

# ITRI TODAY

104

Spring Issue 2021



## World's First Rotating Lab for Subtropics Launched in Tainan

ITRI launched SPINLab, the world's first Subtropical Performance Testbed for Innovative Energy Research in Buildings. Featuring its rotatability, SPINLab can simulate different building orientations to test the effects of different solar azimuth angles on buildings and the performance of assorted building materials and equipment.

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## » Contents



### FEATURE

**G**reen Building Tech Testing Facilities Launched in Southern Taiwan



### TREND FORECAST

**W**hy ASEAN? Opportunities in Thailand and Vietnam

Top 100  
Global  
Innovator  
2021

Clarivate™

### SPOTLIGHT

**I**TRI Named a Top 100 Global Innovator for Fifth Time

### R&D FOCUS

**C**ES 2021 Recap: Trends & Tech Highlights

**H**ow Robots Help Preserve and Improve Heritage Craft in Manufacturing Process



### COLLABORATION

**I**TRI and DuPont Jointly Inaugurate Semiconductor Materials Laboratory

**P**romoting Development of Next-Generation Semiconductors with Tokuyama

## » Feature

### Green Building Tech Testing Facilities Launched in Southern Taiwan



**BOE Director General Cheng-Wei Yu (second right) and ITRI executives pose in front of an Intelligent Green Energy Demonstration House.**

According to the International Energy Agency (IEA), buildings account for 55% of global electricity consumption and generate over a quarter of global greenhouse gases. To accelerate the development of smart energy-efficient solutions, ITRI has launched two facilities to test and validate green energy/building technologies and applications with support from the MOEA Bureau of Energy. Both testbeds are located at the Green Energy Technology Demonstration Site in Shalun Green Energy Science City, including the Intelligent Green Energy Demonstration Houses and the world's first Subtropical Performance Testbed for Innovative Energy Research in Buildings (SPINLab).

Global partners from industrial, academic, and research sectors are welcome to explore innovation and new opportunities from these demo sites and testing platforms. The Intelligent Green Energy Demonstration Houses, for instance, involve the collaboration among ITRI, TEPCO Power Grid and twelve other manufacturers, aiming to uncover business value worth billions of dollars for the smart energy conservation industry. As for SPINLab, ITRI is planning to partner with the Lawrence Berkeley National Laboratory and Singapore Institute of Technology to leverage the capacity of the world's only three rotating testbeds to conduct cross-climate-zone research.

Click below to learn more.

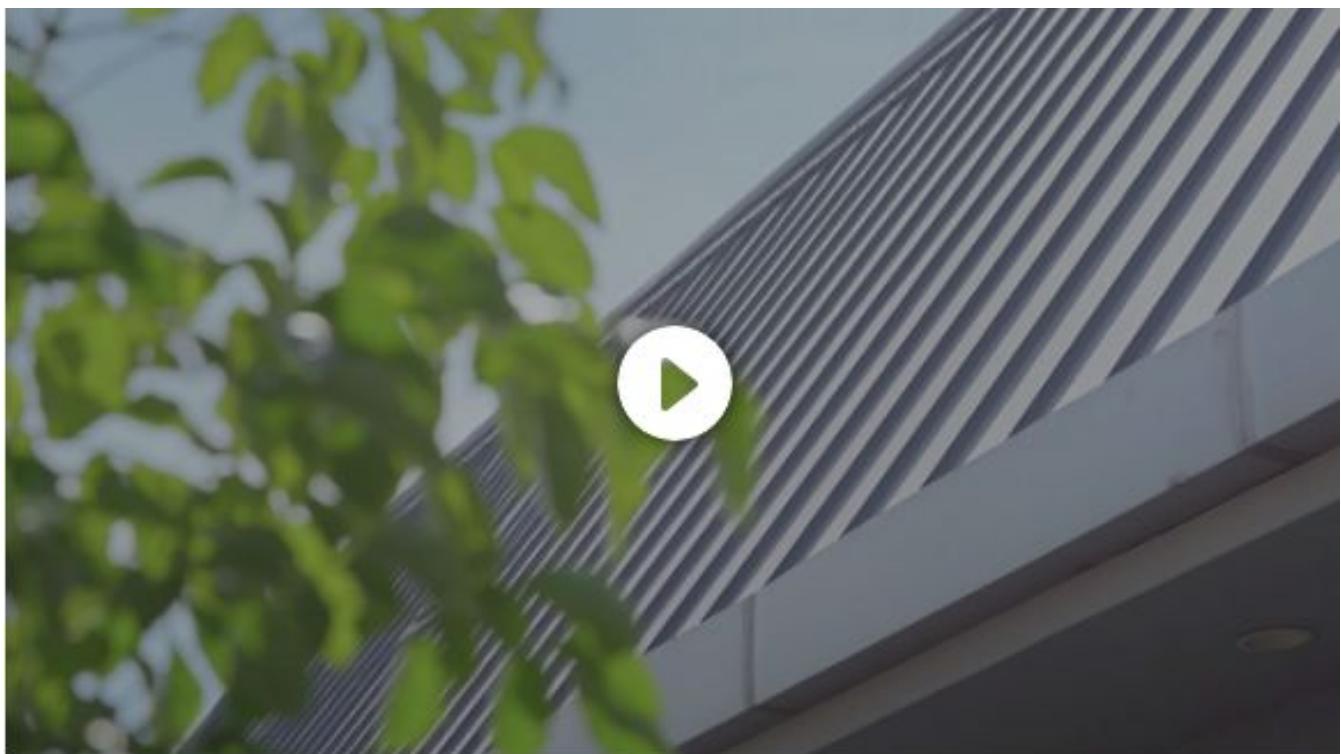
 Intelligent Green Energy Demonstration Houses 

 World's First Rotating Lab for Subtropics Opens 



## » Feature

### Intelligent Green Energy Demonstration Houses



***Video of ITRI's Intelligent Green Energy Demonstration Houses.***

By providing simulations of different house models and scenarios, ITRI's Intelligent Green Energy Demonstration Houses serve to demonstrate and verify a variety of smart energy-saving technologies. Impressively, the houses only consume half the amount of energy used by average households, and their ultimate goal is to maximize green energy efficiency with integrated technologies and streamlined building infrastructure.



***ITRI's Intelligent Green Energy Demonstration Houses simulate typical house models in southern Taiwan to demo and verify smart energy-saving technologies***

The seven demonstration houses built in Tainan's Shalun Green Energy Science City involve joint efforts among ITRI and twelve major industry players, such as TEPCO Power Grid, Delta Electronics, and Formosa Plastics Group. By developing applications for high-efficiency equipment, sensors, lighting, and smart control technologies in the houses, ITRI researchers and industrial partners have been working together to show how energy efficient smart homes can be and how life can be made easier and more enjoyable, especially with incorporation of AI and 5G technologies.

Since 2019, ITRI, TEPCO Power Grid and Tokyo Gas have been committed to the demonstration of the next-generation meter reading system in Taiwan. The efforts include the installation of an innovative metering system that combines power, water and gas meters, the verification of the effectiveness of Wi-SUN for area network and wireless communication among meters, and the adoption of big data analytics to provide insights on residents' utility use.

“It is thanks to the great cooperation and support from Cheng Kung University, Taiwanese companies, and Japanese companies that we have been able to overcome the difficulties of COVID-19 together and start this demonstration,” said Kazuhiko Shiba, Executive Managing Director of TEPCO Power Grid. “We believe that ITRI and other stakeholders will be able to share their knowledge and technologies and further strive to develop smart infrastructure and

create a greener world,” he added.

