OMU-UNSW Joint Symposium on Engineering Research by Women

24 November, 2023

Osaka Metropolitan University
Nakamozu campus

Program and abstract book

Program

14:00	Opening
14:00-14:15	Opening remarks and brief overview of the faculty of engineering at OMU
	Prof. Satoru Watano (Dean, Faculty of Engineering)
14:15-14:30	Brief overview of the faculty of engineering at UNSW
	Prof. Cordelia Selomulya
	(Associate Dean (Research), Faculty of Engineering)
14:30-14:45	Designing functional particles via spray drying
	Prof. Cordelia Selomulya
	(Associate Dean (Research), Faculty of Engineering)
14:45-16:05	Flash presentations* from UNSW and OMU women researchers (invited)
16:20-18:00	Poster presentations from UNSW and OMU women researchers (invited)
18:00-19:30	Mixing party
19:30	Closing

*5 min per person, 8 invited speakers from UNSW and 6 invited speakers from OMU

Lists of invited speakers from UNSW

Name	Affiliation	Title
Prof. Cordelia Selomulya	Associate Dean Research, Faculty of Engineering	Brief overview of the faculty of engineering at UNSW Designing functional particles via spray drying
Dr. Reem Almasri	Biomedical Engineering	Flexible Liquid Crystal Based Optrodes for Electrophysiological Signal Recording
Dr. Yu Jing	Petroleum Engineering	Black coal can be green: CO2 geo-storage in underground coal seams
Dr. Woojeong Kim	Chemical Engineering	Processing strategies for sustainable food proteins
Dr. Jingyao Wu	Electrical Engineering	Can AI Track Emotions from Speech?
Dr. Shiva Abdoli	Mechanical engineering	A target-driven decision support framework for product life cycle management with a Circular System of Systems approach
Dr. Chen Han	Chemical Engineering	Solar-driven production of green fuels for a sustainable future
Dr. Imrana Kabir	Mechanical engineering	Planet on Fire: Optimisation of additives to maximise performance of expandable graphite based intumescent flame-retardant polyurethane composites
Dr. Yinyan Liu	Electrical Engineering	Energy Transition Technologies for Both Demand and Supply Sides

UNSW invited speakers are female researchers that have been selected for the Rising Stars workshop in University of Tokyo.
https://risingstarsasia.org/index.php

Lists of invited speakers from OMU

Name	Affiliation	Title
Prof. Satoru Watano	Dean, Faculty of Engineering	Overview of Faculty of Engineering at OMU
Dr. Shiho Tokonami	Department of Applied Chemistry	Development of Bacterial Captured Substrate and its Application to Microbial Power Generation
Dr. Chihiro Nakagawa	Department of Mechanical Engineering	Component technologies towards self-driving Personal Mobility Vehicles
Dr. Chie Kojima	Department of Applied Chemistry	Dual stimuli-responsive dendritic polymers and their applications
Dr. Etsuko Kusukawa	Department of Electrical and Electronic Systems Engineering	Evolutionary game analysis in biofuel supply chain under government intervention
Dr. Asuka Takai	Department of Mechanical Engineering	Motor learning support robots and systems for people in need of rehabilitation and training
Dr. Arisa Fukatsu	Department of Material Science	Multifunctional DNA-based hydrogels crosslinked by coordinate bonds

Designing functional particles via spray drying

Cordelia Selomulya*

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Spray drying is a versatile method to generate functional particles for different applications, depending on feed material properties, formulation, and pre- and post-treatments. This talk will provide an overview of the design and assembly of functional particles, including thermal sensitive and bioactive particles, microparticles for controlled release and microencapsulation, magnetic and fluorescent composites, and mesoporous microspheres with hierarchal structures and properties superior to those observed on nanomaterials via spray drying [1]. In particular, the use of microfluidic spray drying that can generate uniform particles with tightly controlled characteristics and targeted properties helps us to develop the understanding of how particles with different microstructures are formed, and how the physicochemical properties of feed materials are related to the functionality of the particles. The underlying principles of particle formation mechanisms are applicable for diverse particles such as core-shell, mesoporous, and magnetic particles, with examples given for applications in targeted drug delivery, catalysis, bio-adsorption, functional foods, and others [2-3]. The knowledge is useful for designing spray-dried particles for specific applications, including new formulations of spray-dried powders for commercial productions [4].

References:

[1] Wu, Z., Wu, D.W., Liu, W., Selomulya, C., Chen. X.D., Zhao, D. (2013) Angewandte Chemie, 125:51, 14009-14013
[2] Chakraborty, A., Royce, S. G., Plebanski, M., Selomulya, C. (2019) International Journal of Pharmaceutics, 570, 118654.
[3] Ye, Q., Ge, F., Wang, Y., Wu, P., Chen, X.D., Selomulya, C. (2022) Food Chemistry, 372, 131327.
[4] Luong, V., Wang, Y., Zurrer, T., Scott, A., Selomulya, C. (2022) Industrial & Engineering Chemistry Research, 61, 28, 9950-9961.

Cordelia Selomulya is a Professor at the School of Chemical Engineering and the Associate Dean Research for the Faculty of Engineering, UNSW Sydney. Her research journey took her from figuring out how to separate solids for water treatment, to synthesising nanoparticles for vaccine delivery, to improving the properties of milk and food powders, and to create added value products using plant proteins. She is the Research and Commercialisation Director of Future Food Systems CRC, with the mission is to develop smart, sustainable, resilient food systems in Australia to add value to our primary produce and improve food security.

