

## Addressing your Unmet Needs through **INNOVATION**



The Hong Kong Polytechnic University (PolyU), a university with the vision to excel in professional education, applied research and partnership for the betterment of Hong Kong, the nation and the world, with strong establishments on Chinese mainland and significant impact in internationalization.

Innovation and Technology Development Office (ITDO) serves to nurture platforms to boost high-impact research in collaboration locally and internationally with universities, industry and government. Our research strength includes healthcare, safety, aviation, aerospace, transportation, sustainable development, etc.

# Contribute strategic value to the world technology development

The approval of two Hong Kong Branches of Chinese National Engineering Research Centers (CNERC) and two Partner State Key Laboratories manifests recognition of the PolyU research & development capability of research teams and provides a high-level platform to strengthen the collaboration between the Mainland China and Hong Kong. PolyU and Southwest Jiaotong University jointly established the Innovation Center of Rail Transit Safety Monitoring Technology.



# Push the frontiers of multi-disciplinary research and development initiatives with knowledge transfer potential



PolyU and Huawei Technologies Co. Ltd. established a joint lab for Optical Interconnection Network and Advanced Computing System.



PolyU and The Boeing Company jointly established Hong Kong's first Aviation Services Research Centre (ASRC).



PolyU with Alibaba Group to promote collaborations in the areas of big data and cloud computing, large-scale real-time computing, artificial intelligence & computer vision, navigation & smart city, digital innovation.



PolyU and China Aerospace International Holdings Ltd. (CASIL) established a joint lab on intelligent systems to pioneer research in robotic design and control, energy-saving and cost-efficient vibration control, intelligent systems or structures for control, measurement, sensing and health monitoring etc.

# At the forefront of safeguarding public well-being

PolyU joins hands together with academic, government and industry for the cross-sector research platform. We discover Hong Kong's first anti-cancer drug granted with US FDA Investigational New Drug (IND); another US FDA granted drug is permitted to support cancer patients with all-oral chemotherapy regimen for cancer treatment.



Coordinated and initiating Food Safety Consortium



Research Institute of Sustainable Urban Development



Respiratory Virus Research Foundation



Institute of Translational Medicine

## Join forces with international research institutions to boost high-impact researches



PolyU jointly forces with National Food Institute – Technical University of Denmark (DTU), Alma Mater Studiorum – University of Bologna (Unibo), Lund University (LU) to establish a non-profit collaborative alliance “DISH Global Centre for Food Safety and Quality” for addressing challenges in global food safety.

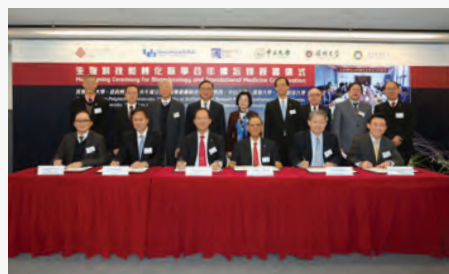
PolyU, Monash University and CollinStar Capital jointly established the first university-industry joint research laboratory on blockchain and cryptocurrency technologies, focus on privacy protection and security of blockchain technologies for standing against attacks from powerful quantum-computing.



PolyU joins forces with the Fraunhofer-Gesellschaft (Fraunhofer) and the Karlsruhe Institute of Technology (KIT), to drive collaborative applied research and technology development in the area of life sciences and engineering for the benefits of the global community.



Together with partners from Greater Bay Area, PolyU initiated a collaboration with The State University of New York at Buffalo (SUNY Buffalo) and Roswell Park Comprehensive Cancer Center for the development of translational medicine and biotechnology research.



## Innovative intellectual property management

PolyU highly values the protection of knowledge creation and breakthrough scientific researches by our staff members and students. With the establishment of the Intellectual Property Assessment Committee (IPAC) and the implementation of an Intellectual Property (IP) web-based system, we have significantly enhanced the University’s IP management process. These enhancements are first of its kind among Hong Kong’s higher education institutions, which contribute to our continuous strive to improve our IP management process.



## PolyU’s TechConnect Global Innovation Awards in 2017

PolyU had bagged three Global Innovation Awards at the TechConnect World Conference and Expo 2017. PolyU was the only awardee from Hong Kong and it was the first time for a local higher education institution to receive such award. The award-winning innovations are:

*Multi-functional nano-coating for glass*



*Passive anti-vibration structures*



*Personalised energy saving thermal-comfort platform*



TechConnect World grants awards to only the top 20% of the submitted innovations, with the assessment based on the potential positive impact of the innovations on a specific industry sector.



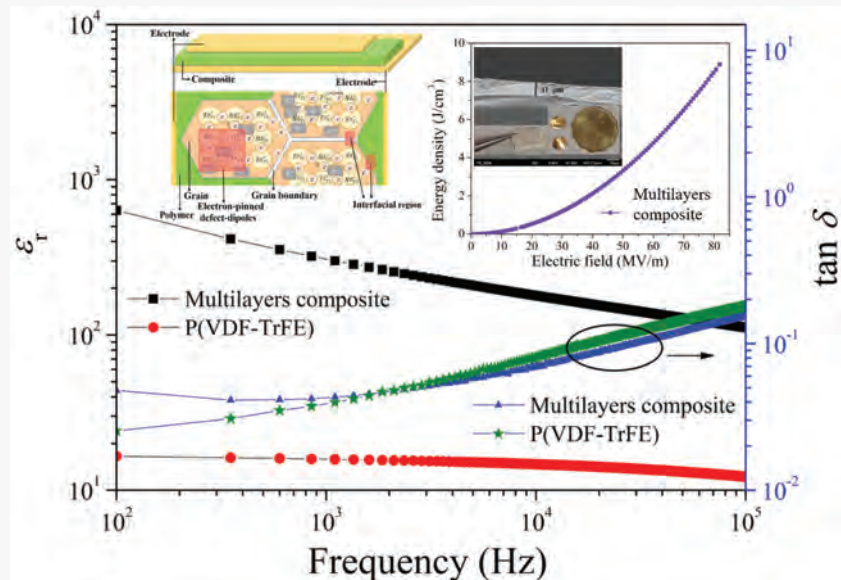
# Composite Multilayers Capacitors with Colossal Permittivity Materials for Electronics and Energy Storage Applications

