ADDRESSING YOUR UNMET NEEDS THROUGH INNOVATION

Innovation and Technology Development Office (ITDO) serves to nurture platforms to boost high-impact research in collaboration locally and internationally with university, industry and government. Our Research strength includes health care, life science, food safety, AI & robotics, smart living, advanced manufacturing, high speed rail and much more.

THE HONG KONG POLYTECHNIC UNIVERSITY
香港理工大學

Innovation and Technology Development Office
創新及科技發展處

COLLABORATION HIGHLIGHTS

Boeing China visit in ASRC

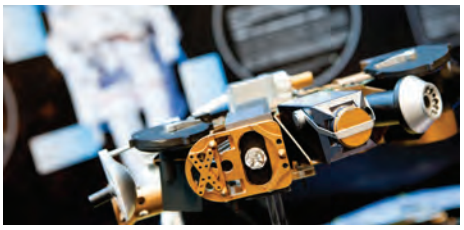
MOU signed with Alibaba Cloud for AI

PolyU—Axis Therapeutics Joint Center for Immunotherapy

INTEGRATED PLATFORMS

• Aircraft Damage Inspection & Assessment

ASRC is developing a completely new approach for airframe inspection from a distance of about 30 meters, thus allowing inspection without disturbing other operations. The project received an Innovation and Technology Fund approximately HK$8M. In summer 2018, the ASRC has successfully tested the technology for Aircraft Inspection on a BOEING 747 fuselage.



• DISH Global Centre for Food Safety and Quality

A unique establishment by four economies – Denmark, Italy, Sweden, and Hong Kong, with the vision to become a global leading collaborative centre for food safety. DISH is designated to advance food safety, building on partner's networks, experiences and skills, to impact on society.

• EU-China Safe Project

PolyU is one of the key players in a food safety initiative to improve food safety and tackle food fraud. The EU-China-Safe project involves 33 players in the food industry, research organisations and governments across two of the world's largest trading areas.

• Joint Lab on Blockchain and Cryptocurrency Technology

PolyU joins forces with Monash University and CollinStar Capital to establish the first university-industry joint research laboratory on blockchain and cryptocurrency technologies in Hong Kong.

WHAT'S HOT

The Hong Kong Polytechnic University (PolyU) has mastered to win two "Global Innovation Awards" again at TechConnect World Conference and Expo 2019 staged in the United States. Claiming to be the planet's largest innovation pipeline, PolyU research team amazingly accumulated the gain of a total of 7 awards from this event within 3 years.

2017

- Passive anti-vibration structures
- Multi-functional nano-coating for glass

2018

- Composite multilayers capacitors
- Personalised energy saving thermal-comfort platform
- Co-catalyst system flame retardant treatment

2019

- New antibiotic candidate to treat superbug-caused inflection
- Seeded sonochemical coatings

• Fighting Cancer with Immunotherapy

Jointly researched BCT-100 that can deplete arginine in patient's body with BCT.

• Robotic Arm for Self-help Rehabilitation

This device will help stroke patient to conduct rehab training anytime, anywhere.

•Defocus Soft Lens for Myopia Control

Retard progression of myopia by approx. 60% amongst children aged 8 to 13.

• Novel Method to Isolate Bacteria

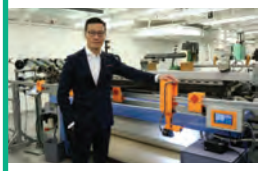
A sensitive method for isolation of mcr-1-bearing bacteria from various sources and investigated the prevalence of mcr-1 in various sample types.

• Fluorescent Probes for Rapid Detection of Formaldehyde in Food

To enhance food safety, researchers have developed fluorescent probes that rapidly detect food-borne formaldehyde.

• Authenticate Genuine and Counterfeit Chinese Medicine

Through direct ionisation mass spectrometry (DI-MS) to detect the major active components of Lingzhi and Tianma.

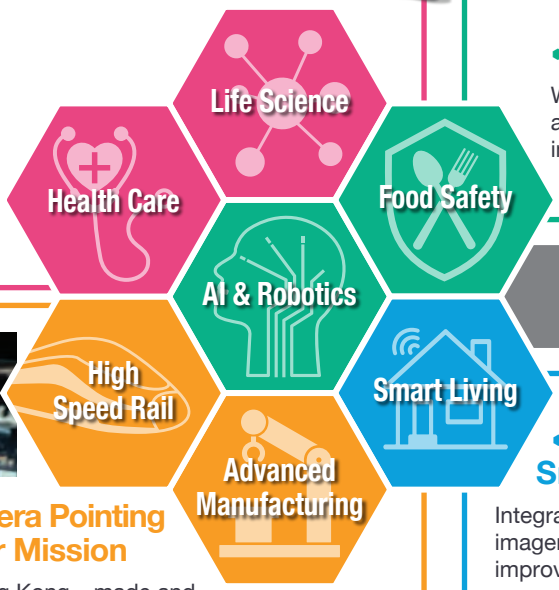


• An Intelligent Fabric Defect Detection System

A system which can minimizes the chance of producing substandard fabric by 90%.

• Fashion AI Dataset

With Alibaba, facilitated the application of AI in the fashion industry by systematic analysis.



STRATEGIC AREAS

• Advanced Camera Pointing System for Lunar Mission

The CPS is the first Hong Kong – made and developed instrument being deployed for the nation's lunar exploration programme since 2007.

• Sprayable Nanocomposite Sensor Technology for Structural Health Monitoring

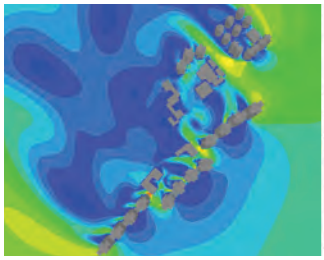
Through spraying, nanocomposite sensors can flexibly be tailor – made into different sizes and can be connected to a network via a wire to monitor structure safety.

• Fibre Optic Sensing System for Railway Monitoring

This system is installed in HK MTR and Singapore MRT to monitor railway operation, allowing continuous surveillance and rapid maintenance.

• Precise 3D Mapping Technology for Smart City Development

Integrating the advantages from multi-platform satellite/aerial imagery and laser scanning data, the technology can greatly improve the accuracy of mapping products by 26-66%.



• Potentials of Generating Clean Solar Energy in Hong Kong

Used high-resolution airborne laser scanning data and geographical information systems data to map the available rooftop area to estimate the potential of installing solar photovoltaic systems on rooftops.

Ultrasensitive High-speed Perovskite Photodetectors

Special features

- *Simple method yet highly compatible*
- *Low cost, highly sensitivity and fast responding system*

Photodetectors are key components for visible light communication. Commercially available photodetectors based on traditional crystalline inorganic semiconductors (e.g., Si and InGaAs) need expensive high-vacuum epitaxial growth.

