ITRI TODAY

Top 100
Global
Innovator
2023

💠 Clarivate™

Top 100 Global Innovator for Seventh Time

It is the seventh time and sixth consecutive year that ITRI has made it on Clarivate's list. "This wouldn't be possible without collective, steady improvement of our research capacity," said ITRI President Edwin Liu.

ITRI
Industrial Technology
Research Institute

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》 Feature

What You Need to Know About ITRI @ CES 2023


ITRI @ CES 2023 Recap.

CES 2023, the largest audited global post-pandemic tech show, concluded this January. With ITRI's strong presence this year, this story recaps what you need to know about the latest innovations that are shaping a better future.

According to IEK Consulting, health and wellness technology stood out as one of the hottest trends at CES 2023, alongside autonomous mobility and sustainability. ITRI caught this wave and showcased several technologies with hygiene sensitivity to promote smarter and healthier lifestyles in the new normal. Its innovations spanning Sports & Fitness, AI, Robotics, and ICT garnered much interest from the attendees worldwide.

Brian Comiskey, Director of Thematic Programs at Consumer Technology Association (CTA), commented on ITRI's showcase. "This exhibit is quite exciting. I am looking at innovation that fits the overall theme of the show, which is how technology is solving challenges," he said. Among ITRI's exhibits, he was especially fascinated by the autonomous mobile robot (AMR)'s getting access to food delivery, the connected fitness technology for better health empowerment, and the AI Aquarium due to its fun, educational purpose, and interactivity.

The ITRI team posed in front of the booth on the opening day of CES 2023.
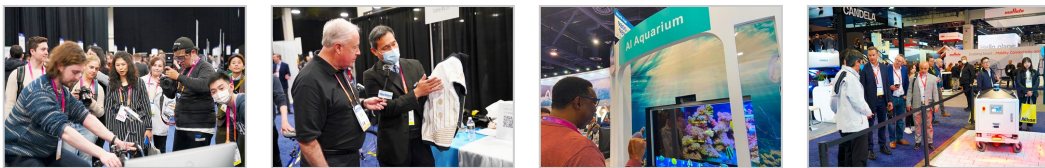
Visitors were also impressed by the interactive experiences and eye-catching demos at ITRI's booth. An industry attendee tested out the [Digital Twin for Sport Guidance with Vital Sign Sensing](#), noting that he would like to have one on his Peloton machine because the system can show him more about his body and exercise status.

Other ITRI innovations also received quite the attention—a smart clothing technology with haptic feedback [iMetaWeaR](#) for sports experiences in the metaverse, the [Athletic Armband for Contactless EMG Detection](#), [Athena Orchestrator—O-RAN SMO & RIC](#), and the energy-efficient [SiC Electric Powertrain Controller](#) for electric vehicles.

Learn more about ITRI's CES 2023 innovations:

Smart Solutions for Sports and Fitness	❯
Innovations in AI, Robotics, and ICT	❯

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》 Feature

Smart Solutions for Sports and Fitness
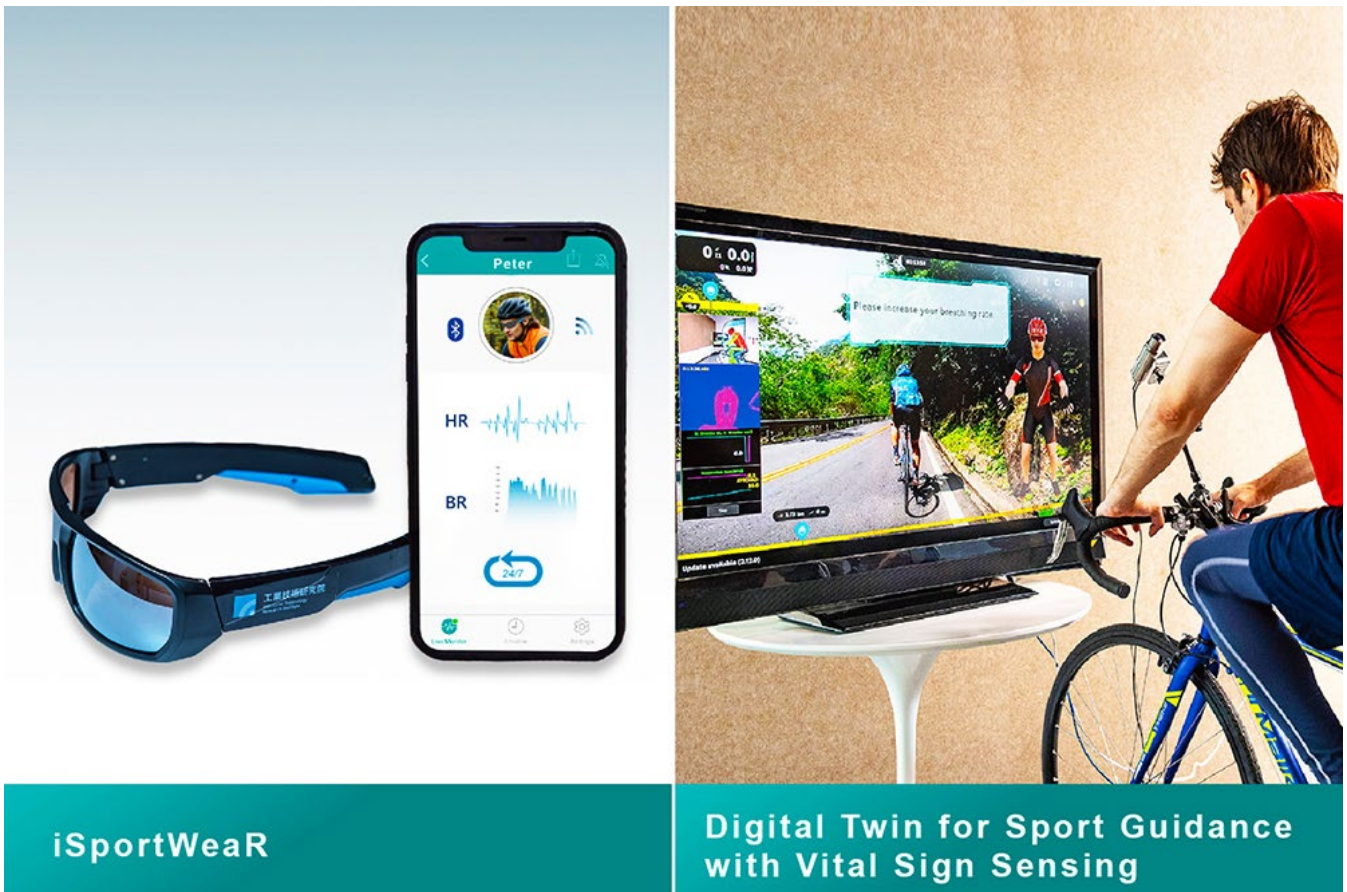
ITRI's two highlight sports and fitness technologies showcased at CES 2023.