Materials with colossal permittivity (CP) have shown great technological potential for advanced microelectronics and high-energy-density storage applications. Original CP ceramics exhibit high-performance dielectric behaviors, including temperature and frequency stable CP value and sufficiently low dielectric loss. Importantly, the technology on ceramics is further developed to multilayer-structured ceramic/polymer composites. Surface hydroxylated ceramic fillers, embedded in copolymer matrix can achieve high dielectric constant and exceptional low dielectric loss over a broad frequency range, as well as high energy density. The host oxides used in this CP system is friendly to the environment, non-toxic and abundant. Additionally, the process developed is relatively simple, low cost and suitable for mass production-scale. Therefore, these composite capacitors have great technological potential for many applications. Compared to the conventional ceramic materials, these composites in this work are lightweight, scalable and easily fabricated into complex

shapes towards miniaturization of the compact systems. The additional flexibility feature of them also possess broad application prospects in modern electronic and energy storage devices.

## Special Features

- Flexible composite capacitor with CP materials
- Friendly to the environment, non-toxic and abundant
- Simple and low cost processing



# Printable MnO<sub>2</sub> Based Rechargeable Sodium Batteries

The inkjet-printed MnO<sub>2</sub> electrode can serve as a cathode material for high performance rechargeable sodium batteries. The as-assembled full cell could reach maximum energy and power densities of 147 Wh·kg<sup>-1</sup><sub>total</sub> and 4.6 kW·kg<sup>-1</sup><sub>total</sub> with average working voltage of 2.3V and ca. 100% capacity retention after 100 cycles, which could be anticipated for practical energy applications. The MnO<sub>2</sub> based

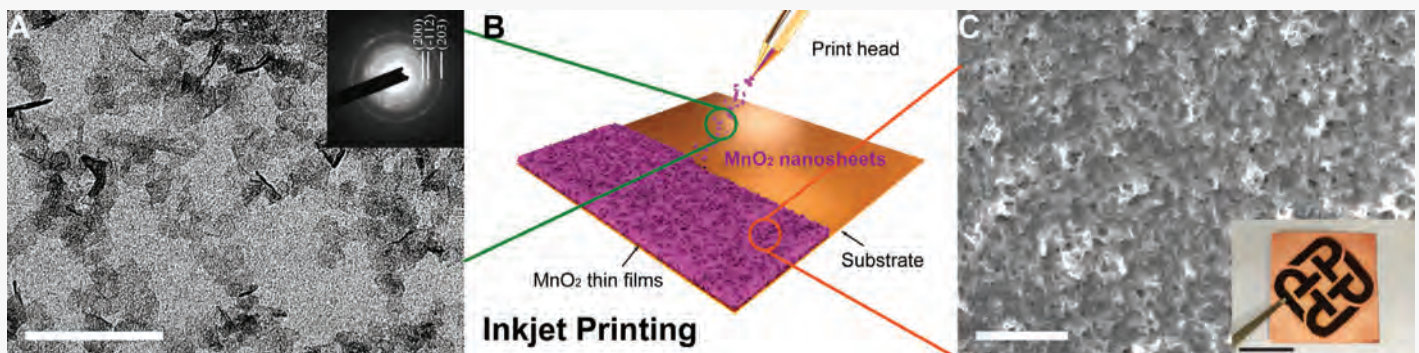
electrode could achieve simultaneously and unprecedentedly a working voltage of 2.5V, maximum energy and power densities of 587 Wh·kg<sup>-1</sup><sub>cathode</sub> and 75 kW·kg<sup>-1</sup><sub>cathode</sub> respectively with a 99.5% capacity retention for 500 cycles at 1 A·g<sup>-1</sup>. These values are approaching the targeted sodium ion batteries.

The long-neglected kinetically limitation effect is found to be effective in controlling the redox

## Special Features

- Low-cost due to abundance of Na
- As a high-performance rechargeable sodium battery

mechanism. The inkjet-printed MnO<sub>2</sub> electrode shows an enhanced redox activity of Mn<sup>4+</sup>/Mn<sup>3+</sup> couple, along with a fully suppressed redox activity of Mn<sup>3+</sup>/Mn<sup>2+</sup> couple. Owing to the earth-abundant and low cost of sodium (Na) as compared to Li, sodium secondary batteries are envisioned to be a viable alternative to replace the current lithium (Li) based battery industry.



Systematic illustrations of the K<sub>0.3</sub>MnO<sub>2</sub> electrode.  
 A) Surface view of the TEM image. Scale bar is 100 nm. Inset: the corresponding SAED pattern.  
 B) Schematic diagram of the inkjet printing process.  
 C) Surface view of the SEM image. Scale bar is 2 μm. Inset: A patterned electrode.

