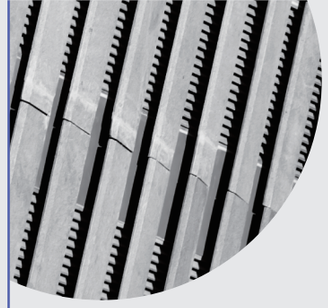

2022

2023

National Tsing Hua University

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NATURE AND LIFE SCIENCE

ENGINEERING

BIOMEDICAL TECHNOLOGY

MATERIALS SCIENCE

HUMANITIES AND SOCIAL SCIENCES

2022/2023
NATIONAL TSING HUA UNIVERSITY
R&D REPORT

About NTHU

National Tsing Hua University (NTHU) has a long and proud history. First established as the Tsing Hua Academy at Tsing Hua Garden in Beijing in 1911, the Academy was renamed as National Tsing Hua University in 1928 as its curricula expanded to that of comprehensive university.

In 1956, NTHU was reinstalled on its current campus in Hsinchu, Taiwan. Since its reinstallation, NTHU has developed from an institute focusing on nuclear science and technology to that of a comprehensive research university offering degree programs ranging from baccalaureate to doctorate in science, technology, engineering, humanities and social sciences as well as management.

NTHU has been consistently ranked as one of the premier universities in Taiwan and is widely recognized as the best incubator for future leaders in industries as well as academics. Such stellar records are particularly exemplified by the outstanding achievements of our alumni, including two Nobel laureates in physics Drs. Cheng-Ning Yang and Tsung-Dao Lee, one Nobel laureate in chemistry Dr. Yuan-Tseh Lee and one Wolf Prize winner in mathematics Dr. Shiing-Shen Chern. On the first of November 2016, NTHU formally incorporated the National Hsinchu University of Education. This merger further diversifies and expands its curricula include arts and education to better prepare our students to take on the challenge of a changing world.

Message from the President

President
Dr. W. John Kao

National Tsing Hua University Hsinchu, Taiwan
November 2023

National Tsing Hua University (NTHU) is a research-intensive university with a long and proud tradition. Since the reestablishment in Hsinchu in 1956, NTHU is known for academic excellence, stellar research output as well as outstanding alumni. NTHU 's core values are shared governance, academic freedom and inclusivity- equality-diversity. NTHU values academic freedom and provides a diverse environment within which our faculty can offer quality teaching and conduct innovative research.

Regarded as one of the top tier research universities, our research activities emphasize fundamental discoveries at the forefront of basic sciences and exploration of breakthrough technologies with high impact. These are reflected in our publications in preeminent journals, international patents received, and technology transferred. In the 2022-2023 R&D annual report, we highlight several important breakthroughs in five fields and also provide the facts and figures related to other important R&D activities.

This volume provides a glimpse into our recent achievements. Hopefully, this can serve as a catalyst for further interactions, exchange of ideas, and establishment of collaborations.We believe that everyone deserves an opportunity to explore and to realize their unique potential. NTHU will uphold our core values—inclusivity, equality, and diversity in everything we do. We will diligently safeguard academic freedom and shared governance as an integral part of our social responsibility and sustainable development.

R&D Facts and Figures

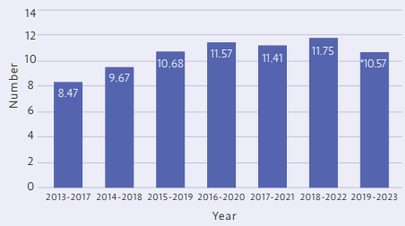
2022 World Rankings

Rankings	Rank
QS Asia University Rankings	34
THE Emerging Economies University Rankings	36
THE Asia University Rankings	59
THE Impact Rankings	201–300

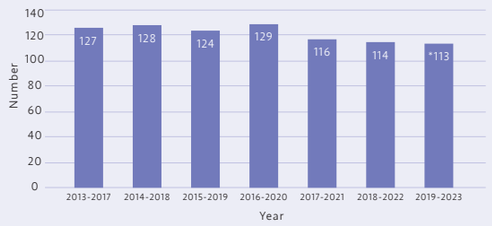
2023 QS World University Rankings by Subject

Top 50-100	Top 100-150
Linguistics (77)	Materials Sciences (105)
Statistics & Operational Research (89)	Electrical & Electronic Engineering (106)
Physics & Astronomy (99)	Chemical Engineering (131)
	Mechanical (133)
	Computer Science & Information Systems (145)

Citations Per Paper



Highly Cited Papers



note1. *Last updated November 10, 2023
note2. Data covers a 10-year and 8-month period: January 1, 2013 -August 31, 2023

2022 Highly Cited Researchers:

Professor. Horng-Tay Jeng (Department of Physics)

2022 Ranking of U.S. Patents

	2016	2017	2018	2019	2020	2021	2022
World Ranking	25	23	24	31	38	46	46
Taiwan Ranking	1	1	1	1	1	1	2

International Patent Application and Registration (2016-2022)

Incubation Programme Glow fast,Glow global

Startups Admitted in 2023	Entrepreneurship by Professors and Students in 2023	Faculty and Student Entrepreneurship Ratio in 2023	2017-2023 Number of Derived Startups (Excluding Departed)
55	40	93%	9

Derived Startups		
	Materials Industry	High Entropy Materials, Inc.
	Biomedical Industry	Enosim Bio-tech Co., Ltd.
		BioPro Scientific Co., Ltd.
		JelloX Biotech Inc.
		Praexisio Taiwan Inc.
		CellEnvision Company Limited
	Software Services Industry	Aydon International Inc.
	Precision Machinery and Instruments Industry	Lei & So Co., Ltd.
		STARX Co., Ltd.

01

Nature and Life Science

Nonlinear compression toward high-energy single-cycle pulses by cascaded focus and compression

Mapping the outskirts of the Milky Way with the Dark Energy Spectroscopic Instrument

Novel two-dimensional magnets for advanced nanoelectronics applications

Exploring Topological Quantum Materials at the Atomic Scale

Nonlinear compression toward high-energy single-cycle pulses by cascaded focus and compression

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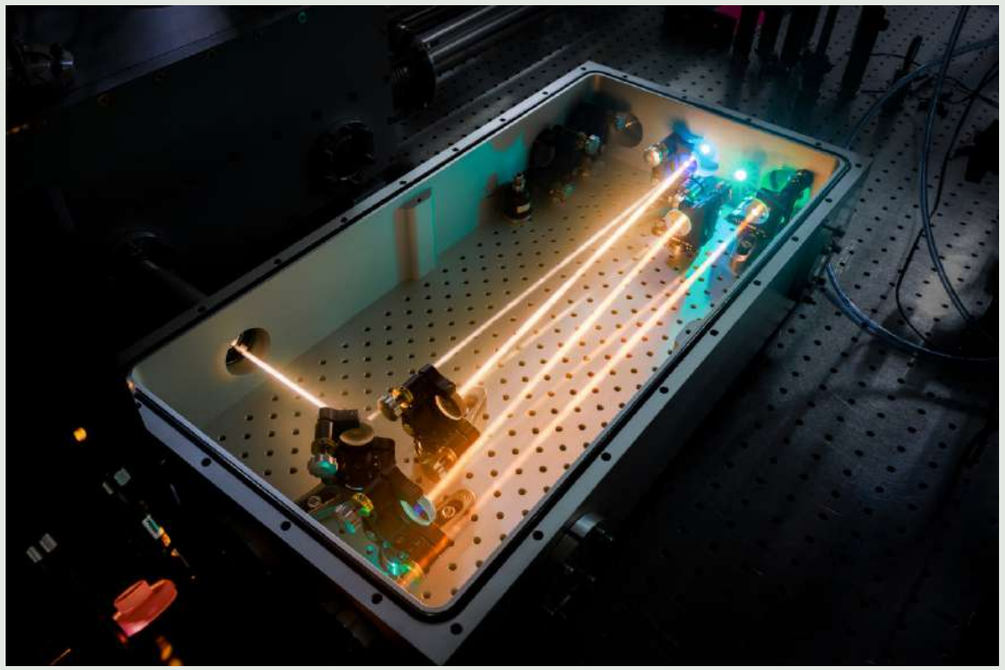


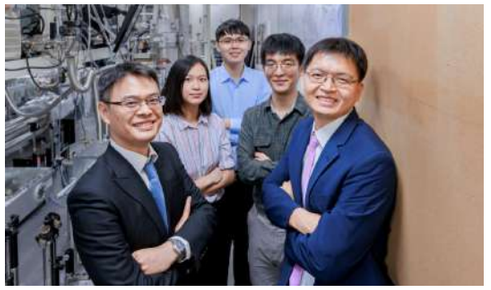
The 3.1 femtoseconds (one-cycle) pulses at 1 um is produced by our new postcompression scheme – CASCADE.

Ultrafast pulses have improved our understanding of how atomic, electronic, and magnetic structures move and change over their fundamental time scales. Attosecond light pulses, particularly those driven by mid–infrared (IR) pulses via high-order harmonic generation (HHG), are receiving substantial attention because they provide further insight into how chemical bonds break and form, how light waves drive devices into the petahertz regime, and how excited electrons reshape the energy landscape of material transformations.

To efficiently produce an isolated attosecond pulse, intense single-cycle pulses become essential, which prevent the HHG process from repeating itself every half cycle, resulting in an attosecond pulse train. Recently, we propose an arrangement of postcompression technique that can efficiently compress the pulse to the single-cycle regime. We refer to this as cascaded focus and compression (CASCADE). One CASCADE unit comprises a focus in matter to carry out nonlinear broadening, together with one compressor that shortens the pulse duration.

When using only four-unit CASCADE in Ar, we realized the compression of millijoule-level 1030-nm pulses from 157 to 3.1 fs (single cycle) in full width at half maximum (FWHM) with a good transmission efficiency of 73%. The experimental spectra show quantitatively good agreement with those acquired from three-dimensional numerical simulations, which indicates that both self-phase modulation and ionization help spectral broadening behind CASCADE. In addition, a satisfactory homogeneity of spectral broadening up to 93.5% across the beam profile was verified when compared to the ideal value of 95.6% acquired from the simulation. Briefly, CASCADE exhibits the advantages of simplicity, high compression efficiency, and multistage scalability. Last, HHG driven by one-cycle CASCADE pulses was performed. We observed a highly CEP-dependent Extreme ultraviolet (EUV) continuum. The attosecond streaking reveals that the CASCADE pulse from a compact and efficient Yb laser is able to provide isolated attosecond pulses via HHG.

We believe that this single-cycle postcompression technique would significantly facilitate time-resolved studies and has an immediate impact on both fundamental and applied aspects of strong-field physics and attosecond science.



Professor Ming-Wei Lin, An-Yuan Liang, Ming-Shian Tsai, Po-Wei Lai,
Professor Ming-Chang Chen

Research Output

- Ming-Shian Tsai, An-Yuan Liang, Chia-Lun Tsai, Po-Wei Lai, Ming-Wei Lin, Ming-Chang Chen*, “Nonlinear compression toward high-energy single-cycle pulses by cascaded focus and compression”, Science Advances, 8(31) (2022)
- Ming-Shian Tsai, An-Yuan Liang, Chia-Lun Tsai, Chia-Lun Tsai, Ming-Chang Chen*, “Cascaded focusing and compressing postcompression system”, US Patent Appl. No.: 17/456,645/ Euro Patent Appl. No.: 21210928.4/ Taiwan Patent Appl. No.: 111140081.

Mapping the outskirts of the Milky Way with the Dark Energy Spectroscopic Instrument

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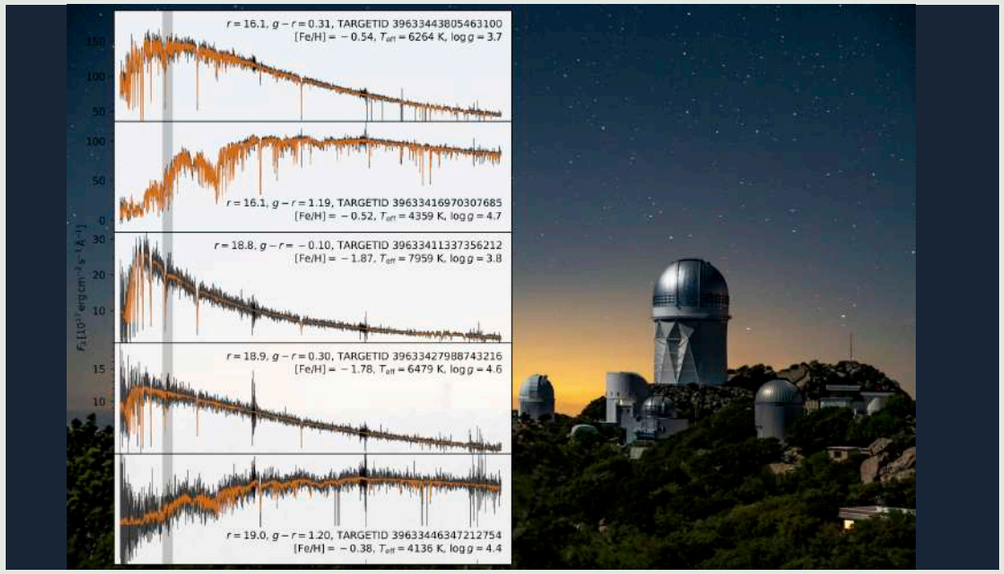

DESI, installed at the Mayall Telescope in Arizona (right), will observe spectra for more than 10 million extremely faint stars (five examples are shown on the left). Features in the spectra reveal the chemical composition of the star and its speed relative to the Sun. DESI will make the largest ever map of these measurements across the sky. Using statistical techniques to uncover co-moving groups of stars with similar chemistry, the team will search the map for archaeological evidence of important events in the ancient history of the Milky Way. (DESI Collaboration; Mayall photo by M. Sargent, LBNL)

The Dark Energy Spectroscopic Instrument (DESI) is a major new international astronomical observing project, involving approximately 500 researchers and 70 institutions worldwide. Led by the Lawrence Berkeley National Lab (LBNL) and funded by the US Department of Energy's Office of Science, DESI is the largest and most ambitious survey yet undertaken to probe the enigma of 'dark energy' by measuring the scale of the universe. The instrument itself, installed on the 4m Mayall telescope at Kitt Peak Observatory, Arizona, is a groundbreaking new optical fiber spectrograph that can observe 5000 stars or galaxies simultaneously.