The Intelligent Green Energy Demonstration Houses work as a hybrid AC/DC residential micro grid, encompassing everything from solar power generation and storage to smart energy management and IoT in home appliances to create an energy self-sufficient, low-carbon life. The houses can also serve as Taiwan’s very first testing site for smart dispatching applications in a community’s distributed energy system. Utilities can run Loading Order tests here, for example, to upgrade energy efficiency and conservation measures and prepare for future power dispatching demands. They can also simulate how an energy management center dispatches power to an entire community and implements demand response and load management programs during peak load periods.



***The demonstration houses include smart green tech applications from solar power generation and storage to energy management and IoT in home appliances.***

The demonstration houses will provide testing and verification services for more intelligent green building technologies and products, domestic or international, spurring innovations that can effectively reduce energy consumption in buildings to enable net-zero emissions and achieve smart living. Meanwhile, this will facilitate the development of related industries such as building and construction as well as energy generation, storage, and conservation.

## » Feature

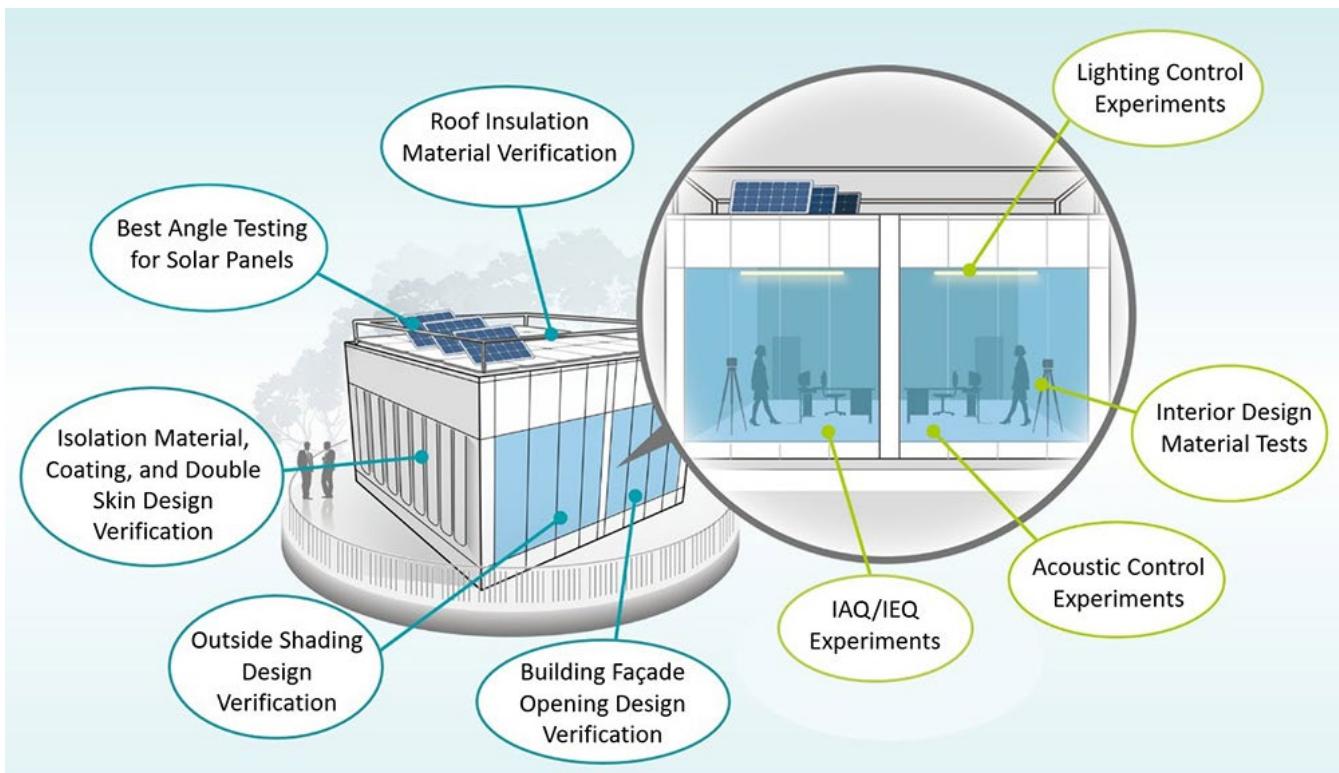
### World's First Rotating Lab for Subtropics Opens



*Video of SPINLab.*

SPINLab, jointly built by ITRI and National Cheng Kung University (NCKU), was launched in Tainan in December 2020. It is the first rotating testing facility for green building technology in the subtropics. Featuring the ability to simulate different building orientations, the Lab allows researchers to observe the effects of different solar azimuth angles on buildings and test the performance of assorted building materials and equipment. A common reference standard can be established for comparing actual experiment results with theoretical calculations.

Dr. Ren-Chien (Joseph) Wang, ITRI's Vice President and General Director of Green Energy and Environment Research Laboratories, highlighted SPINLab's two major functions: First, it can be used to accumulate experimental data and set up a database for architecture design, materials, and equipment, offering practical evidence for green building and energy certification regulation revision. Secondly, the Lab provides one-stop testing services for green building products and can help their marketing to Southeast Asia, which shares the same climate as Taiwan.



### ***Indoor and outdoor verification provided by SPINLab.***

This platform can carry out tests such as construction methods, building materials, air conditioning, artificial and natural lighting, air quality, ventilation, shading, heat isolation, and energy management and control. By simulating different building orientations to create tailor-made testing conditions, SPINLab becomes the only lab among all subtropical areas that provides manufacturers with empirical data on the performance of their energy-efficient technologies and products for buildings.

Dr. Cheng-Wen Wu, Executive Vice President of NCKU, remarked that his university started R&D collaborations with ITRI in 2018 and completed the rotation mechanism and diagnosis equipment for SPINLab in 2019. It was not until 2020, when they completed the integrated testing for the Lab's external and internal measuring components and equipment, that the entire facility was accomplished.

Currently there are only three rotating building technology labs in the world: ITRI's SPINLab, Lawrence Berkeley National Laboratory's FLEXLAB (opened in 2014), and the Singapore Building and Construction Authority's SkyLab (set up in 2016). While the latter two focus on testing green building technologies in temperate and tropical climates respectively, SPINLab presents its features and testing ability specifically for the subtropical climate. ITRI will be thrilled to see SPINLab collaborate with its US and Singapore counterparts to leverage each other's strengths and propel advancements in green building energy-saving technology.

## » Trend Forecast

### Why ASEAN? Opportunities in Thailand and Vietnam

The COVID-19 pandemic and U.S.-China trade war have further restructured the world's economy and the ASEAN market has become a popular destination for investors, including Taiwan. Karen Ma, Division Director of Industry, Science and Technology International Strategy Center, in a recent seminar talked about the industry trends and future prospects in ASEAN, with particular highlights on opportunities in Thailand and Vietnam.

What are some attractive market sectors in ASEAN? And what are foreign industries' choices when they relocate their overseas businesses in the ASEAN area?

Ever since the government's New Southbound Policy launched in 2016, Taiwan has been promoting bilateral partnerships and exchanges of talent and technology with 18 countries in the region, with particular focus on ASEAN. As the pandemic and U.S.-China trade war created more push factors for many enterprises to secure more resilient supply chains, the "China Plus One Strategy" has become a feasible option for Taiwan's electronic firms to look beyond China and diversify product sourcing to nations of ASEAN.

According to Ma, Malaysia and Thailand have been attracting a large number of overseas firms to their electronic clusters, including those from Taiwan. However, northern Vietnam has now emerged as Taiwanese electronics companies' top choice and become the new electronics manufacturing hub.



