

# 2021 7/9-7/10

## 高分子線上聯合會議

2021 INTERNATIONAL CONFERENCE  
ON MODERN CHALLENGES IN POLYMER  
SCIENCE AND TECHNOLOGY (2021 MCPST)

大會手冊

*Program Book*



## Scientific Program

TIME	SPEECH TOPIC/SPEAKER	COORDINATOR
08:20-08:30	<b>Introduction</b> Hsin-Lung CHEN (National Tsing Hua University, Taiwan)	<b>Chen-Tsyrr LO</b> (National Sun Yat-sen University)
08:30-09:00	<b>Self-Assembled Nanomaterials of Glyco-based Polymers for Biomedical Applications</b> Kazunari AKIYOSHI (Kyoto University, Japan)	<b>Hsin-Lung CHEN</b> (National Tsing Hua University)
09:00-09:30	<b>Metallically Conducting Alginate Fiber by Simply Modified Wet-Spinning Process</b> Jun Young LEE (Sungkyunkwan University, Korea)	<b>Wen-Chang CHEN</b> (National Taiwan University)
09:30-09:50	<b>Molecular Assemblies Forming Liquid-Crystalline Nanostructures for Energy, Environment, and Healthcare Functions</b> Takashi KATO (The University of Tokyo, Japan)	
09:50-10:10	<b>Enhanced Physical Properties of Polymer Composites Using Optimized Ionic Block Copolymers</b> Ho Gyu YOON (Korea University, Korea)	<b>Hsin-Lung CHEN</b> (National Tsing Hua University)
10:10-10:20	<b>Coffee Break (Photo Opportunity)</b>	
10:20-10:40	<b>Zwitterionic Building Blocks for Development of Biomaterials</b> Chun-Jen HUANG (National Central University, Taiwan)	<b>Jeng-Shiung JAN</b> (National Cheng Kung University)
10:40-11:00	<b>Design of Smart Polymer Printer Using Liquid Crystallinity for Self-Healing and -Protecting Materials</b> Young-Ki KIM (POSTECH, Korea)	
11:00-11:20	<b>Graphene-Polymer Composites: Synthesis and Applications</b> Yuta NISHINA (Okayama University, Japan)	<b>Jiun-Tai CHEN</b> (National Yang Ming Chiao Tung University)
11:20-11:40	<b>A Double Comb Copolymer Approach for Morphological Control for Energy Conversion and Storage Device</b> Jung Tae PARK (Konkuk University, Korea)	
11:40-12:00	<b>Synthesis of Conjugated Polymers and Molecular Machines for Optoelectronic Applications</b> Masaki HORIE (National Tsing Hua University, Taiwan)	

2021 International Conference on Modern Challenges in  
Polymer Science and Technology

TIME	SPEECH TOPIC/SPEAKER	COORDINATOR
12:00-13:15	<b>Lunch Break</b>	
13:15-13:35	<b>A Versatile Cresols-Based System for Solution Processing of Carbon Nanotubes</b> Kevin CHIOU (National Sun Yat-sen University, Taiwan)	<b>Shyh-Chyang LUO</b> (National Taiwan University)
13:35-13:55	<b>Designing Conjugated Polymers for Transistor and Photovoltaic Applications</b> Tsuyoshi MICHINOBU (Tokyo Institute of Technology, Japan)	
13:55-14:15	<b>Tailoring Hyper-Structured Conductive Materials for Detection and Removal of Potentially Hazardous Substances</b> Joonwon BAE (Dongduk Women's University, Korea)	
14:15-14:35	<b>Designing Material Systems Featuring Mechanochemically Triggered Chemical Cascade</b> Chia-Chih CHANG (National Yang Ming Chiao Tung University, Taiwan)	
14:35-14:45	<b>Coffee Break</b>	
14:45-15:05	<b>Sustainable Peptide Synthesis and the Development of Functional Materials for 3D Printing</b> Sheng-Sheng YU (National Cheng Kung University, Taiwan)	<b>Chen-Tsyr LO</b> (National Sun Yat-sen University)
15:05-15:25	<b>Nanoporous Polymers: Fabrication, Characterization and Applications</b> Sadaki SAMITSU (National Institute for Materials Science, Japan)	
15:25-15:45	<b>Challenges in Numerical Studies of Polymeric Systems</b> Su-Mi HUR (Chonnam National University, Korea)	
15:45-16:05	<b>Adaptive Material Design for Smart Coating: CO<sub>2</sub> Capture and Beyond</b> Takeo SUGA (Waseda University, Japan)	
16:05-16:25	<b>Ultrafast Responsive Non-Volatile Flash Photomemory via Spatially Addressable Perovskite/Block Copolymer Composite Film</b> Jung-Yao CHEN (National Cheng Kung University, Taiwan)	
16:25-16:30	<b>Closing Remarks</b> Hsin-Lung CHEN (National Tsing Hua University, Taiwan)	

## Speakers Introduction & Abstract



### Hsin-Lung Chen

Department of Chemical Engineering,  
National Tsing Hua University, Taiwan

[President of The Polymer Society, Taipei (PST)]

### Research

Self-assemblies of Block Copolymers and Dendrimer-based Supramolecules, Hierarchical Structure and Dynamics of Polymer Hybrids

### Selected Publications

- Mansel, B.W.; Chen, C.-Y.; Lin, J.-M.; Huang, Y.-S.; Lin, Y.-C.; Chen, H.-L. Hierarchical Structure and Dynamics of a Polymer/Nanoparticle Hybrid Displaying Attractive Polymer–Particle Interaction, *Macromolecules* 2019, 52, 8741.
- Young, C.-M.; Chang, Y.-F.; Chen, Y.-H.; Chen, C.-Y.; Chen, H.-L. Ribbon Phase of Dendrimer–Surfactant Complexes, *Macromolecules* 2019, 52, 9177.
- Lin, C.-H.; Higuchi, T.; Chen, H.-L.; Tsai, J.-C.; Jinnai, H.; Hashimoto, T. Stabilizing the Ordered Bicontinuous Double Diamond Structure of Diblock Copolymer by Configurational Regularity *Macromolecules* 2018, 51, 4049.
- Lin, Y.-C.; Chen, H.-L.; Hashimoto, T.; Chen, S.-A. Mechanism of Hierarchical Structure Formation of Polymer/Nanoparticle Hybrids. *Macromolecules* 2016, 49, 7535.
- Huang, Y.-C.; Su, C.-J.; Chen, C.-Y.; Chen, H.-L.; Jeng, U. S.; Berezhnoy, N. V.; Nordenskiöld, L.; Ivanov, V. A. Elucidating the DNA–Histone Interaction in Nucleosome from the DNA–Dendrimer Complex. *Macromolecules* 2016, 49, 4277.