# Self-sustainable Electrical Sensors and Condition Monitors for Smart Cities

The electricity transport and utilization activities can now be loyally, safely, smartly, and continuously guarded by the “Self-sustainable Electrical Sensors (SsESs)” and the “Energy-harvesting Self-powered Wireless Condition Monitors (EhSpWCMS)” without the needs of external power supplies, signal conditioners, or other active auxiliaries to sustain their operations. SsESs can be simply placed on any sensing point of interest (e.g. cables, conductors, busbars, etc.) to detect electrical currents and temperatures while harvesting and also powering microcontroller, memory, display, wireless transmitter, etc. associated with EhSpWCMS. The technology can be applied to sensor and condition-monitoring markets for all electrical devices, equipment, systems, assets, and infrastructures, ranging from personal and home appliances to residential, commercial, and industrial facilities as well as from public utilities to national infrastructures, military defensive and space systems, etc.



Watch shaped design



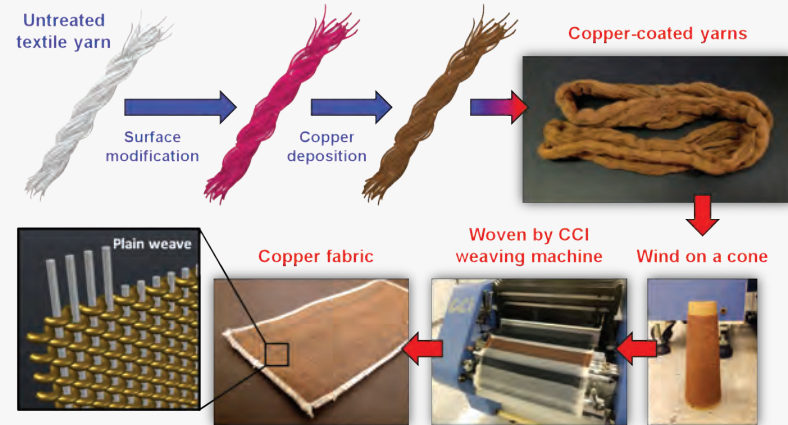
Ring shaped design

## Special Features

- SsESs can convert wasted environmental energies into useful electrical energy for local storage
- Do not require power shut down for installation, commissioning, thereby directly improving the safety, reliability, and availability of electrical assets and systems



# Flexible and Foldable Lithium-ion Battery



Fabrication of metallic textiles.

## Special Features

- Lithium-ion batteries with great flexibility and foldability
- High energy density and long cycling stability



Batteries that are unfolded and folded while operating electronics devices.

Flexible lithium-ion batteries with high electrochemical performance and high mechanical durability, which can be integrated into wearable forms, are highly desired to power up the various wearable electronics. The technology is based on coating of active materials on conductive textiles to fabricate textile-based electrodes, and to assembled them into textile-based

lithium-ion battery full cells. As such, lithium-ion batteries fabricated is of great flexibility and foldability, which is far better than the latest devices available in the market.

The 3D structure of textiles also improves the electrochemical stability and power density significantly. The energy density can reach as high as 200 Wh/kg while the

devices can be folded for more than 1000 cycles without affecting the electrochemical properties. This technology can not only find huge impact in battery industry, but also provide competitive energy storage products for the next generation consumer electronics such as bendable/foldable smartphones and wearable healthcare equipment.



# Co-catalyst System Flame Retardant Treatment for Cotton

## Special Features

- Reduce the curing temperature for flame retardant treatment

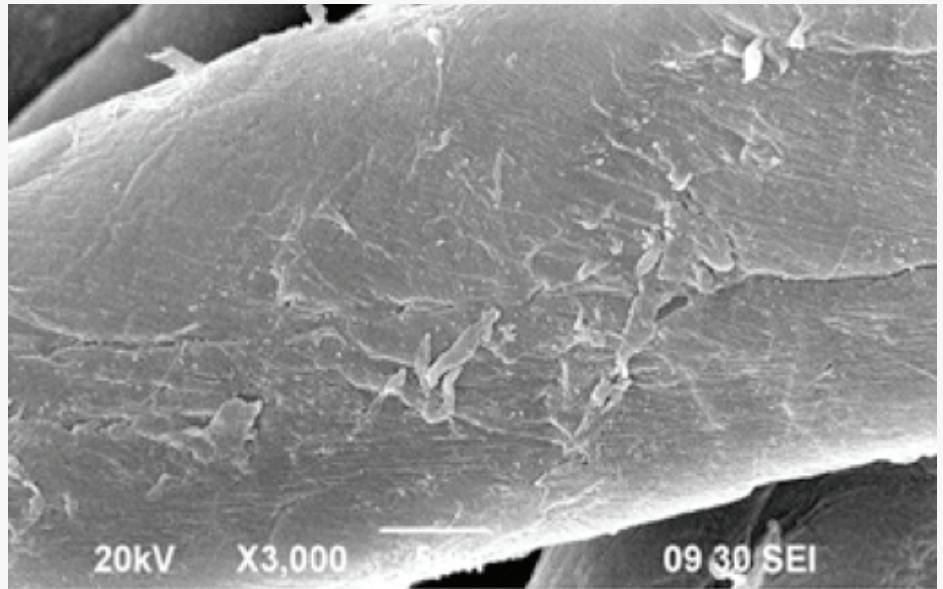
Fabrics made from cellulosic fibres, such as cotton and linen will burn easily with a high flame velocity. Many flame retardant (FR) agents and methods of application have been developed in attempts to produce FR textile materials. However, the FR agents are not efficiently fixed to the cotton fibres unless they are used in combination with a resin and catalyst.

Now, the use of co-catalyst can effectively enhance the flame retardant effect and minimise the side effects of flame retardant treatment. The finishing formulation (recipe)

proposed in this invention was applied to cotton fabric by conventional pad-dry-cure finishing techniques. With the use of co-catalyst system in the flame retardant treatment, it can reduce the curing temperature and time used for flame retardant

treatment, and retain good flame retardant property of cotton fabric even at a lower curing temperature and shorter curing time. It can also minimize the reduction in tearing strength and whiteness of cotton fabric after flame retardant treatment.