**Northern Vietnam has become a top choice for Taiwan's electronics companies to expand their overseas production.**

Ma pointed out that Vietnam is regarded as the biggest winner in the ongoing U.S.-China trade conflict. Since the country's growth rate of exports to U.S. has increased more than 35% in 2019, this suggests that many multinational firms have shifted some of their supply chains or investments from China to Vietnam. "Taiwan's contract electronics suppliers, for instance, choose the area due to its close vicinity to China, relatively mature supply chains, low labor costs and sufficient infrastructure," she explained.

In addition, the country has been making aggressive moves to open up its market by establishing free trade agreements (FTA) with more than 50 countries, include member nations of economic unions ASEAN, EU, Eurasian, as well as mega FTAs - CPTPP and RCEP. "These bilateral trades (between Vietnam and FTA nations) account for 67% of Vietnam's exports in 2019," stated Ma.

"The Vietnamese government also announced its latest Law on Investment (LOI 2020) that encourages investment projects like R&D centers, manufacture of products and provision of services which create or participate in the value chain or associated industries," added Ma. This Law is effective in 2021 and aims to enhance Vietnam's technological innovation capabilities.

Vietnam is also pushing for smart city projects. Cities aim to combine ICT technologies and

devices to enhance city management along with socioeconomic development. “This presents an excellent opportunity for Taiwan’s firms to play a critical role in the development of Vietnam’s smart cities via collaborations with companies specializing in system integration,” said Ma.

Besides Vietnam, another ASEAN country that has attracted increased foreign investment is Thailand. Ma illustrated the country’s investment incentives and benefits with its stimulus package Thailand Plus. The package contains measures like tax deduction of up to 200 percent for investments in science, technology, engineering, and mathematics (STEM) development as well as businesses engaged in automation systems and robotics. With this package, companies are eligible for a further five years of 50 percent CIT reductions if they invest at least Thai Bhat 1 billion (US\$32 million), provided the investment is realized by the end of 2021.



***Thailand is the largest producer of vehicles in the ASEAN region and aims to become a regional EV hub in 2025.***

These bonuses also extend to promoting its targeted industries such as electric vehicles (EVs). According to Thailand’s Board of Investment data, the top three foreign investments in 2019 are automobile, electronics, and chemical and petrochemical industries. “Being the largest producer of vehicles in the ASEAN region, the nation aims to become a regional EV hub in 2025,” stated Ma. A leading Japanese motor company, for instance, has invested billions on building automobile plants for electric and hybrid vehicle production. In terms of cumulative foreign investment, Japan continues to be Thailand’s leading investor, while Taiwan has been among the top five since 2018.

To conclude, in the wave of global production relocation, Vietnam and Thailand are becoming promising destinations for investment, especially in sectors like electronics and automotive industries. With reduced trade barriers and improved market access, these emerging markets have competitive edges in attracting foreign investment and will show great potential in expanding their production capacity.



## » Spotlight

### ITRI Named a Top 100 Global Innovator for Fifth Time



**ITRI is named a Top 100 Global Innovator 2021 by Clarivate, making it a five-time winner for this accolade.**

ITRI is glad to be recognized as a Clarivate Top 100 Global Innovator once again in 2021. It is the fourth consecutive year and fifth time that ITRI has won this honor since 2015, making it the most awarded research institution ever in Asia. Other honorees on this year's list include renowned international companies and institutions, such as Apple, Microsoft, Intel, Fraunhofer, and the University of California.

The Top 100 Global Innovators report was released by [Clarivate™](#), a global leader in providing trusted information and insights to accelerate the pace of innovation. The report has long used patent data analysis to evaluate an organization's innovation capacity, market placement strategy, and the influence of R&D technology. This year marks the 10<sup>th</sup> year of the report, which has become a leading indicator in global R&D innovation.

"We are very pleased to see that ITRI has been on our Top 100 Innovators list for five times

and four consecutive years. This has demonstrated ITRI's increasing capabilities in R&D and bigger impact on industrial innovation. This also well reflected ITRI's efforts in globalization. In today's fast-changing world, the world's innovators represent a resource to society and are more critical than ever before," said Nathan Fan, General Manager of Clarivate in Taiwan.

ITRI President Edwin Liu commented that being repeatedly recognized as a Top 100 Global Innovator demonstrates the success of ITRI's forward-looking R&D, efforts in technology commercialization, and deployment of high-value patent portfolios. This honor, he stressed, also showcases ITRI's world-leading capability in intellectual property (IP) management and how the breadth and depth of its multidisciplinary R&D has made a global impact. "ITRI will keep integrating cross-sector resources and focusing on market-oriented R&D to meet the industry's needs while developing internationally impactful IP strategies," added Dr. Liu.

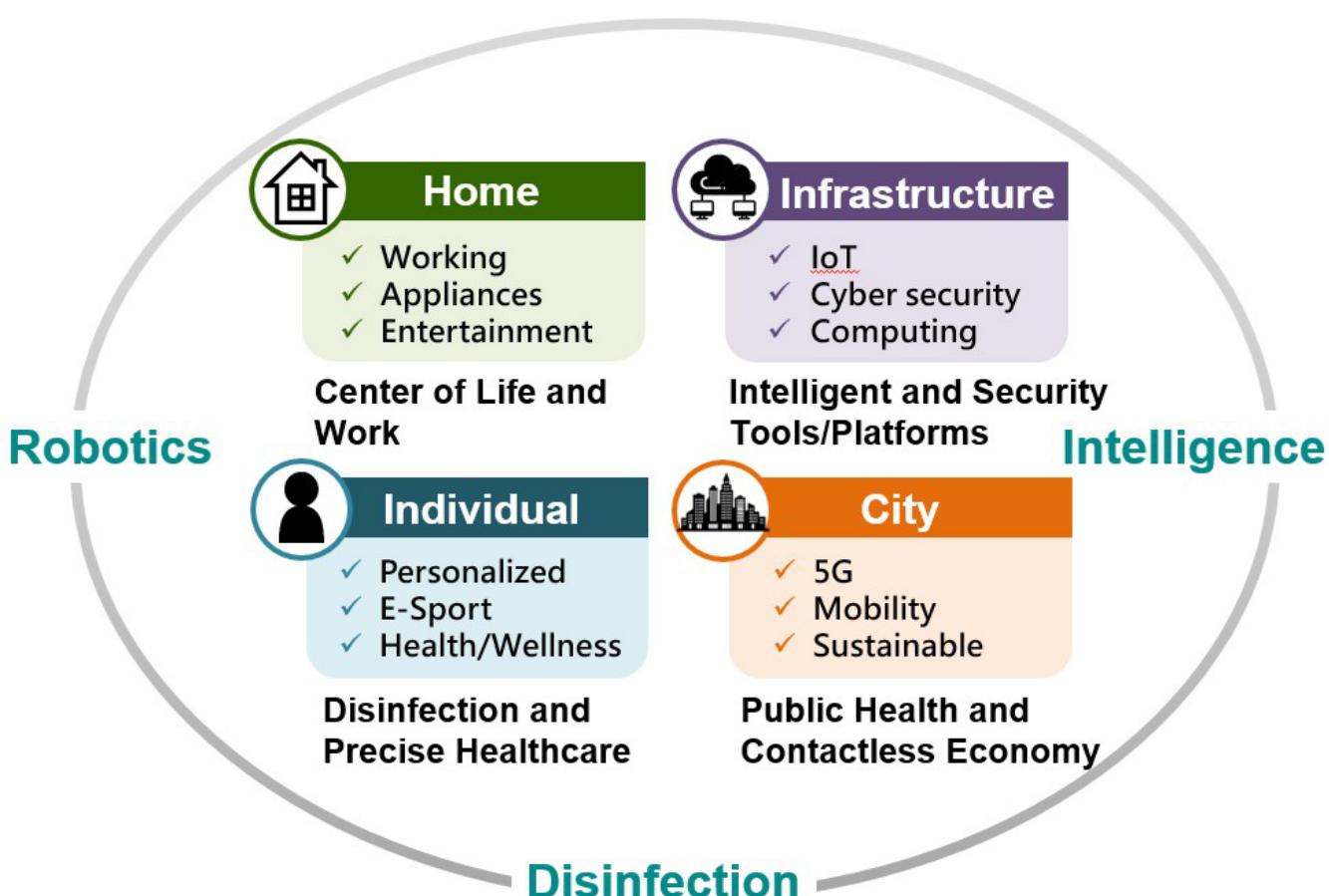
According to Dr. Liu, ITRI continues to promote a comprehensive patent analysis and deployment mechanism to assist in industrial innovation and transformation. With its 2030 Technology Strategy & Roadmap, the Institute will enhance its technology development in the three major application domains, namely Smart Living, Quality Health, and Sustainable Environment, while strengthening Intelligentization Enabling Technologies to support these three domains. The aim is to help industries increase their competitiveness and create new value.

