizing mixed plastics. This approach involves thermally oxidizing the polymers in ambient air to introduce hydroxyl groups, followed by the addition of boric acid, which acts as a dynamic crosslinker. Thermal oxidation facilitates the formation of oxidative functional groups, including hydroxyls, in a wide range of commodity plastics. These functional groups then react with boric acid to form dynamic boronic ester bonds. The resulting reversible crosslinks effectively suppress phase separation and enhance compatibility between mixed polymers, even after repeated heating cycles. We envision that this strategy will significantly enhance the recycling potential of mixed plastic wastes and contribute to the development of a sustainable circular economy by eliminating the need for sorting while preserving material properties during mechanical recycling.

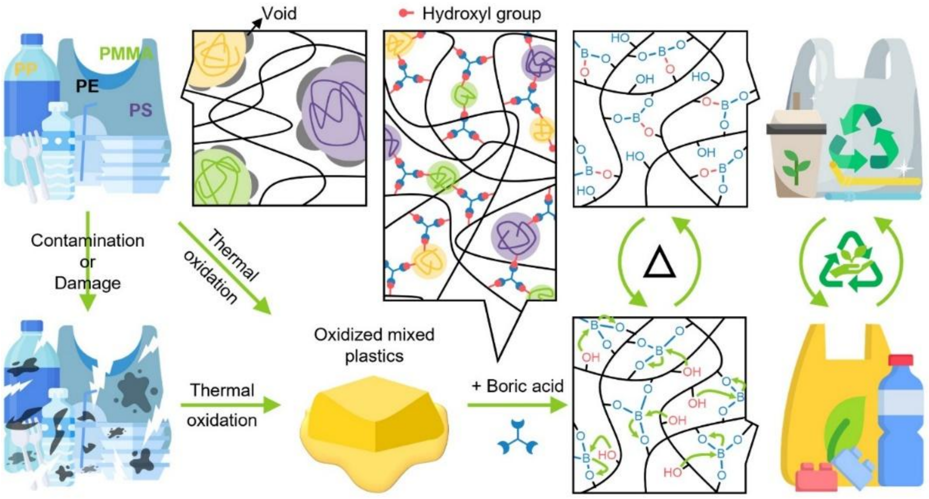

Figure 1. A schematic illustrating the concept of the current research: a general approach to compatibilizing mixed plastics through dynamic boronic ester bond formation.

Self-Supporting Hydrogel Nanofiber Meshes for Directional Neuronal Network Growth

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The development of *in vitro* and *in vivo* technologies to study neural networks and restore lost neuronal connections has attracted significant attention. These technologies require engineered scaffolds that replicate the physiological characteristics of native tissue structures. In this study, we present three-dimensional (3-D) aligned hydrogel nano-microfiber meshes (HNFm) that meet the complex requirements of neural scaffolds. Transparent hydrogel nano-microfiber (HNF) dispersions which could be prepared by solid-state crosslinking and acid-based hydrogelification were deposited via layer-by-layer assembly and aligned using bar-shear force, followed by additional physical crosslinking among fibers. The aligned HNFm supported the formation of 3-D neuronal networks with directional alignment along the fibers. Compared to flat surfaces and randomly oriented scaffolds, the aligned HNFm enabled spontaneous calcium signal propagation along the fiber anisotropy. Furthermore, incorporating a conductive layer such as PEDOT:PSS demonstrated the potential for studying physiological responses of neurons on conductive substrates. The observed oriented axonal growth underscores the scaffold's suitability for investigating and potentially treating peripheral nerve injuries. Overall, this work provides a straightforward strategy for fabricating engineered scaffolds that replicate complex tissue architectures, offering a versatile platform for studying neural connectivity and activity in vitro, with promising potential for *in vivo* applications.

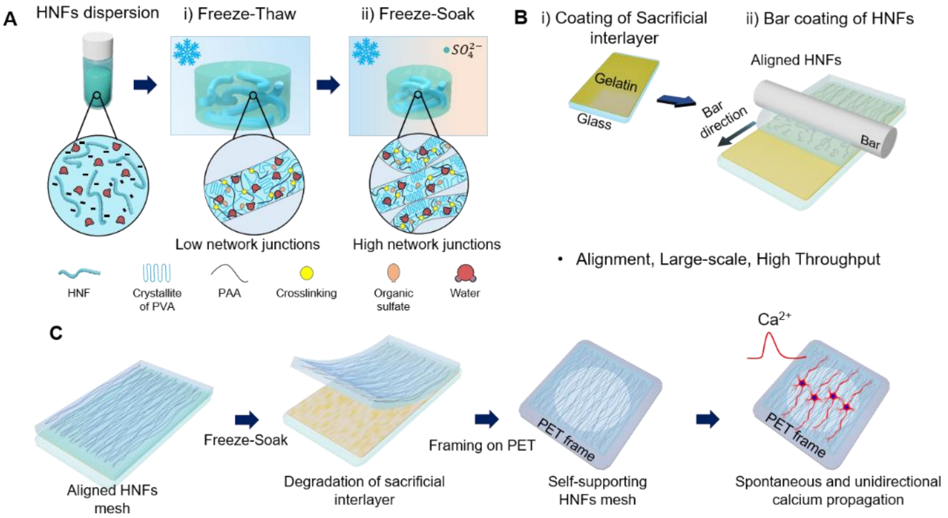

Figure 1 A. HNF formation, B. HNFm alignment, and C. Self-supporting HNFm on PET frame for aligned neuronal cell growth

[1] D.-H. Kang, et al. *ACS Applied Materials & Interfaces* **2024**, *16*, 3031.
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Semiconductor-based Highly-Ordered Nanostructure Arrays: Fabrication and Application

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This presentation highlights the wafer-scale fabrication of highly ordered nanostructure arrays using semiconductor-based lithography and sputter deposition techniques. We have successfully produced diverse array architectures, including nanotube array, pillar array, disk array, and mesh. Notably, our nanotube array fabrication was recognized with an American Chemical Society (ACS) award at Japan Nano Tech 2018 [1] and later featured on the front cover of Nanoscale (Royal Society of Chemistry, RSC) in 2025 [2]. The fabrication process involves sputtering metals onto photoresist-patterned contact-hole array templates. By utilizing both metallic and non-metallic materials, we achieve tunable nanostructures with dimensions ranging from several hundred nanometers to 20 micrometers in height and diameter, and geometries such as tall cylinders, dishes, and rhombuses. Additionally, integrating nanomaterials like ZnO nanowires, graphene oxide, or Au nanoparticles enables the formation of hybrid nanostructures. These nanohybrid arrays expand potential applications across various fields, including thermal emission, triboelectric nanogeneration, SERS-based biosensing, and anti-icing technologies.

As an example, demonstrated in Figure 1 [2], the close-packed rhombic nanotube array exhibits superior SERS performance for detecting many types of analytes compared to other nanotube array configurations. The inset shows an overlay of Raman mapping and scanning electron microscope images, enabling the identification of nanostructures and hotspots. This was made possible by the high fidelity and uniformity of the nanotube arrangement.

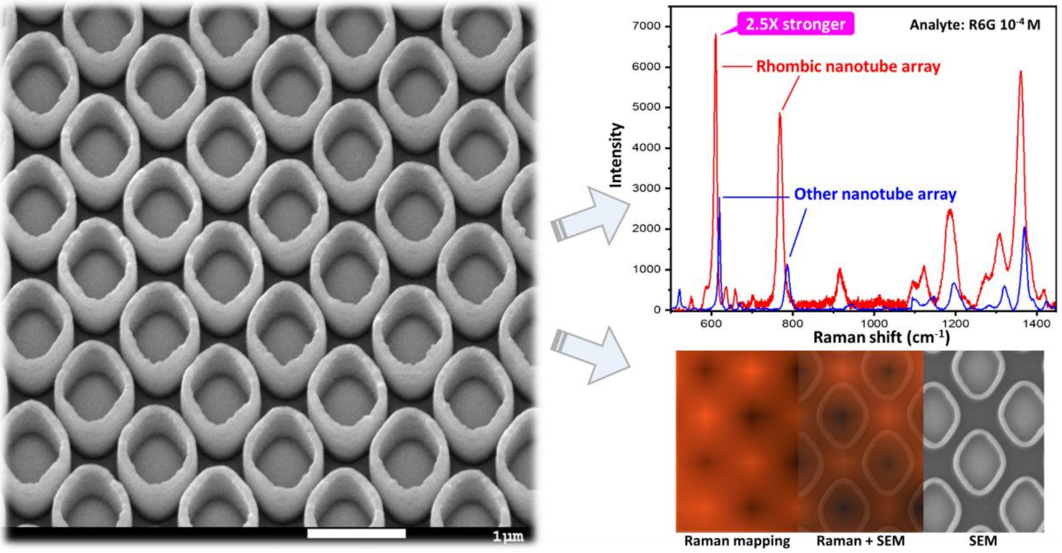

Figure 1. Rhombic nanotube array: (left) SEM image, (right) SERS spectra comparison and overlay of Raman mapping and SEM images [2].

[1] J. P. Chu, *et al.*, Metallic glass nanotube arrays: Preparation and surface characterizations, *Materials Today*, **2018**, *Vol. 21*, 178.

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High-Performance Stretchable Zinc-Ion Micro-Batteries Enabled by PEDOT and Zinc-Ion Co-Intercalated Vanadium Oxide Nanofibers

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In this study, we developed a mechanically robust and cycle-stable stretchable aqueous zinc-ion micro-battery with outstanding electrochemical performance. To achieve this, synergistic strategies including cathode design with enhanced elasticity and conductivity, pre-zincation, wavy structural engineering, and advanced assembly methods were employed [1,2]. Vanadium oxide nanofibers co-intercalated with Zn^{2+} ions and poly(3,4-ethylenedioxythiophene) (PEDOT) were synthesized via a facile sonochemical process. Compared to Zn^{2+}-only intercalated vanadium oxide, the co-intercalated nanofibers exhibited superior mechanical flexibility, higher conductivity, and improved specific capacity. Pre-zincation of the cathode further enhanced cyclic stability. As a result, the device delivered a maximum specific capacity of 0.16 mAh cm^{-2}, an energy density of 0.112 mWh cm^{-2}, and a power density of 3.5 mW cm^{-2}, while retaining 83.7% capacity after 500 cycles. Moreover, the E-ZVONF-SZIMB maintained 78.9% capacity after 7,000 stretching/bending cycles, demonstrating excellent operando dynamic stretchability. Notably, the device preserved 80% and 90% of its capacity under 200% strain at −20 °C and 60 °C, respectively, highlighting its practical feasibility. These results underscore the potential of co-intercalated vanadium oxide nanofibers for advancing the next generation of high-performance, stretchable energy storage devices.

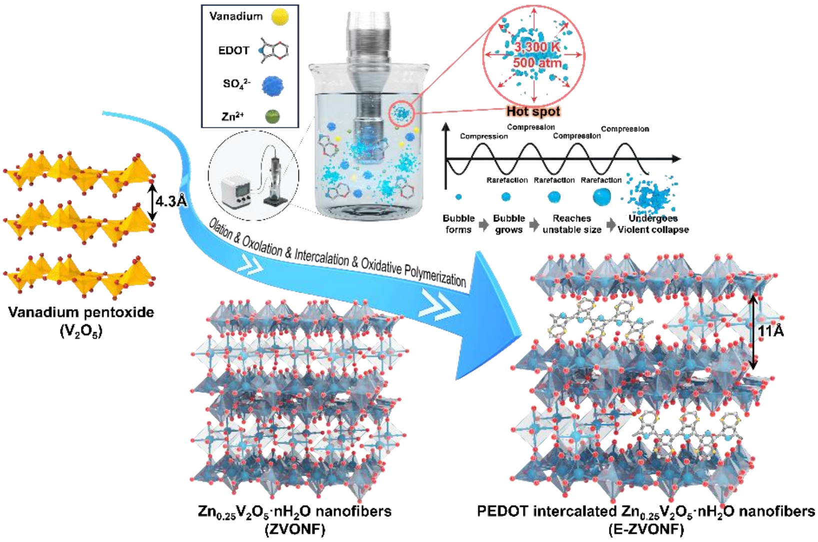

Figure 1. Schematic of ZVONF and E-ZVONF synthesis via the sonochemical method.

[1] J. Kim, S. H. Lee, C. Park, H.-S. Kim, J.-H. Park, K. Y. Chung, and H. Ahn, *Advanced Functional Materials,* **2021**, *31*, 2100005

[2] S. H. Lee, J. Hwang, C. Song, C. Park, H.-S. Kim, and H. Ahn, *Advanced Functional Materials,* **2024**, *34*, 2310571

Relation between Hydration and Tumor Accumulation in Biocompatible Dendrimers

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Polyethylene glycol (PEG) and zwitterionic polymers are biocompatible polymers that suppress nonspecific interactions. Nanoparticles modified with biocompatible polymers are excellent drug carriers in drug delivery system (DDS) for cancer treatment. They passively accumulate in tumors owing to their enhanced permeability and retention (EPR) effect. Dendrimers are regularly branched polymers, which are a candidate for a drug carrier. We have studied PEGylated dendrimers as a drug carrier with prolonged blood circulation property [1]. The intermediate water concept has been reported, in which the amount of intermediate water in a material largely affects the blood compatibility. Intermediate water undergoes cold crystallization and melts below 0°C in differential scanning calorimetry (DSC) experiments. In this study, we examined hydration state and the in vivo behaviors of biocompatible dendrimers to discuss the relation.

The polyamidoamine (PAMAM) dendrimers of G4 were fully and partly modified with PEG2k. The DSC results of PEG by itself with high water contents showed two endothermal peaks at around −20°C and −5°C during the heating process. Because PEG/water mixtures are eutectic systems, PEG crystal and ice melted at these temperatures [2]. Similar DSC patterns were observed from the fully PEGylated dendrimer. In contrast, single endothermic peak appeared around −5°C in the DSC of the partly PEGylated dendrimer. These PEGylated dendrimers labeled with indocyanine green (ICG) were intravenously injected into tumor-bearing mice, and the in vivo and ex vivo imaging were performed using IVIS after 24 h to examine the biodistribution. The fully PEGylated dendrimers accumulated in the tumor, but the partly PEGylated dendrimers did not (Fig. 1). These suggest that the hydration of the PEGylated dendrimers was possibly involved in the biodistribution [3].

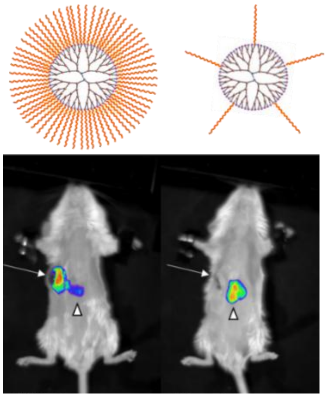

Fig. 1. in vivo imaging of fully (left) and partly PEGylated dendrimers [3].

Next, we synthesized sulfobetaine monomer (SBM)- and polysulfobetaines (PSBs)-conjugated dendrimers and examined the hydration and the biodistribution. Our DSC results showed that the PSB-conjugated dendrimers (PSM-dens) had larger peak than the SBM-conjugated dendrimer (SBM-den), whose intermediate water contents were calculated as 38% and 20%, respectively. PSB-dens accumulated in the tumor after the intravenous administration because of the EPR effect (Fig. 2), but SBM-den did not. These suggest that the intermediate water content, that is the hydration property, is related to the biodistribution in the zwitterionic dendrimers [4].

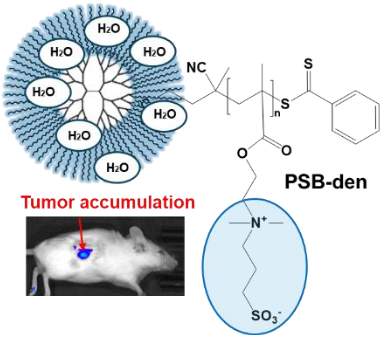

Fig. 2. Structure and the tumor accumulation of PSB-den [4].

In conclusion, our results suggest that the hydration is involved in the biodistribution of biocompatible nanoparticles, which is a possible design criterion for drug carriers.

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[4] C. Kojima, R. Hirata, N. Dei, H. He, Y. Ikemoto, A. Matsumoto, Langmuir, **2025**, *41*, 1411.

Mechanochemical Engineering of Soft and Hybrid Materials Using Laser-Induced Shockwaves

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Laser-induced shockwaves offer a powerful, contactless platform for driving physical and chemical transformations in soft and hybrid materials under extreme, high strain rate conditions. This study explores the multifunctional capabilities of shockwaves across three mechanochemically distinct phenomena: microscale spallation and patterning, energy dissipation via dynamic bond exchange, and mechanically triggered ordering transitions.

First, precision spallation patterning was achieved by exposing colloidal monolayers to spatially modulated shockwaves.[1] By employing non-close-packed microsphere arrays and tailored photomask geometries, we generated high-fidelity micropatterns with sharp features. The resulting patterns suggest that near-field interference of longitudinal and shear wave fronts governs resolution and edge morphology, enabling tunable pattern architectures without chemical processing.

Second, we examined shockwave energy dissipation through mechanochemical reactions in dynamic covalent networks.[2] Disulfide-based covalent adaptable networks exhibited significantly enhanced stress attenuation when exchange kinetics were accelerated by catalytic additives. Laser-induced shockwave testing confirmed that faster bond rearrangement correlates with greater mechanical energy dissipation, highlighting the critical role of reversible network dynamics under rapid loading.

Lastly, we observed shock-induced disorder-to-order transitions in polymer systems with latent microphase-separated structures. Without requiring thermal annealing, transient shock loading triggered rapid structural reorganization, leading to the emergence of ordered domains. This mechanically activated transition demonstrates the ability of shockwaves to overcome thermodynamic barriers and guide nanostructural assembly in soft materials.

Together, these findings establish laser-induced shockwaves as a versatile tool for mechanochemical engineering—enabling material removal, structural transformation, and energy dissipation within a unified, scalable platform.

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Advanced Eco-Friendly Clad Metals: Property Evaluation and Emerging Industrial Applications

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Eco-friendly clad metals are layered composites that combine dissimilar metals into a single structure, thereby integrating the most desirable properties of each constituent. This architecture provides superior advantages such as enhanced mechanical strength, high corrosion resistance, and excellent thermal conductivity in the thickness direction. These multifunctional attributes make clad metals attractive alternatives to conventional alloys, especially in applications demanding structural reliability, lightweight performance, and efficient heat management [1].

A central focus of this work is the systematic evaluation of clad metal properties. Mechanical testing methods such as tensile, shear, and peel tests are critical to assess interlayer bonding strength and durability under service conditions. In parallel, thickness-direction thermal conductivity characterization is highlighted, as it governs heat dissipation in automotive, electronic, and energy systems [2]. Complementary evaluations, including corrosion resistance, microstructural analysis, and long-term stability tests, provide further insights into performance reliability.

As shown in Fig. 1, clad metals find wide applications across industries: in automotive engineering, they reduce weight while improving fuel efficiency and durability; in electronics, they enhance circuit boards, connectors, and electromagnetic shielding with reliable heat transfer; in construction and architecture, they provide structural stability, corrosion resistance, and design flexibility; and in sensors, thin-clad designs offer improved sensitivity and longevity.

This presentation will address recent manufacturing approaches, emphasize evaluation methodologies, and illustrate how clad metals are driving innovations across diverse industrial sectors.

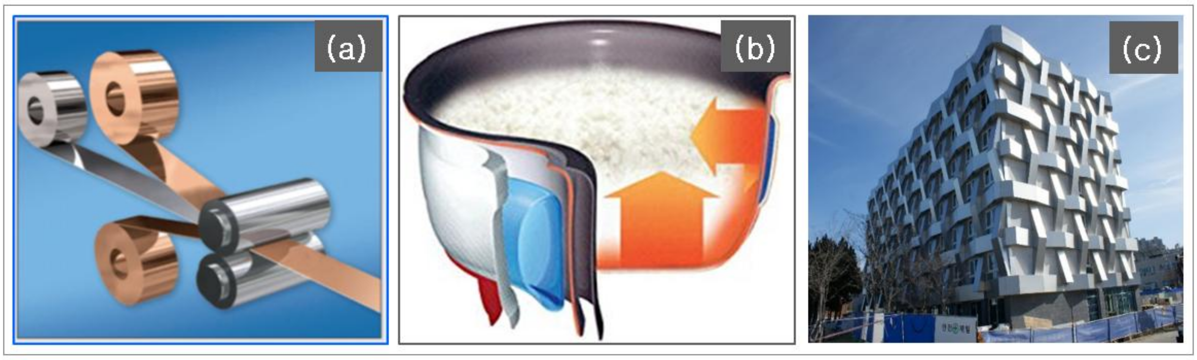

Figure 1. Advanced eco-friendly clad metals: (a) Roll-bonding fabrication process, (b) Cookware applications, and (c) Construction material applications.

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Aqueous Microphase Separation Induced by Coacervation of Zwitterionic Polymers

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While block copolymers exhibit phase separation in the bulk to yield ordered periodic lattice structures, they are capable of forming ordered structures in solution under high-concentration conditions. The morphology depends on the volume fraction of the two phases, which is modulated by various factors, including the composition of the block copolymers, the polymer concentration, and the selectivity of the solvents [1,2]. Molecular assemblies capable of adaptively switching their ordered morphologies under varying conditions are promising as compartmentalized, stimuli-responsive molecular containers. We reported a lyotropic microphase separation in concentrated aqueous solutions of a double zwitterionic diblock copolymer (PCB2-*b*-PSB4), which is composed of a poly(carboxybetaine methacrylate) (PCB2) and a poly(sulfobetaine methacrylate) (PSB4) (**Fig. 1**) [3,4]. The morphology depended on the polymer concentration due to the limited water capacity of the PSB4 phase. This copolymer can be regarded as a new type of molecular compartment that is valid for biomedical platforms. In this paper, the phase behavior of the double zwitterionic PCB2$_n$-*b*-PSB4$_m$ diblock copolymer aqueous solutions was mapped out to address the insights into the unique microphase separation due to the specific interactions of zwitterions [5].

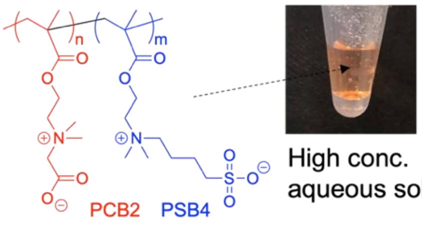

Fig. 1. Chemical structure of PCB2$_n$-*b*-PSB4$_m$ and the aqueous solution.

The phase assignment and determination of the lattice structure were conducted by small angle X-ray scattering (SAXS). The SAXS profiles of the PCB2$_n$-*b*-PSBX$_m$ aqueous solutions exhibits multiple peaks, and the scattering vector of peaks depended on the polymer concentration (ϕ) and volume fraction of PSB4 chain (f_{PSB}). The lattice structure transformed from periodic two phase lamellar to hexagonal packed columnar due to the volume expansion of PCB2 phase. The ϕ vs f_{PSB} phase diagram showed order-order transition boundaries with vertical above $f = 0.44$ while with negative slope below indicating that water exhibited polymer concentration-dependent selectivity, which is neutral above threshold polymer concentration but selective towards PCB2 below the threshold (**Fig. 2**). We have also investigated the anomalous behavior of water within these molecular assemblies, finding that distortions in the hydrogen-bonding network are amplified leading to the promotion of cold crystallization in comparison with bulk water [6].

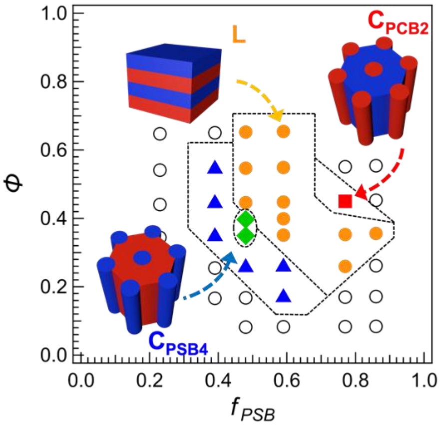

Fig. 2. Polymer concentration, *f*, vs volume fraction of PSB4 in the block copolymers, f_{PSB4}, phase diagram for PCB2$_n$-*b*-PSB4$_m$ diblock copolymer aqueous solutions at 25°C.

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Novel friendly environmental coatings contain Ag-Zn/zeolite, nano Cu_2O, and polysiloxane matrix used in seewater

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For the economic and environmental viewpoints, biofilms and foulings have significant negative influence on boats, navy, marine works and logistics, etc. It is considered as cause of the vessel's corrosion enhancement leading to the hull's deterioration. Besides, the fouling organisms attaching on the ship's surface increases the weight as well as the roughness of the ship, fuel consumption, and emissions grow up [1]. Normally, antibacterial and antifouling coatings include two layers, i.e. primer and topcoat. The primer coating has to act two main roles, i.e. ensuring better adhesion of paint to the steel substrate surface and providing the good anticorrosion performance while topcoat has good antibacterial, antifouling activity and high durability (long lifetime). Nowaday, using antibaterial and antifoulants additives is the most popular approach. Some broad-spectrum biocides like tributyltin, and mercury compounds have been banned because of environmental pollution and ecological hazard. With rising awareness of environmental protection, the antibacterial and antifouling paints, coatings are required to use friendly environmental additives (such Ag-Zn/zeolite). Inorganic nanoparticles, with small content, have been introduced to primer as well as topcoat with purpose improving coating performances. However, due to difference in nature and structure, the inorganic nanoparticles tend to agglomerate in organic polymer matrix [2]. Thus, inorganic nanoparticles are often organically modified by organic agents.

In this study, successful organo - modification of nano ZnO, nano A-TiO_2 particles was achieved using silane/titanate organic coupling agent. These nanoparticles have significantly enhanced the properties of primer coatings based on epoxy resin, as well as the properties of topcoat coatings based on polysiloxane resin, due to good dispersion and interaction between these modified nanoparticles and the polymer matrix. The antibaterial and antifoulants additives, i.e., Irgaguard B (Ag-Zn/zeolite) with a 1 wt.% content compared to topcoating (polysiloxane) weight, demonstrated effectiveness in antibacterial activities against marine bacterial strains such as *P. stutzeri* B27 and reduced sulfate bacteria (RSB). Cu_2O nanoparticles, with a 2 wt.% content compared to polysiloxane binder exhibited high effectiveness in antifouling performance. The primer and topcoat coatings have been ensured full compliance with current requirements for properties and technical standards according to Vietnamese standard (TCVN 8789:2011) [2, 3].

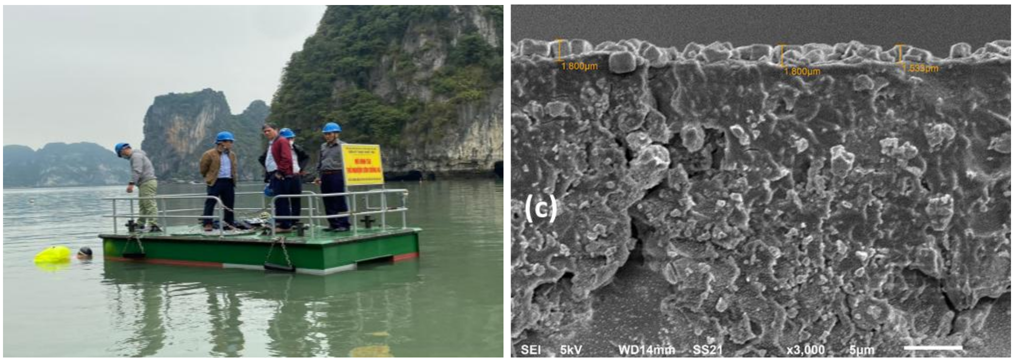

Figure 1. Natural exposure test and cross – section SEM images of polysiloxane topcoating on steel surface of model boat.

After 24-month natural exposure test on a catamaran model boat (Figure 1) under seewater at Bien Mo station at Vung Oan, Ha Long city, Quang Ninh province (Vietnam), the parts of steel boat painted by polysiloxane topcoatings contained 1 wt.% nano A-TiO_2, 1 wt.% Irgaguard B (Ag-Zn/zeolite) and 2 wt.% Cu_2O nanoparticles showed minimal fouling, with no or very little attachment of biofilms and fouling organisms.

Acknowledgement: This research is funded by the Vietnam Academy of Science and Technology under grant number TĐVLTT.02/24-26.

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Silsesquioxanes-based Functional Materials for Sustainable Development

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With the rapid development of industry, resources shortage and environment pollution are emerging. Therefore, it is emergent to find innovative materials to resolve these problems and meet the requirements of sustainable development. Cage-like silsesquioxanes have a rigid inorganic skeleton and organic groups at their peripheries forming organic–inorganic hybrid structures with light weight, good hydrophobicity, and ease of modification. Thus they can be considered to be ideal building components to prepare some target hybrid materials with specific functions, for example, catalysis, adsorption and separation, sensing and self-cleaning, etc.[1, 2] Recently, we have designed and prepared some silsesquioxanes-based porous polymers, superhydrophobic coatings and aerogels etc., which are successfully used as adsorbents, photocatalysts, sensors for environment remediation[3,4]. We believe that more silsesquioxanes-based functional materials will be created and their application will be further expanded.

Keywords: silsesquioxane; function; hybrid fluorescence; photocatalyst;

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The Extensional Rheological Properties of Biodegradable Blends: PLA/LDPE and PHA/LCB-PLA Blends

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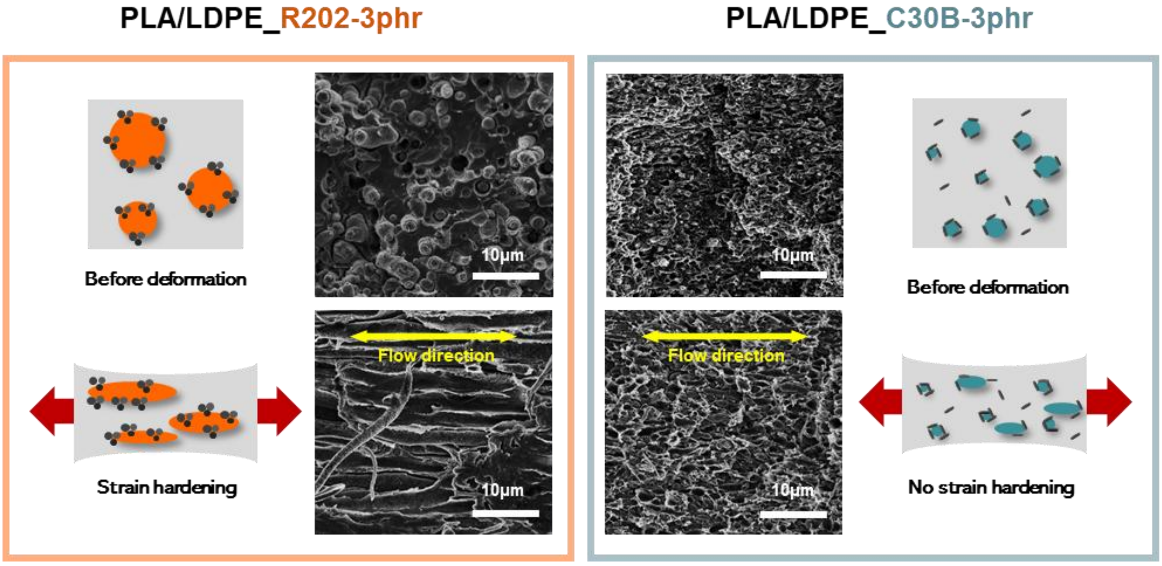
We investigated rheological behavior of biodegradable polymer blends. Owing to the presence of long-chain branches (LCB) in low-density polyethylene (LDPE), polylactic acid (PLA)/LDPE blends exhibit strain-hardening behavior under extensional flow under specific morphological conditions. This strain-hardening effect is highly advantageous for processes such as blow molding and foaming. The same concept has also been extended to polyhydroxyalkanoate (PHA)/LCB-PLA blends.

PHA is a fully biodegradable polymer produced by microorganisms, offering a sustainable solution to the global plastic waste issue. However, PHA alone presents challenges in meeting the physical requirements for certain industrial applications, such as film production and foaming processes. To overcome these limitations, this study explores the development of a polymer blend combining PHA with LCB-PLA. This blend aims to enhance the mechanical properties and processability of PHA by utilizing the inherent stiffness and strain hardening effect of LCB-PLA, while maintaining PHA's biodegradability and introducing material properties suited for more demanding applications.

In this research, both PLA/LDPE and PHA/LCB-PLA blends are assessed through comprehensive rheological testing, including small amplitude oscillatory shear (SAOS) and uniaxial elongation tests. Additionally, Scanning Electron Microscopy (SEM) is conducted to examine the blend morphology. These techniques are crucial for observing the dispersion quality and morphology of PLA/LDPE and PHA/LCB-PLA. The aim of this research is to understand the correlation between extensional rheology and morphology of PLA/LDPE and PHA/LCB-PLA blends.


PLA/LDPE_R202-3phr

PLA/LDPE_C30B-3phr

Figure 1. SEM images of immiscible PLA/LDPE blends containing 3 phr of hydrophobic silica (R202) and organoclay (C30B) before (top) and after (bottom) uniaxial extension at an extension rate of 1 s^{-1}. The morphologies after stretching were preserved by quenching.

Polycaprolactone/Xanthan Gum/Chrysophanol Biomaterials: Preparation, Characterization, Drug Release, and Bioactivities

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Biodegradable polycaprolactone (PCL) and its co-polymerization derivatives are widely applied in controlled drug carriers thanks to their high mechanical strength and manageable decomposition rate [1]. Xanthan gum (XG) is an anionic extracellular polysaccharide secreted by the *Xanthomonas campestris* microorganism. The anionic character of XG is due to the presence of both glucuronic acid and pyruvic acid groups in the side chain [2]. This work suggested a combination of PCL and XG to enhance PCL and XG's potential in drug carriers. Emulsion systems have seen widespread application in drug delivery and controlled drug release, particularly for water-insoluble drugs [3]. Optimizing the component ratio in such systems is critical, as it directly influences the stability and pharmacokinetics of the final product. Microemulsion systems were repared using PCL, XG, and Tween 80, with chrysophanol (CHR) as a model drug. The component ratios were optimized to achieve desired stability, droplet size, and drug loading efficiency. Microemulsion-particles with varying drug content, prepared under optimal conditions, were characterized using scanning electron microscopy, zeta potential and size distribution analysis, infrared spectroscopy, and differential scanning calorimetry. Furthermore, their physicochemical and pharmacological properties were investigated. The PCL/XG/CHR particles showed a melting point of about 64°C with an enthalpy of melting of 123 J/g. CHR content significantly affected the average particle size of PCL/XG/CHR particles, which ranged from 1469.3 to 4304.3 nm. The highest efficiency of PCL/XG/CHR particles of 94.67% was achieved at 0.05% CHR, with efficiency gradually decreasing as CHR content increased. The microemulsion-particles containing 1wt% CHR exhibited high stability, a favorable pharmacokinetic profile, and demonstrated non-toxic and biologically active properties, indicating their potential for biomedical applications.

Acknowledgment. This research is funded by Vietnam National Foundation for Science and Technology Development (NAFOSTED) under grant number 104.02-2021.48.

Keywords: Biomaterials, Emulsion, Biodegradable polymer, Model drug, Drug delivery.

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Rapid Yet High Amplitude Collective Oscillation of Magnetic Micropillar Arrays

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Magnetic soft actuators often suffer from reduced strain amplitudes at high frequencies due to viscoelastic damping. In this study, we introduce an array of micropillars embedded with hard magnetic microparticles, whose magnetization directions can be spatially programmed. This design enables efficient alignment between the magnetic torque and the intended deformation of the structure, which helps maintain large-amplitude oscillations even under high-frequency magnetic actuation. The use of a hybrid composite, combining magnetic microparticles and nanorods, further enhances mechanical responsiveness through cooperative interactions. The actuators exhibit a variety of deformation modes, including bending, twisting, and torsional motion, and they achieve peak velocities of 81.8 millimeters per second, which corresponds to more than 200 times their body length per second. [1] In addition, collective oscillation of the micropillar array allows for macroscopic functions such as directional control of fluid flow based on chirality and untethered soft robotic movement driven by synchronized torsional motion. These findings provide a promising strategy for designing high-performance microactuators applicable to soft robotics and microfluidic systems.

