TECHNOLOGIES FOR SUSTAINABILITY

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY | OKT OFFICE OF KNOWLEDGE TRANSFER

SEPTEMBER 2024

ABOUT THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

The Hong Kong University of Science and Technology (HKUST) (https://hkust.edu.hk/) is a world-class research intensive university that focuses on science, technology and business as well as humanities and social science.

HKUST offers an international campus, and a holistic and interdisciplinary pedagogy to nurture well-rounded graduates with global vision, a strong entrepreneurial spirit and innovative thinking. Over 80% of our research work were rated “Internationally excellent” or “world leading” in the Research Assessment Exercise 2020 of Hong Kong’s University Grants Committee. We were ranked 3rd in Times Higher Education’s Young University Rankings 2024, and our graduates were ranked 29th worldwide and among the best from universities from Asia in Global Employability University Ranking 2024.

As of Aug 2024, HKUST members have founded 1,815 active start-ups, including 10 Unicorns and 14 exits (IPO or M&A), generating economic impact worth over HK$ 400 billion. InvestHK cited QS World University Rankings by Subject 2021 to demonstrate the performance of five world’s top 100 local universities in several innovation-centric areas, among which HKUST ranked top in four engineering and materials science subjects.

FOREWORD

In an era where sustainability is not just a choice but a necessity, the Hong Kong University of Science and Technology (HKUST) stands at the forefront of pioneering innovations that drive impactful change. “Technologies for Sustainability” is a testament to our unwavering commitment to creating a sustainable future through cutting-edge research, innovative solutions, and a collaborative spirit.

This volume encapsulates the essence of HKUST’s mission to integrate sustainability into every aspect of our academic and research endeavors. It highlights the remarkable achievements of our faculty, students, and alumni who have dedicated themselves to addressing some of the most pressing global challenges of our time.

Through these pages, you will discover stories of groundbreaking projects, transformative technologies, and inspiring initiatives that exemplify our dedication to sustainability. From renewable energy advancements to sustainable urban development, each chapter showcases the innovative spirit and relentless pursuit of excellence that define HKUST.

As you delve into this collection, we hope you will be inspired by the ingenuity and determination of our community. It is through their efforts that we continue to make significant strides towards a more sustainable and resilient future. Together, we can build a world where sustainability is at the heart of progress and innovation.

Let us embark on this journey with a shared vision and a commitment to making a positive impact on our future.

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Clean Water and Sanitation:

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Good Health and Well-being:

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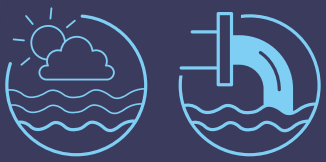
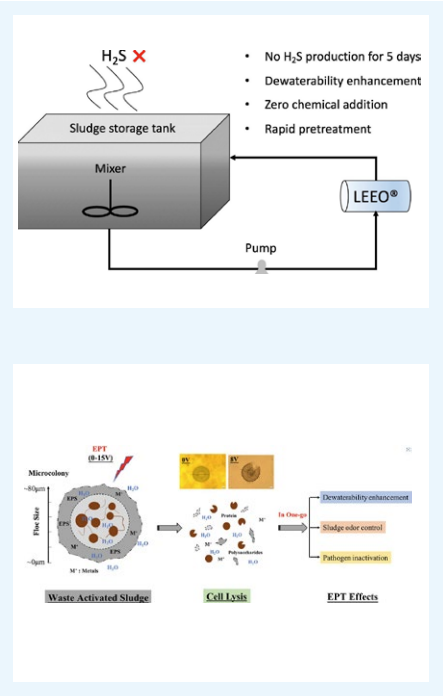
CLEAN WATER AND SANITATION



ELECTROCHEMICAL TECHNOLOGIES FOR WASTEWATER AND SLUDGE TREATMENT

HKUST pioneered novel electrochemical processes for sewage and sludge treatment. These advancements significantly reduce the need for chemical additions, energy consumption, and greenhouse gas emissions. The three pioneering technologies are developed, namely 1) LEEO® for bio-solid deodorizing and enhancing its dewaterability in one-go for smell less and space and cost-efficient sludge treatment, 2) EPT for converting organic solid waste into valuable chemicals for marketing, and 3) ECO for treating high-strength/-salinity landfill leachate.



IP.PA.01188, 01680, SRI.097

US patent No. 20230365441
CN patent No. CN110937768, 117023722, 112624498
HK patent No. 40016292, 40096808

SPECIAL FEATURES AND ADVANTAGES

- Effective sulfide control
- Enhanced dewaterability: improves sludge dewaterability by 20-30%
- Non-toxic supernatant
- Cost savings: implementing **LEEO®** at full scale can lead to significant cost savings, estimated at around 7.5K HKD per day (Siu Ho Wan Sewage Treatment Works (SHWSTW) with a capacity of 817m^3 wet sludge as an example)
- **EPT** enhance sludge reduction and with adaptability to various operation setups
- **ECO** significant reduce chemical oxygen demand from 10,000 mg/L to 400 mg/L, low energy consumption and treatment cost ~35% lower than conventional method

APPLICATIONS

- Environmental management and waste treatment

COMMERCIALIZATION STATUS

- A start-up company ***ElequaNova Limited*** has been established

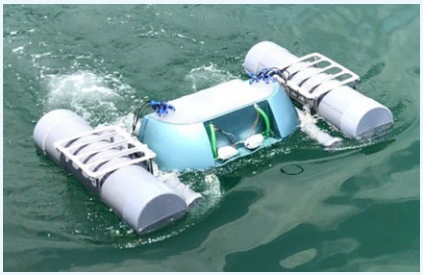
PRINCIPAL INVESTIGATOR

Prof. Guanghao CHEN
Department of Civil and Environmental Engineering

ON-SITE MICROPLASTIC DETECTION FOR RAPID AND ACCURATE WASTE EFFLUENT ANALYSIS

Portable microfiber detection

We developed an innovative and groundbreaking portable device that revolutionizes the detection of microplastics and microfibers, enabling efficient and effective real-time monitoring of effluent quality. This advanced technology provides a reliable and user-friendly solution for on-site analysis, ensuring immediate and accurate detection of contaminants. By delivering rapid results, this device facilitates proactive management of wastewater and industrial effluents. Its ease of use and portability make it an essential tool for continuous monitoring, research, and environmental protection efforts.



Microplastics detection unit

Microfibers in water

IP.KH.00026

Patent in progress

SPECIAL FEATURES AND ADVANTAGES

- **Advanced portable device:** The pioneering portable solution for detecting microfibers and microplastics
- **Prompt response:** Quickly reflects the quality of process effluents, allowing engineers to implement immediate process modifications.
- **Technological foundation:** Lays a solid groundwork for efficient and effective microfiber detection technology in various related industries.

APPLICATIONS

- Water quality assessment on industrial wastewater qualification
- Microplastics detection for process modification, as well as modifying the life cycle analysis and potential ESG analysis
- Analytical equipment for education sectors

COMMERCIALIZATION STATUS

- A start-up company ***Enviridis Technology*** has been established

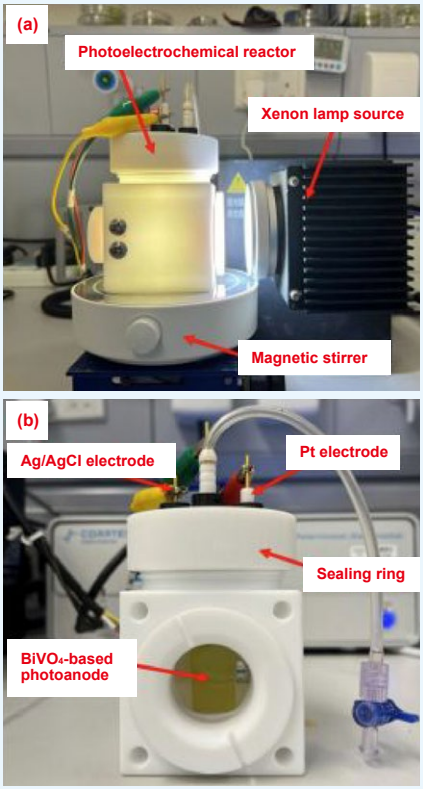
PRINCIPAL INVESTIGATOR

Prof. Leung Yuk Frank LAM, Prof. Cindy Ka Sin LAM
Department of Chemical and Biological Engineering
Department of Ocean Science

PHOTOELECTROCHEMICAL (PEC) SYSTEM FOR LOW-CARBON-EMISSION SALINE SEWAGE TREATMENT COUPLED WITH GREEN H_2 PRODUCTION

Wastewater treatment, green hydrogen generation, and net zero emissions

This innovative technology combines saline sewage treatment with green hydrogen production using a $BiVO_4$-based photoelectrochemical system. It efficiently removes organic compounds, ammonia, and bacteria from wastewater while generating zero carbon emissions. Offering a sustainable alternative to conventional treatment methods, this system reduces the need for chemical additives and supports the goal of net-zero carbon emissions.