At CES 2023, ITRI's highlight technologies in sports and fitness include iSportWeaR, a wearable device that monitors physiological data and provides health analysis and management during exercise; and the Digital Twin for Sport Guidance with Vital Sign Sensing, the world's first virtual coach for indoor bike and flywheel training using contactless detection technology to provide advice on breathing, biomechanics and coordination.

iSportWeaR is a smart personal health management solution for fitness and sporting enthusiasts. Featuring non-contact low-power radar technology, it can be integrated into accessories such as sunglasses and bike handle grips to provide real-time detection and continuous monitoring of physiological parameters. It accurately measures heart rate, breathing rate, and activity behavior such as cycling posture and resting status. This helps athletes better understand their health status and optimize training across various exercises

such as running and cycling. Long-term usage history is logged in a personal database, which users can check anytime.

iSportWeaR also provides data for sports injury prevention. When detecting abnormal physiological conditions, it sends out alerts via the smartphone to users, helping to prevent injuries such as heat exhaustion.

The application in bike handle grips is the first of its kind in the current bike accessory market, marking a breakthrough in health-monitoring cycling solutions. ITRI worked with a leading bicycle brand to develop iSportWeaR and is introducing this technology to various pioneering product designs for additional cycling applications.

The iSportWeaR miniature module enables seamless integration into different sporting accessories, and it eliminates the need for sensors that have direct contact with the user's skin. The sensing device even works with sweat interference and through gloves, and it works indoors or outdoors, rain or shine, in temperatures ranging from 41 to 122 degrees Fahrenheit (5 to 50 degrees Celsius) and relative humidity of 10 to 90%. iSportWeaR uses Bluetooth Low Energy communication to receive and transmit signals, with measurement range for heartbeat rates of 48 to 240 beats per minute (bpm) and respiration rates of 6 to 60 bpm.

The [Digital Twin for Sport Guidance with Vital Sign Sensing](#) is the world's first virtual coach for indoor bike and flywheel training using contactless detection technology and big data analytics to provide advice on breathing, biomechanics and coordination. The system measures respiratory rate via thermal sensing and includes a depth camera for skeletal imaging and motion tracking. It analyzes the user's back, shoulders, elbows, arms, hips, and knees through image-based skeletal movements. It compares collected data with the statistics of world-class cyclists and offers real-time professional-level suggestions on breathing adjustment, motion strength, and body coordination, improving users' training experience and progress. With no monitoring wearables, users can focus more on realistic road condition simulations and enhance training effectiveness. ITRI has cooperated with world-renowned bicycle manufacturers to create powerful solutions for training athletes with the Digital Twin for Sport Guidance with Vital Sign Sensing.

Additional sports and fitness technologies that ITRI showcased:

- [iMetaWeaR](#) is a smart clothing technology enabling haptic feedback via multi-position electrical stimulation to create an enhanced metaverse experience for users playing virtual sports such as boxing and fencing. Dry, washable fabric-based electrodes are screen printed into somatosensory garments, eliminating the need for adhesive electrodes. The elastic feature and customized design offer high comfort, and the robust control mode allows for stimulation variations in an immersive environment.

- The [Athletic Armband for Contactless EMG Detection](#) is a capacitive electromyography (EMG) athletic armband for continuous real-time measurement of electric signals from muscles without direct skin contact. This sports armband can measure muscle strength in professional training, providing information including the order of muscle activation, the level of fatigue and injury alerts through an app. The wearable design includes flexible hybrid electronics (FHE) and redistribution layer (RDL) technologies, and the sensing distance is up to 0.3 mm.
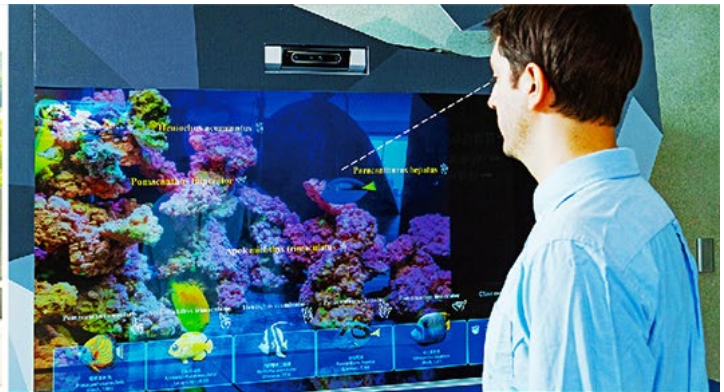
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» Feature

Innovations in AI, Robotics, and ICT

AI Aquarium

RobotSmith

Cubot ONE:
Indoor/Outdoor AMR

The latest technologies in AI, robotics, and ICT that ITRI unveiled at CES 2023.

ITRI's CES 2023 technologies in AI, robotics, and ICT include AI Aquarium, a CES 2023 Innovation Awards honoree, the world's first smart aquarium that helps identify marine life in real time; Cubot ONE: Indoor/Outdoor AMR, an autonomous mobile robot (AMR) integrating AI, IoT and 5G technologies, that can operate indoors and outdoors, take elevators and travel on rugged ground; and RobotSmith, an AI and robotic system for metal workpiece grinding and polishing.

▎ AI Aquarium Offers an Interactive Aquarium Experience

AI Aquarium, a CES 2023 Innovation Awards honoree, is the world's first interactive smart aquarium that helps observers identify marine life in real time. With intuitive virtual-real fusion, the system can recognize aquatic species with up to 98% accuracy and show corresponding information on a transparent display according to an observer's line of sight. AI

Aquarium also performs gesture recognition with up to 98% accuracy. The interactive augmented-reality technology also can be used for exhibitions, information and sightseeing guidance, smart edutainment, retail display and surgical simulation. AI Aquarium has been installed in the National Museum of Marine Science & Technology in Taiwan, serving tens of thousands of visitors and receiving positive feedback.

AI Aquarium incorporates dynamic object recognition technology with an intuitive user interface to provide an intelligent self-guided experience. Observers can learn about marine life in real time and access detailed information via gesture control. AI Aquarium recognizes more than 10 gestures, creating an entertaining and interactive human-machine interface.

Regardless of an observer's height, AI Aquarium detects gaze direction and hand gestures, allowing visitors of all sizes to enjoy unique interactions with aquatic species. AI Aquarium also avoids interference from irrelevant movements or hands of other observers, and it excludes complicated environmental factors that may affect recognition accuracy, such as water clarity, ambient light, underwater light, and fish movements. Moreover, AI Aquarium can play video and audio to enhance the contextual atmosphere for an immersive exhibition experience. With contactless interactive technologies, AI Aquarium avoids hygiene issues from using touchscreens and creates more fun through free movement.