Flexible Liquid Crystal Based Optrodes for Electrophysiological Signal Recording

Reem M. Almasri[1*], Amr Al Abed[1], Nigel H. Lovell[1,3]

[1] Graduate School of Biomedical Engineering, University of New South Wales, Sydney, Australia. [2] Tyree Foundation Institute of Health Engineering, University of New South Wales, Sydney, Australia.

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The use of optical techniques in electrophysiology research has recently garnered significant attention, as numerous efforts strive to develop cutting-edge neural interfaces. Optical-electrodes (optrodes) utilizing liquid crystal technology have exhibited great promise for detecting extracellular activity in excitable cells by passively transducing electrical impulses into quantifiable optical signals [1]. Our research team presents a new flexible version of this technology to enable better interfacing with soft tissues through incorporating polymeric materials and components.

The findings underscore the successful development of a scalable fabrication process for flexible optrode sensors, resulting in a functioning prototype with remarkable mechanical flexibility and no impedance-related complications. The functional characteristics of the flexible sensor are comparable to its rigid counterpart, indicating its potential for future biopotential activity recording. These outcomes not only offer valuable insights into more effective solutions for electrophysiology recording but also broaden the range of applications for optrode sensors to include direct interfacing with various biological tissues.

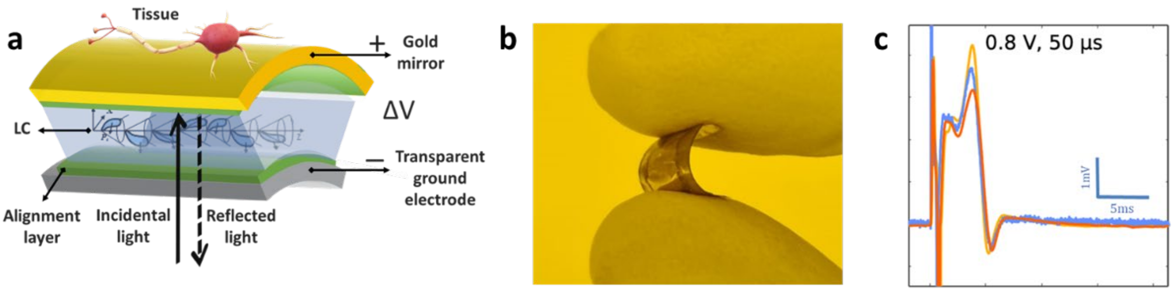

Fig. 1. a) Schematic of a flexible optrode implemented as a ferro-electric liquid crystal cell showing the working principle of this technology. b) A single flexible optrode as developed and fabricated at UNSW. c) Optrode sensing of stimulus-evoked nerve responses.

References

[1] Al Abed, Amr, et al. (2022). Liquid crystal electro-optical transducers for electrophysiology sensing applications. Journal of Neural Engineering, 19(5), 056031.

[SHORT BIOGRAOHY] Dr. Reem Almasri is a Research Associate at the Graduate School of Biomedical Engineering, UNSW working in the fields of brain/machine interfaces, electrophysiology, material characterization, and microfabrication of implantable devices and biomedical sensors. A key theme of her work is designing flexible interfaces and bio-integrated technologies. Reem is currently working on developing flexible photonics-based sensors to detect cardiac and neural electrophysiology using polymers and liquid crystals. As an active member of IEEE Women in Engineering (WIE), she aspires to create a more inclusive and diverse environment in the scientific community. Apart from her professional pursuits, she was born in Syria, and she enjoys travel and adventure, enriching her life with diverse interests.

Black coal can be green: CO2 geo-storage in underground coal seams

Yu Jing[1*], Peyman Mostaghimi[1], Ryan Armstrong[1]

[1] School of Minerals and Energy Resources Engineering, University of New South Wales, Australia

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Due to the cumulative release of greenhouse gases into the atmosphere, the Earth is warmer than ever, causing more large scale and irreversible climate changes. To achieve net zero emission goal to mitigate the global warming issues, CO_2 is captured from air and then permanently stored in underground formations, for example underground coal seams. Different with other geological materials, coal naturally has a high adsorption affinity for CO_2, which makes the abundant reserves become a good option for CO_2 geological storage site.

However, the process of injecting CO_2 into underground coal seams for geological storage is a highly complicated process, which is yet to be understood in depth. Due to its complex heterogenous structure, the underlying multiphysical phenomena are spatially localised as well as time-dependant. In this work, Positron Emission Tomography (PET) imaging, a nuclear imaging technology, is performed to reveal time-lapse CO_2 flow kinetics in coal by using [11C] CO_2 as the radioactive tracer [1]. From PET images, the processes of CO_2 spreading, trapping, migrating and interacting in coal are all observed. Meanwhile, a hydro-mechanical-thermal coupled model is developed to simulate multiphysics CO_2 flow in coal [2]. The simulation is performed based on the digital coal structure obtained by X-ray computed tomography (micro-CT) imaging. By combining PET image data with modelling results, we can fill knowledge gaps from the fundamental basis, and enhance CO_2 geological storage efficiency and safety in coal seams.

References

[1] Jing, Y. et al. (2024). Visualisation of [11C] CO2 storage in coal with positron emission tomography imaging. Fuel, 356, 129511.

[2] Jing, Y. et al. (2020). A hybrid fracture-micropore network model for multiphysics gas flow in coal. Fuel, 281, 118687.

[SHORT BIOGRAOHY] Dr Yu Jing is a Scientia Lecturer in the School of Minerals and Energy Resources Engineering at the University of New South Wales (UNSW). She obtained her PhD degree from UNSW in 2017, and was then awarded UNSW Scientia Fellowship in 2019. Her research focuses on characterising formation rocks to gain insights of underground fluids transport and storage behaviours, so as to seek solutions for geological storage of carbon dioxide and hydrogen energy, and extraction of earth energy resources.

