NSYSU Research

HIGHLIGHTS

National
Sun Yat-sen
University

國立中山大學

National Sun Yat-sen University

"Imagining The Future and Making It Possible"

NSYSU Research HIGHLIGHTS

National Sun Yat-sen University (NSYSU), established in 1980, is one of the top research universities in Taiwan with nearly 9,500 students and more than 500 faculty members. With its unique location by the ocean and the mountains, NSYSU is well-known for its beautiful campus and leading research in the field of Marine Sciences. In addition, the research in the fields of Materials Science, Environmental Sciences, Communication Engineering, Biomedical Sciences, Management, and Social Sciences is also exceptional.

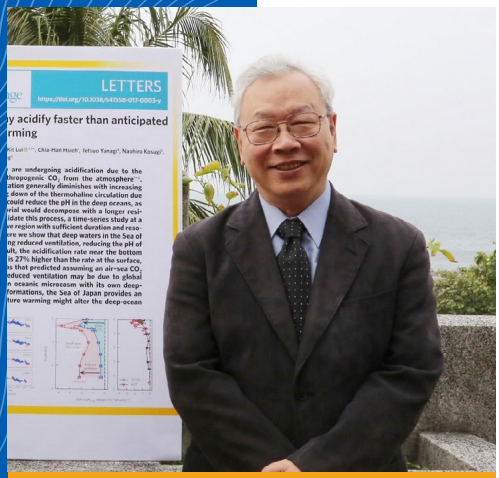
The current President Ying-Yao Cheng holds a PhD degree in Education. He believes that supporting students to dream big and providing them with assistance from the university allows students to make their dreams come true for a better future. He inspires all members of NSYSU to move toward excellence with the encouragement of ***"Imagining the Future and Making it Possible".***

Through diligent leadership by all the Presidents of NSYSU, the university has achieved a great level of success, not only in its role as the academic hub of southern Taiwan, but also as one of the most highly-ranked universities in the world.

MARINE SCIENCES

The Global Ocean Acidification

Dr. Chen-Tung Arthur Chen is a renowned expert on the research of global carbon cycle and ocean acidification. Among many of his international projects, he served as the senior vice chairman of the International Geosphere Biosphere Program of ICSU for seven years. Prof. Chen has published several first-authored papers in Nature and Science on issues related to the carbonate chemistry in the oceans. He was the pioneer of developing a method to calculate the concentration of fossil fuel CO2 in the oceans. The penetration of the fossil fuel CO2 leads to ocean acidification. Prof. Chen was the first to point out that due to the enhanced stagnation of deep waters in the Sea of Japan it may become anoxic by the year 2200. Furthermore, he stresses that the deep waters of the global oceans may become acidified faster than anticipated due to the global warming-induced stagnation. To study the effect of ocean acidification, he started to investigate the hydrothermal vents around Gueishan Island of Northeastern coast of Taiwan and detected a vent with the lowest pH in comparison to the global waters. His research leads him to explore remote areas of the world, and his research achievements are prominent in the field of oceanography.

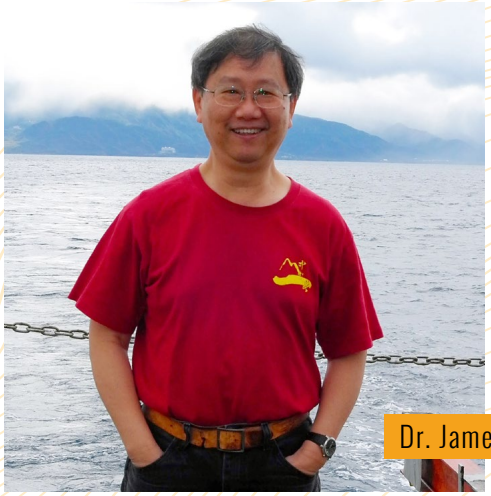


Dr. Chen-Tung Arthur Chen

Research sampling in Papua New Guinea

Source-to-Sink Processes and Records

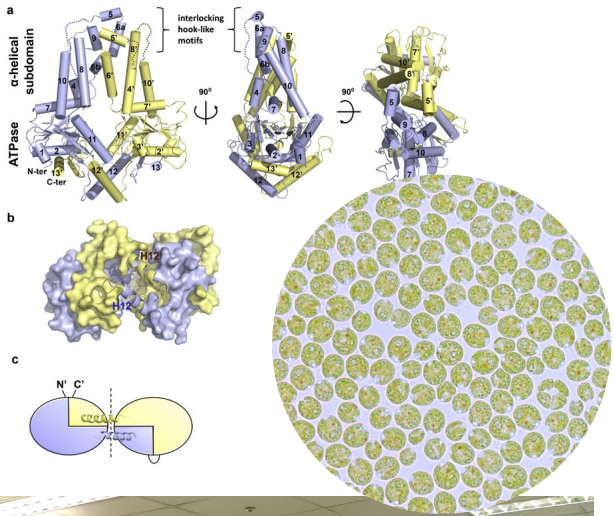
The impacts of Climate Change on human beings are pressing and require everyone's care and concern. Scientists and scholars put in great efforts to research various issues that surround the topic of climate change. One aspect is understanding how the earth system operates on the land-sea boundary. Professor James T. Liu and his team from the Department of Oceanography incorporate innovative thinking and cross-disciplinary approach in their research to help discover insights regarding past and future changes on the land-sea boundary, which can be applied for future planning for coastal developments and prevention and mitigation of geohazards on events extending to millennium time scales.