Pictures of the (a) experimental setup and (b) PEC reactor

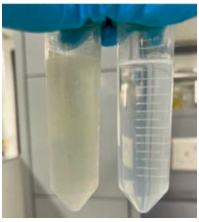
IP.PA.12228

SPECIAL FEATURES AND ADVANTAGES

- **Dual functionality:**
  - Saline sewage treatment: effectively removes organic compounds, ammonia, and bacteria
  - Green H_2 production: generates clean H_2 energy
- **Towards net zero emissions:** low carbon footprint in treatment and green energy generation
- **$BiVO_4$-based photoanodes with high efficiency**
- **Reduced chemical usage**
- **Cost-effective**

APPLICATIONS

- Municipal wastewater treatment
- Industrial wastewater management
- Desalination effluent
- Renewable energy production
- Agricultural runoff treatment
- Coastal applications
- Emergency relief



Photos of sewage samples before and after PEC treatment

PRINCIPAL INVESTIGATOR

Prof. Irene Man Chi LO
Department of Civil and Environmental Engineering

US patent application No. 63/655606

GREEN ANTIFOULING SOLUTIONS BASED ON PATENTED BUTENOLIDE TECHNOLOGY

A green and safe biological solution for marine protection

With over 20 years of research, Prof. Pei-Yuan Qian discovered a novel biodegradable antifouling compound from a marine microbe. This compound boasts excellent antifouling efficiency, a safe biological profile and a green production method. The technology can address the global marine pollution, reducing energy consumption and lowering carbon emission issues. It will enhance the national maritime power in the sustainable development of maritime industries.

IP.PA. 00778, 01470

SPECIAL FEATURES AND ADVANTAGES

- **Broad-spectrum potency:** Effective against a wide range of marine fouling organisms
- **Safe:** harmless to other marine life and safe for the marine environment
- **Simple molecular structure:** Easy production of the compounds
- **Green synthesis methodology:** Minimal environmental impact, biodegradable in seawater

APPLICATIONS

- Anti-Fouling
- Marine coating
- Underwater sensors and equipment

COMMERCIALIZATION STATUS

- A start-up company ***Ocean Science (Hong Kong) Limited*** has been established

PRINCIPAL INVESTIGATOR

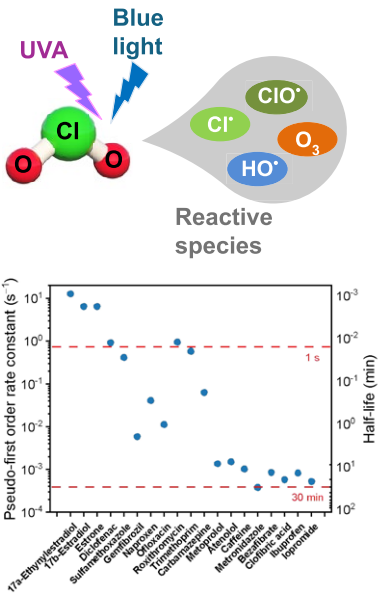
Prof. Peiyuan QIAN
Department of Ocean Science

US patent No. 20160037773, 20220295795
CN patent No. CN105368115, 115109449

AN ADVANCED OXIDATION PROCESS COMBINING USING UVA/BLUE LIGHT RADIATION AND CHLORINE DIOXIDE FOR WATER/AIR DISINFECTION

A greener method to break down pollutants in water and air

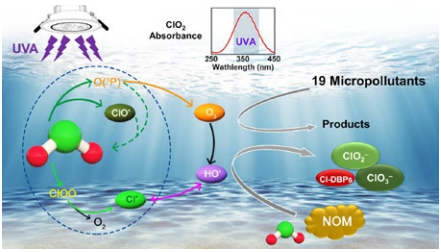
An advanced oxidation process has been developed for water and air disinfection. This is achieved through the photolysis of chlorine dioxide by UVA/blue light radiation, which generates a spectrum of reactive species for various environmental and industrial applications.



Strong Pollutant Degradation

ClO_2 can be effectively activated by either blue light or UVA to produce reactive species, and the combination exhibits synergistic effect on the removal of a broad spectrum of pollutants

IP.PA.01526



SPECIAL FEATURES AND ADVANTAGES

- **Rapid** pollutant degradation in seconds to minutes
- **Fast** removal of sulfide (odour) and decolorize the treated wastewater
- **Energy and cost efficient** – saving over 90% in energy and over 30% in cost due to its high wall plug efficiency
- **Marginal** organic byproduct formation

APPLICATIONS

- Water treatment
- Air disinfection
- Soil decontamination
- UV curing, surface disinfection

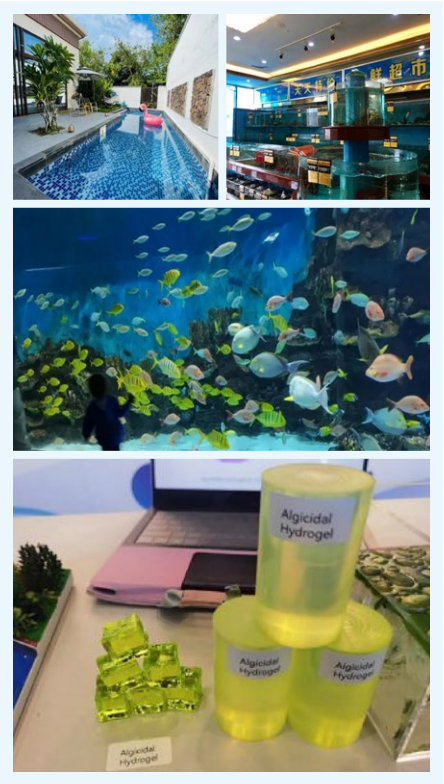
PRINCIPAL INVESTIGATOR

Prof. Chii SHANG
Department of Civil and Environmental Engineering

CN Patent No.: 202210042710.5
HK Patent No.: 42022065588.0

ECO-FRIENDLY ALGICIDAL HYDROGELS FOR SUSTAINABLE WATER MANAGEMENTS

Excessive algal growth is a serious environmental issue, and developing a cost-effective long-term solution is challenging. This invention uses algicidal hydrogels with safe, eco-friendly bioactive ingredients for use in fresh and seawater. These hydrogels release oxidizing and cell-permeable algicides in a controlled manner, inhibiting algal growth without harming aquatic life. Their effectiveness has been confirmed in labs and a 1500 m³ seawater reservoir in Hong Kong. Real-time monitoring equipment provides data to adjust hydrogel amounts and conduct daily water quality tests.



IP.PA.02108, 01759

US patent application No. 63/644510
CN patent application No. 202410196363.0

SPECIAL FEATURES AND ADVANTAGES

- **3D structural hydrogel:** Utilizes environmentally friendly ingredients to achieve a slow-release effect.
- **Long-term effectiveness:** Consistently inhibits algae growth in water bodies without introducing pollutants to the natural water environment.
- **Intelligent dynamic adjustment:** Automatically adjusts to control the concentration of microorganisms and microalgae, maintaining safe levels over extended periods.

APPLICATIONS

- Urban and rural water bodies
- Fish tanks, swimming pool
- Seafood restaurant

COMMERCIALIZATION STATUS

- A start-up company ***EcoTech (HK) EnviroProtect Technology Limited*** has been established

PRINCIPAL INVESTIGATOR

Prof. King Lun YEUNG
Department of Chemical and Biological Engineering

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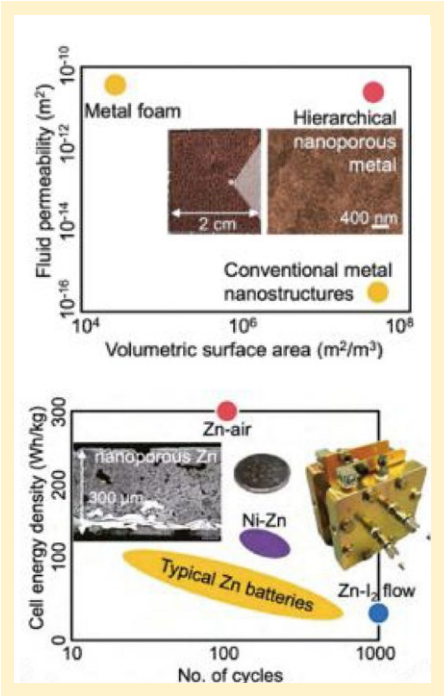
AFFORDABLE AND CLEAN ENERGY

SAFE AND AFFORDABLE ENERGY STORAGE ENABLED BY SELF-ORGANIZED METALLIC NANOSTRUCTURE

Safe, scalable energy storage via nanoporous zinc

Self-organized metallic nanostructures are scalable, robust, conductive, highly permeable to fluids, and rich in functional surface sites. We utilize nanoporous zinc to stabilize zinc anodes during the charge and discharge cycles of rechargeable zinc batteries, offering a safer and more cost-effective alternative to lithium-ion batteries for stationary energy storage.



IP.PA.01325

SPECIAL FEATURES AND ADVANTAGES

- **Easy adoption:** Utilizes the established build of commercial alkaline batteries, making it application-ready
- **Intrinsic safety:** Uses water as the solvent in the electrolyte, eliminating the risk associated with flammable organic solvents
- **Customizable nanoporous Structure:** Can be tailored to the specific design of a battery to maximize its potential

APPLICATIONS

- Stationary energy storage
- Consumer electronics
- Backup power systems
- Industrial power solutions
- Electric vehicles

PRINCIPAL INVESTIGATOR

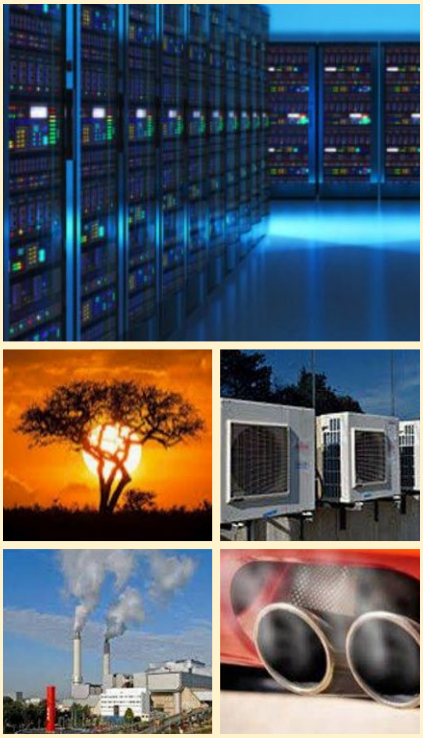
Prof. Qing CHEN
Department of Mechanical and Aerospace Engineering

CN patent No. 116162974
US patent No. 20230163287

ENERGY CONVERSION FROM WASTE HEAT TO ELECTRICITY BY GIANT PYROELECTRIC EFFECT

Turning excessive heat to electricity

Pyroelectric energy conversion has garnered significant interest for its ability to transform waste heat into electricity, significantly reducing carbon emissions in the power sector. We have developed a series of novel energy materials for pyroelectric conversion with greatly improved performance. Additionally, we have established a mature material development approach that incorporates both bottom-up lattice design and top-down grain morphology optimization, broadening its applications in the field of functional ferroelectric devices.