Processing strategies for sustainable food proteins

Woojeong Kim[1,*], Yong Wang[1], Cordelia Selomulya[1]

[1] School of Chemical Engineering, UNSW Sydney, Australia

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An urgent need for sustainable and healthy food systems accelerates the development of superior plant-based ingredients and manufactured food products based on plant ingredients. Plant proteins serve as the primary macronutrient in plant-based foods, while there still remain issues in consumer behavior towards plant-based alternatives due to their unsated taste, texture, and quality. Plant/dairy protein blends have recently emerged as novel ingredients suitable for food application with improved functionality in addition to their textural, sensory, and nutritional properties. In this presentation, processing strategies for plant/dairy protein blends are introduced to improve the protein functionality, enabling their uses as emulsifiers and carriers for lipophilic bioactive compounds. State-of-the-art spectroscopic techniques such as microfluidic modulation spectroscopy and synchrotron infrared microspectroscopy were applied to analyze protein structure and composition. Innovative food processing technologies could broaden the application of plant/dairy protein blends to emulsions and functional particles.

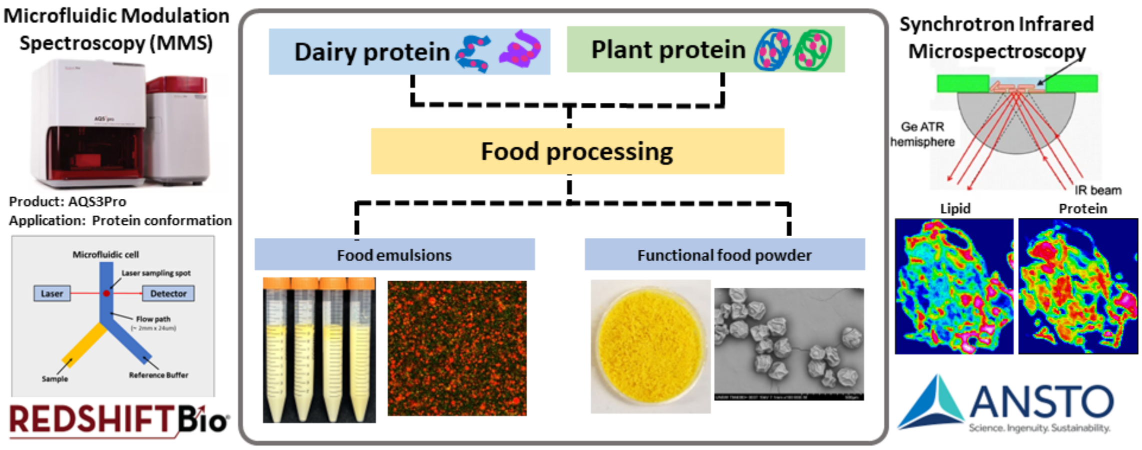

Figure 1. An overview of the application of plant/dairy protein blends and state-of-the art spectroscopic analytical techniques.

[SHORT BIOGRAOHY] Dr. Woojeong Kim is a Research Associate in the School of Chemical Engineering, UNSW Sydney. She received her PhD in Food Science and Technology from UNSW Sydney in 2023. Her research focuses on food processing technologies, food engineering, and protein structure, and functionality. She is particularly interested in improving the functionality of plant proteins by interacting with other macro/micromolecules including polysaccharide, dairy proteins, polyphenols, etc. for emulsion stabilization and microencapsulation. She is a pioneer in applying cutting-edge spectroscopic analytical techniques such as synchrotron-FTIR and microfluidic modulation spectroscopy (MMS) to food science.

Can AI Track Emotions from Speech?

Jingyao Wu[1*]

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*Website: https://sites.google.com/view/jingyaowu

Speech is one of the most natural ways of transmitting information, and speech-based emotion recognition (SER) facilitates more seamless human-machine interactions. Emotion is complex, ambiguous and it evolves. This study addresses the intricacies of emotion recognition with a dual focus: the exploration of emotion ambiguity and the modeling of temporal dynamics within emotional attributes, subsequently integrating them into SER systems. The research develops probabilistic frameworks to capture the ambiguity in continuous emotional labels and employs dynamical models to capture the temporal dynamics. Innovative machine learning and deep learning frameworks have been developed to capture these complex emotional characteristics, providing valuable insights for the field of emotion recognition.

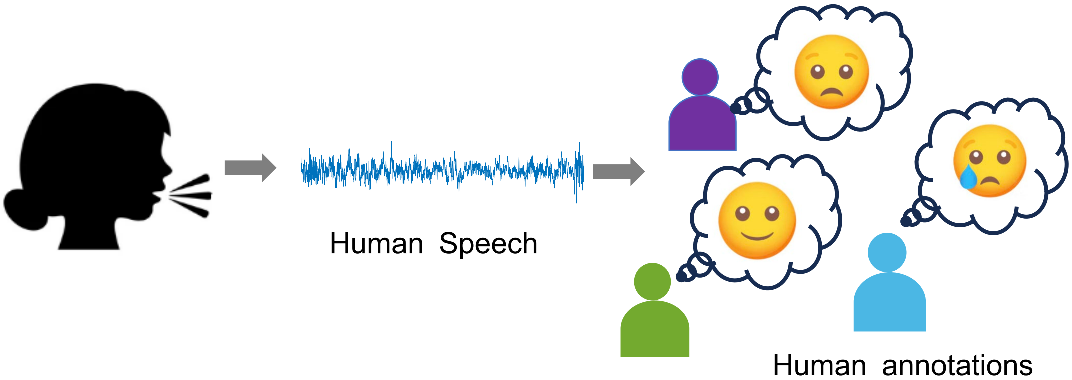

Fig. 1. Emotion perceptions from speech.