The Cubot ONE Autonomous Mobile Robot Delivers Food and More

Cubot ONE: Indoor/Outdoor AMR is an autonomous mobile robot (AMR) that can operate both indoors and outdoors, rain or shine. It is the first AMR that combines 5G, AIoT (artificial intelligence of things), and V2X (vehicle-to-everything) to provide door-to-door delivery services. With smart vehicle perception capability, it avoids pedestrians and obstacles. It can travel on uneven surfaces such as accessibility ramps, take elevators to move between floors, and navigate signalized intersections installed with cellular vehicle-to-everything (C-V2X) roadside units. Cubot ONE also reduces the ecological impact of fuel-powered vehicles used for logistics delivery since its power source is a rechargeable lithium battery and it can travel on public roads.

Cubot ONE has been deployed in several automated-delivery applications. For example, in Taiwan, 7-Eleven uses Cubot ONE for its automated delivery service, foodomo, to deliver food in a science park. A national library in Taiwan uses Cubot ONE as an autonomous book return cart.

Cubot ONE also includes a management platform that can coordinate multiple AMR operations in the same area. The system also provides open APIs that can be easily integrated with any management platform for customized applications and logistics fleet management. The chassis can be refitted for various payloads to fulfill diverse applications, creating more possibilities for the logistics industry.

Cubot ONE can move between floors by communicating with the elevator controller through a 5G network. This makes it an ideal vehicle to provide door-to-door food delivery in office buildings or apartments.

Cubot ONE integrates autonomous driving technology for open environments, including LiDAR perception, high-precision mapping and positioning, and flexible planning technology. These enable Cubot ONE to arrive at the destination safe and sound, without causing collisions or accidents.

Robotsmith Automates Metal Workpiece Grinding and Polishing

[RobotSmith](#) is an AI and robotic system for metal workpiece grinding and polishing. ITRI developed RobotSmith to address the manufacturing industry's challenges and trends of digital transformation, supply chain restructuring and labor shortages caused by the COVID-19 pandemic. RobotSmith's quality grinding and polishing technology has been applied to manufacturing plumbing fixtures, high-end knives, and medical devices such as artificial joints.

RobotSmith digitalizes the grinding and polishing techniques of experienced workers and removes the limitations of human labor and manual precision. It can be easily deployed in traditional industries to implement digital transformation while preserving craftsmanship skills required for production lines. RobotSmith employs AI software to mimic human skills and overcome process bottlenecks.

RobotSmith incorporates sensing, robotics, industry best practices and ITRI's AI software EzSim to offer a total solution for surface finishing. The EzSim software performs simulation and trajectory planning, and it optimizes path parameters to achieve high precision and efficiency to perform surface treatment as delicately as a human expert. Sensors and trained AI models provide real-time defect detection and ensure process quality.

More technologies for CES exhibition:

- The [Athena Orchestrator—O-RAN SMO & RIC](#) is the world's first private network management platform based on the O-RAN ALLIANCE specifications. The platform can provide real-time energy-saving dynamic resource allocation for various private network scenarios and can improve the energy efficiency of mobile networks to meet carbon-emission goals.

- The [SiC Electric Powertrain Controller](#) for electric vehicles features a compact thin-film capacitor busbar kit. This design reduces the module volume to 5 L and increases driving range and vehicle efficiency. With low power loss, the 800 V SiC driver can provide up to 214 kW of power and reach an efficiency over 98%. The power density can be maintained at

> 40 kW/L, exceeding the U.S. Department of Energy's 2025 target of 33 kW/L for a 100-kW traction drive system.

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》 **Spotlight**

ITRI Recognized as Top 100 Global Innovator 2023

ITRI has been named a Top 100 Global Innovator for the seventh time and sixth consecutive year.

ITRI has been named a [Top 100 Global Innovator™ 2023](#). The annual list from [Clarivate™](#) identifies those at the pinnacle of the global innovation landscape by measuring excellence focused on exceptional consistency and scale in innovativeness. Featuring for the seventh time and sixth consecutive year, ITRI has the most wins for this award among the research organizations in Asia. Besides ITRI, the 2023 list also includes world-leading government research agencies such as the French Alternative Energies and Atomic Energy Commission (CEA) and National Centre for Scientific Research (CNRS).

Gordon Samson, Chief Product Officer, Clarivate, said, "ITRI is one of just three national state-funded research organizations on our list this year. We congratulate them on their 7th

appearance - six years in a row. ITRI truly demonstrates consistent, above-the-bar innovation performance, especially at international scale. We look forward to seeing ITRI continue to drive industrial and economic development with its innovative ideas and solutions."

"I am grateful to see ITRI's continuous nomination as a Top 100 Global Innovator. This wouldn't be possible without collective, steady improvement of our research capacity, which gives ITRI an edge on this highly competitive global stage," said ITRI President Edwin Liu. "Another niche for us to win this award is our endeavors in actively bridging the capital and technology markets. We have supported more than 25 startups and small & medium enterprises in technology financing. Joining hands with industry and research partners, we also built the IP Bank, a patent pool that allows teams to collaborate, facilitate innovations, and develop diversified technological solutions," said Dr. Liu.

While rolling out the 2030 Technology Strategy and Roadmap to anchor its R&D activities, ITRI uses the Technical Cycle Time indicator for technological progress measurement and patent checkup. With whole life cycle management and adaptive plans, ITRI has been strengthening its patent portfolios and deployment strategies to embrace market changes and opportunities.

According to Clarivate, the methodology for the Top 100 Global Innovators 2023 adopts a complete comparative analysis of global invention data to assess the strength of every patented idea, using measures tied directly to their innovative power. To move from the individual idea strength to identify the organizations that create them more consistently and frequently, Clarivate sets two threshold criteria that potential candidates must meet and then adds a measure of their patented innovation output over the past five years.

Visit here to learn more about other Top 100 Global Innovators 2023 and the methodology.

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»R&D Focus

GolfHow Helps You Play Golf Smarter, and Better

Golf is a sport that requires skillful musculoskeletal movements, and thus mastering the coordination can be quite challenging. To help beginners play smarter and better, ITRI has developed the AI-based golf training system GolfHow, making golf practice more accessible and efficient.

AI technology provides personalized virtual coaching functions

ITRI developed GolfHow to enhance golfers' practice experience.

GolfHow utilizes AI recognition and motion analysis algorithms to analyze a golfer's swing posture and offer personalized feedback and recommendations. Compared to a conventional golf simulator, GolfHow is advantageous in flexibility, costs, and its analytic performance.