**Kazunari AKIYOSHI**

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Kyoto University, Japan

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Education

1980 B.S. Faculty of Engineering, Kyushu University, Japan

1985 Ph.D. Faculty of Engineering, Kyushu University, Japan

Professional Appointments

- 1985 - 1987: Postdoctoral fellow, Department of Chemistry, Purdue University, USA
- 1987 - 1989: Lecturer, Faculty of Engineering, Nagasaki University, Japan
- 1989 - 1993: Assistant Professor, Faculty of Engineering, Kyoto University, Japan
- 1993 - 2002: Associate Professor, Graduate School of Engineering, Kyoto University, Japan
- 1999 - 2002: Research Member, PRESTO, JST, Japan
- 1997: Visiting Associate Professor, Department of Chemistry, Luis Pasteur University, France
- 2002 - 2010: Professor, Institute of Biomaterials and Bioengineering, Tokyo Medical and Dental University, Japan
- 2010 to present: Professor, Graduate School of Engineering, Kyoto University, Japan
- 2011 - 2018: Research Director, ERATO, Akiyoshi Bio-nanotransporter project, JST, Japan

Research Interests

Bio-inspired Nano-organized System, Nanogel Engineering for DDS and Tissue Engineering, Chaperon-inspired Materials, Cancer and Mucosal Vaccine, Liposome Engineering, Membrane Protein Engineering

## **Self-Assembled Nanomaterials of Glyco-Based Polymers for Biomedical Applications**

Kazunari Akiyoshi

Department of Polymer Chemistry, Graduate School of Engineering, Kyoto University, Japan

The biologics such as proteins and nucleic acids are attracting attention as innovative next-generation pharmaceutical products. We have developed bio-inspired nanocarriers, bionanotransporters, based on nanogel tectonics engineering, proteoliposome engineering and exosome engineering for biologics delivery in drug delivery system (DDS) and tissue engineering.

Various hydrophobized water-soluble polysaccharides in which hydrophobic groups were partially introduced as associative moieties have been designed, and the folding and association of the polymer main chain can be controlled by the type and the degree of substitution of the hydrophobic groups. For example, cholesterol-bearing pullulan (CHP) formed self-assembled nanogels. The nanogels showed molecular chaperone-like activity that enables them to capture various proteins within their polymer matrix and to release in the native form. CHP nanogels are particularly useful as protein nanocarriers for cancer immune-vaccine treatment and nasal vaccine. Furthermore, we proposed a methodology (nanogel tectonics) for constructing functional gels by controlling the association of nanogels as building blocks, and apply them as biomaterials for regenerative medicine.

A therapeutic nanofactory is an enzyme nanoreactor that can accumulate at disease sites in the body, where encapsulated enzymes would convert toxic materials into harmless compounds or transform inert prodrugs into cytotoxic compounds within the tumour or other disease site. Polymer vesicles represent potentially suitable compartments for such nanofactories. However, owing to their thick membranes, their molecular permeability for common drugs is extremely low. Rational molecular design that enhances the molecular permeability remains elusive. We found a polymeric vesicle of glyco-based polymer (poly(propylene oxide)(PPO)) with an intrinsically permeable bilayer membrane as enzyme nanoreactors. A new approach for enzyme prodrug cancer therapy have been proposed using bio-transporting nanofactories.

Controlling polymer vesicle size is difficult and a major obstacle for their potential use in biomedical applications. Facile and broadly applicable control of polymer vesicle size (on the scale of tens of nanometers) remains unexplored. We reported a facile approach to size-tunable polymer vesicles by self-assembly of a thermoresponsive pullulan-graft-poly(propylene oxide) (pullulan-g-PPO) amphiphilic graft copolymer. The graft polymer self-assembled (folded) into a well-defined unilamellar vesicle in response to simple heating of a chilled polymer solution. The size of the resulting vesicles, 40–70 nm, can be tuned by simply adjusting the initial polymer concentration. We have demonstrated reversible vesicle formation from a graft polymer via thermal cycling; in other words, the graft polymer memorizes a particular vesicular structure.

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8. T. Nishimura, L. De Campo, H. Iwase, K. Akiyoshi, *Macromolecules*, 53, 7546-7551 (2020)
9. T. Nishimura, S. Shishi, Y. Sasaki, K. Akiyoshi, *J. Am. Chem. Soc.*, 142, 27, 11784 (2020)



**Jun Young LEE**

School of Chemical Engineering,  
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[President of The Polymer Society of Korea (PSK)]

Education

- Ph. D. in Department of Chemistry, August 1987 – May 1992, University of Massachusetts-Lowell, USA
- M. S. in Department of Textile Engineering, March 1983 - February 1985, Seoul National University, Korea
- B. S. in Department of Textile Engineering, March 1979 - February 1983, Seoul National University, Korea

Work Experiences

- October 1992~February 1998: Senior Researcher, Korea Institute of Science and Technology, Seoul, Korea

[ at Sungkyunkwan University (SKKU), Suwon, Korea ]

- March 1998~present, Professor, School of Chemical Engineering
- March 2007~February 2009: Vice Dean of College of Engineering
- March 2013~February 2015: Vice Dean of College of Engineering / Vice Director of Center for Innovative Engineering Education
- January 2017~December 2020: Dean of College of Engineering / Director of Center for Innovative Engineering Education
- January 2021~present: Vice President, Planning and Coordination Division

Awards and Honors

- 2000 ISI Citation Classic Award
- 2007-2009 Outstanding Professor Award, College of Engineering, SKKU, Korea
- 2008 Best Paper Award, Korean Federation of Science & Technology Societies, Korea
- 2011 Academy Award, Korean Fiber Society, Korea

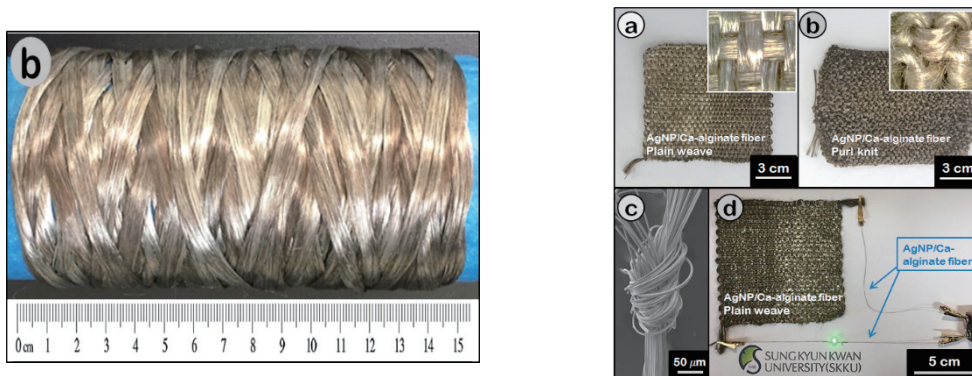


## Metallically Conducting Alginate Fiber by Simply Modified Wet-Spinning Process

Jun Young Lee

School of Chemical Engineering, Sungkyunkwan University, Suwon 16419, Gyeonggi-do, Korea

Electrically conductive fibers play very important roles in realization of wearable technology due to their high flexibility and benefits for knitting and sewing processes. Conductive fibers are able to form electrical conducting path even on textiles, shoes and other wearable electronics. Metallically conducting flexible Ag nanoparticle/alginate (AgNP/alginate) composite fiber with superior mechanical strength and environmental stability was fabricated by metal ion-exchange using a simply modified continuous wet-spinning process. The fiber exhibits superior room temperature electrical conductivity and mechanical strength as high as 2,000 S/cm and 290 MPa, respectively. The AgNP/alginate fiber also possessed excellent environmental stability, showing little conductivity change even after 800 hours under a harsh 60°C and 70% relative humidity condition. Conductive fabric with extremely low surface resistivity of 0.6  $\Omega/\square$  could be fabricated using the AgNP/alginate fibers.