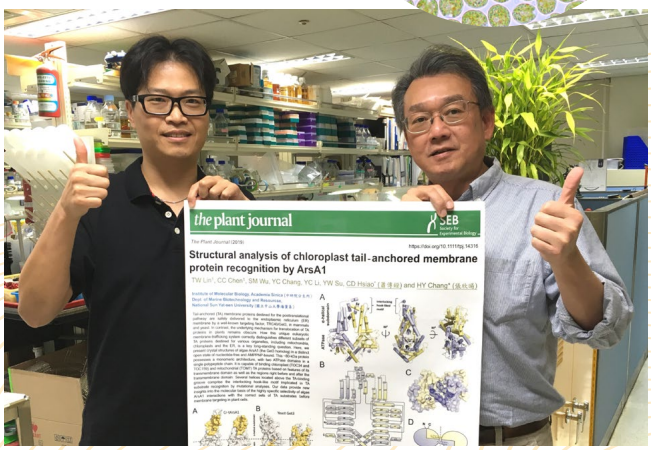


Dr. James T. Liu

Solution to Global Warming: ArsA1, an essential TA protein carrier for algae chloroplast development

Global warming has been one of the most critical global crises in recent decades. Recently, the research team led by Dr. Hsin-yang Chang, assistant professor at the Department of Marine Biotechnology and Resources, and Dr. Chwan-deng Hsiao, research fellow at the Institute of Molecular Biology, Academia Sinica have successfully identified the 3D crystal structure of ArsA1, the carrier that escorts tail-anchored (TA) membrane protein to the chloroplast. They solve the mystery of how TA protein is transported to the outer chloroplast membrane, a mechanism that results in high efficiency of green algae photosynthesis. Because green algae capture 20 times more atmospheric carbon dioxide than trees can do, this discovery could help alleviate and stop global warming. The research has been published in The Plant Journal, a world-leading authority in plant science.





Dr. Chang emphasizes that by understanding the molecular mechanism of chloroplast TA protein transportation, the efficiency of algal photosynthesis can be enhanced, thereby increasing the contribution of algae to carbon fixation. Therefore, large amounts of carbon dioxide could be removed from the atmosphere, alleviating the greenhouse effect.

Dongsha Atoll Research Station (DARS)

National Sun Yat-Sen University, leading the research of Marine Sciences in Taiwan, was sponsored to establish Dongsha Atoll Research Station (DARS) by the Ministry of Science and Technology. Located on the northern part of South China Sea, Dongsha Atoll is a region with versatile ecosystems, including coral reefs, seagrass beds, lagoon, patch reefs, and deep sea, which makes it a significant research base for scientists from the world. It's also one of the best sites in the world for global warming and ocean acidification research as well as marine biodiversity. DARS provides research assistance such as ships that help researchers get through every possible spot on the atoll, facilitating various studies of the air, on the surface and under the sea. The Coral Triangle in South China Sea with abundant resources of marine biodiversity has captivated scientists from over 23 countries to conduct and operate research and experiments at Dongsha Atoll. It is beneficial for NSYSU to extend its international connections with the global academic community.

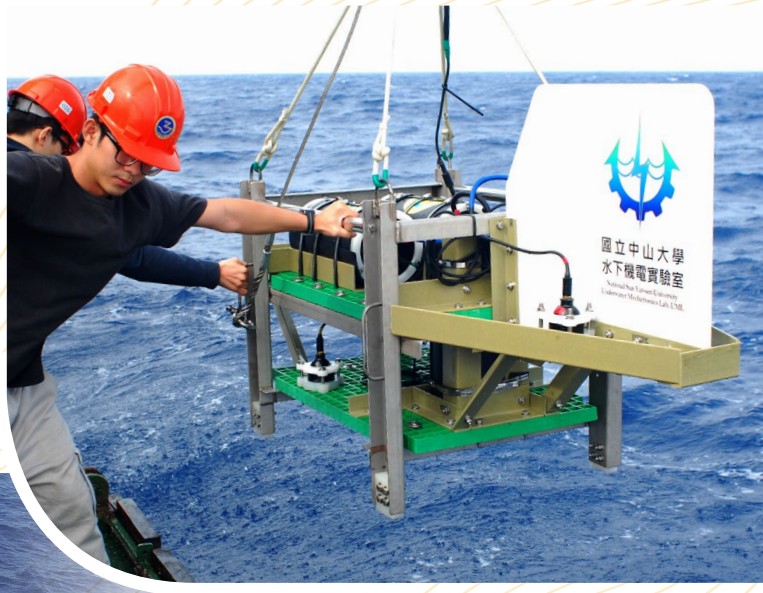
The World's First Ocean Current Power Generation Tested Successfully