From 2021 to 2025, DESI will survey more than 40 million galaxies and 10 million stars. In June 2023, the project reached a major milestone, releasing its first 2 million stellar spectra to the astronomy community. At NTHU, the Galactic Archaeology and Galaxy Formation group led by Dr. Cooper is participating in the DESI Milky Way Survey (MWS), one of the three main components of the DESI project. Dr. Cooper co-led the DESI MWS team from 2017-2022. The team will use DESI observations of stars in our own home galaxy, the Milky Way, to measure their distance, the abundance of different chemical elements in their atmospheres, and the speed with which they are moving relative to the Sun. Taken together, these measurements serve as 'archaeological' clues, from which the MWS team will try to reconstruct the course of the Milky Way's evolution over the last 13 billion years. In particular, they will hunt for the remnants of ancient collisions between the Milky Way and other, smaller galaxies, visible as groups of stars with similar chemical patterns, moving along similar obits but spread thinly across the sky. DESI will be the first survey to map these faint galactic relics with the scale, uniformity and accuracy needed to compare them with corresponding predictions from galaxy formation theories. Meanwhile, MWS will use the motions of stars to improve constraints on the total mass of the mysterious "dark matter" associated with the Milky Way. The MWS dataset will also have enormous legacy value for many areas of stellar astrophysics, providing statistically well-defined samples of many very rare and peculiar types of star. DESI will be the definitive atlas of astronomical spectra for many years to come. Dr. Cooper was lead author of the first flagship paper describing MWS, which demonstrated the remarkable quality of its first 500,000 observations. Dr. Cooper and NTHU PhD candidate Namitha Kizhuprakkat are now leading work in the MWS team to create synthetic surveys for comparison to the real DESI data, using high performance computing facilities at the NTHU Centre for Informatics and Computation in Astronomy (CICA). Their artificial surveys, based on full forward models of the galaxy formation process, will be essential for unravelling complex sampling effects, developing new methods to search for features in the data, and interpreting new discoveries.

Ms. Namitha Kizhuprakkat, Dr. Andrew Cooper, Ms. Sy-Yu Pu and Ms. Li-Wen Liao.

Research Highlights

- Awarded "Builder" status in the Dark Energy Spectroscopic Instrument Project
- Co-chair of the DESI Milky Way Survey (2017-2021) and current co-lead of the DESI MWS simulations topical group.

Research Output

- Cooper, A.P., and 63 colleagues, "Overview of the DESI Milky Way Survey", The Astrophysical Journal, 947, 37 (2023)
- Myers, A.D., Moustakas, J., and 52 colleagues (including Cooper, A.P.), "The Target-selection Pipeline for the Dark Energy Spectroscopic Instrument", The Astronomical Journal, 165, 50 (2023)
- Liao, L.-W. and Cooper, A.P., "Colour gradients of low-redshift galaxies in the DESI Legacy Imaging Survey", Monthly Notices of the Royal Astronomical Society, 518, 3999 (2023)
- Martinez-Delgado, D., Cooper, A.P., and 27 colleagues, "Hidden depths in the local Universe: The Stellar Stream Legacy Survey", Astronomy & Astrophysics, 671, A141 (2023)
- Dey, A., Najita, J. R., and 46 colleagues (including Cooper, A.P.), "DESI Observations of the Andromeda Galaxy: Revealing the Immigration History of Our Nearest Neighbor", The Astrophysical Journal, 944, 1 (2023)

Novel two-dimensional magnets for advanced nanoelectronics applications

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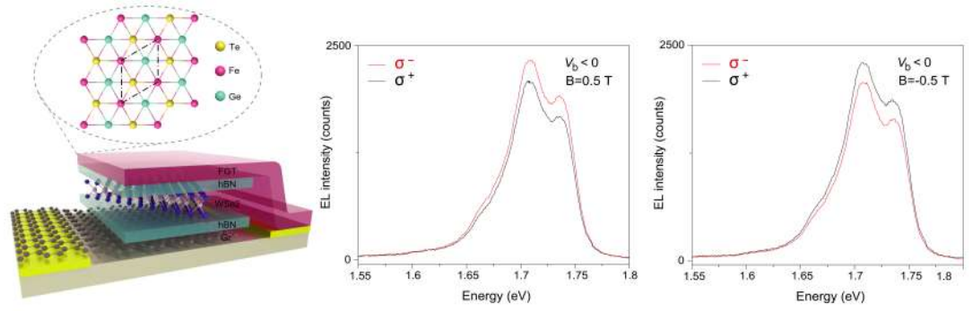

Evidence of electric control of valley polarization using van der Waals magnets.

Monolayer semiconducting transition metal dichalcogenides (TMDs) have garnered great attention due to their unique excitonic and spin-valley characteristics. These materials possess direct bandgaps located at energy-degenerate valleys (±K) within the hexagonal Brillouin zone. At room temperature, electrons and holes within each valley can form tightly bound valley excitons, owing to quantum confinement, reduced screening, and large electron and hole effective masses. Moreover, the substantial spin-orbit coupling and inversion symmetry breaking in monolayer TMDs result in opposite spins for charge carriers across the two valleys, leading to spin-valley locking and distinct optical selection rules. Exploiting these attributes allows for selective polarization of electrons, holes, and excitons to the K or -K valley through illumination with circularly polarized light.

However, when it comes to practical device applications, achieving electrical control over valley polarization becomes imperative. To attain this, various research teams have harnessed ferromagnetic semiconductor, such as Ga(Mn)As, to inject spin-polarized charge carriers into specific valley. But such devices hinge on intricate bottom-up material growth processes. Even though the challenges could potentially be surmounted by utilizing permalloy for local electrodes to introduce spin-polarized carriers, this particular configuration demands high external magnetic fields.

In this study, we tackle this challenge by harnessing the potential of the emerging van der Waals (vdW) ferromagnetic metal Fe3GeTe2 (FGT) as a spin injector, offering several distinct advantages. Firstly, FGT readily integrates with TMDs and other layered materials to form vdW heterostructures, eliminating lattice mismatch concerns and ensuring pristine interfaces. Secondly, previous research highlights that ultrathin FGT exhibits a nearly square-shaped magnetic hysteresis loop with substantial coercivity, indicating a single magnetic domain and strong perpendicular magnetic anisotropy.

Our work introduces a novel vdW heterostructure incorporating an ultrathin FGT-based ferromagnetic tunnel contact. Through helicity-resolved electroluminescence (EL) experiments and density functional theory calculations, we show the ability of the FGT contact to inject spin-polarized holes into a monolayer TMD, consequently inducing valley polarization. Remarkably, when the external magnetic field direction is varied, the sign of EL helicity not only reverses but also exhibits a nearly square hysteresis loop, consistent with magnetic hysteresis loops obtained from reflective magnetic circular dichroism (RMCD) measurements of FGT. Our research opens a novel avenue for electrically controlling valley-dependent polarization in TMDs.

Drawing from our framework, we foresee the potential for achieving electrical control of valley polarization around room temperature, driven by the expanding vdW materials portfolio. This is exemplified by potential substitutes for the top FGT electrode, such as Fe5GeTe2 and MnSex, exhibiting ferromagnetism near room temperature.

Additionally, chalcogenide-alloyed TMD monolayers offer promise, showing robust spin-valley traits at room temperature. Notably, many of these materials are viable at wafer scale, presenting an avenue for scalable valleytronics with significant implications for practical information processing and computing applications.

Group photo of Prof. Chang-Hua Liu's team, Co-PI: Prof. Po-Wen Chiu and Prof. Horng-Tay Jeng

Research Highlights

- Young Scholar Innovation Award, Foundation of the Advancement of Outstanding Scholarship, 2023
- Ta-You Wu Memorial Award, 2022
- Lam Research Award, 2022
- Outstanding Young Electrical Engineer Award, Chinese Institute of Electrical Engineering, 2022

Research Output

- Jia-Xin Li, Wei-Qing Li, Sheng-Hsiung Hung, Po-Liang Chen, Yueh-Chiang Yang, Tian-Yun Chang, Po-Wen Chiu, Horng-Tay Jeng*, Chang-Hua Liu*, "Electric control of valley polarization in monolayer WSe2 using a van der Waals magnet," Nature Nanotech. 17, 721–728 (2022).

Exploring Topological Quantum Materials at the Atomic Scale

Professor Pin-Jui Hsu
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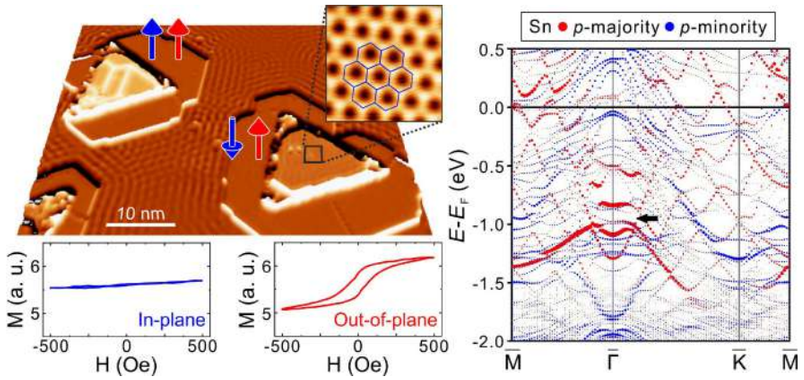
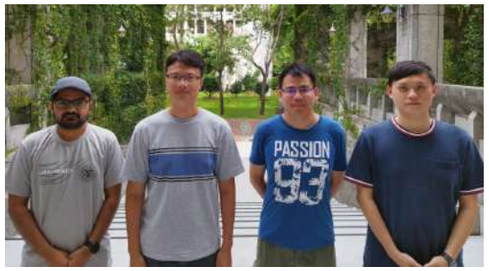


Coexistence of ferromagnetism and topological band structues has been revealed from the single-atomic-layer stanene covered bilayered Co nanoislands/Cu(111).

Exploring novel phase of matter is not only an essential research focus, but also an indispensable pathway toward the discovery of intriguing quantum physics and phenomena in the condensed matter physics. Over past few years, topological quantum materials, for example, topological superconductor has received significant attention because of its importance in fundamental science as well as technology applications ranging from spintronics to quantum computation. In particular, Majorana fermionic quasiparticle emerged from topological superconductor arises as a potential candidate of quantum qubit candidate, which follows the non-abelian anyonic statistics and results in an important application of fault-tolerant topological quantum information processing.

In our recent work, we have successfully fabricated monatomic Ni Kagome lattice on superconducting Pb(111) surface in order to study emergent topological superconductivity and appearance of Majorana fermionic quasiparticle. From the systematic studies carried out by scanning tunneling microscopy/spectroscopy (STM/STS) combined with density functional theory (DFT), sawtooth edge structures with distinct heights due to subsurface Ni atoms have been revealed, leading to asymmetric edge scattering of surface electrons on Pb(111). In addition, a local maximum at about −0.2 eV in tunneling spectra represents a manifestation of characteristic phase-destructive flat bands. Although charge transfer from underlying Pb(111) substrate results in a vanishing magnetic moment of Ni atoms, the proximity-induced superconducting gap is slightly enhanced on the Ni Kagome lattice. In light of single-atomic-layer Ni Kagome lattice on superconducting Pb(111) substrate, it could serve as an ideal platform to investigate the interplay between Kagome physics and superconductivity down to the two-dimensional (2D) limit.