Recently ITRI has also been dedicated to facilitating the link between the capital and technology markets, and has worked with the Small & Medium Enterprise Credit Guarantee Fund of Taiwan and 26 key financial institutions to launch the Technology Value-Added Financing Guarantee Scheme. This will boost IP value and allow Taiwan's technology innovators to connect with the financial system and remain competitive when tapping into global markets.

## » R&D Focus

## CES 2021 Recap: Trends & Tech Highlights

CES 2021 has wrapped up and brought us an all-new digital experience in exhibition visiting. It also revealed the latest technologies that are occupying the consumer electronics landscape and some big tech development trends to watch. According to Jim Chung, Deputy General Director of ITRI's Industry, Science and Technology International Strategy Center, innovations that address the post-pandemic demands for the New Normal hit the mainstream at this year's CES. "We found innovators put strong focus on disinfection, intelligence and robotics, with a variety of solutions developed for individual, home, city and infrastructure applications," he stated (see the figure below).



**CES 2021 highlights tech development for the post-pandemic demands: Disinfection, Intelligence, and Robotics (Source: IEK Consulting).**

ITRI was pleased to join this grand event and showcase twelve of its tech innovations in a

digital format. Its first-ever virtual pavilion, for example, was launched for two months to welcome visitors from all over the world. We were also glad to hold one-on-one meetings with global partners, new and old, to explore new opportunities and possible collaboration.

Haven't had a chance to see our innovations at CES 2021? Then you can't miss the following stories.

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**AI and Robotics Innovations to Make Life Safer and Smarter**



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**ITRI's Latest E-Health Wearable Technologies**



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**ITRI's Innovations in E-Health Monitoring and Inspection**



## » R&D Focus

### AI and Robotics Innovations to Make Life Safer and Smarter

AI and Robotics are always the spotlights of CES. For this year's virtual format, ITRI showcased its **Dual Arm Robot System (DARS)**, **Self-Learning Battery Management System**, and **UVC LED Water Sterilizer System HydroNovation**. These innovations demonstrate how technology helps people in their day-to-day life, creating safer and smarter environments.



Dual Arm Robot System (DARS)



Self-Learning Battery Management System (SL-BMS)



UVC LED Water Sterilizer HydroNovation

#### Dual Arm Robot System (DARS)

ITRI's DARS has two slim robot arms and human-like hands. It mimics human dexterity with high precision to perform diverse tasks, such as playing an electric piano. It features advanced sensor technologies and machine learning algorithms for maximum versatility and completes various tasks for humans without using specifically designed tools. The robot's hands have five fingers and are designed with shape adaptability, enabling them to handle a variety of objects like balls, name cards, mobile phones and plastic bottles. Applications of DARS include

healthcare, professional services, smart manufacturing and hazardous environments.

The unique features of DARS include seven-axis robot arms, which greatly increase freedom of movement over common six-axis robots; three-foot-long arms that reach far and perform versatile tasks; and human-like hands with five fingers that overcome the limitations of traditional robotic grippers with only two to three “fingers,” which can only grasp fixed-shape or hard objects.



*Video of DARS.*

### **Self-Learning Battery Management System (SL-BMS)**

This is the first battery management system to use a self-learning algorithm that provides correct readings of battery aging, remaining and restricted power for electric vehicles (EVs). SL-BMS ensures a margin of error below 5% in calculating energy consumption and range estimation. It also reduces range anxiety by transferring state of charge (SOC) into accurate remaining mileage and mileage with restricted power mode information. This helps reduce range anxiety, the fear of not having enough power to reach the destination.

SL-BMS minimizes maintenance costs, optimizes the use of both in-service and retired batteries, and can be used for large-scale energy storage systems in addition to EVs. With cell balancing, charging, and discharging strategies, SL-BMS extends battery life by over 20% and increases efficiency of utilizing battery capacity by 50%, boosting EV driving range and reducing charging frequency. It also offers real-time battery health check, ensures vehicle safety and saves time and resources for recycling of power batteries. SL-BMS not only helps users avoid situations like battery overheating or power failure caused by long hours of driving at full speed, but also guarantees optimized battery endurance.

SL-BMS maintains a safe state during electric vehicle operation, while allowing the battery's capacity to be fully discharged. The system emits a power cut warning signal before the battery is completely depleted to reduce safety concerns.



*Video of SL-BMS.*

### **UVC LED Water Sterilizer System HydroNovation**

The UVC LED Water Sterilizer System HydroNovation is proven for supplying 99.9 percent pathogen-free water. The system is easy to install and can be used in different applications including humanitarian assistance and disaster rescue. It is also ideal in providing sanitized drinking water for homes, schools and offices.

The sanitizing component used in ITRI's water sterilizer system is UVC LED. Compared to bulky, fragile mercury-vapor ultraviolet lamps that demand high voltage to operate, UVC LED is non-hazardous and can be powered by batteries. The system is energy-efficient, and the on-off switch is controlled by the water flowing through the sterilizer.

ITRI is cooperating with Kemflo Group, a maker of water filters and dispensers, to embed the innovative UVC LED water sterilizer system in its water filtration products under the brand HydroNovation. ITRI has also been working with Tzu Chi Foundation, a not-for-profit organization active in humanitarian rescues, on field trials for simulating emergency situations or challenging hygienic conditions.



# UVC LED Water Sterilizer

## HydroNovation



***Video of UVC LED Water Sterilizer HydroNovation.***

## » R&D Focus

### ITRI's Latest E-Health Wearable Technologies

Due to the fight against the ongoing global pandemic, digital health is high on this year's CES agenda. ITRI has also delivered compelling technologies related to e-health wearables that provide smart monitoring and health management. Innovations include **iCardioGuard** for physiological and psychological status monitoring, **Heart Guardian** for health monitoring of patients with heart disease, **iSmartweaR** for measuring heart rate and respiratory rate using smart textiles, and **iDarlingWear** for infant healthcare.



iDarlingWearR



iSmartweaR



iCardioGuard



Heart Guardian

**ITRI showcases E-Health wearable technologies at CES 2021.**

#### iCardioGuard

iCardioGuard combines multi-sensing microwave and electrocardiogram physiological sensors with psycho-cardiac status analysis software to enable continuous health monitoring for home care, eldercare, exercise and fitness purposes. This technology can measure heart rate and blood pressure and evaluate mood, stress, fatigue levels, and vascular parameters. The device

can be placed on the chest or integrated with a heartbeat belt, electrode patches or smart clothing, allowing users to collect vital readings over long periods. Measurements will be recorded and transmitted to a mobile device by Bluetooth. An app then instantly displays the results and will send a warning notification of irregularity.

iCardioGuard also features ITRI's Low Power Microwave Sensor technology, which passed the FDA-level electromagnetic wave radiation EMC/EMI test by the IEC60601-1/IEC60606-2 regulation. The radiation level is approximately 1,000 times lower than that of mobile phones and has no safety concern.