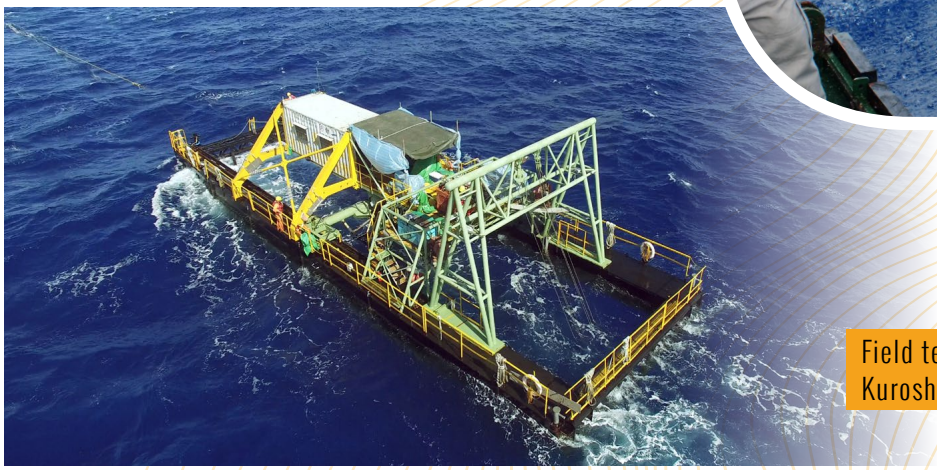
Dr. Yang-Yih Chen, Distinguished Professor of the Department of Marine Environment and Engineering, along with his research team worked on the Kuroshio Power Generation Project for years. In 2016, the team finally performed a successful field test to convert the current power into electricity in the sea near Eluanbi, on the Southeastern coast of Taiwan. The power generating capacity reached an average value of 26.31 kW at the current speed of 1.27 m/s. They installed a mooring system with a deep-water floating platform at a water depth of 900 meters; a 50 kW current energy system was triggered at the minimum current speed of 0.45 m/s to run for 60 hours nonstop. Such testing result attracted global attention as the world's first ocean current power generation demonstration test. If the developing power generation system could be installed along the east coast of Taiwan where the Kuroshio flows, it is expected that the capacity of current power generation would be a great force in moving Taiwan forward to become a nuclear power-free country.

Dr. Yang-Yih Chen

Research on Underwater Mechatronics

Research on underwater mechatronics at National Sun Yat-sen University is outstanding. Profs. Hsin-Hung Chen, Chau-Chang Wang, and Yu-Cheng Chou co-led their team at Institute of Undersea Technology developed underwater instruments, systems and techniques for specific scientific research, such as collecting seafloor images and sediment samples for gas hydrate exploration and mineral resource investigation, etc. The systems that they invented can reach as deep as 3000 meters under water. They integrate mechanical engineering, electrical engineering and computer science in a multidisciplinary model for the development of the cross-field academic and industrial collaborations. Besides, the development of the manned submersible has been working for years, and it is expected to see the first successful MIT human occupied vehicle (HOV) in the near future.





Field test in the mainstream of Kuroshio current on 24-30, July, 2016

Leading Research on Marine Natural Products and Biotechnology

The Department of Marine Biotechnology and Resources (MBR) of National Sun Yat-sen University is one of the significant pioneers in Taiwan that conducts the research of marine natural products. The leading scientists, Dr. Jyh-Horng Sheu, Dr. Chang-Yih Duh, and Dr. Ya-Ching Shen, conducted fundamental research on marine natural products and fostered students' talent on marine natural product research on industrial and medicinal application. Their flourishing publications caught the global scientists' attention and was mentioned in Natural Product Reports, one of the top journals in the field of medicine, in 2013 and 2016, respectively.

Over the course of 30 years, the MBR group studied more than 100 species of marine invertebrates and marine algae. Over 1300 new compounds with various bioactivities and health application have been published. Moreover, the study of high-value ingredients of microalgae-like thraustochytrids in Taiwan proved that protists can be applied as food supplements in aquaculture as well.

Exploring Fish Biodiversity of South China Sea

From the Department of Oceanography, Dr. Teyu Liao is an ichthyologist whose expertise is in phylogeny, biodiversity and population genetics of marine fishes. Dr. Liao and his fellow researchers from Institute of Marine Ecology and Resources, Vietnam investigated together on the fish fauna throughout the entire coastline of Vietnam using morphological characters

to identify the specimens and DNA barcode their COI gene sequences. A total of more than 3,600 tissue samples were collected; their voucher specimens were brought back to Taiwan and deposited in the Department of Oceanography at National Sun Yat-sen University. All species were processed and a reliable DNA barcode reference library for these fish was established by the bilateral collaboration between Taiwan and Vietnam. Their output improves the knowledge of Vietnamese coastal fish faunae, which will contribute to better monitoring, conservation, and management of fisheries in Vietnam. In addition to Vietnam, a bilateral collaboration with the Philippines is underway and a new research project with Brunei will soon be launched.

AI Shrimp Aquaculture System

An Artificial Intelligence Shrimp Aquaculture System was created by Professor Chin-Chang Hung, Department of Oceanography and Professor Ing-Jer Huang, Department of Computer Science and Engineering. The system combines the Information technology facilitating the management of aquaculture farming, including a shrimp pond equipped with feeding machine, central sewage system, underwater camera, water quality sensor, and AI image processing technology. It provides real-time water quality data analysis and highly visible underwater images. It implements a variety of automatic mechanisms, such as prediction and analysis of shrimp growth, critical warning during emergencies, smart feeding and sewage decision. The research is expected to automate the farming process and improve the shrimp's growth, benefiting the population that struggles to respond to weather emergency and other crisis that requires an immediate response. The collaboration of the academic research and the shrimp farming industry can be anticipated to have similar productivity as Norwegian Salmon Aquaculture System.

ENVIRONMENTAL SCIENCES

Development of Green Technologies for Polluted-land Restoration

Dr. Chih-Ming Kao, Chair Professor of the Institute of Environmental Engineering is one of the leading researchers in the areas of polluted land remediation and environmental restoration in Taiwan.