[SHORT BIOGRAOHY] Jingyao WU received the BE (Hons) degree in Telecommunications Engineering from the University of New South Wales (UNSW), Sydney, Australia, in 2020, where she is currently working toward the PhD degree in signal processing. During her PhD studies, she has authored or co-authored papers in both journals and conferences, where she also received the Best Paper Award at ACII2023, MIT Media Lab. Her research interests include affective computing, speech processing, time series analysis and machine learning.

A target-driven decision support framework for product life cycle management with a Circular System of Systems approach

Shiva Abdoli [1, 2*]
[1]School of Mechanical and Manufacturing Engineering, University of New South Wales, Sydney, Australia
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- A decision support framework as a digital twin of product system lifecycle in its supply chain
- A system of systems architecture to identify enablers /interactions influencing realization of CE when implementing End of Life solutions as R-strategies (reuse, recycle, …).
- Digital twin equipped with Machine Learning for dynamic optimization of planning/control parameters through product system various lifecycles to meet sustainability targets.

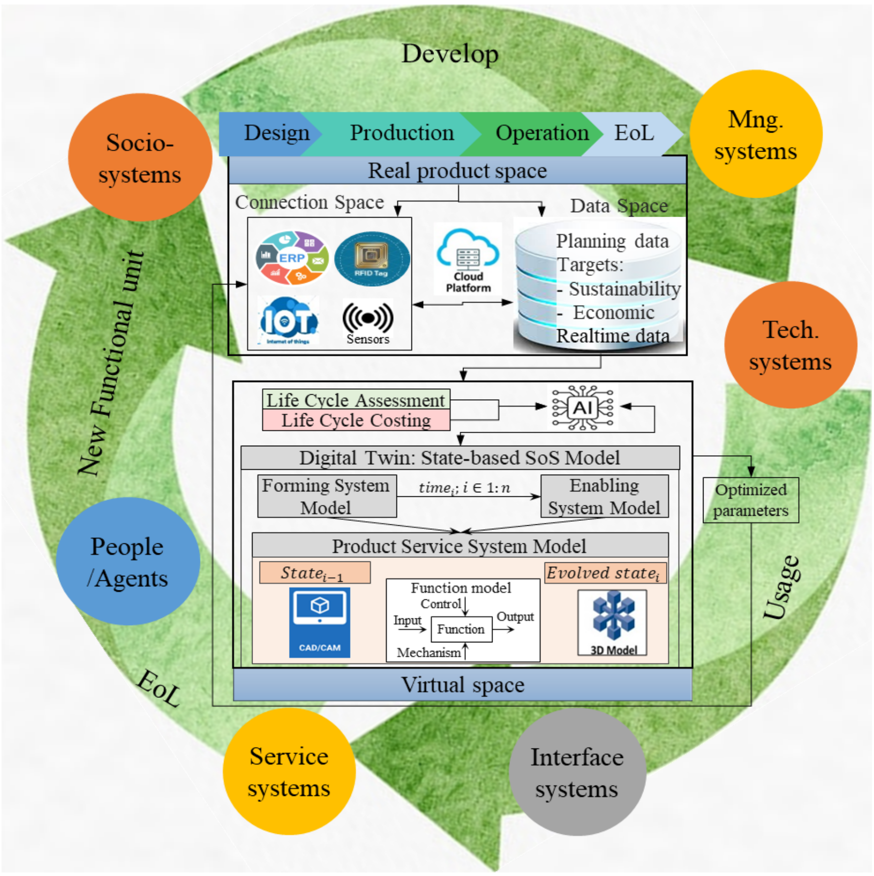

Fig. 1. Target Driven Digital Twin

Dr Shiva Abdoli is a lecturer in School of Mechanical and Manufacturing Engineering, UNSW. She worked as a researcher in KTH university, Sweden before joining UNSW in 2014. She has been active in industry in different roles including Project and Production manager and currently is leading various industry-based research projects. Her research includes Product Life Cycle Management, Industry 4.0, Sustainable Production-Logistic Systems, and Circular Economy.

Solar-driven production of green fuels for a sustainable future

Chen Han[1], Jian Pan[1*], Xiaojing Hao[2*] and Rose Amal[1*]

[1] School of Chemical Engineering, University of New South Wales, Sydney, Australia.
[2] School of Photovoltaic and Renewable Energy Engineering, University of New South Wales, Sydney, Australia.

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Solar-driven green fuels production has emerged as a promising solution to address the challenges posed by energy crisis and climate change. By harnessing the abundant and renewable energy from the sun, this approach aims to convert solar energy into valuable chemicals and fuels using water, air, CO_2 emissions and wastes. However, the technology is still pending for improvement and optimization to maximize solar utilization efficiency.

This study focuses on designing novel photovoltaic devices and highly efficient catalysts to develop a comprehensive (photo)electrochemical system capable of producing target products at an industrial relevant rate. In-depth investigations, employing advanced characterizations, particularly in-situ techniques, have been conducted to gain a thorough understanding of material properties and complex reaction mechanisms. Furthermore, modeling calculations and feasibility analyses have been employed to enhance theoretical understanding and evaluate economic viability, respectively. The advancements of this work in materials science, energy conversion technologies, and system engineering are paving the way for solar-driven synthesis in rational design and practical application. This study will contribute to the transition towards a carbon-neutral and sustainable energy society.