A simple method is designed to fabricate the pre-contact layer of perovskite photodetector. The device performance was the best up to recent reported n-i-p photodiodes (Detectivity>10^{14} Jones & response speed< 1μs) with a low-temperature glancing angle deposited TiO_2 nano-forest.

Low temperature fabrication (<80°C) enables the compactness with wearable electronics, like bendable/foldable smartphones, wearable healthcare equipment, etc. To be highlight, this controllable growth technique can be used to fabricate other transporting layers and metal electrodes in solar cells, lithium ion batteries, thermal and mechanical sensors, light-emitting diodes, etc.

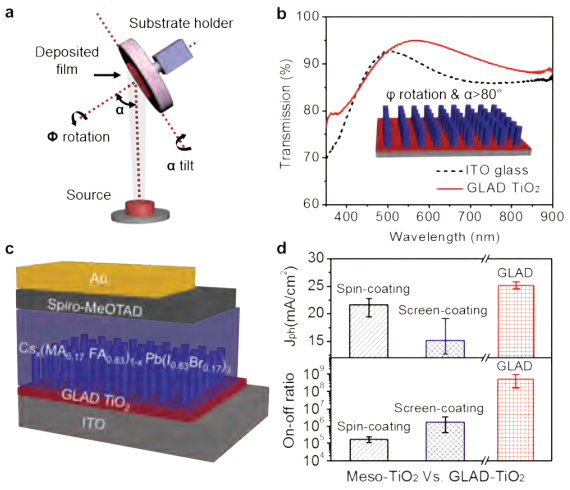


Figure 1. a, Schematic figure for low temperature glancing angle deposition. b, Transmission spectra of front-contact layers. By manipulating the light interaction, GLAD-made TiO_2 can enhance the total transmission up to 95%. c, Device structure of n-i-p perovskite photodiodes and the TiO_2 nanoforests structure could support an active layer thickness near 1 μm. d, Short-circuit photocurrents and on-off ratios of photodiodes with different TiO_2 pre-contact layers. The short-circuit photocurrent of the champion n-i-p photodiode on GLAD-TiO_2 can over 26 mA/cm^2 and the on-off ratio is near 10^9.

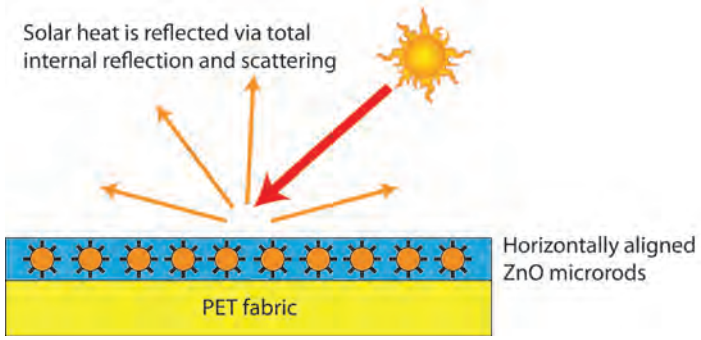
Solar Heat Shielding Using Micro-hair from Saharan Silver Ant

Outdoor solar shielding is often expensive and inefficient. A bionic textile finishing is developed that will turn polyester fabrics into solar heat reflecting textiles for sustainable green buildings. It solves to the main drawback of current architextile products, i.e. the limited protective ability against solar heat during the hot summer. This finishing technology simulates the micro-hair structure of Saharan silver ant (SSAnt) by coating the fabricated ZnO microrods in aligned array on the PET fabric. These microrods on PET fabric can effectively reflect the solar heat. The finished fabric can shield the solar heat and reduce temperature of the area under the treated fabric.

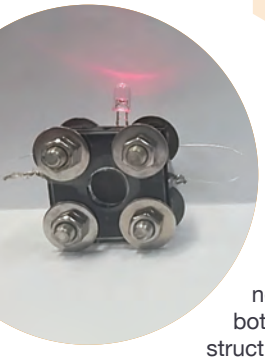
This technology can improve solar heat shielding ability of fabric roofs, allowing them to be applied as low-cost cool roof. Thus, the increase of thermal comfort architextile construction, resulting in the reductions of use of air conditioners, power consumption and urban heat island effect.

Special features

- *Use of inexpensive finishing equipment*
- *Easily to be carried out in conventional textile factories*



Zn-based Hybrid Batteries for Flexible Electronics



Special features

- *Energy efficiency significantly improved from 60% (conventional) to 70%*
- *Discharge voltage increased from 1.2-1.4V (conventional) to >1.8V*
- *Excellent cycling stability by minimizing Zn-dendrite formation*

Existing Zn-air batteries show poor efficiency due to high charge voltage and low discharge voltage. We developed the new technology which perfectly integrates the advantages of both Zn-air batteries and Zn-metal batteries. By developing nano-structured Zn-electrode and Ag-RuO_2/carbon nanotube air electrode or Co_3O_4/carbon cloth air electrode, it can successfully increases the discharge voltage and decreases the charge voltage, leading to higher efficiency (over 70%) and higher discharge voltage (>1.8V) than existing Zn-air batteries. In addition, the Zn-dendrite formation is significantly minimized, leading to excellent cycling stability. By replacing the liquid electrolyte by the gel electrolyte, we developed flexible Zn-air batteries for powering flexible electronics.

This hybrid battery is more efficient, more durable, cheaper and safe for use and can have various applications, such as power sources for portable electronics (mobile phones, notebook, digital watches) and wearable sensors, etc.

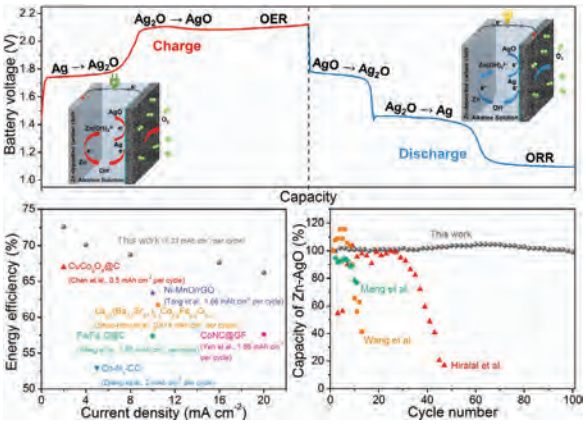


Figure 1. Our newly developed Zn-Ag/air hybrid batteries showed higher efficiency and higher stability than existing Zn-based batteries.