*Video of iCardioGuard.*

## **Heart Guardian**

Another monitoring innovation called Heart Guardian is a non-invasive wearable that monitors cardiac output per minute, heart rate, pulmonary artery blood flow velocity, and blood output volume. With a miniature, high-sensitivity patch-type transducer, the first low-power Doppler ultrasound signal processing chipset, and a mobile computing device, the Heart Guardian offers continuous real-time monitoring of patients with heart disease. The device can be worn throughout the day including during exercise to assess blood circulation and cardiovascular conditions. It is safe, rapid, accurate, and can detect atrial tremors. It is also a low-cost solution that does not require the assistance of medical staff to use. This extends cardiovascular disease prevention and care from hospitals to homes.

# HEART GUARDIAN

## WEARABLE CARDIAC OUTPUT MONITORING TECHNOLOGY



***Video of Heart Guardian.***

### iSmartweaR

ITRI also developed iSmartweaR, which integrates non-contact nanosecond pulse near-field sensing (NPNS) technology into fabrics to measure physiological conditions including heart rate and respiratory rate. The system detects signals from up to 20 cm, unlike existing smart textile technologies which require contact with the wearer's skin. It has been verified for hospital night care with high accuracy. Medical workers can access the real-time information delivered by Bluetooth to a mobile app. iSmartweaR's applications include healthcare or medical management for the elderly and it offers new business opportunities in the smart healthcare market.



***Video of iSmartweaR.***

### **iDarlingWeaR**

Finally it's iDarlingWear, a CES 2021 Innovation Awards Honoree. This baby care wearable features harmless low-power radar sensing technology and helps protect infants from dangers such as sudden death syndrome and accidental suffocation. Caregivers and parents need only attach the device to the baby's blanket for continuous heartbeat, activity and respiratory monitoring. iDarlingWear also detects whether the baby is asleep or awake and sends alerts if it detects abnormality. Unlike other infant monitoring technologies, iDarlingWear does not require contact with the infant's skin. It is easy to operate and carry, and deviation in average heart rate per minute is less than 5%. In addition to home care for infants, it can be used in postnatal and childcare centers.



# iDarlingWear



*Video of iDarlingweaR.*

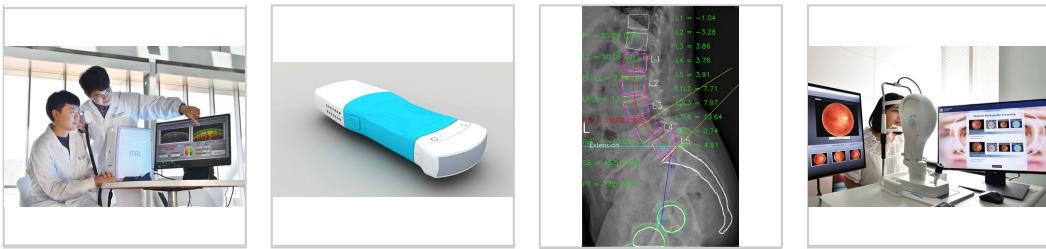


## » R&D Focus

### ITRI's Innovations in E-Health Monitoring and Inspection

ITRI presented five e-health monitoring and inspection technologies including **In-Sleep Target Memory Consolidation Technology**, the **Handheld Skin Quality Optical Coherence Tomography** system, the **Handheld Ultrasound System**, the **Measurement Technique for Lumbar Spine X-Ray Images** and the **AI Decision Support Technology of Fundus Image in Diabetes Mellitus** at this year's CES digital show. These innovations highlight the importance of e-health technology that can provide efficient and accurate detection and examination, helping individuals maintain wellness and achieve better quality of life.





## In-Sleep Target Memory Consolidation (ISTMC) Technology

ITRI's In-Sleep Target Memory Consolidation (ISTMC) Technology offers users a breakthrough capability of seamlessly strengthening the memorization of selective subjects without wearing any sensors such as electroencephalography (EEG) sensors. During the day, a user reads out loud the subjects to be memorized, such as new words and phrases of a foreign language, anatomical details of the human body, provisions of an election law, etc., and ITRI's ISTMC device records them. During the night, ITRI's ISTMC device detects when the user is in the deep sleep stage and replays the recorded sounds to reinforce the brain's process of transferring the sounds' corresponding memorized subjects from short-term memory to long-term memory. The key enabling technology of this innovative device is the ability to detect, reliably and accurately, when a user enters the deep sleep stage based solely on the user's breathing rate, heart rate and body movement, which in turn are measured by the application of recurrent neural network technology to the channel state information (CSI) in the Wi-Fi signals emitted by the user's smartphone.

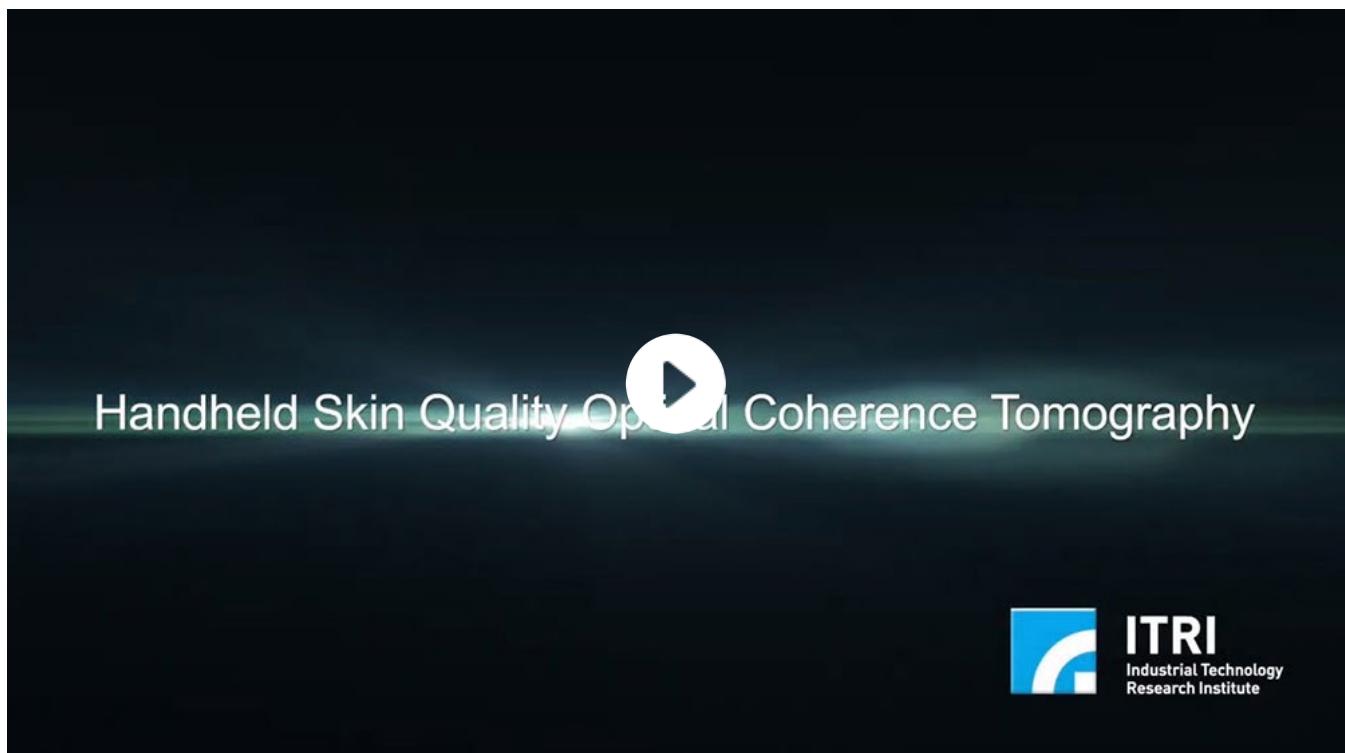


*Video of ISTMC.*

## Handheld Skin Quality Optical Coherence Tomography

ITRI developed Handheld Skin Quality Optical Coherence Tomography (OCT), the first