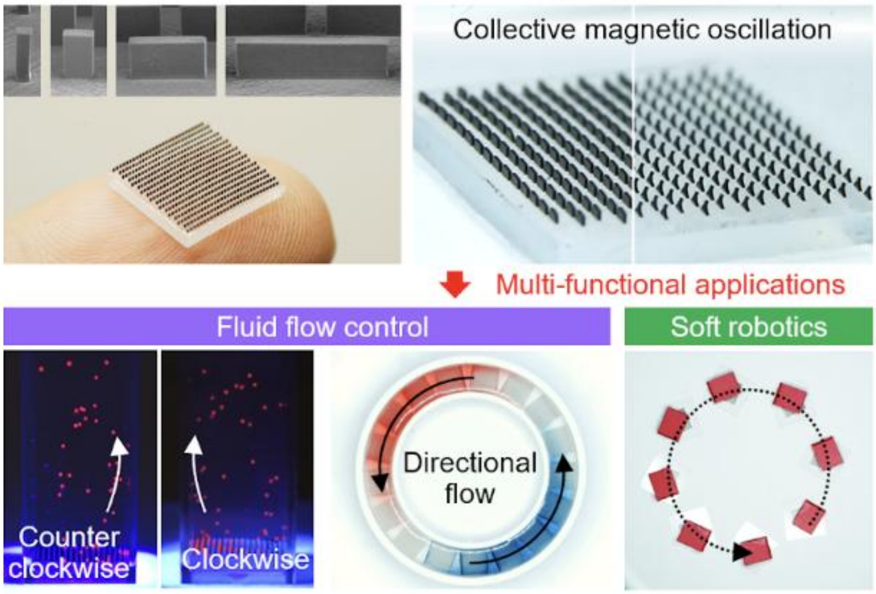

Figure 1. Synchronized magnetic oscillation of micropillar arrays enables directional fluid flow control and untethered soft robotic locomotion through programmable deformation.

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New Opportunities in Sustainable Nano-Polymeric Materials for Treatment of Cancer

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In recent years, nanoparticles have been developed as promising drug delivery devices to enhance therapeutic efficacy with less side effects, owing to their enhanced permeability retention (EPR) characteristics [1,2]. In this context, various types of environmentally responsive polymeric nanoparticles have been extensively studied for drug delivery technologies due to their unique tunable properties (i.e., colloidal stability and fluid like transport) that can be used to improve the conventional drug delivery systems [3]. Environmentally responsive polymeric nanoparticles represent a compelling category of biomaterials capable of sensing and reacting to external stimuli. However, after systemic drug delivery, the efficiency of drug release in the tumor microenvironment is limited, owing to the drug's early release before reaching the tumor cell. An intracellular cleavable polymeric drug carriers has been designed for systemic and local administration of doxorubicin, an anticancer drug [3].

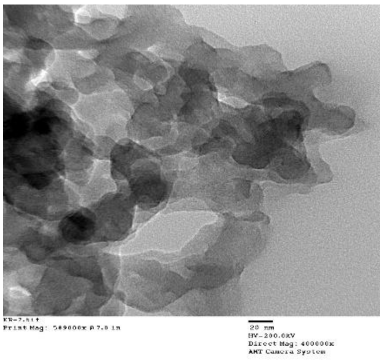

Figure 1. TEM image PVCAPA polymeric nanocarriers.

Polymeric nanoparticles of PEGylated micelles, PEGylated gels and also poly(N-vinylcaprolactam-co-acryloyl-L-phenylalanine), PVCAPA, were prepared by crosslinking monomers of BAC and MBA. The monomers and PVCAPA nanoparticles are characterized by NMR, FTIR, DSC, SEM to better understand the dispersion of drug in the polymer matrix and size of the gels, respectively. Doxorubicin (DOX) encapsulated effectively into the PVCAPA nanoparticles, release of the same exhibited stimuli-triggered in pH, temperature and reducing environment. Further, the cytotoxicity results demonstrated that the placebo PVCAPA nanoparticles were nontoxic to normal cells while DOX-loaded PVCAPA nanoparticles presented significant antitumor activity to A549 and B16F10 cells.

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Nanoparticles Made from the Polymer L-Tyrosine Phosphate and VEGF Receptor Genes Normalize Hypertension in Pregnancy

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Preeclampsia accounts for more than 50,000 maternal and 500,000 fetal deaths worldwide each year. Although women at risk cannot be identified prior to pregnancy, abnormal placentation is strongly linked to uterine artery dysfunction, resulting in reduced placental perfusion. In response, maternal blood pressure rises in an attempt to maintain circulation; however, perfusion remains insufficient, frequently causing fetal growth restriction or death. While antihypertensive medications can alleviate maternal hypertension, their potential risks to the fetus often lead women to prefer bed rest.

To address this challenge, we investigated a non-viral gene therapy approach to locally regulate vascular endothelial growth factor (VEGF) receptors. Gene delivery is particularly effective for modulating cellular receptors, as nucleic acids can drive overexpression of specific proteins. Upregulating VEGF receptors enhances receptor–ligand interactions with VEGF and other cytokines already present in hypoxic tissues, thereby strengthening vascular signaling and improving placental perfusion. Unlike direct growth factor delivery, this strategy leverages endogenous signaling molecules without introducing additional exogenous proteins. We encapsulated plasmid DNA (pDNA) encoding VEGF Receptor 2 (VEGFR2) and Neuropilin 1 (NP1) into nanoparticles formulated with L-tyrosine polyphosphate (LTP), a biodegradable and non-cytotoxic polymer. These nanoparticles were administered to rats subjected to reduced uterine perfusion pressure (RUPP), an established in vivo model of preeclampsia. Therapeutic efficacy was assessed by evaluating uterine artery vascular responses.

Our findings show that myogenic reactivity of uterine arteries in RUPP rats treated with LTP nanoparticles was comparable to that of healthy controls. VEGF-neutralization studies further confirmed enhanced VEGF signaling. Treated groups exhibited increased placental and fetal weights alongside normalized maternal blood pressure. In conclusion, selective upregulation of VEGF receptors via LTP nanoparticle-mediated gene delivery represents a promising therapeutic strategy to improve both maternal and fetal outcomes in preeclampsia.

Natural Lignin-based Environmental Functional Materials with Improved Performance

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With the fast development of economy and industry, the emerging pollution which caused by electronic microwave, heavy metal ions, micro-plastics and antibiotics has been a global environmental issue [1]. To address this immediate issue, various processes have been undertaken and amongst, the research interest in designing and performance exploration of biomass-derived environmental functional materials has been paid particular attention. Taking advantage of the intrinsic molecular characteristics of various bio-masses like lignin, a series of high-performance environmental functional materials, through which can efficiently remediate emerging pollution from air and water, has been designed using controllable chemical pathways like surface modification, site imparting and reactive sites tailoring. In a word, utilizing industrial lignin or its derivatives as platform matrix, varied environmental functional materials can be designed and explored, which might shed light on the value-added utilization of biomass [2,3].

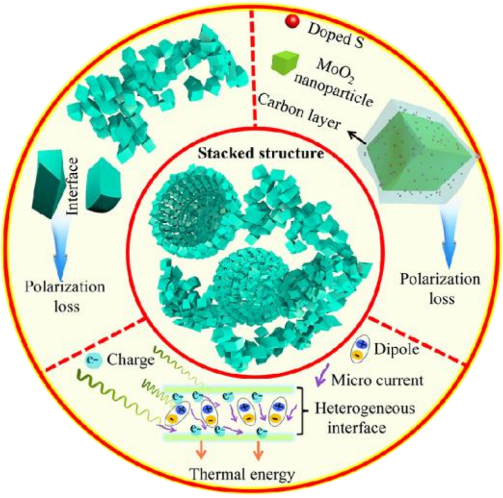

Fig. 1. Lignin-based microwave-absorbing materials.

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Preparation and Properties of Electromagnetic Interference Shielding Polymer Composites with Extreme Environment Resistance

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A strategy was developed for fabricating polyimide (PI)/MXene-POSS nanocomposite films exhibiting superior electromagnetic interference (EMI) shielding, water resistance, and flame retardance. The hydrophobic MXene-POSS hybrid was successfully synthesized by modifying MXene with polyhedral oligomeric silsesquioxane (POSS). This modification enhances compatibility with PI, enabling the preparation of uniform films, while simultaneously imparting hydrophobicity to improve performance in harsh environments. Specifically, the nanocomposite film containing 20 wt% MXene-POSS achieved an EMI shielding effectiveness of 12.7 dB. Furthermore, the composite material demonstrated exceptional fire resistance. Owing to its hydrophobic nature, the water uptake of the PI/MXene-POSS-20% film was only approximately 1.4% under 70% relative humidity. Overall, these nanocomposite films offer reasonable EMI shielding combined with high stability and durability, showing promising potential for applications in electronic devices operating under extreme outdoor conditions.

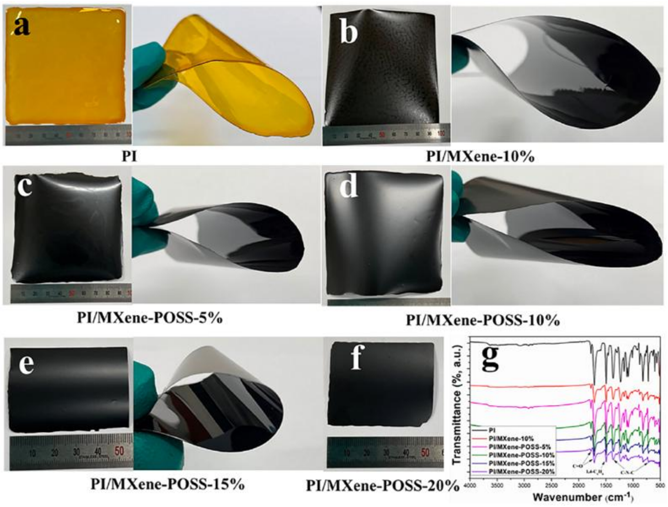

Figure 1. Photographs of EMI shielding nanocomposite films.

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Nanohybrid Materials Based on Polymers and Periodic Mesoporous Organosilicas

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Organic/inorganic hybrid nanocomposites, in particular polymer-based hybrid nanocomposites, constitute emerging advanced materials since they combine unique properties from the inorganic and organic (i.e., polymeric) components. In this talk, we will overview nanohybrid materials based on polymer. In our laboratory, we investigated three different hybrid nanocomposites depending on the dimensions of the dispersed phase in the nanometer range: polymer-layered silicate (PLS) nanocomposites, where polymers are mixed with layered silicates, polymer/graphene oxide hybrid nanocomposites, and polymer hybrid nanocomposites with reinforcing polymers with isodimensional phases of inorganic silicas using sol-gel reactions. In addition, we will touch on the development of periodic mesoporous organosilicas (PMOs) that have been done for years in this laboratory. In summary, this talk reports the chronological progress of our work on the nanohybrid materials, i.e., polymer-based nanohybrid materials and/or PMOs that have been prepared in our laboratory for more than three decades, with their impacts, importance, and advanced applications.

Oral Presentation

OL-1 ~ OL-19

Better Together: Integrating Adhesion and Ion Conductivity in Composite Binders for High-Performance Silicon Anodes

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The choice of binder plays a critical role in mitigating the severe volume changes of silicon (Si) anodes. Poly(acrylic acid) (PAA) is widely used for its strong adhesion with the Si surface, yet its brittle and non-conductive nature often leads to performance decline over prolonged cycling. In this study, we developed a composite binder integrating PAA with a tailored terpolymer comprising (1) Li-ion conducting groups, (2) hydrogen bonding motifs, and (3) covalent crosslinking sites. This combination yields synergistic improvements in electrochemical performance and mechanical integrity of Si anodes, resulting in a high specific capacity of 2026 mAh g^{-1} and a capacity retention of 71% over 300 cycles, surpassing PAA-based counterparts. The integrated binder system effectively enhances adhesion, mechanical durability, ion-conductivity and electrode morphology offering a promising strategy for stable and high-capacity Si anodes.

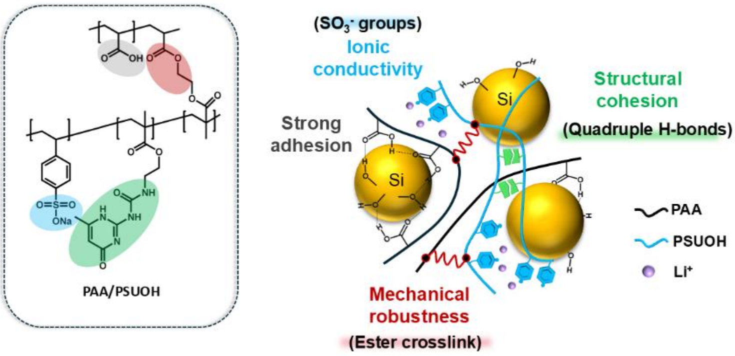

Figure 1. Schematic illustration of the PAA/PSUOH composite binder showing synergistic functions: strong adhesion (PAA), ionic conductivity ($-SO_3^-$ groups), structural cohesion (quadruple H-bonds), and mechanical robustness (ester crosslinks).

[1] A. N. Preman, S. Aswale, T. T. Salunkhe, S. Lee, M. C. Kim, S. Devaraju, K. Hyun. H. -j. Paik, I. T. Kim, S. -k. Ahn, *J. Mater. Chem. A*, 2025, 13, 8355.

Multicomponent alloys as catalysts for the production of carbon nanofibers and metal-carbon composites

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Production of new carbon nanomaterials (CNM) is one of the important areas for materials science. CNM are used in electronics, medicine, catalysis, etc. [1]. Carbon nanofibers (CNF) can be termed as one of the varieties of CNM. In our research, the synthesis of CNF is carried out by catalytic pyrolysis of light hydrocarbons over Ni-based bulk alloys. Being subjected to the action of carbon-containing atmosphere, bulk Ni-M alloys undergo rapid disintegration with formation of disperse catalytic particles. Subsequently, it is they that carry out the synthesis of CNF.

At the same time, alloys consisting of a large number of metals (so-called high-entropy alloys) are of increasing interest [2]. Due to their unique physical and chemical properties, such as high stability and efficiency in various catalytic processes, these systems can be also considered for the synthesis of CNF. We have studied the behaviour of [CoFeNi]-Pd alloys in the process of CNF synthesis from light hydrocarbons. The maximum carbon yield of 46 g/g_{cat} was observed for the alloy containing 8 at.% Pd [3]. Figure 1 demonstrates CNF obtained over [CoFeNi]-Pd alloy.

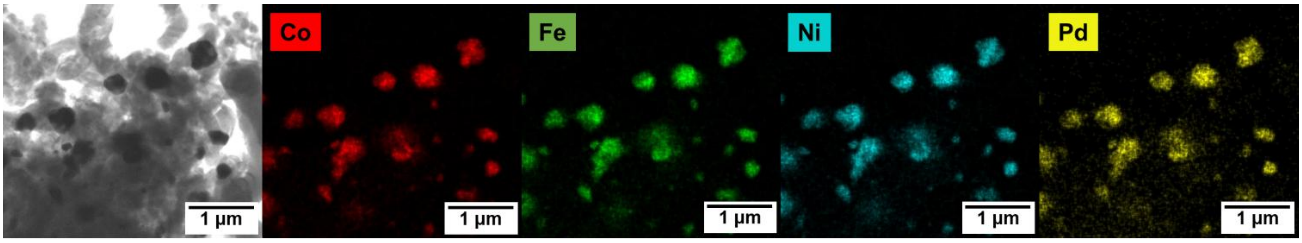

Figure 1. EDX-TEM data of CNF samples obtained over [CoFeNi]-Pd alloy (10 at.% Pd) (675°C). Reaction conditions: C_2-C_4/H_2, 30 min.

In present work, the catalytic activity of multicomponent alloys [CoFeNi]-M_x (M = Pd, Cu) has been analyzed. The starting alloys were prepared by two methods: thermolysis of multicomponent precursors and mechanochemical alloying. The kinetic patterns (accumulation rate, deactivation time, etc.) of CNF synthesis over multicomponent systems will be presented. The regularities of CNF formation, as well as the structural features and textural characteristics oft he produced CNF materials will also be discussed in detail.

Particular attention will be paid to the potential use of the resulting carbon nanomaterials.

The study was financially supported by Russian Science Foundation (project № 22-13-00406-П, https://rscf.ru/en/project/22-13-00406/).

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Preparation of Nickel-containing Carbon Xerogels and Their Catalytic Properties

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The research is aimed at developing a new approach for the preparation of catalysts, namely, a one-pot method for producing metal-containing carbon xerogels. The essence of the method lies in co-polymerization of resorcinol and formaldehyde in the presence of metal salts and subsequent pyrolysis at 800 °C. At the first stage of the work, optimization of the procedure for preparing carbon xerogels containing nickel (Ni-CX) was carried out. The effect of such parameters as pH, concentration of reagents in the mixture, presence of complexing agents was studied. The obtained materials have specific surface area of 650-750 m^2/g, and their pore size can be controllably varied in the range from 15 nm to more than 100 nm. In the optimized conditions, average particle size of Ni in the catalysts is 7 nm.

The samples demonstrated interesting catalytic properties in hydrogenation and hydrodechlorination reactions. Butadiene hydrogenation activity was highly dependent on pore structure of the samples (Figure 1a), the best performance was achieved for macroporous samples. Butene selectivity was in a range of 80 to 95 % (Figure 1b) and reached almost 100 % in stability tests at constant temperature. The samples demonstrated unusual stability in chlorobenzene hydrodechlorination, despite the tendency of Ni to form $NiCl_2$. Complete conversion of chlorobenzene to benzene with 100 % selectivity was possible at 300 °C. The reasons for such performance were considered.

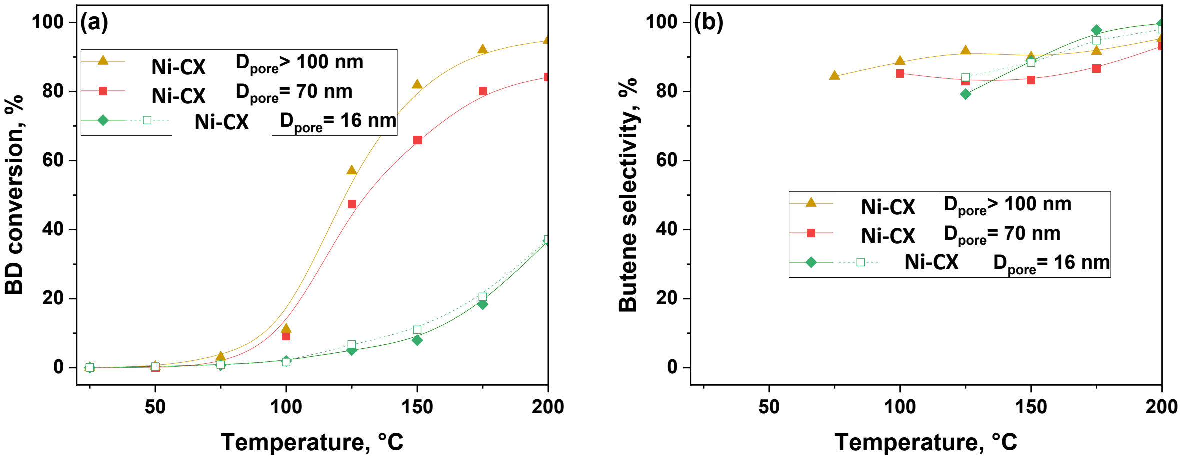

Figure 1. Effect of Ni-CX Pore Radius on the Catalytic Properties of 2.5Ni @ CX Samples. (a) – Butadiene (BD) conversion, (b) – butane selectivity.

The developed preparation method was modified to obtain bimetallic Ni-Cu-CX catalysts. The most uniform bimetallic particles were obtained in the case of 70 nm pores while smaller pore size hindered alloy formation significantly. Thus, sol-gel method presents large possibilities for preparation of nanostructured carbon-based catalysts with different composition.

This work was supported by the Ministry of Science and Higher Education of the Russian Federation within the governmental assignment for Boreskov Institute of Catalysis (project FWUR-2024-0034).

Hierarchical Engineering of Single-Crystalline Mesoporous Metal-Organic Frameworks with Hollow Structures

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Although the superiority of hierarchical structure has driven extensive demand for applications [1], establishing hierarchy in a long-range ordered single-crystal remains a formidable challenge due to the inherent competition and contradiction between single-crystallinity and controllable hierarchical structure. Herein, we demonstrate a growth and dissociation kinetics cooperative strategy for synthesizing a family of hollow single-crystalline mesoporous metal-organic frameworks (meso-MOF) with hierarchical structures. In this approach, by changing the HCl/CH_3COOH ratio, the reaction system's pH can be tuned to regulate the dissociation kinetics of the acid-sensitive seeds serving as hard templates for the formation of hollow structure, while simultaneously modifying the concentration of the dual acids to control the growth kinetics of meso-MOF shells. The strategy can effectively balance the competition between maintaining single crystallinity and achieving a well-defined hierarchical structure. Driven by the two interfacial kinetics, the uniform octahedral single-crystalline meso-MOF with controllable hollow size (80-1100 nm) and tunable wall thickness (30-60 nm) can successfully be prepared. In addition, we further fabricated a series of novel hollow meso-MOFs with hierarchical nanostructures, including hollow open-capsule meso-MOFs, 2D hollow meso-MOFs, hollow interlayer-structured meso-MOFs, macro-meso-micro tri-modal porous MOFs and so on. As a proof of concept, by controlling the hierarchical structures of meso-MOFs, the ion separation and ion transport efficiency can be regulated to obtain high-performance osmotic energy harvesting (8.92 W m^{-2}) [2].

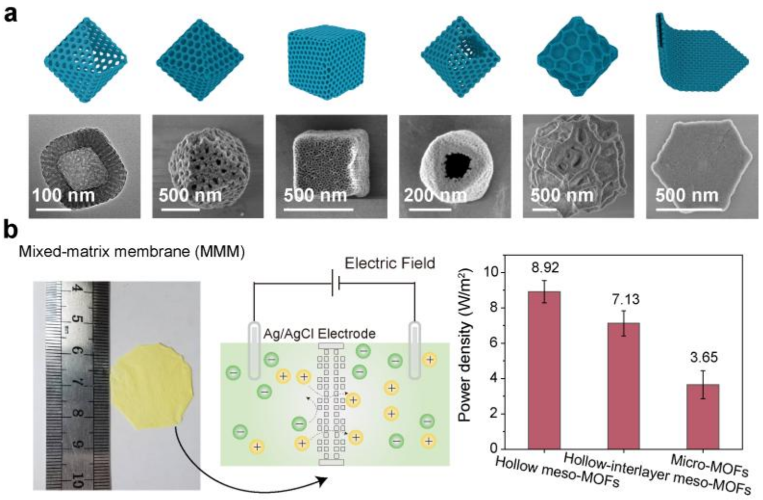

Figure 1. (a) Characterization of single-crystal meso-MOFs with different hierarchical structures, (b) preparation of a mixed matrix membrane using kevlar fibers and the meso-MOFs for osmotic energy harvesting.

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Nano composite of bio-based poly(arbutin) with silver nanoparticle

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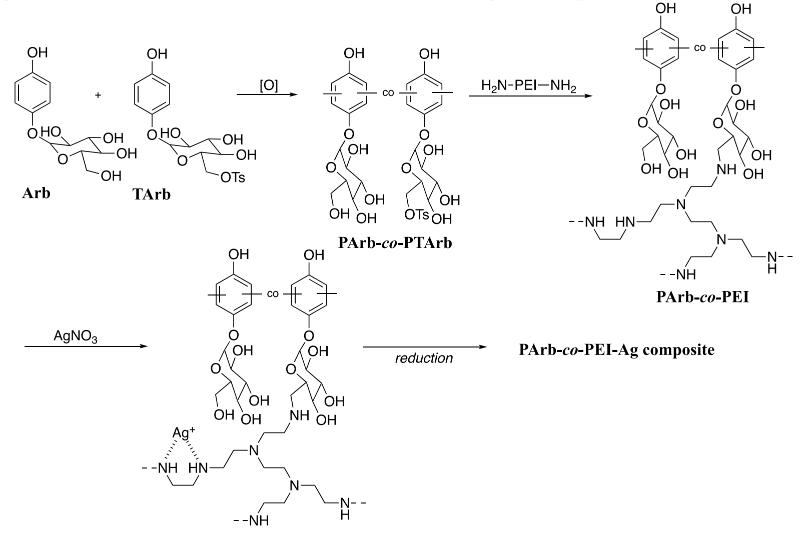
Polyphenols are widely used as health foods in our daily lives. While many natural and synthetic polymers such as chitin and poly(ethyleneimine) (PEI) show antibacterial activity, polyphenols also exhibit mild antimicrobial property. Arbutin (Arb) is a natural glycoside of hydroquinone found in pear skin and uva-ursi and has been used as a urinary tract antiseptic. Recently, we reported that Arb polymer (PArb) with a molecular weight of about 10 kDa can be easily synthesized by the copper-catalyzed oxidative polymerization of Arb in an aqueous media [1]. We also reported the micelle formation [2], antimicrobial properties [3], and shape-memory characters [4] using this polymer. To realize such functions as the PArb skeleton, we here describe the synthesis of PArb-*co*-PEI copolymer, formation of the Ag-nanocomposite, and the properties.

PArb-*co*-PEI copolymers were successfully synthesized by oxidative copolymerization of arbutin (Arb) with tosylated arbutin (TArb) (TArb : Arb 20 : 80, 50 : 50, 80 : 20 in mol), followed by the polymer reaction with hyperbranched polyethyleneimine (PEI) in aqueous solution. The copolymer-Ag nanocomposite was prepared by applying $AgNO_3$ aqueous solution onto the copolymer film, and the nanocomposite formation was characterized by IR, WAXD, SEM, and EDX spectroscopy. The copolymer was the most effective in the formation of the nanocomposite when it was compared with poly(PArb) (PArb) and PEI alone. The elution rate of Ag ion from the nanocomposite into pure water was estimated to be 0.68wt% a day, which is one of the slowest rates in the reported composites so far. Minimum inhibitory concentration (MIC) against *E.coli* of the copolymer and the nanocomposite with 10 wt% Ag was 0.63 and 0.31 mg/mL, which were superior to that of PArb alone (MIC = 15 mg/mL). The infection reduction rate of the nanocomposite against *Influenza virus* and *Enterobacteria phage Qbeta* were 94.98% and 99.99%, again superior to those of PArb alone.



Scheme 1. Synthetic pathway of PArb-co-PEI-Ag nanocomposite

[1] M. Hashimoto, S. Iwabuchi, Y. Oishi, Y. Shibasaki, *Europ. Polym. J.*, **2016**, *81*, 152.
[2] A. Seto, R. Kajiwara, J. Song, E. Shin, B.S. Kim, H. Kofujita, Y. Oishi, Y. Shibasaki, *RSC Adv.*, **2019**, *9*, 7777.
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Engineering Polymer Topologies for Tunable Properties: Insights from Characterization to Application

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Polymer topology plays a crucial role in physical properties and determines potential material applications.[1] Beyond conventional linear chains, advanced architectures such as cyclic and 8-shaped polymers offer unique conformational constraints that can be harnessed for functional design.

In this work, we synthesized poly tert-butyl acrylate (PtBA) and poly acrylic acid (PAA) with various shapes including linear, tetra-arm, cyclic, and 8-shaped polymers using ARGET-ATRP, click chemistry and deprotecion.[2] This approach allowed us to control both the size and structure of the polymers. Comprehensive analysis using ^{1}H NMR, FT-IR, SEC, DSC, and MALDI-TOF mass spectrometry techniques confirmed the successful synthesis of these polymers. Our investigation revealed that the topologies significantly influenced the properties. Cyclic polymers showed higher glass transition temperatures and lower intrinsic viscosities than their linear precursors, reflecting their compact structures.[3] Comparison of their thermal and solution properties, particularly when linear and cyclic PAA topologies are used to modify PNIPAM-based hydrogels, reveals that cyclic architecture impart enhanced pH responsiveness, tighter volume control, mechanical reinforcement, and tunable LCST shifts. These effects arise even at constant molar mass, demonstrating that topology alone strongly influences multi-responsive hydrogel behavior. The insights gained support in the targeted design of hydrogels for applications including drug delivery, tissue engineering, adhesives, and soft actuators. This work establishes clear relationships between polymer topology, key properties, and potential utility, creating a framework for next-generation functional materials.

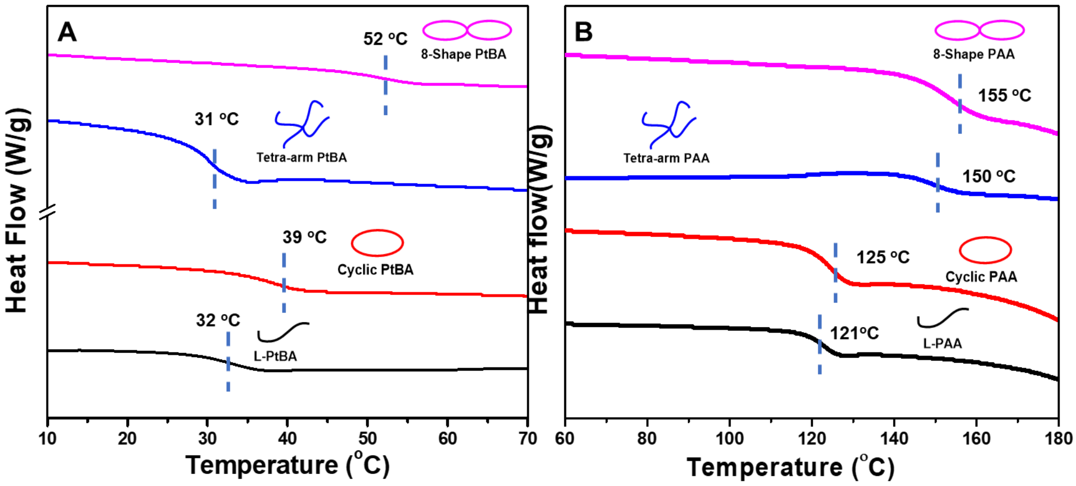

Figure. Differential scanning calorimetry (DSC) analysis of glass transition temperatures (Tg) for different polymer topologies: (A) PtBA and (B) PAA

Reference:

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Wax-Enabled Multifunctional Glass Fiber-Reinforced Polymer Composites: Self-Healing, Self-Lubrication, and Enhanced Mechanical Performance

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Glass fiber-reinforced composites (GFRPs) are widely used as exterior panels and mold materials due to their high strength, low weight, design flexibility, and excellent chemical resistance. However, conventional GFRPs face challenges in repairing surface cracks and require complex processes. To address these limitations, this study introduces a simple processing strategy by incorporating wax into the composite matrix, thereby imparting self-healing, self-lubricating, and enhanced mechanical performance [1].

By inducing wax sweating above 85 °C, wax migrated to the surface, effectively repairing scratches and microcracks. This mechanism enabled autonomous crack healing and extended the service life of GFRPs. In addition, the surface wax layer provided self-lubrication, significantly reducing friction and allowing operation without external lubricants. Moreover, wax incorporation improved the mechanical integrity of the composites through phase separation and physical crosslinking effects [2].

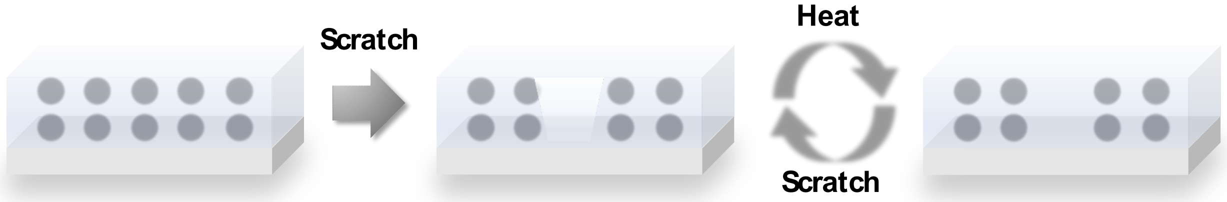

Figure 1. Synergistic effects of wax incorporation in GFRPs: reinforcement via phase separation and autonomous self-healing and self-lubrication via wax sweating

This work demonstrates a facile approach to producing multifunctional GFRPs with enhanced durability and reliability. The proposed strategy is expected to facilitate large-scale production and broaden applications of high-performance composites in exterior and mold materials.

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Polyion Complex (PIC) Micelles Composed of Random Copolymers

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Water-soluble polyion complex (PIC) micelles have significant potential for numerous applications. As the polyelectrolytes complex to form a core-shell structure with PIC core and nonionic shell. As this PIC system does not contain a hydrophobic unit, it can not encapsulate a hydrophobic drug. We prepared water-soluble PIC micelles using cationic and anionic random copolymers (PC*m* and PS*n*). PC*m* and PS*n* were prepared via reversible addition-fragmentation (RAFT) controlled radical polymerization of zwitterionic biocompatible 2-(methacryloyloxy)ethyl phosphorylcholine (MPC) unit with cationic methacryloyloxylcholine chloride (MCC) as well as MPC and anionic potassium 3-(mtthacryloyloxy)propanesulfonate (MPS), respectively, with a degree of polymerization (DP) of approximately ca. 100. To prepare stable water-soluble PIC micelles the polyelectrolytes should have strong interaction between the oppositely charged units. In this study, MCC was selected as a cationic charge containing electrolyte monomer. To get a strong interaction with the strong polycation, MPS was chosen because it is a strong polyanion. Methacrylic acid also exerts an anionic charge but forms a weak polyanion. The interaction between a strong polycation and a weak polyanion cannot form a stable PIC system.

We prepared well-controlled random copolymers, PC*m* and PS*n*, with different mol% of the charge-containing units (*m* and *n* = 30–90 mol%).1) When oppositely charged random copolymer aqueous solutions were mixed stoichiometrically, PIC micelles with definite sizes and spherical shapes were formed spontaneously. To the best of our knowledge, it is the first report on the PIC micelles formed from oppositely charged random copolymers. The obtained water-soluble PIC micelles were characterized by ^{1}H NMR, dynamic light scattering (DLS), static light scattering (SLS), and transmission electron microscopy (TEM). The size of the PIC micelles depends on the mixing ratio of PC*m* and PS*n* and charge-containing units (*m* and *n* mol%). The maximum PIC micelle was formed at the stoichiometric charge neutralization with maximum charge-containing units. To study the dynamic nature of the PIC micelles, the effect of dilution was evaluated through a light scattering measurement.

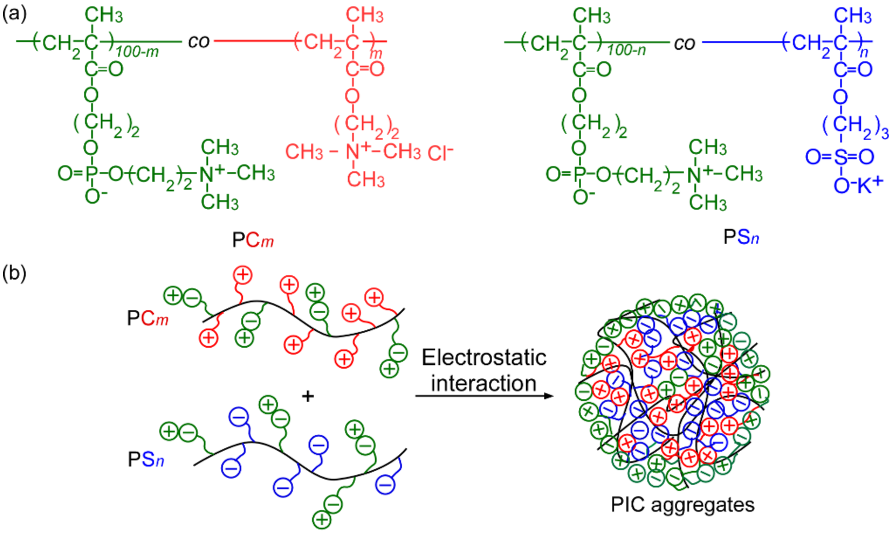

Figure 1. (a) Chemical structures of random copolymers PC*m* and PS*n*. (b) Schematic representation of PC*m*/PS*n* PIC micelles.

Programmable Micropatterns via Photomask Mediated Laser-Induced Shockwave Spallation

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The selective removal of surface-adhered objects including colloidal particles, thin films, and microstructures using laser-induced shockwaves offers a promising non-contact and chemical-free pathway for microscale patterning, which is particularly valuable for avoiding contamination, minimizing material damage, and simplifying processing steps. While our previous studies successfully demonstrated the size-tunable circular micropatterns of colloidal particles using shadow mask–mediated shockwave control [1], achieving sharp-edged angular or polygonal patterns has remained a significant challenge due to the inherently isotropic nature of shockwave expansion. For broader applications such as precision microfabrication and advanced circuit design, it is crucial to establish strategies that enable reproducible formation of well-defined, angular geometries.

In this work, we address this challenge by combining photomask-mediated spatial control of laser spots with non-close packed polystyrene (PS) microsphere monolayers. The non-close packed configuration effectively suppresses in-plane particle interactions, thereby producing sharper edges and improving reproducibility, while photomasks allow systematic control over input geometries. Interestingly, polygonal photomasks resulted in output spallation patterns distinct from their original shapes, displaying diffraction-induced interference-like transformations, which we hypothesize arises from spot-edge effects during shockwave expansion. To explain these phenomena, we developed a Cumulative Element Simulation (CES) model to capture the spot-edge effects in shockwave expansion. The CES predictions were quantitatively compared with experimental results using an image-processing protocol, providing reliable evaluation of geometric transformations and validating the predictive capacity of the model. Beyond revealing the underlying mechanism, this approach enables programmable generation of diverse spallation patterns, from polygonal outputs to encrypted alphabetic structures and pixelated assemblies for QR codes or complex two-dimensional images. Collectively, these findings position laser-induced shockwave patterning as a versatile and scalable technique with strong potential for next-generation microfabrication and information encoding.