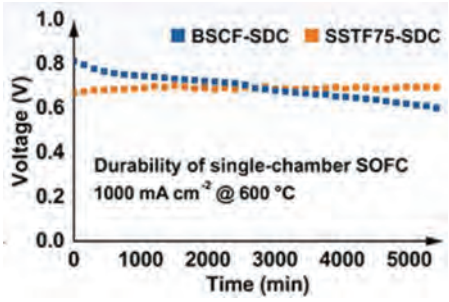


Figure 1. The newly developed perovskite oxide materials (SSTF75) showed excellent CO_2 – resistance, in comparison with existing SC-SOFC cathode: BSCF-SDC

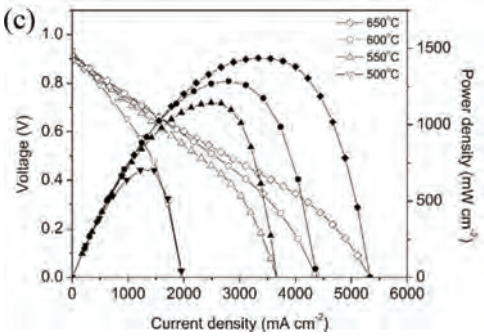


Figure 2. Our developed SC-SOFC delivered a high power density of over 1.4W/cm² at 650°C, exceeding the performance of existing SC-SOFC.

Energy Conversion through Durable Single Chamber Solid Oxide Fuel Cell

Special features

- *Higher fuel cell efficiency (>50%)*
- *Stable in CO_2-rich environment*

High performance and durable single chamber solid oxide fuel cells (SC-SOFCs) are developed for efficient energy conversion at 500-700°C. The cathode is the key to realize the efficient and durable operation of SC-SOFC, as typical cathode materials degrade significantly in a CO_2-rich environment. Cobalt-free novel perovskite oxide materials $SrSc_{0.075}Ta_{0.025}Fe_{0.9}O_{3-\delta}$ (SSTF75) are fabricated as SC-SOFC cathode. The materials showed excellent activity (very low resistance) towards oxygen reduction reaction (ORR) and high resistance to CO_2. SC-SOFC demonstrated excellent stability in CO_2 environment and delivered high power density of over 1.4W/cm² at 650°C, exceeding the performance of existing SC-SOFCs.

The SC-SOFCs can be used for combined heat and power co-generation, a backup power source for vehicles and various stationary applications. It can make significant contribution to sustainable energy conversion.

Simple and Cost Effective Fabrication Process for Making Flexible Transparent Electrodes

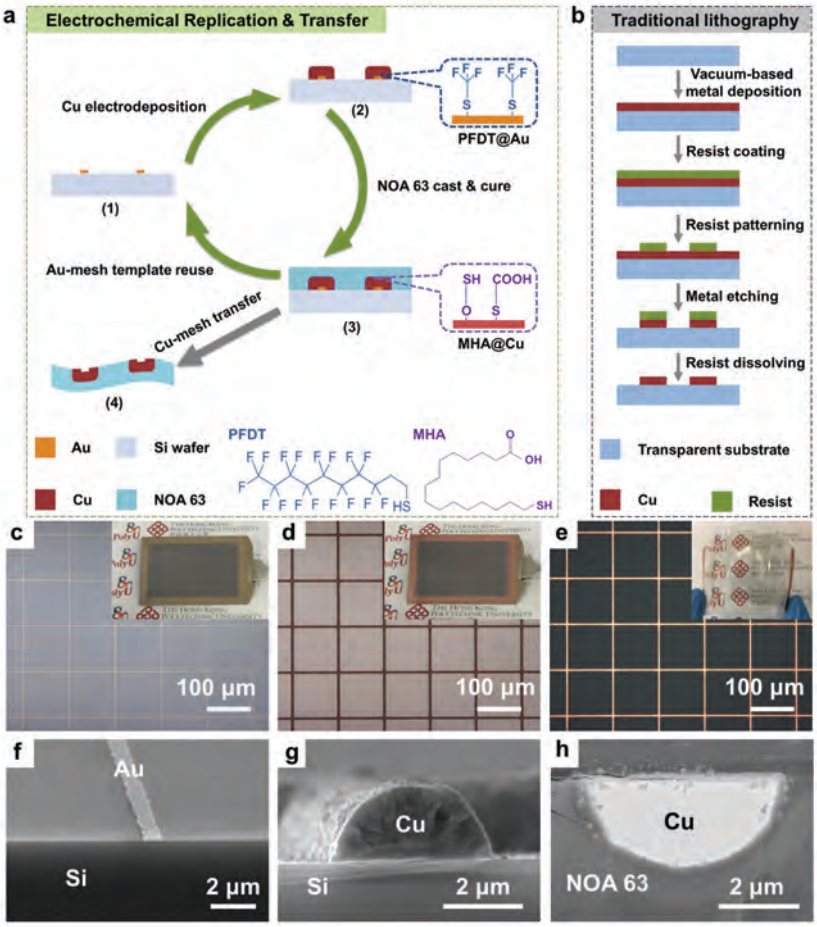
Special features

- *Low material and processing cost while maintaining a good performance on scalability, surface smoothness and metal adhesion*
- *Avoids complicated lithography or printing steps that will simplify the fabrication of metal mesh*

Metal mesh is a more preferable kind of transparent electrode materials due to its impressive optoelectronic properties. However, the fabrication process involve complicated and high-cost patterning techniques.

A cost-efficient and facile fabrication process, namely as electrochemical replication and transfer (ERT), is developed to produce the metal mesh-based flexible transparent electrodes (FTEs). The key innovation of ERT method is the adoption of a reusable Au-mesh template to realize high-quality metallic patterns by low-cost solution process. This bottom-up process only consists of two facile steps, where is vacuum free, resist free and etching free. Furthermore, as-made embedded metal mesh-based FTEs show remarkable electro-optical performances. Particularly, the figure of merit soars up to 25,000, which is one new record while compared with previous transparent electrodes.

Considering the cost-efficient, facile and scalable fabrication and excellent properties, we believe our ERT fabrication strategy could effectively promote widely practical application of metal mesh in flexible and wearable optoelectronic devices, such as organic light-emitting diodes, solar cells, touch screen panels, transparent heaters, photodetectors, human-machine interaction apparatus, etc.



Flexible Wire Type Lithium Battery

Special features

- *Low resistance metallic fibrous carbon current collectors*
- *Flexible fibrous lithium composite anodes*

Flexible lithium metal batteries with high theoretical energy density are highly desired to power up various wearable electronics. The flexibility of current device is limited by either stacking device configuration or utilization of fragile current collectors (Cu and Al foil) and bulky lithium anode.

This technology involves the designing of omnidirectionally flexible wire-type lithium battery via scalable process. The cell achieves both remarkable device flexibility (flexing radius = 1mm) and high electrochemical performance (> 400 cycles' charge/discharge at 0.2 C).

This technology broadens the applications of flexible lithium batteries such as integration with bendable/foldable smartphones or woven into breathable electronic textiles.