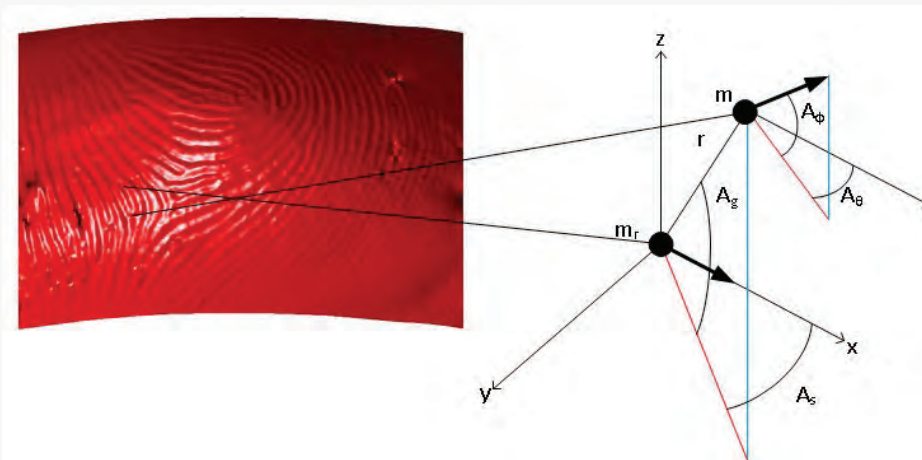
Catalyst



# 3D Low-Cost, Contactless and Accurate Fingerprint Identification System

## Special Features

- 3D biometrics images for more accurate personal identification with advanced biometrics technologies
- To deliver more accurate low-cost and faster identifications of humans for a wide range of civilian or forensic applications



Computing relative localization of two 3D minutiae features in 3D space from the (real) reconstructed 3D fingerprint in the system.

A low-cost and more accurate contactless 3D fingerprint identification system have been developed to provide more accurate personal identification as rich information is available from 3D biometrics images.

The minutiae details in two-dimensional space are widely used by the law-enforcement personnel's and also employed in almost all the fingerprint system commercially deployed today. The 3D system have been able to accurately recover and match these fingerprint minutiae details in three dimensional spaces. This research is also fundamentally significant as it reveals that such recovery and matching of 3D minutiae features will significantly alter the theoretical believed limits on the accuracy of identifying the human's population using fingerprints which is the most popular biometric modality today.

# Magnetic Negative Stiffness Damper (MNSD)

Compared with existing passive negative stiffness device, MNSD adopts a completely different magnetism principle. A passive MNSD can provide symmetrical negative stiffness integrated with damping in a compact and simple configuration. Its mechanical properties can be easily designed by adjusting magnet properties and arrangement.

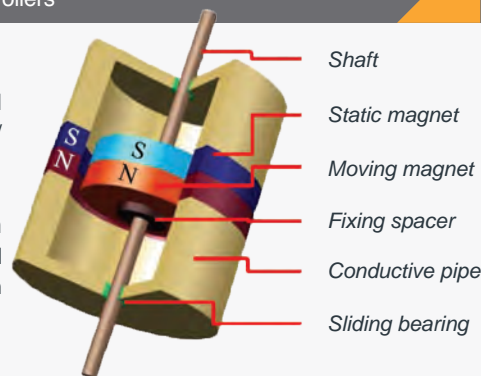
The passive operation mode of MNSD, together with its compact size and simple design, makes MNSD a promising vibration suppression technique with high performance,

cost-effectiveness, reliability and practicability. It has a great potential to replace conventional active or semi-active vibration suppression/isolation systems for various civil, mechanical, and aerospace structures.

The performance of MNSD for vibration mitigation was successfully illustrated in bridge stay cables, high-speed train suspensions, vehicle suspensions, vibration isolation tables, etc.

### Special Features

- Magnetic negative stiffness damper (MNSD) can achieve a vibration suppression performance comparable to that of active control
- Does not require any power supply, sensing or feedback controllers



# Wrinkle Resistant for Cotton by Co-catalyst System

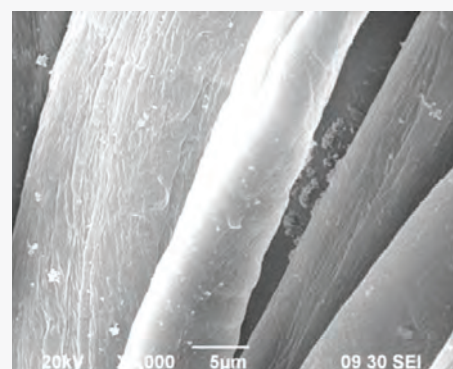
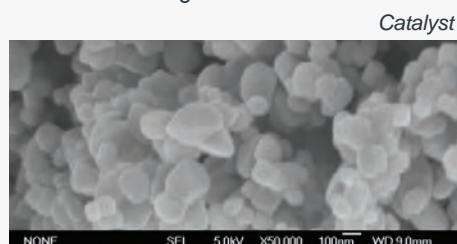
One of the main drawbacks of cotton is wrinkling after washing which has been overcoming by N-methylol reagents in the textile industry, but it produces free formaldehyde.

A conventional wrinkle resistant (DMDHEU) recipe that minimizing side effects like fabric strength loss, reduce in whiteness, free formaldehyde release with the use of co-catalyst. The production cost of wrinkle resistant treatment for cotton fabric is lowered. The technology can also help to reduce the curing temperature and time used

for wrinkle resistant treatment, and retain good wrinkle resistant property of cotton fabric even at a lower curing temperature and shorter curing time.