Another interesting work is introducing magnetism to a 2D topological insulator that becomes a central issue in the pursuit of magnetic topological materials with a low-dimensionality. Since there are time-reversal symmetry broken and an exchange gap opened at the Dirac cone when a spontaneous magnetization is present, the quantum anomalous Hall effect (QAHE) can be realized at zero magnetic field in the magnetic topological insulators. Stanene, the tin (Sn) analogue of graphene with a 2D honeycomb lattice, has been predicted to be a promising 2D topological insulator because of a strong spin-orbit coupling (SOC) from heavy atomic mass of Sn atom. By means of low-temperature growth at 80 K, we succeeded in fabricating a monolayer stanene on Co/Cu(111) and resolving ferromagnetic spin contrast by field-dependent spin-polarized STM. Increases of both remanence to saturation magnetization ratio (Mr/Ms) and coercive field (Hc) due to an enhanced perpendicular magnetic anisotropy (PMA) are further identified by out-of-plane magneto-optical Kerr effect (MOKE). In addition to ultraflat stanene fully relaxed on bilayer Co/Cu(111) from density functional theory (DFT), characteristic topological properties including an in-plane s-p band inversion and a SOC-induced gap about 0.25 eV at the $\bar{\Gamma}$ Point have also been verified in the Sn-projected band structure. Interfacial coupling of single-atomic-layer stanene with ferromagnetic Co biatomic layers allows topological band features to coexist with ferromagnetism, facilitating a conceptual design of atomically thin magnetic topological heterostructures.



Nitin Kumar, Prof. Pin-Jui Hsu, Yen-Hui Lin, Chia-Ju Chen

Research Highlights

- Actively Recruit Overseas Outstanding Junior Scholar Award (2017) Foundation for the Advancement of Outstanding Scholarship
- Columbus Young Scholar Fellowship (2019) Ministry of Science and Technology (MOST)
- New Faculty Research Award (2022) National Tsing Hua University (NTHU)

Research Output

- Y. H. Lin, C. H. Hsu, I. Jiang, C. J. Chen, P. M. Chiu, D. S. Lin, C. T. Wu, F. C. Chuang, P. Y. Chang, and P.-J. Hsu, “Proximity-effect-induced anisotropic superconductivity in monolayer Ni-Pb binary alloy”, ACS Appl. Mater. Interfaces, 14, 23990 (2022)
- N. Kumar, Y. S. Lan, C. J. Chen, Y. H. Lin, S. T. Huang, H. T. Jeng, and P.-J. Hsu, “Self-assembled magnetic Co atoms on stanene”, Phys. Rev. Materials, 6, 066001 (2022)
- Y. H. Lin, C. J. Chen, N. Kumar, T. Y. Yeh, T. Z. Lin, S. Blügel, G. Bihlmayer, and P.-J. Hsu, “Fabrication and imaging monatomic Ni Kagome lattice on superconducting Pb(111)”, Nano Lett., 22, 8475 (2022)
- C. J. Chen, Y. C. Chao, Y. H. Lin, Y. H. Zhuang, Y. M. Lai, S. T. Huang, A. H. MacDonald, C. K. Shih, B. Y. Wang, J. J. Su, and P.-J. Hsu, “Single-atomic-layer stanene on ferromagnetic Co nanoislands with topological band structures”, ACS Nano, 17, 7456 (2023)

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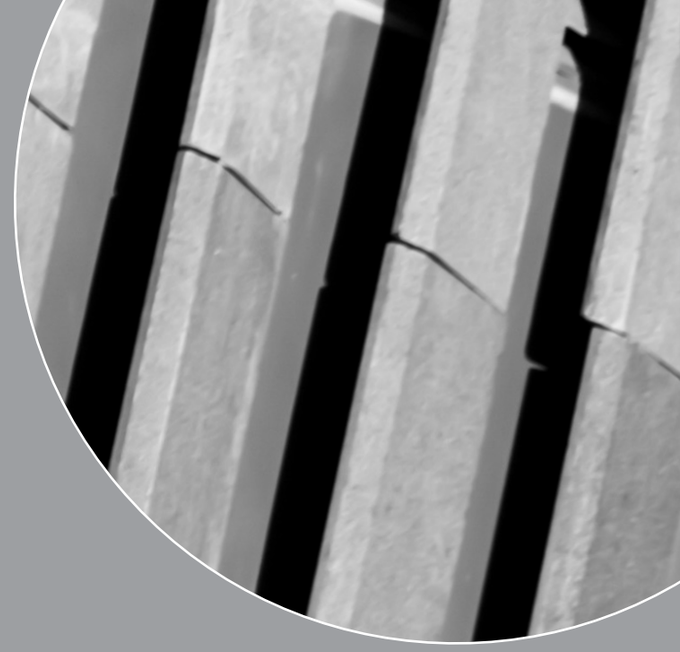

Engineering

Eco-Friendly and Scalable Radiative Cooling for Metal Substrates with Electrophoretically Deposited Chitosan

Professor Yu-Bin Chen
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Fig. 1 (a)

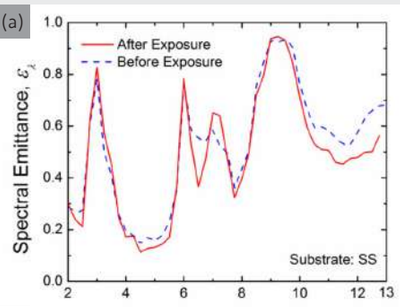


Fig. 1 (b)

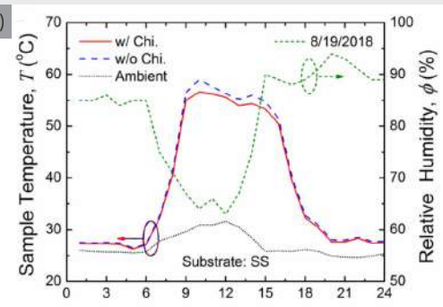


Fig. 2 (a)

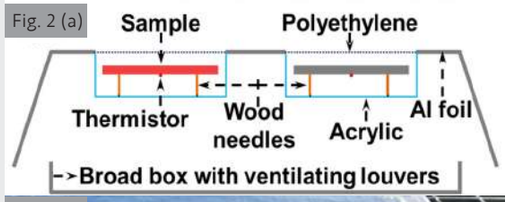


Fig. 2 (b)

Fig. 2(c)

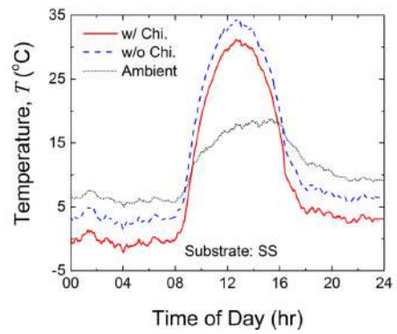


Fig. 1 (a) Spectral emittance before and after experiment; (b) change of temperature over time with and without chitosan deposition along with the relative humidity change.

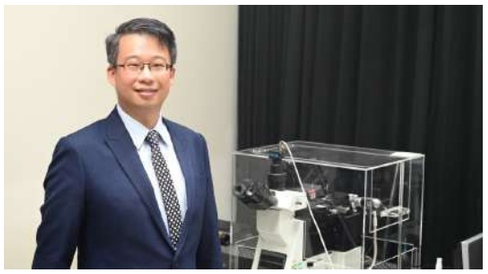
Fig. 2 (a) Design and (b) picture of the setup of radiative cooling experiment; (c) change of temperature over time with and without chitosan deposition.

Radiative cooling has become popular in various applications because the heat is dissipated passively with zero energy consumption. A radiative cooling coating for metallic substrates was developed in this study via electrophoretic deposition of a chitosan layer. The tailored optical properties of coating, generality to different metals, and the cost-effectiveness of the employed fabrication facility are described. The deposited area for coating is scalable without requiring high-precision lithography. Additionally, the employed chitosan itself has been considered eco-friendly.

This technology utilizes a naturally abundant and non-toxic material called chitosan (a polysaccharide derived from the shells of crustaceans) that is commonly considered waste. It is deposited on various metal substrates and, under conditions of zero energy consumption, effectively releases heat into space, reducing the substrate temperature.

The principle of operation of the radiative heat dissipation substrate is based on the reflection of solar radiation by the metal surface, while the chitosan layer radiates in the atmospheric window range, transferring heat energy through radiative electromagnetic waves to space, achieving the purpose of radiative heat dissipation.

The use of natural chitosan as the deposition material offers advantages such as good biocompatibility. Furthermore, chitosan can be extracted from waste materials, such as shrimp and crab shells. It not only reduces waste but also adds higher commercial value to these waste products. This technology adjusts the optical properties and is applicable to different metal surfaces. The process is simple and cost-effective, making it suitable for a wide range of devices, including metal pipelines, transportation vehicles, metal storage tanks, and metal roofs.



Professor Chen, Yu-Bin

Research Highlights

- Fellow, International Association of Advanced Materials (IAAM)
- Fellow, The Asian Union of Thermal Science and Engineering (AUTSE)
- Fellow, The American Society of Mechanical Engineers (ASME)
- Outstanding Research Award, 2022 Energy Program, National Science and Technology Council, Taiwan

Research Output

- Yu-Bin Chen, Hung-Sheng Han, 2021, "Radiative Cooling Substrate and Manufacturing Method of the Same," USA, Invention Patent No. US 11,078,593 B2.
- Yu-Bin Chen, Hung-Sheng Han, 2020, "Radiatively Cooling Substrate and Manufacturing Method Thereof ," ROC, Invention Patent No. I695910.
- Chang, J.-Y., Han, H.-S., Wang, C.-Y., Long, L., Wang, L., Sheremet, M., Miroshnichenko, I., and Chen,* Y.-B., 2020, "Eco-Friendly and Scalable Radiative Cooling for Metal Substrates with Electrophoretically Deposited Chitosan," Solar Energy Materials and Solar Cells, Vol. 216, p. 110707-1/7.

NTHU Racing develop the first driverless racecar in Taiwan

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Professor Pei-Jen Wang
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The car steering on the racetrack is our TH07. It's crucial to conduct comprehensive testing to ensure the car is fully prepared for the upcoming competition. We honored to be invited to ARTC (財團法人車輛研究測試中心) to do the endurance testing on the professional racetrack.

Integration of Autonomous System

A well-functioning driverless racecar relies on the integration of the following components:
Driverless control system: To manage large and complicated algorithms for autonomous driving (YOLOv4, SLAM, etc.), our controlling system is designed with high computing power and neat program architecture, the Upper-Lower architecture, which ensures both computing power and real-time control for vehicle safety.
Driverless perception system: Camera and Lidar are both utilized to detect the colors and positions of the cones on the track to calculate precise race line as soon as possible. Two mono cameras are installed for left and right views respectively. The collected image will go through multiple OpenCV image-processing functions before inputting into darknet YOLOv4 and calculating the positions of detected cones. Additionally, 40-channels mechanical lidar is applied to get precise detections while filtering out unnecessary information.

Driverless hardware:
(1) Driverless Steering System: A redesign steering System, including Single Bar Double Rack and Electronic Clutch Mechanism, can achieve lightweight design and distinct differentiation between driver and driverless steering input.
(2) Emergency Brake system: The Emergency Brake system enhances vehicle safety, with the EBS Actuator directly connected to the brake pedal. Redundancy is achieved through two separated pneumatic circuits in the front with check valves.

Weight saving

The maneuverability and dynamic performance of the vehicle is highly related to its weight. To achieve lightweight design, we have made several efforts:
Chassis: The new aluminum monocoque and primary structure in TH07 reduce weight by 19% through improved manufacturing, skin reinforcement and metal brackets reduction. The process of one-piece vacuum forming is applied for higher precision. Local skin reinforcement and two types of material inserts provide sufficient strength, and lighter lamination could be applied on the rest part of monocoque.
Suspension: We have re-evaluated the safety factor of each A-arm component and used the FEM method for optimization. The upper A-arm was found to withstand 200% less force than lower A-arm by force calculation, leading us to replace the rod end of upper A-arm and reducing the weight by 49%.
Aerodynamics: Spread-tow carbon fiber and Kevlar carbon fiber hybrid were introduced to possibly achieve excellent stiffness to weight ratio for wing skins. The inner structure and the mountings of aero parts have also been redesigned, improving both force translation and lightweight.

Accumulator cooling

Drawing from the lessons from the previous competition, we have developed our 1st gen water-cooled Thermal Management system to efficiently manage temperature. By utilizing the top surface of the battery cells for wire bonding and BMS (battery management system), and the bottom surface for water cooling, a smaller, more compact accumulator can be created. Our manifold is optimized by CFD and manufactured by SLM to minimize the pressure drop. Based on simulation, the resulting maximum temperatures are 58 degrees Celsius at the rearrest cells, below the allowable 60 degrees Celsius while operating at room temperature 30°C.
Wrapping high thermal conductivity insulating graphite film around the side of the cell can further reduce the temperature at the top of cell by 3 degrees Celsius.In conclusion, TH07 is our first-generation EV race car with Autonomous System. Additionally, the active water-cooling system effectively maintained the battery cells' temperature below 60 degrees Celsius. Furthermore, we successfully reduced the car's weight by 10%. With a strong commitment to conquering the competition, our team continuously strives to polish our technical capabilities.