Excess of heat produced in daily life

US patent No. US20200335997
CN patent No. CN111835230
HK patent No. 40034503

SPECIAL FEATURES AND ADVANTAGES

- **Direct energy conversion:** The material itself acts as an engine
- **Efficiency at low temperatures:** Converts small thermal fluctuations around 100°C, ideal for harvesting waste heat
- **Solid state energy conversion:** Clean, simple, and compact solution

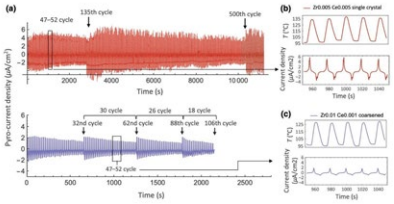
APPLICATIONS

- Industrial waste heat recovery
- Automotive sector
- Consumer electronics
- Renewable energy systems
- Power plants

PRINCIPAL INVESTIGATOR

Prof. Xian CHEN
Department of Mechanical and Aerospace Engineering

IP.PA.01210

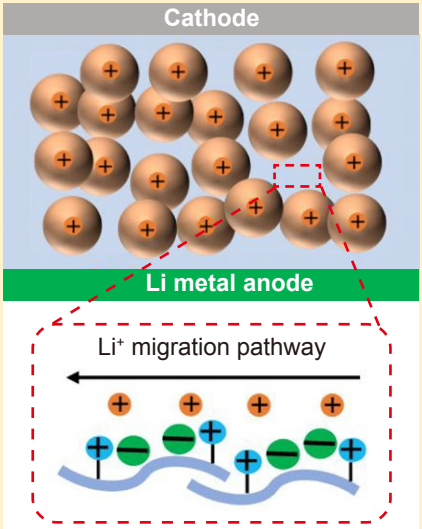


Performance of energy conversion device by phase-transforming ferroelectric capacitor

REVOLUTIONIZING ENERGY STORAGE: TUBE TRANSPORT-INSPIRED ALL-SOLID-STATE ELECTROLYTES FOR LI-BASED BATTERIES

Solid state composite electrolytes with a super conductive

Developing high-energy-density, safe Li batteries is essential. Our new composite solid-state electrolytes provide enhanced safety, electrochemical stability, and high conductivity. These electrolytes selectively and efficiently transport Li+ ions, enabling the creation of smaller, lighter rechargeable batteries. They outperform conventional electrolytes in conductivity, transference number, and stability.



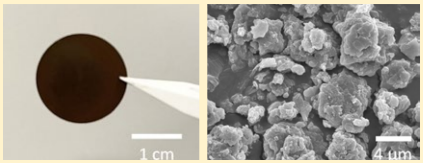


Photo and SEM image of composite

IP.PA.01745

US patent No.20240145773
CN patent No. 117878395
HK patent No. 40103215

SPECIAL FEATURES AND ADVANTAGES

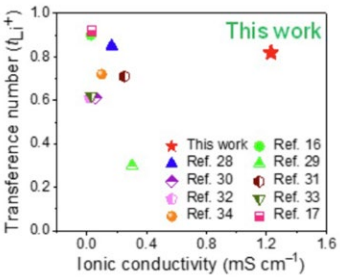
- **Superior Li+ conductivity and transference**
- **High performance:** prototype coin cell with Li metal anode and LCO cathode shows a capacity of 150 mAh g^{-1}.
- **Safety:** these all-solid-state electrolytes are fire-proof
- **Cost-effective:** economical for large-scale production

APPLICATIONS

- All-solid-state electrolytes
- Li-metal batteries
- High-energy-density energy storage devices

PRINCIPAL INVESTIGATOR

Prof. Yoonseob KIM
Department of Chemical and Biological Engineering



HIGH-PERFORMANCE POLYMER-BASED QUASI-SOLID ELECTROLYTES FOR HIGH-ENERGY-DENSITY BATTERIES

Advanced polymer gel electrolytes

Our groundbreaking technology develops polymer gel electrolytes with exceptional conductivity and safety through in situ polymerization. This innovation has been successfully implemented in commercial high-loading batteries, addressing critical issues like graphite exfoliation and silicon pulverization. With its remarkable performance, our technology holds immense potential for commercialization.

SPECIAL FEATURES AND ADVANTAGES

- **Commercial compatibility:** Fits current commercial electrodes and high mass loading batteries.
- **Unique mechanical properties:** Quasi-solid electrolyte prevents electrode pulverization.
- **Enhanced safety:** Reduces risk of fires and explosions by eliminating free liquid molecules.

APPLICATIONS

- Electric vehicles
- Consumer electronics
- Renewable energy storage
- Aerospace
- Industrial equipment

PRINCIPAL INVESTIGATOR

Prof. Minhua SHAO
Department of Chemical and Biological Engineering

IP.PA.12209

CN patent application No. 202411045664.X

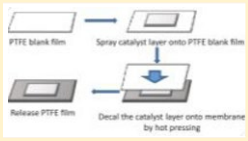
HIGH PERFORMANCE AND LONG DURABILITY Pd@Pt CORE-SHELL FUEL CELL CATALYSTS

Clean energy innovation with efficient hydrogen power

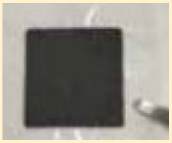
This technology converts hydrogen's chemical energy into electricity, producing only water as a byproduct over an extended period. The catalyst uses a minimal amount of platinum, offering superior performance and long-lasting durability.

Ink preparation

Ultrasonic spray



Decal transfer



Catalyst coated membrane

IP.PA.01378, 01324

US patent No. 20230147818, 20230068441
CN patent No. CN114068966, 114982021
JP patent No. JP2023517822, 2023514512

SPECIAL FEATURES AND ADVANTAGES

- **High performance:** Delivers high power density output
- **Long-lasting durability:** Excels in two extreme acceleration tests (DOE Standard)
- **Cost efficiency:** Reduces the usage of costly platinum

APPLICATIONS

- Hydrogen Fuel Cells
- Backup Power Systems
- Portable Power
- Industrial Power Solutions
- Renewable Energy Integration

PRINCIPAL INVESTIGATOR

Prof. Minhua SHAO
Department of Chemical and Biological Engineering

ADVANCED ORGANIC PHOTOVOLTAIC (OPV) MATERIALS

Highly efficient organic solar cell

Unlike traditional silicon-based solar cells, organic solar cells (OSCs) are semi-transparent, flexible, color-tunable, and eco-friendly. These advantages broaden their potential applications to include indoor use, vehicles, buildings, and portable devices. By leveraging inventions in advanced materials and fabrication methods, we are focused on developing and commercializing highly efficient and stable third-generation organic photovoltaics (OPV). Additionally, we are exploring prototypes of OPV products for various markets.

IP.PA.01042,01043,01132,01133,01257

US patent No. 11205753

CN patent No. ZL201880017468.8, ZL201980006127.5, ZL201880024183.7

CN patent application No. 201980005239.9, 202010369781.7

HK patent application No. 42021027930.3

SPECIAL FEATURES AND ADVANTAGES

- High power conversion efficiency (PCE) up to 12.7%
- High reproducibility
- Bendable
- Reliable and stable (life time >15yrs)
- Customized colors (Green/blue/gray)
- Seme-transparent (adjustable degree of transparency)
- Light weight (1/50 of regular silicon type)

APPLICATIONS

- Organic solar cell
- OPV in curved cover
- OPV installed in between colored glass layers

COMMERCIALIZATION STATUS

- A start-up company ***eflexPV*** has been established

PRINCIPAL INVESTIGATOR

Prof. He YAN
Department of Chemistry

ALL-ROUNDED PERFORMANCE IMPROVEMENTS FOR VANADIUM FLOW BATTERY

High performance, scalable, and sustainable energy storage solution

HKUST has developed a series of innovative technologies to address and improve the performance issues of vanadium flow batteries (VFB). These advancements tackle performance depreciation and bottlenecks from various angles, including:

- Ion concentration adjustment: enhancing voltage efficiency by simply diluting the vanadium electrolyte to shift the concentration of active ions.
- Flow field optimization: implementing a new flow field arrangement using a bifurcate flow field design on a bipolar plate to ensure uniform electrolyte distribution along branch channels.
- Capacity and efficiency recovery: introducing an online method to restore the VFB's capacity and efficiency to nearly 100% after extended use through a novel mixed liquid treatment of the catholyte and anolyte.