[SHORT BIOGRAOHY] Ms. Chen Han holds a bachelor's degree from the China University of Petroleum and a master's degree from the East China University of Science and Technology. Currently, she is a fourth-year PhD student in Chemical Engineering at the University of New South Wales (UNSW), under the supervision of Professor Rose Amal, Professor Xiaojing Hao, and Dr. Jian Pan. Her doctoral research focuses on 'Solar-to-fuel conversion through (photo)electrochemical processes'. She will be a postdoctoral research fellow at the University of Cambridge starting in 2024. She has published 18 articles, h-index 11.

Planet on Fire: Optimisation of additives to maximise performance of expandable graphite based intumescent flame-retardant polyurethane composites

Imrana Kabir[1*], Juan Baena[1], Cheng Wang[1], Guan Yeoh[1]

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The effect of varying the weight percentage composition (wt.%) of low-cost expandable graphite (EG), ammonium polyphosphate (APP), fibre glass (FG) and vermiculite (VMT) in Polyurethane (PU) polymer was studied using a traditional intumescent flame retardant (IFR) system. The synergistic effect between EG, APP, FG and VMT on the flame-retardant properties of the PU composites was investigated using scanning electron microscope (SEM), thermal gravimetric analysis (TGA), tensile strength tests, and cone calorimetry. The IFR that contained PU composites with 40 wt.% EG displayed superior flame-retardant performance compared with the composites containing only 20 wt.% or 10 wt.% EG. The peak heat release rate, total smoke release (Fig. 1) and carbon dioxide production from the 40 wt.% EG sample along with APP, FG and VMT in the PU composite was 88%, 93% and 92% less than the PU control sample, respectively. These new PU composite materials provide a promising strategy for producing polymer composites with flame retardation and smoke suppression for construction materials.

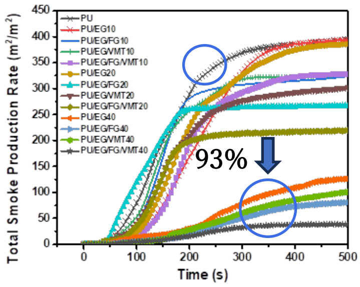

Fig. 1. Total smoke production (TSP).

Dr Imrana Kabir is currently a Lecturer in the School of Mechanical and Manufacturing Engineering, UNSW Sydney. She is actively involved in research of novel materials and designs aimed at developing new approaches to the thermomechanical response of fire conditions. Her current research foci are on models and simulations of flame-retardant, eco-composite, green, biodegradable, photocatalyst, recyclable, and transformable materials. Recently, she is collaborating with European institutions working on wildfires.

Energy Transition Technologies for Both Demand and Supply Sides

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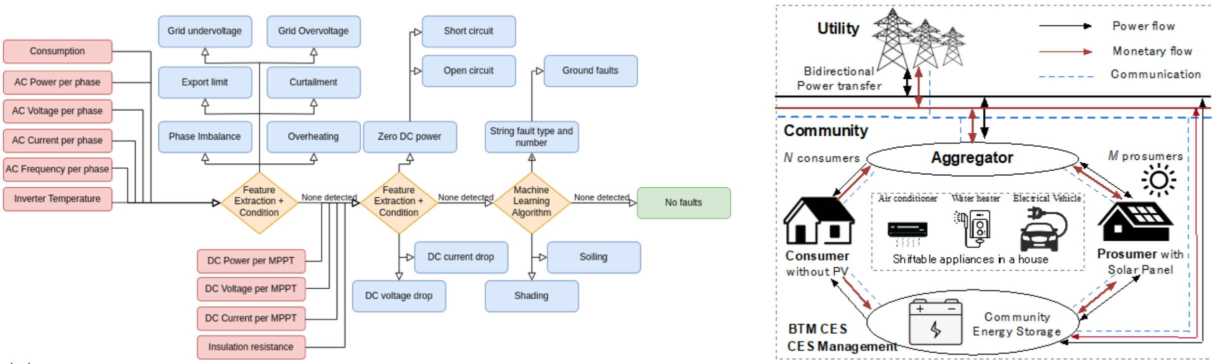
From the supply side, the rapid evolution of Photovoltaic (PV) technologies and the proliferation of PV systems emphasizes the need for more efficient and cost-effective monitoring strategies to ensure reliable operation and energy efficiency [1].



(a) Workflow for diagnosing underperformance in PV systems (b) Community energy management

Figure 1. Work for energy transition at both supply and demand sides.

On the demand side, energy communities appear as new participants that search the aggregation of energy resources to offer the flexibility required by the grid through energy storage and demand response (DR) capabilities [2]. Energy can be managed/scheduled cooperatively at the community level from a local economic and environmental perspective. Users within the community can obtain energy cooperation benefits, which requires more active participation in DR. Community energy storage (CES), an alternative to grid-scale and single-household scale storage solutions, is now gaining more and more attention to resolving the cost and usage inefficiency of private energy storage.

References

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[2] J. J. Cuenca, E. Jamil, and B. Hayes, "State of the Art in Energy Communities and Sharing Economy Concepts in the Electricity Sector," *IEEE Trans. Ind. Appl.*, vol. 57, no. 6, pp. 5737–5746, Nov. 2021, doi: 10.1109/TIA.2021.3114135.