The system can be accessed from anywhere with an internet connection and a mobile device. Users can simply install the App on a smartphone, set it up in a 2 ft² space, and have their swings filmed and analyzed by GolfHow. There is neither need for expensive specialized equipment nor a large dedicated place.

GolfHow can automatically break down the swing into the phases of set up, back swing, top

swing, down swing, impact, and follow through, and process posture analysis for each stage. The algorithm provides detailed advice for each phase, which allows beginners to check on their postures repeatedly and adjust them accordingly. The system also scores swings. Statistical results help learners assess their learning performance and set goals.

GolfHow analyzes the swing posture and offers adjustment instructions with visual aids and voice notification.

Besides recognizing human body nodes via deep learning, GolfHow can detect golf clubs with high precision. Thanks to its patented algorithm that integrates clubhead recognition with 2D-skeleton tracking, GolfHow offers users a comprehensive understanding of the interaction between their body and the club, which is conducive to refining their swing.

"GolfHow removes the constraints of practicing golf, offering golf beginners an efficient and convenient learning experience. With this smart training system, golfers can receive instant feedback on their swings without the need for a coach to be present. This can significantly save training time and costs," said ITRI's Division Director William Huang.

In addition to self-training, GolfHow can also be used as a powerful coaching aid. With the insights from learners' swing clips and the AI-assisted instructions, coaches can provide further comments and guidance for improvement using the built-in audio and drawing tools. Instructors can even customize swing standards to rate different learners, as well as view their practice history and adjust coaching plans based on the progress. A golf instructor at Stanford University and several golf learning centers in Taiwan have applied GolfHow to their remote

coaching lessons, citing improved teaching efficiency and learning results.

Coaches can give advice with the built-in audio and drawing tools.

ITRI plans to launch GolfHow on the app store in the second quarter of 2023. In addition, plans have been made to collaborate with academies to organize campaigns that aim to expand the user base.

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» R&D Focus

Cutting-Edge 5G Ultrasound Brings Advanced Medical Solutions to Underserved Areas

In cooperation with MacKay Memorial Hospital, Compal Electronics, and Techman Robot, ITRI unveiled a remote-operated 5G ultrasound technology. This technology provides remote areas with access to essential medical resources, allowing rural residents to receive abdominal ultrasound checkups without having to travel long distances to urban areas. Efforts are underway to provide more accessible telemedicine services.

Pei-Zen Chang, Executive Vice President of ITRI, spoke about the progression of the collaboration between ITRI and MacKay Memorial Hospital. "MacKay Memorial Hospital contributed their medical expertise and facilities for testing, while ITRI worked on system integration and

A physician uses a force feedback joystick to carry out remote robotic ultrasound scans.

core network equipment deployment," said Chang. "We addressed the needs of medical care providers by developing an electronic consultation system and a real-time high-definition abdomen ultrasound system that can be operated remotely."

Minister of Digital Affairs Audrey Tang pointed out that the Ministry's support in the development of 5G private networks and telemedicine applications has paved the way to the launch of the remote-operated 5G ultrasound technology, which bridges the medical resource gap between urban and rural populations. "We are glad to see doctors working in cities can now provide care to patients with limited resources by offering virtual appointments and remote ultrasound scanning services," said Tang.

The robotic arm performs an abdominal ultrasound examination.

The remote ultrasound checkup service integrates robotics, 5G communications, and medical knowledge. A robotic arm equipped with an ultrasound probe is installed on a check-up vehicle and can be remotely manipulated by a physician using a force feedback joystick to perform the examination. While the robot's force-sensing and distance detection abilities ensure the safety and effectiveness of the procedure, a high-definition camera captures the status of the robotic arm and the patient's reactions. The physician then provides a diagnosis based on the wireless ultrasound imaging and communicates with the patient via a video conferencing system.

Dr. Jian-Han Lai, a physician from MacKay Memorial Hospital's rural care team, was impressed by the benefits of the low-latency, high bandwidth 5G network on remote healthcare. "Despite the mountainous terrain of the village, the system shows excellent connectivity and steady image transmission," he said. "It is also easy for medical professionals to master the system operation and control. Patients who tried the service were highly satisfied and willing to use it again. We can say that the 5G robotic-assisted checkup is comparable to having a doctor giving examination in person," he added.

From left: ITRI Executive Vice President Pei-Zen Chang, MacKay Memorial Hospital Physician Dr. Jian-Han Lai, Minister of Digital Affairs Audrey Tang, and MacKay

Memorial Hospital Vice Superintendent Dr. Chie-Pein Chen.

The mobile and user-friendly nature of the technology eliminates the geographical barrier of traditional ultrasound diagnostics to mitigate healthcare inequality. ITRI plans to work with medical centers to launch a medical checkup bus tour and offer abdominal ultrasound screening services to rural areas in Taiwan this year. The technology is also expected to be expanded to other locations, making real-time medical examinations available for more people in need.