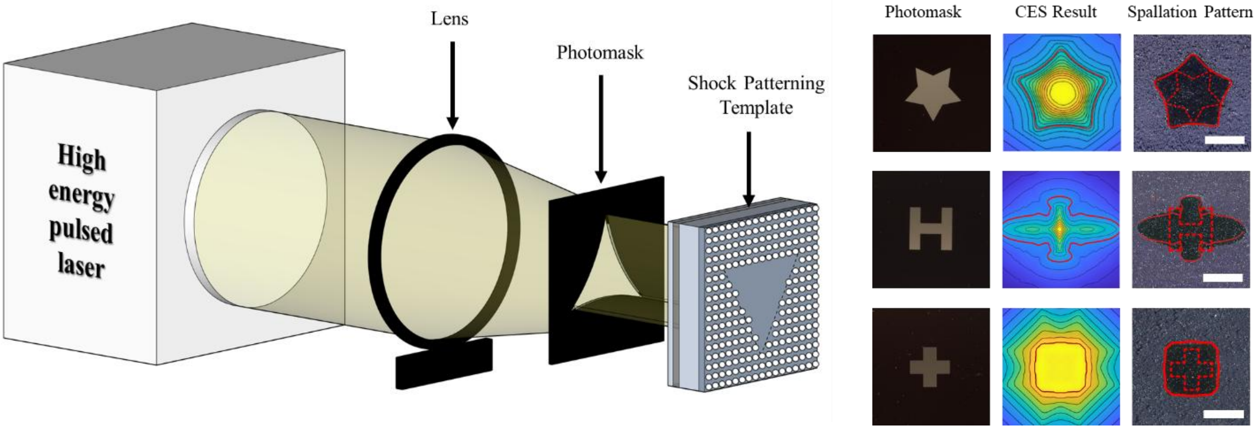

Figure 1. Schematic of laser-induced shockwave spallation and representative results showing photomask inputs, CES result, and corresponding spallation patterns (scale bars = 400 μm).

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Transformable Hybrid Fiber-Reinforced Polymer Fabricated Using Multi-Resin Dispensing

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Deployable structures have attracted increasing attention in aerospace, architectural, and biomedical applications owing to their ability to be compactly stored and later expanded at the target location [1]. However, conventional foldable materials such as paper, polymers, and ultra-thin glass often lack the mechanical robustness required for load-bearing functions. Consequently, recent studies have explored high-stiffness fiber-reinforced polymers (FRPs) as potential materials for deployable systems [2].

Building on these efforts, several studies have attempted to realize deployable structures purely through material design, eliminating mechanical or thermal coupling mechanisms such as hinges or welding. Examples include carbon and glass fiber-based Tachi–Miura polyhedron fabricated via vacuum bag-only processing and Kresling tube structures produced through filament winding. Nevertheless, precise fabrication control of complex FRP geometries remains challenging, and studies addressing material-level characteristics—particularly interfacial interactions—are still limited.

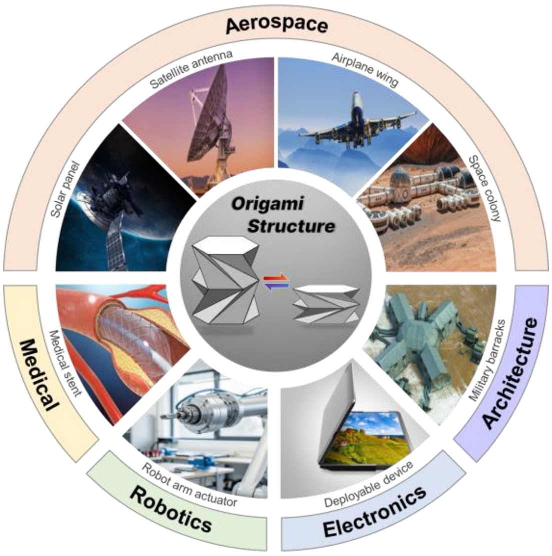

Figure 1. Schematic image of origami structure and applications.

To address these challenges, this study introduces a multi-resin dispensing process capable of depositing rigid and flexible epoxies in spatially controlled patterns. This approach enables the fabrication of high-quality “origami-type” FRPs with clearly defined rigid and flexible regions, expanding their potential use in programmable and deployable aerospace structures.

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Conflicting Entropy-Driven Zwitterionic Dry Polymer Electrolytes for Scalable High-Energy All-Solid-State Batteries

Kyeong-Seok Oh[1], Ji Eun Lee[2], Jong Chan Shin[3], Dokyung Kim[4],
Young Joo Lee[4]*, Minjae Lee[3]*, Sang Kyu Kwak[5]*, and Sang-Young Lee[1]*

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Inorganic electrolytes dominate all-solid-state batteries (ASSBs), but face critical limitations, including interfacial instability, complex manufacturing, and challenges in operating under commercially viable conditions. Here, we present a transformative approach using zwitterionic dry polymer electrolytes (ZPEs) designed via a conflicting entropy strategy to enable scalable energy-dense ASSBs. Guided by Flory–Huggins theory, liquid-state zwitterionic monomers exhibit higher mixing entropy with Li salts compared to conventional long-chain polymers, forming homogeneous monomer/salt mixtures with enhanced intermolecular electrostatic interactions to promote salt dissociation. *In-situ* polymerization of these mixtures yields directionally aligned ion channels decoupled from the polymer backbone, characterized by reduced conformational entropy, allowing rapid Li^+ migration via an ion-hopping mechanism under ambient conditions. The ZPEs are seamlessly incorporated as a solid catholyte into pre-fabricated high-areal-capacity (10.0 mAh cm^{-2}) $LiNi_{0.8}Co_{0.1}Mn_{0.1}O_2$ cathodes, ensuring compatibility with existing cell manufacturing processes, significantly reducing production complexity and cost. Paired with thin Li-metal anodes (N/P (negative-to-positive electrode capacity) ratio = 1.0), pouch-type ASSB full cells demonstrate high energy densities (516 Wh kg_{cell}^{-1}/1329 Wh L_{cell}^{-1}) and stable cycle life at practical operating conditions (25 °C and 0.5 MPa) in such a constrained cell configuration, far outperforming previously reported ASSB full cells.

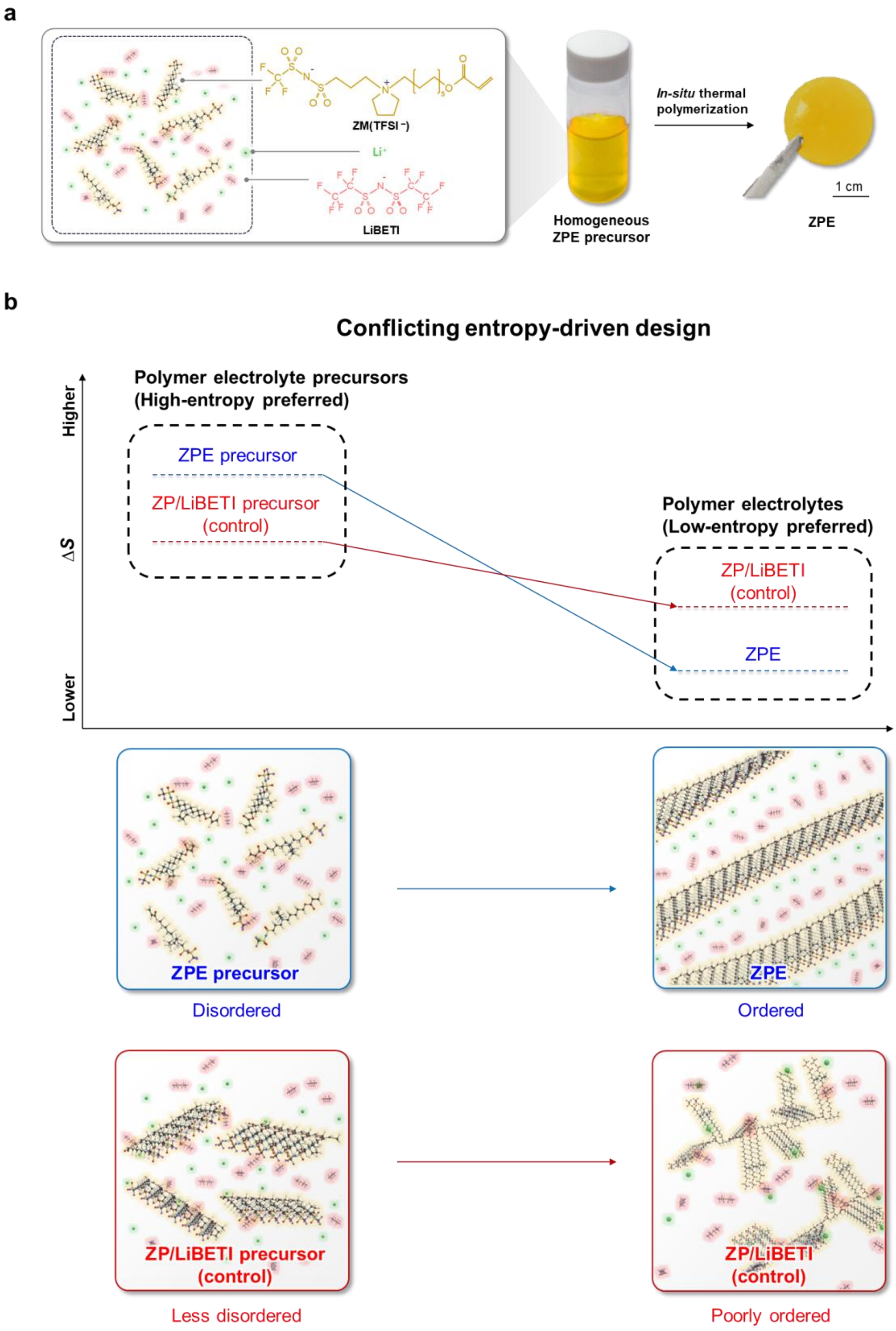

Fig. 1 | Conflicting entropy design for ZPE.

a, Chemical structure of ZM(TFSI$^-$) and LiBETI, and preparation of the self-standing ZPE. **b**, Schematic representation showing the structural feature of the ZPE compared to the ZP/LiBETI (control sample) with the same chemical structure and composition.

Synthesis of Low-Dielectric Poly(ether-imides) Derived from a Bio-Based Novel Diamine

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The dielectric performance of conventional polyimides presents a significant barrier to their implementation in advanced technologies, such as Internet of Things (IoT) and 5G/6G communications, where high-performance polymers with low dielectric constants are essential for rapid signal transmission and signal integrity. Nevertheless, polyimides (PIs) have emerged as a more cost-effective alternative, offering exceptional thermal stability, tunable mechanical strength, and low dielectric properties. Consequently, PIs are widely adopted in high-performance electronic devices to minimize signal delay and power loss. In this study, a diamine monomer derived from benzoin was synthesized and utilized to design and fabricate a series of PI films. The resulting PI films exhibited a range of desirable properties, including low dielectric constants (<2.5 at 1 MHz). The films demonstrated moderate thermal performance, with glass transition temperatures between 150 and 260 °C and 5% weight loss temperatures ranging from 200 to 380 °C, indicating moderate thermal resistance. Furthermore, the PI films showed low moisture uptake (<1.85%) and good solubility in common organic solvents. These attributes can make the PIs particularly suitable for microelectronics to gain high signal strength.

Sorting-free Carbon Nanotube Channel Synaptic Transistor for Simple and Facile Fabrication Process

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The exponentially growing demand for large-scale data processing has driven the development of neuromorphic devices to overcome the bottleneck limitations of the von Neumann architecture. Recent research has focused on achieving multi-level states through precise conductivity modulation and enabling scalable fabrication. Among various materials, carbon nanotubes (CNTs) have attracted significant attention for synaptic devices due to their high charge mobility, transparency, mechanical flexibility, stretchability, structural stability, and solution processability. However, conventional approaches rely on sorting processes that separate semiconducting CNTs from metallic CNTs, which complicates fabrication, requires considerable cost and time while achieving high-purity CNTs still challenging.

Here, we implement unsorted CNT (UCNT) channel synaptic transistors that enable precise conductivity modulation without a sorting process. Conductivity was modulated by reversible ion doping through ion reservoir consisting of the ferroelectric polymer P(VDF-TrFE) and the ionic liquid [EMIM][TFSI]. Raman spectroscopy confirmed that anions contribute to the p-type doping of CNTs. Electrical characterization revealed clear switching behaviors and reliable synaptic functionalities, including long-term potentiation (LTP)/ depression (LTD), short-term plasticity (STP), paired-pulse facilitation (PPF), spike-frequency dependent plasticity (SFDP) with excellent stability under repeated measurements. Furthermore, pattern recognition simulations validated the synaptic performance of devices. This work demonstrates a simple, fast, and cost-effective strategy for fabricating stable neuromorphic transistors with highly linear conductance modulation, contributing to the advancement of next-generation neuromorphic electronics.

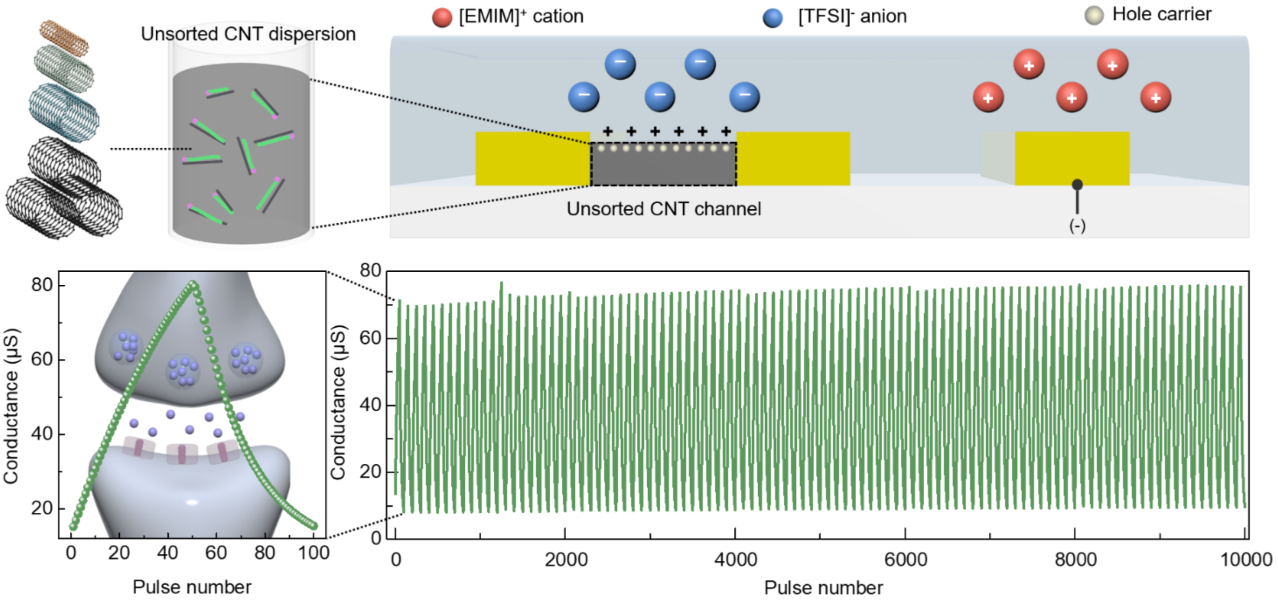

Figure 1. Anion-induced p-type doping of unsorted CNTs enables highly linear conductance modulation with excellent cycling durability.

Poster Presentation

PS-1 ~ PS-77

A Highly-Ordered Close-Packed Metallic Nanotube Array for Surface-Enhanced Raman Scattering (SERS) Applications

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This study presents a novel rhombic metallic nanotube array (MeNTA) for high-performance surface-enhanced Raman scattering (SERS) applications. The close-packed structure comprises over one hundred million silver rhombic nanotubes per cm^2, fabricated using a semiconductor-compatible top-down lithographic method followed by room-temperature sputtering. This approach enables mass production of highly ordered, defect-free nanostructures with precise control over composition, shape, dimensions, and periodicity [1].

The rhombic MeNTA design was optimized using finite difference time domain (FDTD) simulations to maximize electromagnetic field enhancement. The rhombic geometry with rounded corners (curvature radii of 120 nm and 60 nm) and dense spacing of 150 nm significantly outperformed circular, triangular, and square configurations, achieving maximum electric field enhancement (E_{max}/E_0) of 9.79. The rhombus array arrangement further increased enhancement by ~24% compared to square arrangements due to denser packing.

Experimental validation demonstrated exceptional SERS performance across multiple analytes. For rhodamine 6G (R6G), the detection limit reached 10^{-11} M with an enhancement factor of 1.35×10^8 and relative standard deviation of only 6.98%. Crystal violet detection achieved even lower limits of 10^{-12} M with enhancement factors of 3.23×10^8 and 5.92% standard deviation. Additional successful detection was demonstrated for folic acid, malachite green, and methyl parathion.

The substrate exhibited remarkable reproducibility with only 6.31% standard deviation across 60 randomly selected measurement locations, attributed to the highly ordered periodic structure. Raman mapping revealed that hotspots primarily originated from sharp corners and edges, validating the lightning rod effect predicted by simulations. The jagged rim profile created during fabrication enhanced localized surface plasmon resonance effects [2].

This semiconductor-compatible fabrication approach represents a significant advancement in scalable SERS substrate production. The combination of wafer-scale processing, high reproducibility, and exceptional sensitivity positions these arrays as commercially viable platforms for biosensing, environmental monitoring, and trace-level analytical applications requiring reliable quantitative detection.

[1] T.H. Chang, A.K. Altama, J.T. Wang, P. Yiu, J.P. Chu, Nanoscale, 2025, 17, 13685-13697.
[2] T.H. Chang, J.P. Chu, A.K. Altama, Applied Surface Science, 2024, 615, 156892.

Octahalogen-substituted Metal Phthalocyanines and Hybrid Materials Based on Them: Structural Features and Sensor Properties

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Among organometallic semiconductors, metal phthalocyanines (MPc) are of particular interest due to their high thermal and chemical stability in combination with their unique electrophysical properties [1]. By changing the molecular structure of the complexes, phthalocyanines with various properties can be obtained. Halogen-substituted metal phthalocyanines ($MPcHal_n$), due to electron-withdrawing substituents in the macrocycle, have a high sensor response to ammonia, hydrogen sulfide, and nitrogen oxides in the wide concentration range from 1 ppb to 1000 ppm [2].

In this work octahalogen-substituted phthalocyanines $MPcHal_8$ (Hal = F, Cl; M = Co, Zn, Cu, VO) were synthesized and characterized, hybrid materials based on carbon nanotubes (SWCNT) and halogen-substituted metal phthalocyanines were obtained. Structural features and spectral characteristics of the complexes were studied, and films were obtained by physical deposition from the gas phase, as well as by centrifugation of solutions of the compounds. Structural features of the obtained films of halogen-substituted metal phthalocyanines and SWCNT/$MPcHal_n$ hybrid materials were studied, sensor response to low concentrations of hydrogen sulfide, ammonia and nitrogen oxide was investigated (fig. 1).

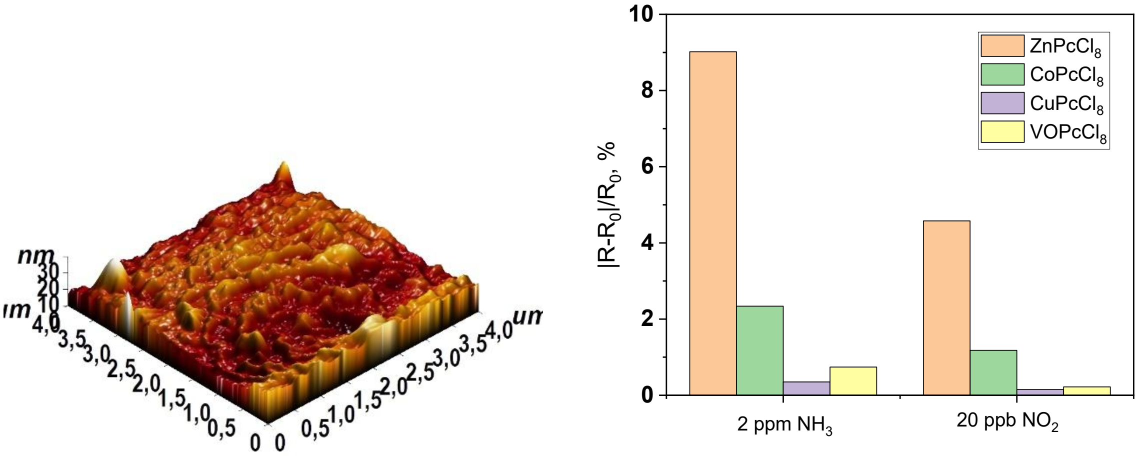

Figure 1. $CoPcCl_8$ film morphology and a comparative diagram of the sensor response of metal octachloro-substituted phthalocyanines to 2 ppm NH_3 and 20 ppb NO_2.

A comparative analysis of the effect of the phthalocyanine molecular structure and the method of film deposition on the sensor properties of the sensor devices active layers has been carried out.

This work was supported by the Russian Science Foundation (project No 24-73-10058).

[1] R.R. Cranston and B.H. Lessard, *RSC Adv.*, **2021**, 11, 21716.
[2] D. Klyamer, D. Bonegardt, T. Basova, *Chemosensors*. **2021**, 9(6), 133.

Styrene butadiene rubber (SBR) prepared by *ab initio* emulsion polymerization using macro-RAFT agent

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Emulsion styrene butadiene rubber (ESBR) is widely used in tire manufacturing due to its excellent physical properties and environmentally friendly water-based synthesis process. However, its free-radical mechanism leads to side reactions such as coupling and disproportionation, which terminate chain growth and complicate molecular weight distribution (MWD) control. The resulting broad MWD increases energy loss and negatively affects mechanical and viscoelastic properties.

In this study, we report the first successful synthesis of SBR via *ab initio* reversible addition-fragmentation chain transfer (RAFT) emulsion polymerization using poly(acrylic acid-*b*-styrene) with a trithiocarbonate end group as a reactive surfactant. By employing RAFT polymerization, we successfully synthesized ESBR with a narrow MWD. The polymerization was confirmed using FT-IR and NMR spectroscopy, while particle size was analyzed using dynamic light scattering (DLS).

Furthermore, we fabricated a SBR, natural rubber (NR), and aramid chip composite using RAFT ESBR as a dispersant for the aramid chip. The acrylic acid (AA) block at the polymer chain end facilitates hydrogen bonding with the aramid surface, while the butadiene units in the SBR segment participate in the vulcanization reaction with the base rubber. This molecular design improves both the dispersion of aramid chip within the rubber matrix and the mechanical properties of the resulting composite.

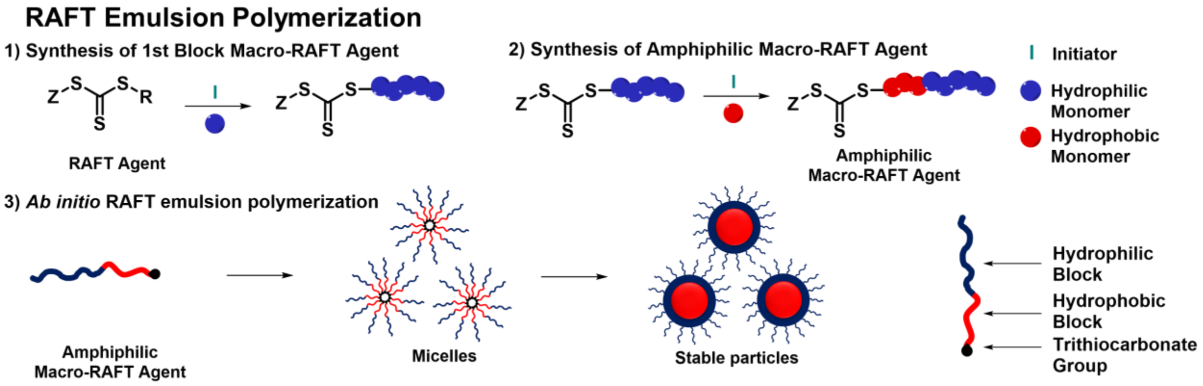

Figure 1. Overview of *ab initio* RAFT emulsion polymerization using trithiocarbonate as both a surfactant and a macro-RAFT agent.

[1] H. Mun, K. Hwang, and W. Kim, *J. Appl. Polym. Sci.*, 2019, 136, 47206.

Poisson-like Living Chain Isolation in ATRP-Synthesized Block Copolymers

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In reversible deactivation radical polymerization, block extension increases the fraction of terminated chains, significantly reducing the proportion of living species. Living chains inherently follow a Poisson-like molecular weight distribution, making their isolation essential for enabling high-performance multiblock and functional materials. Here, we report the first separation of living chains from poly(benzyl acrylate-block-styrene) (PBzA-b-PS) block copolymers synthesized via activators regenerated by electron transfer atom transfer radical polymerization (ARGET ATRP). Based on our earlier work with poly(benzyl acrylate) homopolymers, we employed high-performance liquid chromatography (HPLC) to separate the living fraction. Bromine termini were converted to azides and subsequently functionalized with polar alkynes via copper-catalyzed azide-alkyne cycloaddition (CuAAC), enhancing polarity contrast between living and terminated chains.[1] HPLC enabled successful isolation of the living chains, with size-exclusion chromatography confirming a narrow dispersity of $Đ \approx 1.017$. Further analysis by MALDI-TOF mass spectrometry and Gaussian fitting revealed $M_n = 11{,}843$ g mol^{-1} and $Đ = 1.009$, validating the Poisson-like nature of the living fraction. This approach demonstrates the feasibility of chain-end-defined purification in complex block copolymer systems and expands the applicability of living chain separation beyond homopolymers.

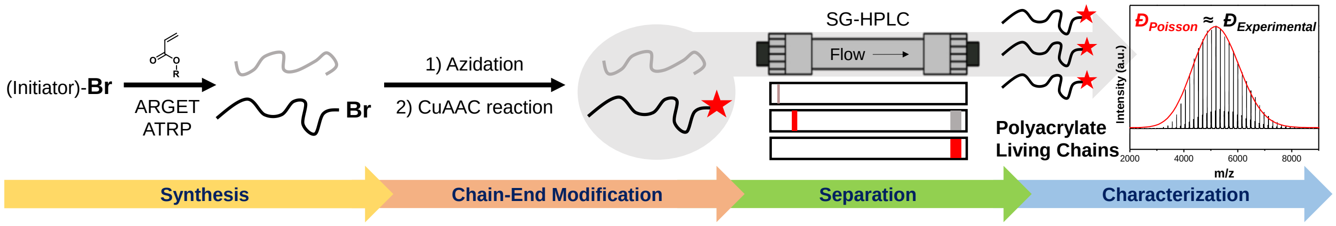

Figure 1. Schematic representation of the synthesis, chain-end modification, separation, and characterization, confirming separation and Poisson-distributed molecular weights.

[1] J. Oh, J. Kuk, T. Lee, J. Ye, H.-J. Paik, H. W. Lee, and T. Chang, ACS Macro Lett., 2017, 6, 758.

Compression-Induced Vertical Alignment of Smectic Liquid Crystal Elastomers

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Vertically aligned liquid crystal elastomers (LCEs) are crucial for advanced applications such as membranes, sensors, haptic devices, wavelength-tunable photonic systems, and adaptive lenses.[1-3] Conventional approaches to achieve such alignment have primarily relied on command surfaces or the application of electric and magnetic fields; however, these methods are often constrained by process complexity and limitations in thin films.[4] In this study, we demonstrate that vertical alignment can be effectively induced by exploiting the smectic phase through a facile compression method. Under thermal stimulation, the vertically aligned LCEs exhibited a radial actuation of approximately 80% (Figure 1). In addition, the impact of LC phase on the vertical alignment was systematically investigated using polarized optical microscopy and X-ray scattering analyses. Overall, compression-induced vertical alignment provides a simple yet efficient strategy, offering significant potential for the development of diverse LCEs–based actuating devices.

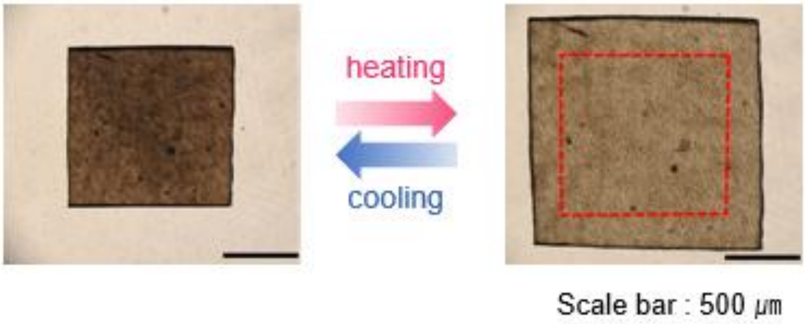

Figure 1. Radial actuation observed in vertically-aligned LCE.

[1] Ji, X., et al., Untethered Feel-Through Haptics Using 18-μm Thick Dielectric Elastomer Actuators. *Adv. Funct. Mater.*, **2021**, 31, 2006639
[2] Jiang, L., et al., Electrohydrodynamic printing of a dielectric elastomer actuator and its application in tunable lenses. *Compos. Part A Appl. Sci. Manuf.*, **2021**, 147, 106461
[3] Nam, S., et al., Omnidirectional color wavelength tuning of stretchable chiral liquid crystal elastomers. *Light Sci. Appl.*, **2024**, 13, 114.
[4] Jiang, Z.-C., et al., Liquid crystal elastomers for actuation: A perspective on structure-property-function relation. *Prog. Polym. Sci.*, **2024**, 153, 101829

Liquid Crystal Elastomers with Enhanced Reprocessability via Exchangeable Networks

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Exchangeable liquid crystal elastomers (xLCEs) incorporating dynamic covalent bonds offer significant advantages including reprocessing and reprogramming. However, conventional reprocessing for xLCEs are largely limited to hot pressing, which requires long processing times and restricts shape formation to simple 2D films. In this work, we synthesize a series of xLCEs that can undergo rapid bond exchange, thereby enhancing thermal processability. By systematically tailoring the network structure of xLCEs, we achieve a broad range of mechanical and rheological properties. Importantly, the optimized xLCEs exhibit liquid-like behavior at elevated temperatures, enabling versatile melt-processing into 1D fibers, 2D films, and complex 3D shapes. Our approach addresses key limitations of conventional xLCE processing and opens new opportunities for applications in soft actuators, active textiles, and reconfigurable surfaces.

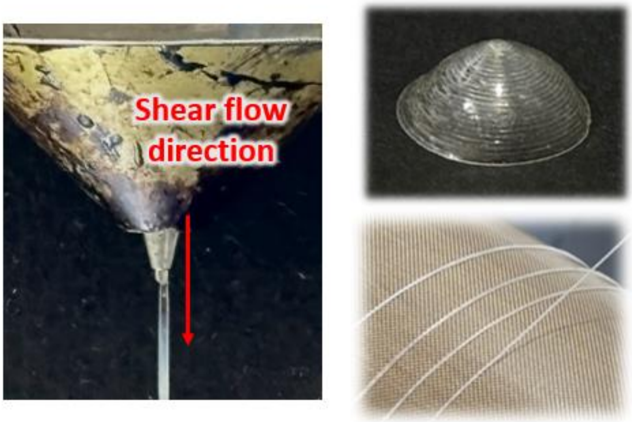

Figure 1 Enhanced reprocessability of xLCEs enables melt-processing (DIW, melt spinning)

Architectural Control and Rheological Properties of Long Chain Hyperbranched Polystyrene Synthesized *via* Sulfoxide-Functionalized ATRP

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The precision synthesis of architecturally defined hyperbranched polymers remains a significant challenge, often limited by conventional methods. In this work, we utilized an effective one-pot synthesis based on temperature-controlled sulfoxide chemistry to create long chain hyperbranched polymers with precisely controlled branch lengths [1]. The strategy employs a thermal switch: a linear polystyrene precursor is first synthesized below 40°C, after which an increase in temperature to 100°C triggers the in situ generation of polymerizable vinyl groups on the backbone. Subsequent polymerization from these sites yields hyperbranched structures with target branch lengths (5k, 10k, and 20k Da) tuned by the linear precursor's molecular weight. The resulting polymer structures were successfully characterized by ^{1}H NMR, SEC, and MALLS.

An investigation of the rheological properties revealed that branch length is a critical determinant of viscoelastic behavior, particularly in the nonlinear regime. Longer branches led to increased relaxation times and more pronounced strain hardening. This trend was quantitatively confirmed by the Strain Hardening Factor (SHF), which increased systematically with branch length. By integrating precision synthesis with in-depth rheological analysis, our work provides fundamental insights into the structure-property relationships of long chain hyperbranched polymers, paving the way for the rational design of advanced materials with tailored performance.

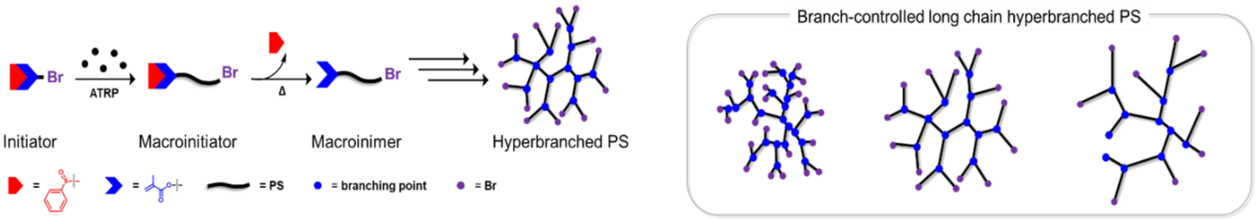

Figure 1. Schematic for the synthesis of long chain hyperbranched polystyrene with controlled architecture *via* sulfoxide-mediated ATRP

[1] D. Kim, J. Do, K. Kim, Y. Kim, H. Lee, B. Seo, W. Lee, H. B. Jeon, H. Y. Cho, and H.-j. Paik, *Macromolecules*, **2021**, *54*, 7716.

High-Temperature Creep-Resistant and Reprocessable Epoxy Adhesive Based on Disulfide-Linked Covalent Adaptable Networks

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The rapid growth of industries such as automotive and construction has led to increased technical demands, requiring engineers to enhance material performance while reducing costs. Among various solutions, structural adhesives have recently attracted attention in these fields due to their ease of application and lightweight design, which contribute to high mechanical performance. However, most conventional adhesives lack reprocessability and exhibit significant creep and/or failure under high-temperature conditions. To address these limitations, we introduce a covalent adaptable network (CAN) into a structural adhesive system, utilizing a disulfide exchange reaction. The adhesive is formulated with an aromatic epoxy resin and an amine-based crosslinker and is cured via the epoxy–amine reaction to form a dynamic network capable of reversible bond exchange. This enables strong adhesion to metal substrates while maintaining reprocessability. Thanks to its high glass transition temperature (T_g) and dynamic bonding characteristics, the adhesive retains excellent adhesion performance even under elevated temperatures and can be reprocessed when needed.

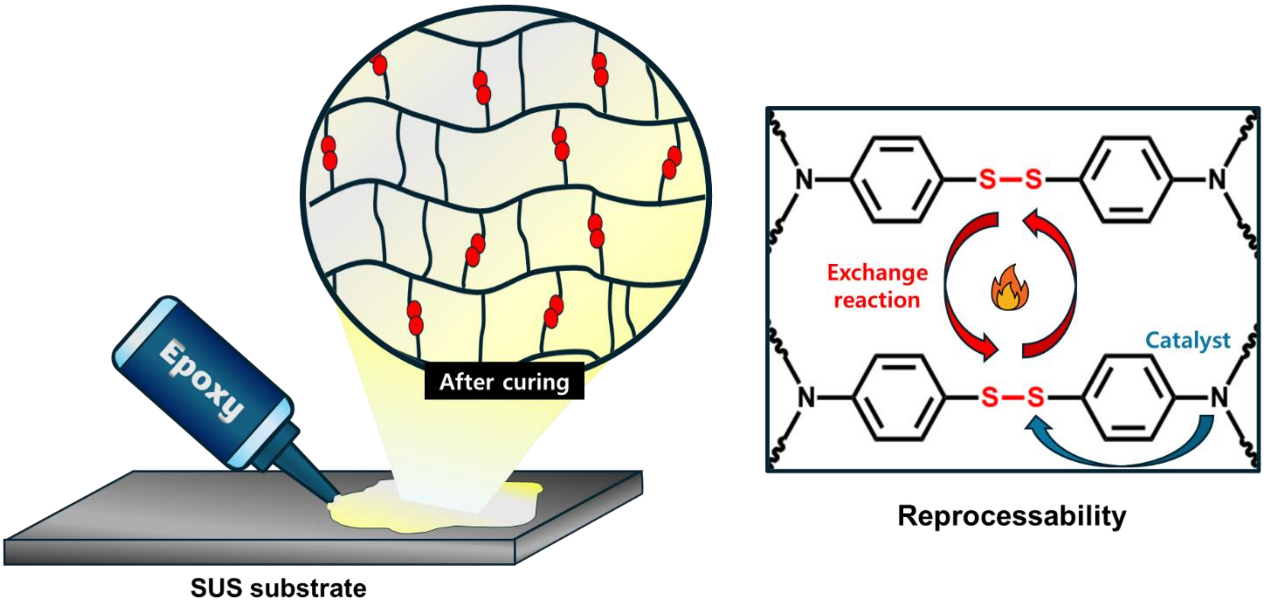

Figure 1. A schematic illustrating CAN-based adhesive via disulfide exchange reaction.