**Fig.** Metallically conducting alginate fiber and woven or knitted fabric.

### Keywords

Metallically Conducting Alginate Fiber, Modified Wet- Spinning Process, Ion-Exchange during Spinning, High Mechanical Strength and Flexibility



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### Education

1983 B.S. The University of Tokyo

1988 Ph.D. The University of Tokyo

### Professional Appointments and Recent Activities

- 1988-1989: Postdoc, Cornell University
- 1989-1999: Assistant Professor, Associate Professor, The University of Tokyo
- 2000-Present: Professor, The University of Tokyo
- 2018-2020: The President of the Society of Polymer Science, Japan
- 2016-2018: The President of the Japanese Liquid Crystal Society
- 2012-2018: Research Supervisor of PREST Research “Molecular Technology” (JST)
- 2012-2018: Editor-in-Chief, Polymer Journal / Advisory Board: Advanced Materials, Chemical Science, Advanced Science, Small, etc.
- 2021: The Medal of Purple Ribbon (Cabinet Office, Government of Japan)
- 2017: The Chemical Society of Japan Award
- 2014: Fellow of the Royal Society of Chemistry (FRSC)
- 2012: The Japanese Liquid Crystal Society (JLCS) Awards
- 2010: The Award of the Society of the Polymer Science, Japan

### Research Interests

Design, Synthesis, Structural Control, and Functionalization of Self-Assembled Materials

## Molecular Assemblies Forming Liquid-Crystalline Nanostructures for Energy, Environment, and Healthcare Functions

Takashi Kato

Department of Chemistry and Biotechnology, School of Engineering, The University of Tokyo, Tokyo, Japan

Here we describe new generation of polymeric nano-assemblies and nanostructured liquid crystals with unconventional design of molecular and assembled structures. They can be applied as functional materials in the field of energy, information, environment, and healthcare.[1-5] We have developed a variety of nanostructured LC materials exhibiting ionic, electronic, photonic, separation, and stimuli responsive properties.[1-11] Functional LC nanostructured materials form smectic, columnar, and bicontinuous cubic structures.[1-4] They are applied as electrolytes for lithium batteries and solar cells.[6-8] Polymerized nanostructured liquid crystals act as water treatment membranes and they remove ions and harmful agents such as viruses.[12-15] As new LC materials, hydroxyapatite and calcium carbonate/polymer nanorods have been obtained.[16-18] These hybrids are expected to be environmentally friendly and bio-functional biodegradable materials. These ordered soft materials have great potential as highly functional materials.

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Department of Materials Science and Engineering,  
Korea University, Korea

Education Background

- B.E., February, 1984, Dept. of Materials Science and Engineering, Korea University
- M.E., February, 1989, Dept. of Materials Science and Engineering, Korea University
- Ph.D; March, 1993., Dept. of Materials Science and Engineering, Nagoya Institute of Technology, Japan (Scholarship from Ministry of Education, Japan)

Business Background

06/15/1993~02/24/1996: Samsung Cheil Industries Inc. as senior researcher

03/01/1996~present: Department of Materials Science and Engineering, Korea University

PSK Experiences

2012: Managing Director

2013: Executive Director

2015: Auditor

Present: Vice President, Elected as Chief Vice President

## **Enhanced Physical Properties of Polymer Composites Using Optimized Ionic Block Copolymers**

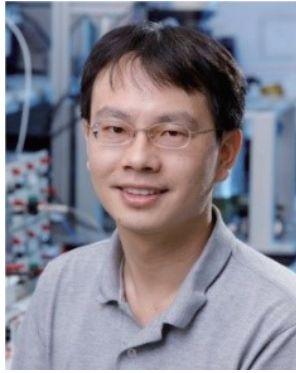
Ho Gyu YOON

Department of Materials Science and Engineering, Korea University

It is most important to maximize the dispersion and the interfacial interaction and compatibility of nanoparticles (NP) in order to achieve the synergistic effect of polymer, nanocarbon and nano-sized metals in nanocomposites. To this end, we synthesized pyrene-functionalized ionic block copolymers (PIB) such as poly(methyl methacrylate)-b-poly(dimethyl aminoethyl methacrylate) (PMMA-b-PDMAEMA) and poly(dimethylaminoethyl methacrylate)-b-poly[poly(ethylene glycol) methyl ether methacrylate] (PDMAEMA-b-PPEGMEMA) sblock copolymers, and nanocarbons such as MWCNT, GO, rGO and GNP were modified with the PIB. The PIB-modified carbon facilitated adsorption of metal precursor, resulting in compact decoration of metal NPs on the carbon surface and exhibiting that the catalytic hydrogenation activity substantially surpassed that of reference catalyst. we also report a facile route for the synthesis of uniform, large-area mesoporous metal NPs thin films based on ionic polymer doped graphene, which show enhanced activity and durability for oxygen reduction relative to commercial Pt/C. By modifying the surface of nanocarbons with the PIB the effect of the modified nanocarbons on the thermal and mechanical properties of polymeric composites are demonstrated.