He was sponsored by Taiwan Environmental Protection Administration and Ministry of Science and Technology to develop a series of green and sustainable remediation technologies for polluted site cleanup. These technologies include innovative, long-lasting, and nano-zero valent iron-contained colloidal substrates to enhance the bioremediation processes, biobarrier system for plume containment, and novel strains for contaminant biodegradation. The developed remediation system is a cost-effective, in situ, and biological technology, which reduces the carbon emissions during site remediation. Thus, it is cutting-edge and a cleaner remediation method.

Rapid Screening Research Center for Toxicology and Biomedicine (RSCTB)

Dr. Jentaie Shiea, professor of the Department of Chemistry and director of RSCTB, is one of the world's leading scientists in the area of ambient mass spectrometry. He is one of the cofounders of both the Taiwan Society for Mass Spectrometry and the Asia and Oceania Mass Spectrometry Conference, a former executive board member of the International Mass Spectrometry Foundation, and an Asia and Oceania Regional Representative for seven years.

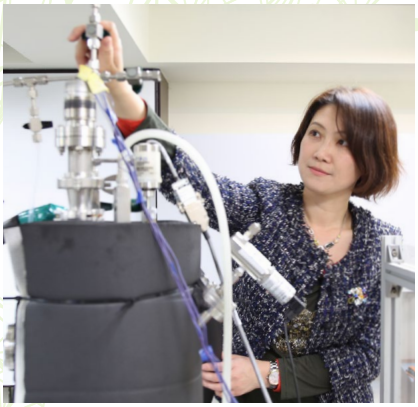
Dr. Shiea's research interests include analytical chemistry, mass spectrometry, instrumentation, and biomedicine. Specifically, he has worked on developing transportable ambient mass spectrometric techniques that are applicable to the on-site detection of toxins, drugs, explosives, and pollutants relevant to food safety, anti-drugs, anti-terrorism, environmental chemistry, and emergency medical treatment. Also, he has interfaced mass spectrometry with chromatographic techniques to increase efficiency of separation and identification of chemical and biological compounds, and applied modern mass spectrometry to clinical diagnoses.

The First Aerosol Science Research Center in Asia for PM2.5 Control

Dr. Chia-Chen Wang, a physical chemist and pioneering aerosol scientist in Taiwan, established the first Aerosol Science Research Center (ASRC) in Asia in Feb 2017. By bridging the efforts from the fundamental studies of aerosols to numerous aerosol-related fields, ASRC provides a multidisciplinary platform where researchers can work together to resolve various urgent issues related to aerosols, including man-made PM2.5.

Dr. Wang developed the first high-resolution aerosol vacuum ultraviolet photoelectron spectroscopy technique, providing insights into the valence electronic structures of aerosols and their chemical activities. Dr. Wang also put in great endeavors in developing preventive medicine for morbidities associated with PM2.5 exposure.

Since 2017, ASRC made tremendous contributions in promoting the environmental education and academia-industry collaboration. ASRC has established a global network and an international advisory committee, with an ultimate goal to alleviate the global environmental crisis caused by air pollution and anthropogenic aerosols, restoring the homeostasis of our planet earth.

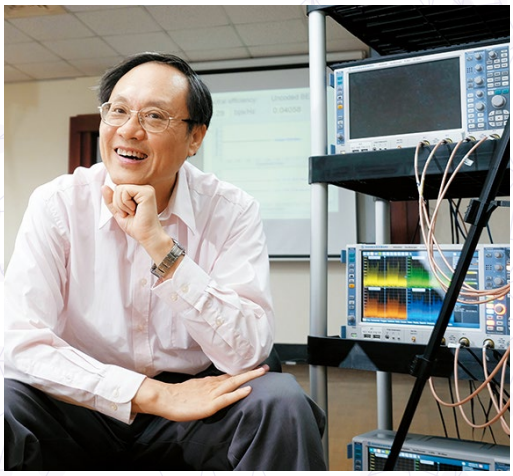


1st international Symposium on Aerosol Chemistry and Related Reactional Dynamics was held in NSYSU