Light-Driven Tunable Adhesion in Donor-Acceptor Stenhouse Adduct Functionalized Polymer Networks

Minkyeong Gwon[1], Siwoo Kim[1], Kyungwon Seo[2], Woojin Noh[2], Hyosung An[2], Jaejun Lee[1]*
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The development of tunable adhesives with on-demand adhesion control represents a significant advancement in smart material applications. While conventional adhesives provide fixed bonding properties, next-generation applications demand dynamic adhesion systems capable of switching bonding and debonding under external stimuli. Photoswitchable materials offer an attractive solution, enabling non-contact and precise temporal and spatial control of adhesion strength under light irradiation.

Previous studies on light-responsive adhesion using photoswitches such as azobenzene and spiropyran have been limited by their reliance on ultraviolet light, restricted structural tunability, and only modest changes in adhesion strength, thereby constraining their practical applicability. A donor-acceptor Stenhouse adducts (DASA) emerge as a particularly promising candidate due to their visible-light responsiveness and significant molecular volume and polarity alterations.[1] These unique photoisomerization characteristics make DASA highly suitable for modulating interfacial adhesion in polymer networks.

In this study, we prepared a novel photo-responsive adhesive system by chemically conjugating DASAs in polyethyleneimine (PEI) matrix, where a diglycidyl ether was used as a crosslinker. This synthetic approach ensures uniform distribution of the photoswitch molecules throughout the polymer matrix. The photoisomerization of DASA induced distinct variations in glass transition temperature (Tg), storage modulus, and contact angle, reflecting simultaneous changes in both bulk and interfacial properties of the polymer network.[2] The photo-responsive adhesion properties were systematically characterized using probe tack tests and atomic force microscopy based force-distance measurements. Upon visible light irradiation, the DASA-functionalized films exhibited remarkable changes in adhesion strength, attributed to photoisomerization-induced modifications in both surface energy and bulk mechanical modulus.

Our DASA–PEI adhesive system offers a major step forward in smart adhesives by using visible light instead of damaging UV and achieving strong, reversible adhesion changes. Its pronounced tunability and compatibility with diverse polymers make it ideal for flexible electronics, biomedical devices, and soft robotics, where precise, non-contact bonding and easy detachment are essential. This approach provides a practical, versatile platform for integrating light-controlled adhesion into real-world applications.

[1] Sameh Helmy, Frank A. Leibfarth, Saemi Oh, Justin E. Poelma, Craig J. Hawker, and Javier Read de Alaniz, Journal of the American Chemical Society, **2014**, 136 (23), 8169-8172
[2] Miranda M. Sroda, Jaejun Lee, Younghoon Kwon, Friedrich Stricker, Minwook Park, Megan T. Valentine, and Javier Read de Alaniz, ACS Applied Polymer Materials, **2022,** 4 (1), 141-149

One-Pot Free Radical Polymerization: Thermal Activation of a Dual-Functional Initiator for Block Copolymer Synthesis

Seunghyeon Lee[1], Seoyoung Lee[1], Minji Kim[2], Yerin Jang[2], Heungbae Jeon[2*], Hyun-jong Paik[1*]
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*Prof. Hyun-jong Paik (hpaik@pusan.ac.kr)

Dual-functional initiators containing both azo and per-ester groups facilitate efficient block copolymer synthesis by enabling polymerization under different reaction conditions. Since the 1980s, azo-peroxide initiators have been employed for block copolymer synthesis using thermal, redox, and UV initiation pathways. [1,2] In contrast, our study presents a simplified strategy that relies solely on thermal initiation. This one-pot polymerization approach eliminates intermediate purification steps, thereby enhancing synthetic efficiency compared to conventional procedures.

In this work, we utilize di-tert-butyl 4,4′-azobis(4-cyanoperoxyl-valerate) (AIBN-PEN) as a dual-functional initiator in thermal free radical polymerization (FRP). The polymerization proceeds in two sequential stages: initially, at 70 °C, poly(methyl methacrylate) (PMMA) macro-initiators are produced, followed by polystyrene (PS) block extension at 110 °C. A semi-batch process regulates monomer consumption, ensuring stable polymerization kinetics. Using this strategy, block copolymers with molecular weights ranging from 10,000 to 200,000 were successfully synthesized. Residual homopolymers were removed through preparative liquid chromatography (PREP LC) as well as Soxhlet extraction, resulting in high-purity PSt-b-PMMA. The successful formation of block copolymers was verified by gel permeation chromatography (GPC) and nuclear magnetic resonance (NMR) spectroscopy.

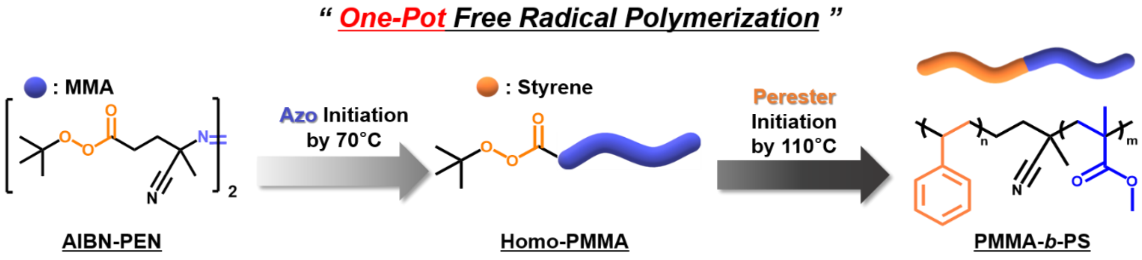

Figure 1. Scheme for block copolymer synthesis using Dual-functional initiator

[1] I. Piirma and L.-P. H. Chou, *J. Appl. Polym. Sci.*, 1979, 24, 2051.
[2] P. S. Engel, Y. Ying, and S. He, *Macromolecules*, 2003, 36, 3821.

Stretch-Driven Thermal Conductivity Modulation in Emulsion-Templated Porous Vitrimers

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Emulsion templating enables precise control over porosity and pore size by solidifying the continuous phase and removing the internal phase. In this study, two types of water-in-oil (w/o) high internal phase emulsions (HIPEs) were stabilized using either silicone-based surfactants or hydrophobic nanoparticles, with a β-amino ester-based elastomeric vitrimer as the continuous phase. Due to dynamic bond exchange above the topology freezing transition temperature (T_v), the vitrimer allows post-processing shape tuning. To examine the effect of pore morphology on thermal insulation, porous vitrimers were stretched at various elongation ratios above T_v to fix the deformed structure, followed by thermal conductivity measurements. The results showed that out-of-plane thermal conductivity decreased with increasing elongation, mainly due to the shortened minor axis of the pores. This work offers a simple strategy to tailor anisotropic thermal conductivity in porous vitrimers via mechanical deformation.

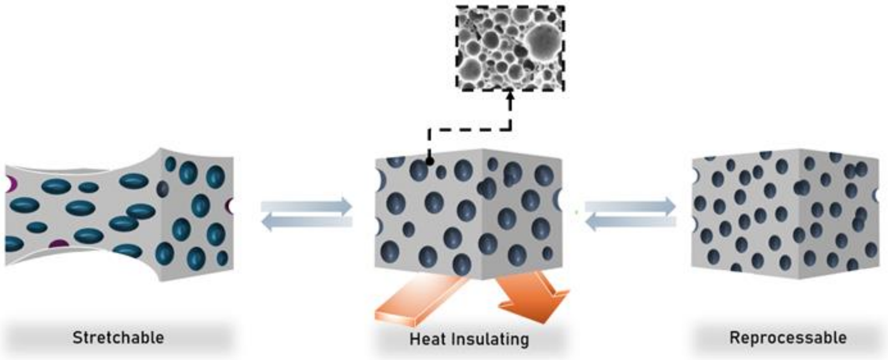

Figure 1. Schematic illustration of stretch-induced modulation of pore morphology and thermal conductivity in emulsion-templated porous vitrimers.

Coordination Geometry-Controlled Shock Wave Energy Dissipation in Metallosupramolecular PDMS Networks

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Conventional shock wave energy dissipation (SWED) materials are limited by their irreversibility and single-use behavior. To address these challenges, we designed metallosupramolecular poly(dimethylsiloxane) (PDMS) networks incorporating reversible metal-ligand coordination bonds that enable self-healing and reusability while providing multiple energy dissipation pathways.

We synthesized networks using poly(dimethylsiloxane) (PDMS) backbone with transition metals Zn^{2+}, Cu^{2+}, and Ni^{2+} coordinated to imidazole ligands at L/M ratios of 4.0 and 4.5, where the metal-ligand bonding crosslinked backbone chains. Laser-induced shock wave testing revealed distinct metal-dependent performance. Among them, Cu^{2+} coordinated PDMS showed superior SWED behavior with 22.1% pressure mitigation improvement at 1.49 GPa, whereas Zn^{2+} and Ni^{2+} coordinated PDMS achieved 9.1% and 4.7%, respectively.

Although classical viscoelastic analysis failed to explain the dependence of SWED on coordination geometry, CoGEF-density functional theory (DFT) calculations showed that coordination geometry governs SWED efficiency, with Cu^{2+} square-planar (trans) complexes exhibiting significantly lower bond-breaking strain (11.48%) than Zn^{2+} tetrahedral (30.92%) and Cu^{2+} planar (cis) (45.83%) structures. Under shock loading with greater strain, the Cu^{2+} square-planar (trans) bonds to rupture preferentially while Zn^{2+} tetrahedral and Cu^{2+} planar (cis) bonds remain intact and preserve network integrity.

Overall, this study identifies coordination geometry as a key parameter for optimizing SWED and presents a framework for designing next-generation shock-absorbing materials that combine self-healing capability with tunable energy dissipation. In addition, this work delivers a detailed SWED mechanism analysis through the integrated use of laser-induced shock-wave tests and DFT calculations

Photoinduced Shape-Fixation and Reconfiguration of Soft Microarchitectures in Covalent Adaptable Networks

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Dynamic network exchange reactions enable covalent adaptable networks (CANs) to be malleable and reprocessable analogue of thermosetting polymers. Unlike conventional CANs, which rely on thermally activated network exchange reactions, a new CAN incorporating both UV- and heat-responsive disulfide bonds is introduced [1]. UV irradiation at room temperature effectively accelerates the stress relaxation of this CAN, achieving results comparable to those obtained at elevated temperatures (> 100 °C) without UV irradiation. As a result, UV irradiation can be adopted as an on-demand, reversible, and non-contact shape-fixation method, eliminating the need for heat, toxic solvents, or support structures. To maximize the effectiveness of this approach, we employ the facile fabrication of three-dimensional (3D) staggered-overlapped microdenticles, mimicking sharkskin, that demonstrate non-contact/spatiotemporal shape fixation using UV light. To further investigate the dynamic characteristics of this system in response to temperature and/or UV, non-equilibrium molecular dynamics (NEMD) simulations were also performed.

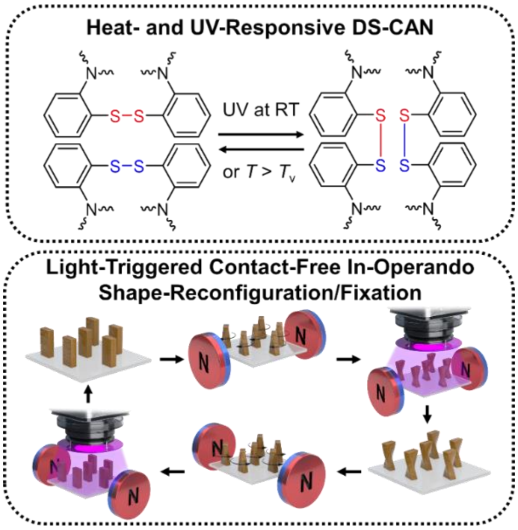

Figure 1. Bond exchange mechanism in a covalent adaptable network (DS-CAN) with dynamic disulfide bonds via heating or UV irradiation (top). When combined with ferromagnetic particles, its photoresponsiveness at room temperature enables contactless, spatiotemporal regulation of dynamic bond exchanges during magnetomechanical actuation (bottom).

[1] Y. Yoon, H. Moon, W. Cho, D. Lee, S. Jeong, J. J. Wie, and C. B. Kim, *Advanced Materials*, **2025**, 2503161. (in press)

Microphase Separation of Phosphocholine-Cholinephosphate Diblock Copolymers in Aqueous Solutions

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As shown in the asymmetric lipid distribution in cell membranes, phase separation of zwitterions is a crucial molecular mechanism in biological systems [1]. Poly(2-methacryloyloxyethyl phosphorylcholine) (PMPC) and poly(2-methacryloyloxyethyl isopropyl cholinephosphate) (PMCPiPr) both comprise phosphobetaine pendant groups but their dipole orientation is asymmetric. Significant contrast in their cell adhesion and hydration behaviors have been reported [2]. This study explores a novel aqueous microphase-separated biphasic system induced by the asymmetric orientation of zwitterion dipoles (Figure 1).

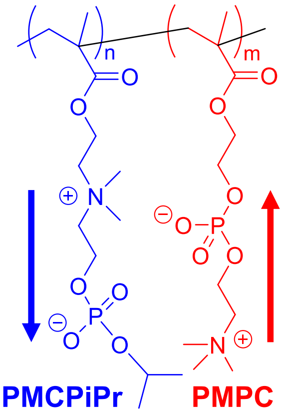

Figure 1. Chemical structure of PMCPiPr-*b*-PMPC.

The aggregation behavior of the polymers in dilute solutions was measured by dynamic light scattering (DLS), and the morphology of the ordered structures formed in concentrated solutions was investigated by small-angle X-ray scattering (SAXS). A well-defined block copolymer, $PMCPiPr_{93}$-*b*-$PMPC_{122}$, with controlled molecular weight was successfully synthesized. The homopolymers $PMPC_{109}$ and $PMCPiPr_{121}$ were soluble in water. In a water-ethanol mixed solvent with an ethanol volume fraction (f_{EtOH}) of 0.90, $PMPC_{139}$ formed aggregates via a cononsolvency-induced association, while $PMCPiPr_{121}$ remained soluble. In highly concentrated water/ethanol mixed solutions of $PMCPiPr_{93}$-*b*-$PMPC_{122}$ (667 mg/mL), the f_{EtOH} modulation induced their morphology transition from a disordered to a lamellar, and eventually to a highly ordered morphologies of lamellar and columnar with hexagonally packed PMPC cylinders (Figure 2**)**. The lamellar periodicity increased with increasing f_{EtOH} from 0.6 to 0.7, and subsequently decreased from 0.7 to 1.0. This trend was attributed to a rise in the interaction parameter (χ) due to pronounced cononsolvency in the PMPC block, which led to an expansion of the periodic lamellae thickness. At higher ethanol fractions of f_{EtOH} = 0.9 and 1.0, the reduction of electrostatic repulsion induced a chain shrinkage, resulting in a decrease in lamellae thickness. These results suggest that the dipole orientation asymmetry between PMCPiPr and PMPC blocks leads to the differences in their cononsolvency characteristics, thereby promoting microphase separation in the water-ethanol mixed system.

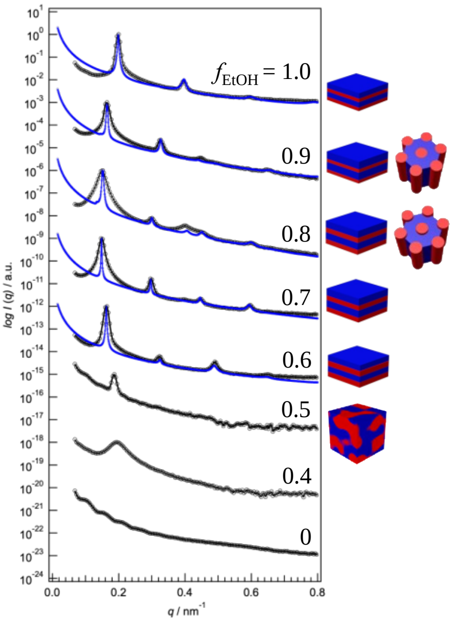

Fig. 2. SAXS intensity profiles of 667 mg/mL $PMCPiPr_{93}$-*b*-$PMPC_{122}$ water-ethanol mixed solutions depending on the ethanol volume fraction (f_{EtOH}).

[References]
[1] Rothman, J. E.; Lenard, J. *Science* **1977**, 195, 743.
[2] Li, S.; Wang, F.; Li, X.; Chen, J.; Zhang, X.; Wang, Y.; Liu, J. *Mater. Interfaces*. **2017**, 9, 17736.

Horizontal Lithium Electrodeposition on Atomically Polarized Monolayer Hexagonal Boron Nitride

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Both uncontrolled Li dendrite growth and corrosion are major obstacles to the practical application of Li-metal batteries. Despite numerous attempts to address these challenges, effective solutions for dendrite-free reversible Li electrodeposition have remained elusive. Here, we demonstrate the horizontal Li electrodeposition on top of atomically polarized monolayer hexagonal boron nitride (hBN). Theoretical investigations revealed that the hexagonal lattice configuration and polarity of the monolayer hBN, devoid of dangling bonds, reduced the energy barrier for the surface diffusion of Li, thus facilitating reversible in-plane Li growth. Moreover, the single-atom-thick hBN deposited on a Cu current collector (monolayer hBN/Cu) facilitated the formation of an inorganic-rich, homogeneous solid electrolyte interphase layer, which enabled the uniform Li^+ flux and suppressed Li corrosion. Consequently, Li-metal and anode-free full cells containing the monolayer hBN/Cu exhibited improved rate performance and cycle life. This study suggests that the monolayer hBN is a promising class of underlying seed layers to enable dendrite- and corrosion-free, horizontal Li electrodeposition for sustainable Li-metal anodes in next-generation batteries.

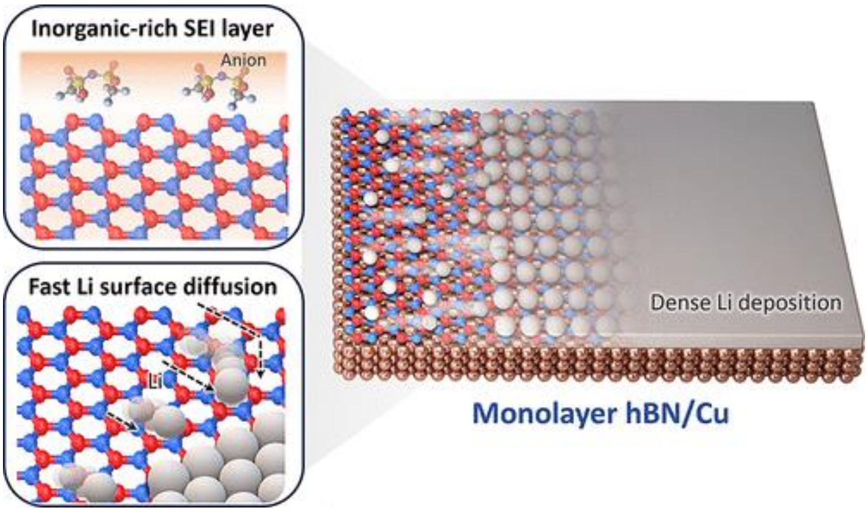

Figure 1. Monolayer hBN/Cu allowed for the reduction of the activation energy for Li surface diffusion and formation of inorganic-rich SEI layer, resulting in uniform and compact in-plane Li deposition.

Glass Fiber Reinforced Plastic Embedded with Silica-Coated Hollow Glass Microspheres for Enhanced Thermal Insulation in Liquid Hydrogen Storage

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With the growing demand for alternatives to fossil fuels, liquid hydrogen (LH2) has emerged as a next-generation energy source owing to its high storage capacity. However, as LH2 must be stored under cryogenic conditions below -253 °C, specialized storage containers are required to prevent external heat ingress, which can cause boil-off gas through evaporation [1]. For the efficient storage and transportation of LH2, the development of advanced materials with superior thermal insulation and mechanical strength is essential, compared to the conventional materials such as stainless steel (SUS).

In this study, silica-coated hollow glass microspheres (sHGM) were incorporated into glass fiber reinforced polymer (GFRP) using polydopamine (PDA) by the VA-RTM process. To maximize thermal insulation, silica spheres were synthesized on the surface of HGM using a semi-batch sol-gel method to increase surface roughness [2]. This roughened surface not only extended the heat transfer pathways but also strengthened the interfacial bonding, leading to improvements of approximately 29% in thermal insulation and 43% in interfacial strength compared to neat composites without sHGM. Consequently, the results validate the potential of sHGM-integrated composites as promising candidates for efficient LH2 storage applications.

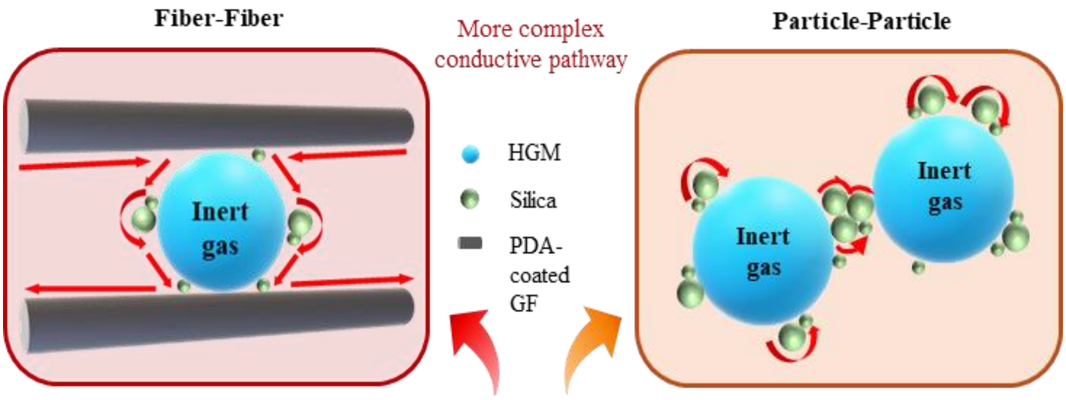

Figure 1. Schematic illustration for the thermal insulation mechanism of sHGM-GFRP.

[1] Cai, W., Ren, G., Liu, S., Chen, Y., Che, X., Zhang, Z., & Li, Q., *International Journal of Hydrogen Energy*, **2025**, *159*, 150507.

[2] Ng, S., Jelle, B. P., Sandberg, L. I., Gao, T., & Mofid, S.A., *Construction and Building Materials,* **2018**, *166*, 72-80.

Highly Stable Lithium-Ion Battery Based on Hybrid Separators Containing Terpolymer Binders

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The safety and performance of lithium-ion batteries (LIBs) depend on the structural and thermal integrity of separator films, which play a critical role in preventing direct contact of electrodes. Commercialized polyolefin-based separators have a merit in terms of cost-effectiveness, but their thermal stability is not high enough to withstand a thermal runaway condition upon electrical shortages, etc. To overcome this problem, a variety of strong materials, including polyimide and aramid fiber, have been extensively studied. However, the fabrication cost and process conditions of such potential candidates could not meet the requirements to enter the existing market. As an alternative way, it has been proposed that the conventional polyolefin separators could be strengthened by coating inorganic materials on their surfaces. Here, an issue arises for the effective adhesion of inorganic materials to the surface of polyolefin separators. This presentation demonstrates the concept of developing efficient binders to adhere inorganic materials to the polyolefin surfaces and discusses the performance of LIBs.

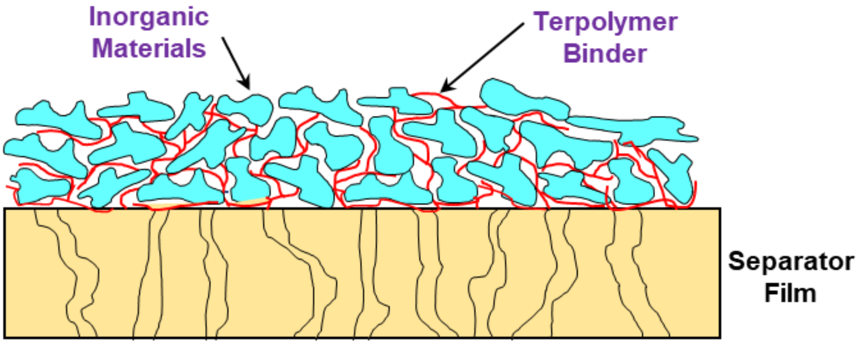

Figure 1. Illustration for the cross-section part of polyolefin separator films coated with inorganic materials with the aid of the terpolymer binder synthesized in this work.

[1] S. Lee, J. Kim, D. Park, H. Kim, and Y. Kim, *Chem. Eng. J.*, 517, 164127 (**2025**).
[2] K. Rafiz, et al., *Electrochim. Acta*, 421, 140478 (**2022**).
[3] H. Yuan, et al., *J. Colloid Interface Sci.*, 686, 930-940 (**2025**).

Thermoelectric Devices Based on Hybrid Composites of Conducting Polymer and Zeolite

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Thermoelectric (TE) devices are expanding their applications in clean energy harvesting and thermal management systems due to their unique ability to convert waste heat into electricity. Conventional TE devices have been fabricated using inorganic materials, such as bismuth telluride (Bi2Te3) alloys, which deliver TE performances. However, the high-temperature process and intrinsic rigidity of such inorganic materials restrict TE applications for soft and round-shaped systems, including humanoid robots, etc. In this regard, organic materials have been introduced to TE devices due to their soft properties and low-temperature processes. Given that TE devices require high electrical conductivity and low thermal conductivity, various conducting polymers were used to fabricate organic TE devices (OTEDs). Recently, our group made OTEDs by employing poly(3,4-ethylenedioxythiophene):poly(styrene sulfonate) (PEDOT:PSS)-based films in horizontal and vertical geometries. In particular, the pathways of thermal and electrical conduction were attempted to be controlled by compositing the conducting polymers with inorganic materials. This presentation reviews our recent progress on TE devices fabricated with hybrid materials consisting of PEDOT:PSS and zeolites.

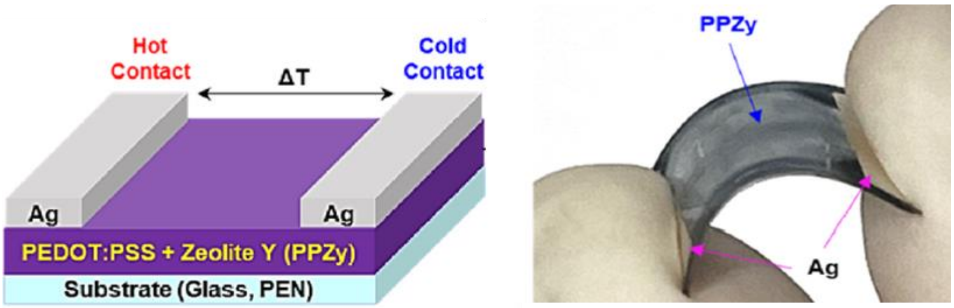

Figure 1. (Left) Structure of vertical type TE devices with the PPZy hybrid films and (right) demonstration of flexible hybrid TE devices.

[1] W. Lee, M. Song, S. Park, S. Nam, H. Kim, and Y. Kim, *Sci. Rep,* **5**, 33795 (2016).
[2] W. Lee, S. Lee, H. Kim, and Y. Kim, *Chem. Eng. J.*, **415**,128935 (2021).
[3] D. Murukadas, W. Lee, C. Park, H. Kim, and Y. Kim, *Mater. Today Sustainability*, **28**, 100993 (2024).

Smart photonic contact lens to control the function of smart glasses

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Smart glasses have attracted a great attention as a next generation wearable device. However, its operation requires a special functional unit in the glasses, making it difficult to operate under certain environment. Here, we develop a smart photonic contact lens to control the function of smart glasses. This technology employs smart LED contact lenses and smart glasses that utilize eye movement and surrounding muscle activity to generate signals to enable the device control and simple communication. The integration of conductive frames into smart glasses enables communication and control with external devices, facilitating seamless interaction with a variety of systems. The eyeglass frames can wirelessly power LED contact lenses and monitor the wearer's eye movements.

This is facilitated by the integration of light sensors into the frames, which serve to detect variations in light intensity. The integration of micro-LEDs within the frame facilitates the control of discrete devices in accordance with predetermined commands. These commands are based on eye movements and blinks, thus ensuring seamless integration of technology and optics into everyday life. The photodetector systems integrated into eyeglass frames or placed externally can detect the user's activity and utilize stored gestures as commands to operate separate devices.

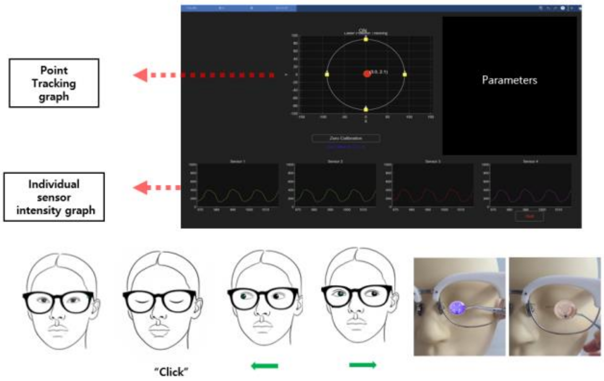

Figure 1. Human-Device interface via smart glasses with LED smart contact lens.

Substantial research has been conducted to establish connections between the real world and digital twins. The present study puts forward a methodology for human-computer interaction that employs smart contact lenses and glasses. It is evident that this system possesses the capacity to facilitate an auxiliary control environment, particularly for patients who are unable to use their hands or in circumstances or conditions that necessitate augmented eye control. It is evident that contemporary research endeavors will play a pivotal role in addressing the impending technical challenges and meeting the evolving demands of the contemporary era.

Thermally Conductive and Stable Organic PCM Composites Enabled by Segregated Filler Architectures

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Phase change materials (PCMs) can absorb and release heat during phase transitions without a change in temperature, making them attractive for thermal management applications. However, organic PCMs typically suffer from low thermal conductivity and leakage, which limit their practical use. In this work, we present a PCM composite incorporating a highly interconnected network of thermally conductive hexagonal boron nitride (h-BN) fillers to address these challenges. The composite is fabricated by blending h-BN with two immiscible organic PCMs in the molten state, forming a Pickering emulsion that solidifies upon cooling. This process induces the formation of a 2D segregated filler network that significantly enhances thermal conductivity (~20.2 W/m·K) and ensures structural stability even above the melting points of both PCMs. Compared to conventional single-PCM-based composites, the resulting material exhibits markedly improved heat transfer and thermal stability. This strategy offers a promising pathway for advancing the performance and reliability of PCM-based thermal regulation systems.

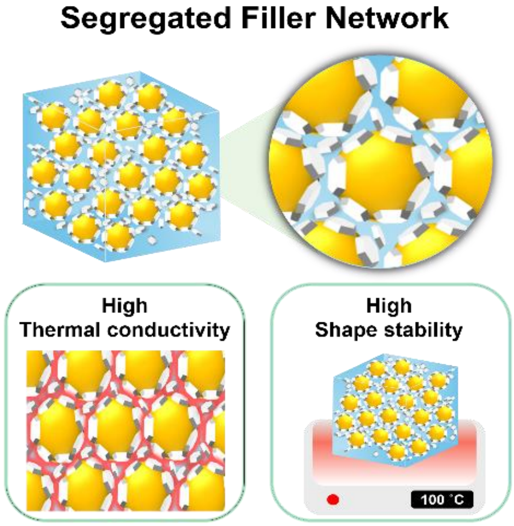

Figure 1. Schematic illustration of the segregated filler network in a Pickering emulsion-based composite, demonstrating enhanced thermal conductivity and improved leakage stability.

Composition-Controlled Network Formation in Reactive Polyacrylate Binders for High-Performance Silicon Anodes

Gihun Lee, Seungwoo Lee, Hyerin Kang, Suraj Aswale, Suk-kyun Ahn,* and Hyun-jong Paik*

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Lithium-ion batteries require high energy density for efficient energy storage. Silicon has attracted significant attention because it offers exceptionally high theoretical capacity compared with other anode materials. Yet the severe volume change of silicon during lithiation and delithiation causes structural degradation and rapid performance loss. Poly(acrylic acid) (PAA) is regarded as the standard binder for silicon electrodes, as its abundant carboxyl groups form strong hydrogen bonds with the silicon surface [1]. Nevertheless, PAA-based electrodes still fall short of the cycling stability required for practical application.

In this study we introduce a reactive polyacrylate binder that mitigates silicon volume expansion. The binder is prepared by uniformly blending PAA with a polyacrylate crosslinker (PAC) bearing blocked isocyanate groups. During thermal curing deblocked isocyanate reacts with PAA carboxyl groups to form a crosslinked network. Within this structure PAA maintains adhesion to silicon particles through hydrogen bonding, and PAC crosslinks increase mechanical strength and compliance. The elasticity of the binder is tuned by adjusting the PAC monomer ratio so the matrix can accommodate repeated expansion and contraction of silicon (see Figure 1). As a result electrodes with this binder show higher cycling stability and better rate capability than those using PAA alone. The synthesis is straightforward and the processing is scalable, highlighting strong potential for commercial implementation.

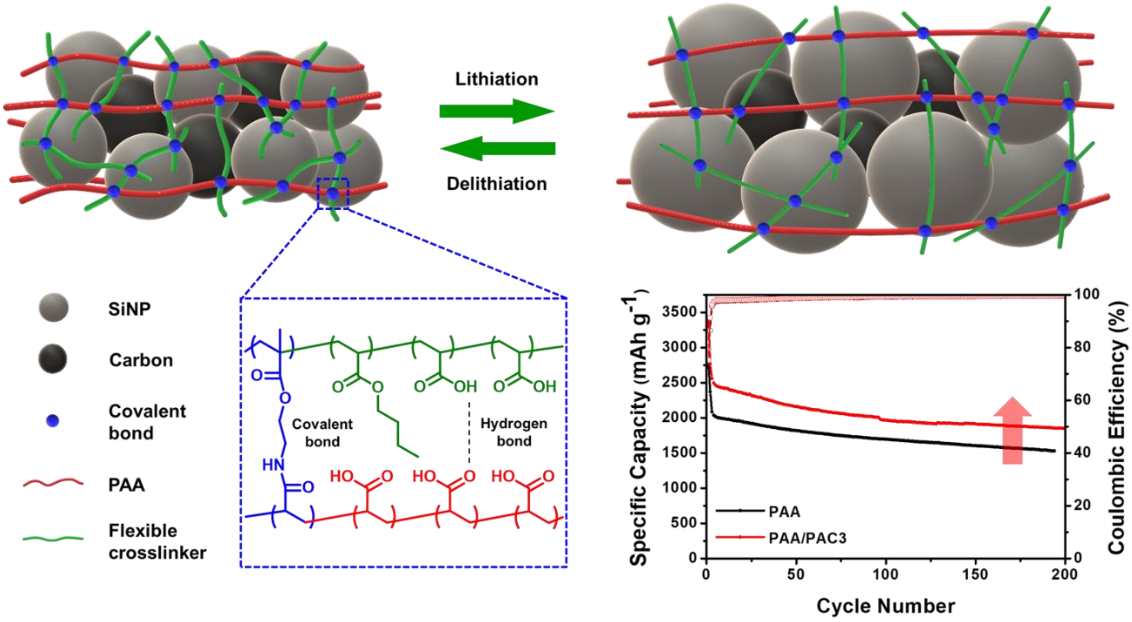

Figure 1. Schematic of crosslinked PAA/PAC binder accommodating silicon volume change

[1] A. Magasinski, B. Zdyrko, and I. Kovalenko, *ACS Applied Materials & Interfaces*, **2010**, 2, 3004.