(from left) Dr. Chao-An Lin, Dr. Pei-Jen Wang, the entire NTHU Racing team

Research Highlights

- ► 2019 FSAE Japan EV overall ranking 2nd /27
- ► 2022 Formula Student Germany EV Overall 18th/66
- ► 2022 Formula Student Alpe Adria EV Overall 5th/31
- ► 2022 Formula Student Alpe Adria EV Skidpad 3rd
- ► 2022 World Ranking 21st
- ► 2023 Formula Student Czech Republic DV Skidpad 2nd
- ► 2023 Formula Student Czech Republic EV Overall 8th/66

Interdisciplinary Intelligent Advanced Process Manufacturing Technology and Application

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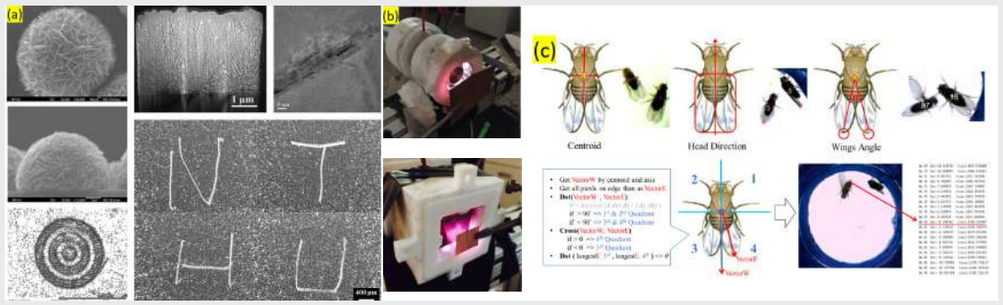

(a) SEM and TEM images of carbon nano-flake ball; (b) Field emission enhanced handheld atmospheric pressure plasma generator; (c)Wings analysis and Overlap processing with image processing for drosophila behaviors

Image processing

In collaboration with Academician of Academia Sinica Ann-Shyn Chiang, PhD from the Brain Research Center, National Tsing Hua University, a state-of-the-art automated analysis system has been developed for studying drosophila's mating and social behavior. Advanced computer vision algorithms, image processing, and big data analysis power this cutting-edge system. The system is designed to analyze the mating behavior of multiple pairs of drosophila, and it is the first of its kind to do so. Its motion prediction model has been proven to be highly effective in analyzing the complex mating behavior of these tiny insects. Despite the small size of drosophila, their body center feature enables the recognition of direction and body contour, even when behaviors overlap across multiple fruit flies. This means that even in small groups, male fruit flies' individual mating behavior can be precisely distinguished. With the capability to track and analyze up to 20 drosophilas simultaneously, the system is highly efficient in handling social behavior analysis. Its accuracy and reliability make it an indispensable tool for studying drosophila's intricate mating and social behavior, and its potential applications in various research fields are immense.

Advanced manufacturing, fabrication of nano-scale carbon-based materials

The proposal to synthesize Carbon nanoflake balls (CNFB) through the Laser ablation and MPCVD methods under low power and chamber pressure processes has created a buzz in the scientific community. The laser ablation technique has been found to be effective in controlling the surface roughness condition, which increases the nucleation site density for the vapor-solid (V-S) transport growth of CNFBs without a metal catalyst. As a result, the CNFBs exhibit a sheet resistance of 2.88 Ω/sq and a conductivity of 1.39 ×104 S/m, which is superior to the conventional diamond film. In-depth research has revealed that a 3-4 nm layer of SiC forms during the H_α etching process at protrusive defects on the Si substrate. It has been demonstrated that diamond nucleation takes place on top of silicon protrusions covered by SiC, and the nucleation behavior and subsequent CNFBs growth are strongly dependent on the H_α and carbon species (CN, C_2), which is attributed to the re-nucleation and growth processes. Additionally, H_α plays a critical role in forming SiC at the beginning growth process and assists the simultaneous re-nucleation and growth processes during CNFBs growth.In another exciting development, a handheld atmospheric plasma generator has been developed using a self-fabricated bilayer film of carbon nanotubes and aluminum oxide as the cathode. The result is a compact, safe, and water-cooled atmospheric plasma generator that can produce plasma in ambient conditions. The handheld atmospheric plasma generator has obtained patents in many countries. This invention is expected to revolutionize the field of atmospheric plasma generators and is a significant step towards a more efficient and environmentally friendly plasma generation process.

(from left) Doctoral Candidate Ji Huang, Doctoral Candidate Shang-Ru Wu, Professor Hung-Yin Tsai, Dr. Yi-Hung Chen, Ph.D. Student Ruei-Chi Hsu

Research Highlights

- Outstanding Research Award from National Science and Technology Council in 2020 and 2023
- Distinguished Engineering Professor Award from Chinese Institute of Engineers in 2022

Research Output

- H.Y. Tsai*, E. Ceretti, D. Rizzi, P. Ginestra, T.H. Kao, M.C. Leu, "Laser induced metallization on flexible polymer coating: Analysis and application," Journal of Materials Processing Technology, vol. 290, 116986, 2021
- C.K. Cheng, H.Y. Tsai*, "Enhanced detection of diverse defects by developing lighting strategies using multiple light sources based on reinforcement learning," Journal of Intelligent Manufacturing, 2021
- Y.Z. Huang, S.C. Tseng, Y.H. Chen, H.Y. Tsai*, "The Mechanisms of Carbon Nano-Flake Balls Growth by Laser Ablation and Microwave Plasma Chemical Vapor Deposition," Surface and Coatings Technology, vol. 425, 2021
- C.H. Chen, A.S. Chiang, H.Y. Tsai*, "Three-Dimensional Tracking of Multiple Small Insects by a Single Camera," Journal of Insect Science, vol. 21, Issue 6, pp1~12, 2021
- J. Huang, C. Kuo, H.Y. Tsai*, "Stiffness Enhancement, Anti-Aging, and Self-Forming Holes in Polycarbonate/ Acrylonitrile- Styrene-Acrylic by the Core-Shell Structure of Acrylic Resin," Polymers, vol. 14, Issue 4, 782, 2022

Pattern

- H. Y. Tsai, T. Y. Lin, Y. Y. Chen, S. R. Wu, T. C Lee. "Field emission enhanced handheld atmospheric pressure plasma generator" U.S. Patent No. 10403479, 2019；Taiwan Patent No. I686106, 2019；China Patent No. CN111491436, 2019.

Building a Safer Homeland through Big Data Analytics

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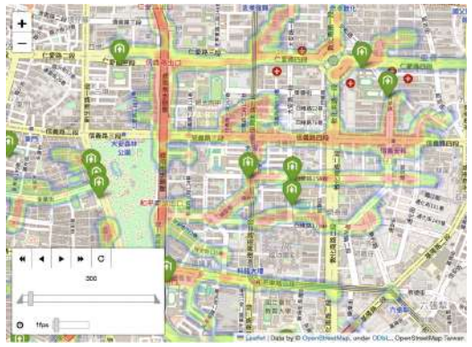
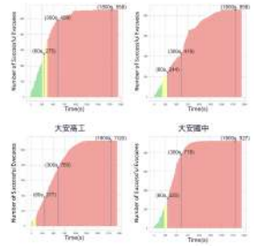
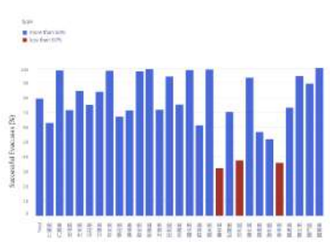


(a) Animated map of evacuee flow

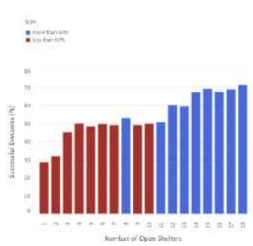
(b) Isolated road segments



(c) Shelter occupancy vs. time



(d) Evacuation success rate by borough



(e) Overall evacuation success rate vs.number of open shelters

Figure (a) is an animated map of the flow of pedestrian evacuees as a function of time throughout the course of a simulated evacuation. Red indicates areas with the highest density of evacuees, while green represents areas with the lowest density of evacuees. Open shelter locations are depicted using green pins, and hospital locations are represented as red circles with white crosses. Figure (b) shows the locations of isolated road segments, i.e., segments of the road network which were destroyed during the simulated earthquake and are thus not connected to the main network. These isolated road segments are shown in red. Figure (c) depicts how many evacuees, initially located in a specific borough at the time of the simulated earthquake, have successfully reached a shelter over time. Figure (d) shows the evacuation success rate for each borough. In other words, it illustrates the proportion of evacuees, initially located in a specific borough at the time of the simulated earthquake, who successfully reached a shelter. Figure (e) shows the overall evacuation success rate vs. number of open shelters. That is, it displays how the overall proportion of successful evacuees varies with different numbers of open shelters.

The damage and destruction of homes, buildings, and other infrastructure after a major earthquake makes it necessary for a segment of the population to be evacuated to emergency shelters. However, since areas prone to earthquakes face a major strike at highly unpredictable and infrequent times, disaster and evacuation management can and should be enhanced through the development and effective utilization of useful simulation models.

We utilize the Stochastic Pedestrian Cell Transmission Model (SPCTM), a real data-based pedestrian evacuation simulation framework built in collaboration with the National Science and Technology Center for Disaster Reduction (NCDR) in Taiwan to carry out various statistical analyses to gain useful insights for disaster management decision makers. In particular, SPCTM is used to (1) examine how evacuee compliance rate with the current government evacuation protocol (as opposed to SPCTM) affects the total evacuation time (2) compare the results of the evacuation process for different neighborhoods and compliance rates in Da'an district, and (3) determine how allocating different subsets of shelters to be opened affects the evacuation response time.

Furthermore, we develop a two-stage stochastic programming model that allows the optimal number and location of emergency shelters to be determined. The analysis results are insightful for government officials to formulate effective evacuation guidelines and strategies in the preparedness or response phases.

Prof. Kuo-Hao Chang and his research team members

Research Highlights

- 2023 IFORS Prize for OR in Development Winner
- 2017 IEEE Transactions on Semiconductor Manufacturing Best Paper Award
- 2015 The K.D. Tocher Medal by The OR Society
- 2015 IIE Transactions Best Application Paper Award

Research Output

- Kuo-Hao Chang*, Ying-Zheng Wu, and Siao-Syun Ke, "A Simulation-based Decision Support Tool for Dynamic Post-Disaster Pedestrian Evacuation," Decision Support Systems, 157, 1-16 (2022).
- Kuo-Hao Chang*, Tzu-Yi Hsiung, Tzu-Yin Chang, "Multi-Commodity Distribution under Uncertainty in Disaster Response Phase: Model, Solution Method, and an Empirical Study," European Journal of Operational Research, 303(2), 857-876 (2022).
- Kuo-Hao Chang, Tzu-Li Chen*, Fu-Hao Yang, and Tzu-Yin Chang, "Simulation Optimization for Stochastic Casualty Collection Point Location and Resource Allocation Problem in a Mass Casualty Incident," European Journal of Operational Research, 309 (3), 1237-1262 (2023).

03

Biomedical Technology

Wireless charging-mediated angiogenesis and nerve repair by adaptable microporous hydrogels

Tumor Stroma-targeted Nitric Oxide Nanogel For Cancer Therapy

Vinculin Phosphorylation Impairs Vascular Endothelial Junctions Promoting Atherosclerosis

Wireless charging-mediated angiogenesis and nerve repair by adaptable microporous hydrogels

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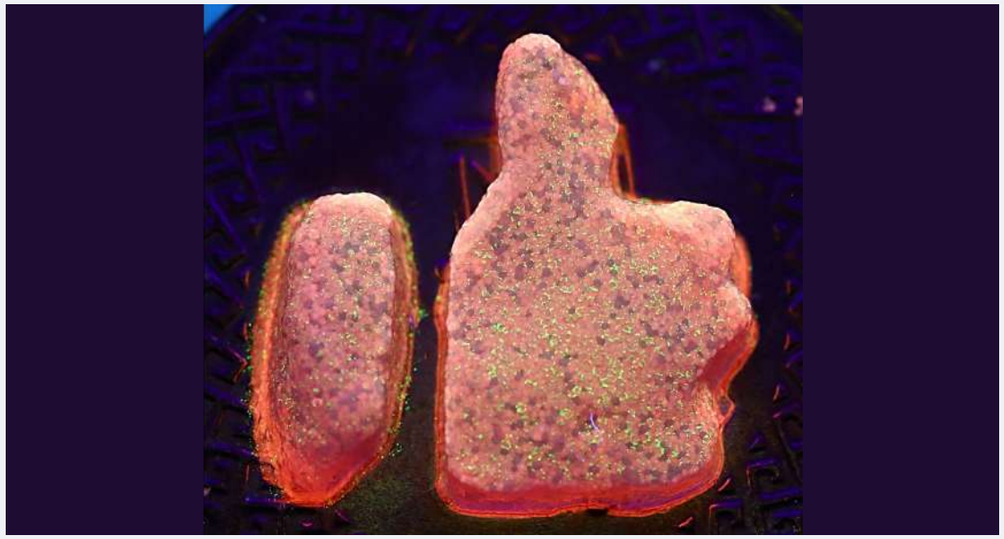

Wireless charging-mediated angiogenesis and nerve repair by adaptable microporous hydrogels from conductive building blocks

Repairing damage to the brain and spinal cord may be medical science's most daunting challenge. Survivors of traumatic brain injury (TBI) may find themselves wondering, can the brain repair? And the possibility is yes. The brain tissue is incredibly resilient and possesses the ability to repair through the process of angiogenesis, neurogenesis. Prof. Shang-Hsiu Hu and his team at National Tsing Hua University displayed a new class of hydrogel-assisted neuroregeneration approaches towards brain injury therapy.At a cost of $400 billion worldwide, an estimated 50 million people suffer from TBI due to the chronic dysfunctions of mood and permeant disability. Clinical trials in TBI to date have not specifically treatments at cerebral atrophy and lack of an effective medical therapy that promotes long-term recovery.