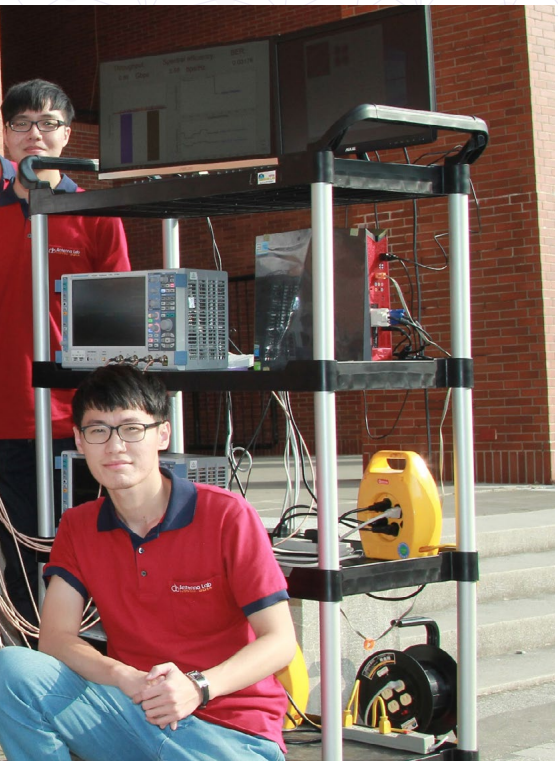
COMMUNICATIONS ENGINEERING

The Forefront Research of Multi-Gbps Smartphones for 5G/B5G Communications

Dr. Kin-Lu Wong is the National Chair Professor of Department of Electrical Engineering (2016 National Academic Award). His expertise is in the massive multiple-input and multiple-output (MIMO) antenna system for the applications of the 5G mobile phones. Wong's current research focuses on the development of massive MIMO antennas for terminal devices. His research team has successfully developed the promising 12 and 16 MIMO antennas for the 5G multiGbps smartphone and the innovative massive MIMO capacity which facilitates the development of 5G communications. Wong explains that a mobile phone antenna's main function is to receive signals. The 16-antenna design opens 16 gates for signal transmission. For example, a mobile phone with a single antenna requires 4 minutes to download a 500 MB movie, whereas a mobile phone with 16 antennas requires only 15 seconds for the same task under the same bandwidth. The 16-antenna devices are expected to operate 16 times faster than single-antenna devices under 16 × 16 MIMO.Wong's team has published more



than 800 journal papers and granted over 250 patents in Taiwan, China, USA, and Europe. More than half of the top ten international mobile phone companies collaborated with Dr. Wong for technical exchanges and consultations. He received numerous inquiries in an exhibition in Beijing in 2016. “They were amazed by Taiwan’s technology in massive MIMO antenna development for terminal devices,” Wong said. Dr. Wong is confident that NSYSU's antenna technology can be counted as the top leader in both academia and industry.

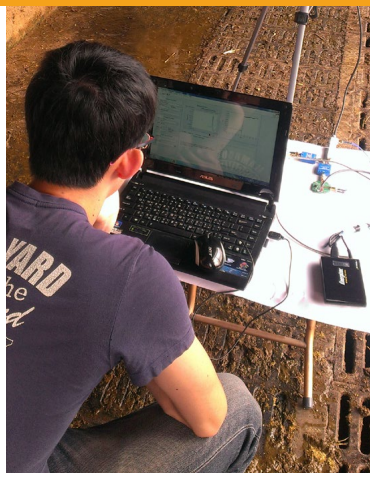


NSYSU Self-Injection-Locking Technology Leads the World in Biomedical Radar Research

Dr. Tzyy-Sheng Jason Horng, Chair Professor of the Department of Electrical Engineering, is the principal inventor of the self-injection-locking (SIL) technology that breaks through sensitivity limitations for Doppler radars which show promising potential for biomedical sensing applications. The Doppler radar deploys SIL technology so it is not only sensitive but also immune to stationary clutter such as that produced by antenna coupling and background reflection. As a result, it's operated with a single antenna in harsh backscattering environments, also, with the feature of seeing through walls.

Today, Dr. Horng’s innovative research has inspired many professionals and companies around the world to develop SIL Doppler radars for human and animal healthcare applications.

Touch-less monitoring of cow’s vital signs using SIL Doppler radar



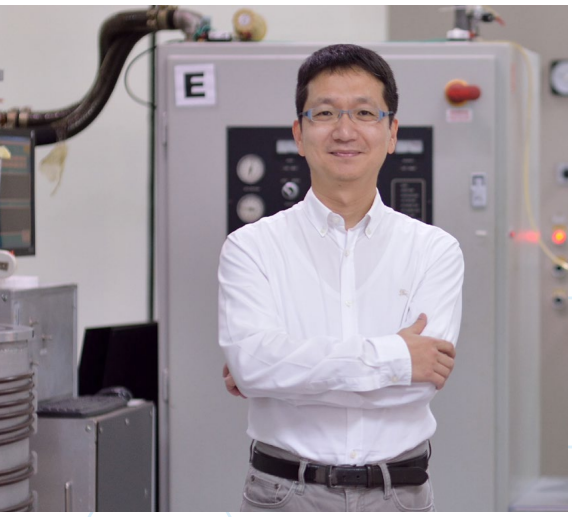
MATERIALS SCIENCE

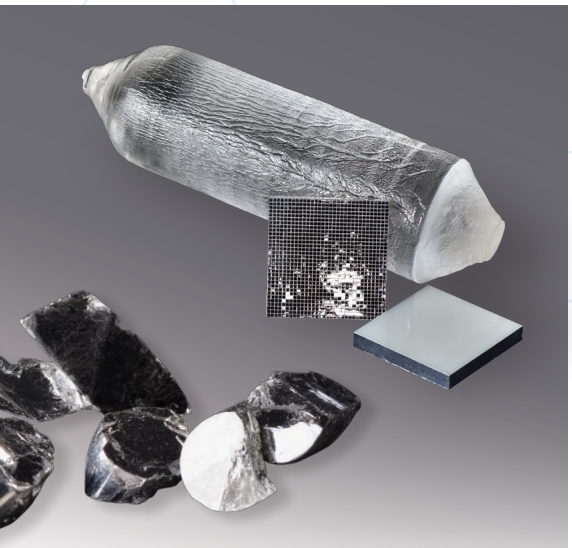
The Growth of Novel Crystalline Materials Attracted Global Attention