IP.PA.01320, 01586, 01674

SPECIAL FEATURES AND ADVANTAGES

- Comprehensive performance improvement and endurance

APPLICATIONS

- Vanadium flow batteries
- Wind and solar energy harvesting systems

COMMERCIALIZATION STATUS

- A start-up company ***E-Fuel Energy Technology*** has been established

PRINCIPAL INVESTIGATOR

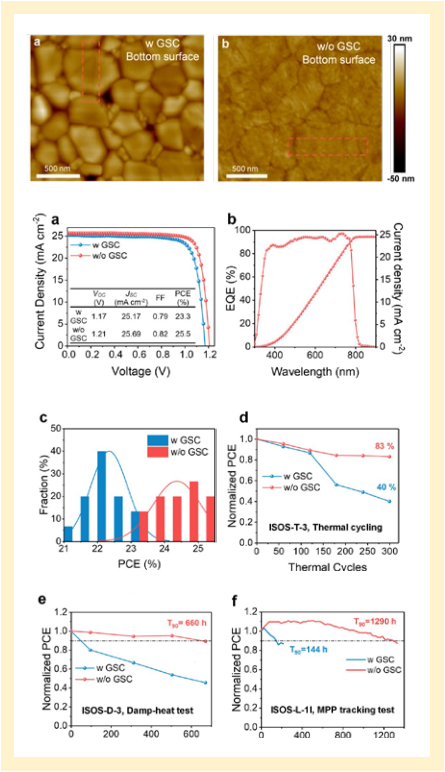
Prof. Tianshou ZHAO
Department of Mechanical and Aerospace Engineering

CN patent No. 111509278, 113903964, 114824338

ELIMINATION OF GRAIN SURFACE CONCAVES IN METAL HALIDE PEROVSKITE FILMS FOR IMPROVED SOLAR CELLS

New way of making more efficient and stable perovskite solar cells

HKUST research team has discovered surface concavities on individual crystal grains, the fundamental components of perovskite thin films. These concavities significantly impact the properties and reliability of the films. Leveraging this discovery, the team has developed a novel method to enhance the efficiency and stability of perovskite solar cells by using surfactants to smooth out grain surface concavities.



SPECIAL FEATURES AND ADVANTAGES

- Surfactant-regulated grain growth technique
- High-power conversion efficiencies (PCEs) of 25.5%
- Improved stability: retained initial efficiencies of
  - **83%** after undergoing 300 thermal cycles (ISOS-T-3 protocol)
  - **90%** after 660 h of damp heat exposure (ISOS-D-3 protocol
  - **90%** after 1290 h of maximum power point operation (ISOS-L-1I protocol)

APPLICATIONS

- Solar energy
- Optoelectronic devices
- Flexible electronics
- Energy storage

PRINCIPAL INVESTIGATOR

Prof. Yuanyuan ZHOU
Department of Chemical and Biological Engineering

IP.PA.12206

US patent application No. 63/651408

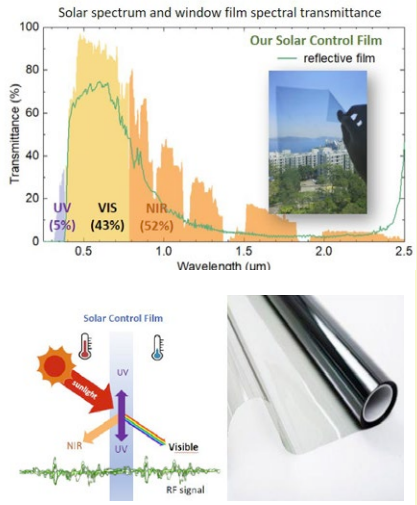
3

SUSTAINABLE CITIES AND COMMUNITIES

ADVANCED SOLAR CONTROL FILM FOR GLASS WINDOWS

Blocks heat and UV, maintains high visibility and RF/WiFi transmission

This innovative film effectively moderates the environment to a pleasant temperature by selectively dealing with the solar light and infrared of different spectra and filtering out undesired radiation. Several cooling films for glass windows have been developed for cars, trains and buildings, tailor-designed according to their application scenarios.



- ✔ **Visible Transmittance:** High transmittance of visible lights (VIS), with the transmittance **> 72%**
- ✔ **UV Shielding:** Low transmittance of ultraviolet (UV), with the blocking rate **> 99%**
- ✔ **Solar Heat Reflection:** High reflectance of near-infrared (NIR), with the reflectance **> 70%**
- ✔ **Radio Transmittance:** Transmittance similar to air with attenuation of radio signal **< 10db**

IP.PA.01602

US patent No. 20230366265
CN patent No. 116141786
HK patent application No. 202211451923.X

SPECIAL FEATURES AND ADVANTAGES

- **Effective cooling and comfort:** blocks over 80% of near-infrared solar energy and the majority of UV exposure.
- **High visibility:** achieves similar visual comfort to other Low-E films using advanced micron-scale manufacturing techniques
- **Super-high transmission of microwave (WiFi/RF) for communication:** significantly reduces electromagnetic shielding effects, ensuring high transmission of microwave signals through novel techniques.

APPLICATIONS

- Glass windows on cars, trains and buildings
- Greenhouses

COMMERCIALIZATION STATUS

- A start-up company ***ThermoSpectra Limited*** has been established

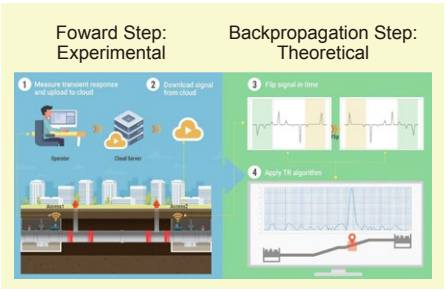
PRINCIPAL INVESTIGATOR

Prof. Baoling HUANG
Department of Mechanical and Aerospace Engineering

TIME-REVERSAL DIAGNOSTIC FOR THE HEALTH MONITORING OF PRESSURIZED PIPELINES

A quick and non-disruptive way to identify multiple defects

Our pipeline conditioned assessment technology pioneered the use of Time Reversal (TR) for defect detection and condition assessment of pipelines. The TR technology is reliable, low cost and long-range, and it has the unique feature of providing high resolution while being non-intrusive and non-disruptive. The TR technology can detect existing leaks, bursts, blockages malfunctioning devices, pipe wall strength conditions and harmful transients.



IP.PA.01821, IP.PA.01812, IP.PA.01836

CN patent No. 118294546, 118209484
US patent No. 20240201041, 20240219355
HK Patent No. 40105481
US patent application No. 63/484167, 18/422087
CN patent application No. 202410136151.3
HK patent application No. 42024093905.8

SPECIAL FEATURES AND ADVANTAGES

- Non-disruptive and non-intrusive, eliminating service interruption, isolation of mains, and contamination risks
- A fast-traveling waves been used forrapid diagnostic testing, ~1000 times faster than roving sensors
- Controllable localization resolution, automated and autonomous processes

APPLICATIONS

- Water supply systems
- Sewage rising mains
- Gas & oil pipelines

COMMERCIALIZATION STATUS

- A start-up company ***Hyele Ltd.*** has been established

PRINCIPAL INVESTIGATOR

Prof. Moez LOUATI
Department of Civil and Environmental Engineering

CEMENTLESS LIGHTWEIGHT MATERIALS FROM CO_2-SEQUESTRATING WASTE MIXTURES FOR SUSTAINABLE CONSTRUCTION

Turning wastes into building material

By utilizing construction waste, plastic waste, and food waste, HKUST researchers have developed a building material without using cement. This material is intended for non-structural applications such as partition walls, pavements, and landscaping. This innovation not only transforms waste into profitable products but also reduces dependence on traditional construction materials. Ultimately, it can significantly lower carbon emissions and promote sustainable development in society.

IP.PA.01939, IP.PA.01722

US patent No. 20240018043
US patent application No. 63/515346
CN patent No. 117417143, HK patent No. 40098394
CN application No. 202411001259.8

SPECIAL FEATURES AND ADVANTAGES

- Sequestrate CO_2 in wastes to form cementless construction materials
- Lighter construction materials with more flexible dimensions to improve construction flexibility
- Collaborations with government authorities & stakeholders across the industry value chain

APPLICATIONS

- Partition wall, pavement, floor etc.
- Waste reduction and recycling
- Urban development, construction

COMMERCIALIZATION STATUS

- A start-up company ***TerraGreen Limited*** has been established

PRINCIPAL INVESTIGATOR

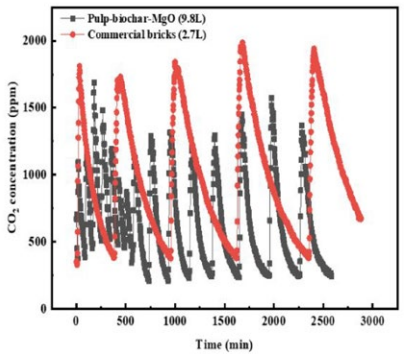
Prof. Charles Wang Wai NG
Department of Civil and Environmental Engineering

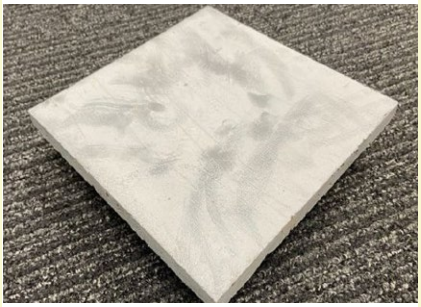
CARBON SPONGE BRICKS

A new wall material allows massive CO_2 sequestration

This green material innovation comprises of affordable hollow natural fibers for full-depth CO_2 penetration, and reactive MgO cement for massive CO_2 sequestration. Not only can this innovation greatly reduce the carbon footprint of new buildings, but it can also cut down energy consumption by facilitating smart ventilation by retrofitting existing buildings.