### Special Features

- Retain good wrinkle resistant property of cotton fabric



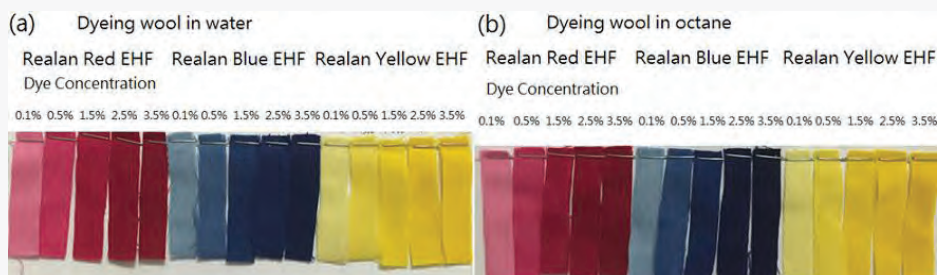
# Non-aqueous Wool Fiber Dyeing Process using Reverse Micellar Approach

In textile industry, reactive dyeing using nanoscaled dye carrier in non-aqueous solvent mostly is well dispersibility, low viscosity and high diffusion into wool fabric matrix properties can result in shorter dyeing periods in comparison with the conventional water dyeing process.

The working temperature of non-aqueous dyeing is 88°C, which is 10 degrees lower than in conventional water-dyeing process in terms of energy saving aspect. The obtained color strength in terms of K/S sum value is better than that in conventional aqueous dyeing. Dyeability of wool fibre with reactive dye from the reverse micellar solution was improved without incorporation of textile auxiliaries such as electrolytes and chemicals like acetic acid or sodium bicarbonate for pH adjustment.

### Special Features

- Achieve good color fastness
- Optimization of dyeing and fixation process could be achieved in a one-bath reverse micelle solution, leading to a potential of lowering the operation costs and energy consumption
- The used solvent can be recycled and reusable

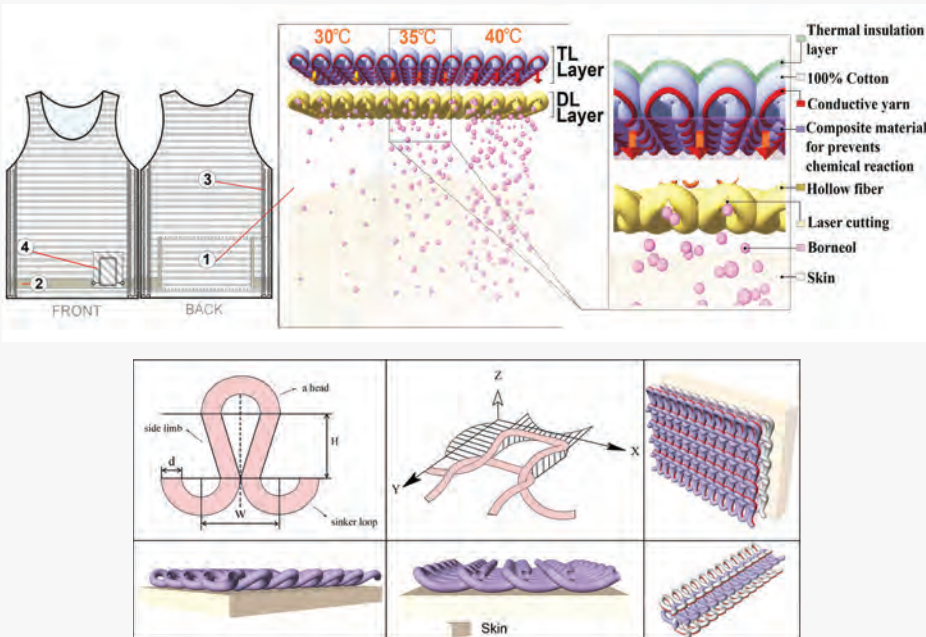


Dyed wool sample in (a) water and (b) octane (the dye concentration from 0.1% to 3.5%)

# A Functional Textile-based Thermal-stimuli Drug Delivery Apparel System

## Special Features

- Low cost and deliver rapid efficient patient care
- A functional textile system is conducted for developing healthcare apparel for patients



Pierce's 2D loop model and loop geometric configuration; contact regions between skin & loops and contact regions between the loops.

Fibre technology has not only entered an essential position in textile industry but also the medical and hygiene fields.

This research focuses on how "second-skin" apparel and skin interact with each other to serve therapy functions. The relation between the thermo-stimulated drug-delivery system and the textile will be studied for the development of healthcare apparel for patients whose disease are typically realized by applying ointment or dressing to the skin.

This study provides a functional textile system that delivers low-cost, rapid, and efficient patient care. It is expected that the development of this system will bring great benefits to both patients who seek long-term daily medical treatment and the apparel industry.

The application of the system will potentially apply to the following areas: textiles in healthcare development, functional fashion innovation, and care possibilities for patients.

# Micro Magnetic Driven Bidirectional Turbine for Hydropower Generation

## Special Features

- A micro magnetic driven bidirectional hydro turbine was developed to generate electricity using limited water head inside water mains, in order to provide constant and reliable power supply
- Environmental-friendly
- Reduce cost