### Keywords

Polymer Composites, Pyrene-Functionalized Ionic Block Copolymer, Nanocarbon, Oxygen Reduction, Physical Properties



**Chun-Jen HUANG**

Department of Chemical and Materials Engineering,  
National Central University, Taiwan

Education

- 2010 Ph.D Max-Planck Institute for Polymer Research and Johannes Gutenberg Universität Mainz, Germany
- 2003 M. S., National Taiwan University
- 2001 B. S., Chang Gung University

Professional Appointments

2015-present: Associate Professor, National Central University, Taiwan

2012-2015: Assistant Professor, National Central University, Taiwan

2011-2011: Post Doctor, Shaoyi Jiang's lab, University of Washington, WA

Research Interests

Biomolecular Interfaces, Biomaterials, and Biosensors—particularly on the Development of Zwitterionic-based Functional Materials for Biomedical and Engineering Applications

## **Zwitterionic Building Blocks for Development of Biomaterials**

Chun-Jen Huang

Department of Chemical & Materials Engineering, National Central University, Chung-Li, Taoyuan 320, Taiwan

R&D Center for Membrane Technology and Department of Chemical Engineering, Chung Yuan Christian University, Chung-Li, Taoyuan 320, Taiwan

This presentation will touch on development of functional self-assembled zwitterionic materials and their biomedical applications. Zwitterion is a electrolyte molecule, carrying both positively and negatively charged moieties to keep charge balance and strong hydration via ionic solvation. There is increasing interest in zwitterionic materials due to various combinations from different charged groups and robust fouling resistance. In current years, we have developed a molecular toolbox, containing different types of self-assembling zwitterionic molecules and building blocks for polymers. The zwitterionic self-assemblies enable to spontaneously and effectively modify all types of inorganic oxides and novel metals to afford biocompatibility, bio-inertness, and superhydrophilicity. In an attempt to use zwitterionic materials in more demanding applications, we designed the molecular structures for uses in thermodynamic therapy with plasmonic nanoparticles, biosensors, photo-responsive biointerfaces, coatings for catheters, oil-water separation, collection of rare cells and so on. Moreover, various zwitterionic building blocks for synthesis of functional polymers have been carried out. By implementing state-of-the-art polymerization technologies, we can fabricate sophisticated polymeric structures, such as linear, branched, crosslinked, and block polymers, which open a wide spectrum of imagination and medical applications. For example, the amino acid-based zwitterionic polymeric hydrogels can be used for reversible removal of heavy metals from complex fluids, such as blood, which will be extended to new therapeutic approach for heavy metal poisoning treatment and detection.



**Young-Ki KIM**

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Professional Appointments

- 06.24.2019 – Current: Assistant Professor, Department of Chemical Engineering, POSTECH
- 08.2018 – 06.2019: Postdoctoral Associate, Department of Chemical & Biomolecular Engineering, Cornell University, USA
- 08.2015 – 08.2018: Postdoctoral Associate, Department of Chemical & Biological Engineering, University of Wisconsin-Madison, USA
- 2015: Ph.D., Chemical Physics, Liquid Crystal Institute, Kent State University, USA

Awards & Achievements

- POSCO Science Fellowship, POSCO (2020)
- Materials Research Science and Engineering Center (MRSEC) Honored Scholar Award, University of Wisconsin-Madison (2018, 2017)
- Wisconsin Alumni Research Foundation (WARF) Invention Award, University of Wisconsin-Madison (2017, 2016)
- University Fellowship, Kent State University (2013-2014)
- Graduate Student Senate Award, Kent State University (2012-2013)



## **Design of Smart Polymer Printer using Liquid Crystallinity for Self-Healing and -Protecting Materials**

Young-Ki Kim

Chemical Engineering, POSTECH, KOREA

Liquid crystal (LC) is a phase of matters possessing both mobility of liquids and long-range molecular ordering of crystals, leading to anisotropic characteristics such as elasticity, dielectricity, and birefringence. The unique combination of properties has enabled LCs to be used for responsive/functional materials that can amplify a wide range of chemical/physical stimuli into macroscopic optical outputs. Recently, we have designed a new class of LC materials that not only optically report targeted stimuli but also transform their environment via triggered release of microcargo that is initially sequestered within the LC.<sup>1</sup> In this presentation, we will show that the smart LCs can be programmed to print three-dimensional polymeric structures with diverse sizes (from nanometer to millimeter) and morphologies (e.g., sphere, worm-like structure) via triggered polymerization. Specifically, we will demonstrate that it is possible to trigger the polymerization of hydrogels or amphiphilic polymers by hosting initiators and monomers within microcargo sequestered in LCs and then releasing them into a surrounding environment in response to programmed stimuli. The capabilities of smart polymer printer that can be designed for multi-scale responses, and diverse geometries (e.g., film, droplet) and size suggest the potential to create new class of self-healing and -protecting materials.

### References

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**Yuta NISHINA**

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Education

- 2007 M.S. Graduate School of Natural Science and Technology, Okayama University, Okayama, Japan
- 2010 Ph.D. Graduate School of Natural Science and Technology, Okayama University, Okayama, Japan

Professional Appointments

- 2008.04~2010.03: Research Fellowship for Young Scientists (DC2), Japan Society for the Promotion of Science
- 2010.04~2014.03: Special Appointed Assistant Professor, Research Core for Interdisciplinary Sciences, Okayama University, Okayama, Japan
- 2011.01~2011.02: Visiting Scientist, Florida State University, Florida, USA
- 2011.12~2012.01: Visiting Professor, Nanyang Technological University, Singapore
- 2013.10~2017.03: PRESTO Researcher, Molecular Technology research area, Japan Science and Technology Agency, Saitama, Japan
- 2014.03~2018.10: Associate Professor, Research Core for Interdisciplinary Sciences, Okayama University, Okayama, Japan
- 2017.04~2019.03: Visiting Associate Professor, The Institute of Scientific and Industrial Research, Osaka University, Osaka, Japan
- 2018.10~present: Research Professor, Research Core for Interdisciplinary Sciences, Okayama University, Okayama, Japan
- 2019.04~2020.03: Visiting Professor, The Institute of Scientific and Industrial Research, Osaka University, Osaka, Japan

Research Interests

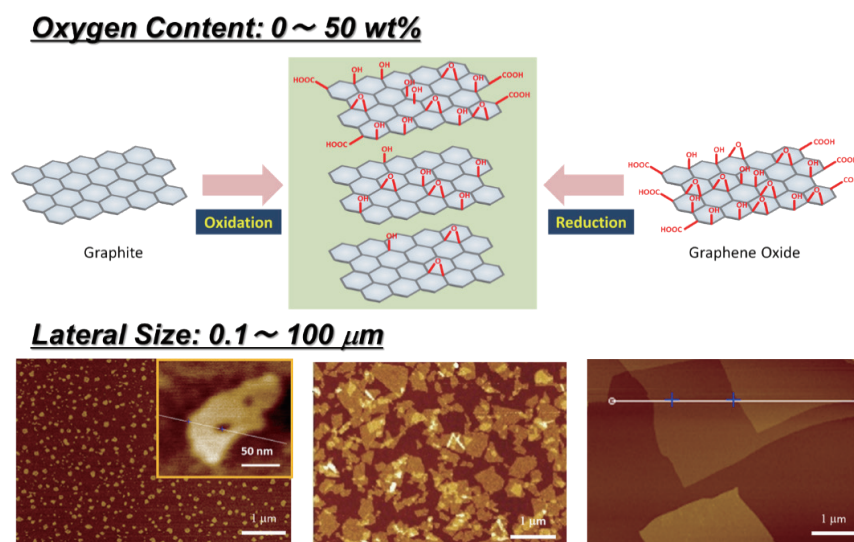
Nanocarbons, Graphene, Catalysis, Radical, Grafting, Composites, Energy Device