handheld OCT system that analyzes subsurface skin structures and detects collagen distribution in the dermis layer. The system replaces the conventional approach of an invasive biopsy for examining tissue underneath the skin. It incorporates a built-in skin quality analysis model, AI, and anti-shake image capturing technology to evaluate skin quality within 10 seconds. It weighs less than 400 grams (14 ounces), allowing users to operate the device with one hand. This innovation is used for medical purposes and provides valid scientific proof for product development in the cosmetic industry, shortening time-to-market while reducing the number of animals used in experiments. The device combines an optomechanical-electronics controller and an image processor to provide 3D optical biopsy using a broadband near-infrared light source. This user-friendly system features high resolution (of few microns) and a fast scan rate. It determines skin quality by analyzing key parameters including dermis and epidermis thickness, collagen density, and pore size as well as the number of blood vessels.



***Video of Handheld Skin Quality Optical Coherence Tomography.***

## **Handheld Ultrasound System**

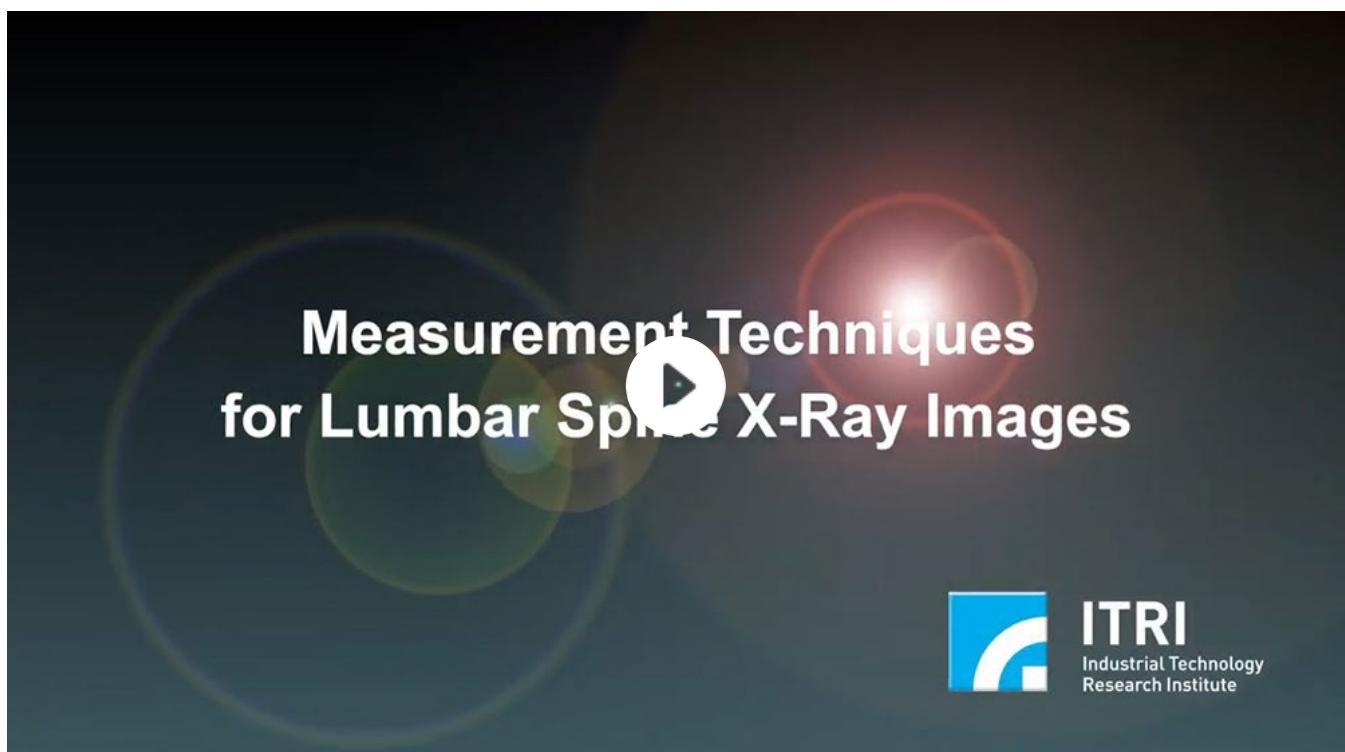
The Handheld Ultrasound System enables healthcare professionals to perform ultrasound exams anywhere, anytime. It saves critical time in emergency and intensive care. The system includes a lightweight, portable scanner and a mobile application. The 64-channel system supports changeable transducers (linear 7.5MHz/convex 3.5MHz) and can process B-mode and color Doppler mode images. In the future, deep learning technology can be integrated to perform quantitative analysis for diagnosis of liver diseases.



***Video of Handheld Ultrasound System.***

### **Measurement Technique for Lumbar Spine X-Ray Images**

The Measurement Technique for Lumbar Spine X-Ray Images combines deep learning and image processing algorithms to reduce time and labor for lumbar spine X-ray interpretation. The system provides real-time measurements of pelvic incidence (PI) and lumbar lordosis (LL), and abnormal findings such as spondylolisthesis. It also can assist in surgical planning and offers precise calculation of surgical implants for clinical diagnosis. The system uses AI to conduct X-ray imaging simulation and enable prediction of postoperative PI and LL values for clinical and auxiliary analysis.



***Video of Measurement Technique for Lumbar Spine X-Ray Images.***

## **AI Decision Support Technology of Fundus Image in Diabetes Mellitus**

The AI Decision Support Technology of Fundus Image in Diabetes Mellitus is the first AI technology to enable early detection and timely treatment of diabetic retinopathy (DR) by classifying and locating lesions and determining DR severity. It locates the four main DR lesions including microaneurysms, hemorrhages, soft exudates, and hard exudates, and classifies examination results into one of the five stages of DR (no DR; mild, moderate, or severe non-proliferative DR; or proliferative DR). The technology uses AI to provide binary decision support for ophthalmologist referrals, and optimal treatment timing for Clinical Significant Macular Edema (CSME).