The critical reason for these consequences is that brain damage commonly results in extensive tissue loss and the barrier to tissue regeneration following injury to the central nervous system. However, a long-lasting repair response occurs angiogenesis and neurogenesis into the damaged tissue in the brain is problematic. Following trauma cavity, no extracellular matrix supports cell infiltration into the lesion or physically supports a growing tissue. A large influx of microglia, macrophages and the activation of highly reactive astrocytes, which release pro-inflammatory response and lead to further glial scarring and neuronal death in the peri-trauma area which results in cerebral atrophy (brain shrinkage) occurring in the motor/sensory cortex. These inflammation and glial scarring that impede brain tissue repair, so stimulating angiogenesis and recovery of brain function remain challenging. Currently, hydrogels for brain repair after trauma injury is an emerging treatment option.

Endogenous signals, such as nitric oxide (NO) and electrons, induce multifaceted physiological functions in the regulation of cell fate as well as vascular and neuronal systems. However, clinical difficulties exist due to the short half-life of NO and the lack of tools to spatiotemporally drive gas release and electrical stimulation. Additionals, we propose a "magnetoelectric massager" strategy based on alternating magnetic field (AMF)-triggered on-demand NO release and electrical stimulation to restore brain function in traumatic brain injury. The NO and electron transport system was constructed as a metal-organic framework (MOF)-derived molybdenum carbide octahedron (MoCx-Cu) and an NO donor (S-nitrosoglutathione, GSNO), which was embedded in an implantable silk in a microneedle. Under AMF irradiation, eddy currents on conductive MoCx-Cu induced NO release from GSNO through electrical stimulation, thereby significantly promoting the differentiation and growth of neural stem cell (NSC) synapses. A combined strategy of in vivo traumatic brain injury allows NO and electrical stimulation-mediated inhibition of inflammation, angiogenesis, and neuronal interrogation.

Mr. Yi-Chen Chuang, Ms. Gi-Yi Huang, Mr. Chuang-Wei Tseng, Mr. Ping-Hua Chen, Dr. Min-Ren Chiang, Dr. Kang-Li Wang, Prof. Shang-Hsiu Hu, Mr. Chia-Ko Chen, Ms. Ping-Hsuan Huang, Ms. Chia-Yuen Hsu, Ms. Yun-Yan Kuo, Ms. Shih-Lin Chu, Ms. Wan-Chi Pan, Ms. Mong-Sing Wu, Ms. Shin-Yu Shi, Ms. Wan-Yu Yan.

Research Highlights

- 2022 MOST Outstanding Research Award
- 2022 National Innovation Award- Academic Innovation
- 2022 Future Tech Award
- 2022 Research Award on Biomadical Engineering of Prof. Chao-Ren Lee.

Research Output

- Yi-Chieh Chan, Ya-Hui Lin, Hsiu-Ching Liua, Ru-Siou Hsu, Ming-Ren Chiang, Li-Wen Wang, Tsu-Chin Chou, Tsai-Te Lu, I-Chi Lee, Li-An Chu*, Shang-Hsiu Hu*, In Situ Magnetoelectric Generation of Nitric Oxide and Electric Stimulus for Nerve Therapy by Wireless Chargeable Molybdenum Carbide Octahedrons, Nano Today, 2023, 51, 101935.
- Bhanu Nirosha Yalamandala, Thi My Hue Huynh, Min-Ren Chiang, Wei-Han Weng, Chien-Wen Chang, Wen-Hsuan Chiang, Shang-Hsiu Hu*, Adv. Funct. Mater. 2022, 2210644.
- Ru-Siou Hsu, Ssu-Ju Li, Jen-Hung Fang, I-Chi Lee, Li-An Chu, Yu-Chun Lo, Yu-Jen Lu*, You-Yin Chen*, Shang-Hsiu Hu*, Nat. Comm. 2022, 13, 5172.
- Wei Cheng, Yu-Lin Su, Hao-Hsiang Hsu, Ya-Hui Lin, Li-An Chu, Wei-Chen Huang, Yu-Jen Lu, Chi-Shiun Chiang, Shang- Hsiu Hu*,ACS nano, 2022, 16, 3, 4028.

Tumor Stroma-targeted Nitric Oxide Nanogel For Cancer Therapy

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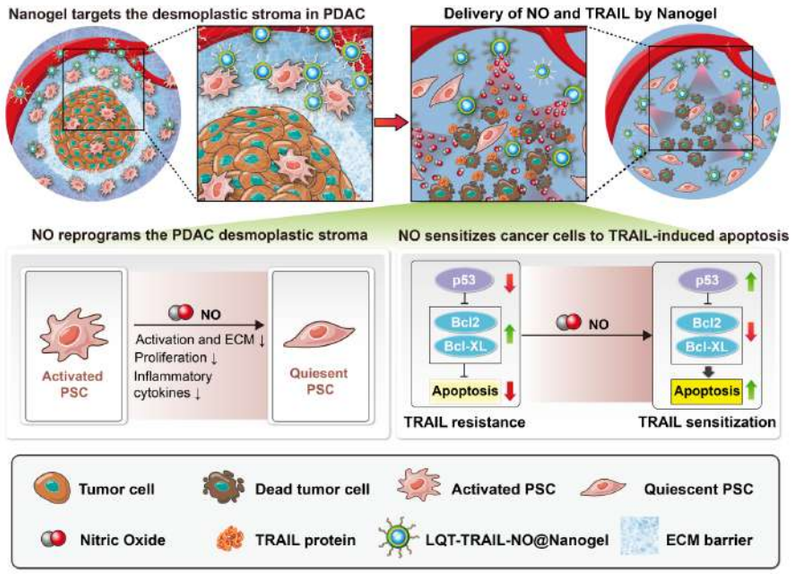


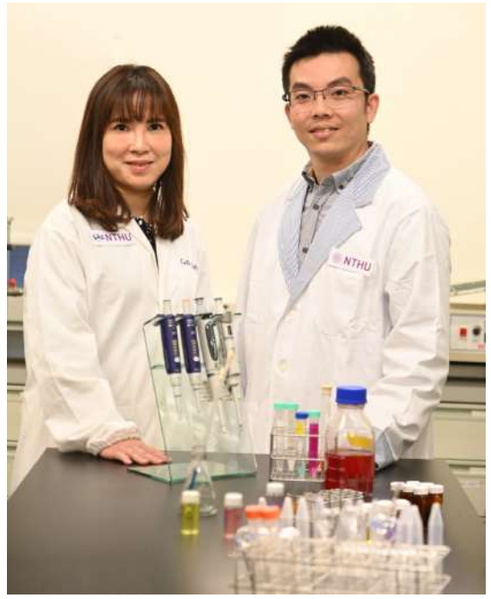
The schematic provides a visual representation of the tumor stroma-targeted Nanogel mode of action in suppressing the progression of pancreatic ductal adenocarcinoma (PDAC) in mice. The central theme is the remodeling of the fibrotic tumor microenvironment characteristic of desmoplastic PDAC by the released NO. In the first step, the Nanoparticles (NPs), which are embellished with tumor stroma-targeting peptides identified through phage display, release NO that directly suppresses Pancreatic Stellate Cells (PSC) activation. This leads to a decrease in Extracellular Matrix (ECM) production and a subsequent enhancement in tumor perfusion within the PDAC environment. The second step highlights the versatility of NO in reprogramming the desmoplastic stroma, thereby breaking down TRAIL resistance and making the PDAC tumors more susceptible to TRAIL-based therapy. Finally, in the third step, the concurrent delivery of both TRAIL and NO via the tumor stroma-targeted TRAIL-NO@Nanogel manifests in a marked suppression of tumor growth. This step-wise depiction elucidates the therapeutic strategy's systematic and multifaceted approach towards PDAC management.

Abnormal tumour vasculature significantly dictates tumour progression and therapy responsiveness. Nitric oxide (NO), known for its role in regulating angiogenesis and maintaining vascular homeostasis, stands out as a potential therapeutic agent to standardize such aberrant vasculature. Yet, the absence of an effective NO delivery system, marked by prolonged half-life and sustained release, remains a challenge.

Our research introduces NanoNO, a nanoscale delivery platform for NO, targeting hepatocellular carcinoma (HCC). Impressively, low doses of NanoNO can revitalize tumour vessels, thus improving the delivery efficacy of anti-cancer therapies in primary and metastatic tumours. Additionally, it shifts the tumour microenvironment from being immunosuppressive to immunostimulatory, enhancing cancer immunotherapy outcomes.

In parallel, stromal barriers, notably the dense desmoplastic stroma of pancreatic ductal adenocarcinoma (PDAC), obstruct the effective penetration of therapeutics. Employing an in vitro-in vivo phage display approach, we identified peptide ligands targeting the desmoplastic stroma in PDAC.

We then engineered a tumor stroma-targeted system for concurrent delivery of NO and anti-cancer protein TRAIL. This approach successfully mitigated tumor desmoplasia. Consequently, TRAIL penetration improved, amplifying its antitumor effects. Collectively, these investigations underscore the profound therapeutic potential of targeted NO delivery in reprogramming tumour microenvironments and optimizing cancer treatment.



Professor Y. Chen, Professor T. T. Lu.

Research Highlights

- Academia Sinica Early-Career Investigator Research Achievement Award
- The 16th Young Investigator Award, TienTe Lee Biomedical Foundation
- Outstanding Research Award, National Science Council, Taiwan.

Research Output

- Reversal of Pancreatic Desmoplasia by a Tumor Stroma targeted Nitric Oxide Nanogel Overcomes TRAIL Resistance in Pancreatic Tumors. Gut 71 (9), 1843-1855
- Highly Efficient and Tumor-Selective Nanoparticles for Dual-Targeted Immunogene Therapy against Cancer. Science Advances, 6(3), eaax5032.
- Delivery of Nitric Oxide with a Nanocarrier Promotes Tumour Vessel Normalization and Potentiates Anti-Cancer Therapies. Nature Nanotechnology, 14, 1160–1169.

Vinculin Phosphorylation Impairs Vascular Endothelial Junctions Promoting Atherosclerosis

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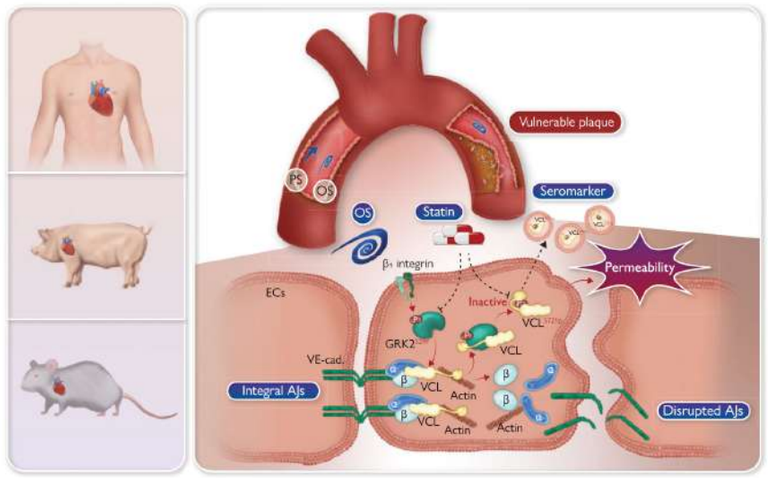

Proposed mechanisms by which disturbed flow induces vinculin phosphorylation at serine 721 (VCLS721p) in vascular endothelium, leading to atherosclerosis. A combination of porcine models, large-scale phosphoproteomics, transgenic mice, and clinical specimens was used to demonstrate that disturbed flow induces endothelial VCLS721p via G-protein-coupled receptor kinase 2 (GRK2), resulting in an inactive form of VCL with a closed conformation. This disrupted the VE-cadherin junction/catenin complex to enhance endothelial permeability and atherosclerosis. Statin therapy was associated with reduced levels of VCLS721p and VCLS721p/VCL in the serum of patients with coronary artery disease. AJs: adherens junctions.