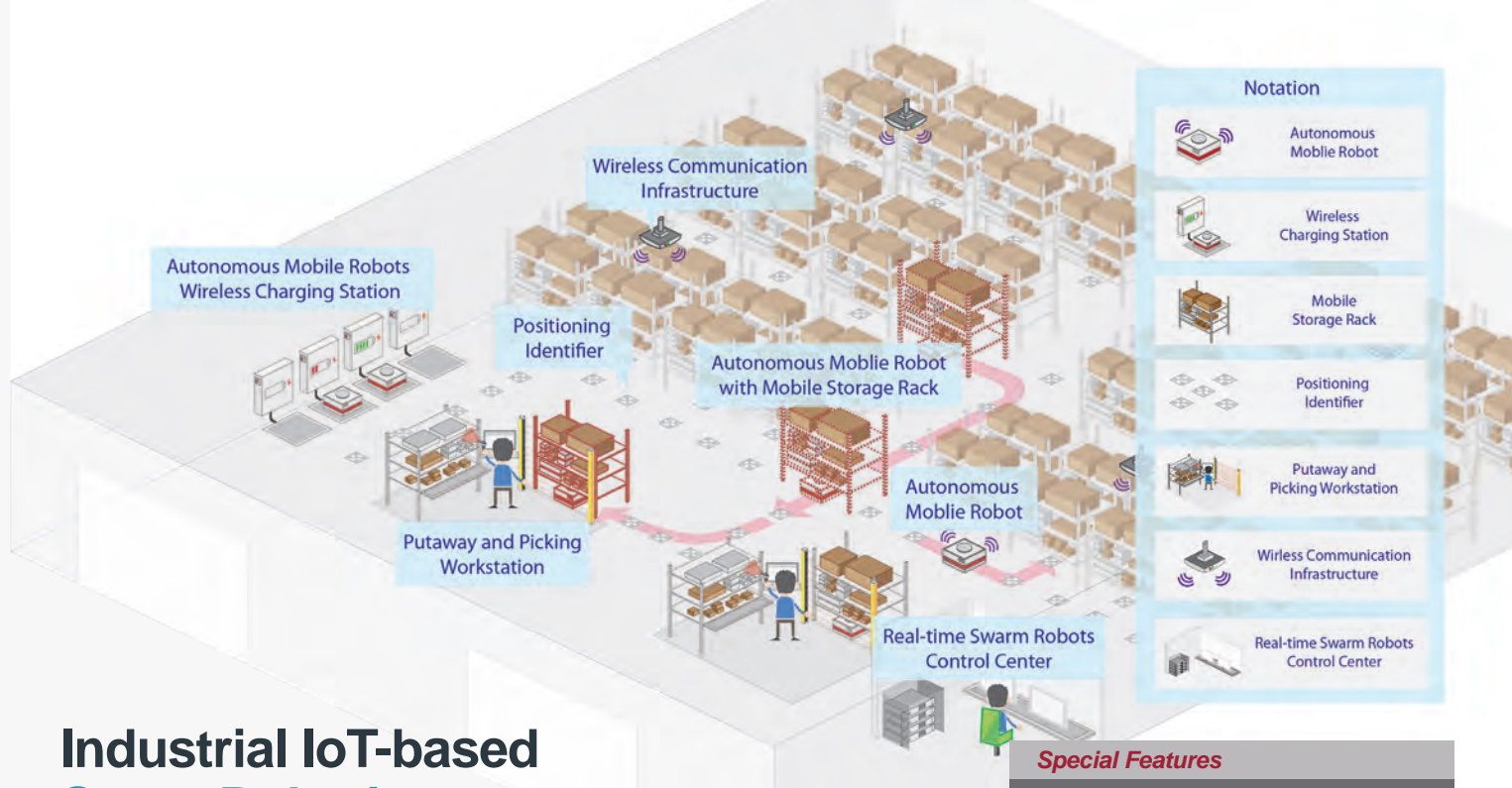
Water supply pipelines monitoring systems are composed of sensors and meters, which need power supply through batteries, which need to be replaced frequently.

The application of magnetic coupling in the developed turbine for avoiding leakage and water pollution make the turbine more reliable. This turbine is helpful to continuous monitoring of leakage and water quality, which can reduce environmental influence caused by waste batteries.

As most water monitoring sensors or meters are powered by chemical batteries, the monitoring system would die once the batteries ran out. Application of the proposed technology can not only make water monitoring more reliable and continuous, but also reduce the high cost and huge labor demand for batteries replacement.







## Industrial IoT-based Smart Robotic Fulfillment System

In response to the growing demands from the e-commerce, advanced swarm intelligent algorithms to provide autonomous and self-coordinated Unmanned Ground Vehicles (UGVs) was developed. By applying the “Swarm Robot Strategy”, UGVs are assigned with specific role in the order

fulfillment operation. This helps to increase productivity and efficiency of the fulfillment center. “Rack Defragment Optimization” approach is adopted to pre-organize the racks’ location to reduce UGVs’ traveling distance. Therefore, the productivity and fulfillment rates are enhanced.

### Special Features

- Offers a “Simulation Mode” for top-management to model, analyze, plan and predict future situation and supports decision making on investment of spaces, labors and equipment for fulfillment center
- Provides a comfortable and safe working environment for operators and the utilization of labor can be optimized to solve the labor shortage in logistics industry

## Friction Tester Characterizing the Stickiness Property of Textiles under Wet Skin Surface

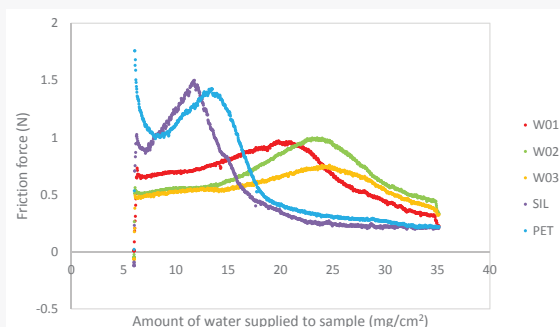
The presence of moisture within fabric-skin interface will cause sensorial discomfort and even lead to skin irritations, abrasions. This study describes the design and construction of TFT. First, predetermined amount of water was sprayed onto the

simulated skin layer. Then, the sample was put on top of it and was dragged at a constant speed. A force gauge connecting to the sample was used to measure the force required to drag on a wet skin surface. The results revealed that TFT was highly sensitive and