Crystalline and Stable Hierarchical Porous Conjugated Organic Framework as an Ideal Platform for Electrosynthesis

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Fully π-conjugated organic frameworks (π-COFs) have attracted considerable attention due to their enhanced stability and conductivity compared to conventional covalent organic frameworks (COFs). Here, we report the synthesis of a crystalline and stable hierarchical porous π-COF (polyphthalocyanine, HPPc) and demonstrate its potential as an ideal electrosynthesis platform. The as-synthesized crystalline HPPc possess a high surface area (~324 m^2 g^{-1}), plentiful inherent microporous (1.4 nm), along with a hard-template-induced, uniform and interconnected mesoporous (35 nm). This dual-porosity design can lead to improved active site dispersion and mass diffusion. Moreover, the long-range ordering brought by high crystallinity enables the precise customization of active sites as needed. Anchored with nickel and cobalt atoms, the optimized catalyst exhibits an outstanding oxygen evolution reaction performance, including a competitive overpotential of 305 mV at 10 mA cm^{-2} and a low Tafel slope of 40 mV dec^{-1}, significantly surpassing the commercial RuO_2. This work opens a new avenue for the rational design and synthesis of chemically stable and crystalline hierarchical porous π-COFs for various applications.

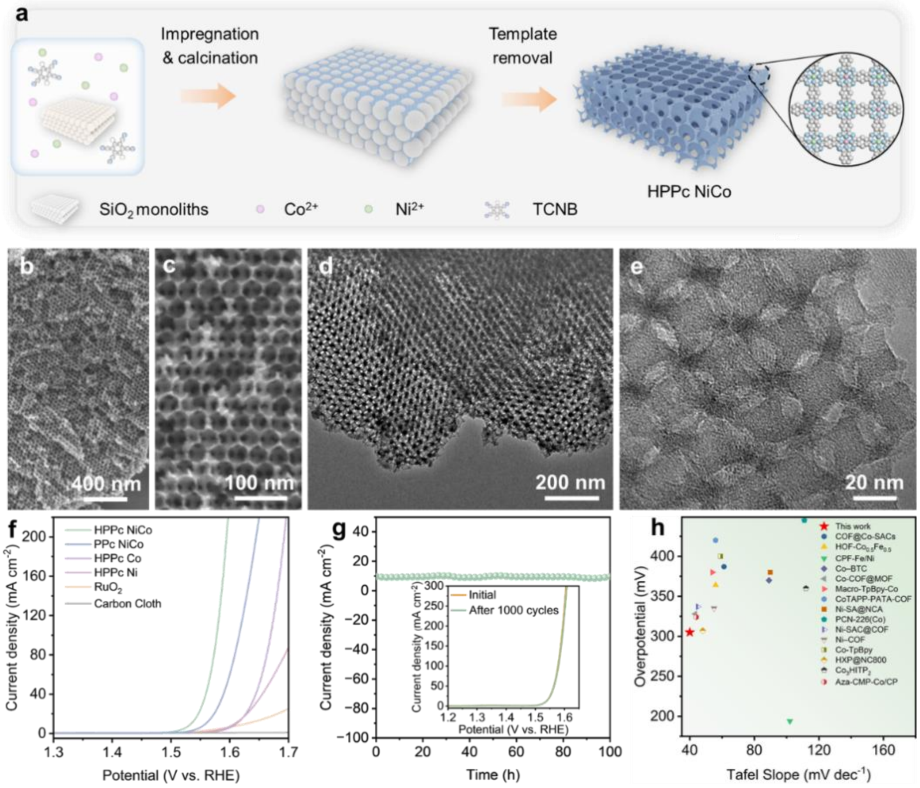

Figure 1. (a-e) Synthesis and characterizations of the HPPc NiCo, (f-h) Electrochemical OER performances of the HPPc NiCo [1].

[1] H. Wu, S. Yin, H. Zhang, H. Xu, Y. Luo, F. Li, and D. Zhao, *J. Am. Chem. Soc,* **2025**, *24*, 21089

Comprehensive Investigation of Anti-solvent Free Processed $CsPbI_2Br$ Perovskite Thin Films

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Developing reliable and scalable processing strategies is essential for advancing perovskite-based devices. In this study, we explore the anti-solvent free fabrication of $CsPbI_2Br$ perovskite thin films, where additive-assisted crystallization is introduced to overcome the limitations of conventional anti-solvent methods, such as poor reproducibility and limited compatibility with large area processing. Our results show that the additive effectively delays nucleation onset and promotes a gradual crystallization pathway, leading to highly ordered films with vertically aligned grains. These structural improvements are directly linked to enhanced charge transport, reduced defect density, and improved film stability, all of which are crucial for high performance photovoltaic operation.

By correlating processing conditions with crystallization behavior and material properties, this work demonstrates how chemical modulation enables precise control over film formation. Overall, our study highlights anti-solvent free processing as a promising and scalable route for producing high quality $CsPbI_2Br$ thin films, providing valuable guidance for bridging fundamental crystallization control with practical device performance in perovskite solar cells and enrgy-related optoelectronic applications.

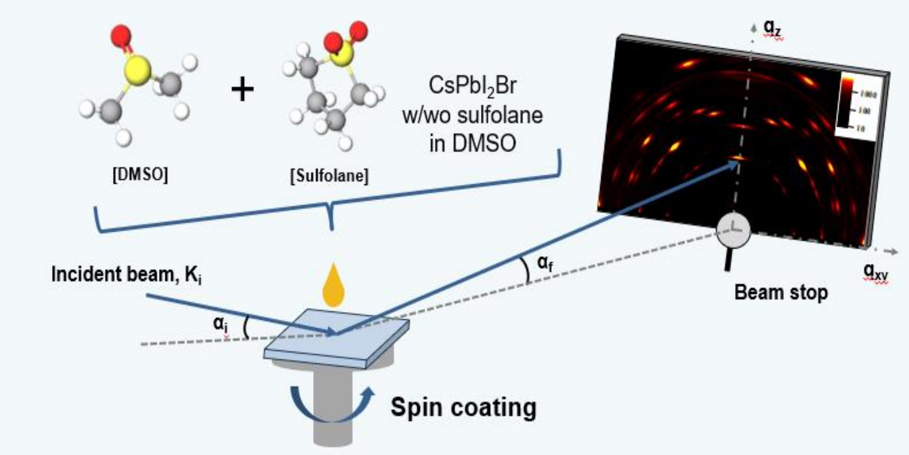

Figure 1. Schematic illustration of the in-situ GIWAXS method applied during perovskite spin coating, allowing real-time tracking of nucleation and crystallization behavior.

Transparent PEDOT:PSS/MXene Thin-Film Heater with Enhanced Conductivity and Joule Heating Efficiency via Trifluoroacetic Acid Treatment

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MXene is an emerging two-dimensional material for electronic and thermal applications, including heaters, owing to its exceptional electrical conductivity, mechanical robustness, and versatile surface chemistry. However, its intrinsic flake-like morphology hinders the fabrication of transparent, uniform thin films via simple techniques such as spin coating, and its conductivity deteriorates markedly as the film thickness decreases.

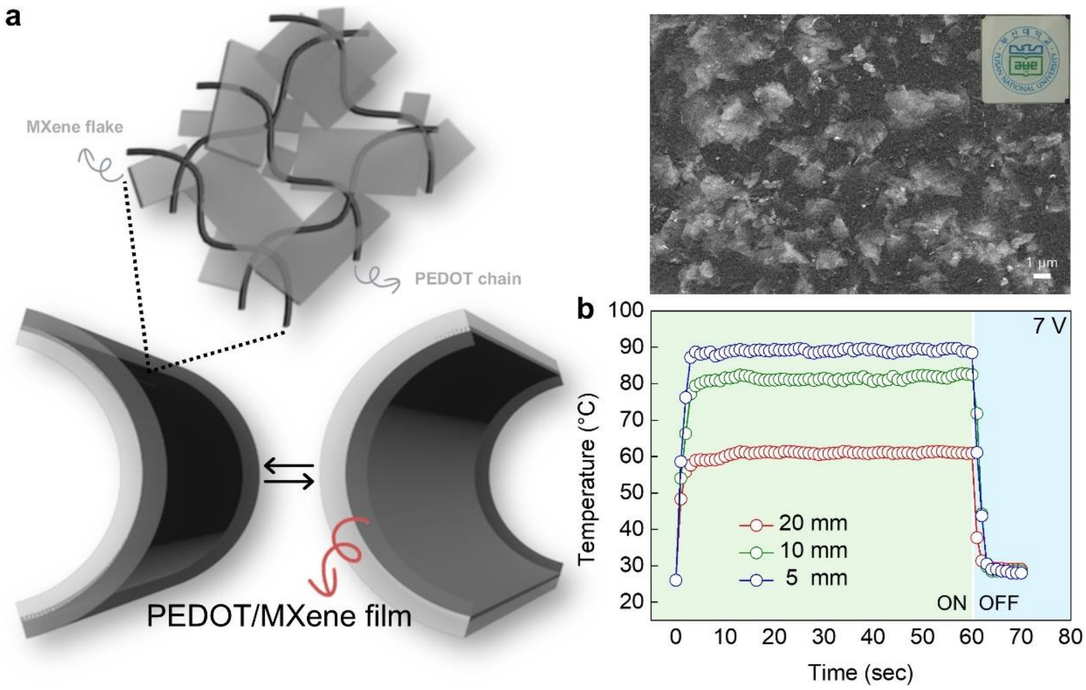

Figure 1. (a) Schematic illustration and SEM image of the PEDOT:PSS/MXene thin-film heater. (b) Joule heating performance of the PEDOT:PSS/MXene TFHs with different pattern widths.

In this study, we developed a transparent, uniform composite thin-film heater by blending MXene with PEDOT:PSS through a one-step spin-coating process. The polymeric PEDOT:PSS formed a percolation network with MXene, dramatically improving the surface coverage of MXene on the substrate. Subsequent trifluoroacetic acid treatment effectively doped the polymer chains, thereby enhancing their electrical conductivity. Moreover, micropatterning of the PEDOT:PSS/MXene film confined charge transport pathways, resulting in a substantial improvement in Joule heating efficiency. This strategy offers a facile and scalable route for high-performance transparent electrode heaters, expanding the application potential of MXene-based materials in advanced electronics and thermal management systems.

Stretchable MXene/Silver Nanowire (MXAg) Electrodes for Biophotonic Applications of Stretchable Light-Emitting Diodes

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Silver nanowires (AgNWs) have been widely recognized as promising candidates for stretchable electrodes in flexible electronics, offering a combination of high electrical conductivity, mechanical deformability, and optical transparency. These properties are critical for enabling next-generation technologies such as wearable sensors, soft displays, transparent touch panels, and biophotonic devices. Unlike conventional rigid metallic electrodes, which suffer from brittleness and limited tolerance to bending or stretching, AgNW networks can accommodate significant strain, thereby supporting the development of mechanically robust and soft electronics. However, despite these advantages, AgNW electrodes still face challenges including reduced mechanical durability and degradation of electrical or optical performance under repeated deformation, mainly due to nanowire breakage and percolation network failure.

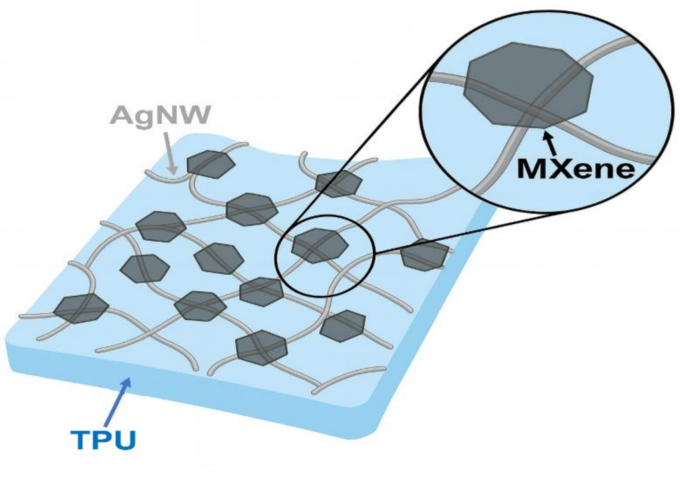

Figure 1. Schematic illustration of MXene-AgNW electrodes on Thermoplastic Polyurethane (TPU) substrate.

To overcome these limitations, MXenes a class of two-dimensional transition metal carbides, nitrides, and carbonitrides (e.g., Ti_3C_2) have emerged as attractive reinforcement materials. Owing to their intrinsic mechanical resilience, high conductivity, and structural stability under strain, MXenes can be integrated with AgNWs to form hybrid MXAg electrodes [1]. The layered MXene sheets act as stress-distributing matrices that protect nanowire junctions, suppress disintegration, and maintain electrical continuity during stretching. This synergistic combination significantly enhances the stretchability, durability, and stability of the electrodes, positioning MXAg hybrids as a highly effective platform for biophotonic applications, particularly in stretchable light-emitting diodes (LEDs).

[1] W. Jiang, S. Lee, and C. Park, *ACS Nano*, **2022**, *16*, 9203-9213.

Silica Nanoparticles with Second-Scale Room Temperature Phosphorescence and *in situ* Generated Carbonaceous Defects for Theranostic Applications

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Room-temperature phosphorescence (RTP) has tremendous potential in optics and bioimaging, providing extended acquisition times and a high signal-to-noise ratio under time-gated bioimaging. However, conventional RTP materials, both metal-containing and metal-free organic compounds, typically have limited photostability and inherent toxicity, making them unsuitable for long-term biological applications. Here, we report in situ formation of carbonaceous defects (CDs) within silica nanoparticles (SNPs), termed CD@SNPs, for second-scale RTP. Polycondensation of tetraethyl orthosilicate(TEOS) and (3-aminopropyl)triethoxysilane(APTES) enabled the formation of crosslinked SNPs, which created a pore structure within the silica matrix. Upon calcination, the carbon-related structures within the pores deformed, leading to the formation of CDs. Confined within a robust silica matrix, the molecular motion of the CDs were restricted, facilitating the generation of a stable triplet state and suppressing nonradiative decay, thus enabling prolonged phosphorescence emission. The research culminates in the synthesis of a hyaluronic acid hydrogel containing SNPs (HA-SNP), capable of encapsulating drugs such as lidocaine. As the HA-SNP complex reaches the targeted organ, it releases lidocaine while SNPs emit vibrant green RTP. With the added advantages of silica nanoparticles being inherently non-toxic and biocompatible, their potential applications extend to the field of biology, including cell imaging and drug delivery. [1].

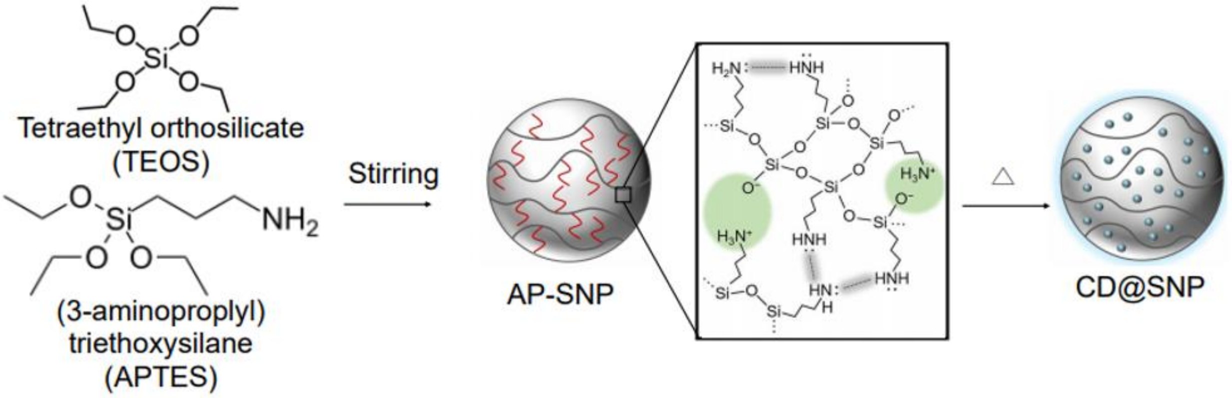

Figure 1. Synthesis scheme for silica nanoparticles with *in situ* generated carbonaceous defects.

[1] C. Han, S. Lee, K. Lee, H. Chang, H. Jo, S. Seo, H. Park, S. K. Hahn, Y. H. Kim, and W. Kwon, *ACS Applied Materials & Interfaces,* **2024** *16* (47), 65012-65023

Designing Phase-Change Thermal Interface Materials via Pickering Emulsions and Segregated Filler Networks in Covalent Adaptable Networks

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Efficient thermal management in electronic devices demands high-performance thermal interface materials (TIMs). However, conventional polymer-based TIMs often suffer from low thermal conductivity and poor structural integrity. Here, we present a composite TIM comprising a covalent adaptable network (CAN) and phase change materials (PCMs), integrated with a segregated network of hexagonal boron nitride (h-BN) fillers. The composite is fabricated via a Pickering emulsion approach, where h-BN selectively assembles on PCM droplet surfaces, followed by polymer matrix crosslinking. This results in a continuous h-BN network that enhances thermal conductivity and mechanical stability through the dynamic CAN matrix. Compared to conventional TIMs, the composite exhibits superior thermal conductivity, latent heat buffering, and recyclability. This strategy offers a promising pathway toward thermally efficient, mechanically robust, and sustainable TIMs for next-generation electronics.

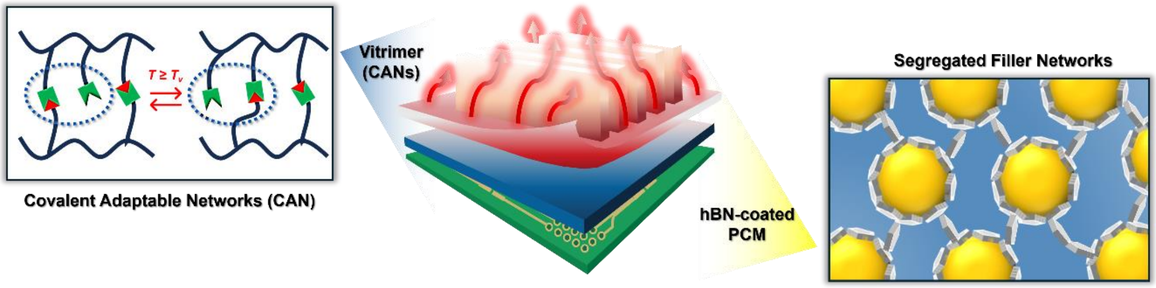

Figure 1. Schematic illustration of a high-performance thermal interface material (TIM) integrating PCM functionality, vitrimer-like adaptability, and thermal conductivity through the use of h-BN fillers and a Pickering emulsion-derived segregated network.

Electrostatic Covalent Organic Frameworks as On-Demand Molecular Traps for High-Energy Li Metal Battery Electrodes

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Regulating electrostatic interactions between charged molecules is crucial for enabling advanced batteries with electrochemical reliability. To address this issue, herein, we present a class of electrostatic covalent organic frameworks (COFs) as on-demand molecular traps for high-energy-density Li metal batteries (LMBs). A bipyridine-based COF and its quaternized derivative are synthesized and incorporated into $LiNi_{0.8}Co_{0.1}Mn_{0.1}O_2$ (NCM811) cathodes and Li metal protective layers, respectively. These COF molecular traps are effective in chelating transition metal ions dissolved from the cathodes, enhancing Li^+ desolvation, suppressing solvent decomposition, and immobilizing anions of electrolytes. The resulting LMB with the COF molecular traps fully utilizes the theoretical specific capacity of NCM811 at cathodes and allows stable Li plating/stripping at anodes. A pouch-type LMB full cell with the COF molecular traps provides high gravimetric/volumetric energy densities (466.7 Wh kg_{cell}^{-1}/1370.1 Wh L_{cell}^{-1}) under a constrained cell configuration, exceeding those of previously reported Li metal batteries based on porous crystalline frameworks.

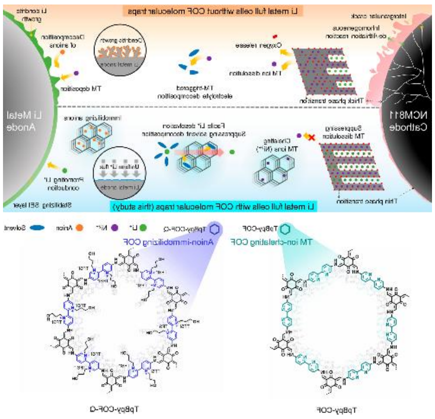

Figure 1. Advantageous Effects of On-Demand COF Molecular Traps on the LMB Electrodes, and the Chemical Structures of the β-Ketoenamine-Linked COF (TpBpy-COF) for the NCM811 Cathode and the Postquaternized TpBpy-COF (TpBpy-COF-Q) for the Li Metal Anode.

[1] Sejung Oh, Kyeong-seok Oh[2], Sang-Young Lee[*], *ACS Energy Lett.*,2023, 8, 2463−2474

Restructuring of Aqueous Electrolytes Using a Soft-acidic/Hard-basic Zwitterion for Low-temperature Anode-free Zn batteries

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Despite the growing interest in aqueous Zn batteries as a safe and low-cost alternative to commercial Li batteries, the use of aqueous electrolytes has limited their application at sub-zero temperatures, Here, we propose a new electrolyte design using zwitterions based on the Hard and Soft Acids and Bases principle to restructure aqueous electrolytes. Incorporation of a soft-acidic/hard-basic zwitterion into an aqueous electrolyte results in the disruption of hydrogen bonds of water molecules, weakening of Zn-OTf interactions, and destabilization of Zn solvation sheath. The resulting electrolyte enhances the anti-freezing phenomena with a solid-liquid transition temperature of −95 ℃ and the Zn desolvation kinetics. Consequently, the anode-free full cell with this electrolyte exhibits high energy and powder densities with stable cyclability at −40 ℃, which exceeded those of previously reported Zn batteries and are comparable to those of low-temperature Li-metal batteries

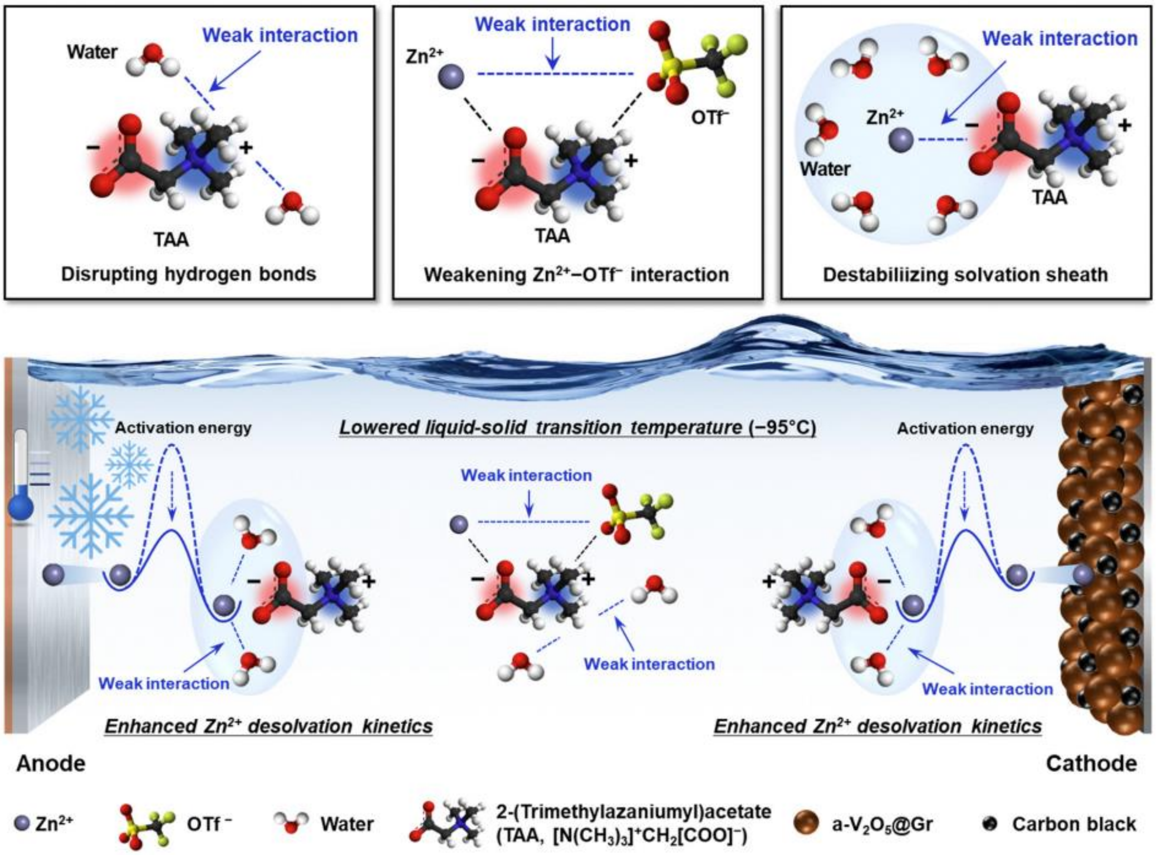

Figure 1. Schematic depicting the roles of soft-acidic/hard-basic TAA in enabling the low-temperature aqueous electrolytes.

Enhancement of Stretchable Ferroelectric Capacitors through Amine-Functionalized Graphene Oxide Additives

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Ferroelectric polymers such as PVDF-TrFE, PVDF-HFP, and PVDF-CFE are considered promising materials for stretchable capacitors and memory devices due to their flexibility and electroactive properties. However, their low remanent polarization (P_r) and the challenge of stabilizing the polar β-phase remain significant obstacles to optimizing ferroelectric performance.

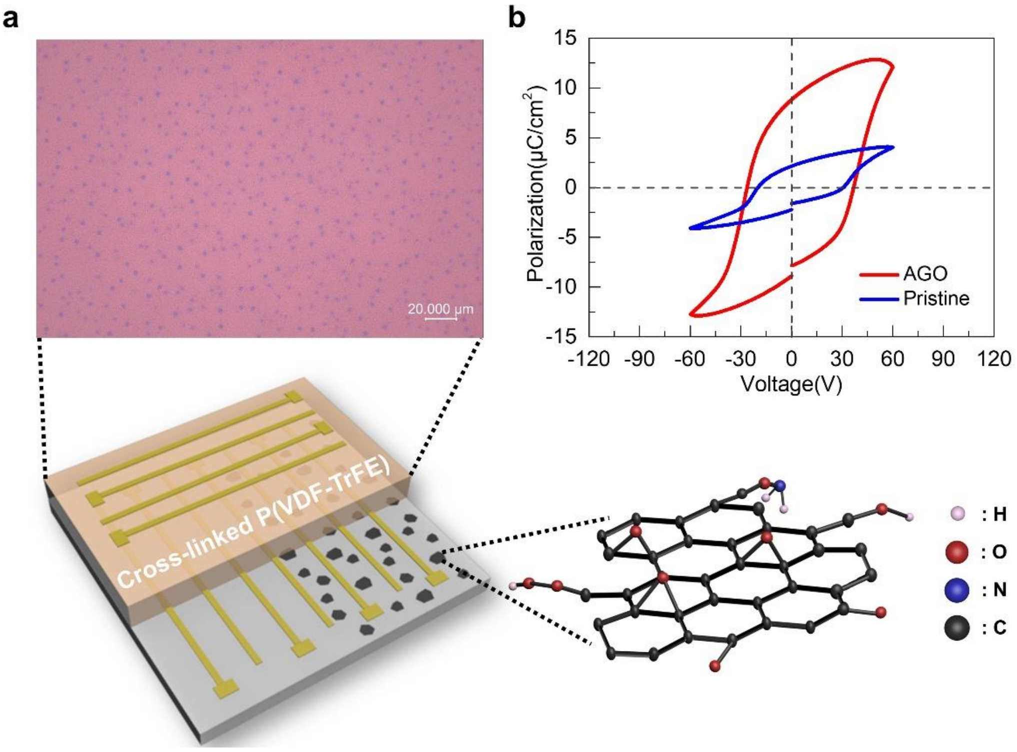

Figure 1. (a) Schematic illustration of the bilayer ferroelectric capacitor device. The optical micrograph (OM) of the cross-linked P(VDF-TrFE) and a molecular illustration of AGO are also shown. (b) Hysteresis loops of the device with AGO (Red line) compared to the device without AGO (Blue line).

In this study, a bilayer structure was engineered, where the top layer consisted of a P(VDF-TrFE)/PEG diamine blend, maintaining elasticity, and the bottom layer incorporated amine-functionalized graphene oxide (AGO). The AGO layer promoted dipole alignment and epitaxial crystallization, leading to enhanced interfacial interactions. This bilayer design greatly improved Pr by favoring better β-phase alignment and domain orientation, facilitated by AGO-induced epitaxy. This approach could be valuable in advancing the development of high-performance flexible ferroelectrics and wearable electronic devices.

Additive Engineering for Crystallization and Defect Passivation in Perovskite Solar Cells

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The incorporation of functional additives into organic–inorganic hybrid perovskite films provide an effective strategy to tailor their structural and optoelectronic properties. In this work, we examined the impact of introducing an additive directly into the perovskite precursor solution on film formation and defect passivation. Scanning electron microscopy revealed significantly enlarged grains with reduced boundary density, indicating suppressed nucleation and enhanced crystal growth. These morphological improvements were supported by X-ray diffraction and grazing-incidence wide-angle X-ray scattering analyses, which confirmed higher crystallinity and preferential vertical orientation. Photophysical studies, including steady-state and time-resolved photoluminescence, demonstrated reduced nonradiative recombination and lower trap densities. Enhanced optical absorbance across the visible spectrum further suggested improved crystallinity and light-harvesting efficiency. Overall, these results highlight the critical role of additive engineering in controlling crystal growth, suppressing defect states, and improving the intrinsic quality of perovskite films, offering valuable insights for the advancement of high-performance perovskite solar cells.

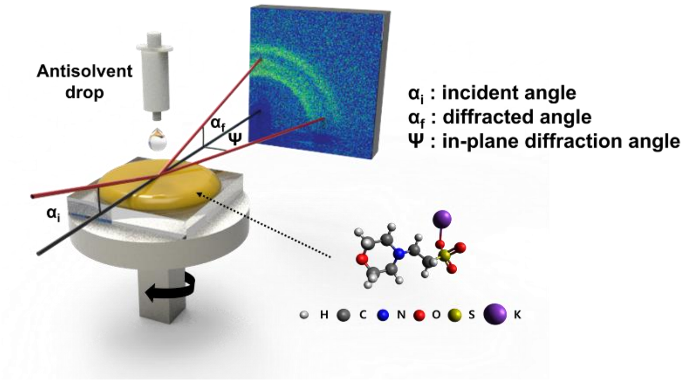

Figure 1. Schematic illustration of the in-situ GIWAXS measurement setup with additive-incorporated perovskite precursor solution.

Tuning Mechanical and Electrochemical Properties of ROMP-Derived Copolymer Binders for Silicon Anodes

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Silicon has emerged as a next-generation anode material for lithium-ion batteries due to its high theoretical capacity and potential for fast charging. However, its practical application is limited by significant volume changes during charge–discharge cycles, which compromise long-term stability. In this study, we synthesize a series of polynorbornene-based copolymer binders incorporating ethylene glycol and carboxylic acid functionalities with varying compositions via ring-opening metathesis polymerization (ROMP). The living nature of ROMP allows rapid synthesis of polymers with precise control over molecular weight and sequence. Interestingly, variations in molecular sequence (i.e., block vs. random) and composition in binders significantly influence the mechanical integrity and electrochemical performance of the silicon anodes. Our study highlights the importance of sequence and composition control in designing high-performance binders for silicon anodes.

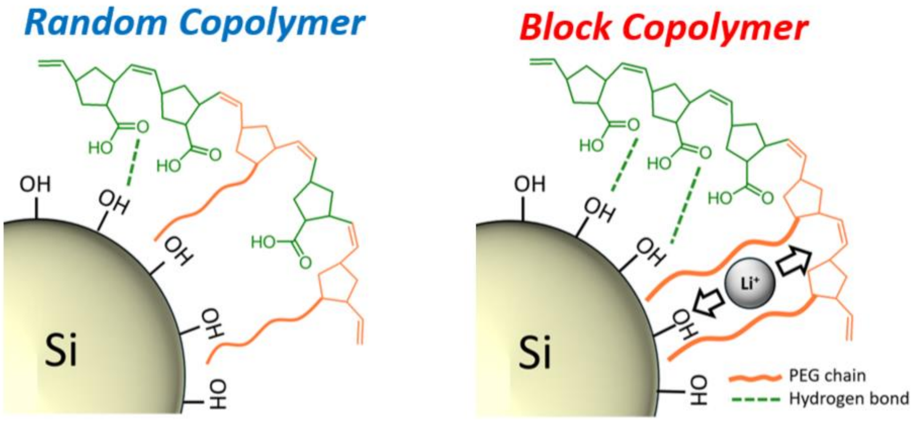

Figure 1. Schematic illustration of ROMP-derived random and block copolymer binder in Si anodes

Keyword: polymer binder, silicon anodes, lithium ion battery, polymerization

Additive Engineering Strategies for Commercial Perovskite Solar Cells Exhibiting Superior Moisture and Thermal Stability

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We investigated additive engineering strategies to enhance the stability of ambient air-processed, antisolvent-free perovskite solar cells, focusing on both moisture and thermal robustness. Perovskite thin films were fabricated via a vacuum-flash assisted antisolvent-free process, incorporating two representative additives: oleylamine (OAm), which acts as a surface-linking agent providing hydrophobic passivation of grain boundaries, and ammonium chloride (NH_4Cl), which is known to facilitate large grain growth. To elucidate their effects under thermal stress, we employed time-resolved in-situ grazing-incidence wide-angle X-ray scattering (GIWAXS), enabling direct observation of phase transitions and crystal orientation. Films treated solely with OAm exhibited vertically oriented (100) planes that improved resistance to moisture ingress, while NH_4Cl addition alone produced peak patterns similar to pristine films with reduced stability. Remarkably, the synergistic use of both OAm and NH_4Cl resulted in large-grain, preferentially oriented (100) perovskite crystals that exhibited significantly enhanced thermal stability. A P–i–N structure PSC incorporating the optimized $Cs_{0.175}FA_{0.75}MA_{0.075}Pb(I_{0.875}Br_{0.125})_3$ film achieved a power conversion efficiency of 19.3% under ambient processing conditions. These results demonstrate that rational additive engineering is essential for the development of commercially viable perovskite solar cells with improved moisture and thermal stability, and that X-ray scattering based real-time microstructural analysis serves as an effective strategy for evaluating such improvements.

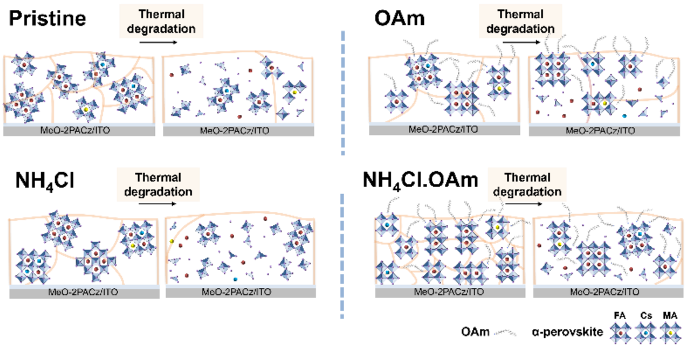

Figure 1. The film conditions scheme before and after thermal stress is applied for each of the three additive conditions.

Real-Time Observation of Perovskite Film Stability under Continuous Illumination and Bias

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The stability of perovskite films under operating conditions remains a key challenge for the advancement of perovskite solar cells. In this work, real-time structural analysis was performed to investigate the structural behavior of perovskite films exposed to continuous illumination and external bias. Distinct structural changes were observed during stress exposure, and these changes were systematically monitored. The results provide direct evidence of how external stress factors induce structural modifications in perovskite materials, offering valuable insight into the mechanisms that limit their long-term stability. This study provides fundamental insights into the structural responses of perovskite films under stress and suggests approaches for enhancing the long-term stability of perovskite solar cells.