CO_2 adsorption test in a sealed chamber (70 x 70 x 70 cm^3) Specimen surface area = 0.4 m^2





IP.PA.01578

SPECIAL FEATURES AND ADVANTAGES

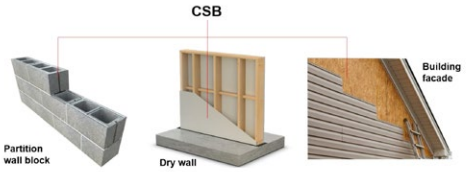
- High CO_2 sequestration rate and capacity
- Huge self-healing potential
- Improved natural fiber durability (pH of MgO < ordinary Portland cement)
- Comparable physical properties (density, compressive strength, bending capacity)

APPLICATIONS

- Building facades (either prefabricated or cast in situ)
- Dry walls
- Lightweight blocks of partition walls

PRINCIPAL INVESTIGATOR

Prof. Jishen QIU
Department of Civil and Environmental Engineering



CN patent No.202211085820.6

ACOUSTIC METAMATERIALS: NEXT-GENERATION NOISE CONTROL AND AUDIO SOLUTION

Absorb the noise using recycled plastic

Leveraging advanced acoustic metamaterials technology, we have developed next-generation noise control and audio products. Since 2014, Acoustic Metamaterials Group Limited (AMG) has achieved numerous commercial applications of acoustic metamaterials across diverse industries, including Hi-Fi, smart wearable devices, automotive, consumer electronics, construction, electrical and mechanical systems, home appliances, and more. As a novel foundational material, acoustic metamaterials have demonstrated superior performance compared to traditional acoustic materials, revolutionizing the way people interact with sound.

IP.PA.00685, 00784, 01217, 01218, 01390

US patent No.: US20160078857, US20170116976, US20220045435 US20200211527, US20210381231

CN patent No.: CN105393300, CN106536189, CN111402852, 114069250, CN112969830

HK patent/ Application No. 1216447, 202280030322.3

SPECIAL FEATURES AND ADVANTAGES

- Effective noise reduction
- Broadband coverage
- Tailored solutions & optimized performance
- Enhanced airflow
- High-efficiency noise absorption while maintaining high ventilation

APPLICATIONS

- HVAC silencer
- Acoustic panel for building noise reduction
- Noise control for home or daily appliances
- Audio functional parts for Hi-Fi and speech recognition

COMMERCIALIZATION STATUS

- A start-up company ***Acoustic Metamaterials Group Limited (AMG)*** has been established

PRINCIPAL INVESTIGATOR

Prof. Ping SHENG
Department of Physics

LOW-CARBON LARGE-POWER REFRIGERATION TECHNOLOGY

A green, energy-saving and safe cooling solution

A high-efficiency, solid-state cooling technology to replace traditional vapor-compression cooling systems. Our solution uses a graphene nanofluid to transfer heat from a multi-cell architecture of tubular Shape Memory Alloy (SMA). This elastocaloric cooling device has a much higher coefficient of performance (COP) compared to conventional refrigeration. Widespread adoption of our green cooling technology has the potential to save over 3 trillion kWh of electricity and reduce 1.2 billion tons of CO_2 emissions per year globally. This disruptive cooling solution addresses the significant energy inefficiency and high global warming impact of current air conditioning and refrigeration systems.

IP.PA.01446, 01455, 01539, 01591, 01361

CN patent No. 115930479, 116147221, 114074373,114992978, 114909821

SPECIAL FEATURES AND ADVANTAGES

- 48% increase in cooling effciency
- Refrigerant-free, eco-friendly
- Simple and compact structure
- Save electricity consumption and related carbon emission by at least 10%
- The cooling core material (SMA) is 100% recyclable, endurable for >100 million cyclic operation, accounting for ~10-year service time

APPLICATIONS

- Fridges
- Air conditioners
- Homes, Office, Shopping Malls, Industries, anywhere in need of cooling
- Energy and environmental industries

COMMERCIALIZATION STATUS

- A start-up company ***CoolStar Innovation Technology Limited*** has been established

PRINCIPAL INVESTIGATOR

Prof. Qingping SUN
Department of Mechanical and Aerospace Engineering

MULTI-FUNCTIONAL GREEN COATING MATERIALS FOR SUSTAINABLE GLAZING SURFACE

Anti-reflecting self-cleaning nano-coating

We have developed multi-functional green coating materials with high photocatalytic performance, anti-reflection properties, and durability for various glazing surfaces, including PV panels, curtain walls, and automobile rearview mirrors. Notably, its application on PV panels can enhance power generation by 15-20%. Unlike commercial coatings, this technology features a unique inorganic micro-nano hierarchical porous structure within the nanocoating, maintaining high transparency and promoting superior photocatalysis under visible light radiation. Beyond glazing surfaces, this coating can also be applied to various building cement or metal surfaces.

IP.PA.01300

CN patent No. CN112694769

SPECIAL FEATURES AND ADVANTAGES

- Excellent anti-static, anti-reflection, weather resistance, and water souring resistance
- Improved PV panels efficiency by ~20%
- High porosity and mechanical durability suitable for practical use
- Strong Durability, save 50% on cleaning labor cost

APPLICATIONS

- PV panel, curtain wall, automobile rearview mirror
- Sustainable glazing surface, building cement , or metal surface

COMMERCIALIZATION STATUS

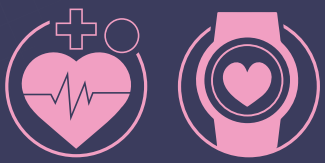
- A start-up company ***Coalot Tech Limited*** has been established

PRINCIPAL INVESTIGATOR

Prof. Jinglei YANG
Department of Mechanical and Aerospace Engineering

4

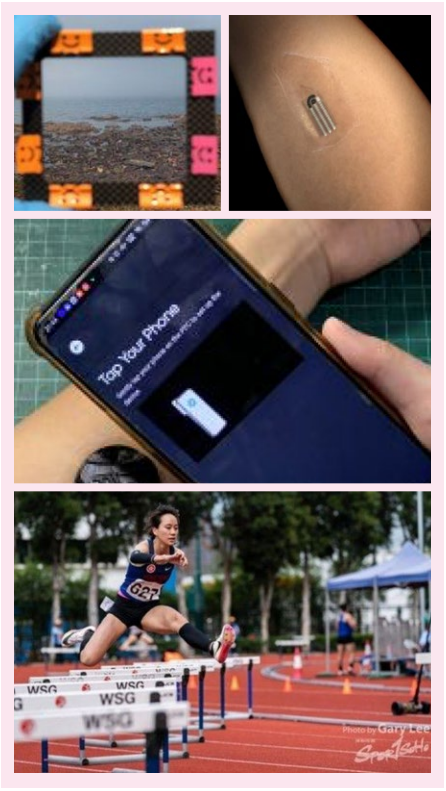
GOOD HEALTH AND WELL-BEING



SKIN PATCH SWEAT SENSOR FOR NON-INVASIVE & CONTINUOUS HEALTH MONITORING

Ultra-thin skin sensor for easy and continuous health tracking

We developed an UHMWPE-based nanomembrane skin sensor that detects biomarkers (e.g. hormones, metabolites, proteins) non-invasively and transmits directly to mobile app in real-time for precautionary diagnostics.



IP.PA.01009, 01114, 01189, 01418

CN patent No. CN109997247, CN111491719, CN110960995, 116261579

US patent No. 20190267594, US20200360870, US20200101427, 20230356155

HK patent/application No. 40028642 / 62023074997.5

JP patent No. 2024511911

SPECIAL FEATURES AND ADVANTAGES

- **Ultra-thin and strong:** at 1/3000 the thickness of human hair, the sensor boasts a specific tensile strength 25 times greater than that of stainless steel at the same mass.
- **Modular biomarker detection:** the platform material allows for highly customizable biomarker detection with interchangeable biomolecular receptors (e.g., Enzymes, MIP, aptamers).
- **Highly porous and breathable:** the sensor is approximately 150 times more breathable than the human sweat secretion rate, ensuring comfort and efficiency.

APPLICATIONS

- Continuous health monitoring
- Preventive diagnostics
- Sports and fitness
- Chronic disease management
- Personalized medicine
- Occupational health

COMMERCIALIZATION STATUS

- A start-up company ***PointFit Technology Limited*** has been established

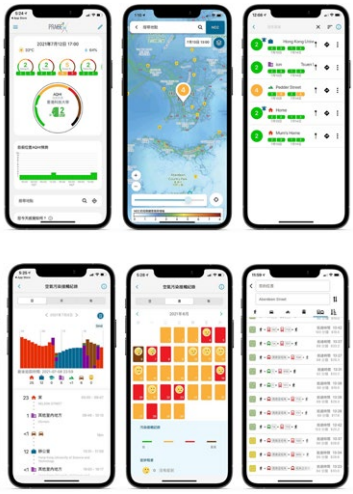
PRINCIPAL INVESTIGATOR

Prof. Ping GAO
Department of Chemical and Biological Engineering

PERSONALIZED REAL-TIME AIR QUALITY INFORMATICS SYSTEM FOR EXPOSURE – HONG KONG

PRAISE-HK

HKUST developed an innovative mobile app to help us manage and reduce our individual exposure to air pollutants. The interactive app is powered by the Personalized Real-Time Air Quality Informatics System for Exposure – Hong Kong (PRAISE-HK), an advanced new system that we are building. With the PRAISE-HK mobile app, users gain convenient access to real-time, location-specific air pollution data and personalized daily exposure reviews. The project has also formed partnerships with the Hong Kong Asthma Society and Hong Kong Red Cross to extend the advantages of the PRAISE-HK to both vulnerable populations and the general public, helping users minimize the health impacts of air pollution exposure. To learn more about the PRAISE-HK, visit praise.hkust.edu.hk.