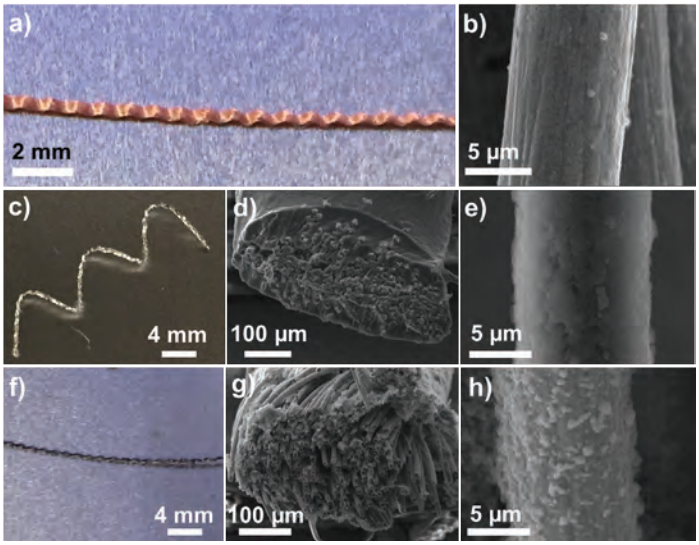


Figure 1.
a) Optical image of Cu coated C yarn current collector
b) SEM image of Cu coated single C fiber
c) Optical image of flexible fibrous Li composite anode
d) SEM image of fibrous Li composite anode, side view
e) SEM image of Li coated on single Cu/C fiber
f) Optical image of as-fabricated fibrous LFP cathode
g) SEM image of fibrous LFP cathode, side view
h) SEM image of LFP coated on single Ni/C fiber

Non-invasive Glucose Detection Wearable Sensor

Special features

- *High sensitivity and low detection limit*
- *Light-weight and inexpensive fabric*

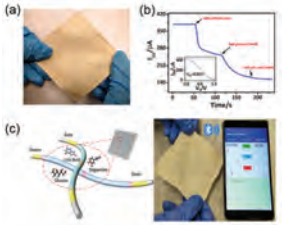


Figure 1. (a) Flexible fabric OECT sensors by weaving fiber-based devices with cotton yarns with good stretchability. (b) Current responses of a fabric glucose sensor integrated in a diaper to the additions of artificial urine, 3 ×10–3 M glucose solution, and 1 ×10–3 M uric acid solution, sequentially. (c) The illustration of fabric OECT used for wireless wearable healthcare monitoring.

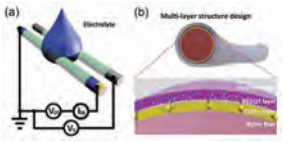


Figure 2. (a) The illustration of fiber-based OECT used for biosensing application which is consist of channel fiber with drain and source electrodes and gate fiber with gate electrode, respectively. (b) The design of a core-shell conductive nylon fiber with Cr/Au/PEDOT:PSS/parylene coating

People with diabetes often need to monitor blood glucose levels regularly to maintain treatment records or regulate eating habits. Traditional monitoring techniques are invasive which require frequently finger pricking and normally restricted to one kind of glucose sensing scenarios. A new type of wearable non-invasive glucose biosenor is developed by using flexible fabric organic electrochemical transistor. With in situ amplification of target analyte signal in solution, the biosenor can be used to detect glucose in different sensing scenarios, such as saliva, sweat and tear.

This wearable sensor has excellent bending stability, high sensitivity (down to 30 nM glucose concentration) and good selectivity due to the utilization of material engineering, electrochemical engineering and enzyme modification method during sensor fabrication. The real time and long term reliable monitoring of glucose level in body fluids can be realized by wireless detection platform so that better diabetic management can be provided to needed patients.

This technology will be a revolution towards traditional blood glucose meter and can be expanded to different healthcare monitoring systems.

Wearable Strain Sensing Textiles for Human Motion Monitoring

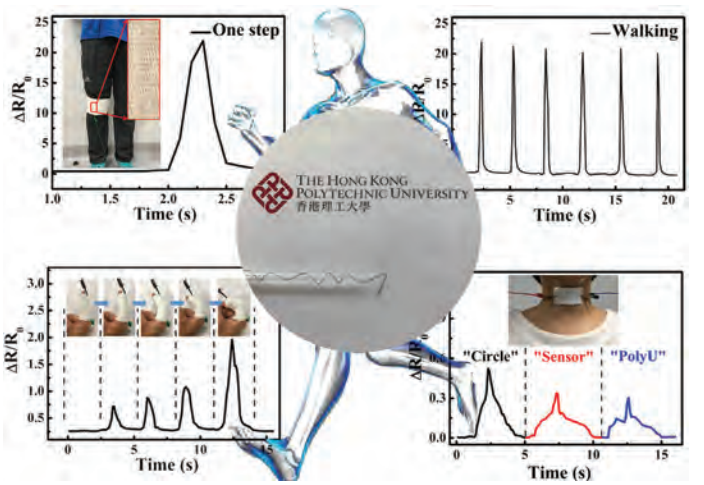
Special features

- *Good weavability for the integration into textiles*
- *Good wearability and washability, lightweight and comfort*
- *Good flexibility for 3D strain/pressure mapping and large measuring area*

There is a rapidly growing demand for flexible and wearable strain sensors to monitor human motions and physiological conditions. However, most reported sensors for wearable electronics are usually fabricated in two-dimensional strip configurations, which cannot be properly integrated into textile structures and thus greatly degrade intrinsic properties and aesthetic feeling of clothing.

A new one-dimensional weavable strain sensing yarn with unique multilayer structure has been designed and fabricated through an easily manipulated protocol. The strain sensor not only exhibits excellent sensing performance but also possesses good weavability. Consequently, such yarn sensor has been directly integrated into various textile structures by using existing textile technologies for fabricating sensing textiles. The sensing textiles demonstrate their strong capability for real-time monitoring of human motions.

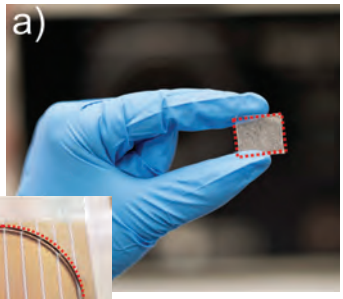
Some potential application areas for this technology include research on human biomechanics for health care and clinic medicine, outdoor activity for healthy and fitness, athletic training, functional clothing for the measurement of strain/pressure distribution and garment design and garment fitting evaluation.



Anti-reflection Haze Film for Optoelectronic Devices

Special features

- *Low cost, simplifies fabrication process and multifunctional for optoelectronic devices*
- *Haze film shows significant anti-reflection effect and can be easily adjusted for different applications*



Traditional manufacturing of anti-reflection coating require complicated lithography process. Moreover, major light absorption loss is caused from the insufficient thickness of the absorbers.