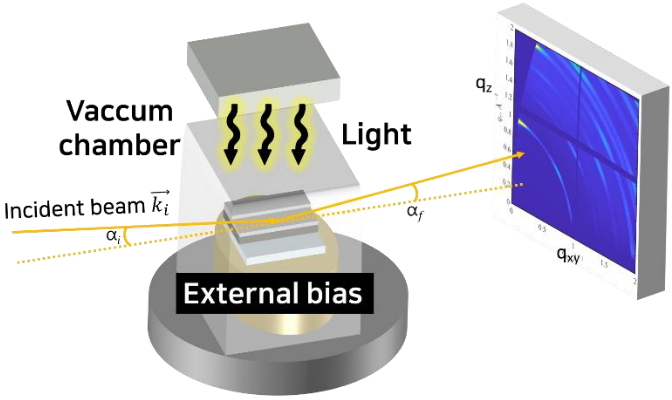

Figure 1. Scheme of the experimental setup for GIWAXS measurement of perovskite films under simultaneous illumination and electrical bias

Stepwise Self-Assembly of Multi-segment Mesoporous Silica Nanobamboos for Enhanced Thermal Insulation

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Imitating the multi-nodal structures of plants and arthropods, precisely engineered multi-segment nanostructures demonstrate enhanced synergistic properties and exceptional functionalities that surpass those of individual components. Utilizing micelle assemblies for constructing segments allows for precise structural control but requires management of interactions and assembly from molecular to mesoscopic levels, posing a significant challenge. In this paper, we present a stepwise self-assembly strategy to fabricate multi-segment mesoporous silica ($mSiO_2$) nanobamboos. The nanobamboos are characterized by 16-25 shuttle-shaped mesoporous segments connected end-to-end in line, forming the main chains with an overall length of approximately 0.7-1.0 µm. Due to multiple segments along with multilayer mesostructures, the nanobamboos can significantly restrict gas flow, resulting in a very low thermal conductivity (~ 41.67 $mW{\cdot}m^{-1}{\cdot}K^{-1}$). By blending the multi-segment $mSiO_2$ nanobamboos with cellulose nanofibers, mechanically stable, lightweight, porous aerogels with an ultra-low thermal conductivity (~ 19.85 $mW{\cdot}m^{-1}{\cdot}K^{-1}$) can be obtained, verifying their potential in thermal insulation devices. The fabrication of this multi-segment mesoporous nanobamboos enhances our understanding of micro-nano scale assembling, establishing a foundation for precise control of complex structures.

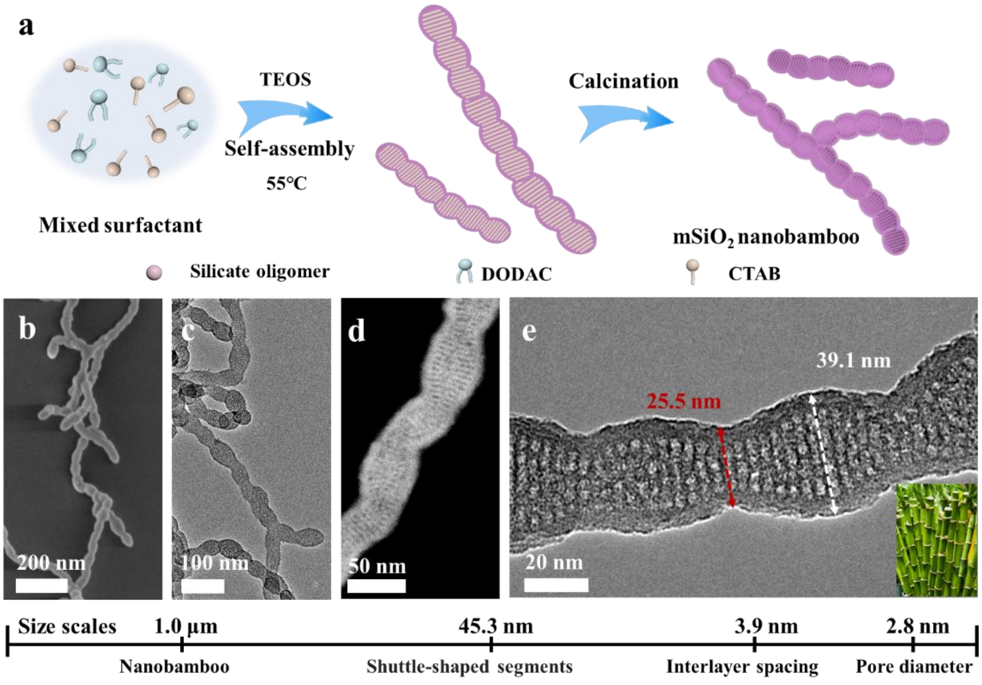

Figure 1. Synthesis and characterizations of the multi-segment $mSiO_2$ nanobamboos [1].

[1] Xirui Huang, Tingting Ren, Runfeng Lin, Zirui Lv, Sixing Yin, Yifei Xu, Yupu Liu, Chin-Te Hung, Min Wang, Xiaomin Li, Tiancong Zhao, and Dongyuan Zhao, *J. Am. Chem. Soc,* **2025**, *18*, 15890.

Dendrite-Free, Conformal Deposition of Lithium Metal on Electroactive Organic Materials

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Despite the enormous efforts to control the growth behavior of Li, achieving a dendrite-free Li deposition and high-energy-density have remained an inevitable challenge of Li metal batteries. Here, the conformal deposition of Li metal is reported on electroactive organic materials to achieve a high-energy-density and electrochemical longevity. To this end, $Li_2C_8H_4O_4$ (Li_2TP), which can act as both the electrode material (providing the redox capacity) and Li host (inducing the dendrite-free Li deposition), is used as the model electroactive organic material. The Li_2TP host exhibits reversible sequential lithiation/delithiation and Li deposition/stripping reactions. Consequently, a Li-free full cell constructed by the Li_2TP host (without pre-charging) and a $LiFePO_4$ cathode delivered a high areal capacity (≈3.8 mAh cm^{-2}), exceptional rate performance (≤12 mA cm^{-2}), and superior cyclability (80% capacity retention after 100 cycles). This electroactive organic material-based Li host strategy can provide a new perspective for the development of practical Li metal batteries.

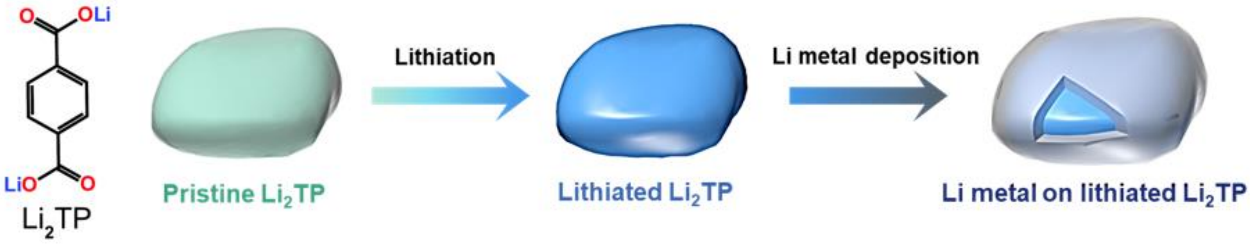

Figure 1. Schematic illustration of the conformal deposition of Li metal on the lithiated Li2TP.

Environmentally Friendly Processing Of Trichloroethylene On Ni-M (M = Mo, W, Pd) Catalysts Into Carbon Nanofibers For Further Application

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Currently, carbon nanofibers (CNFs) are highly demanded objects of scientific researches. Most of the articles demonstrate their high strength, large specific surface area and porosity, and good electrical and thermal conductivity [1]. To date, composite materials (concrete products, polymers, etc.), sorbents, catalysts, and carriers have already been developed on the basis of CNFs [2].

In this work, carbon nanofibers were obtained through the catalytic decomposition of trichloroethylene (C_2HCl_3, TCE) on bulk nickel and its alloys (Ni-Mo, Ni-W, Ni-Pd). The selection of a modifying metal in certain cases significantly enhances the activity of nickel and its resistance to deactivation. It has been shown that the introduction of Mo/W into the nickel-based alloy increases the catalyst's yield of carbon products during the decomposition of 1,2-dichloroethane by 1.5 to 2 times [3].

The choice of raw materials for the production of carbon nanofibers is not random. Chlorinated aliphatic compounds (including TCE) are toxic wastes that are generated in huge amounts during the production of vinyl chloride, allyl chloride, and others. However, the approach presented in this work (Fig. 1) will allow the conversion of multicomponent mixtures of chlorine-containing waste into valuable carbon material and hydrochloric acid, which can be returned to the production cycle.

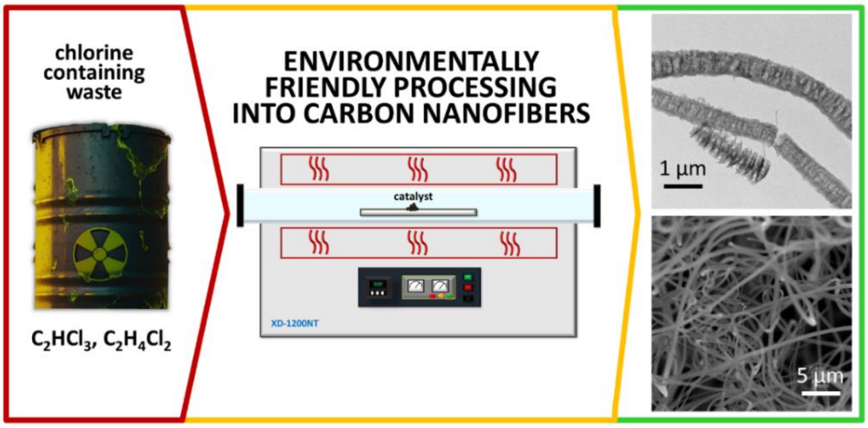

Figure 1. A recycling scheme of chlorine-containing waste through catalytic pyrolysis to obtain CNFs.

In this work, the features of forming various types of carbon nanofibers obtained by the pyrolysis of C_2HCl_3 on Ni-M catalysts (M=Mo, W, Pd) will be discussed. The results of physicochemical analysis methods (TEM, SEM, XPS) and the textural characteristics of the carbon products will also be presented. In addition, potential areas of application for the synthesized carbon products as sorbent-catalysts will be discussed.

This study was supported by the Russian Science Foundation (project #22-13-00406-П, https://rscf.ru/en/project/22-13-00406/).

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[2] D. Yadav, F. Amini, A. Ehrmann, *Eur. Polym. J.*, **2020**, *138*, 109963.
[3] Y.I. Bauman, Y.V. Shorstkaya, I.V. Mishakov etc, *Catalysis Today*, **2017**, *293*, 23.

P-NIPAM-based Hydrogel for Sustainable Separation of Miscible Liquids

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An azeotrope is a mixture of fluids that maintains a constant boiling point and composition during simple distillation. Separating azeotropes is critical in various fields, such as chemical and pharmaceutical engineering, to produce high-purity products and recover valuable substances. Current technologies, such as pressure swing distillation and pervaporation, are complex, energy-intensive, and often require additional purification step. To our knowledge, there are no materials or technologies capable of separating azeotropes at ambient conditions without altering the environment or adding chemicals. We have demonstrated that P-NIPAM-based hydrogel can separate polar-non-polar azeotrope (e.g., ethanol-n-heptane) at ambient conditions with separation efficiency of > 99.9% by selectively absorbing ethanol while repelling n-heptane. This can be attributed to the interplay of interfacial energy, absorbency, and intermolecular interactions between the hydrogel and contacting liquid. We envision that our hydrogel has the potential to replace current energy-intensive separation technologies.

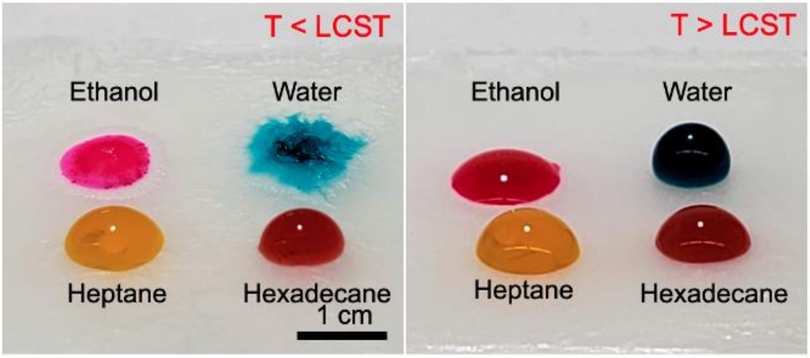

Figure 1. Photographs of the hydrogel below its LCST (left) and above its LCST (right). Polar liquids are absorbed while non-polar liquids are no at T < LCST, whereas all liquids are repelled by the hydrogel at T > LCST.

TiO_2 Nanohelices Decorated with Homogeneous Au-Core Pd-Shell Nanocatalysts for Selective Toluene Gas Detection

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The precise decoration of bimetallic nanocrystals (NCs) with uniform size and homogeneous composition on metal oxide (MOX) surfaces is crucial for developing highly sensitive and selective MOX-based gas sensors. In this study, MOX-based gas sensors are present decorated with homogeneous Au-Pd bimetallic (Au@Pd) NCs synthesized via seed-mediated sequential reduction of Au and Pd on an array of TiO_2 nanohelices (NHs) matrix. Due to the uniform composition, size, and dispersion of the bimetallic NCs, the sensor exhibits outstanding toluene (C_7H_8) sensing performance. The optimized Au@Pd NC composition (Au:Pd = 55:45) facilitates chemisorbed oxygen spillover and electronic sensitization, achieving an exceptionally high response (R_a/R_g) of ≈130 000 and rapid response/recovery (69 s/4 s) toward 100 ppm of C_7H_8 at 200 °C. Furthermore, the homogeneity of Au@Pd NCs enhances selectivity by providing controlled active sites, yielding a 1008-fold higher response to toluene compared to acetone. Density functional theory calculations and mechanistic experiments reveal that Au@Pd NCs generate toluene-selective catalytic sites that enable complete oxidation. The findings demonstrate that homogeneous core-shell bimetallic NCs can be uniformly integrated on a highly porous MOXs-based gas sensing matrix, enabling exceptional selectivity and sensitivity for advanced gas sensor applications [1].

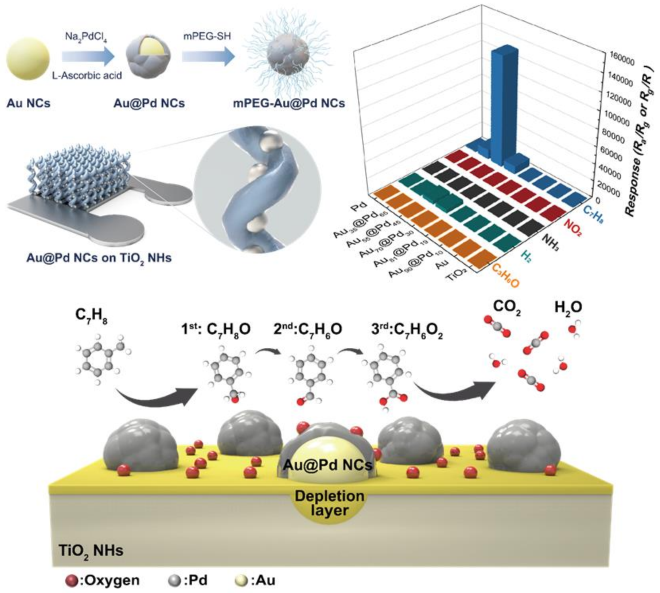

Figure 1. Schematic illustration of fabrication procedure and reaction mechanism, and gas sensing performance of Au@Pd NCs decorated TiO_2 NHs.

[1] H. Hwang, H. Bae, E. Ahn, D. Lee, H. H. Cho, S. Cheong, T. Y. Kim, J. Kim, Y. Yun, D. Lee, S. K. Hahn and J. K. Kim, *Small*, **2025**, 21, 2504976.

Impact of Carbonate Content in CO2-Based Polyols on the Properties of Thermoplastic Polyurethanes

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Carbon dioxide (CO_2) is attractive feedstock for polymer synthesis because it is inexpensive, non-flammable and non-toxic gas. CO_2 can be copolymerized with various epoxides to produce polyols using a double metal cyanide (DMC) catalyst. In this study, CO_2-based polyols with varying carbonate contents (0–50 wt%) were synthesized and employed as precursors for the preparation of thermoplastic polyurethanes (TPUs). The mechanical, thermal, and water absorption properties of the resulting TPUs were systematically investigated. As the carbonate content in the polyols increased, both viscosity and glass transition temperature (Tg) also increased. Notably, the TPU derived from the polyol with 50 wt% carbonate content exhibited the highest tensile strength (9.6 MPa) and superior water resistance. These results demonstrate that tuning the carbonate content in CO_2-based polyols offers an effective strategy for tailoring the thermal, mechanical, and water-resistance properties of TPUs.

Eco-Friendly UV-Curable Acrylic Adhesives with Selective Cleavability Using Lipoic Acid-Derived Crosslinkers

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Polymers containing lipoic acid (LA), a 1,2-dithiolane ring, have gained attention for applications in self-healing coatings, sustainable adhesives, and dynamic polymer networks [1]. LA polymerizes via disulfide ring opening, enabling reversible bonding through disulfide exchange. In this study, BDLA, synthesized by esterifying LA with 1,4-butanediol (BDO), was used as a ring opening at both ends photocrosslinker for acrylic prepolymers, enabling reversible polymerization and degradation. Disulfide bond cleavage was performed by both reductive cleavage using a reducing agent and thermal cleavage by heating in DMF. GPC was used to analyze the evaluation of molecular weight changes after disulfide bond cleavage. Mechanical properties such as peel strength, strain-stress curve were measured using a universal testing machine (UTM). Thermal stability and transitions were assessed through TGA, DSC, and DMA to evaluate the performance of LA-based dynamic adhesive materials.

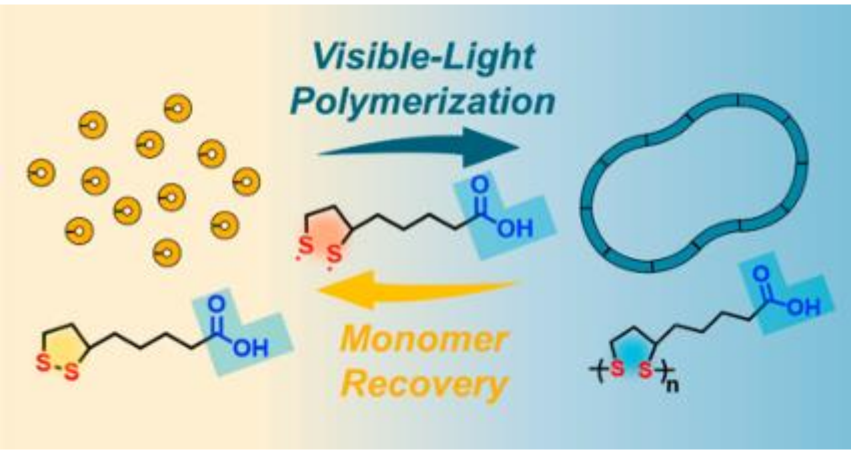

Figure 1. Molecular structure and schematic representation of the photoinduced ring-opening polymerization of Lipoic acid.

[1] C. Y. Shi, Q. Zhang, B. S. Wang, M. Chen, and D. H. Qu, *Interfaces*, **2021**, *13*, 44860.

3D Printable Photocurable Dental Composites Based on Catechol-Functionalized Acrylic Polymers

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Mussel-inspired catechol polymers attract attention with strong interfacial interactions via hydrogen bonding, enabling diverse applications, including the biomedical industry. 3,4-Dihydroxyphenylalanine (DOPA) with catechol moieties was reacted with methacrylic anhydride to synthesize a polymerizable monomer. Dopamine methylacrylamide (DMA) was characterized using FT-IR, ^{1}H-NMR, and ^{13}C-NMR spectroscopies. It was mixed with ethoxylated bis-GMA (EBPDMA) in various compositions to 3D print using the DLP technique. The synthesized DMA was copolymerized with MMA (methyl methacrylate) to be applied to bone cement. It was copolymerized with acrylic acid and 2-hydroxyethyl methacrylate (2-HEMA) to formulate glass ionomer cement for dental restorative applications, and characterized through GPC, FT-IR, and ^{1}H-NMR spectroscopies. The specimens with various ratios were used to measure mechanical properties such as compressive and flexural strengths.

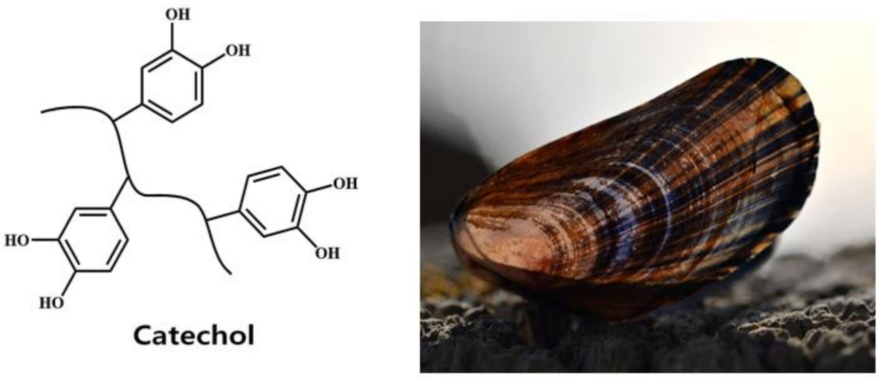

Figure 1. Catechol in mussel foot protein.

Synthesis of Solution-Processable Borosiloxane Networks as Advanced Flame-Retardant Platform

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With increasing demands for fire safety in electronics, aerospace, and energy storage applications, the development of advanced flame-retardant materials has become critically important. Borosiloxane networks containing Si-O-B linkages have attracted significant attention for their potential thermal stability advantages over conventional siloxane systems. Incorporating boron into silicon-oxygen frameworks enables the formation of denser, more stable char layers during thermal decomposition[1]. However, the synthesis of well-defined borosiloxane networks with controlled architecture and solution processability remains challenging.

This study presents a systematic approach to synthesizing solution-processable nano-borosiloxane networks through carefully designed sol-gel chemistry[2]. The synthesis strategy involves controlled condensation reactions between functionalized organo-silanes and boronic acid derivatives, enabling the formation of hybrid Si-O-B networks with tailored molecular architecture. Key synthetic parameters including reaction temperature, catalyst selection, and monomer ratios were optimized to achieve high conversion efficiency and network uniformity. The resulting nanoresin exhibits excellent solution processability, allowing for facile film formation through casting and subsequent thermal and UV curing processes.

Comprehensive structural characterization was conducted using FT-IR spectroscopy to confirm Si-O-B bond formation, ^{29}Si and ^{11}B NMR spectroscopy for detailed network analysis, and GPC for molecular weight distribution. The influence of different organo-silane chain lengths and boronic acid substituents on network architecture on processability and thermal properties was systematically investigated by using rheometry and thermogravimetric analysis.

Rheological measurements and multinuclear NMR analysis (^{29}Si and ^{11}B NMR) confirmed successful hybrid network formation and provided insights into the overall structural characteristics of the borosiloxane networks. Based on the controlled Si-O-B network architecture achieved through this synthetic approach, we anticipate significantly enhanced thermal stability and increased char yield compared to conventional siloxane systems.

These findings establish a robust synthetic methodology for producing solution-processable borosiloxane networks with tunable architecture. The synthesized materials are expected to demonstrate superior thermal performance, offering promising potential for advanced flame-retardant coating applications in high-temperature environments.

[1] G. D. Soraru, N. Dallabona, C. Gervais, and F. Babonneau, Chem.Mater., **1999**, 11, 910
[2] J.-S. Kim, S. Yang, H. Park, and B.-S. Bae, *Chem. Commun.*, **2011**, *47*, 6051.

Recyclable Thermoset Polyurethane Foams with Dynamic *β*-Amino Ester Networks for Thermal Insulation Applications

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Thermoset polyurethane foams (PUFs) are widely used for insulation and structural applications due to their mechanical robustness and low thermal conductivity. However, their permanently crosslinked networks hinder recyclability, posing challenges for environmental sustainability. In this study, a PUF was synthesized from isocyanates and acrylate-functionalized polyols, yielding a highly porous structure (50–200 μm pore size) with excellent thermal insulation performance, achieving a thermal conductivity of 0.0254 W/m·K. To overcome the recyclability limitations of conventional thermosets, *β*-amino ester functionalities were introduced via post-synthetic surface amine treatment. This modification enables dynamic covalent bonding within the foam network, allowing for hydrolytic degradation at 95 °C in 24 hours and reprocessability without requiring additional catalysts. This approach provides a promising pathway toward recyclable and sustainable thermoset foams for advanced insulation applications.

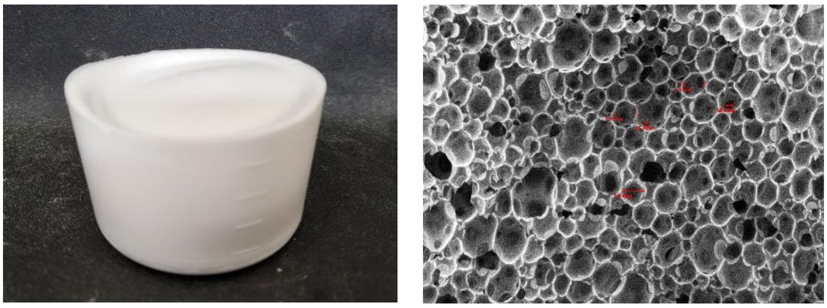

Figure 1. Schematic of polyurethane foam preparation via the blowing method and SEM image showing the resulting porous microstructure.

Lubricant-Infused Metallic Glass Nanotube Arrays for Enhanced Slippery and Icephobic Surfaces

Man Yun Hsu[1], Helmi Son Haji[1] , Ting Hao Chang[1] , Jhen De You[2], Jinn P. Chu [1] , Pakman Yiu[2 3*]

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[2] *Department of Materials Engineering, Ming Chi University of Technology, New Taipei City, Taiwan (Times New Roman 10 pt Italic, centered)*

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We present a novel slippery liquid-infused porous surface (SLIPS) design based on metallic glass nanotube arrays (MeNTA) fabricated by photolithography and multilayer thin film deposition. The nanotube arrays consist of Zr-Cu-Al-Ni and W-Ni-B thin film metallic glasses arranged in precise periodicity and controlled aspect ratios, enabling systematic evaluation of substrate geometry on SLIPS performance [1]. Perfluoropolyether (PFPE) lubricants with viscosities of 82, 522, and 1535 cSt were infused into MeNTA structures to form a continuous lubricant layer. The infused MeNTA-SLIPS exhibited water sliding angles lower than 2° and contact angles of approximately 100°, significantly outperforming bare MeNTA surfaces where water droplets were pinned (>90° sliding angle) [1]. Mechanical durability tests revealed that high-viscosity lubricants (GPL105 and GPL107) provided enhanced oil retention under high shear rates, maintaining excellent slipperiness up to 3000 rpm spin speeds. Icephobic testing demonstrated delayed freezing times and stable anti-icing performance for 24 freeze–thaw cycles before noticeable degradation, with low-aspect-ratio nanotube arrays exhibiting reduced structural damage during repeated ice removal[1]. These results indicate that both lubricant viscosity and nanotube array geometry critically influence SLIPS durability and icephobic performance. This study provides a cost-effective fabrication route using conventional UV lithography and highlights the potential for scalable deployment of metallic-glass-based SLIPS in applications requiring long-term anti-icing and water-repellent properties.

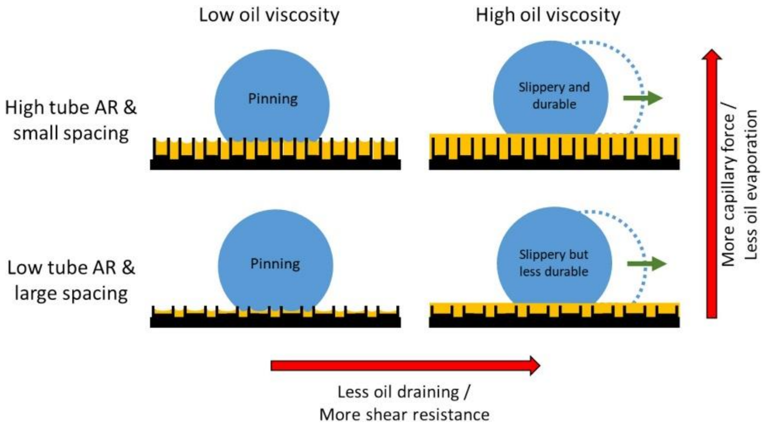

Figure 1. A schematic summary on how MeNTA dimensions and choice of lubricant contribute to the resultant SLIPS performance in this study [1].

[1] Helmi Son Haji, Ting Hao Chang, Jhen De You, Jinn P. Chu, Pakman Yiu, Applied Surface Science, 2025, 690, 162565.

Non-Fluorinated Long Alkyl Acrylates for Water Repellent

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Although widely used fluorine-based water repellents, perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS), have the advantages of excellent in water repellency, chemical stability, and maintenance of the original properties of fibers, their use are limited due to non-biodegradation and toxicity to human body. In this study, a non-fluorinated water repellent was synthesized through an emulsion polymerization process using nonionic and cationic emulsifiers, and stearyl acrylate, as a long-chain alkyl acrylate, in the presence of alkysiloxane resin in order to maximize water repellent effect. The synthesized water repellent was applied to a fiber substrate, dried and coated to evaluate the water repellency and surface properties through the contact angle measurement and AATCC 22 water repellency test.

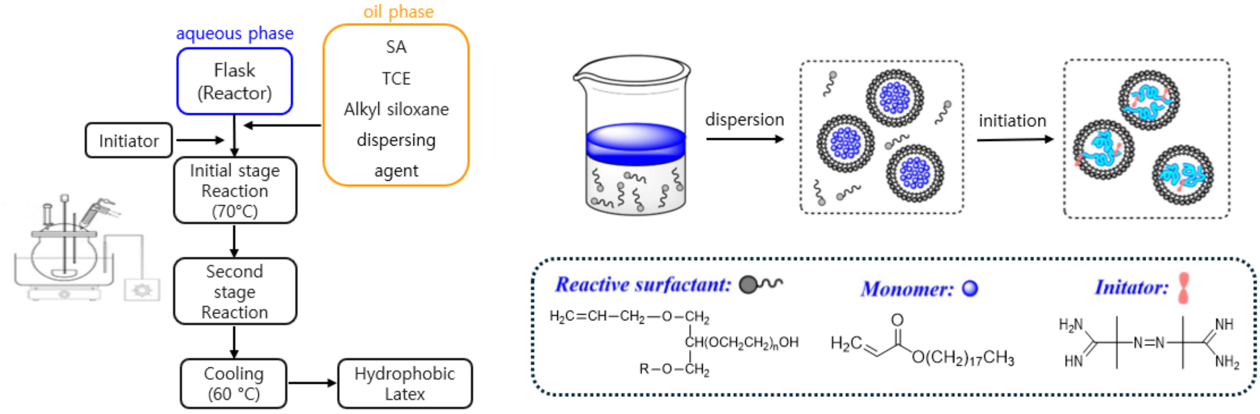

Figure 1. Schematic illustration of a two-stage emulsion polymerization for synthesizing non-fluorinated water repellent.

Upcycling Polyolefin Waste into Reprocessable Adhesives via Covalent Adaptable Networks

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Polyethylene (PE) production continues to increase, and PE constitutes a substantial fraction of global plastic waste. As the world moves toward a circular economy, developing high-value upcycling strategies for these commodity polymers is becoming increasingly important. Here, we propose a covalent adaptable network (CAN)–based adhesive system that exploits dynamic crosslinking by first introducing functional groups into waste PE and then incorporating a dynamic crosslinker. The dynamic bonding—mediated by the crosslinker—occurs between the installed functional groups and hydroxyl groups present on metal surfaces, enabling strong and reversible adhesion to metal substrates. The adhesive can be readily fabricated through a simple two-step process: (i) functionalization of waste PE and (ii) incorporation of the dynamic crosslinker. During functionalization, the loading was optimized to prevent unintended permanent crosslinking, and the formation of dynamic crosslinks was confirmed after mixing with the crosslinker. Because crystalline domains generally diminish wettability in adhesives, the crystallinity of each sample was compared. Adhesion performance, evaluated by lap-shear testing, showed that the dynamically crosslinked sample achieved the highest lap-shear strength. Overall, this system demonstrates the feasibility of upcycling polyolefin waste into a functional adhesive with tunable bonding performance, providing a sustainable route for plastic-waste valorization.

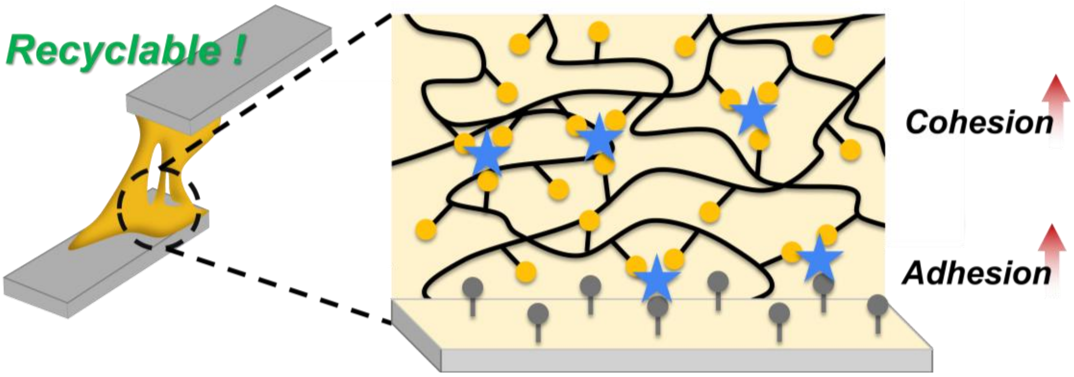

Figure 1. Schematic illustration of an upcycled polyolefin-based CAN adhesive utilizing dynamic bonds.

Synthesis and Intrinsic Anti-Ultraviolet Performance Regulation of Biobased Polythioethers

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The depeletion of the ozone layer, with increasing ultraviolet (UV) radiation may threat the ecological environment and human health, and accelerate the aging process of polymer materials. To address these issues, the development of high-performance anti-UV material is of great significance. In pursuit of sustainability and to reduce reliance on fossil resources, we focus on the preparation of high-performance anti-UV polymers through various polymerization methods using biobased monomers.[1,2] Here, we report high-molecular-weight polythioethers with excellent intrinsic anti-UV performance were prepared by anion ring-opening polymerization (AROP) of episulfides derived from the biobased epoxides containing a substituted phenyl group.[3] They possessed high M_n of 48.5-104.5 kDa and T_g ranging from 6-45 °C. In addition, the cross-linked copolythioethers with enhanced mechanical properties, good reprocessability, and the anti-UV performance were improved by the cross-linking reaction of the poly(hydroxyl thioether) segment with a long-chain isocyanate. the results exhibited an excellent tensile strength of 14.3-19.1 MPa, the elongation at break ranged from 430 to 730%, and the UPF value was between 47.9 and 91.8. The representative cross-linked copolythioether **P(MVPT-*co-p*HMPT)-PU** film was colorless and transparent with outstanding intrinsic anti-UV performance, and can be used in the appliacation of lenses film. Furthermore, the cross-linked copolythioether has better resilience, reduced hysteresis loss, and relatively stable resistance to UV aging, which made it possible for better durability and service life. This work provided an effective strategy for obtaining functional polythioether with high molecular weight from renewable resources to optical materials.

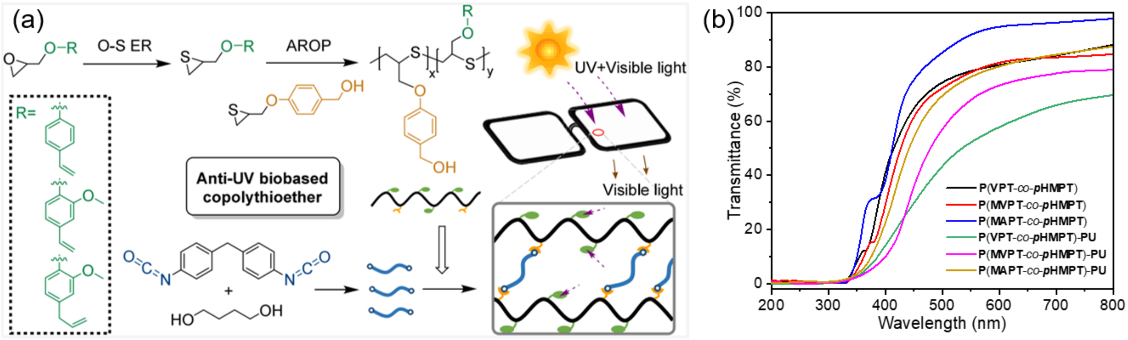

Figure 1. Synthesis of anti-UV polythioether (a); UV light transmittance curves of modified polythioether films (b).[3]

[1] Q.B. Wang, Q.C. Liu and M.R. Xie. Macromolecules, **2024**, 57, 5849-5859.
[2] Q.B. Wang, X.J. Liao and M.R. Xie. Polym. Chem., **2024**, 15, 4852-4863.
[3] Q.B. Wang, X.J. Liao and M.R. Xie. *Macromolecules*, **2025**, 58, 4769-4779.