Atherosclerosis is an important medical problem in Taiwan and worldwide, which leads to significant incidence of cardiovascular diseases, causing a serious social and economic burden. Clinical observations reveal that atherosclerosis preferentially develops in arterial branches and curvatures, where the blood flow is very complex, often causing disturbed flow with low and oscillatory shear stress (OSS). This disturbed flow with OSS is proposed to be the main cause of early development of atherosclerosis. However, the detailed mechanisms by which disturbed flow with OSS induces early development of atherosclerosis remain unclear. Through a combination of state-of-the-art technologies including porcine models, large-scale phosphoproteomics, tissue-specific transgenic mice, and clinical specimens, Chiu's team has discovered a novel atherosclerosis-related phosphoprotein vinculin (VCL) with disturbed flow-induced phosphorylation at serine 721 (VCLS721p). This induction of VCLS721p was mediated by G-protein-coupled receptor kinase 2 (GRK2) and resulted in an inactive form of VCL with a closed conformation, leading to the VE-cadherin/catenin complex disruption to enhance endothelial permeability and atherogenesis. Studies on clinical specimens from patients with coronary artery disease (CAD) revealed that endothelial VCLS721p is a critical clinicopathological biomarker for atherosclerosis progression and that serum VCLS721p level is a promising biomarker for CAD diagnosis. The findings of this study indicate that endothelial VCLS721p is a valuable hemodynamic-based target for clinical assessment and treatment of vascular disorders resulting from atherosclerosis. Such information has provided new insights into the mechanisms by which disturbed flow promotes atherosclerosis development and may generate new therapeutic approaches for early diagnosis and intervention for atherosclerosis and their complications.

Chiu's team has long-term collaboration with internationally renowned research institutions and universities in Taiwan and abroad, including Academia Sinica, National Taiwan University, Tri-Service General Hospital, China Medical University, and the Department of Bioengineering and Institute of Engineering in Medicine at the University of California, San Diego. This innovative scientific research achievement is a concrete manifestation of long-term collaboration with these domestic and foreign research institutions and universities.

Members of Dr. Jeng-Jiann Chiu's laboratory: (from left) Professor J. J. Chiu, Ms. T.E. Lin, Mr. H. W. Chen (Head covered by a dark blue coat), Ms. L. M. Chiang, Ms. T. Y. Shih, Ms. C. H. Xu, Dr. L. J. Chen, Dr. D. Y. Lee, Dr. Y. T. Shih, Ms. C. I. Lee, Ms. S. N. Liao, Ms. P.L. Lee, Ms. R. C. Chang, Ms. M. C. Wang, Ms. M. Xu, Ms. Y. H. Huang, Dr. S.Y. Wei, Dr. W.L. Wang.

Research Highlights

► This work was supported by the Frontier Science Research Program of the Department of Life Sciences of National Science and Technology Council, which discovered for the first time a novel molecular target critical for the diagnosis and treatment of atherosclerosis.

Research Output

► Shih YT, Wei SY, Chen JH, Wang WL, Wu HY, Wang MC, Lin CY, Lee PL, Lin CY, Chiang HC, Chen YJ, Chien S, Chiu JJ*. Vinculin phosphorylation impairs vascular endothelial junctions promoting atherosclerosis. Eur Heart J. 2023 Jan 21;44(4):304-318.

04

Materials Science

Main-chain engineering of polymer photocatalysts with hydrophilic non-conjugated segments for visible-light-driven hydrogen evolution

High-Rate and Stable Lithium-Ion Battery Anode: A Hierarchically Porous MoS2 Foam in Three Dimensions

Ternary chalcogenide anodes for high-performance potassium-ion batteries and hybrid capacitors via composition-mediated bond softening and intermediate phase

Main-chain engineering of polymer photocatalysts with hydrophilic non-conjugated segments for visible-light-driven hydrogen evolution

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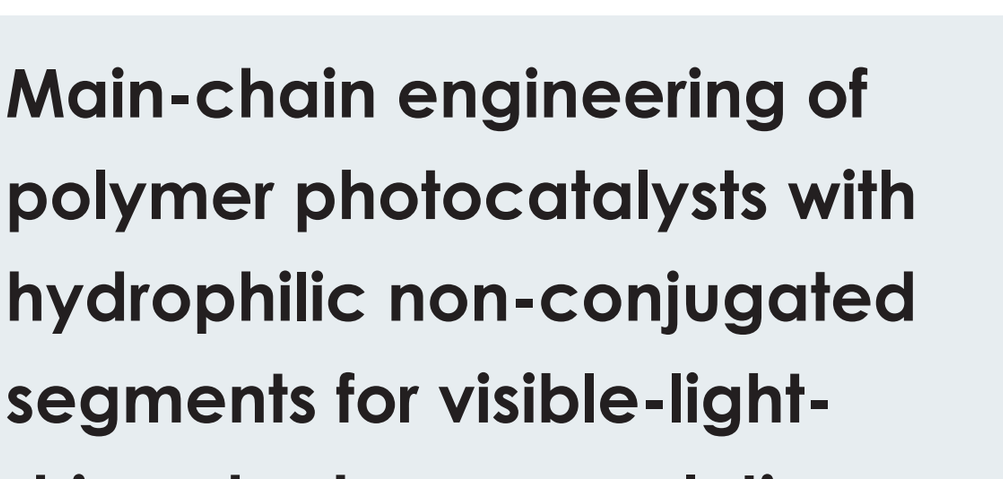

Schematic illustration of design strategy and polymer structures.

In this study, we successfully developed a series of DCPs by inserting hydrophilic non-conjugated segments into the main-chain of hydrophobic CPs to produce photocatalysts with high HERs under visible-light irradiation. The DCPs with interrupted conjugation showed enhanced HER values in both the film state and the solution state compared to those of their hydrophobic photocatalyst counterparts under otherwise identical conditions.

The hydrophilic non-conjugated segments effectively brought water into the inner polymer chain of main-chain-engineered DCPs, which increased the HER without obviously changing the semiconducting properties of the polymers, thereby overcoming a major limitation in the field.

DCPs with hydrophilic segments of 5–10 mol% exhibited HERs comparable to those of hydrophobic CPs with the use of 33 vol.% organic solvent. Furthermore, in this study, we exploited a full atomistic study using molecular dynamics simulation to elucidate the interaction between water and DCPs which agrees well with the experimental measurements. This indicates that main-chain engineering using hydrophilic non-conjugated segments increases the possibility of water-DCP interaction and is more efficient in comparison with ordinary conjugate polymers. Importantly, we also demonstrated that our proposed approach is a universal route for synthesizing classes of DCPs with enhanced photocatalytic hydrogen evolution.

The use of hydrophilic non-conjugated segments in the main-chain engineering of semiconducting polymers could lead to further optimization and greater molecular-design possibilities for developing high-performance photocatalysts for the generation of clean and renewable energy and future industrial applications.

(center) Professor Ho-Hsiu Chou.

Research Highlights

- LCY Outstanding Young Professor Research Award (2022)
- Ta-You Wu Memorial Award (2021)
- Outstanding Young Polymer Scientist Award (2020)
- FutureTech Breakthrough Award from NSTC (2020)

Research Output

- Chih-Li Chang, Wei-Cheng Lin, Li-Yu Ting, Chin-Hsuan Shih, Shih-Yuan Chen, Tse-Fu Huang, Hiroyuki Tateno, Jayachandran Jayakumar, Wen-Yang Jao, Chen-Wei Tai, Che-Yi Chu, Chin-Wen Chen, Chi-Hua Yu, Yu-Jung Lu, Chi-Chang Hu, Ahmed M Elewa, Takehisa Mochizuki, Ho-Hsiu Chou*"Main-chain engineering of polymer photocatalysts with hydrophilic non-conjugated segments for visible-light-driven hydrogen evolution "Nature Communications , 2022 , 13, 5460

High-Rate and Stable Lithium-Ion Battery Anode: A Hierarchically Porous MoS_2 Foam in Three Dimensions

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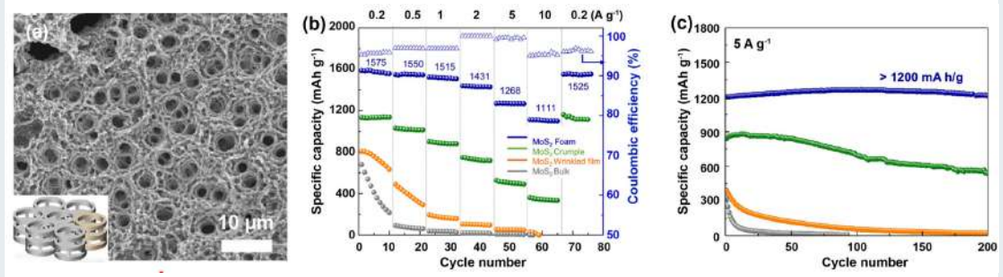

(a)3D MoS_2 foam; (b) Rate capacity performance, and (c) cycling stability of MoS_2 foam along with MoS_2 bulk, wrinkled film, and crumples.

Architected materials, characterized by 3D architectures at micro- and nanoscales, have a range of potential applications such as photonic devices, energy storage, mechanical reinforcement, wearable electronics, and biomedical devices. Molybdenum disulfide (MoS_2), a 2D material with a thickness of three atoms, has inherent structural features like phase heterojunctions, grain boundaries, dislocations, and defects, making it a promising candidate for 3D architectures. However, the stacked and brittle structure of MoS_2 limits its electrochemical stability and Li-ion diffusion in lithium-ion batteries (LIBs).

Here we collaborated with Prof. Vincent Tung (University o Tokyo) and his research group since 2019. We proposed a manufacturing method to create 3D hierarchically organized MoS_2 entities with enhanced mechanical and electrochemical properties. This approach involves using chemically exfoliated MoS_2 dispersed in a mixture of deionized water and isopropyl alcohol for electrohydrodynamic (EHD) printing. This process leads to the formation of structures with vortical truss unit cells that can be printed on target substrates. The MoS_2 foam delivered a high reversible capacity of 1575 mAh g^{-1} at 0.2 A g^{-1}, and 1092 mAh g^{-1} after cycling at 5 A g^{-1} for 1000 cycles, showing excellent high-rate performance and cycling retention.

The resulting MoS_2 foam demonstrates superior performance as a LIB anode compared to conventional materials like black phosphorus, silicon-graphene composites, and mesoporous graphene particles. The 3D architected MoS_2 foam exhibits remarkable electrochemical stability, high capacity, and rate capability. The hierarchical structure contributes to the mechanical resilience, adaptability, and recoverability of the foam, preventing structural degradation due to repeated cycling. The foam's hierarchical architecture also facilitates efficient Li-ion transport and ion diffusion, resulting in excellent electrochemical performance. Furthermore, operando X-ray absorption spectroscopy confirms the contribution of both Mo and S ions to the redox reactions, enabling the high capacity of the foam.

This work showcases the potential of 3D architected materials, specifically using MoS_2 foam, as an alternative anode material for high-performance lithium-ion batteries. The foam's unique combination of hierarchical structure, pseudocapacitive behavior, and strain-engineered properties leads to exceptional electrochemical performance. The approach is not limited to MoS_2 and can be extended to other 2D materials, opening possibilities for various applications beyond energy storage.

In conclusion, we presents a novel manufacturing method to create 3D architected MoS_2 foam with superior electrochemical properties. The hierarchical structure and strain-induced properties contribute to its outstanding performance as a lithium-ion battery anode material, showcasing its potential for energy storage applications.

(from left) Professor Han-Yi Chen, Prof. Vincent Tung

Research Highlights

- 2023 NSTC Ta-You Wu Memorial Award
- 2023 NSTC 2030 Cross-Generation Young Scholars Program- Excellent Young Scholars
- 2021 Materials Research Society-Taiwan Excellent Young Scholar Award
- 2021 Carbon Society of Taiwan Excellent Young Scholar Award
- 2018 MOST Young Scholar Fellowship

Research Output

- Xuan Wei, Chia-Ching Lin, Chuanwan Wu, Nadeem Qaiser, Yichen Cai, Ang-Yu Lu, Kai Qi, Jui-Han Fu, Yu-Hsiang Chiang, Zheng Yang, Lianhui Ding, Ola. S. Ali, Wei Xu, Wenli Zhang, Mohamed Ben Hassine, Jing Kong, Han-Yi Chen*, and Vincent Tung*, "Three-dimensional Hierarchically Porous MoS_2 Foam as High-Rate and Stable Lithium-ion Battery Anode", Nature Communications, 2022, 13, 6006
- Yu-Ming Chang, Yu-Ching Wen, Tsung-Yi Chen, Chia-Ching Lin, Shao-Chu Huang, Chung-Sheng Ni, An-Yuan Hou, Chih-Wei Hu, Yen-Fa Liao, Chun-Han Kuo, Shih-Fu Liu, Wen-Wei Wu*, Lain-Jong Li*, Han-Yi Chen*, "Understanding Charge Storage Mechanisms for Amorphous $MoSnSe_{1.5}S_{1.5}$ Nanoflowers in Alkali-ion Batteries", Advanced Energy Materials, 2023, 13, 2301125
- Chia-Ching Lin, Hao-Yu Liu, Jin-Wei Kang, Chun-Chi Yang, Chih-Heng Li, Hsin-Yi Tiffany Chen, Shao-Chu Huang, Chung-Sheng Ni, Yu-Chun Chuang, Bo-Hao Chen, Chung-Kai Chang, Han-Yi Chen*, "In-situ X-ray Studies of High-Entropy Layered Oxide Cathode for Sodium-Ion Batteries", Energy Storage Materials, 2022, 51, 159-171

Ternary chalcogenide anodes for high-performance potassium-ion batteries and hybrid capacitors via composition-mediated bond softening and intermediate phase

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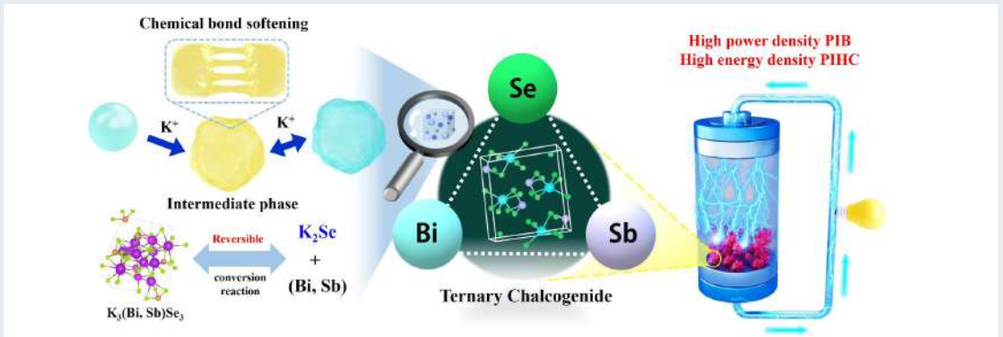

Ternary chalcogenide anode ($Bi_{2-x}Sb_xSe_3$) as an anode for high power density/energy density of PIBs and PIHCs, and two key factors affecting their high electrochemical performance as follows: (1) chemical bond softening suppresses potassiation-induced volume expansion and pulverization; (2) the formation of intermediate quaternary-phase $K_3(Bi,Sb)Se_3$ enables a better reversibility of the conversion/alloying reaction.