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» R&D Focus

Upgrading Plasma Processing for Display Production

Garcia Liang and Jia-Jhih Shen

Driven by global markets of the metaverse, 5G, and smart vehicles, the demand for display products has been steadily growing. In panel manufacturing, plasma processing has been widely used, accounting for 50% of the display production equipment. Plasma processing equipment involving etching, coating, and surface modification are valued as important assets in the display industry as they can achieve high efficiency and yields. To improve the performance of the plasma processing equipment, ITRI recently developed two innovations.
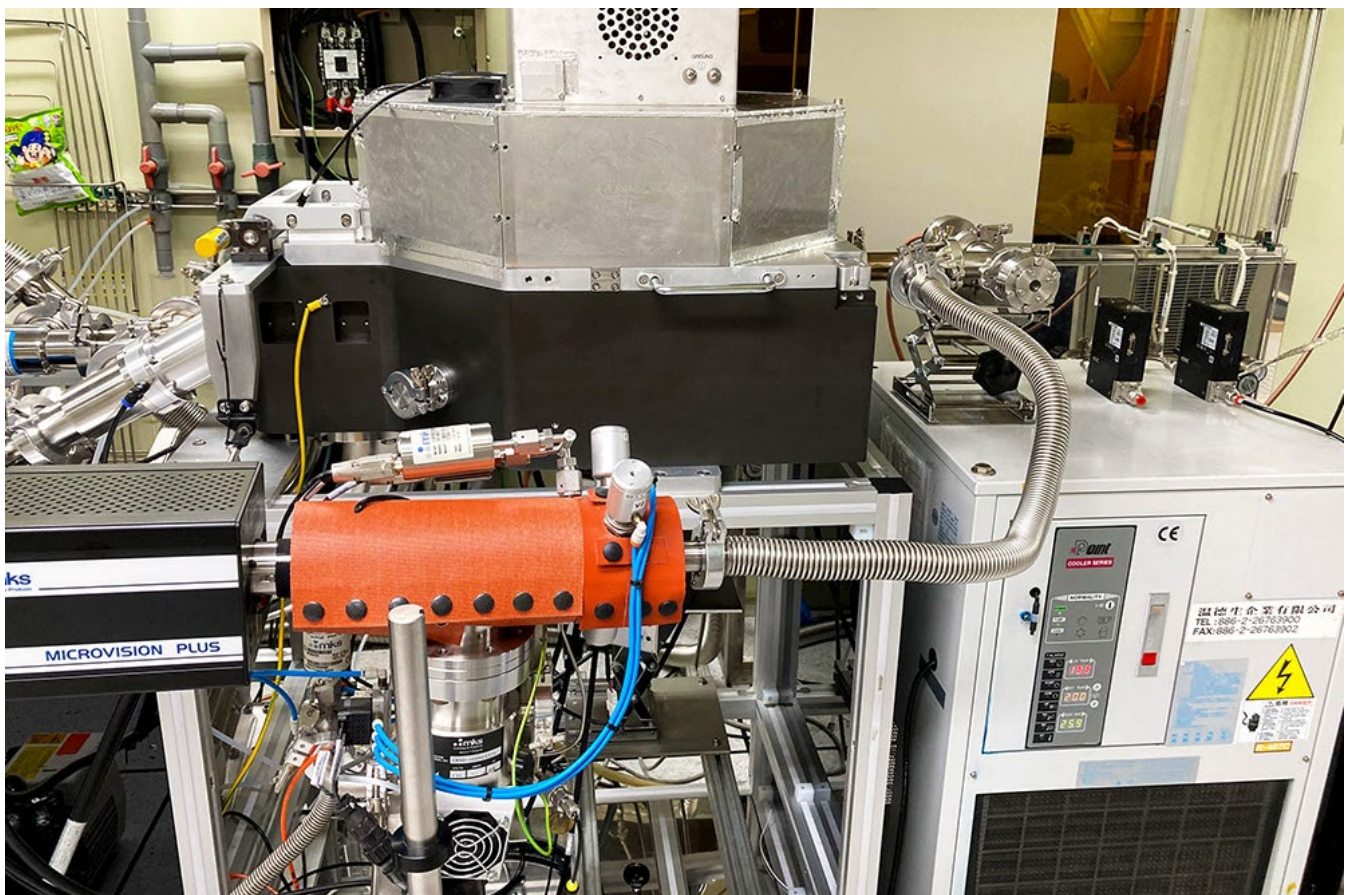
*With ITRI's assistance, manufacturers now can independently build plasma systems and equipment.*

Plasma Source Design and Simulation Analysis

The new Plasma Source Design and Simulation Analysis uses a multi-physical coupling simulation software to conduct analyses based on the parameters of fluid dynamics, heat transfer, chemistry, and electric fields. This helps developers better design the key components of plasma equipment, such as the chamber.

With ITRI's innovation, a new inductively coupled plasma (ICP) source equipment can generate plasma with high density over 10^{11} cm-^{3} and high uniformity above 95% (i.e., the non-uniformity is less than 5% on a 12-inch wafer). This technology has been applied to developing deposition and etching processes and proved to increase production capacity and yield, with reduced thin-film damages. The equipment can also perform low-temperature processes with low ion impacts.

Plasma Diagnosis and Monitoring Module

To optimize the density and uniformity of a plasma chamber, it is important to have not only simulation analysis but also accurate diagnosis of the equipment. ITRI's Plasma Diagnosis and Monitoring Module is composed of three core technologies: (1) RF ion diagnostic measurement, (2) plasma spectral efficiency measurement, and (3) Langmuir probe measurement. With these technologies, the module can monitor the status of the plasma chamber to control the deposition and etching processes, issue abnormality alarms, and collect statistical data. This can effectively suppress plasma damage and film defects, ensure process stability, and increase productivity.
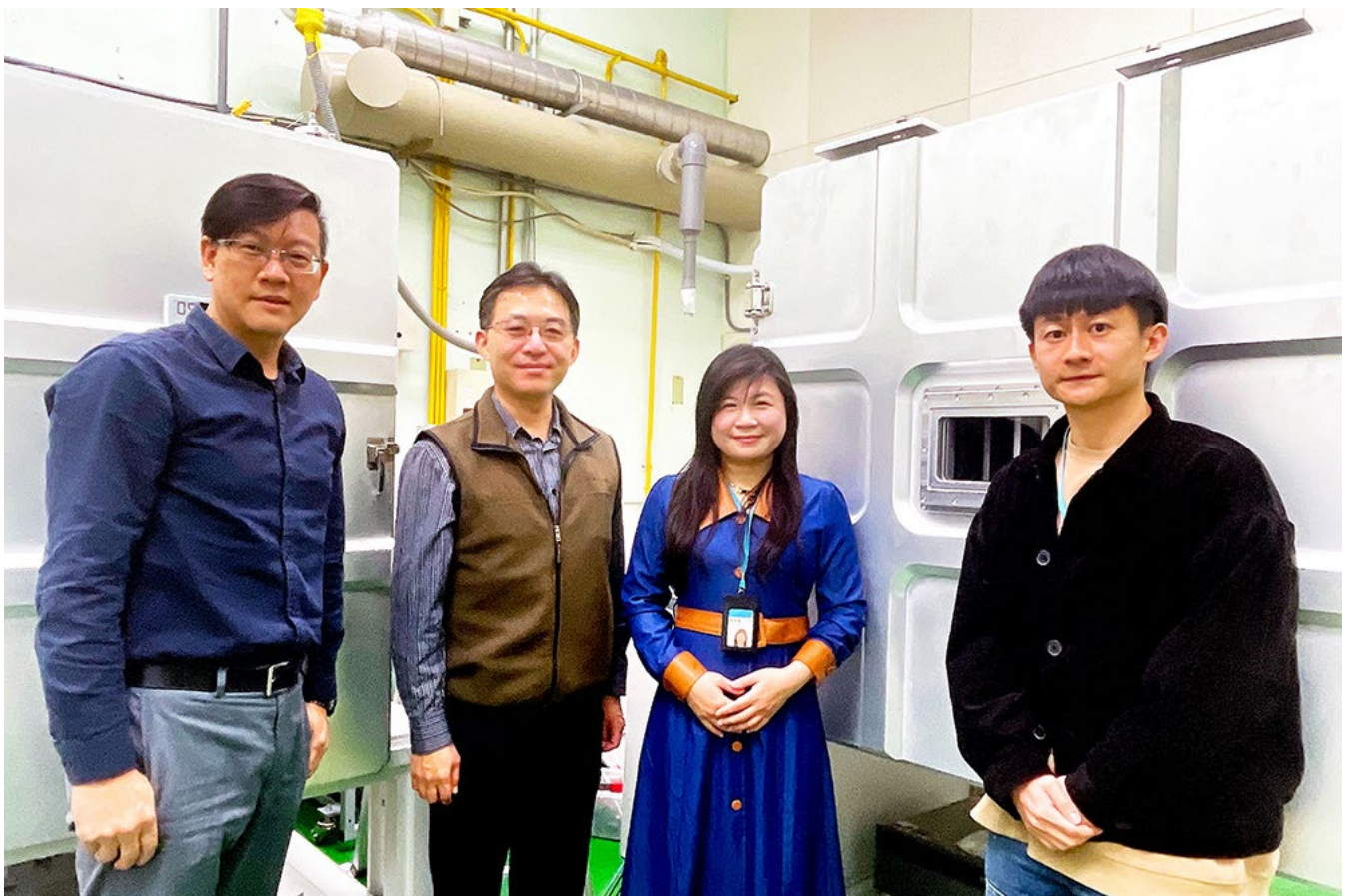
The research team of ITRI's plasma processing development. From Left: Dr. Chih-Hung Liu, Dr. Bing-Shiang Yang, Garcia Liang, and Jia-Jhih Shen.