SPECIAL FEATURES AND ADVANTAGES

- Rveaanl-ttiamgee asnd forecast air quality information
- Personal air pollution exposure review
- Concerned location bookmark
- Cleaner air route suggestion
- Asthmatic symptoms report
- Custom heath alerts and advice

APPLICATIONS

- Health management
- Daily commuting
- Outdoor activities planning
- Public awareness
- Policy making

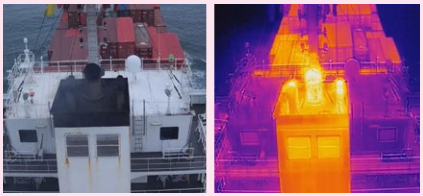
PRINCIPAL INVESTIGATOR

Prof. Alexis LAU, Prof. Jimmy FUNG
Prof. Zhi NING, Prof. Hong Kam LO
Prof. Huamin QU, Prof. Lei CHEN
Department of Civil and Environmental Engineering, Division of Environment and Sustainability, Department of Computer Science and Engineering

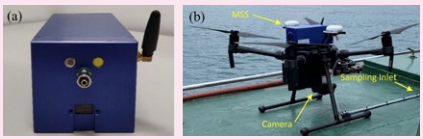
UAV-BASED AIR SENSING FOR MARINE EMISSION CONTROL

Real-time quantification of pollutants

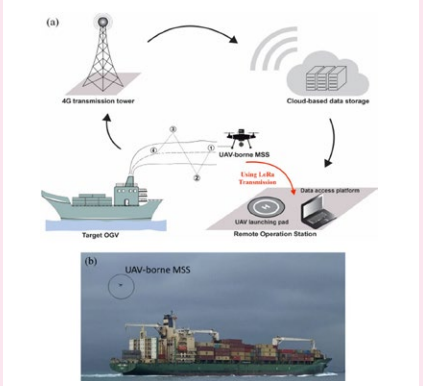
HKUST researchers developed a lightweight microsensor system (MSS) carried by unmanned aerial vehicles (UAVs) to measure ship emissions in real-time. The MSS can detect sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon dioxide (CO_2), carbon monoxide (CO), and particulate matter. This technology can help enforce ship emission control regulations effectively.



Ambient and Thermal images from UAV during ship FSC screening



(a) MSS (Sirius E-2 sensor), and (b) MSS mounted on the UAV with a Teflon tubing extending from the module for sampling



(a) Schematic diagram for field operation demonstrating (b) UAV-borne MSS deployed during FSC screening of a ship in the South China Sea near Telegraph Bay, Hong Kong.

SPECIAL FEATURES AND ADVANTAGES

- **Real-time monitoring**
- **Lightweight and portable:** Weighing only 750 grams, the MSS is easily carried by UAVs, making it a flexible and efficient solution
- **Multi-gas detection**
- **Enforcement support:** By accurately measuring ship plume emissions, the MSS assists in enforcing ship emission control regulations, contributing to cleaner air and reduced environmental impact

APPLICATIONS

- Environmental compliance
- Port management
- Research and policy development
- Emergency response
- Environmental impact assessment

PRINCIPAL INVESTIGATOR

Prof. Alexis LAU and Prof. Zhi NING
Department of Civil and Environmental Engineering
Division of Environment and Sustainability

ALTERNATIVE PROTEIN SOLUTIONS AND NEW GENERATION FOOD TO COMBAT CLIMATE CHANGE

Innovative plant-based protein

The HKUST research team is dedicated to developing and offering delicious, nutritionally balanced, and affordable alternative protein products. The key ingredient in this food technology, tigernuts, is packed with dietary fiber, antioxidants, and essential minerals for a healthy diet. Through the creation of New Generation Food, we aim to address food shortages and combat climate change.

SPECIAL FEATURES AND ADVANTAGES

- Cultivating Tiger Nuts in desert regions
- Cultivating green hope
- Emerging food engineering technologies like dry & wet extrusion and precision fermentation

APPLICATIONS

- Plant-based Vegan Protein Products -- plant-based meat, dairy-free milk
- Animal-derived functional protein alternatives -- plant-based honey, bird's nest
- Functional plant-based proteins

COMMERCIALIZATION STATUS

- A start-up company ***Meat the Next Company Limited*** has been established

PRINCIPAL INVESTIGATOR

Prof. Marshal Yuanshuai LIU
Department of Chemical and Biological Engineering

AERODYNAMIC ANALYSIS AND AIRBORNE TRANSMISSION RESEARCH OF SARS-COV-2

Decoding airborne pathogen spread

The highly infectious and transmissible nature of the SARS-CoV-2 prompted the HKUST team to analyze its spread in two phases in Renmin Hospital of Wuhan University and Wuchang Fangcang Field Hospital. Sampling airborne SARS-CoV-2 at 30 different sites, in Phase 1, we employed traditional aerosol capture devices to gather Total Suspended Particles (TSP), size-segregated particles, and deposition-based samples. PI Ning's expertise was pivotal in designing the study, analyzing data, and revealing the bimodal nature (0.25 to 2.5 um) of SARS-CoV-2 aerosol in its airborne form. Phase 2 explored the effectiveness of stringent sanitization measures.

The study's key finding was the airborne transmission pathway of SARS-CoV-2, a crucial understanding that has significantly influenced public health policies and practices globally. The study proposed that virus-laden aerosols originate from patients and are dispersed via human activities, highlighting the importance of ventilation, personal protection, and sanitation.

Air Sampling Monitor installation outside (left), in Staff area (middle) and ICU (right) of Renmin hospital

SPECIAL FEATURES AND ADVANTAGES

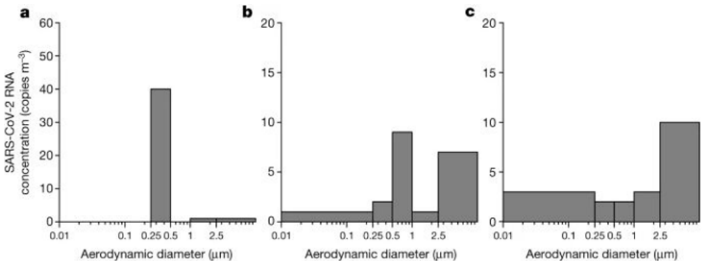
- Airborne transmission understanding
- Risk mitigation insights
- Public health impact

APPLICATIONS

- Hospital design and management
- Public health policies
- Emergency preparedness
- Risk communication

PRINCIPAL INVESTIGATOR

Prof. Zhi NING
Division of Environment and Sustainability



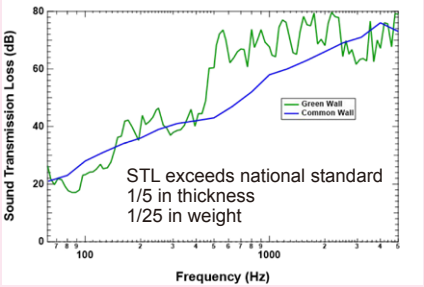
Concentration of SARS-CoV-2 in a protective-apparel removal room in zone B ,zone C and medical staff's office of Fangcang Hospital

TRANQUILITY ACOUSTRONICS

Light weight, thin, highly efficient soundproof panels and flexible effective sound blocking blankets

By leveraging the principle of resonance, HKUST has developed a sound insulation technology that effectively manages low-frequency noise and provides comprehensive noise control across all frequencies. This technology targets the noise spectrum and uses specialized structures to insulate against different noise bands, reducing material dependency. It overcomes the space limitations of traditional materials, making it suitable for industrial, military, and civilian applications, including ventilation ducts, road traffic, home environments, and electrical appliances.

Green noise shield thickness 80mm, weight 30kg/m^2



IP.PA.00525, 00579, 00667, 00644

US patent No. US20050194209, US20130133979, US20140060962, US20160027427, US20140116802
CN patent No. CN103137118, CN105122348, CN103810991
HK patent No. 1183150, 1212499, 1194851

SPECIAL FEATURES AND ADVANTAGES

- Effective low-frequency noise insulation
- Full-frequency noise management
- Material efficiency
- Space-saving design
- Versatility
- Customizable structures

APPLICATIONS

- Industrial: ventilation ducts & machinery
- Civilian: home environments & appliances
- Transportation: road traffic ventilation & automotive
- Commercial: office buildings & public spaces

COMMERCIALIZATION STATUS

- A start-up company ***Tranquility Acoustronics (HK) Limited*** has been established

PRINCIPAL INVESTIGATOR

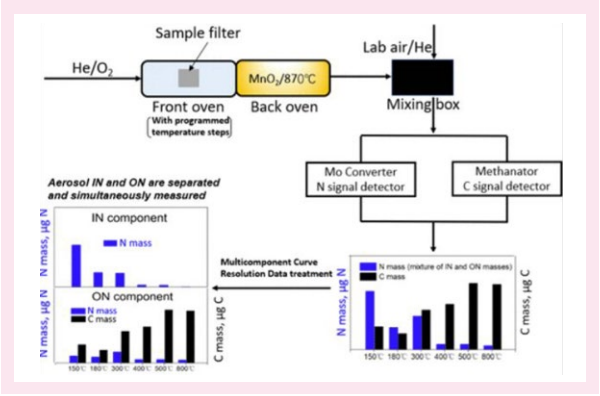
Prof. Zhiyu YANG
Department of Physics

NOVEL AUTOMATIVE WAYS FOR ATMOSPHERIC MONITORING

Simple, sensitive and simultaneous detection for air pollution

HKUST research team developed a pioneering instrument method for simultaneous quantification of aerosol inorganic nitrogen (IN) and organic nitrogen (ON). Using programmed thermal evolution, chemiluminescent detection, and multivariate curve resolution, the team quantified IN and ON. The method was validated against ion chromatography measurements of IN on offline filters. The results identified biomass burning and secondary formation as key sources of aerosol ON. The instrument can be operated as either an online nitrogen analyzer or for offline measurements of aerosol filters. This innovative system provides accurate and simultaneous IN and ON quantification that were previously unachievable.