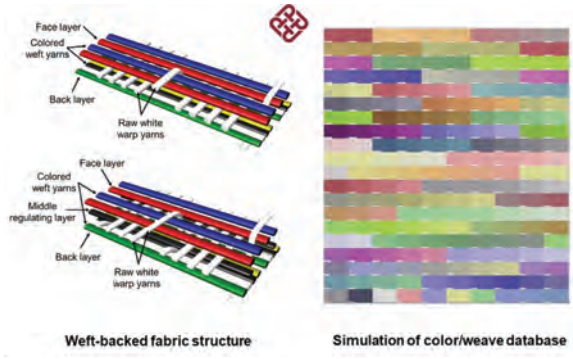
The development of self-formed haze film improves the performance of optoelectronic devices by elongating the optical path, and anti-reflection effect. The substrate of the haze film is commercially available polydimethylsiloxane (PDMS), which is cheap, flexible and highly transparent. The haze film is obtained by curing the mixture of PDMS pre-polymer, curing agent and a polymeric additive.

This technology is good for photodetectors or displays, the anti-reflection effect improves the sensitivity of the detector, or enhances the brightness of the screen. For photovoltaics, the haze film enhances the power conversion efficiency significantly.

Enhance Technology that Simplifies Production for Graphic Fabrics

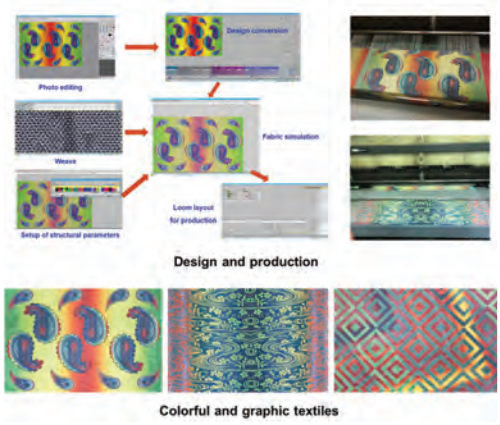
Special features

- *Novel weft-backed structures for maximizing the presentation of weft-yarn color mixing effect and minimizing the white-warp effect on the fabric performance*
- *Elimination of special preparation of warps for multicolored-warps and reduction of complex of the process and production cost*



Weft-backed fabric structure

Simulation of color/weave database



Design and production

Colorful and graphic textiles

Colorful and graphic fabric produced by using colored-yarns represents high technology and high value-added product that are widely used for fashion, home furnishings and decorations. However, the existing manufacturing methods for colorful and graphic fabric by using both multicolored warp and weft yarns include a complex yarn preparation process, which results in the great increase of production cost and the lowering of the flexibility of fabric design and production.

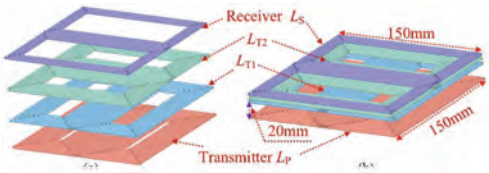
This new manufacturing technology based on a raw-white-warp and multi-colored weft approach offers a new technique feasible, cost-effective and sustainable technology for colorful and graphic fabric. Including the optimal weft color combinations for full-color creation and presentation and new color / weave databases for creating color and figure.

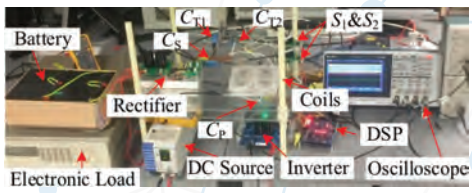
Potential application areas for this innovation can be high-end / high-quality fashion, home furnishing and decoration industries.

Intermediate Resonant Circuit Based Wireless Charging Technology

Special features

- *The size of the charger is more compact by using the proposed magnetic coupling structure*
- *Since the energy conversion efficiency is higher, it is a way of promoting green environment for the society*





Existing wireless charging technologies for electric vehicles required complex sensors, closed-loop controllers and communications facilities which resulted for bulky in size.

A new wireless charging technology based on a novel reconfigurable intermediate resonant circuit is design to reduce complexity and increase efficiency and reliability. Based on a new magnetic coupling structure, the system is able to achieve wireless load-independent constant current charging and constant voltage charging without the need of communication between the receiver and the transmitter side.

This new technology can stimulate the large-scale deployment of electric vehicles with wireless charging. Also, it is applicable for mobile items like electric bicycles and smart phones.

Electrochemical Water Splitting Catalysts with Nanostructure

Special features

- *Low cost hydrogen fuel technology*
- *Water splitting achieved at low voltage of 1.66V at 10mA/cm^2 for continuous 30 hours operation*

Hydrogen production by electrochemical water-splitting is a very promising method and a key technology for hydrogen fuel cell vehicles. It is also important to support the application of intermittent and fluctuating renewable solar and wind power. Conventional electrolyzers for water splitting employ expensive catalyst such as Pt, which in turn causes high cost of electrolyzers.

Pt-free catalyst heterostructured CoP@a-CoOx plate is designed, which consisting of the embedded crystalline cobalt phosphide (CoP) nanoclusters and amorphous cobalt oxides (CoOx) nanoplates matrix for use as oxygen evolution reaction (OER) and hydrogen evolution reaction (HER). It is found that the composite material exhibits comparable activity with the traditional Pt-based catalyst but the use of Pt is reduced to zero (reduced the cost substantially). In addition, the developed catalyst exhibits good stability for hydrogen and oxygen production by water splitting.

The technology can be applied for hydrogen and oxygen production at large scale, which allow the use of excessive solar and wind power for hydrogen generation to support the hydrogen fuel cell vehicle development.

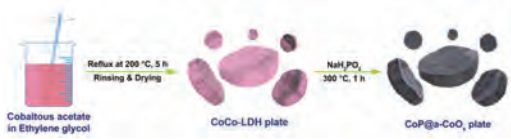


Figure 1. The newly developed fabrication process

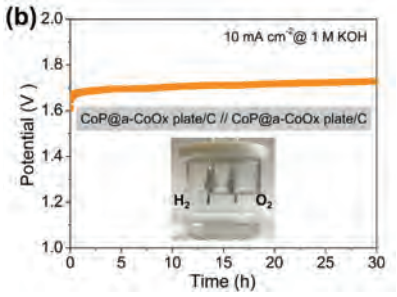


Figure 2. The newly developed catalyst can be used to produce hydrogen and oxygen by water splitting

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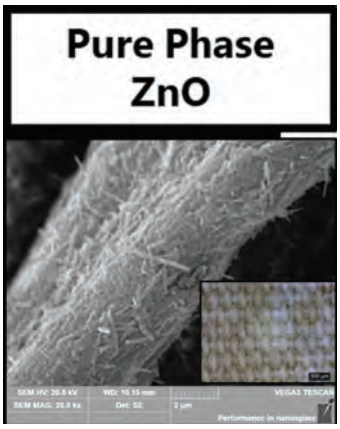
Durable Inorganic Metal Oxide Layer Achieved Using Seeded-sonochemical Deposition Method