The multi-physics simulation for plasma equipment has been adopted by established plasma processing equipment makers in Taiwan and Japan. Besides guiding the manufacturers to independently develop next-generation plasma modules and intelligent dry-etching equipment, ITRI provided a total solution that integrates non-invasive plasma characteristics and processing diagnosis to meet the requirements of advanced nano-level processes.

"To deal with the challenge the future holds in plasma processing, I am glad to see ITRI working with a selection of industry players, and it does not stop there. With advancements such as simulation analysis and diagnosis monitoring of plasma sources, ITRI is bound to further its worldwide engagement and collaborations," said ITRI's Deputy General Director Dr. Bing-Shiang Yang.

"These techniques help industry players drastically reduce development time and stay competitive," stressed ITRI's Deputy Business Director Dr. Chih-Hung Liu. The efforts include assisting them to roll out diverse products spanning smart components, modules, systems, platforms, and equipment as well as carry out trials and verification tests with world-leading panel manufacturers.

ITRI has strengthened the core technology and complemented plasma process equipment with virtual predictions of the processing results. This empowers industry players to embrace the next-generation high-end plasma process equipment technology while enhancing their competitiveness and visibility in the global market.

About the Authors

Garcia Liang is a business manager of the Mechanical and Mechatronics Systems Research Laboratories at ITRI. She has dedicated herself to business promotion and international cooperation for ITRI.

Jia-Jhih Shen is a researcher of the Mechanical and Mechatronics Systems Research Laboratories at ITRI. He earned his B.S. and M.S. degrees in chemical engineering from Chung Yuan Christian University. His research focuses on plasma technology and application, with over 30 technical papers published.

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» Collaboration

Technology Cooperation Fosters Development of Semiconductors in Lithuania

Lithuanian government officials and Taiwan's representative to Lithuania Eric Huang (fourth left) attended the agreement signing ceremony.

ITRI signed a technology cooperation agreement with the Lithuanian high-tech company Teltonika IoT Group. Through this partnership, ITRI will share with Teltonika technologies that can facilitate the creation of a semiconductor chip industry in Lithuania. The agreement entitles Teltonika to obtain licenses for semiconductor chip manufacturing technologies and devices developed by ITRI. It also ensures that the company group will get assistance in preparing detailed plans and engineering training for its employees. These are the key elements that lay the groundwork for semiconductor chip projects in Lithuania.

ITRI Chairman Chih-Kung Lee gave an online speech at the reception.

"This is a truly historic event for Lithuania, as it will be the largest ITRI cooperation project with a foreign country in its 50-year history," said Arvydas Paukštys, Founder and President of Teltonika. "I am thankful to the Government of Taiwan for its confidence in us and to the Lithuanian politicians for their support in the negotiations. This agreement proves that we are reliable partners capable of developing such complex projects. I believe that by implementing the planned works, we will help Lithuania to break through alongside the most advanced countries in the world."

Paukštys stressed that they decided to develop niche semiconductor technologies used in renewable energy, electric vehicles, or other industrial power module solutions, and that they hope to offer semiconductor chip design, assembly, and testing services to their customers. ITRI will provide technologies that are widely used today in power electronics to produce energy management devices such as solar inverters, electric vehicle chargers, and other home and industrial electronics.

The bilateral cooperation is funded by Taiwan's Ministry of Foreign Affairs, the major sponsor, and the Teltonika company group. Thanks to the newly established relations between Lithuania and Taiwan, Taiwan's technologies and the knowledge of their experts will be used in preparation for the launch of a semiconductor chip industry in Lithuania.

Teltonika will soon start preparing detailed plans for these projects and then begin the construction of the facilities, which could take approximately two more years. According to the

technology cooperation agreement between ITRI and Teltonika, the projects necessary for initiating the semiconductor chip industry in Lithuania will be completed by 2027.

🔍 About Teltonika

Teltonika is a fast-growing Lithuanian high-tech company group with offices in 20 countries around the world, employing around 2,500 people. Teltonika's state-of-the-art technologies and extensive design and manufacturing experience help to create high-quality and secure IoT devices. The company is proud of its unique IoT products made in Lithuania and aims to become a global leader in the design and manufacture of unique IoT solutions that help people around the world. Teltonika has already produced more than 21 million IoT devices in its modern production facilities in Vilnius and Molėtai.

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≫ **Collaboration**

ITRI Unveils New Collaboration with PEGATRON on 5G Private Networks

ITRI and PEGATRON signed an MoU at CES 2023 to mark their collaboration on energy-saving 5G private network solutions.

Leading the transformation for sustainability and connectivity, ITRI partnered with leading electronics manufacturer PEGATRON Corporation to promote the development of the software platform Athena Orchestrator—O-RAN SMO & RIC, the 5G Energy-Saving O-RAN System, and the Citizens Broadband Radio Service (CBRS) Solution. The two parties signed a memorandum of understanding (MoU) at CES 2023.

Based on the Athena Orchestrator—O-RAN SMO & RIC, ITRI and PEGATRON co-developed the 5G Energy-Saving O-RAN System, a private network solution for both smart factories and portable use. AI algorithms monitor flows and diversions, optimize network traffic distribution, and allow idle base stations to hibernate, saving power consumption while

maintaining service quality.