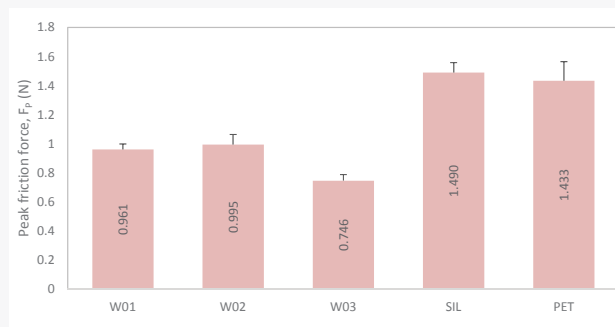
### Special Features

- A new Textile Friction Tester (TFT) was developed for characterizing the frictional property of textiles under wet skin surface
- This technology can be applied for sportswear, hygiene products or medical textiles application

reproducible in differentiating these fabrics and it suggests that frictional properties of fabrics are skin wetness dependent.



The friction force curves for five different fabrics under different wetness level of skin surface. Friction force as a function of amount of water supplied to the sample per unit area.



TFT results. The error bars represent mean + S.D. of five samples in term of peak friction force.

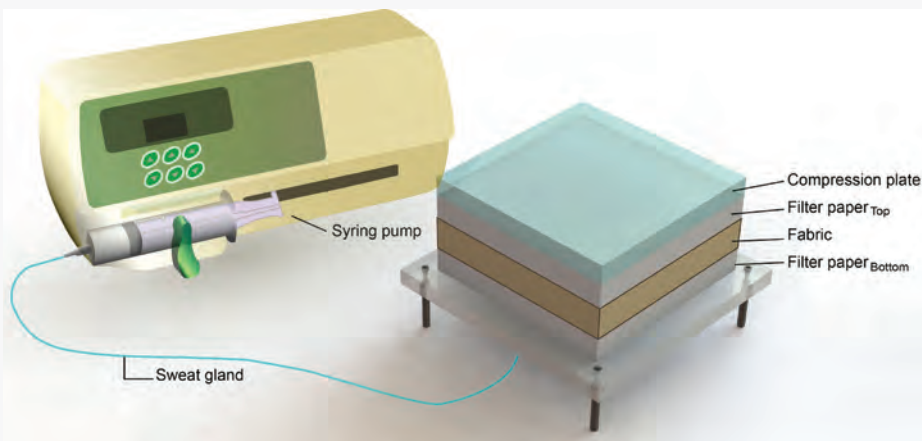
# Forced Flow Water Transport Tester (FFWTT) Characterizing Different Sweat Rate

## Special Features

- Strong correlation with subjective wetness sensation
- Developed for characterizing the transplanar and in-plane wicking property of fabrics

The water absorption and transport properties of fabrics are important in determining the thermophysiological comfort of apparel and health-care products. Forced FFWTT can be divided into (i) sample stage and (ii) water supply part. On top of the stage, the testing specimen was placed in-between two layers of standard material for examining the direction of water spread. A compression loading was placed above the sample to ensure even contact between the layers. For the water supply part, syringe pump was utilized which enables constant rate of water supply. For the measurement parameters, the amount of water absorbed, the water spreading area and the water content of each layer was measured. The results showed that it was highly sensitive

and reproducible in differentiating fabrics and it has strong correlation with subjective wetness sensation.



# East Meets West in Fighting Against Alzheimer's Disease with Novel Dimers

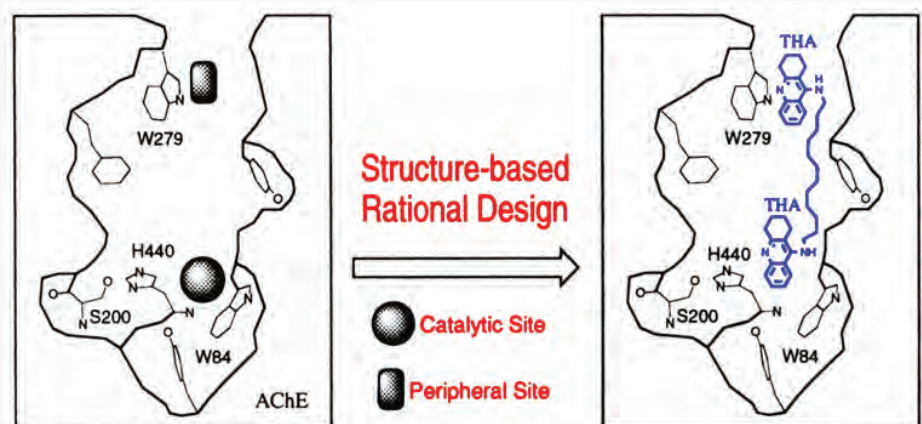
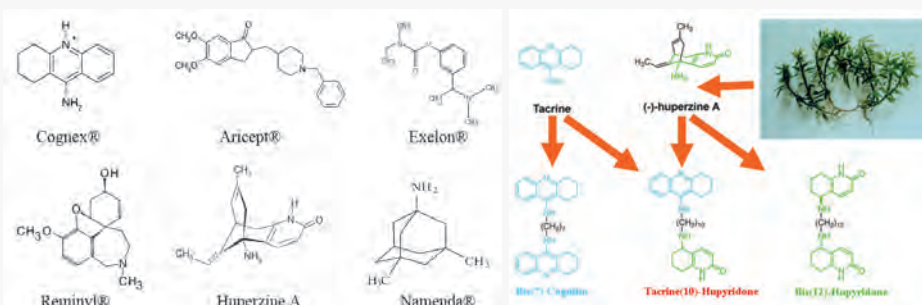
## Special Features

- Novel dimers to deal with Alzheimer's disease
- Lower cost as to isolate HupA from the natural plant

Alzheimer's disease (AD), a progressive brain disorder that severely destroys memory, has emerged as the third leading cause of death among the elderly. Three series of Chinese medicine-derived novel anti-AD homo- and hetero-dimers particularly those derived from huperzine A are developed.