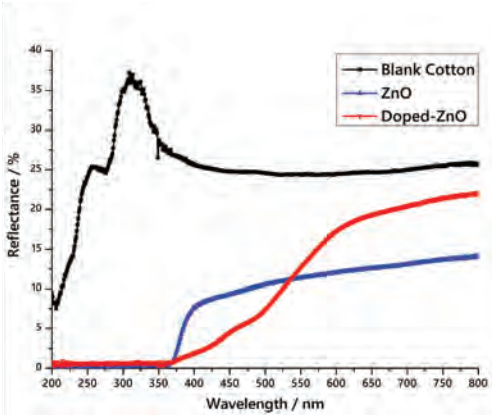
Special features

- *Requires no external heating*
- *Occurs in ambient air and atmospheric pressure*



Currently known techniques for over-coating inorganic metal oxide layer requires high temperature, low pressure and specialized gaseous environments procedures.

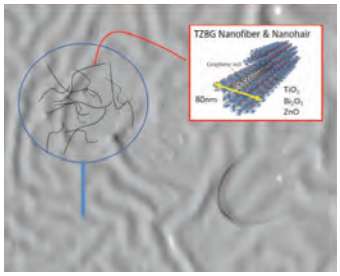
Seeded-sonochemical deposition method utilizes the presence of small seeding layers in order to direct a more durable overcoating inorganic metal oxide layer, which is a faster method and can occurs in room temperature environment. As a result, pure products can be obtained in high quality with cheaper and more efficient process. Functional clothing and glazing apparel are some areas that can utilize this method.



Air/Water Purification and Disinfection using Whitewash Photocatalyst

Special features

- *Air and water purification*
- *Many folds better than the best TiO2 nanoparticles*



This intervention is to developed a powerful photocatalyst, namely Whitewash, which can break down harmful indoor volatile organic compounds to harmless substances.

Whitewash is a photocatalyst made of Titania composite that absorbs visible light, even under diffuse light condition, and generates necessary radicals that oxidize harmful gas molecules, viruses and bacteria that adsorbed onto the photocatalyst surface. The photocatalyst are made into nanofibers with diameter less than 1/1000 times the diameter of human hair. When combined with oxygen and water vapor in air, special ions and radicals are produced to oxidize the undesired gases adsorbed on the photocatalyst.

Whitewash can be used as coating on walls with adequate air circulation and lighting in elevators, vehicle cabins, hospital wards, commercial kitchens to breakdown harmful gases, and kill viruses and bacteria with high level of formaldehyde to acceptable.

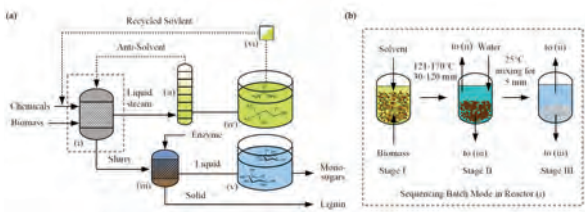
Lignocellulosic Biomass Treatment for Waste Management

The technology aims to fractionate high-value lignin from wastes derived lignocelluloses. The overall biomass conversion is conducted by mixing the biomass with 1,4-butandiol (BDO) in reactor operated under a sequencing batch reactor mode for pretreatment, cellulose regeneration, and enzymatic hydrolysis. The regenerated substrate will be subjected to hydrolysis and the solvent in the spent liquor will be recycled.

In comparison with other organosolv processes, BDO show high feasibility to harvest reactive lignin (high solubility and favorable structure for downstream utilization) at high yield, which does not relate to the severity of pretreatment. The reaction condition of the process is considered mild, which preserve the potential value of the dissolved lignin and hydrolysability of cellulose. The specific features of non-biomass specific, low operation pressure, and high yield make the process particularly suitable to be applied in highly populated cities for waste management.

Special features

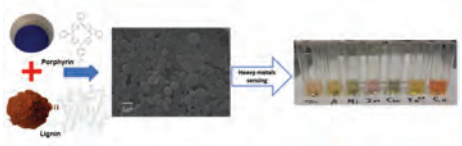
- *Low operation pressure and high yield*
- *Readily convertible into downstream products*



Green Nano-polymer for Fast Screening of Heavy Metals

Special features

- *Rapid heavy metals sensor (including Co, Cu, Mn, Ni & Zn) via UV-vis spectroscopy*
- *The sensitivity can cover the heavy metal concentration ranges in water from 10 ppm to 500 ppm*



Porphyrin and its families are widely applied in various commercial products like chemical sensors, bio-imaging agents and cancer drugs. These products are usually applied with synthetic and petroleum-based polymers as the building block. During the incorporation with porphyrin, a complex procedure is involved while hazardous chemical reagents are always created.

In this prototype, a natural plant-based polymer (Alkali lignin) is applied for incorporation with Porphyrin. The produced biorefinery-derived Lignin-porphyrin Nano-polymer (Lignin-TPP) demonstrated remarkable performance and contain outstanding feature which cannot be provided by the original chemicals alone. It can be served as a rapid sensor to detect different types of heavy metals via simple UV-vis spectroscopy (R2=0.99). In comparison with porphyrin, the emission intensity of Lignin-TPP is significantly enhanced (>50 folds) in high-water fraction (>90%) environments with broad pH range. Therefore, it showed the potentials in bio-imaging application due to its stable and intense emission at a broad range of pH.

This technology demonstrated an example of effective utilizing lignin to fabricate a new functional material and offering significant benefits to waste valorization and industries.

Artificial Intelligence Industrial Internet of Things based Robotic Warehouse Management System