[SHORT BIOGRAOHY] Dr. Yinyan Liu is a postdoctoral research associate at the School of Photovoltaic and Renewable Energy Engineering, University of New South Wales, Australia.
Her research interest broadly includes energy management systems for decarbonization and decentralization, data-driven smart grids, fault diagnosis of PV systems, and pricing and planning of shared energy storage for future power systems. Yinyan is also a recipient of the National Scholarship, Tsinghua University, the University of Sydney International Scholarship, Faculty of Engineering PhD Completion Award, and Full Scholarship for the API's Powerful Women Leadership Program in 2023.

Development of Bacterial Captured Substrate and its Application to Microbial Power Generation

Shiho Tokonami[1, 2*] Shinya Kurita[1,2], Ryo Yoshikawa[1,2], Kenji Sakurai[1,2], Ryota Ishikura[1,2], Anna Honda[1,2], Shota Watanabe[1,2], Mamoru Tamura[2] , Takuya Iida[2,3]

[1] Department of Applied Chemistry, Osaka Metropolitan University, Japan
[2] Research Institute for Light-induced Acceleration System, Osaka Metropolitan University, Japan
[3] Department of physics, Osaka Metropolitan University, Japan

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A light-induced convection generated by laser irradiation enabled us to trap bacteria in the micropores on honeycomb polymer film (Fig. 1A). Fig.1B shows the fluorescence image of live bacteria when photothermal assembly was performed. The survival rate was maintained at high levels of around 80 to 90%. Next, we evaluated the electrochemical application potential of our proposed system using a representative electricity-producing bacterium. As the number of irradiation points increased, the current density increased almost proportionally (Fig. 1C). In addition, this presentation includes recent achievements in the rapid and specific detection of bacteria by using the photothermal assembling technique.

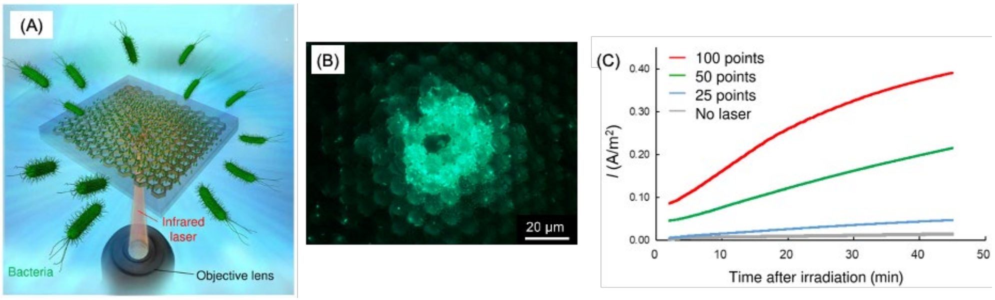
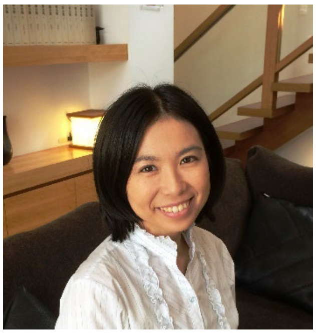


Fig. 1 (A) Conceptual diagram of light-induced assembly of bacteria. (B) Fluorescence image of assembled bacteria. (C) Time dependence of current generated from electricity-producing bacteria photoinduced and accumulated by multipoint irradiation.

References

[1] *Sci. Adv.*, **6**, eaaz5757 (2020)., [2] *Commun. Biol.,* **4**, 385 (2021)., [3] *AIP Adv.,* **12**, 125214 (2022).

[SHORT BIOGRAOHY] Shiho TOKONAMI, Associate Professor at Department of Applied Chemistry, Osaka Metropolitan University (OMU). She received her Ph.D. degree at Osaka Prefecture University (OPU). She was a postdoctoral fellow at Hiroshima University, Tokyo University of Science Yamaguchi, and OPU. After that, she was a special lecturer at Nanoscience and Nanotechnology Research Center (N2RC), OPU. She was promoted to her present position in 2015. Her research area is microbial power generation and analytical chemistry, including a development of sensor for bio-associated materials and bacteria.



Component technologies towards self-driving Personal Mobility Vehicles

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This study introduces Personal Mobility Vehicles (PMVs) as a means of individual transportation. In particular, component technologies for self-driving to improve safety and convenience will be discussed. There are following important aspects of autonomous driving of PMVs. 1. To provide assistance according to the dynamics of each PMV. 2. The mass ratio of humans to PMVs is large and human behavior is important to the stability of the entire system. 3. The dynamics of the system are different between a human driver driving the vehicle on his/her own intention and a ride in automated driving. For example, Fig. 1. shows the driver's center of gravity position during sudden braking. The left figure shows the case braking by the driver's intention and the right is the case braking by the stand-up type PMV. It is shown that the sudden braking by the PMV largely affects the driver's posture stability.

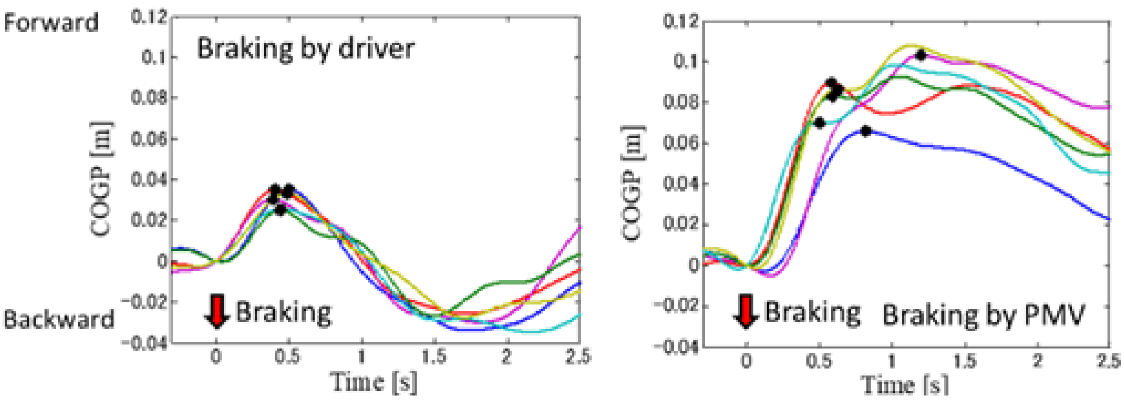

Fig. 1. Driver's center of gravity position during sudden braking.