Lithium-ion batteries and supercapacitors are two typical examples of electrical energy storage. However, the scarcity of lithium resources (0.0017%), high cost, and the serious safety issues brought about by lithium dendrites may not meet the needs of growing large-scale applications. Therefore, the development of alternative and sustainable battery systems. Potassium-ion energy storage has the following advantages due to an energy storage mechanism similar to Li^+ components: (1) the redox potential of K^+ (−2.93 V vs. SHE) is close to that of Li^+ (−3.04 V vs. SHE), implying a high voltage platform and energy density; (2) K^+ has higher ionic mobility and ionic conductivity because its Stokes radius (3.6 Å) in propylene carbonate solvent is smaller than that of Li; (3) it is considered a low-cost and sustainable system due to its lower electrolyte price (e.g., KPF_6 is 20 times cheaper than $LiPF_6$) .

Chalcogenides, such as sulfides (e.g., SnS, Bi_2S_3, and Sb_2S_3) and selenides (e.g., SnSe, Bi_2Se_3, and Sb_2Se_3), for potassium-ion anodes have attracted attention because they simultaneously undergo conversion and alloying reactions to achieve higher theoretical capacities relative to intercalation-based anodes, such as graphite. Selenide systems have higher electronic conductivity compared with metal sulfides due to the high conductivity of Se (1×10^{-3} S m^{-1}), which is higher than S (5×10^{-28} S m^{-1}), suggesting lower energy barriers for ion diffusion than those in oxides and sulfides. Although the gravimetric capacity of Se (679 mA h g^{-1}) is lower than that of S (1,675 mA h g^{-1}), the volumetric capacity of Se (3,250 mA h cm^{-3}) is comparable to that of S (3,470 mA h cm^{-3}) due to the density of Se (4.8 g cm^{-3}) being higher than that of S (1.8 g cm^{-3}).

Ternary compounds have attracted much attention relative to binary compounds because the introduction of a third element enables a synergistic effect between the various components to generate new attractive properties or functions. The electrochemical performance of binary or ternary original materials can be improved by tailoring the solid solution composition.

$Bi_{2-x}Sb_xSe_3$ with controllable composition and structure was synthesized by a simple high energy mechanical milling method. Since Sb and Bi have the same crystal structure, which can form a $Bi_{2-x}Sb_xSe_3$ solid solution, the composition can be systematically tuned over a wide range. The following two advantages of $BiSbSe_3$ anodes allow highly reversible potassium-ion storage: (1) Bi/Sb composition-induced chemical bond softening can reduce the effect of volume expansion/contraction during cycling, which shows outstanding structure stability, and (2) the intermediate quaternary-phase $K_3(Bi,Sb)Se_3$ observed during the potassiation/depotassiation process promotes a reversible conversion/alloying reaction based on 12-electron transfer.

Overall, the strategy of exploiting composition-induced chemical bond softening and intermediate phase opens a new avenue for existing potassium-ion anode materials. It also enables those compounds that originally performed poorly under their binary system to improve their performance under ternary chemical composition regulation. We believe that this research can facilitate the realization and conceptual expansion of ternary or multi-element materials in multidisciplinary material science and electrochemical reactions for next-generation potassium-ion storage systems.

Tuan Lab group photo

Research Highlights

- International Outstanding Young Scholars in 2030 Cross-Generation Young Scholars Program

Research Output

- K.-T. Chen, H.-Y. Tuan*, Bi–Sb nanocrystals embedded in phosphorus as high-performance potassium ion battery electrodes, ACS Nano, 14 (2020) 11648–11661.
- C.-H. Chang, K.-T. Chen, Y.-Y. Hsieh, C.-B. Chang, H.-Y. Tuan*, Crystal facet and architecture engineering of metal oxide nanonetwork anodes for high-performance potassium ion batteries and hybrid capacitors, ACS Nano, 16 (2022) 1486–1501.
- Y.-Y. Hsieh, H.-Y. Tuan*, Architectural van der Waals Bi2S3/Bi2Se3 topological heterostructure as a superior potassium-ion storage material, Energy Storage Mater., 51 (2022) 789–805.

05

Humanities and Social Sciences

The Application of Just Transition to evaluate Taiwan's Energy Transition and Nuclear-free Homeland Policy since 2016

Cross-cutting issues related to real estate research

How to "improve" prediction using behavior modification

Discourses on Chinese Lyrical Tradition and Literary Historiography

The Application of Just Transition to evaluate Taiwan's Energy Transition and Nuclear-free Homeland Policy since 2016

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	Results in 2016	Up and/or down by 2021	Annual scheduled average target to meet 2025 goals (2017-2025)	Annual average achievement (2017-2021)	Required annual achievement to meet t 2025 goal (2022-2025)
50% gas-fired power target	31.56% (2016)	↑: 35.7% (2020); 38% (2021)	+2.05%	+1.288%	+3%
30% coal-fired power target	45.90% (2016)	↑: 47.34% (2017), 47.65% (2018) ↓: 46.13% (2019), 45.02% (2020), 43.5% (2021).	-1.77%	-0.48%	-3.375%
20% RE target	4.82% (2016)	↑: 5.56% (2019), 7.1% (2021)	+1.69%	+0.456%	+3.225%
0% Nuclear power	8.31% (2016)	↑:10.05% (2017),11.79% (2019), 11.24% (2020) ↓:8.5% (2021)	-0.92%	-0.038%	-2.215%

Dream and Reality of the Evolution of Taiwan's Electricity Mix towards 2025 Energy Transition Targets

In general, there is a huge gap between the original plan and the reality in terms of achieving these four key energy transition targets in 2025. Firstly, annual average achievement since 2017 in four sectors fall behind the annual scheduled average target to achieve 2025 goals (2017-2025), which leads to huge pressure on the required annual achievement for 2025 goals (2022-2025). Moreover, for some targets like coal-fired and nuclear power, the backlash and step back and deviation can be found. Energy transition has been considered a new paradigm for energy policy in recent decades. Considering the multiple perspectives of energy, environment, and climate, the concept of a just transition has recently received much attention. Since 2016, Taiwan has followed this trend by introducing an energy transition mainly embracing dramatic RE promotion and a nuclear-free homeland by 2025, with a supplementary agenda of reducing coal-fired power and increasing gas-fired power. However, this study shows that this energy transition is proceeding without considering justice appeals, which is its main weakness. Achieving the 2025 vision at all costs is a suitable way to describe the government's attitude towards this energy transition since 2016. The lack of public participation and deliberation or proper assessment (e.g., SEA) to decide and evaluate the targets has planted the seeds of failure since the beginning.Such flaws could have been rectified or fine-tuned by responding to the results of the three energy referenda in 2018. However, the government and ruling party's insistence on its position now leads to an irreversibly failed situation. None of the planned 50-30-20 targets are likely to be realised by 2025. The minister of MOEA admitted such failure earlier this year and blamed it on excessive electricity consumption due to the rapid economic growth of Taiwan during the pandemic and the prosperity of the semiconductor industry. However, she ignored the fact that the central doctrine of the energy transition was to decouple economic growth from increased energy consumption and emissions . Taiwan's experience could be a lesson for the rest of the world. First, it demonstrates that a transition that considers multiple interests, such as climate change, the environment, economics, land justice, would not hamper the energy transition itself but would smoothen the transition. However, an old fashioned, top-down manner with too little engagement with affected communities is unlikely to reach its original objective. Despite being time-consuming, energy democracy may do more good than harm to achieve energy transition goals . Careful planning by adopting multiple policies and legal instruments will contribute to the success of the energy transition goals. These goals cannot be realised simply by setting them. Tailor-made measures, including proper incentives and regulations, will be helpful in gradually achieving the targets. Laws and policies should be responsive to the updated situation and the results of energy democracy to reflect the dynamic and complex policy situation. For instance, Taiwan's lessons can be attributed to the government's unwillingness to engage in time-consuming comprehensive policy and legislation processes and public participation. In fact, the government's unwillingness stalled the achievement of the targeted goals. Therefore, a transition and the energy transition goals can come together for mutual benefits. Finally, compared with the EU's three pillars (emission reduction, energy efficiency, and renewable energy), Taiwan's 2016 energy transition seemed narrow to respond to the needs of the Paris Agreement and the Global SDGs. Taiwan depends only on RE and ignores European countries' main approach to simultaneously maintain nuclear power and increase RE. After Taiwan achieves the nuclear-free homeland target by 2025, fossil fuels are expected to account for more than 90% of electricity generation in the country. If this happens, Taiwan's energy transition may become unsustainable and cause climate injustice.

Professor Anton Ming-Zhi Gao

Research Highlights

- The first article using just transition concept to assess Taiwan's energy transition policy of 2025.
- The study evaluates Taiwan's ambitious energy transition plan.
- The study evaluates Taiwan's ability to meet the 2025 electricity mix vision.

Research Output

- Anton Ming-Zhi Gao, Tsung Kuang Yeh, Jong-Shun Chen, An unjust and failed energy transition strategy? Taiwan's goal of becoming nuclear-free by 2025, Energy Strategy Reviews, Volume 44, 2022, 100991, ISSN 2211-467X, https://doi.org/10.1016/j.esr.2022.100991.
- Gao, A. M. Z.*, Huang, C. H., Lin, J. C., & Su, W. N. (2021). Review of recent offshore wind power strategy in Taiwan: Onshore wind power comparison. Energy Strategy Reviews, 38, 100747.
- Anton Ming-Zhi Gao, Chien-Te Fan, Jong-Shun Chen, A critical review of the World's first renewable portfolio standard (RPS) for large electricity users in Taiwan: The return of the RPS?, Energy Strategy Reviews, Volume 32, 2020, https://doi.org/10.1016/j.esr.2020.100585.
- ANTON MING-ZHI GAO, ENVIRONMENTAL LAW IN TAIWNA (2ED.), KLUWER (2023).
- ANTON MING ZHI GAO, ENERGY LAW IN TAIWAN (2ED.), KLUWER. (2021).

Cross-cutting issues related to real estate research

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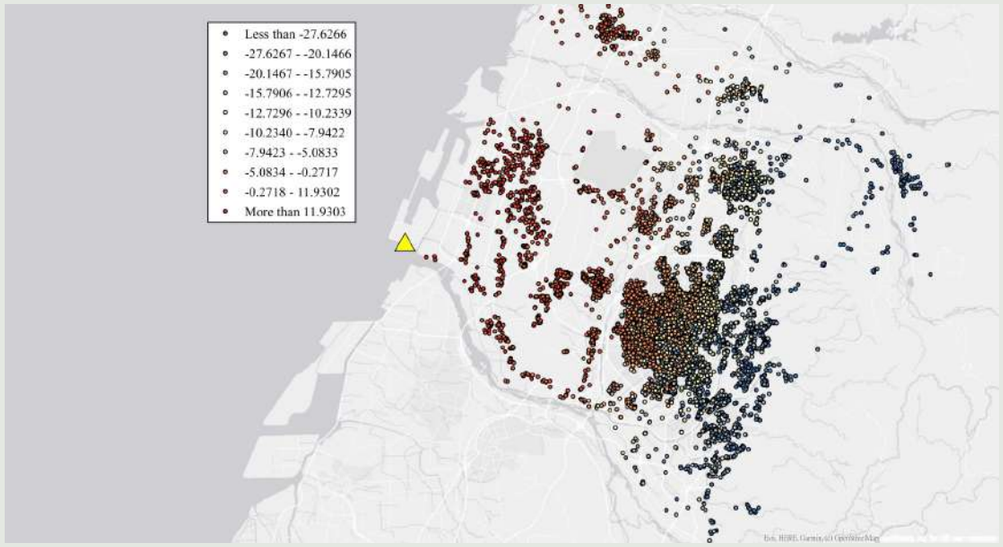

This figure is Figure 2 in Tsai (2022). It shows that the areas subjected to greater effects from the thermal power plant (i.e., those colors closer to blue) are located in the Southeast area. Houses in this area tend to be high-priced. Hence, it indicates that these higher-priced houses may be more impacted negatively by the "not-in-my-back-yard" factors.