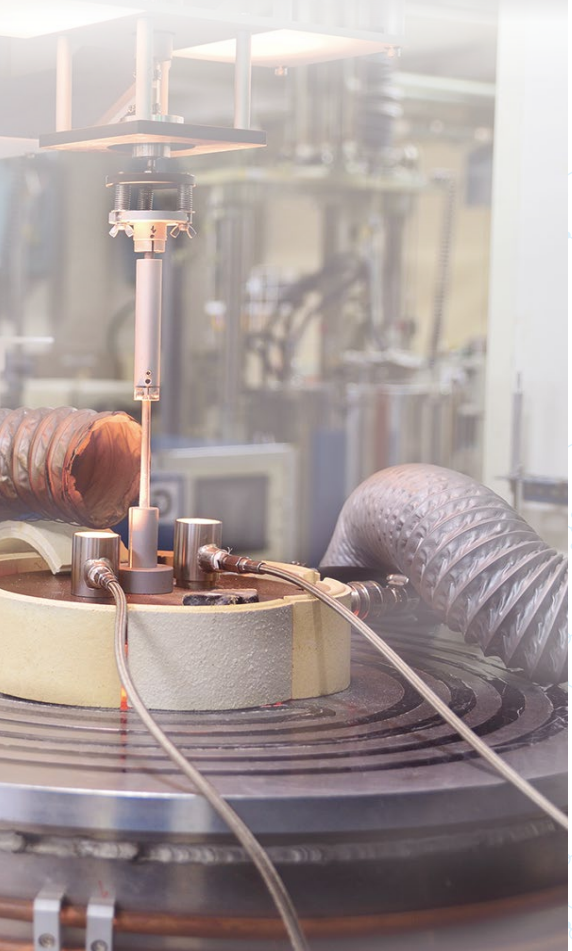
Dr. Ming-Chi Chou, Chair Professor of the Department of Materials and Optoelectronic Science, is one of the leading researchers in the growth of crystalline materials in Taiwan.

He was sponsored by the Ministry of Science and Technology (MOST) for establishing the “Taiwan Consortium of Emergent Crystalline Materials” (TCECM), the largest crystal growth laboratory in Taiwan. In the lab, the cultivation of different kinds of single crystals can be applied in the following research and industrial fields, such as substrates for compound semiconductors, laser, nonlinear optics, high-temperature semiconductor, topological insulator, nuclear science, and medical science.

Dr. Chou’s research strengthens Taiwan’s development of crystal growth and its competitiveness in the global society of rising high-tech industry. His research captivates global attention.



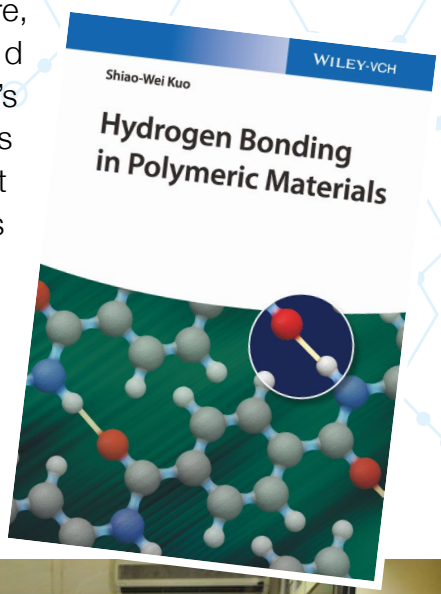




Center for Functional Polymers and Supramolecular Polymers

Dr. Shiao-Wei Kuo, Professor of the Department of Materials and Optoelectronic Science is one of the leading researchers in the functional polymers and supramolecular materials all around the world.

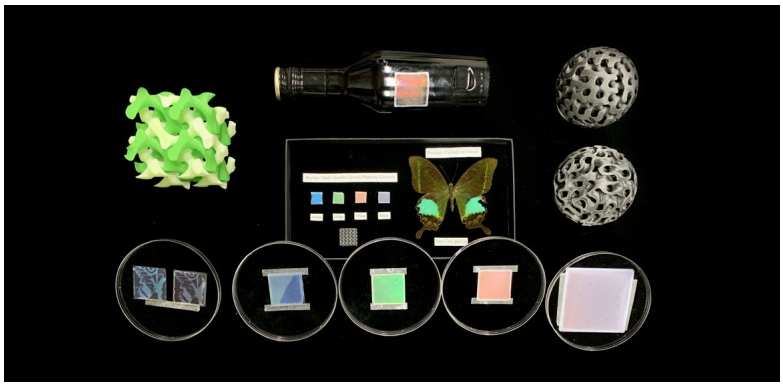
His research interests focus on polymer interaction which provides some applications in optical materials, low surface free energy materials of polybenzoxazine, self-assembly nanostructure, mesoporous materials, organic frameworks, porous materials, POSS nanocomposites, and polypeptides. These functional polymeric materials could be used in aerospace, biomedical science, carbon dioxide capture, supercapacity, and lithium battery. Dr. Kuo's research strengthens Taiwan's development of functional polymers and also promotes the competitiveness of Taiwan's polymeric technology in the global polymer society.