[SHORT BIOGRAOHY] Dr. Chihiro Nakagawa graduated with Ph.D. (Engineering) degree from University of Tokyo. She is currently Associate Professor of Department of Mechanical Engineering at Osaka Metropolitan University. Her principal research interests lie in interaction between Personal Mobility Vehicles(PMVs) and humans in terms of dynamics and control. Recent her research topics are self-driving of PMVs, modeling of a driver's dynamic behavior using 3D motion capture system and multibody dynamics, etc.

Dual stimuli-responsive dendritic polymers and their applications

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[1] Department of Applied Chemistry, Osaka Metropolitan University, Japan

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Dendrimer is a synthetic polymer with well-defined structure. Because various compounds can be conjugated at a single dendrimer molecule, dendrimers are a potent multifunctional nanocarrier (Figure 1). Stimuli-responsive polymers are useful as smart materials. We have shown that carboxy-terminal PAMAM dendrimers modified with a hydrophobic amino acid, phenylalanine (Phe), showed dual pH- and temperature-sensitive properties [1]. Gold nanoparticle (AuNP) was loaded in the stimuli-responsive dendrimer, which was applied as a naked-eye colorimetric sensor [2]. We also showed that the stimuli-responsive dendrimer could work as a pH-dependent drug carrier for immune cells [3].

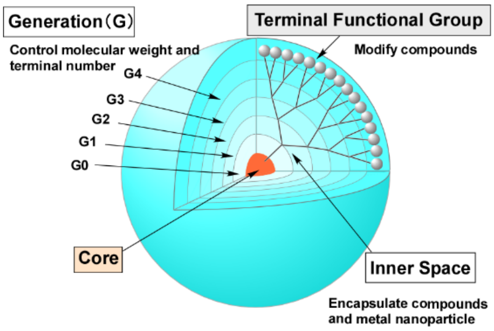

Fig. 1. Dendrimer structure.

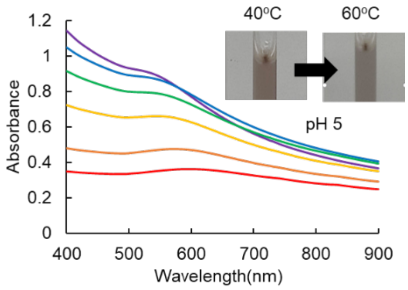

Fig. 2. Colorimetric change of AuNP-loaded stimuli-sensitive dendrimer.

References

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[2] C. Kojima, H. Xia, Y. Yamamoto, H. Shiigi, ChemNanoMat 8 (2022) e202100442.

[3] H. Shiba, M. Nishio, M. Sawada, M. Tamaki, M. Michigami, S. Nakai, I. Nakase, I. Fujii, A. Matsumoto, C. Kojima, J. Mater. Chem. B 10 (2022) 2463.

[SHORT BIOGRAOHY] Prof. Chie Kojima graduated with Ph.D. degree in Biostudies from Kyoto University. She is currently Associate Professor of Department of Applied Chemistry at Osaka Metropolitan University. She studied in National Cancer Institute (NCI)/ National institutes of Health (NIH) in 2008. Her principal research interests lie in polymer chemistry, especially dendrimer chemistry, and their applications in biomedical fields. Recent her research topics are polymer-based functional biomaterials for drug delivery and imaging.

Evolutionary game analysis in biofuel supply chain under government intervention

Etsuko Kusukawa[1*]

[1] Department of Electrical and Electronic System Engineering, Osaka Metropolitan University, Japan, Japan
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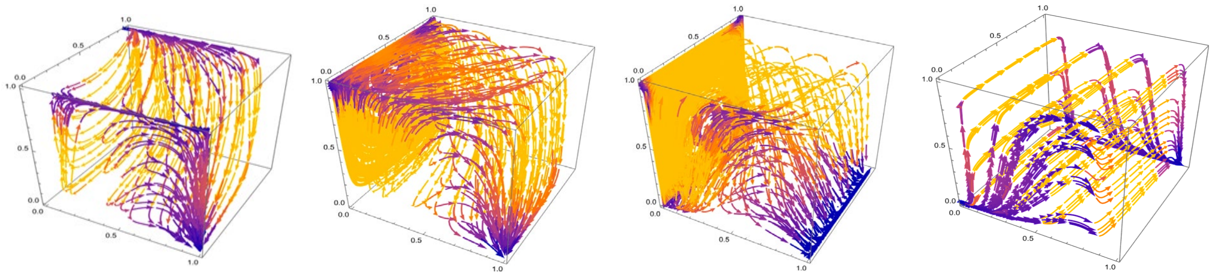
This study focused on a biofuel supply chain and used evolutionary game theory to clarify what strategies a farmer (F), a biorefinery (B), and the government (G) would choose in a long term when G intervened to promote biofuel production (BP) and converted to second-generation biomass (2G-Bio). In cases of government intervention to promote BP and conversion to 2G-Bio, this paper assumed that F, B, and G took two behavior strategies: F took two behavior strategies of producing 1G-Bio (F1) or producing 2G-Bio (F2), and B took two behavior strategies of producing bioethanol (B1) or sales of biomass to a local markets (B2). G took two behavior strategies of monitoring strategies of F and B (G1) or no monitoring them (G2). Using Jacobian matrix in evolutionary game theory, it was judged which behavior strategy F, B and G always took as their long-term behavior strategy that was stable evolutionary stable strategy (ESS). Numerical analysis verified which combination of behavior strategy taken by each member was judged as ESS in a long term by giving numerical examples including sales price.