Last year, two of her independent studies regarding real estate markets were accepted by two internationally renowned journals, Journal of Cleaner Production and Building and Environment.

The first study explores the impact of the Taichung Thermal Power Plant in Taiwan on the housing prices of surrounding houses. By employing empirical data to capitalize the hidden costs of air pollution, this study proposes an objective way to demonstrate that negative externalities should be considered in the estimation of the costs of thermal power generation to incentivize power plant operators to invest in more environmentally friendly power generation methods and relieve the burden shared by residents living in proximity to the power plant.

The literature related to the cost of thermal power plants in the past mostly belongs to the domain of natural science. This paper provides evidence indicating the Taichung Thermal Power Plant should endeavor to improve air quality. The cost to reduce air pollution and the negative costs of operating the coal-fired power generation unit should be included in the operating costs of the thermal power plant. These hidden costs must be capitalized to accurately reflect the power generation costs and energy prices to thereby incentivize power plant operators to adopt more environmentally friendly power generation methods.

The second study explores the capitalization effects of green buildings. It finds that Taipei residents are willing to pay higher prices for houses with green-label certification. In addition, the higher the certification level is, the higher the price that residents are willing to pay. This study additionally identifies two characteristics of the capitalization effects in the development of the green building market in Taiwan. The first is that the price premiums vary with the market condition: building green premiums may be unremarkable or non-existent during housing market downturns. The second effect is that green buildings tend to exhibit an 'aristocratic trend.'

Although the Green Building Evaluation System has been implemented in Taiwan for many years, studies on green building premiums in Taiwan and the EEWH (ecology, energy saving, waste reduction, and health) system are scant. This study illustrates the EEWH system and demonstrates the effect of showing the attention of Taiwanese people and government to environmental protection and sustainability. The results also provide suggestions for promoting the development of green construction.

Professor I-Chun Tsai

Research Highlights

- The 2014 Ta-You Wu Memorial Award
- Editor in Chief of the Journal of Housing Studies (TSSCI)
- An Editorial Board Member of the International Journal of Strategic Property Management (SSCI)

Research Output

- Tsai, I-Chun (2022). Impact of Proximity to Thermal Power Plants on Housing Prices: Capitalizing the Hidden Costs of Air Pollution. Journal of Cleaner Production, Vol. 367, 132982. (IF: 11.1, 22/274, ENVIRONMENTAL SCIENCES).
- Tsai, I-Chun (2022). Value Capitalization Effects of Green Buildings: a New Insight through Time Trends and Differences in Various Price Levels. Building and Environment, Vol. 224, 109577. (IF: 7.4, 6/139, ENGINEERING, CIVIL).
- Tsai, I-Chun and Wen-Kai Wang (2022). The Value of Land Redevelopment in Different Types of Properties: Considering the Effect of Hold-out Problems on the Development Probability. Land Use Policy, Vol. 119, 106118. (IF: 7.1, 18/127, ENVIRONMENT STUDIES).

How to “improve” prediction using behavior modification

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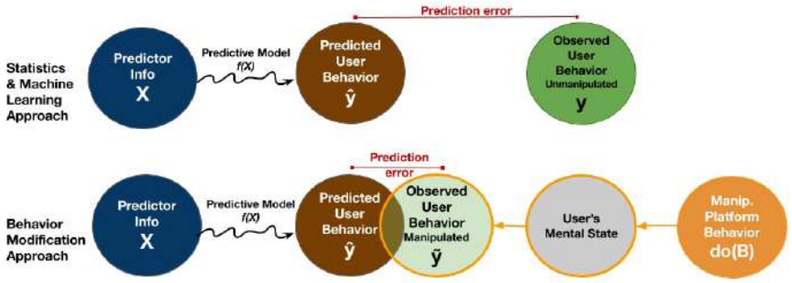

Prediction error with no behavior modification (top) vs. with behavior modification (bottom). Manipulating platform behavior pushes the observed user behavior toward its predicted value. Note that only orange arrows denote causal effects; squiggly black arrows denote correlation-based predictive relationships.

Our work investigates the capabilities of digital platforms due to integrating behavior prediction and behavior modification. In our recent paper, published in the International Journal on Forecasting (Shmueli & Tafti, 2023) and followed by three commentaries and a rejoinder, we examine how internet platforms could potentially "improve" the accuracy of their behavioral predictions by nudging users towards their predicted behaviors, rather than actually improving the predictions. Platforms like Facebook and Google sell prediction products to business customers who use the predictions for personalization, targeting, and other decision-making. Predicted behaviors include the probability of purchase, churn, engagement, and even voting intentions and life events such as pregnancy. Platforms have strong incentives to improve predictive accuracy in order to sell more valuable prediction products. The standard approaches in statistics and machine learning for improving predictions focus on developing better algorithms and getting more or richer training data. However, platforms now have the additional option of reducing prediction errors by modifying users' actual behavior, using the extensive behavior modification tools they have developed and implementing them via sequentially-adaptive, autonomous, and interactive technologies such as reinforcement learning. By pushing users towards their predicted behaviors, platforms can make their predictions appear more accurate.

We call this a “predict-then-modify” strategy. To formally study this "predict-then-modify" strategy, we integrate causal notation (Pearl's do-operator) with standard predictive modeling notation.

This allows expressing both the initial predictions and the subsequent causal behavior modification steps within a single formal framework. We then decompose the expected prediction error given behavior modification and identify the components impacting predictive power. Our derivation elucidates implications of such behavior modification to data scientists, platforms, their customers, and the humans whose behavior is manipulated. Our analysis shows how behavior modification can reduce prediction error by countering model bias and by reducing variability in prediction errors across users. Behavior modification can make users’ behavior more predictable and more homogeneous. However, the resulting accuracy may not reflect the platform's true unaided predictive capabilities and thus could mislead customers seeking to utilize the predictions. The modified behavior also may not generalize to new users not subject to the same interventions. More concerning is that nudging outcomes toward their predicted values, even if flawed, could push users towards potentially dangerous behaviors. In other words, turning high-risk predictions into high-risk realities. For example, when predicting drivers' accident risk for an insurance customer, the platform can modify a driver’s behavior toward its predicted risk by manipulating their engagement with the app.

While platforms have the incentive and capabilities to minimize the prediction errors, the predict-then-modify strategy is likely to occur given the growing use of automated personalization techniques, such as reinforcement learning, that interact with users, apply sequential interventions, and combine prediction and behavior modification. Therefore, it is essential to have a useful technical vocabulary that integrates intentional behavior modification into the correlation-based predictive framework to facilitate studies of such contemporary strategies.

Professor Galit Shmueli (left) with UIC Professor Ali Tafti (right), during sabbatical at UIC

Research Highlights

- Keynote address at the International Symposium on Forecasting (ISF) on "Improving" Prediction of Human Behavior Using Behavior Modification (June 2021)
- ISBIS Gosset Lecture on “The Language of Statistics (and What’s Lost in Translation)”, at the 63rd ISI World Statistics Congress (July 2021)
- Editor-in-Chief, INFORMS Journal on Data Science
- 2022 E.SUN Bank Academic Award, Taiwan
- 2022 Hou De Association Outstanding Research Award 厚德會傑出研究獎 , NTHU
- 2021 Outstanding Research Award, National Science & Technology Council, Taiwan

Research Output

- Greene, T., Shmueli, G., and Ray, S. (2023), “Taking the Person Seriously: Ethically-aware IS Research in the Era of Reinforcement Learning-based Personalization”, Journal of the Association for Information Systems (JAIS), forthcoming.
- Shmueli, G., and Tafti, A. (2023), How to “Improve” Prediction Using Behavior Modification, International Journal on Forecasting, vol 39 issue 2, pp. 541-555.
- Shmueli, G., and Tafti, A. (2023), Rejoinder: How to “Improve” Prediction Using Behavior Modification, International Journal on Forecasting, vol 39 issue 2, pp. 566-569.
- Greene, T., Martens, D., and Shmueli, G. (2022), Barriers to Academic Data Science Research in the New Realm of Algorithmic Behaviour Modification by Digital Platforms, Nature Machine Intelligence, issue 4, pp. 323–330.

Discourses on Chinese Lyrical Tradition and Literary Historiography

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Professor Kwok Kou Leonard Chan (on the right) was awarded the 11th Academia Sinica Scholarly Monograph Award in the Humanities and Social Science.

Discourses on Chinese Lyrical Tradition and Literary Historiography aims at reconfiguring the development of the conception of "lyrical tradition" as a way of rethinking the history of Chinese literature. The book first focus on how Chen Shih-Hsiang and Kao Yu-Kung unfolded their narratives of "lyrical tradition" and "lyric aesthetics". It then expounds on Juroslav Průšek's thoughts of "Chinese lyricism" which he acknowledged as the signature of both pre-modern and modern Chinese literatures. The historical senses and poetical sensibilities of the three scholar-critics were scrutinized concurrently with careful inspection of their academic and life journeys.This book points out that Chen Shih-Hsiang had an interest in literary modernism in his early life. He turned to classical literature after he left from China, and finally propounded the concept of "lyrical tradition" contrasting with the western literary traditions of tragedy and epic. Kao Yu-Kung, equipped with theoretical tools of analytical philosophy, delved into Chinese literature and arts and arrived at an aesthetic with "lyricism" as the core value.

On the other hand, Jaroslav Průšek, a humanistic Marxist immersed in Prague structuralism, recognized a dialectics of the lyric-epic attributes of Chinese literature. The three scholars shared the same belief that literature is one of the best manifestations of Chinese cultural experience. Ironic enough, memories of the cultural China could only be sustained in Chen's and Kao's learning and professing of classical Chinese literature when they were far away from their homeland, whereas Průšek were forced to surrender his aspiration and ambition of Chinese study after Prague Spring in 1968 and passed away desolately in 1980.The book also probes into the literary-historical writings of three academics and men of letters: Lin Geng (1910-2006), Hu Lancheng (1905-1981), and Sima Changfeng (1920-1980). Lin Geng's History of Chinese Literature was written at the time of Sino-Japanese War, and published in 1941. Readers of this lyrical narrative could hardly lose sight of its social and political context. On the other hand, Hu Lancheng tried his best to fashion a literary landscape in his Remarks on the History of Chinese Literature, completed in 1977 and first published in 1980, with the intention of purging and cleansing of all sinful deeds in his own past. Sima Changfeng completed his 3-volume History of Chinese New Literature (1974-1978) in the colonial Hong Kong. His doomed quest of the "apolitical" literary space symbolized a diasporic intellectual's sentimental journey to Nowhere. The literary histories Lin, Hu and Sima produced are at odds with those standard models of similar titles. Nonetheless, all three are distinctive in their narrative modes and to a great extent correlated with the conception of "Chinese lyrical tradition".

Discourses on Chinese Lyrical Tradition and Literary Historiography is Professor Chan's first academic book published in Taiwan since his appointment as the Yushan Scholar at National Tsing Hua University. His reading of the works and life journeys of the mentioned men of letters is arisen from the critical reflections of the socio-cultural ruptures and continuities in the mid-twentieth century. It is also a reflection of the situatedness of intellectuals in a state of crisis.

Professor Kwok Kou Leonard Chan

Research Highlights

- The main focus of this book monograph lies in addressing pertinent issues within the "Chinese lyrical tradition." Through a reflective dialectic, it engages in a dialogue between this discourse and literary history, thereby unveiling the "poetic sentiment" underlying literary texts and the "historical consciousness" within literary history, revealing their intricate interconnectedness.
- The book examines the various conceptions of "lyrical tradition" propounded by Chen Shih-Hsiang, Kao Yu-Kung, and Juroslav Průšek, along with analyses of the works on "Chinese literary history" by Lin Geng, Hu Lancheng and Sima Changfeng.
- Critiquing and at the same time substantiating these multifarious discourses so as to synthesize a comprehensive framework of literary interpretation, the book initiates a novel approach to studying Chinese literature and literary history.

Research Output

- "Poetry and Language: Approaching Human Reality through History and Poetry". Paper presented at Observing Cultural Variabilities: Reflection and Refabrication of Chinese Cultural Tradition": The International Conference to Commemorate the 60th Anniversary of the Department of Chinese Language and Literature, Chinese University of Hong Kong. on April 18, 2023