Meanwhile, to address the market demand in the U.S., ITRI and PEGATRON will enhance the development of the CBRS Solution, which includes the SAS-CBSD protocol software and domain proxy meeting the Wireless Innovation Forum (WInnForum) standards. Base stations using CBRS will lead to the completion of high-performance and energy-saving 5G private networks, which will accelerate the deployment of 5G networks worldwide.

ITRI President Edwin Liu in the MoU signing ceremony stressed the significance of the partnership with PEGATRON. "The joint development of the CBRS Solution shows that ITRI has been focused on market-oriented R&D and aiming for global opportunities. This solution can help networking and communication equipment manufacturers upgrade the capability and halve the time to market of their 5G private network products," he said. "We hope that the collaboration will strengthen the 5G private network industry chain and assist suppliers in marketing their products globally."

The Portable All-in-One features high robustness and mobility.

According to CY Feng, BG6 general manager, PEGATRON Corporation, the company has cooperated with ITRI in the past two years to develop scalable 5G private network equipment and systems, which have been successfully applied in the field of smart manufacturing. "The 5G private network market in the U.S. is just emerging. We are glad to join ITRI at CES 2023 to unveil new collaboration on CBRS and showcase our low-carbon 5G private network solutions including the Portable All-in-One. The compact briefcase-shaped device features

high robustness and mobility. It can receive satellite signals and work in areas with poor communication," he said. "We are keen to develop innovative applications and will continue to deliver quality products in cooperation with partners from different areas of expertise."

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» Collaboration

Introducing Hospital Robots to Help Health Workers and Patients

ITRI teamed up with Taiwan's China Medical University Hospital (CMUH) to introduce hospital robots to assist in surgical operation, logistics, and environmental cleaning through a three-phase collaboration program. The robotic services including autonomous mobile robots (AMRs) and a surgical navigation robotic arm system will be applied in CMUH branches, and are expected to ease the strain on health workers and enhance surgical precision.

In the first stage of the program, AMRs will be deployed in operating rooms, emergency rooms, and isolation wards to provide administrative, logistics, and infection control solutions; meanwhile, robotic arms will assist orthopedic and neurosurgical physicians in locating lesions with improved accuracy. In the second stage, other intelligent technologies will be deployed to more CMUH departments. In the last stage, the robots are planned to be used in the new Taichung Senior Rehabilitation General Hospital to be launched in 2025 to offer long-term care services for the elderly.

"CMUH ranks as the second largest healthcare system nationwide. With Taiwan's aging population growth and the recent pandemic in mind, CMUH was actively looking for solutions to improve medical efficiency and service quality, and technologies can help," said ITRI's Executive Vice President Pei-Zen Chang. "CMUH is ITRI's first hospital partner to sign an MOU to develop hospital robots. We hope to see more cross-disciplinary research like this flourishing," he added.

Below are the first two technologies jointly developed by ITRI and CMUH.

Autonomous Mobile Robot (AMR)

Without pre-defined courses or marks, the intelligent AMR can calculate the best route and automatically avoid obstacles to complete delivery tasks. It also replenishes a range of supplies and disinfects areas such as the emergency room, operating room, and negative pressure room 24 hours a day. Always on standby, it is best suited for environments that require high-level infection control.

"It will free our staff from highly repetitive tasks like getting wound dressing kits and saline solution that takes them about 250 to 270 rounds per day, allowing them to redirect their focus onto patients," said CMUH Superintendent Dr. Der-Yang Cho. "We project it to be very helpful in cutting down nurse workload and lowering their injury risks. Other highlights include supply inventory tracking and improved infection control quality."

The hospital AMR model is tasked to clean hospital wards and deliver drugs, devices, and even patients.

Surgical Navigation Robotic Arm System

ITRI's spinal surgical navigation system can drive the medical robotic arm to accomplish minimally-invasive surgeries at a neurosurgical level of accuracy. Besides shortening pre-operative time and boosting surgery precision, it also significantly reduces patient radiation exposure. Compared to a traditional surgery that needs more than 200 x-ray images, it only takes two images for the system to navigate and guide the robotic arm. This technology can be used with ITRI's [3D Printing Biomimetic Materials and Structures for Tissue Integration (BioMS-Ti)](#), a 3D printed bone implant for tissue integration, to speed up post-surgery recovery and reduce hospital stay.
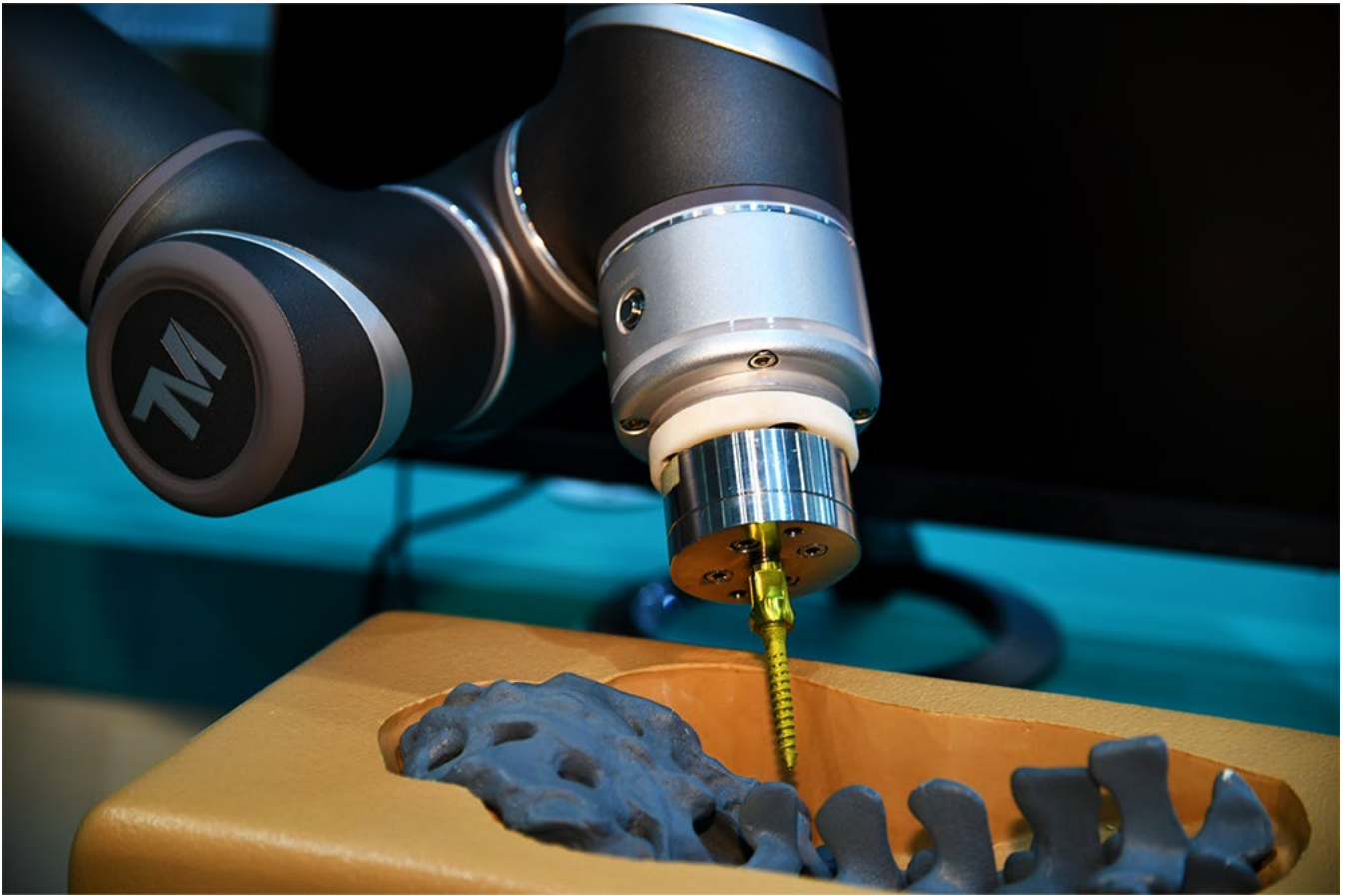
The spinal surgical navigation robotic arm system ensures higher precision and reduces surgical time.