P = 0.01 *P* = 0.05 *P* = 0.1 *P* = 0.5

Fig. 1. The effect of bioethanol sales price *P* in a biofuel market on ESS judgement

References

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Motor learning support robots and systems for people in need of rehabilitation and training

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The research focuses on understanding how humans acquire motor skills and aims to develop robotic support systems for motor learning. There is a growing interest in motion support robots, like power-assist robots, which can supplement human strength or reduce the need for physical effort. However, it is crucial to consider the diverse needs of users, such as the elderly needing increased physical activity or patients with neurological disorders requiring a balance between assistance and self-effort during rehabilitation. Unquestioningly increasing assistance can be counterproductive, emphasizing the importance of finding the right balance tailored to individual needs. The goal is to enable users to experience appropriately adjusted physical exertion and instruction, facilitating the acquisition of effective motor skills through motion learning support robots and systems developed by the research group.

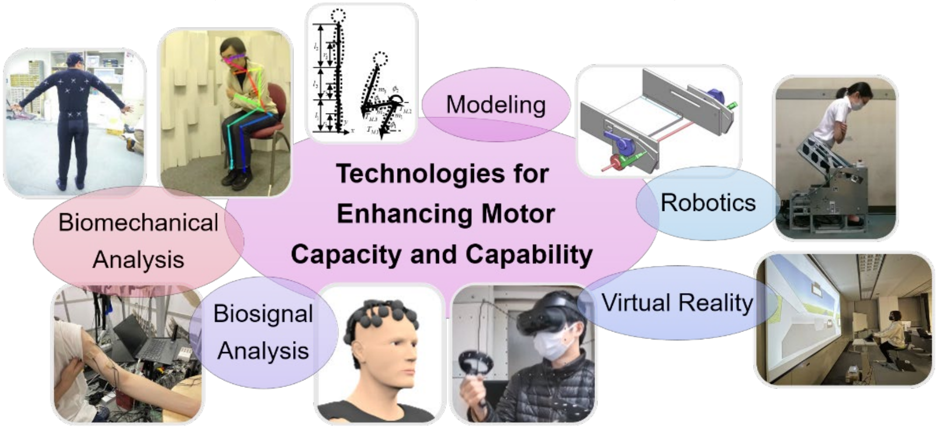

Fig. 1. Key technologies for motor learning support robots and systems.

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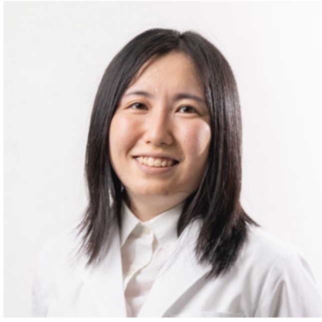
Multifunctional DNA-based hydrogels crosslinked by coordinate bonds



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DNA, which can be extracted from biomass, is an environmentally friendly, biodegradable polymer with diverse functional groups including various heteroatoms such as nitrogen, oxygen, and phosphorus. It adopts a double helical structure through weak interactions such as intramolecular hydrogen bonds, π-π interactions, and electrostatic interactions. In addition, various functional groups in DNA form specific coordinate bonds and other interactions with various metal ions, thereby influencing the behavior of DNA. For example, the anticancer drug cisplatin (*cis*-$[PtCl_2(NH_3)_2]$) coordinates with adenine and guanine in DNA to exert its anticancer activity. Other metal ions also interact with various functional groups in DNA, and the binding and dissociation activities depend on the electronic state of the metal ions. Therefore, by exploiting the interaction between DNA and metal ions, the structural properties of the DNA materials can be effectively manipulated, opening new avenues for innovative materials using DNA derived from biomass. In this study, hydrogels crosslinked by naturally occurring DNA and various metal ions were prepared, with different functions resulting from the interaction between DNA and metal ions (Fig. 1). This approach holds great promise for the development of novel materials and applications.

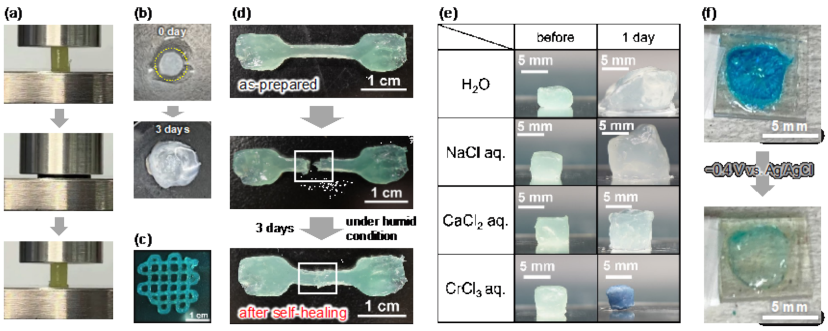

Fig. 1. DNA hydrogels with various functions; (a) high elastic, (b) biodegradable, (c) 3D-printed, (d) self-healing, (e) crosslinker exchanged, and (f) electrochromic hydrogels.

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