Bioinspired Gyroid Photonic Crystals

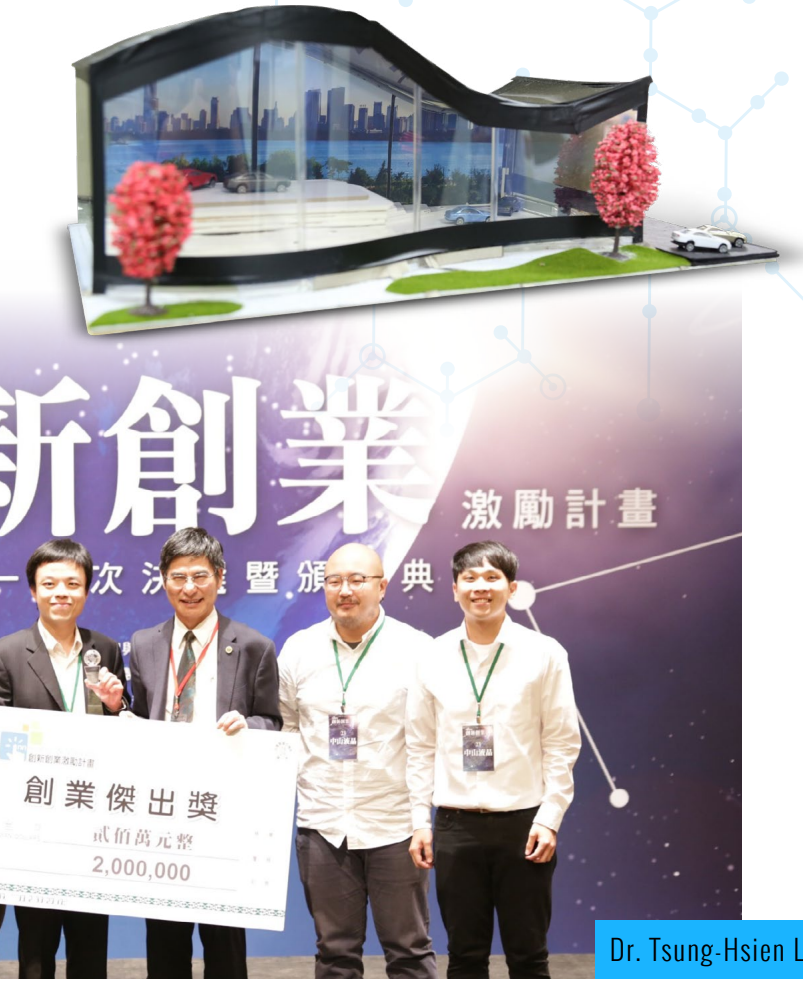
Unlike usual pigments, natural photonic crystals like butterfly's wings are able to reflect shining and beautiful colors due to the inner ordered bicontinuous network microstructures called gyroid. Gyroid-structured photonic crystals could theoretically exhibit advanced optical properties as a result of their highly interconnected network. However, the visible gyroid photonic crystal could not be artificially fabricated currently due to the extremely complicated structural shape and its downsizing to hundreds of nanometer. Prof. Yeo-Wan Chiang and his research team at the Department of Materials Science and Optoelectronic Science develop a unique technique—trapping of structural coloration (TOSC)—through which human-made butterfly-wing-like gyroid photonic crystal films are carried out by spontaneous self-assembly of polymeric materials. By manipulating TOSC, their human-made gyroid photonic crystal films in the solid state could exhibit any reflectance hue and controllable reflectivity in visible wavelength range you desired without the need to introduce any additives or to synthesize new compounds. Also, their gyroid films are highly flexible and possess switchable structural coloration triggered by various stimuli such as heat, alcohol, solvent, and irradiation, being superior to natural butterfly wings. As a result, the mass production of the human-made visible gyroid photonic crystal films is accomplished. It is applicable in the fields of optical communication, energy, light-emission, sensor, and display.

Dr. Yeo-Wan Chiang and his research team



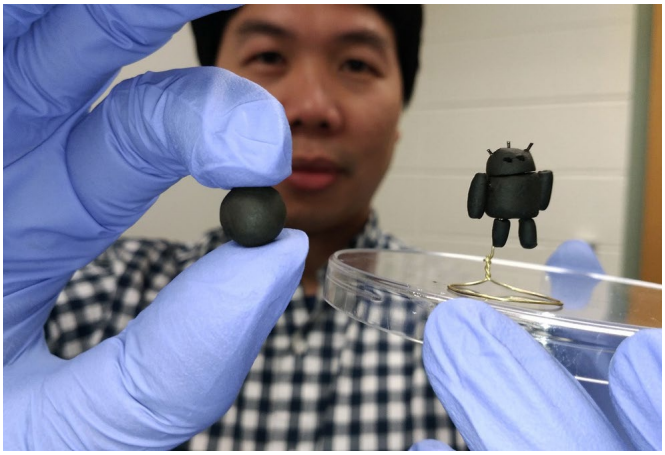
Multi-functional Smart Window Film

Dr. Tsung-Hsien Lin, from the Department of Photonics, led a research team to invent a multi-functional smart window film. The film is very thin and can be cut in different sizes, also directly coated onto the window glass. The glass with the film can control the brightness of the light ranging from transparent, tinted, or completely dim. The most significant part of the innovation is that the light can be controlled through the Smart Phone APP. The tinted window is good for privacy protection and is also used as a screen for image display. The invention has won many top outstanding innovative prizes and has granted seven patents in Taiwan. It has also attracted the attention of industrial manufacturers for technical collaboration domestically and internationally.