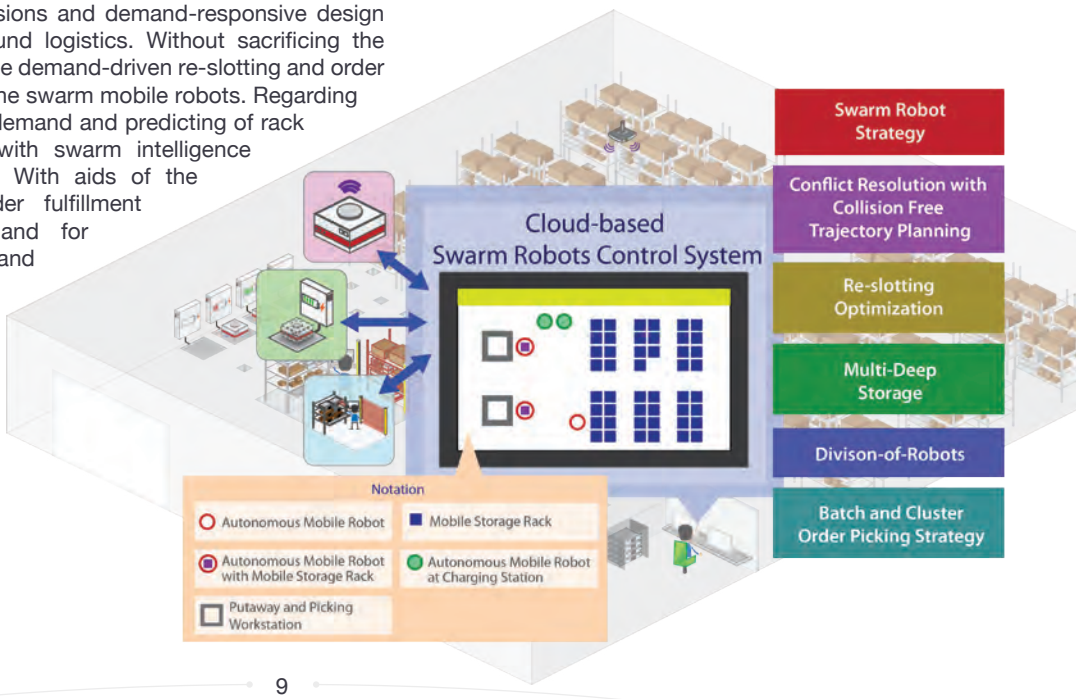
Streamlining the efficiency, transparency and cost consideration on inbound logistics are critical factors for seamless delivery experience. It is always a challenge for supply chain to match real-time order with its order fulfillment. The cyber-physical solution that is fully visible over the inbound logistics by analyzing the real-time demand and improving racks allocation via collaborative swarm robots is developed.

The synergy between cyber-physical decisions and demand-responsive design can deal with the lack of agility in inbound logistics. Without sacrificing the capacity of order fulfillment performance, the demand-driven re-slotting and order fulfillment is performed simultaneously by the swarm mobile robots. Regarding the discrepancy between order fulfillment demand and predicting of rack re-slotting requirements, mobile robots with swarm intelligence is assigned with different role of tasks. With aids of the cyber-physical warehouse systems, order fulfillment status in actual operations and demand for e-Commerce products are synchronized and connected with “Digital Twin” to cope with the e-Commerce-level dynamics.

The potential applications of predictive rearrangement racks in robotic warehouse are using as express smart E-commerce electronic computerized parcel locker and with smart locker function.

Special features

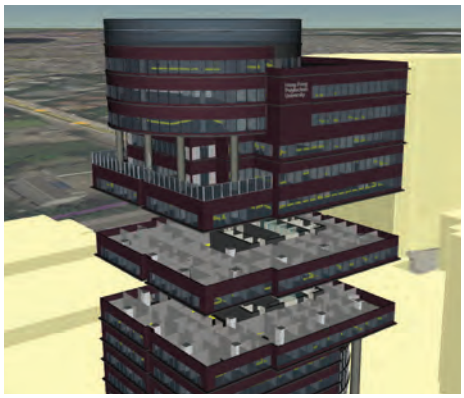
- *Can achieve better cycle time of order fulfillment*
- *Fully visible over real-time demand and demand driven re-slotting technology*



Lightweight 3D Seamless Spatial Data Acquisition System (SSDAS)

Special features

- *Detailed 3D GIS model for the framework covering 3D geometric and topology modelling with semantics*
- *Enabled multi-source and multi-format data exchange*
- *Lightweight 3D LiDAR for backpack platform*
- *Data collection both outdoor and indoor*



With the continuous urbanization of Hong Kong, the complexity and heterogeneity of spatial data in 3D and temporal-dimensions raise new challenges to the traditional 2D geodatabases.

There are 2 deliverables in this design: 1) 3D geodatabase framework design, and 2) Lightweight 3D Seamless Spatial Acquisition System. For the framework design, it has the capability to provide comprehensive topological relationship modeling, detailed 3D geospatial modelling, semantic & geometry modelling and interactive geo-visualization in 3D. While the SSDAS can integrate multi-sensor with an all-in-one mobile platform and light in weight.

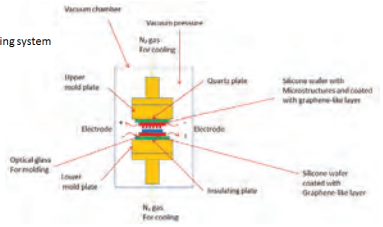
This application will be applicable for geospatial modelling on complex city environment like Hong Kong.

Coated Silicon Mold for Miniature Glass Optics Production

Special features

- *Can replicate very fine optical microstructures with micron level accuracy and nanometric surface finish*
- *Use 60 times less electricity than traditional infrared heating*
- *Equipment cost is one-third of traditional glass molding machine*

Schematic diagram of Graphene-like heating system



The conventional precision glass molding process is difficult to produce miniature optics as it involves infra-red heating which requires long thermal cycle time and will result with higher thermal deformation which will affect the accuracy of finishing product.

Rather than using the expensive tungsten carbides for hot molding, a special technique is developed to fabricate a graphene like material coated on a silicon die based on single point diamond turning. The glass workpiece is heated up directly via the coated silicon die and therefore it is not necessary to heat up the whole mold setup. A control and monitoring software is also developed to provide accurate and on-lie contrail of the process parameters.

Comparing with the existing commercial glass molding machines, this design is environmentally friendly and cost effective and can produce a wide range of high-quality precision optical components to replace optical plastics, such as smartphones and micro projectors, compound eyes for 3D camera, Fresnel lens for solar cell applications, and micro-lens array for laser optical systems.

A Multi-jet Polishing Technology that Boost Polishing Efficiency and Provide Good Surface Quality

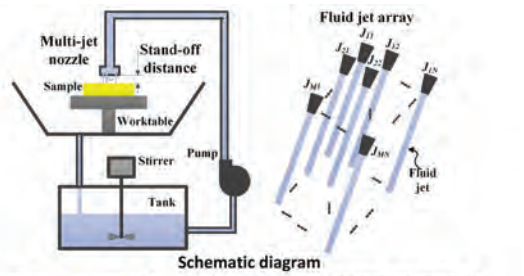
Special features

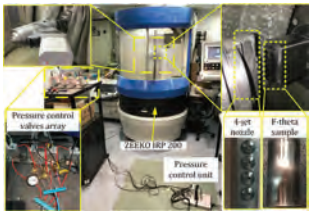
- *High adaptability to variation of curvature of freeform surfaces*
- *Useful for patterning various kinds of structures such as lens arrays*
- *More cost-effective*

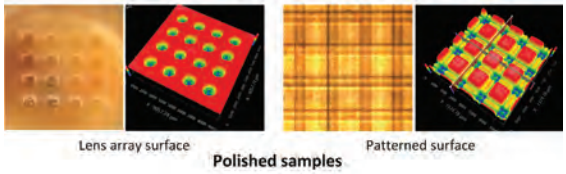
Ultra-precision freeform surfaces have been widely applied in many fields such as aerospace, photonics, optics, biomedical, etc. However, the low polishing efficiency of fluid jet polishing (FJP) adversely affects its application in polishing large-sized components or components made of difficult-to-machine materials.