## Graphene-Polymer Composites: Synthesis and Applications

Yuta Nishina

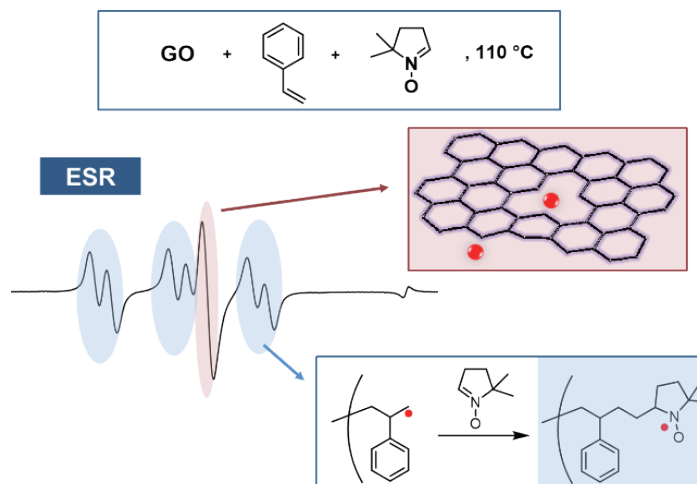
Research Core for Interdisciplinary Sciences, Okayama University, Okayama, Japan

Carbon nanosheets have been employed in various fields, but its structure and composition have still not been fully controlled. Among carbons, I have been focusing on graphene oxide (GO). Based on the formation mechanism of GO, we have developed general strategies to control the oxidation degree by two types of methods: oxidation of graphite by  $\text{KMnO}_4$  in  $\text{H}_2\text{SO}_4$  (oGO), and reduction of highly oxidized GO by hydrazine (rGO) (Figure 1). Even though the oxygen content was the same, oGO and rGO showed different properties in adsorption ability, oxidation ability, and electron conductivity, because of the difference in persisting graphitic structure and defects. These results will be a guideline to produce tailor-made GO.<sup>1</sup>



**Figure 1.** Tailoring the structure by oxidation of graphite or reduction of highly oxidized GO.

Applications such as conductive films, electrodes for lithium-ion batteries, supercapacitors, and catalysts often require surface functionalizations to improve GO's performances. With our tailor-made GO, we achieved grafting polymers on GO through radical pathway.<sup>2</sup> The grafting mechanism was clarified by in situ ESR measurements, employing a spin trap reagent. The radicals were generated by cleaving C-O bonds of GO during thermal treatment.<sup>3</sup>



**Figure 2.** Detection of radicals by ESR using a spin trap method.

#### Reference

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**Jung Tae PARK**

Department of Chemical Engineering,  
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Education

- Ph. D. in Department of Chemical and Biomolecular Engineering, Feb. 2012, Yonsei University, Republic of Korea
- B. S. in Department of Chemical Engineering, Feb. 2007, Yonsei University, Republic of Korea

Work Experiences

- Mar. 2020~present, Associate Professor  
Department of Chemical Engineering, Konkuk University, Seoul, Republic of Korea
- Mar. 2016~Feb. 2020, Assistant Professor  
Department of Chemical Engineering, Konkuk University, Seoul, Republic of Korea
- Dec. 2014~Feb. 2016, Assistant Professor  
Department of Flexible and Printable Electronics, Chonbuk National University, Jeonju, Republic of Korea
- Dec. 2013~Nov. 2014, Postdoctoral Associate  
Department of Chemical Engineering, Massachusetts Institute of Technology, USA
- May. 2012~Nov. 2013, Postdoctoral Associate  
Department of Chemical and Biomolecular Engineering, Yonsei University, Republic of Korea
- Jan. 2012~April. 2012, Visiting Scholar  
Department of Chemical and Biomolecular Engineering, University of Pennsylvania, USA

Professional Societies

- Member, Polymer Society of Korea
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## **A Double Comb Copolymer Approach for Morphological Control for Energy Conversion and Storage Device**

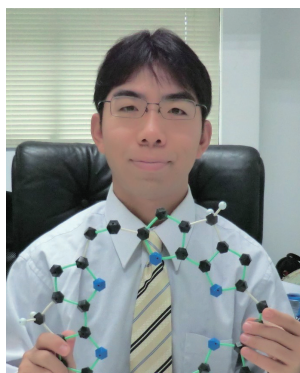
Jung Tae Park

Department of Chemical Engineering, Konkuk University, Seoul, Republic of Korea

New materials hold the key to fundamental advances in energy conversion and storage, both of which are vital in order to meet the challenge of global warming and the finite nature of fossil fuels. Double comb copolymers offer unique properties or combinations of properties as electrodes and electrolytes in a range of energy conversion and storage devices. Also, one of the key challenges facing the widespread use and commercialization of promising energy conversion and storage devices (*i.e.* solar cells, photoelectrochemical cells, electrochemical cells, supercapacitors etc.) is the high cost of the electrode and electrolyte materials and inefficiencies in their assembly and utilization. In this talk, I will present examples of how we are designing double comb copolymers that can be incorporated into multifunctional composites for high performance energy conversion and storage devices.

### Keywords

Double comb copolymer, Electrode, Electrolyte, Energy conversion, Energy storage.



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Education

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Professional Appointments

- 2004.04~2007.03: Special Postdoctoral Researcher, RIKEN, Wako, Japan
- 2007.05~2010.02: Postdoctoral Research Associate, School of Chemistry, University of Manchester, UK
- 2010.02~2014.07: Assistant Professor, Department of Chemical Engineering, National Tsing Hua University, Taiwan
- 2014.08~2018.07: Associate Professor, Department of Chemical Engineering, National Tsing Hua University, Taiwan
- 2018.8~present: Professor, Department of Chemical Engineering, National Tsing Hua University, Taiwan

Research Interests

Conjugated Polymers, Molecular Machines, Supramolecular Materials, Stimuli Responsive Materials

## Synthesis of Conjugated Polymers and Molecular Machines for Optoelectronic Applications

Masaki Horie

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Conjugated polymers have tremendous potential as the active components of organic electronic devices.<sup>1-4</sup> Typical conjugated polymers have been synthesized by step-growth polymerization, such as Suzuki and Stille couplings. In this presentation, I will report direct arylation polymerization for the synthesis of conjugated polymers for the high-performance lithium ion battery applications.<sup>2,4</sup> On the other hand, crystalline molecular machines undergo structural changes by external stimuli such as photoirradiation and heat.<sup>5-8</sup> Among them, rotaxanes and pseudorotaxanes composed of axle and ring molecules have structural flexibility because of their interlocked structures.<sup>5-9</sup> This study presents photoresponsive dynamic pseudorotaxane crystals comprising of azobenzene and ferrocenyl groups in an axle component threaded through crown ether rings.<sup>8,9</sup> Single crystals of the pseudorotaxane exhibit reversible bending motions caused by cis-to-trans photoisomerization of the azobenzene group using alternating 360 nm and 445 nm lasers. These pseudorotaxane crystals will lead to new type of optical, switching, memory, and mechanical devices.