*Video of AI Decision Support Technology of Fundus Image in Diabetes Mellitus.*

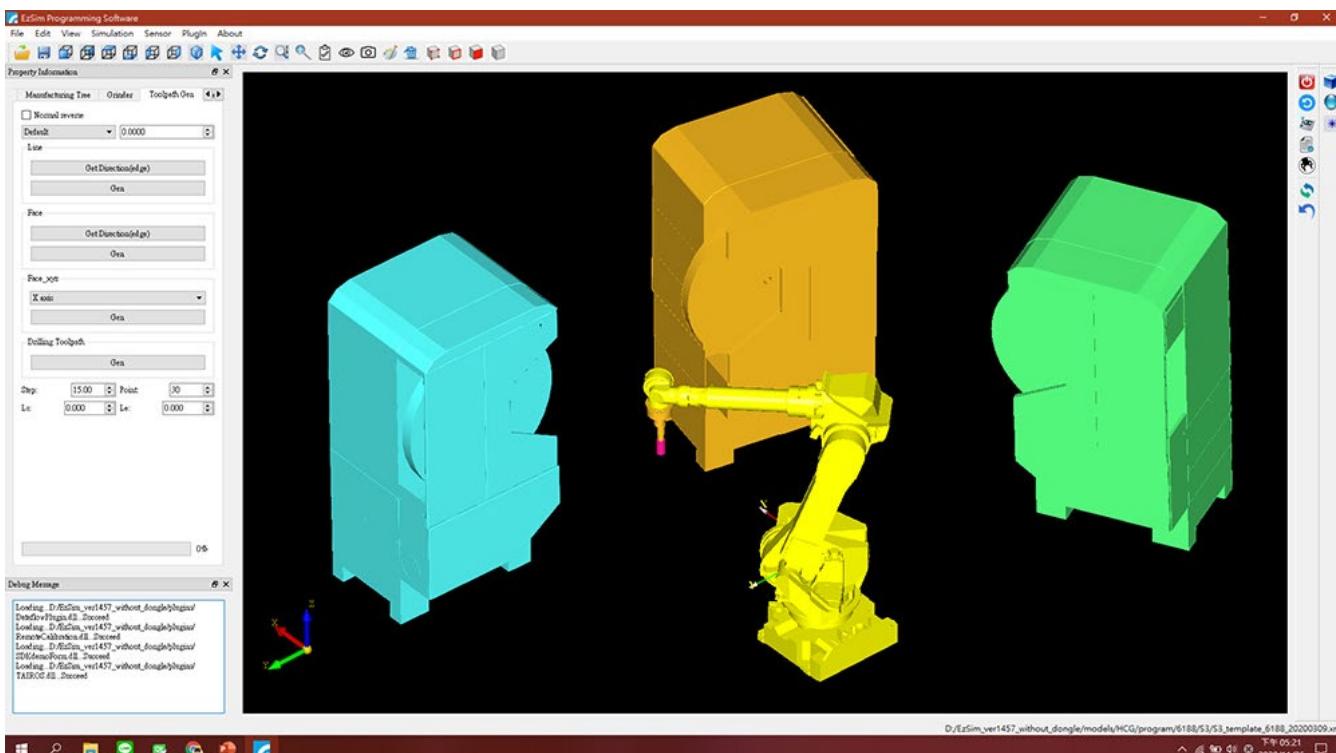
## » R&D Focus

# How Robots Help Preserve and Improve Heritage Craft in Manufacturing Process

By Darryl Tsai

Metal grinding and polishing factories such as plumbing fixture manufacturers require sophisticated craftsmanship to produce high-quality output. However, many manufacturers have long suffered from a shortage of experienced professionals, and require robotic assistance to help increase productivity.

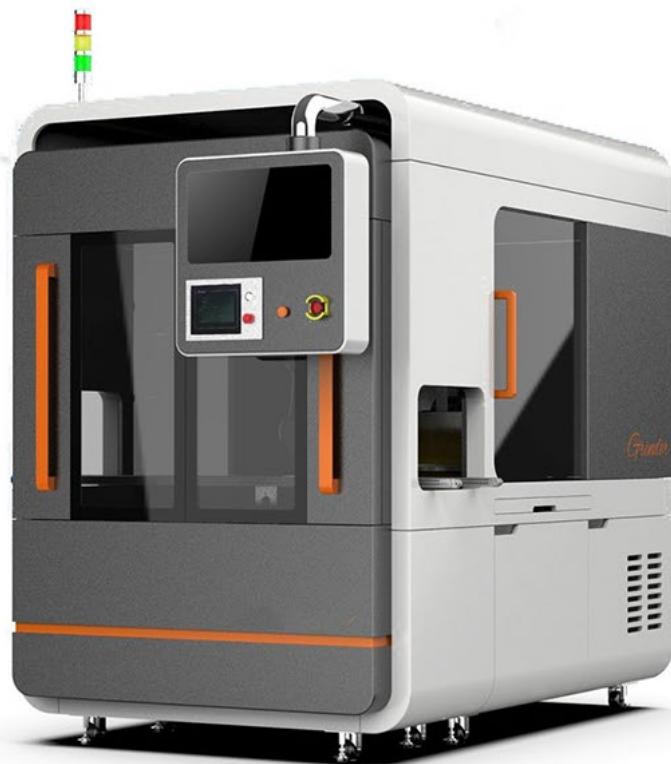
To address this issue, ITRI has developed RobotSmith-EzSim, a software that incorporates Cyber-Physical System (CPS) for robotic applications to automate the output and hasten the process of human craftsmanship for metal parts manufacturing. CPS is based on 3D models of robots, peripheral equipment and workpieces to perform functions such as trajectory planning. The CPS system can enhance programming efficiency and flexibility to shorten the time for robot teaching and initial setups. This allows RobotSmith-EzSim to easily perform grinding and polishing for customized products.



**A simulation software called RobotSmith-EzSim incorporates CPS to enhance robotic applications.**

Our team has collaborated with HCG, a major Taiwanese manufacturer of bathroom fixtures to deploy this technology in their factory. During the cooperation, we applied RobotSmith-EzSim to mimic and perform skills of craftsmen to produce faucets with complex appearances. RobotSmith-EzSim successfully demonstrated its capability to achieve various production targets and satisfy the needs of the industry. This software can be applied in other sectors as well, for instance, aerospace manufacturing and semiconductor equipment manufacturing. It is suitable for use in fabricating aircraft components such as engine blades and those with irregular shape and curved surface.

In addition, we adopted vision-based workpiece recognition containing 3D visual orientation and trajectory compensation with laser scanning for workpiece measurement and precise positioning in RobotSmith-EzSim. This resolves the known issue that the use of virtual models in CPS may not always accurately reflect the real environment and minimizes the simulation-to-reality gap. During the grinding or polishing process, acoustic emission (AE) sensors are used with deep learning mechanisms to analyze frequencies and vibration for product quality monitoring. Hence, virtual grinding is added to assess and monitor outcomes of different grinding parameters like the angle or the contact force between the belt and workpieces to improve quality control.



***An image of RobotSmith-minicube.***

A new robotic system RobotSmith-minicube was first introduced at the TAIROS 2020 in Taipei with these developed functionalities. Driven by RobotSmith-EzSim, it demonstrated

attractive refined grinding and polishing capabilities including contour measurement and vision recognition. Furthermore, RobotSmith participated in ITRI Startup Day and was awarded as a finalist.



***The RobotSmith Team was recognized as a finalist on ITRI Startup Day.***

As a digital master, RobotSmith presents a cutting-edge solution to deliver advanced automated applications in grinding and polishing processes, while functioning to preserve heritage craft in the manufacturing sector.



### About the Author



Darryl Tsai is an associate researcher at ITRI. He received both his master's degree and bachelor's degree in Mechanical Engineering at National Chiao Tung University (NCTU). His research interest centers on the development of Cyber-Physical Systems for industrial robot applications.

## » Collaboration

### ITRI and DuPont Jointly Inaugurate Semiconductor Materials Laboratory



**VP and General Director of ITRI's Electronic and Optoelectronic System Research Laboratories Chih-I Wu (third left), DuPont Taiwan President Dennis Chen (third right) and their colleagues inaugurated a new semiconductor materials laboratory at ITRI's headquarters.**

ITRI and [DuPont Electronics & Imaging](#) (DuPont) celebrated the opening of a new semiconductor materials laboratory in Hsinchu, Taiwan on January 25, 2021. The DuPont Semiconductor Lab was established to stay close to the semiconductor industry in Taiwan.