Additionally, the team developed an innovative automated system that enables fast and sensitive assessment of health impact of particulate matter pollutant. At its core is an integrated device that continuously monitors the oxidative potential of airborne particles - a critical toxicity indicator using the dithiothreitol (DTT) assay. This system achieves exceptional precision and reliability at low cost, empowering air quality agencies to more effectively assess and address the health risks posed by air pollution.



IP.PA.01574, 12328

SPECIAL FEATURES AND ADVANTAGES

- Advanced automated detection method
- Ensuring accuracy
- Allows continuous, real-time monitoring
- Compact, low-maintenance design enables easy field deployment

APPLICATIONS

- Environmental monitoring
- Air quality and public health

PRINCIPAL INVESTIGATOR

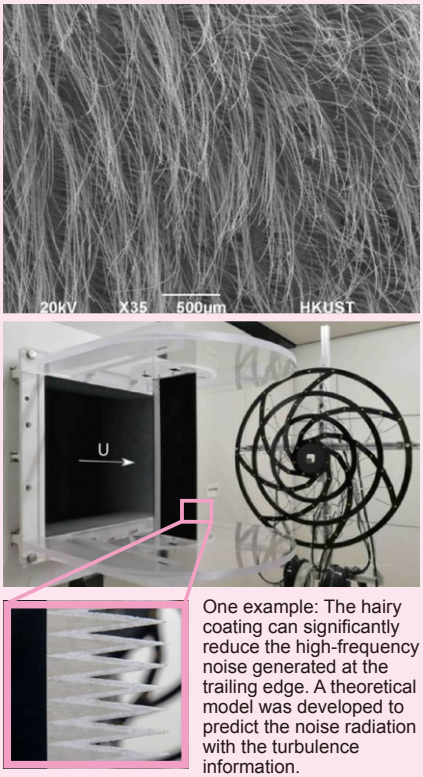
Prof. Jianzhen YU
Department of Chemistry
Division of Environment and Sustainability

US patent No. 20230107753
US application No. 63/677423

A CLASS OF COMBINED TREATMENTS FOR AIRFOIL TRAILING EDGE NOISE MITIGATION

Aerodynamics acoustics & noise control solution

HKUST presents several combined treatments for airfoil trailing edge noise reduction. Each treatment consists of a base structure which has a serrated geometry. The base structure is covered by porous layers/ velvety layers/ porous velvety layers on both sides, forming the trailing edge of the wing. Compared with conventional trailing edge serrations, the new class of combined treatments can provide better broadband noise reduction in a wider frequency range, and the performance of the combined treatments are relatively insensitive to the misalignment between the structure and the local airflow.



One example: The hairy coating can significantly reduce the high-frequency noise generated at the trailing edge. A theoretical model was developed to predict the noise radiation with the turbulence information.

SPECIAL FEATURES AND ADVANTAGES

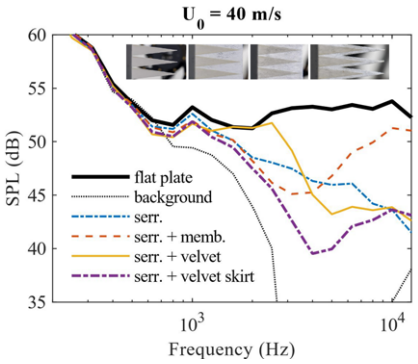
- Broadband noise reduction
- Robust performance

APPLICATIONS

- Aircraft design
- Unmanned aerial vehicles (UAVs)
- Wind turbines
- Automotive spoilers and wings

PRINCIPAL INVESTIGATOR

Prof. Xin ZHANG, Prof. Peng ZHOU
Department of Mechanical and Aerospace Engineering



IP.PA.01510

CN patent No. 115892443

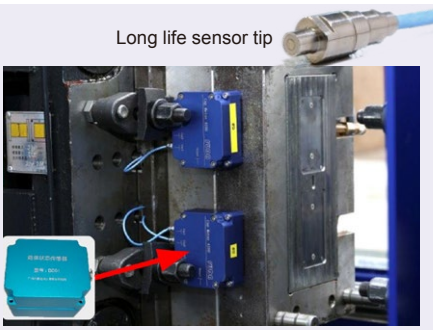
5

RESPONSIBLE CONSUMPTION AND PRODUCTION

SMART POLYMER PROCESSING PLANT (S-P³)

Intelligent real-time monitoring and precision control for superior quality

The next-generation intelligent injection molding with real-time material and quality monitoring using breakthrough sensors, award-winning control algorithms for superior precision, and a dedicated big-data system for intelligent collaboration.



Long life sensor tip

High-precision capacitive signal transmitter

Control system

Plant automation

FYT.CPPS.068, FYT.CPPS.110, FYT.CPPS.061

CN patent No. ZL201520916639.4, ZL201920788422.8, CN105328886

SPECIAL FEATURES AND ADVANTAGES

- **Revolutionary sensor technology:** world's first real-time material and quality change detection.
- **Award-winning control algorithms:** superior precision in injection molding.
- **Collaborative intelligent molding:** big-data open system for enhanced collaboration.
- **Energy & cost saving:** efficient processes reduce expenses.
- **Waste reduction:** minimizes material waste.
- **Improved product quality:** enhances polymer product standards.
- **Real-time quality monitoring:** continuous quality assessment during production.

APPLICATIONS

- A smart sensor for a huge injection mold market (14 million molds annually for Chinese mainland alone)
- Injection molding
- Automotive manufacturing
- Consumer electronics
- Medical devices
- Packaging industry
- Aerospace
- Construction materials

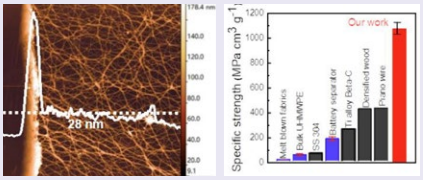
PRINCIPAL INVESTIGATOR

Prof. Furong GAO
Department of Chemical and Biological Engineering

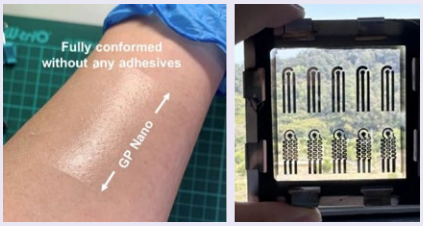
ULTRA-STRONG POLYMER NANOFILM FOR CUTTING-EDGE APPLICATIONS

The world's first and most rigid porous polymeric film

HKUST research team developed an ultrathin polymer nanofilm: 25 times stronger than steel by mass, transparent, gas-permeable, and adjustable porosity, ideal for advanced energy separators, wearables, biomedical applications, and desalination



Structure-properties of the Ultra high molecular weight polyethylene (UHMWPE) nanomembrane



The world's first and most rigid porous polymeric film

IP.PA.01009,01073,01114,01418

SPECIAL FEATURES AND ADVANTAGES

- **Ultrathin:** Less than 20 nm, thinner than 1/1000 the thickness of a hair strand.
- **High strength:** 25 times stronger than steel by mass, offering exceptional durability and resilience.
- **Cost-efficient:** improved formulations reduce production costs.
- High transparency, high gas permeability
- Free standing and self-supporting

APPLICATIONS

- Advanced energy separators
- Fuel cell proton exchange membrane
- Liquid/gas filtration
- Wearables
- Biomedical applications

PRINCIPAL INVESTIGATOR

Prof. Ping GAO
Department of Chemical and Biological Engineering

US patent No. 20190267594, US20200360870, 20230356155
CN patent No. CN109997247, CN111491719, 110831768, 116261579
HK patent/application No. 40028642 / 62023074997.5
JP patent No. 2024511911

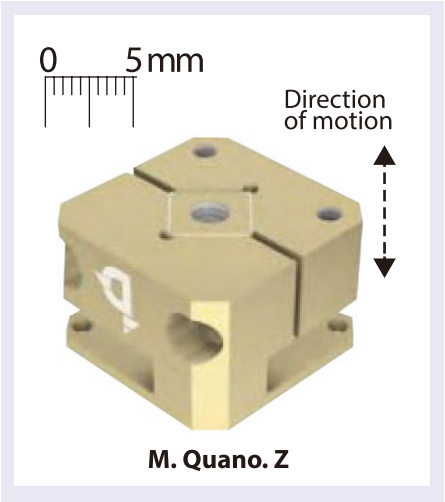
NANO POSITIONING STAGE FOR APPLICATIONS UNDER EXTREME ENVIRONMENTAL CONDITIONS

Precision positioning solutions

Today, advances in artificial intelligence, quantum technologies, and space exploration rely on our ability to fabricate nanometer-sized computer chips and components with extreme precision. This makes precision positioning devices essential in the high-tech and manufacturing sectors. Our devices use piezoelectric actuation to achieve millimeter to centimeter displacements with nanometer accuracy.