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Education

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2014 B. S. in macromolecular science and engineering, Case Western Reserve University

Work Experiences

- Aug. 2020 – Current: Assistant Professor, National Sun Yat-sen University – Kaohsiung, Taiwan
- Apr. 2016 – June 2020: Graduate Research Assistant with the Huang group, Northwestern University
- Oct. 2014 – Feb. 2016: Graduate Research Assistant co-advised by both Stupp group and Olvera de la Cruz group, Northwestern University
- May 2012 – Aug. 2012: Visiting Scholar with the Landfester group, Max Planck Institute for Polymer Research
- Sept. 2010 – May 2014: Undergraduate researcher with the Ishida group, Case Western Reserve University

Patent

J. Huang; K. Chiou, Additive-free carbon nanoparticle dispersions, pastes, gels, and doughs. World Intellectual Property Org. 040564, February 28, 2019

## **A Versatile Cresols-Based System for Solution Processing of Carbon Nanotubes**

Kevin Chiou

Department of Materials and Optoelectronic Science, National Sun Yat-sen University

Carbon nanotubes can be mass-produced as powders, but they need to be disaggregated before being processed into useful devices. Since carbon nanotubes' discovery, extensive efforts were spent to find easily removable and effective solvents for nanotubes. We found that cresols, a group of methylphenols used extensively in the chemical industry, are surprisingly good solvents for processing carbon nanotubes. Cresols can disperse various types of carbon nanotubes at high concentrations of tens of weight percent without dispersing agents or additives. Cresols are effective because they interact with carbon nanotubes via a charge-transfer interaction through the phenolic hydroxyl proton. Even with the favorable interactions, this solvent can still be easily evaporated or washed without altering the surface of carbon nanotubes. As an effective solvent, cresols make carbon nanotubes behave like viscoelastic macromolecules with polymer-like processability. With increasing the nanotube concentrations, a nanotube mixture undergoes a continuous transition of four states including, a dispersion, a paste, a gel, and a kneadable, playdough-like material. As demonstrated with proof-of-concept applications, cresols can process powders of agglomerated carbon nanotubes directly into desirable functional structures.

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Professional Appointments

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- 2006.03~2008.03: Research Assistant, Tokyo University of Agriculture and Technology, Japan
- 2008.04~2012.09: Assistant Professor, Tokyo Institute of Technology, Japan
- 2012.10~present: Associate Professor, Tokyo Institute of Technology, Japan

Research Interests

Organic Semiconductors (D-A type molecules and polymers), Nonlinear Optics, Thin Film Transistors, Transistor Memory, Organic Solar Cells, Click Chemistry, Bio-based Polymers

## Designing Conjugated Polymers for Transistor and Photovoltaic Applications

Tsuyoshi Michinobu

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Conjugated polymers containing organic dye units often show excellent charge carrier mobilities. For example, diketopyrrolopyrrole (DPP), naphthalenedimide (NDI) and benzobisthiadiazole (BBT) are promising dye units to produce high-performance organic semiconducting polymers in thin film transistors and photovoltaic devices. We also demonstrated that carbazodioxazine (CZ) derivatives become a good semiconductor or an insulator by appropriate molecular design. The former was studied in thin film transistors, while the latter was employed as an electret in transistor memory devices. Charge carrier mobilities are correlated with thin film morphology, polymer packing orientation and crystallinity, which can be revealed by atomic force microscopy (AFM) and wide-angle X-ray scattering (WAXS). Structure-property relationship suggests that backbone planarity and high crystallinity are key to achieve high carrier mobilities.

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Education

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Work Experiences

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- Oct 2008~Feb 2012: Research Staff  
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- Oct 2005~Aug 2008: Postdoc Fellow  
Department of Polymer Science and Engineering (PSE), University of Massachusetts  
Amherst, US

Professional Societies

- Korea Polymer Society
- Korea Society of Industrial and Engineering Chemistry
- Associate Editor, Journal of Industrial and Engineering Chemistry (Elsevier)

## **Tailoring Hyper-Structured Conductive Materials for Detection and Removal of Potentially Hazardous Substances**

Joonwon Bae

Department of Applied Chemistry, Dongduk Women's University, Seoul, Republic of Korea

In this presentation, the preparation, characterization, and application of diverse hyper-structured conductive materials such as conducting polymer-based nanomaterials, carbon nanostructures, and hydrogels are discussed. The unique materials are prepared by simple micelle mediated approaches such as microemulsion, suspension, and dispersion methods. Also, the physical structures and behavior features of the obtained materials are investigated, that is, interesting properties of ultrathin polymer films were investigated under stimulated conditions. In addition, diverse strategies using the environmentally benign materials/structures derived from the above-mentioned materials for detection and control of potentially hazardous substances are demonstrated. Those techniques are practically transplanted into versatile sensor systems for better compatibility with wide range of materials and tissues. This study can provide information for future research activities.

Keywords

Conducting Polymer, Composite, Chemical Sensor, Oligosaccharide, Hydrogel



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Education

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Professional Appointments

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Research Interests

Covalent Polymer Mechanochemistry, Surface Modification, Polymer for Energy Harvesting

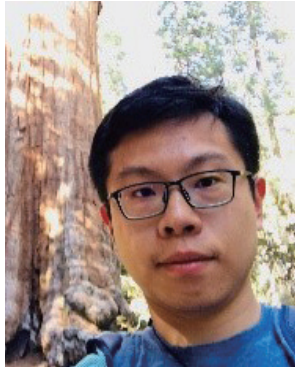
## **Designing Material Systems Featuring Mechanochemically Triggered Chemical Cascade**

Chia-Chih Chang

Department of Applied Chemistry, National Chiao Tung University, Hsinchu, Taiwan

Covalent polymer mechanochemistry offers many opportunities for constructing advanced material systems that are capable of stress-sensing, stress-strengthening and self-healing. Externally applied mechanical force can be exploited to promote selective chemical transformation in the overstressed region, resulting in the formation of new functional groups at the polymer chain scission point. Molecular engineering of mechanochemically responsive motifs provides a means for exploiting organic chemistry in the context of force-responsive materials. In this talk, we will discuss two material systems that are capable of undergoing retro-Diels-Alder reaction to unveil a highly fluorescent anthracene derivative or ring-opening reaction to enable delayed scission. Specifically, mechanically accelerated retro [4 + 2] cycloaddition of a anthracene-maleimide mechanophore allows for damage assessment in bulk materials, while the concept for programmable polymer degradation is demonstrated by utilizing mechanically triggered ring-opening of a [4.2.0]bicyclooctene mechanophore that sets up a delayed, force-free cascade lactonization.