Dr. Tsung-Hsien Lin and his team won many awards

Graphene Oxide Doughs and Clean Energy



Dr. Chun-Hu Chen, associate professor from the Department of Chemistry at National Sun Yat-sen University led an international research team, collaborating with Jiaxing Huang's group at Northwestern University, the USA has successfully achieved using "graphene oxide dough" for water splitting, a critical technology to treat water as a battery to store green energy. Their team has converted graphene oxide materials into a highly cohesive dough state, named as graphene oxide dough. This dough stage carries much higher contents of graphene oxide than the previous examples and allows arbitrary shaping, sizing, and reconnecting; such features of the dough are similar to the clay that kids play. The products of graphene oxide dough can solve the problem of long-distance transportation and storage with a much-lowered cost for the graphene industry. Compare to the past, the dough products can achieve the reduction of the cost to 1/500. The team further demonstrated the breakthrough technologies of water splitting and the future possibility of flexible electronics and devices for the green energy industry. Nature Communications, the high-profile international journal, published their research work in 2019.

BIOMEDICAL SCIENCES

Biomedical Research for Next-ge

National Sun Yat-sen University was named in memory of Dr. Sun Yat-sen, the Father of the Nation in the Republic of China. Since Dr. Sun was a medical doctor, NSYSU with this background has a vision of establishing a Medical College. Paving the way for the establishment of a medical college, NSYSU already founded the Department of Biological Sciences, Institute of Biomedical Sciences, and Institute of Medical Science and Technology. In 2020, the Institute of Precision Medicine and Institute of Biopharmaceutical Sciences will be established soon.

The main focuses of medical research of NSYSU are categorized into four topics: 1. target discovery and functional validation; 2. biosensors and medical devices for biomarker detection; 3. new drug/treatment developments; and 4. disease animal models. The most significant ones would be the developments of microneedle patches as a vaccination strategy against hepatitis virus infection (collaborating with National Institute of Health/USA)

neration Therapeutics against Human Diseases

Biomedical research team

and customized spinal cord 3D printing (with Ritsumeikan University/Japan). For functional characterizations and new treatment development, unique transgenic mouse models for pancreatic ductal adenocarcinoma (with National Health Research Institute) and human-like mouse models for endometriosis and the associated malignancies (with Edinburgh University/UK) have been established which can facilitate more advanced study. In recent years, NSYSU aims to develop biomimetic materials for next-generation innovations, such as green energy, anti-freeze substances, and neuro-sensing and deep-learning technologies.

To strengthen the power of medical research, NSYSU collaborates with the medical centers and hospitals in Southern Taiwan for many inter-institutional research projects. For examples, we have started the AI-based deep learning projects with CGMH (Chang-Gung Memorial Hospital) and KVGH (Kaohsiung Veterans General Hospital) and have tried to decode disease-related image features into approachable targets for better clinical decision. We also announced another project with six regional municipal hospitals to develop wearable smart devices/biosensors for monitoring PM2.5 and possible outbreaks of infectious diseases or nosocomial infection. Additionally, signing a MoU with Kaohsiung Armed Forces General Hospital was for collaborations in Smart Long-term Care Medical Services.

We expect that the traditional biomedical research combined with the cross-disciplinary technologies will make NSYSU a key player in the medical research both domestically and globally.

SOCIAL SCIENCES AND MANAGEMENT

Taking on Social Responsibility Drives Regional Development toward Excellence

National Sun Yat-sen University takes on social responsibility as an academic leader in driving the development of culture, cultivation of talents, and industrial advancement of the Kaohsiung Metropolitan Area towards excellence. The University established the Social Engagement Center in 2018 for the basis of research and engagement in revitalizing the old communities in its neighborhood. Professor Ying-Yao Cheng, also the President of the University, has been appointed Director of the Center. Under his leadership, the research team conducted many regional revitalization projects that contributed to the reanimation of the old communities like Hamaxing, Gushan, Chijin, and Yancheng along the Port of Kaohsiung. They help renovate the historical buildings and uphold the traditional culture, shining a new light into the communities with a more livable, dynamic, and prosperous environment for tourist attraction, which in turn restores pride and encouragement back to the communities.

Center for Southeast Asia Studies Cooperates with New Southbound Policy

National Sun Yat-sen University has competitive advantages in geographical location and higher education resources that puts it in the best position to follow the New Southbound Policy. In 2016, the University established the Center for Southeast Asia Studies for serving as a think tank and helping the cultivation of talents for promoting the mutually beneficial relations with countries in the Association of Southeast Asian Nations and South Asia, Australia and New Zealand.

The Director of the Center is Dr. Hung-Jeng Tsai, Professor of the Department of Sociology. His professional and academic expertise in regional and global political economy studies helps the Center improve in excellence, not only for the University's academic collaborations with the institutes in the ASEAN community but also for the development of the New Southbound Policy.

Intelligent Electronic Commerce Research Center

"Intelligent Electronic Commerce Research Center" at NSYSU is led by Dr. Ting-Peng Liang, who is the Lifetime National Chair Professor granted by the Ministry of Education. He has received the Fellow Award and the Leo Award for Lifetime Achievement from the USA-based Association for Information Systems (AIS) and was elected the President of AIS for 2018-2019.

The objective of the Center is to conduct top-tier research in applying artificial intelligence and new information technology for state-of-the-Art service innovation and the enhancement of organizational performance. The Center was established in 1999 and have received major research grants from the Ministry of Education and the Ministry of Science and Technology, including the Center for Research Excellence in the Top University Project and the recent Higher Education Sprout Project. The Center offers a big data analytics platform to support faculty research and also has an industrial consortium to build close connections with more than 25 companies in electronic commerce.

NSYSU Research HIGHLIGHTS

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