Multifunctional Waterborne Anti-Icing Coatings Using a Polarity-Switchable Maleic Anhydride Copolymer

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[4] *Research Institute for Convergence of Biomedical Science and Technology, Pusan National University Yangsan Hospital, Yangsan 50612, Republic of Korea*
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Global environmental concerns have driven efforts to reduce the use of toxic and volatile organic solvents in polymer coatings. While water is an eco-friendly alternative, it mainly works with hydrophilic polymers, which often lack durability in humid environments. To address this, a polarity-switchable copolymer containing maleic anhydride (MA) was developed. Base-induced ring opening of MA introduces hydrophilicity for waterborne coating formulation, followed by thermal ring closure that restores hydrophobicity for long-term stability. When applied to rough surfaces, the coating adopts a Cassie–Baxter wetting state, enhancing superhydrophobicity and reducing ice adhesion. Incorporating graphene oxide improves hardness, thermal stability, and photothermal properties, enabling faster ice removal under sunlight. This multifunctional and sustainable polymer coating offers a promising solution for passive anti-icing applications on large-scale outdoor surfaces.

Figure 1. Schematic illustration of the ring-opening and ring-closing reactions of maleic anhydride (MA) units in the polarity-switchable MA-based copolymer

Sustainable TPU Designed from CO_2-Derived Carbonate Polylols with Tunable Functionality

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While thermoplastic polyurethanes (TPUs) are becoming increasingly important due to their unique combination of flexibility, durability, and recyclability, traditional TPUs are often synthesized from fossil-based raw materials. In this work, we present a series of TPUs synthesized using CO_2-derived polycarbonate polyols comprising allyl functional groups. The presence of reactive allyl groups in the polyols not only enables tuning of the thermal and mechanical properties of the resulting TPUs, but also provides opportunities for post-polymerization modification, such as thiol–ene click reactions.

By carefully adjusting the allyl content in the polyols and converting them into carboxylic groups through post-polymerization modification, we achieved a broad range of thermal, mechanical, and adhesive properties of the resulting TPUs.

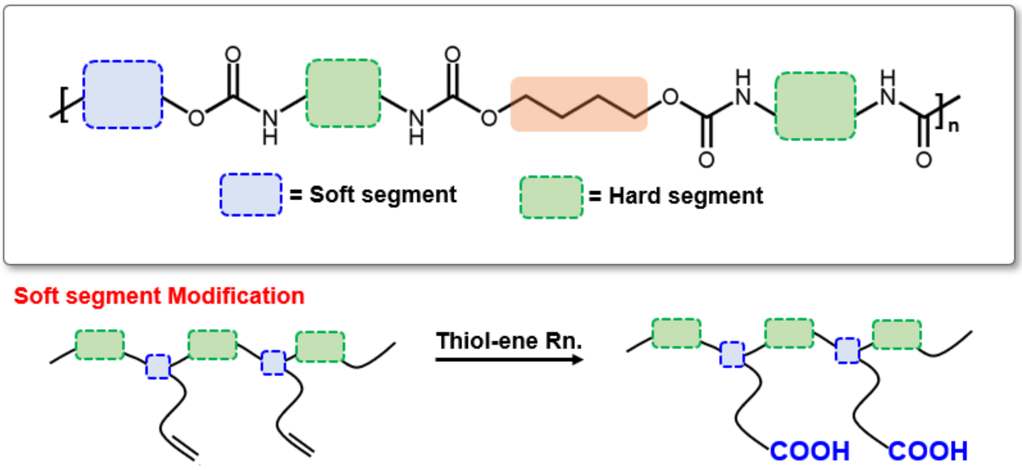

Figure 1. Schematic of CO_2- derived polycarbonate TPU with allyl-functionalized soft segments, modified to carboxylic acid groups via thiol–ene click reaction.

[1] K. Deng *et al.*, *ACS Appl. Mater. Interfaces*, 2023, 15, 6546.

Water-Coatable Acrylonitrile–Maleic Anhydride Copolymers for Eco-Friendly Carbon Fiber Precursors and Flame-Retardant Coatings

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[3] *Research Institute for Convergence of Biomedical Science and Technology, Pusan National University Yangsan Hospital, Yangsan 50612, Republic of Korea*
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Polyacrylonitrile (PAN) is a widely used precursor for carbon fibers due to its excellent mechanical and thermal properties. However, its conventional wet spinning process relies heavily on organic solvents, raising environmental and economic concerns. In this study, we developed an acrylonitrile–maleic anhydride (AN–MA) copolymer by incorporating maleic anhydride (MA) into the PAN backbone. Upon base treatment, the MA units undergo ring-opening reactions, rendering the copolymer soluble in eco-friendly solvents such as water and ethanol. This enables the fabrication of carbon fiber precursors without the use of hazardous organic solvents. In addition to its application in fiber processing, the AN–MA copolymer functions as a sustainable flame-retardant coating. When applied via spray or dip coating using water/ethanol solutions, followed by thermal treatment, the polymer undergoes PAN cyclization and char formation, providing effective flame retardancy. This work presents a dual-purpose material strategy for environmentally friendly carbon fiber production and flame-retardant coatings.

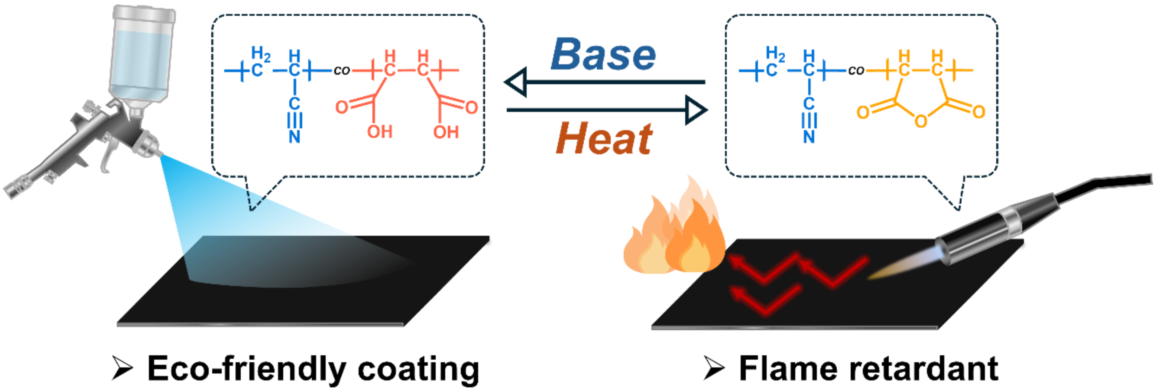

Figure 1. Schematic illustration of the eco-friendly coating process and flame-retardant functionality of the AN–MA copolymer.

Two-Component Binder System of Water Glass and Starch for Iron Ore Pelletization

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Since iron ore fines reduce the reaction efficiency, their pelletization has prompted the creation of binders that are eco-friendly, sustainable, and provide lower energy consumption. Traditionally, bentonite has been utilized as a binder, but it consumes more energy during the processing and contributes to poorer pellet quality by adding unwanted gangue materials. An innovative binder system made up of two components, namely water glass (sodium silicate) and starch, has been developed to overcome these limitations. Water glass has a fast process for gelating and, biodegradable starch is considered green strength and also improve mechanical strength, making it suitable for sustainable processing. A dual binder system has been developed to enhance the strength of pellets while also minimizing environmental impact. This is an ideal combination of both mechanisms. The compressive strength of pellets bonded to water glass alone and starch water glass combination was tested in a series of experiments. Also, to understand the impact of starch on drying kinetics and green strength development, we examined water evaporation behavior at room temperature as well as 50 °C. These results demonstrate the water glass–starch binder system could replace bentonite, but it will need further refinement to improve its performance for industrial use.

Comparative Study of Drug Encapsulation and Release Kinetics in MOF-808 and ZIF-8

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Skin diseases affect approximately 30% of the global population, representing a major public health concern. To address this challenge, researchers are developing advanced treatment strategies that rely on innovative technologies. A key scientific hurdle lies in designing efficient "nanocontainers" capable of high drug loading, controlled release, and targeted skin penetration. Recent progress has highlighted the potential of metal-organic framework (MOF)-polymer composites for epidermal and transdermal drug delivery, owing to their exceptional drug-loading capacity and efficient delivery to skin layers. Understanding the release kinetics of bioactive molecules from these composites, along with their diffusion mechanisms in skin models, is therefore critical for biomedical applications.

In this study, we investigated the sorption of nitroxyl radicals—serving as model drug molecules—onto MOF-808 and ZIF-8 particles. Using electron paramagnetic resonance (EPR) spectroscopy, we confirmed successful drug loading and identified the carboxyl group as essential for chemical binding between the molecules and MOF-808. By varying radical concentrations, we achieved precise control over drug loading within the framework. Subsequent experiments analyzed the release profiles of drug@MOF-808 and drug@ZIF-8 complexes in water, establishing stable plateaus at targeted concentrations.

We further explored the release kinetics of antifungal agents, ibuprofen, and nitroxyl radicals from MOF-808 embedded in hydrogel matrices for transdermal and epidermal applications. EPR spectroscopy and spectrophotometry were employed to monitor release dynamics, while the effects of hydrogel composition and stimulating agents (e.g., phosphates, organic acids) on release patterns were systematically evaluated.

This work was supported by the Russian Science Foundation (No. 24-43-10002).

Sensitivity Control by Material Design and Structure Engineering for Organic Transistor Sensors - *Reactive Oxygen Species*

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[2]School of Semiconductor Convergence Engineering, Kyungpook National University, Daegu 41566, Republic of Korea

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Reactive oxygen species (ROS) remain relatively underexplored for easy sensing applications with electronic devices, despite their pivotal role in triggering diseases (cancer, Alzheimer's, and diabetes) and aging-related disorders. Because our daily environment on this planet is getting worse in terms of air quality and hard work, reliable and sensitive monitoring of ROS is crucial for preventing oxidative stress–induced cellular dysfunction. Although several detection methods for ROS have been developed so far, most systems based on magnetic resonance and optical spectroscopy are huge and limited in mobility for real-time sensing. Hence, we have introduced organic field-effect transistor (OFET)-based biosensors, which can be fabricated with a micron-sized sensing area and are capable of amplifying sensing signals due to their three-terminal architectures. In particular, organic sensing layers could be designed in various ways and coated using solution processes. The recently developed ROS-OFET sensors exhibited outstanding sensing capability, promising the eventual goal of compact, portable, rapid on-site analysis. In this work, we present a material design strategy that enables tunable ROS sensitivity through material structure engineering, achieving a detection limit of sub-nanomole range.

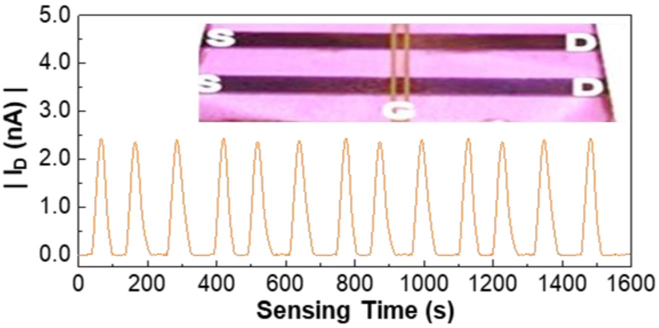

Figure 1. Sensing result by employing the present ROS-OFET sensors with a structure-engineered sensing layer.

[1] C. Lee, J. Jeong, H. Kim, and Y. Kim, *J. Hazard.Mater,*, **374**, 159 (2019).
[2] B. Kim, H. Kim, and Y. Kim, *in preparation* (2025).

3D Printed PDRN/GelMA Bioink for Muscle Tissue Engineering

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Volumetric muscle loss (VML) remains a major therapeutic hurdle due to the insufficient regenerative ability of current grafting strategies. Three-dimensional (3D) bioprinting provides a powerful platform to address this limitation, yet the development of bioinks capable of simultaneously maintaining construct fidelity and stimulating myogenesis is still required. In this study, we designed a novel bioink enriched with polydeoxyribonucleotide (PDRN), a DNA-derived agent with established anti-inflammatory and tissue-repairing functions. To enhance its bioactivity, single-stranded DNA (ssDNA) fragments from PDRN were conjugated with hyaluronic acid (HA), forming a stable ssDNA@HA hybrid complex. This complex was integrated into a gelatin methacryloyl (GelMA) matrix to generate printable muscle constructs. Encapsulation of C2C12 myoblasts within ssDNA@HA-GelMA scaffolds resulted in robust cell survival, enhanced proliferative activity, and significant upregulation of myogenic differentiation markers in vitro. Collectively, these findings demonstrate the potential of ssDNA-based hybrid bioinks as a versatile tool for fabricating functional muscle tissues and suggest a promising avenue for treating VML through advanced bioprinting strategies.

Wound Management with Zinc Ion-Releasing Gelatin-Based Bioadhesives

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Traditional wound dressings, such as gauze and film, have been widely used to protect and close wound areas [1]. However, they often face challenges, such as weak adhesion, incomplete hemostasis, and poor adaptability to irregular surfaces. Bioactive adhesive hydrogels have potential in wound healing because they seal wounds and actively promote tissue regeneration [2]. Among the various strategies, incorporating bioactive inorganic ions, particularly zinc ions (Zn^{2+}), attracts increasing attention because of their crucial roles in hemostasis, immunomodulation, cell proliferation, angiogenesis, and collagen remodeling [3]. Herein, Zn^{2+}-releasing adhesive hydrogels are developed via ZnO_2-mediated disulfide bonding, Zn^{2+}-thiol metal coordination, and thiol-ene reactions between thiolated and maleimide-conjugated gelatin (Figure 1). These hydrogels exhibit tunable gelation time (11–21 s), mechanical strength (520–810 Pa), and enzymatic degradation behavior depending on the ZnO2 concentration. They also provide sustained Zn^{2+} and H_2O_2 release for up to 21 days. Notably, the hydrogels show strong adhesion (142–165 kPa), outperforming fibrin glue, and adhere to various tissue surfaces. In vivo, Zn^{2+}-releasing hydrogels significantly enhance wound healing by improving hemostasis, anti-inflammatory effects, angiogenesis, and tissue remodeling. The results suggest that these hydrogels have substantial potential as multifunctional wound adhesives for effective wound management.

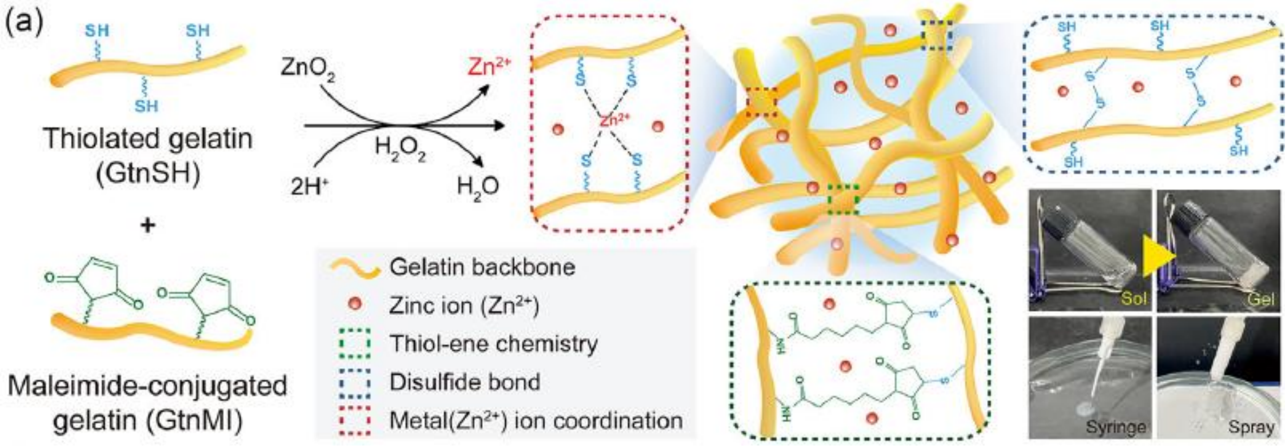

Figure 1. Schematic representation of hydrogel formation and digital images of the sol–gel phase transition, injection of syringe, and spray.

[1] A. Bal-Ozturk, B. Cecen, M. Avci-Adali, S. N. Topkaya, E. Alarcin, G. Yasayan, Y.-C. E. Li, B. Bulkurcuoglu, A. Akpek, and H. Avci, *Nano Today*, **2021**, *36*, 101049.
[2] Z. Zheng, X. Chen, Y. Wang, P. Wen, Q. Duan, P. Zhang, L. Shan, Z. Ni, Y. Feng, and Y. Xue, *Adv. Mater.*, **2024**, *36*, 2408538.
[3] E. Degtyar, M. J. Harrington, Y. Politi, and P. Fratzl, *Angew. Chem., Int. Ed.*, **2014**, *4*, 419.

Synthesis and Characterization of L-Tyrosine Polyester (LPE) for Drug Delivery Vehicle

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L-Tyrosine, a naturally occurring amino acid containing both amino and carboxylic functional groups, is a promising candidate for biomedical materials due to its high biocompatibility and functionality. In this study, a novel L-tyrosine-based polyester (LPE) was synthesized to serve as a biodegradable carrier for therapeutic agents. The polyester backbone was constructed via esterification between desaminotyrosyl tyrosine hexyl ester (DTH) [1], as a diol which was pre-synthesized from L-tyrosine and 1-hexanol, and succinic acid, as a biocompatible dicarboxylic acid. All the synthetic processes were confirmed by ^{1}H-NMR, ^{13}C-NMR and FT-IR spectroscopies, and the molecular weight of the polyester was characterized by GPC. In the future, we plan to use water-in-oil-in-water double emulsion technology to fabricate nanoparticles having drugs or genes.

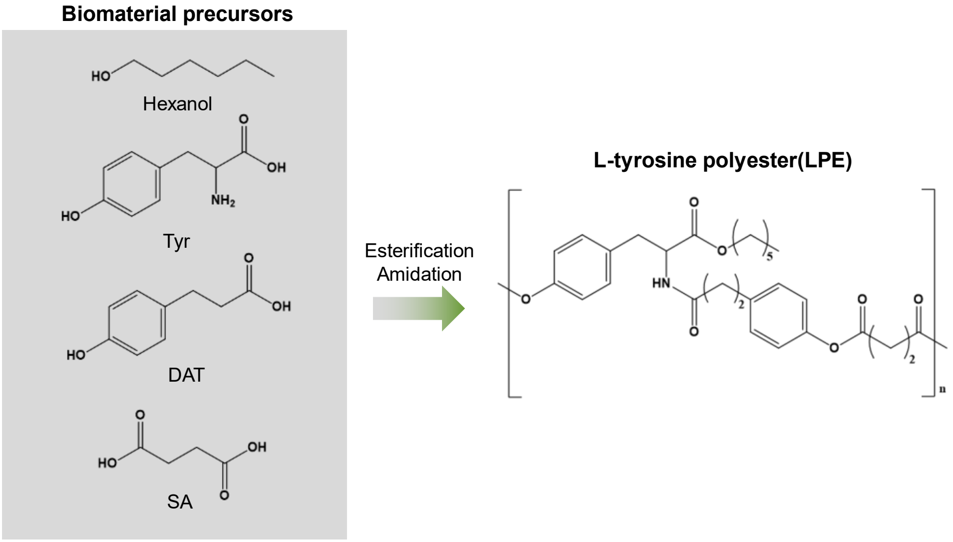

Figure 1. Schematic of synthesizing L-tyrosine polyester (LPE).

[1] S. Oh, S.Y. Park, H.I. Seo, and I. Chung, *Pharmaceutics*, **2025**, *17(1)*, 28.

3D Printable PEKK-based Dental Resins Incorporating Multifunctional Groups with Improved Mechanical Properties

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Poly(ether ketone ketone) (PEKK) is notable for its excellent thermal stability, mechanical strength, and versatile chemistry [1] due to two ketone groups. In this study, a GDMA end-capped PEKK oligomer (CAEKK-GDMA) was synthesized by reacting carboxylic acid-terminated PEKK oligomer (CAEKK) with glycerol dimethacrylate (GDMA). The tetra-functionality of GDMA increases enhancing the mechanical properties cross-linking density, of the resulting polymer network. The structure of CAEKK-GDMA was confirmed by FT-IR, ^{1}H-NMR, and GPC analyses. Various blends of CAEKK-GDMA and Bisphenol A ethoxylate dimethacrylate (EBPDMA) were photopolymerized using a DLP 3D printer. Mechanical testing demonstrated improved compressive and flexural strengths compared to neat resins. These results suggest that incorporating GDMA's four functional groups facilitates a tightly cross-linked network, significantly improving the mechanical performance of 3D-printed dental resins.

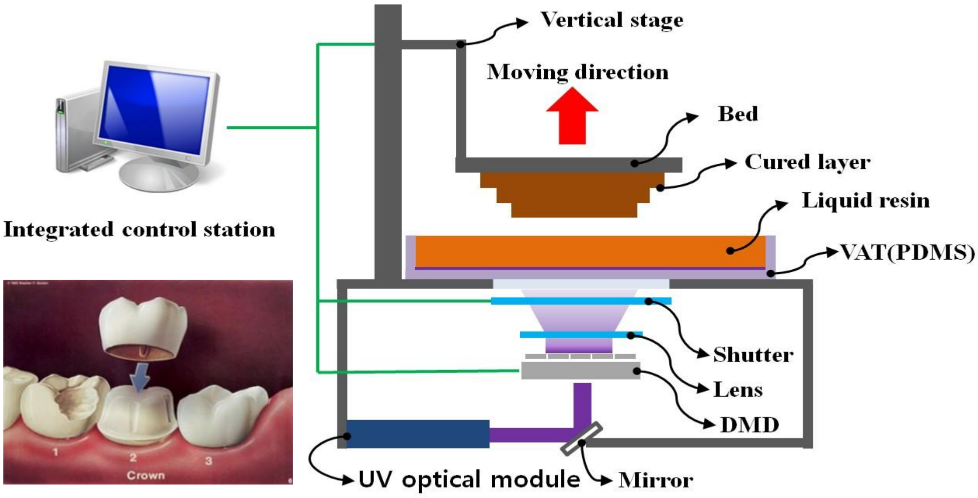

Figure 1. Schematic of DLP-based 3D printing process for dental crown fabrication.

[1] Y. Sakaguchi, K. Kimura, M. Omori, and Y. Yamashita, *Polymer*, **2002**, *34*, 219.

Poly(ether ketone ketone)-Based Hybrid Resins for Dental 3D Printing

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Poly aryl ether ketones (PAEKs) has now gradually become the leading polymer material in the fields of biomedical polymer, due to its good biocompatibility and high thermal, mechanical properties. Among PAEKs, PEKK has advantages such as higher thermal stability, better mechanical properties, versatile chemistry due to two ketone bonds compared to other PAEKs [1]. We focused on poly(ether ketone ketone) based oligomer to improve the mechanical properties of dental resin. In this study, HEMA-terminated poly(ether ketone ketone) oligomer (CAEKK-HEMA) was synthesized using carboxylic acid-terminated poly(ether ketone ketone) oligomer(CA-EKK) and 2-Hydroxyethyl methacrylate(HEMA) and characterized by FT-IR, ^{1}H-NMR, and GPC. To investigate mechanical properties, the mixture of CAEKK-HEMA and ethoxylated bis-GMA(EBPDMA) with various ratios were photopolymerized by DLP 3D printer and their mechanical properties such as compressive and flexural strength were measured.

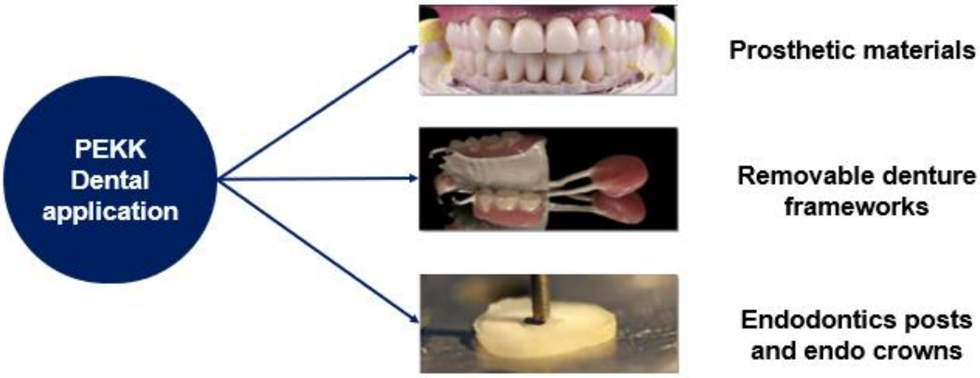

Figure 1. PEKK applications in dentistry: prosthetic Materials, removable denture frame-works, and endodontic restorations.

[1] Wei, L., G. Wang, and M. Cai, *Polymer International*, **2021**, *70(8)*, 1048.

Synthesis and Characterization of Biocompatible and Biodegradable L-Lysine Polyurethane (LPU) Nanoparticles for Use in Drug Delivery

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L-Lysine polyurethane (LPU) was designed to obtain biodegradable biomaterial for matrix of drug delivery using PLA-PEG-PLA triblock oligomer as a soft segment, 1,6-hexamethylene diisocyanate (HMDI) as a hard segment and L-lysine ethyl ester (LEE) as a chain extender, and used to fabricate its nanoparticles by using water-in-oil-in-water double emulsion technique for encapsulating anticancer drugs such as 5-fluorouracil (5-FU). PLA-PEG-PLA was synthesized by ring opening polymerization of lactide onto PEG core using stannous octoate as a catalyst. LEE was synthesized by esterification of L-lysine with ethanol using thionyl chloride as a catalyst. The structure and composition were confirmed by 1H-NMR, 13C-NMR, FT-IR spectroscopies, and molecular weights were characterized by GPC analysis. Nanoparticle morphology was analyzed by DLS, FE-SEM, and TEM. Drug encapsulation was visualized by confocal microscopy, and loading and encapsulation efficiencies were measured by UV/Vis spectroscopy.

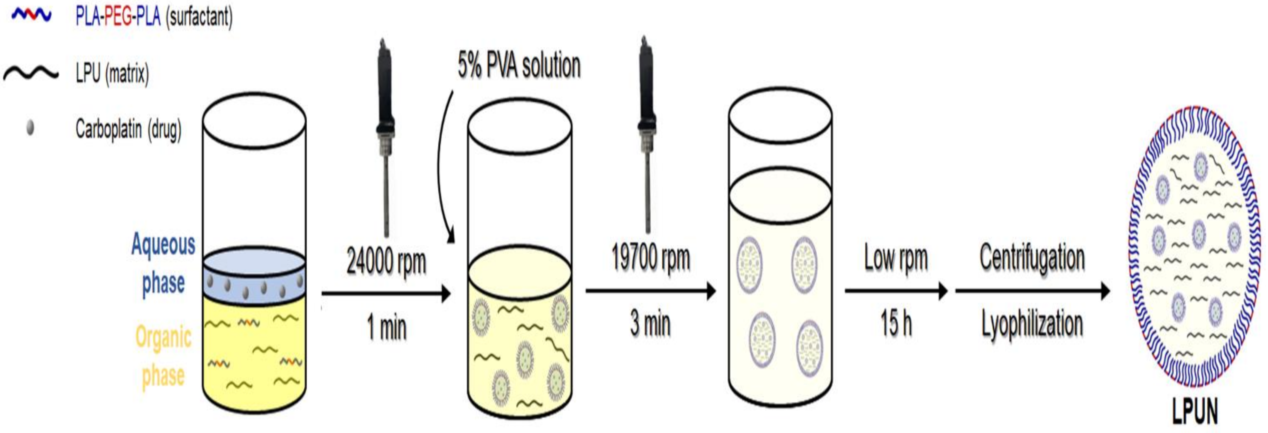

Figure 1. Fabrication of LPU nanoparticles.

[1] S. Oh, S.Y. Park, H.I. Seo, and I. Chung, *Pharmaceutics*, **2025**, *17(1)*, 28.

Fabrication and Characterization of Crosslinked Hyaluronic Acid Incorporating Polymerizable Polyrotaxane

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Hyaluronic acid (HA) has attracted considerable attention as a wound healing material due to its excellent biocompatibility and moisturizing properties. However, its application is often limited by insufficient mechanical strength and rapid degradation in vivo. To address these issues, we developed a HA-based hydrogel utilizing polymerizable polyrotaxane (PRMA) as a multifunctional crosslinker. Polyrotaxane was synthesized by threading β-cyclodextrin onto poly(propylene glycol) (PPG, MW = 4000), followed by end-capping with N-(triphenylmethyl)-glycine (Trt-Gly-OH) using DMT-MM as a catalyst. Methacryloyl chloride was subsequently grafted onto the threaded β-cyclodextrin to introduce polymerizable groups. Characterization by NMR, FT-IR, DSC and TGA confirmed the chemical structure and properties of the synthesized materials.

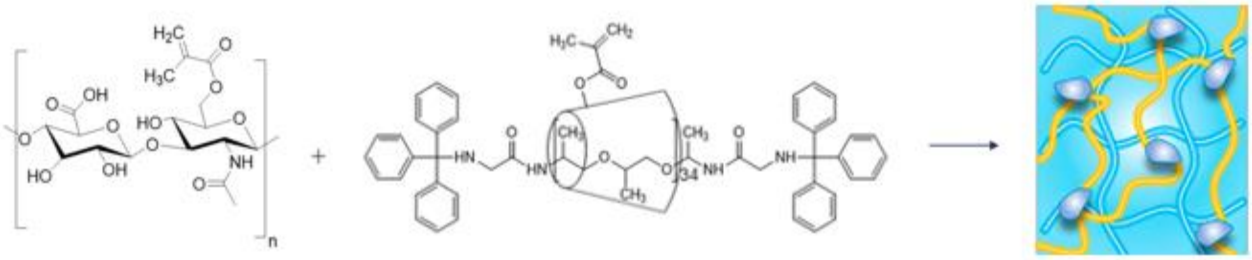

Figure 1. Proposed crosslinked structure of HA-MAC and PRMA.

Fabrication of edible sodium alginate-zein based membranes with aligned patterns for cultured meat applications

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[2]Research Institute of Cell Culture, Yeungnam University, Gyeongsan 38541, Republic of Korea
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Aligned patterns are essential in cultured meat production, as they replicate the natural anisotropic alignment of muscle fibers found in animal tissue, which is crucial for achieving authentic meat texture and function [1]. This study presents a novel method for fabricating edible sodium alginate-zein membranes with engineered aligned surface patterns, intended for use as scaffolds in cultured meat. The aligned topography was generated using a rotating patterned drum and stabilized through ionic crosslinking with calcium ions. The resulting membranes were characterized by scanning electron microscopy, and fourier-transform infrared spectroscopy, and mechanical performance. Importantly, the aligned patterns promoted muscle cell alignment, enhanced differentiation, and supported the formation of mature, elongated muscle fibers closely mimicking the parallel architecture of native muscle. Moreover, the cell proliferation greatly improved the higher amount of zein protein. This structural anisotropy also improved biological signaling and cellular organization, resulting in membranes with mechanical properties and tissue-like qualities that resemble conventional meat. As edible, non-animal-derived, and cost-effective biopolymer scaffolds, these membranes hold significant promise for advancing the development of high-quality cultured meat products.

Keywords: Edible scaffolds, sodium alginate, zein, aligned patterns, muscle cell alignment, anisotropic architecture, cultured meat production.

[1] K.M. Rao, S.M. Choi, and S.S. Han, A review on directional muscle cell growth in scaffolding biomaterials with aligned porous structures for cultivated meat production. *Food Research International*, **2023**, 168, 112755.

Organic Field-Effect Transistors for the Ultrasensitive Detection of Reactive Oxygen Species

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[3]Samsung Electronics, Suwon 16677, Republic of Korea
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Organic field-effect transistors (OFETs) have emerged as key components for next-generation flexible and wearable electronics, offering advantages such as solution processability at low temperatures and low-cost fabrications using flexible film substrates. These advantageous features make them highly attractive for chemical and biological sensing applications in various fields. To bestow sensing capability, in most cases, the channel layers in OFETs should consist of organic materials with particular functional groups. Therefore, conventional organic semiconductors, such as conjugated polymers, need substantial processes to attach functional moieties via either synthesis or modification reactions. Our group has recently attempted to develop OFET sensors for the detection of reactive oxygen species (ROS), which can cause oxidative stress and cellular damage, leading to diverse health disorders. To make cost-effective OFET sensors, we introduced a strategy of blending naturally derived polyphenolic antioxidants with well-defined semiconducting polymers for sensing channel layers. These bio-inspired molecules could effectively detect ROS with high sensitivity under various conditions. In this presentation, we demonstrate the detailed concept of ROS sensing using specialized OFET devices.

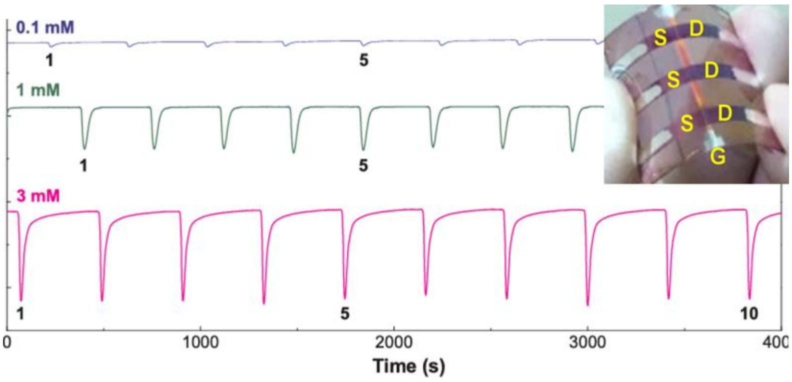

Figure 1. Example of continuous ROS detection using OFET sensors with functionalized sensing channel layers.

[1] J. Jeong, M. Essafi, C. Lee, M. Haoues, M.F. Diouani, H. Kim, and Y. Kim, *J. Hazard. Mater.*, 355, 17 **(2018)**.
[2] M. Kim, H. Kim, and Y. Kim, *in preparation* **(2025)**.

Synthesis of Acrylic Pressure Sensitive Adhesives Using Supramolecular Movable Cross-linkers with Improved Adhesion Properties

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Pressure-sensitive adhesives (PSAs) are a type of adhesive that form a bond with variety of surfaces under light pressure, enabled by their inherently tacky characteristics at ambient conditions. PSAs are extensively useful across a broad spectrum of applications, from everyday labels and packaging tapes to demanding environments such as electronics and medical devices. However, the PSAs with movable cross-links facilitate stress relaxation and enhanced adhesion performance without compromising cohesive strength through the dynamic nature of the cross-links. In this work, we investigate the role of mobile cross-links in the properties of a bio friendly pressure-sensitive adhesive, formulated using composites of cyclodextrin-based macromolecules. The cyclodextrin of polyrotaxane was modified with two different pendants like lipoic acid and 2-isocyanato ethyl methacrylate. The prepared adhesives were characterized with FT-IR, DSC, TGA and mechanical studies. By systematically varying the adhesive formulations and evaluating their mechanical and adhesive performance, we identified structure–property relationships that allow for the tuning of network properties, enabling the development of bio friendly, high-tack adhesives.

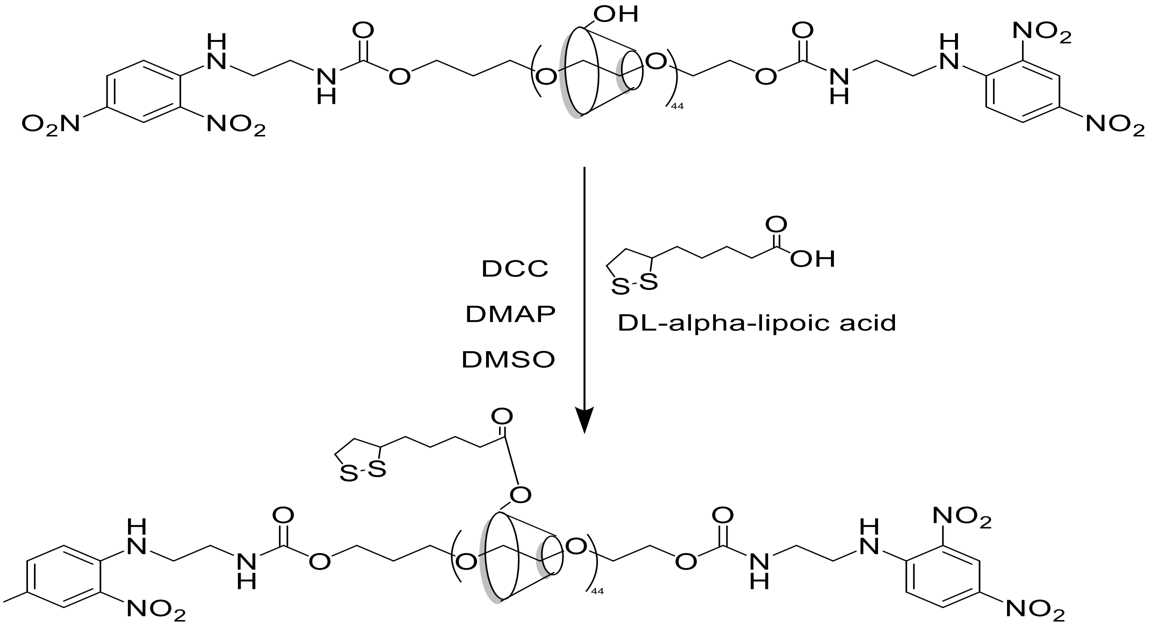

Figure 1. Schematic of polyrotaxane derivative via esterification with DL-alpha-lipoic acid.