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Education

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- 2017 Ph.D. School of Chemical & Biomolecular Engineering, Georgia Institute of Technology, Atlanta, USA

Professional Appointments

- 2017.06~2018.06: Postdoctoral Researcher, Department of Materials Science & Engineering, University of California, Berkeley, USA
- 2018.08~present: Assistant Professor, Department of Chemical Engineering, National Cheng Kung University, Tainan, Taiwan

Research Interests

Novel Strategy for Peptide Synthesis, Functional Materials for Additive Manufacturing, Sustainable Polymers

## Sustainable Peptide Synthesis and the Development of Functional Materials for 3D Printing

Sheng-Sheng Yu

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Polymers have been widely used in various applications in today's world. However, most polymers are synthesized from petrochemical feedstock. The consumption of petrochemical resources and waste disposal might become a challenge in the future. Our work is to develop green processes to synthesize polymeric materials with new functionalities from sustainable feedstock.

We will first introduce our recent development of sustainable peptide synthesis. Polypeptides are high-value products in the food and pharmaceutical industries. However, the mass production of polypeptides needs large amounts of organic solvents and expensive coupling agents. Here, we combine deep eutectic solvents (DESs) and ester-mediated amide bond formation as a new route for the synthesis of polypeptides. Glycolic acid and tetraethylammonium chloride (TEACl) formed DES as a solvent to dissolve amino acids. Glycolic acid then copolymerized with amino acids by esterification and ester-amide exchange reaction. We demonstrated DES could regulate the reaction pathways and promote the formation of amino acids-enriched oligomers with peptide backbones. Overall, we achieved both high yield and high selectivity of peptide synthesis by introducing DESs as renewable solvents.

Next, we develop a 3D printable ink from cellulose nanocrystals (CNCs), DESs and ionically cross-linked polyacrylic acid (PAA). DES serves as a non-volatile medium with high ionic conductivity. The dispersion of CNCs in a mixture of DES, acrylic acid, and  $Al^{3+}$  ion, formed gels with reversible physical networks for 3D printing. The photo-polymerization of acrylic acid led to a second ionically cross-linked network. The first physical network of CNCs provided an energy-dissipating mechanism to make a strong and highly stretchable nanocomposite ionogel. We further 3D printed an auxetic sensor with negative Poisson's ratios, so that the sensor provided a conformal contact with the skin during large deformation. The auxetic sensor could continuously monitor and identify different motions of the human body by the change of resistance. These results demonstrate a simple and rapid strategy to fabricate stable and sensitive strain sensors from renewable feedstock.

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## **Sadaki SAMITSU**

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### Education

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- 2006 Ph.D. Department of Applied Physics, Faculty of Engineering, The University of Tokyo, Japan

### Professional Appointments

- 2006.4~2009.3: Postdoctoral Fellow, Division of Physics and Astronomy, Faculty of Science, Kyoto University, Japan
- 2009.4~2014.3: Researcher, Organic Nanomaterials Center, National Institute for Materials Science, Japan
- 2014.4~2020.3: Senior Researcher, Polymer Materials Unit, National Institute for Materials Science, Japan
- 2020.4~present: Principal Researcher, Research and Services Division of Materials Data and Integrated System, National Institute for Materials Science, Japan
- 2021.4~present: Professor, Department of Nanoscience and Nanoengineering, Faculty of Science and Engineering, Waseda University

### Research Interests

Porous Polymer, Nanoporous Polymer, Mesoporous Polymer, Polymer Nanofiber, Polymer Processing, Fabrication of porous polymers, Crystallization, Phase Separation Phenomenon, Membrane Science, Organic Absorbent, Thermal Insulation, Shock Absorbing Material, Materials Informatics, X-ray CT

## **Nanoporous Polymers: Fabrication, Characterization and Applications**

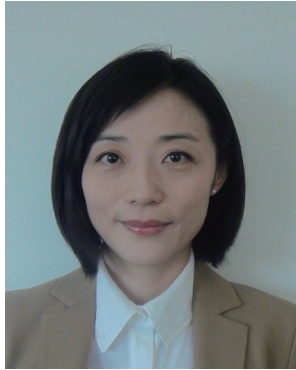
Sadaki Samitsu

National Institute for Materials Science (NIMS), Japan

Nanoporous polymers have been industrially used in valuable products such as large-scale separator sheet of Li-ion batteries, hollow fiber membranes for medical usage, and high-performance membrane and adsorbent for gas and water purification. New development of fabrication methodology of nanoporous polymers is therefore a key challenge that will make it possible to launch new applications. Here we have developed new concepts of nanoporous polymer fabrication: flash-freezing nanocrystallization and physical gel precursor methods. Using commercially-available polymers such as polystyrene and engineering plastics, these methods provide a membrane, a fiber, and a monolith of mesoporous polymers with large specific surface areas (over 300 m<sup>2</sup>/g). The mesoporous polymers are useful as separation membranes and adsorbents for water purification and gas separation.

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Education

Mar/2012 Ph.D., Chemical Engineering, University of California, Santa Barbara

Feb/2002 M.S., Chemical Engineering, Seoul National University, Korea

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Current Position

Mar/2019-present: Associate Professor, Chonnam National University, Korea

Mar/2015-Feb/2019: Assistant Professor, Chonnam National University, Korea

Research Interest

Statistical Mechanical Theory and Field-/Particle-based Simulations to Investigate  
Structural, Thermodynamic, and Dynamic Phenomena in Soft Materials

Academic Honors, Awards & Fellowships

- 2017: ASML Tech Talk Young Prof. Award | ASML Korea
- 2010: Doh Wonsuk Memorial Award | Korean Institute of Chemical Engineering US Chapter
- 2009, 2010: IBM Ph.D. Fellowship Award | IBM

## Challenges in Numerical Studies of Polymeric Systems

Su-Mi Hur

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The self-assembly in various polymeric systems is the core principle of many advanced nanotechnologies. Theoretical and numerical studies have provided valuable insights into understanding the underlying physical principles in the self-assembly of polymeric systems and powerful tools and guidelines for designing experiments. Especially, coarse-grained fields- or particle- base models have successfully predicted equilibrium morphologies of self-assembled structures and have assisted in finding feasible ways to control the shape, size, and arrangement direction of self-assembled structures. However, often complicated interactions, non-flat free surface, high sensitivity on various system parameters, a wide range of length and time scales related to self-assembled structures prevent the usages of existing theoretical/numerical models which only applicable in limited cases. In this presentation, I would like to present our efforts on overcoming the limitation of existing models and extending the scope of numerical approaches to describe experimentally observed microstructures, to predict new mesophases, to examine the suitability of different polymeric systems, as well as to provide the kinetic routes between various microphases in polymeric self-assembly. Here, we propose an efficient coarse-grained model that allows predicting the morphology of amphiphilic BCPs system over a wide range of chain architecture, concentrations, and solvent qualities. Model parameters are directed mapped to solvent quality and interfacial tensions of the systems through scaling analysis of single-chain size and molecular dynamic simulations.