SPECIAL FEATURES AND ADVANTAGES

- **Reliable operation:** functions effectively under extreme temperatures and pressures.
- **Heat load management:** efficient heat removal across the device, a unique selling point.
- **Mechanical stability:** reinvented structural design without glue joints ensures unmatched stability.



IP.PA.01733

APPLICATIONS

- Optical and microscopy setups
- Steering, alignment, and focusing of lithography instrumentation
- Advanced manufacturing
- Scientific research
- Medical equipment

COMMERCIALIZATION STATUS

- A start-up company ***Quano Technologies Ltd.*** been established

PRINCIPAL INVESTIGATOR

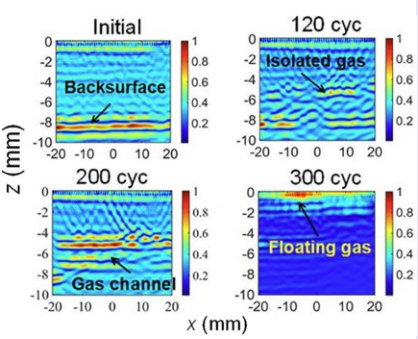
Prof. Berthold JAECK
Department of Physics

US patent application No.18/474323
CN patent No. CN118056641

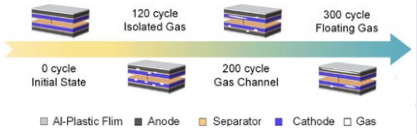
ULTRASONIC PHASED ARRAY SYSTEM FOR BATTERY INSPECTION

Advanced technology for mapping and evaluating battery properties

HKUST developed an advanced in-situ subsurface ultrasonic array imaging system that uses phased array tomography for comprehensive mapping and evaluation of various battery types. We utilize ultrasonic phased array imaging to non-invasively track gas appearance and evolution in lithium-ion batteries. By capturing ultrasonic data with multiple pairs of array elements and producing subsurface images of the battery, the technology enhances battery analysis, contributing to safer and more efficient energy storage.



Imaging results snapshots during 300 charging /discharging cycles of the Li-ion batteries



Total focusing method images for battery-cycling experiment

IP.PA.02090

SPECIAL FEATURES AND ADVANTAGES

- **Comprehensive mapping:** detailed cross-sectional images.
- **Accurate detection:** identifies internal anomalies precisely.
- **Advanced technology:** utilizes phased arrays for precise signal collection.
- **Versatile:** suitable for various battery types.
- **Real-time evaluation:** assesses batteries without dismantling.
- **Handles variations:** accommodates lateral and thickness differences.

APPLICATIONS

- Battery manufacturing
- R&D
- Battery maintenance
- Safety testing
- Electric vehicles
- Energy storage systems

PRINCIPAL INVESTIGATOR

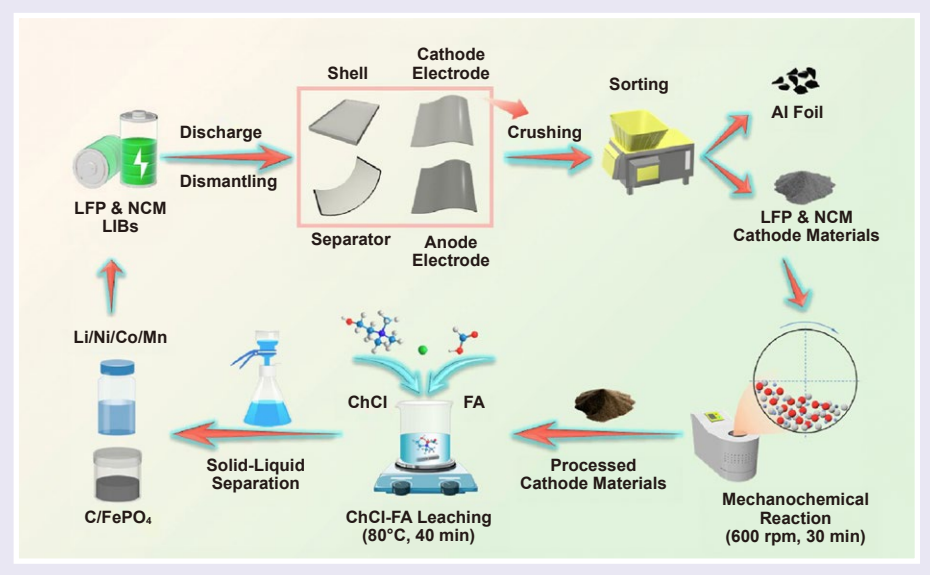
Prof. Fan SHI
Department of Mechanical and Aerospace Engineering

US patent application No. 63/658880

A METHOD FOR LITHIUM RESOURCES EXTRACTING FROM RETIRED LITHIUM-ION BATTERY WASTES

Utilizing deep eutectic solvents for efficient lithium recovery

HKUST developed a method using deep eutectic solvents can extract lithium resources from retired lithium-ion battery (LIB) waste. It addresses the complexity and cost of lithium recovery from retired LIBs and the low recovery rate from electrolytes. The process involves separating cathode material and electrolyte, then treating the residual lithium resource waste with deep eutectic solvents. This results in lithium products with an extraction efficiency of 60-95 wt%. The method is applicable to power battery recycling



IP.PA.02103

SPECIAL FEATURES AND ADVANTAGES

- **Efficient lithium extraction**
- **Versatility in cathode materials:** the technology allows for the extraction and recovery of residual lithium resources from cathode electrode sheets with different sources, compositions, and lithium residual amounts.

APPLICATIONS

- Battery recycling industry
- EV supply chain

PRINCIPAL INVESTIGATOR

Prof. Dan TSANG
Department of Civil and Environmental Engineering

US patent application No. 63/641947

MICROCAPSULE TECHNOLOGIES FOR HIGH VALUE-ADDED INDUSTRIAL ADHESIVES

μcaps with release-on-demand feature

Industrial adhesives are vital in modern manufacturing, used in automotive, aerospace, electronics, and construction. Despite their advantages, traditional adhesives face issues like uncontrollable curing times, limited resistance, and safety concerns. HKUST has developed advanced microcapsule technologies for high-value industrial adhesives, emphasizing domestically-produced products, autonomous technologies, and a secure supply chain.

IP.PA.12218, 01692, 01603, 01512, 02009, FYT. CEMAR.045

US patent No. 20230143503

CN patent No. CN113831898, 117414771, 116020078, CN111790325

HK patent/application No. 40098365 / 42023073705.8,

US patent application No. 63/655834, 63/602671

SPECIAL FEATURES AND ADVANTAGES

- **High performance-price ratio:** delivers exceptional value and efficiency
- **Eco-friendly:** features low volatile organic compounds (VoC) and waterborne formulations
- **High temperature stability:** maintains performance under extreme temperatures
- **Domestic replaceable & customizable:** meets urgent needs for domestically replaceable and customizable microencapsulation technologies

APPLICATIONS

- High-value-added industrial adhesives
- Automotive industry
- Aerospace sector
- Electronics manufacturing
- Construction

COMMERCIALIZATION STATUS

- A start-up company ***New Materials Intelligent Technology Co., Ltd.*** has been established

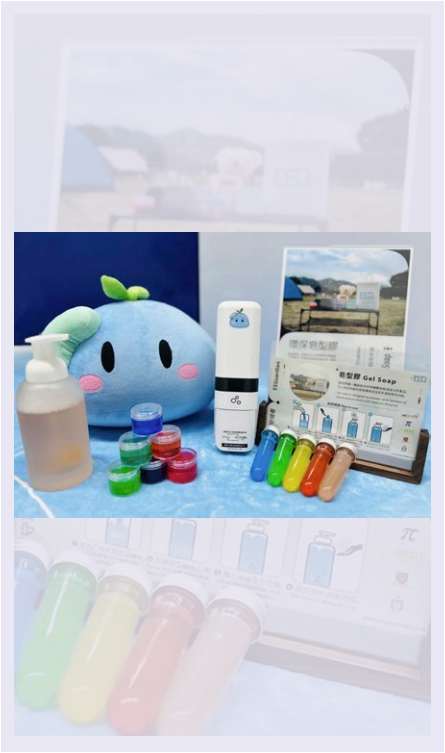
PRINCIPAL INVESTIGATOR

Prof. Jinglei YANG
Department of Mechanical and Aerospace Engineering

ZERO CARBON GELSOAP FOR A HEALTHY AND SUSTAINABLE LIVING STYLE

Soap in silica capsules with prolonged release properties

This innovative technology encapsulates concentrated active ingredients within silica-based capsules. When mixed with water, a small amount of the capsule-infused product provides the same functionality as a larger quantity of traditional products. This reduces the size and weight of these products, making them more economical and environmentally friendly. Using this silica capsule technology, GelSoap has been developed as an eco-friendly soap alternative. Additionally, a range of related household and personal products is under development.



IP.PA.01744, 00499

SPECIAL FEATURES AND ADVANTAGES

- **Environmental impact:** reduces carbon emissions and storage needs.
- **Waste reduction:** minimizes packaging waste and supports reusable dispensers.
- **Cost saving:** lowers storage and transportation costs.

APPLICATIONS

- Household products: cleaners, detergents etc.
- Personal hygiene: hand soaps, shampoos etc.
- Healthcare products
- Travel essentials
- Industrial cleaners

COMMERCIALIZATION STATUS

- A start-up company ***Environmental Sustainability Guardian Limited*** has been established

PRINCIPAL INVESTIGATOR

Prof. King Lun YEUNG
Department of Chemical and Biological Engineering

US patent No. US20130287723, US20190060502
CN patent No. 117717484, CN103339068
HK patent No. 40102008, 1185335

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