An array of orifices are designed and integrated into one multi-jet polishing (MJP) nozzle, which generates an array of pressurized abrasive water jets for removing material after impinging to the target surfaces. It works under two modes including integrated polishing mode and discrete polishing mode. In integrated polishing mode, all jets have the same fluid pressure, and the jet array is considered to be a large polishing pad to boost the polishing efficiency. In discrete polishing mode, the pressure of each jet is controlled independently through the connected pressure control valve, which can implement curvature-adaptive polishing of multi-regions of the surface simultaneously.

This MJP technology can be used for the polishing of freeform and structured surfaces used in biomedical (e.g. artificial implants), optics (e.g. freeform lenses), aerospace (e.g. turbine blades), etc. Further applications can be extended to polish 3D printed freeform surfaces.



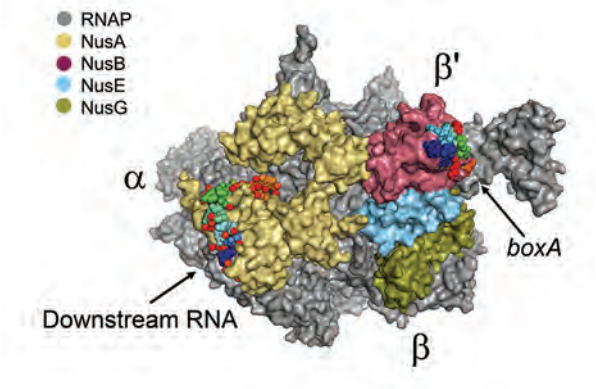


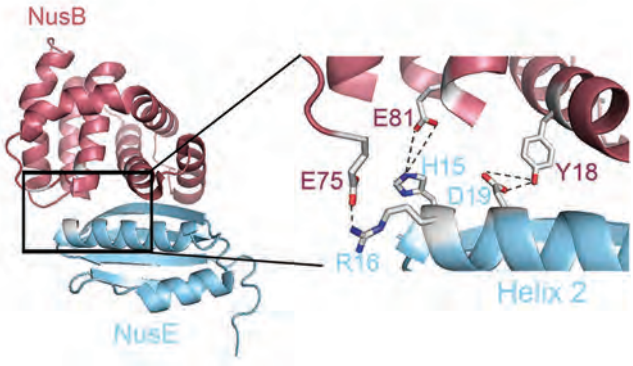


New Antibiotic Candidate to Treat Superbug-caused Inflection

Special features

- *Capable of eliminating current antibiotic-resistant pathogens (superbugs)*
- *Non-toxic to human cell*





Through the use of biological research of bacterial transcription system, new antibiotic drug candidates were discovered. Unlike current antibiotics in the market, these first-in-class antimicrobial small molecules with new mechanism of action displayed excellent bactericidal effects against bacteria including antibiotic-resistant pathogens.

These molecules target the important bacterial protein-protein interactions not existing in mammals, therefore demonstrated no toxicity to human cells, while the pre-clinical studies are ongoing. These new antibiotic drug candidates are expected to be developed to complement the current antibiotic drugs for treating bacteria caused infectious diseases, and contributing to the society and healthcare system threatened by antibiotic-resistant bacteria.

Non-Invasive Selective Neural or Cellular Stimulation by Ultrasound

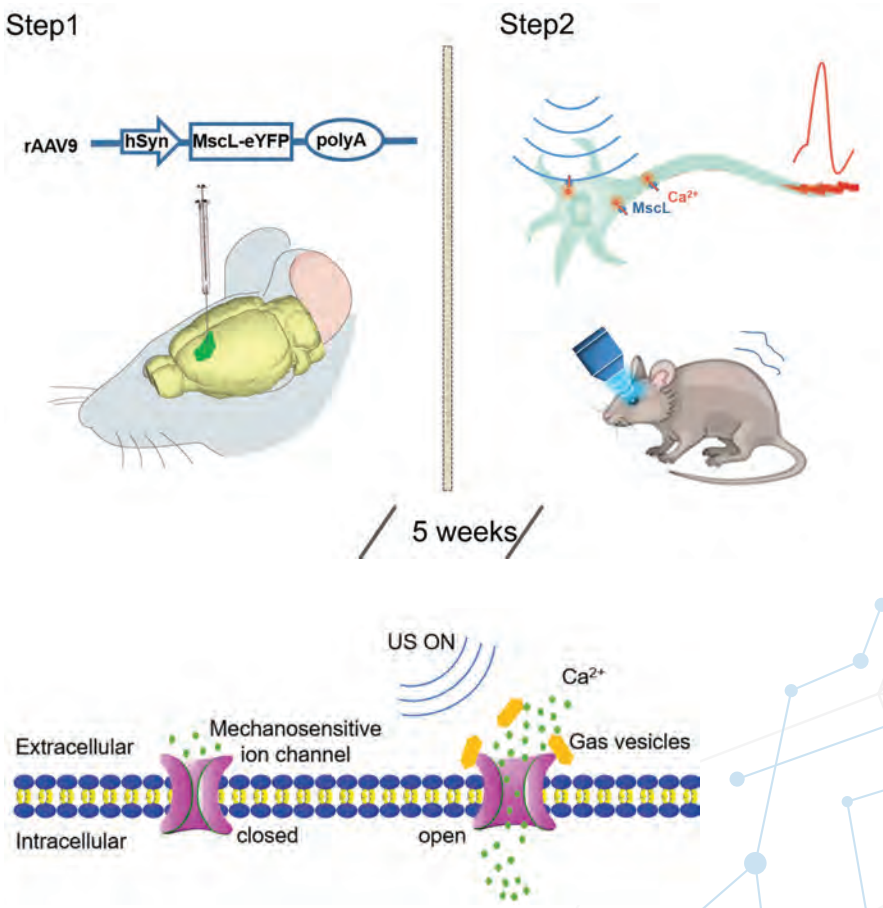
Special features

- *Neural type selective with high spatiotemporal resolution*
- *Better precision and safer*

The existing technology e.g. deep brain stimulation, optogenetics is invasive, while the noninvasive technology "Transcranial Magnetic Stimulation" lack spatial resolution and cell type selectivity.

This technology developed is a non-invasive method, which have significant impact both on fundamental brain function research and treating brain dysfunction. Using ultrasound in specific spatio-temporal regions, one is able to collect selectively manipulation of neuronal activity.

The success translation of this technology can result in significant impact on brain initiative projects and clinical needs.



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