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Education

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Professional Appointments

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- 2008.09~2012.03: Research Assistant Professor, Research Institute for Science and Engineering, Waseda University, Tokyo, Japan
- 2012.08~2016.03: Assistant Professor (tenure track), Waseda Institute for Advanced Study, Waseda University, Tokyo, Japan
- 2016.04~2021.03: Assistant Professor (tenured), Department of Applied Chemistry, Waseda University, Tokyo, Japan
- 2021.04~Present: Associate Professor, Department of Applied Chemistry, Waseda University, Tokyo, Japan

Research Interests

Functional Polymers, Organic Electronic Devices, Energy-conversion/–storage, Phase-separation and Self-assembly, Polymer interface, In-situ reaction

## **Adaptive Material Design for Smart Coating: CO<sub>2</sub> Capture and Beyond**

Takeo Suga

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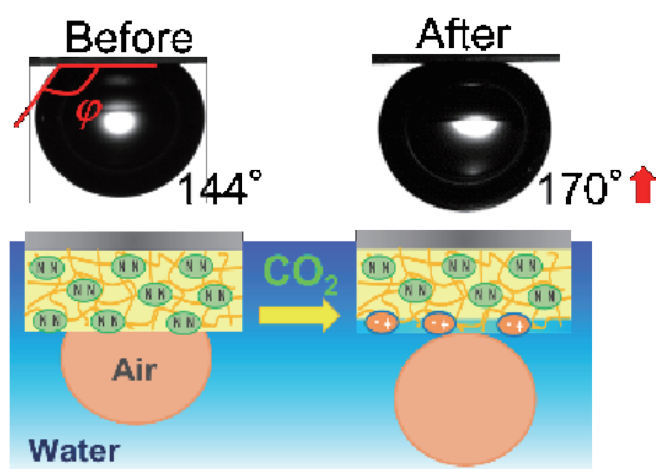
Marine biofouling is a global issue for marine industries related to fuel efficiency loss, material durability, and marine environment. Conventional marine coatings containing copper or zinc metals, or siloxane polymer are widely used, however, new development of “metal-free” coatings for anti-fouling and self-cleaning have been strongly desired to reduce a negative impact on the marine environment.<sup>1</sup> Among these approaches, superhydrophilic surface based on zwitterion (e.g., sulfobetaine or phosphorylcholine) polymer brushes have been proposed as anti-fouling or self-cleaning surface to avoid cell adhesion.<sup>2</sup> The zwitterion-based superhydrophilic surfaces are also attractive to deliver additional anti-fogging and anti-icing property. “Polymer brush” approach provides a mechanically durable surface, but the procedure of surface-initiated controlled radical polymerization requiring the strict oxygen-free conditions, etc, is rather difficult to cover large surface area and thick layer (tens of micrometers). In practical point of views, the coatings should be durable under the operating conditions, and even after the abrasion under water flow conditions, the coating performance should be recovered.

Compared to intrinsic zwitterion polymers above, we propose an alternative design of diamine-containing, reactive polymers to accumulate CO<sub>2</sub> at water interface, which transform from neutral to zwitterion group in-situ. Aliphatic and aromatic amine derivatives have attracted much attention as absorbents to capture waste CO<sub>2</sub> in the industrial processes.<sup>3</sup> The formed carbamic acids release CO<sub>2</sub> and are recovered reversibly. Here we design various diamine derivatives to capture/bind CO<sub>2</sub> more strongly, and incorporated into the polymer coating for anti-fouling applications.

Aqueous solutions of various diamine derivatives (primary to tertiary amines with different spacer lengths) were treated with CO<sub>2</sub>, and in-situ NMR spectra estimated the ratio of zwitterion to dication species. CO<sub>2</sub>-responsive diamine polymer was synthesized and added to epoxy thermosets. Thermally cured coating exhibited surface property change by CO<sub>2</sub> addition under water. Not only bubbling CO<sub>2</sub>, but also atmospheric CO<sub>2</sub> concentration (300 ppm) allowed surface property change. Contact angle measurement indicated drastic decrease in interfacial tension between water and surface. Swelling behavior of the crosslinked polymer layer will be discussed by In-situ AFM and neutron reflectivity.



Further molecular design to capture atmospheric CO<sub>2</sub> to transform surface property of the polymer coatings will be also discussed.



**Figure.** Wettability switching of diamine polymer surface via CO<sub>2</sub> capture

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Education

2016 Doctor of Philosophy in National Taiwan University, Taipei, Taiwan

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Professional Appointments

- 2021-now: Assistant Professor, Department of Photonics, National Cheng Kung University
- 2018-2021: Assistant Professor, Department of Chemical Engineering, National Chung Chang University
- 2016-2018: Postdoctoral Fellow, Department of Chemical Engineering, National Taiwan University
- 2015-2016: Visiting student, Department of Material Science Engineering, University of Washington

Research Interests

Polymer Physic and Engineering, Perovskite, Composite Material, Electrospinning, Soft Optoelectronic

## Ultrafast Responsive Non-Volatile Flash Photomemory Via Spatially Addressable Perovskite/Block Copolymer Composite Film

Jung-Yao Chen

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The exotic photophysical properties of organic-inorganic hybrid perovskite with long exciton lifetime and small binding energy have appeared as promising front-runners for next-generation non-volatile flash photomemory. However, the long photo-programming time of photomemory limits its application on light-fidelity (Li-Fi), which requires high storage capacity and short programming time. Herein, the spatially addressable perovskite in polystyrene-*block*-poly(ethylene oxide) (PS-*b*-PEO)/perovskite composite film as photoactive floating gate was demonstrated to elucidate the effect of morphology on the photo-responsive characteristics of photomemory. The chelation between lead ion and PEO segment promoted the anti-solvent functionalities of perovskite/PS-*b*-PEO composite film, thus allowing the solution-processable poly(3-hexylthiophene-2,5-diyl) (P3HT) to act as the active channel. Through manipulating the interfacial area between perovskite and P3HT, fast photo-induced charge transfer rate of  $0.056 \text{ ns}^{-1}$ , high charge transfer efficiency of 89%, ON/OFF current ratio of  $10^4$  and extremely low programming time of 5 ms can be achieved. This solution-processable and fast photo-programmable non-volatile flash photomemory can trigger the practical application on Li-Fi.

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5. Ercan E., Chen J.-Y., Shih C.-C., Chueh C.-C., \* Chen W.-C. \* *Nanoscale*, 2018, 10, 18869-18877