“Bringing together ITRI’s semiconductor-related technical strength and DuPont’s expertise in materials, this laboratory in ITRI’s vicinity will enable closer exchanges between the two organizations to meet the immediate needs of Taiwan’s semiconductor and IC substrate industries,” said Dr. Chih-I Wu, VP and General Director of ITRI’s Electronic and Optoelectronic System Research Laboratories.

Dr. Wu stressed that ITRI has long invested in semiconductor research and development and has a solid foundation in the fields of electronics and optoelectronics, advanced packaging processes, chemistry and materials. With the support from the AI on Chip Program of Department of Industrial Technology (DoIT), Ministry of Economic Affairs (MOEA), ITRI will expand investment in advanced equipment and technology, heterogeneous integrated packaging experiment platforms and diversified design, manufacturing processes and prototype production services.



***The new DuPont Semiconductor Lab was set up in ITRI to stay close to the semiconductor industry in Taiwan.***

supporting the strategic technology roadmap in Taiwan. The inauguration of this laboratory marks another important milestone as we continue to enhance innovation and R&D capabilities in Taiwan.”

DuPont, on its part, has been conducting business in Taiwan for more than 50 years and has grown alongside Taiwan’s industrial development, especially in the electronics industry.

“DuPont’s investment in semiconductor technology and manufacturing centers in Taiwan serves as our hub in Asia Pacific to promote advanced semiconductor technologies globally,” said Dennis Chen, DuPont Taiwan President. “Over the years, we have made efforts in strengthening technological breakthroughs, terminal applications and

Added Rob Kavanagh, global business director, DuPont Advanced Packaging Technologies, “DuPont is committed to the development of advanced materials in support of the increasingly complex packaging technologies. We have seen positive outcomes from our past collaboration with ITRI and look forward to further leveraging each other’s competencies and experience for our customers and Taiwan’s semiconductor industry.”

The launch of the DuPont Semiconductor Lab is creating a win-win situation as it will further enhance the two parties’ collaboration on semiconductor material R&D and accelerate pilot testing and commercial viability to support industries in pursuit of the next generation of semiconductors.

## » Collaboration

### Promoting Development of Next-Generation Semiconductors with Tokuyama

Strong demand in the 5G, IoT, and automotive electronics markets, along with the thriving development of AI, is driving the trend of miniaturization in the semiconductor industry. ITRI and Tokuyama, Japan's renowned semiconductor chemical materials manufacturer, are to jointly develop quality detection technology for semiconductor materials, thereby rapidly screening out impurities and enhancing production quality. It is hoped that the cooperation will create the foundation for the semiconductor industry to produce products with even higher quality and specifications, thus enabling new-generation smart applications.



***ITRI and Tokuyama held a collaboration agreement signing ceremony to announce their joint development of quality detection technology for semiconductor materials.***

Dr. Tzeng-Yow Lin, General Director of ITRI's Center for Measurement Standards, commented that ITRI and Tokuyama started collaboration in 2018. "It is Taiwan's advantages in semiconductor manufacturing and ITRI's excellence in semiconductor nano-related detection technology that attracts Tokuyama to work with ITRI on optimizing material

detection in the wafer manufacturing process,” stated Dr. Lin. “The two parties hope to provide Taiwan’s semiconductor makers with advanced quality control technology to lower the product defect rate in the process of miniaturizing semiconductor components. Meanwhile, this cooperation will expand the use of ITRI’s measurement technology in the international semiconductor market,” he added.

Tokuyama Managing Executive Officer Director Fumiaki Iwasaki mentioned that over a century since its establishment, Tokuyama has branched out into a wide range of businesses, including chemical, specialty, cement, and medical products. Presently, in response to the needs of the semiconductor industry, Tokuyama and ITRI are embarking on long-term cooperation to launch joint R&D of quality inspection technology for semiconductor materials. ITRI’s advanced semiconductor nano-related detection technology in conjunction with Tokuyama’s semiconductor chemical materials technology will pave the way for the development of state-of-the-art measurement technology for the semiconductor industry. He further expressed his hopes for the joint creation of a technology blueprint for even more advanced production process miniaturization to satisfy actual customer needs and raise the international competitiveness of Taiwan’s semiconductor industry.

ITRI has been involved in the development of a wide range of measurement technologies for over 30 years, and it has been commissioned by the Bureau of Standards, Metrology and Inspection under the Ministry of Economic Affairs to operate the National Measurement Laboratory. Besides focusing on the traceability of measurements and standards, it is also dedicated to R&D in semiconductors, including the development of thin films, surface analysis, and particle measurement technology. ITRI has a wealth of experience in cooperation with industry, and its considerable R&D successes are satisfying the needs of the semiconductor industry in precision testing.

In addition to utilizing the expertise of Tokuyama in semiconductor materials, this cooperation will spur the development of even more advanced and sensitive measurement equipment, helping to bolster inspection services and reduce the risk of wafer contamination. These efforts, in turn, will assist manufacturers in launching next-generation miniaturized semiconductor production processes.

# ITRI TODAY

104

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## » About Us



Industrial Technology Research Institute (ITRI) is one of the world's leading technology R&D institutions aiming to innovate a better future for society. Founded in 1973, ITRI has played a vital role in transforming Taiwan's industries from labor-intensive into innovation-driven. To address market needs and global trends, it has launched its 2030 Technology Strategy & Roadmap and focuses on innovation development in Smart Living, Quality Health, and Sustainable Environment. It also strives to strengthen Intelligentization Enabling Technology to support diversified applications.

Over the years, ITRI has been dedicated to incubating startups and spinoffs, including well-known names such as UMC and TSMC. In addition to its headquarters in Taiwan, ITRI has branch offices in the U.S., Europe, and Japan in an effort to extend its R&D scope and promote international cooperation across the globe. For more information, please visit <https://www.itri.org/eng>.

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**Subscription:**

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**Inquiries:**

E-mail: [itritoday@itri.org.tw](mailto:itritoday@itri.org.tw)

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**Tel:** +886-3-582-0100

**ITRI Website:**

<https://www.itri.org/eng>

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## **ITRI's Overseas Offices**

### **ITRI International Inc.**

2880 Zanker Road, Suite 103, San Jose, CA 95134, U.S.A.

Tel: +1-408-428-9988

Fax: +1-408-428-9388

E-mail: [seanwang@itri.com](mailto:seanwang@itri.com)

### **ITRI Japan Office**

TTD Bldg., 3F, 1-2-18 Mita, Minato-ku, Tokyo, 108-0073, Japan

Tel: +81-3-54193836

Fax: +81-3-34555079

E-mail: [itritokyo@itri.org.tw](mailto:itritokyo@itri.org.tw)

### **ITRI Berlin Office**

7 OG., Hohenzollerndamm 187, 10713 Berlin, Germany

Tel: +49-30-8609-3610

E-mail: [contact\\_germany@itri.org.tw](mailto:contact_germany@itri.org.tw)

### **ITRI Moscow Office**

125009, Tverskaya Str., Building 9, Block 7, Office 205, Moscow, Russia

Tel: +7-499-9511952

E-mail: [contact\\_Russia@itri.org.tw](mailto:contact_Russia@itri.org.tw)

### **ITRI Eindhoven Office**

High Tech Campus 9, 5656 AE Eindhoven, the Netherlands

Tel: +31-408512242

E-mail: [contact\\_nl@itri.org.tw](mailto:contact_nl@itri.org.tw)



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