The cost to synthesize these new dimers is much lower than that to isolate HupA from the natural plant. The idea of dimerization is a novel concept to modify the existing drugs. The dimerisation of available drugs is one of most effective and economical strategies for developing multifunctional drugs.

According to the above properties, tacrine and hupyridone are chosen as moieties for synthesizing novel dimers with low side effects. Comprehensive comparisons of these dimers and the existing agents with regard to their AChE inhibitions, neuroprotection and memory-enhancing effects were conducted. The results suggest that these novel multi-functional analogs can be highly promising drug candidates for AD and other neurodegenerative diseases.





## High Frequency Ultrasound for Medical Diagnoses

### Special Features

- Single-crystal based high-frequency phase-array ultrasound transducer for medical imaging and diagnoses
- Provide more solutions for clinical diagnoses of eyes and also in micro-surgery monitoring

## Concentrated Ultrasonic Conducting Resin

An ultrasound gel concentrate were developed to provide doctors who need to travel with their ultrasound machines or patients who keep their ultrasound machine at home a better way of storing the gel and more supply in a smaller container.

The concentrated ultrasonic conducting resin comprises a viscosity conditioning agent, a lubricant, a pH conditioning agent and a bactericide. A coloring agent and a spice can be added into the concentrated ultrasonic conducting resin. The preparation method of the concentrated ultrasonic conducting resin for medical science comprises the following

### Special Features

- Highly concentrated ultrasound gel
- Easy to be stored and delivered

steps of viscosity conditioning agent swelling, raw material mixing and stirring, system pH value adjustment and the like.

The conducting resin can be used after being diluted to reach a requirement. The concentrated ultrasonic conducting resin has high concentration and thus product transport and storage are convenient which reduces the cost. It is a ready-to-use preparation and thus reducing preservative use.

With increased frequency, bandwidth and sensitivity, the resolution of ultrasound imaging can be increased significantly making it possible for eye imaging and small animal imaging.

Our invention developed a fabrication proven technology process involving ultrasound wire bonding, photolithography, laser cutting etc, to fabricate piezoelectric single crystal based 20 MHz phase-array transducer.

The current invention has very large impact to industry and markets, it will provide more solutions for clinical diagnoses of eyes and also in micro-surgery monitoring.

## A Novel Drug helps Suppressing Tumor Growth

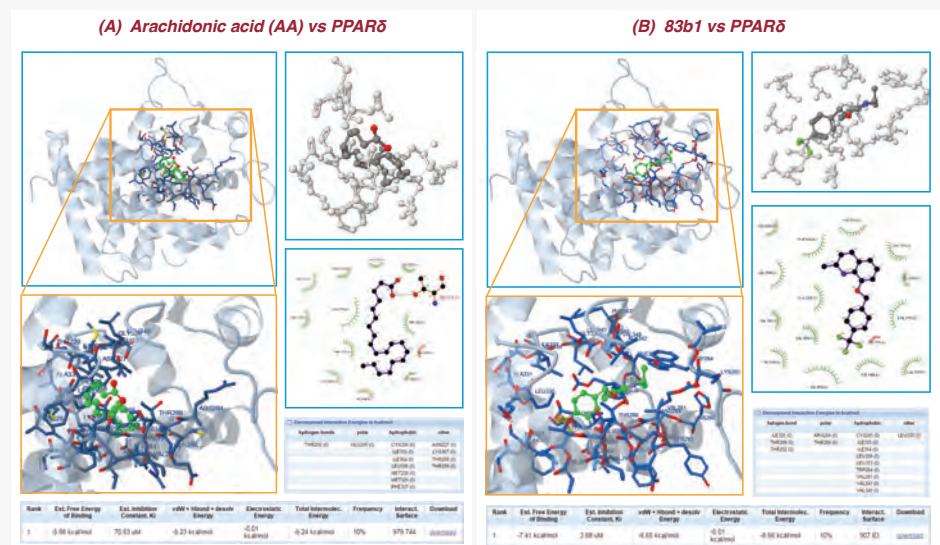
A novel and natural-source based synthetic drug (83b1) was shown to suppress tumor growth via targeting an oncoprotein PPAR $\delta$  which produces the carcinogenic products COX-2 and PGE2.

83b1 with novel composition can target on a known cancer oncoprotein with no exiting drugs which were intended to do the same. Moreover, the existing data showed low toxicity on non-tumor cells and normal mice which offers a very good opportunity with high potential to be developed as a new anti-cancer agent.

The invention has been recently granted with US and China patents which were licensed to a drug company with the continuous search for sub-licensees. Moreover, the potential action of 83b1 to suppress PGE2 production will also offer another opportunity to explore it as a novel anti-inflammatory agent.


### Special Features

- Natural-source based novel drug to suppress tumor growth
- Low toxicity and anti-inflammatory



Molecular Docking Analysis showing the binding of PPAR $\delta$  to (A) the natural ligand (arachidonic acid) and (B) 83b1 using DockingServer (Bikadi Z, et al., J Cheminform 1:15 (2009))

## Contact ITDO today!

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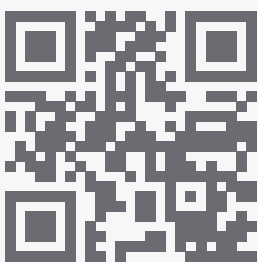
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