Synthesis and Characterization of Slide-ring Polyurethane based on Poly(propylene glycol)-methyl-β-cyclodextrin Polyrotaxane

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In this study, highly stretchable low covered movable slide-ring polymer gel was synthesized by crosslinking with diisocyanate and poly (propylene glycol)-methyl-β-cyclodextrin polyrotaxane. Low covered polyrotaxane was synthesized from methyl-β-cyclodextrin (Me-β-CD) and poly (propylene glycol) (PPG) with a molecular weight of 1000 and expected to have higher elongation properties than full covered polyrotaxane because of easier movement of ring structure along the main chain. The slide ring movement of crosslinked Me-β-CD on polyurethane backbone allows it to stretch without deformation. These unique properties of the resulting gels potentially act as flexible materials and create new opportunities for biomedical applications. The low covered polyrotaxane and polyurethane were characterized by FT-IR, ^{1}H-NMR and UV-vis spectroscopies. In addition, the elongation of polyurethane according to the content of polyrotaxane was shown through tensile strength measurement.

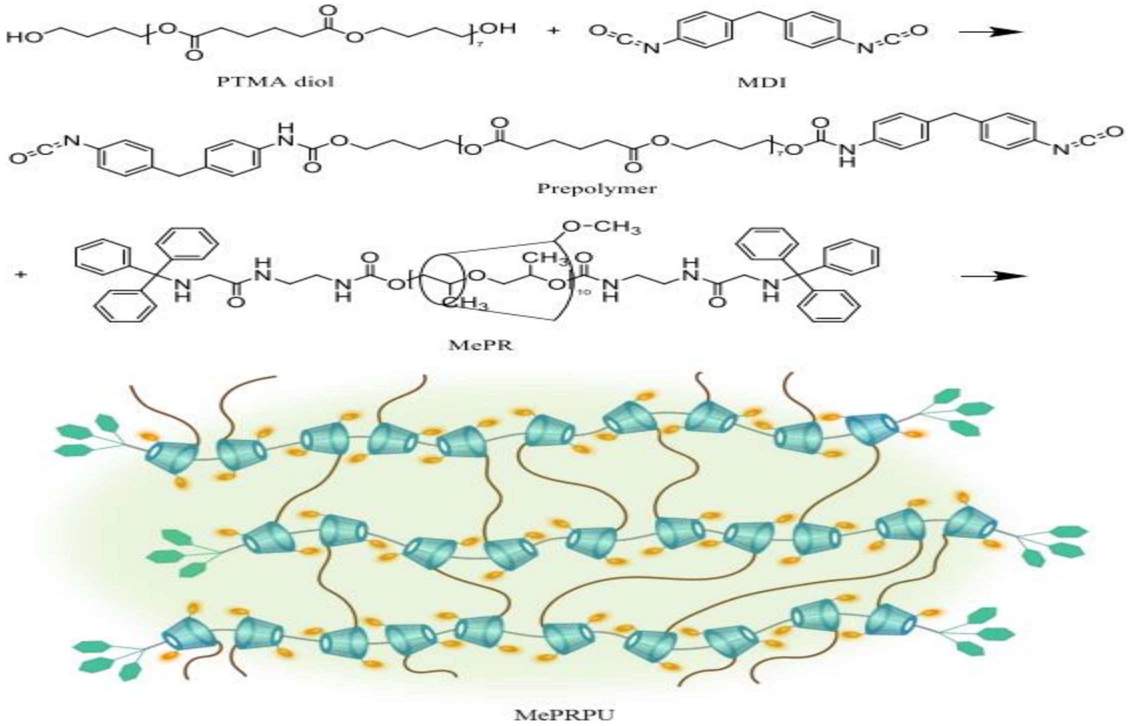

Figure 1. Reaction scheme for synthesis of MePR-polyurethane (MePRPU).

Development of High-Perfomance Photocurable Resin for Dental Applications using Methacrylate-Modified Poly(phenyl sulfone)

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Poly(phenyl sulfone) (PPSU), composed of repeating aryl ether (Ar–O–Ar) and sulfone (–SO_2–) units, exhibits excellent thermal stability and mechanical strength, attributed to the high polarity of the sulfone groups, as well as strong resistance to chemicals, UV radiation, and hydrolysis. These characteristics allow the PPSU to withstand high-temperature and high-pressure environments. [1] In this study, photocurable methacrylate-terminated poly(phenyl sulfone) (MAPPSU) was synthesized via etherification of dichlorodiphenyl sulfone (DCDPS) and 4,4-dihydroxybiphenyl (DHBP) using potassium carbonate as the catalyst, followed by the reaction with methacryloyl chloride (MAC) using triethylamine (TEA) as an esterification catalyst to introduce methacrylate end groups. The formation of MAPPSU was confirmed through FT-IR, ^{1}H-NMR, GPC, TGA and DSC analyses, and used to formulate dental resin via DLP 3D printer to evaluate its mechanical properties much as compressive and flexural strengths.

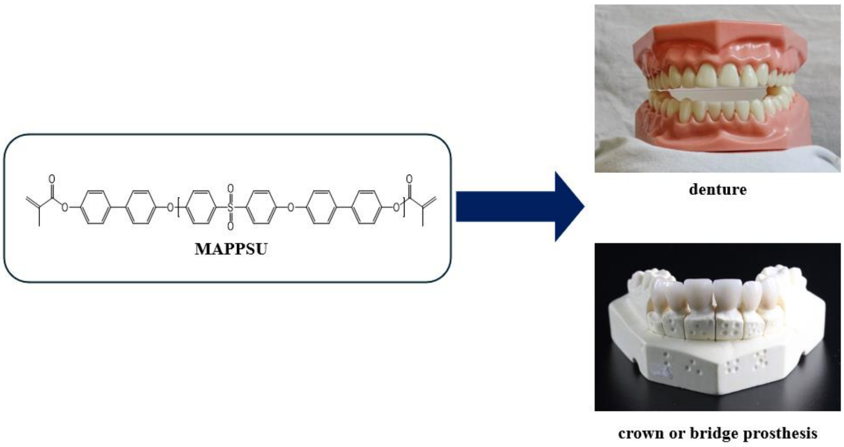

Figure 1. MAPPSU applications in dental materials: dental denture, crown or bridge prosthesis.

[1] A. K. Shukla, J. Alam, and M. Alhoshan, *Membranes (Basel)*, **2022**, *12(2)*, 247.

Microfluidic Sweat Patch Integrated Smartwatch for Non-Invasive Photonic Continuous Glucose Monitoring

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Noninvasive continuous glucose monitoring (CGM) offers a promising alternative to conventional blood-based approaches for diabetes management. Among various body fluids, sweat is an attractive medium to reflect the blood glucose levels in the body. However, technical challenges for the sweat analysis persist due to the low analyte concentrations, potential contamination, and inefficient sampling. Here, we develop a microfluidic Tesla valve sweat patch integrated smartwatch for real-time optical continuous monitoring of glucose as well as oxygen and heart rate. The self-driven, unidirectional Tesla valve microchannel enables efficient and continuous sweat collection with minimal backflow. The optical hydrogel sensor is composed of glucose oxidase, catalase, and an oxygen-sensitive dye. The glucose oxidation and the following catalase reaction can be monitored by the oxygen-sensitive dye, producing optical signals reversibly proportional to glucose concentrations. The integrated smartwatch platform, equipped with micro-LEDs and a photodetector, provides optical readout and wireless data transmission for noninvasive continuous monitoring of glucose, oxygen and heart rate. On-body tests validate reliable CGM within the physiological sweat glucose range from 0.01 mM to 0.1 mM, showing the statistically significant correlation with blood glucose levels. Taken together, this smartwatch would be successfully used as a promising wearable healthcare system for personalized diabetes management [1,2].

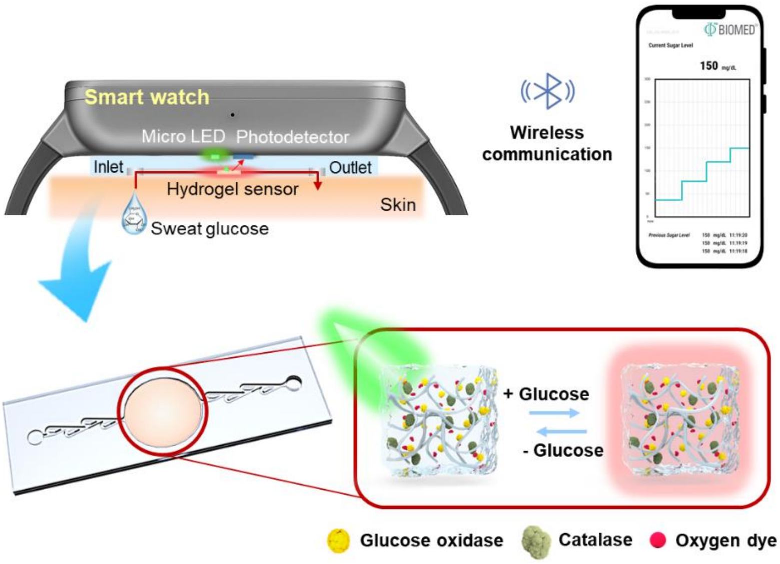

Figure 1. Schematic illustration for the microfluidic glucose patch integrated smartwatch system

[1] S. Cheong, J. Chae, H. Lee, S. H. Hong, H. Lim, H. Bae, K. Lee, S. Shin, T. Y. Kim, and S. K. Hahn, *Biosensors and Bioelectronics*, **2025**, 289, 117925.

[2] S.-K. Kim, G. -H. Lee, C. Jeon, H. H. Han, S. -J. Kim, J. W. Mok, C. -K. Joo, S. Shin, J. -Y. Sim, D. Myung, Z. Bao, and S. K. Hahn, *Advanced Materials*, **2022**, 34, 2110536.

Polydopamine-Coated hBN Segregated Networks for Flame Retardancy and Mechanical and Thermal Properties Reinforcement in CAN Composites

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Flame retardancy is a crucial property for materials used in high-temperature or extreme environments to ensure safety during fire incidents and to protect lives and property. In this study, we explore a strategy to impart flame resistance to covalent adaptable networks (CANs), which combine high mechanical strength due to their crosslinked structure with the advantage of being reprocessable. The goal of this work is to develop composites that exhibit both flame retardancy and reprocessability. A segregated network structure was achieved by introducing hexagonal boron nitride (hBN) into the CAN matrix, where the hBN selectively accumulates along the matrix boundaries to form continuous pathways. This network not only enhances thermal conductivity through efficient heat-transfer paths but also acts as a barrier to heat and oxygen, thereby improving flame resistance. To reinforce the interfacial bonding between the CAN matrix and hBN and to improve mechanical strength, hBN was coated with polydopamine, producing PDA-coated hBN (PhBN). Polydopamine enhances adhesion to the matrix and also contributes inherent flame-retardant characteristics. As a result, the PhBN/CAN composite achieves a combination of flame retardancy, mechanical strength, and high thermal conductivity while maintaining the reprocessability of CANs. This approach provides a promising route for designing safer and more durable next-generation composites.

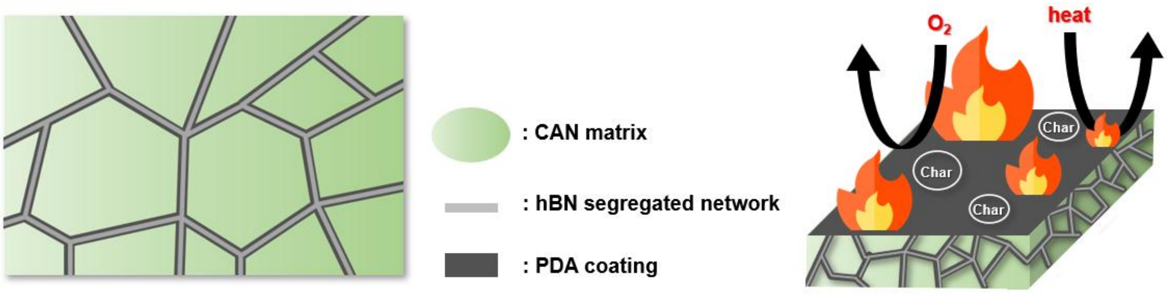

Figure 1. Schematic illustration of a CAN/PhBN composite featuring a segregated filler structure that enhances flame retardancy, mechanical strength, and thermal conductivity

Development of a Water-Cooled Heat Dissipation Plate for Electric Vehicle Batteries Using a Polymer Heterojunction Film

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[2] *Department of Polymer Science and Engineering, Pusan National University, Busan* 46241, *Korea*
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There is increasing emphasis on the development of alternative technologies to conventional brazing processes in order to secure a stable domestic supply, reduce manufacturing costs, and enhance the safety and performance of water-cooled heat dissipation plates, which are essential for managing the heat generated during the charging and discharging of electric vehicle batteries. Furthermore, the advancement of dissimilar metal joining technology for bonding aluminum (Al) with stainless steel (STS/SUS) is critically required to reinforce the structural integrity of the lower metal plate and to ensure the safety and reliability of eco-friendly electric vehicle battery packs.

In this study, a polymer heterojunction film with a three-layer structure for joining dissimilar metals, including aluminum (Al) and stainless steel (STS/SUS), was fabricated via co-extrusion. The physical and mechanical properties, such as peel strength, airtightness, flatness, and fusion strength, were optimized to evaluate its suitability for application in water-cooled heat dissipation plates for electric vehicle batteries. A prototype heat dissipation plate incorporating the heterojunction film was subsequently developed and applied to eco-friendly electric vehicles, demonstrating its potential for future commercialization.

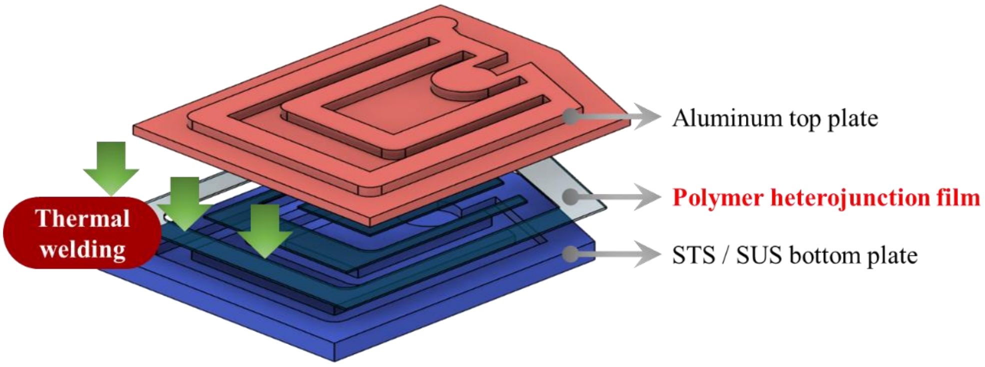

Figure 1. Schematic illustration of a water-cooled heat dissipation plate for electric vehicles using a polymer heterojunction film.

Charge-Trapping Control in Organic Field-Effect Transistors for Memory and Neuromorphic Applications

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Hysteresis characteristics in organic field-effect transistors (OFETs), which are considered futuristic platforms in various advanced systems such as humanoid robots, have been extensively studied due to their important roles in memory and neuromorphic applications. Among several methods for achieving hysteresis in OFETs, 'charge-trapping' is understood to be a key when it comes to the fastest action of charges (electrons). The charge-trapping phenomenon is typically achieved in the gate-insulating layers of OFETs, even though some approaches can deliver charge-trapping phenomena in the channel layers. Limiting to the gate-insulating layers, various approaches in the material aspect are available to make charge-trapping sites. Our group has recently reported that the permanent charges formed in the gate-insulating layers act as charge-trapping sites and deliver pronounced hysteresis characteristics in OFETs. Based on this pioneering attempt, the permanent charge structures were effectively designed from nonvolatile memory devices to neuromorphic transistors. In this presentation, the basic concept of charge-trapping actions in OFETs is discussed with the measured device data. In addition, the updated charge-trapping technology is introduced for organic neuromorphic transistors, which can be applied to physical artificial intelligence (AI) systems.

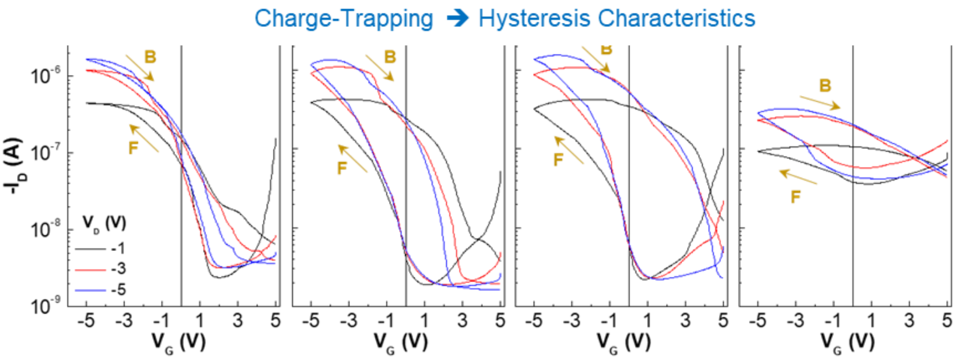

Figure 1. Transfer curves of the OFET devices with the charge-trapping layers: 'F' and 'B' denote the forward and backward sweeps of gate voltages, respectively.

[1] Chulyeon Lee, Jaehoon Jeong, Hwajeong Kim, and Youngkyoo Kim, *Mater. Horiz.*, 6, 1899 (**2019**)
[2] Taehoon Kim, Woongki Lee, and Youngkyoo Kim, *Small Methods*, 9, 2401885 **(2025)**
[3] Xiaowei Chen, Shiya Zheng, Baoshuai Liang, Xiaosong Wu, Donghui Wang, Yu Dong, Wei Huang, Yifan Liu, Xiaolan Yu, Jinghui Shen, Shiyu Feng, Chia-Chih Chang, Weiguo Huang, *Chem. Mater.*, 35, 2808 **(2023)**

Programming Mechanochromism in Spiropyran-Incorporated Liquid Crystal Elastomers via Direct-Ink-Writing

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Mechanoresponsive polymers have received significant attention for their potential applications in stress and strain sensing, as well as damage detection. Among them, spiropyran (SP)-based polymers, which exhibit force-induced color changes, are widely studied, but most studies are limited to isotropic polymer matrices.[1] In this study, we use UV-assisted direct-ink-writing to print SP-incorporated liquid crystal elastomers (LCEs) and investigate how LC alignment influences their mechanochromic response. Unlike conventional SP-based polymers, the mechanochromic behavior of SP-LCEs is strongly dependent on the stretching direction relative to the nematic director. To gain deeper insight into this behavior, we employ finite element analysis (FEA) simulations and in-situ X-ray measurements, which reveal a direct correlation between the nematic director and mechanoresponsive characteristics. The ability to program the mechanochromism in SP-LCE monolith opens new possibilities for advanced anti-counterfeiting materials and strain sensors.

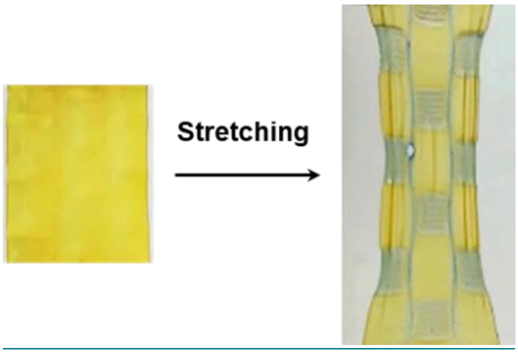

Figure 1. Spatially programmed mechanochromic response of the SP-LCE monolith with a checkerboard pattern.

[1] S. R. White, J. S. Moore and N. R. Sottos, *Nature*, **2009**, *459*, 68.

Programmable Shape-Morphing Textiles from Liquid Crystal Elastomers

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Liquid crystal elastomers (LCEs) are crosslinked polymer networks that combine the elastic properties of rubber with the anisotropic properties of liquid crystals.[1] Owing to these properties LCEs exhibit large reversible deformations when exposed to external stimuli. One-dimensional LCE fibers stand out among various geometries due to combining scalable production, rapid actuation and broad compatibility with textile fabrication techniques. Controlling the mesophase during extrusion allows the fabrication of LCE fibers oriented parallel or perpendicular to the fiber axis, resulting in contracting and elongating actuation, respectively.[2] Incorporating these fibers into woven structures enables diverse programmable shape transformations, including bending, curling, cone, and saddle shape. This approach enables alignment-driven LCE fibers to serve as programmable building blocks for “active textiles”, paving the way toward next-generation smart fabrics and textile-based actuators.

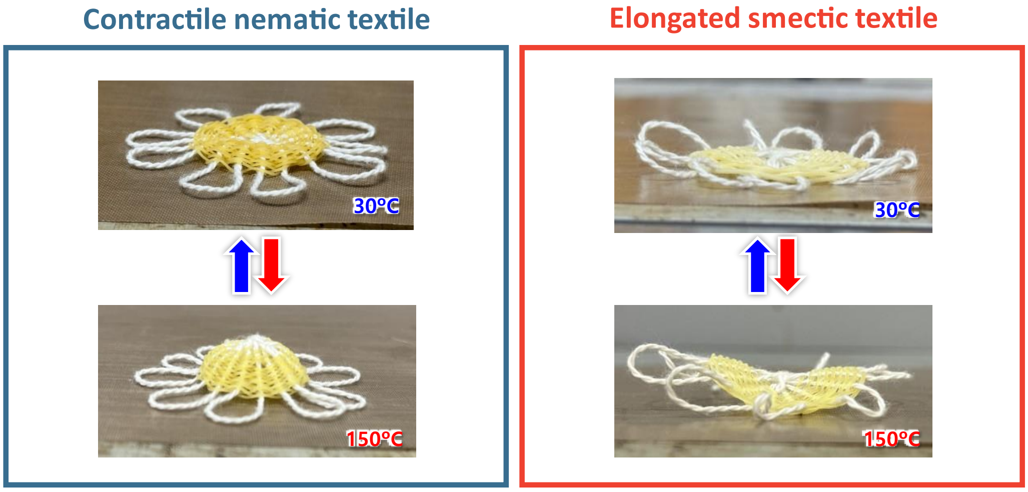

Figure 1. Thermal actuation behaviors of nematic (left) and smectic (right) textiles woven from contracting and elongating fibers.

[1] T.J. White, *Nat. Rev. Mater,* **2021**, 7, 23
[2] J-H. Lee, and S-k. Ahn, *Sci. Adv,* **2025**, 11, (3), eadt7613

Cross-linked hybrid polyimide films for low dielectric applications

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With the rapid growth of wireless mobile communications, integrated circuits, and foldable displays, the demand for flexible substrates with low dielectric constants is steadily increasing. To satisfy these requirements, materials must provide not only high signal transmission rates and, but also excellent signal integrity. In this context, polyimides (PIs) that have low dielectric constants, are thermally stable, optically transparent, and easy to process have attracted a lot of interest. They are useful for advanced 5G/6G communications and the microelectronics industry, where they serve as interlayer dielectric materials and help develop wearable displays and other next-generation technologies. In this regard, PI hybrid films were fabricated by incorporating a hyperbranched fluorinated cyclotriphosphazene polymer. The PI was first prepared from fluorinated diamine and flexible 4'-oxydiphthalic anhydride, which then incorporated with hyperbranched cyclotriphosphazene. The hybrid PIs significantly increased the cross-linking density within the polyimide matrix, leading to notable enhancements in film performance. Specifically, the resulting hybrid PI films exhibited excellent water resistance, improved thermomechanical properties, superior flame-retardant characteristics, and a reduced dielectric constant.

Organic Neuromorphic Transistors Based on Thermally Crosslinked Water-Soluble Polymers

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Organic neuromorphic transistors are attracting great interest as promising unit devices for neuromorphic computing systems due to the advantages of organic materials, including structural tunability, mechanical flexibility, and solution-based processability. Recently, water-based fabrication processes using environmentally friendly organic materials have been highlighted for their potential in sustainable large-scale manufacturing of next-generation electronics. In this regard, we have focused on water-processable functional polymers that serve as a memory gate-insulating layer in organic neuromorphic transistors. Our studies uncovered that certain water-soluble polymers with high hysteresis characteristics lose memory retention even under mild conditions, limiting their applications in viable neuromorphic systems. To overcome this, we developed a controlled thermal crosslinking (CTC) strategy to stabilize the polymeric memory gate-insulating layers. This method utilizes partial crosslinks of polymer chains in the memory gate-insulating layers, which can retain the hysteresis characteristics. The results showed that organic neuromorphic transistors fabricated with this approach were stably operated with excellent retention performances at low voltages. This presentation demonstrates the concept of the CTC approach and the performance of organic neuromorphic transistors in detail.

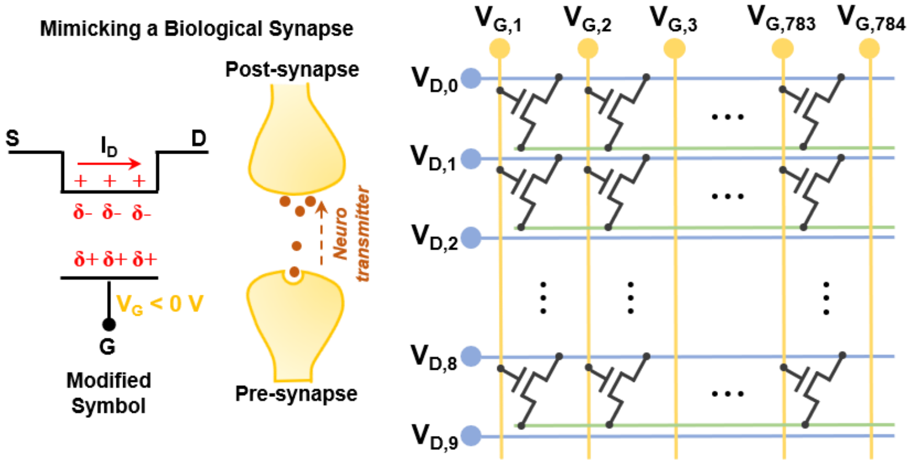

Figure 1. Scheme for mimicking a bio-synapse with an organic neuromorphic transistor and the transistor array structure.

[1] Taehoon Kim, Woongki Lee, Soyeon Kim, Dongchan Lim, and Youngkyoo Kim, *Adv. Intell. Syst.* 6, 2300651 (**2024**)

[2] Woongki Lee, Taehoon Kim, Hwajeong Kim, and Youngkyoo Kim, *Adv. Mater.* 36, 2403645 (**2024**)

Covalent Organic Framework based on Multi-Acceptor Planar Structure for Efficient Photocatalytic Production of H_2O_2

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Donor-acceptor (D-A) covalent organic frameworks (COFs) have garnered significant attention as advanced photocatalysts owing to their exceptional structural precision, high surface-area-to-volume ratios, and superior charge transport properties.[1] Nonetheless, the polarized nature of imine linkages inherently restricts π-electron delocalization, resulting in localized electronic trap states that impede long-range carrier mobility.[2] The dual challenge of independently controlling molecular arrangement while achieving extensive π-electron delocalization has remained a critical obstacle in this field. To address these limitations, we introduce a post-treatment modification strategy that transforms partially conjugated imine linkages into fully conjugated fused heteroaromatic linkages, thereby enhancing molecular planarity (see TZ-COF and OZ-COF, Figure 1). This engineered molecular architecture, characterized by an A-π-A configuration, coupled with robust in-plane π-electron delocalization, substantially enhances charge transport efficiency. Furthermore, the accelerated carrier migration effectively directs photogenerated electrons toward electron-deficient thiazole moieties, promoting the generation of superoxide anion radicals ($\cdot O_2^-$) and expediting the rate-limiting step of the oxygen reduction reaction (ORR). These synergistic enhancements culminate in a remarkable photocatalytic hydrogen peroxide production rate of 6.83 mmol g^{-1} h^{-1} under visible light irradiation, surpassing the performance of most reported COF-based systems (Figure 1). This study underscores the transformative potential of fully conjugated D-A COFs in the rational design of high-performance photocatalysts, paving the way for advanced applications in sustainable energy conversion.

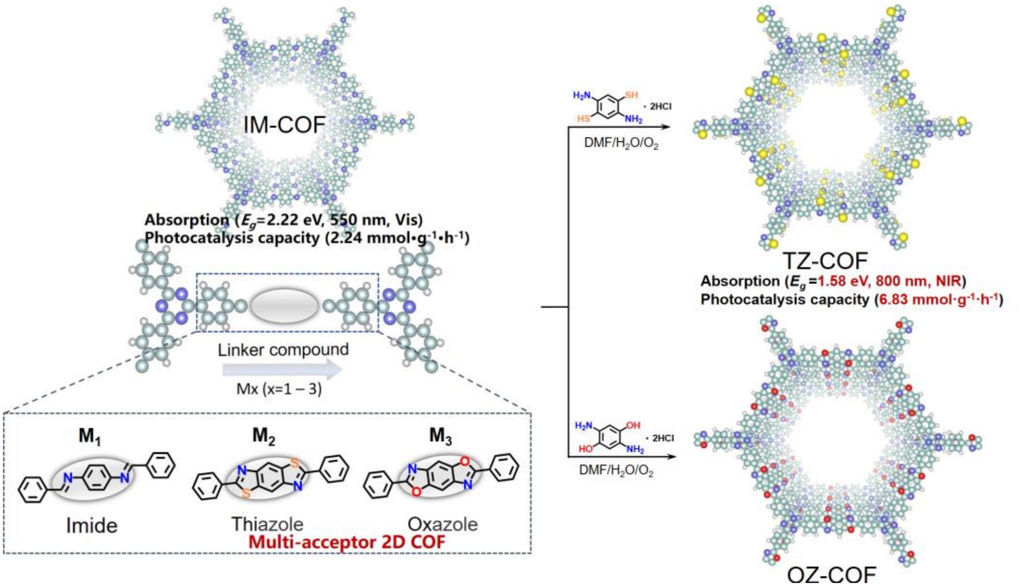

Figure 1. Covalent organic framework based on multi-acceptor planar structure in this study

[1] M. R. Rao, Y. Fang, S. De Feyter, D. F. Perepichka, *J. Am. Chem. Soc.* **2017**, *139*, 2421-2427.
[2] R. Ma, Y. Zhang, F. Yu, S. Wei, Y. Xing, C. Qiao, Z. Xia, Q. Yang, G. Xie, S. Chen, *ACS Catal.* **2025**, *15*, 3046-3060

PI-based CFRPs Fabricated by a Novel CNTF-assisted Joule Heating Process for Multifunctional Aerospace Applications

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The growing demand for lightweight and thermally stable materials in aerospace has increased interest in carbon fiber-reinforced plastics (CFRPs). However, conventional epoxy resins degrade at 200-250℃, making them unsuitable for high-temperature applications. To overcome this issue, high-heat-resistant resins such as polyetherimide (PEI), polyetheretherketone (PEEK), and polyimide (PI) have been employed, but their high processing temperatures result in substantial energy consumption and increased manufacturing costs [1].

In this study, we propose a novel process for fabricating PI-based CFRPs in a more energy-efficient manner while achieving superior quality compared to conventional methods [2]. As the thermal source, carbon nanotube film (CNTF) was introduced owing to its lightweight, flexible, outstanding electrothermal properties, and ability to reach processing temperatures above 500℃. CNTF also has electrical and thermal conductivity, hydrophobicity, which enables functionalities such as de-icing, anti-icing, and electromagnetic interference (EMI) shielding.

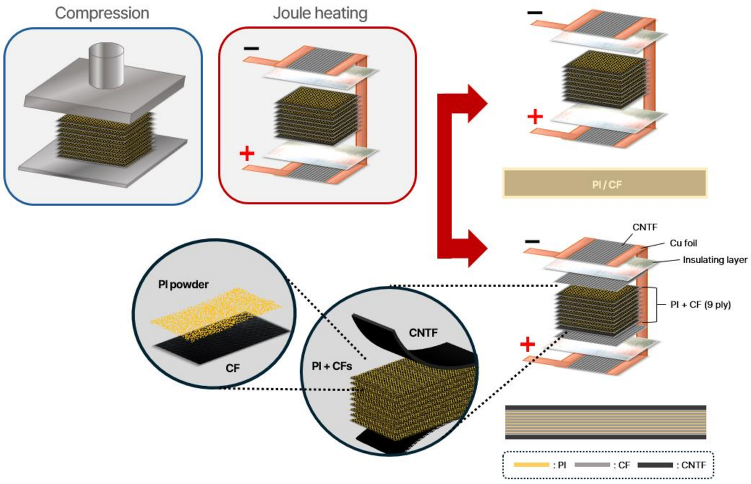

Figure 1. Fabrication of PI/CFRP via compression and CNTF-assisted Joule heating

PI-based CFRPs were fabricated through this CNTF-assisted Joule heating process, with additional integration of CNTFs onto the composite surface to fabricate multifunctional CFRPs. The composites were evaluated in terms of mechanical and thermal properties against those produced by conventional compression molding. The influence of CNTF surface incorporation was examined through contact angle, EMI shielding, and de-icing tests. This work presents the first integration of CNTF with high-temperature-resistant PI, achieving superior thermal stability, mechanical strength, and multifunctionality in CFRPs. The results demonstrate that CNTF-assisted Joule heating offers an energy-efficient processing, while surface integration of CNTFs provides multifunctional performance for aerospace structures.

[1] LI, Xiaochen, et al, *Composites Part B: Engineering*, **2023**, *262,* 110814.
[2] Karalis, George, et al, *ACS applied materials & interfaces*, **2021**, *13*, 39880.

Infrared Organic Phototransistors with Polymeric Gate Sensing Layers

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[3]Samsung Electronics, Suwon 16677, Republic of Korea
[4]Priority Research Center, Research Institute of Environmental Science & Technology, Kyungpook National University, Daegu 41566, Republic of Korea
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Infrared (IR) sensors have become key components for various advanced applications, including military devices, humanoid robots, autonomous vehicles, and healthcare monitoring systems. Conventional IR sensors have been fabricated using inorganic materials featuring rigid, heavy, hard, and inflexible characteristics. To meet the requirements for such advanced applications in the flexible electronics era, organic phototransistors that can detect IR light need to be developed for practical installations in round-shaped systems. However, owing to the small energy gap of IR light, it is impossible to employ typical methods using IR-absorbing organic materials as channel layers in organic phototransistors. To resolve this issue, we have introduced the proprietary concept of gate-sensing layer (GSL), which is separated from the channel layers and does not critically involve in the basic charge transport between the source and drain electrodes. In this presentation, we demonstrate the GSL concept for organic phototransistors and discuss our recent results on the IR sensing performances.

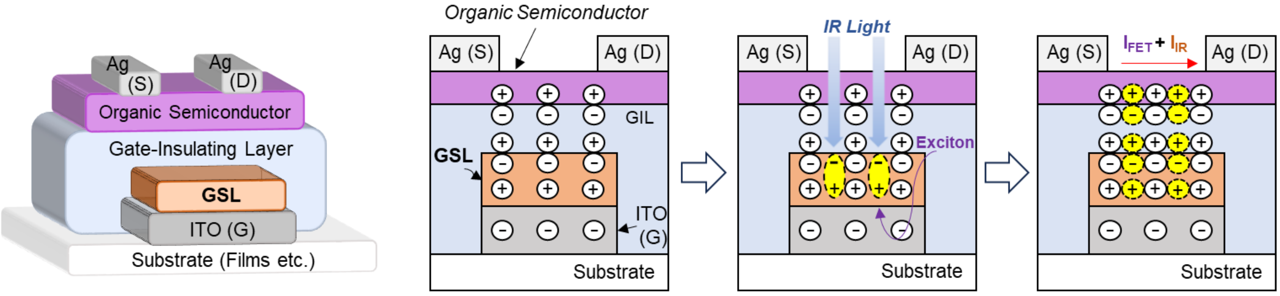

Figure 1. Illustration of device structure and operation mechanism for IR-detecting organic phototransistors with organic gate-sensing layers (GSLs).

[1] Chulyeon Lee, Hwajeong Kim, and Youngkyoo Kim, *ACS Appl. Mater. Interfaces,* 13, 19064 (**2021**)
[2] Chulyeon Lee, Hwajeong Kim, and Youngkyoo Kim, *npj Flexible Electronics*, 5, 10 (**2021**)
[3] Hyemi Han, Chulyeon Lee, Hwajeong Kim, and Youngkyoo Kim, *Adv. Funct. Mater.*, 28, 20 (**2018**)

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