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» **Activity**

New Initiative for Steel and Chemicals Co-Production

ITRI and CSC collaborated on the field verification of carbon capture and utilization technology at the steel and chemicals co-production pilot plant.

A technology brief at COP27 suggested the cement, iron and steel, and chemicals and petrochemicals industries as the most significant industrial CO_2 emitters. To pursue carbon neutrality, ITRI has recently worked with leading steel producer China Steel Corporation (CSC) to verify some of its carbon capture and utilization technology innovations at the newly-launched pilot plant for steel and chemicals co-production in Kaohsiung, Taiwan.

The collaboration will verify:

1. the carbon dioxide capture and purification system, which will capture the CO and CO_2 generated in CSC's manufacturing process, and then separate and purify

the gas;

2. a catalytic conversion system to transform the captured CO and CO2 into green chemical materials such methanol and methane;

3. an electrolysis hydrogen production system, in conjunction with the catalytic conversion system, to alleviate the need and cost for downstream chemical plants to import raw materials.

With these technologies, the steel and chemicals co-production plant will convert gas by-products from the manufacturing process into low-carbon chemicals, which is estimated to reduce 4,900 tons of carbon output a year. CSC plans to cooperate with chemical industry partners in forming a steel and chemicals alliance, and will launch a demonstration factory to prove the viability of this business model. Following verification, they will participate in the establishment of a carbon circular economy industrial park. Some 2.9 million tons of carbon emissions will be reduced annually, which may generate great value in the green industrial chain.
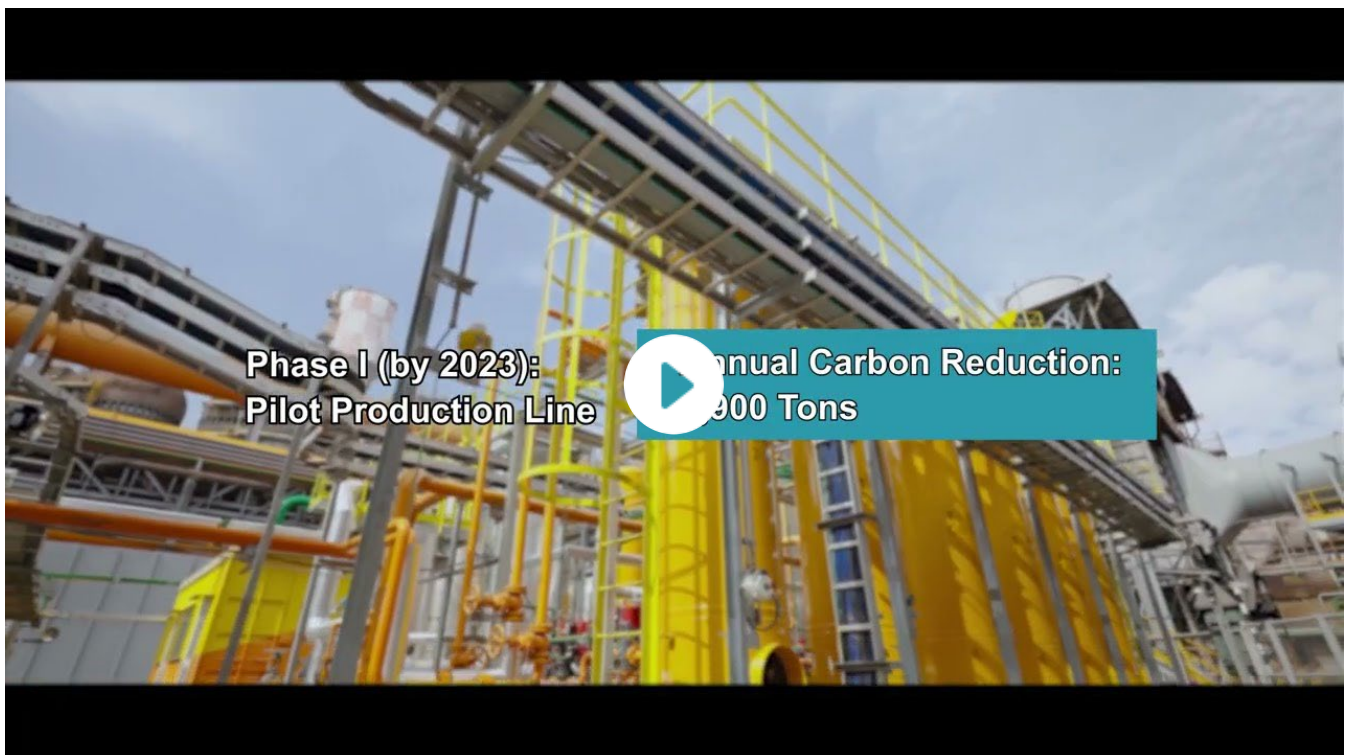
Steel and Chemicals Co-Production Initiated to Build a Sustainable Industry.

"Kaohsiung is home to the steel and chemical industry, which offers great geographic advantages for the development of steel and chemicals co-production along with the integration of carbon resources," said ITRI President Edwin Liu. "ITRI's cooperation with CSC on this venture will see the joint development of carbon recycling technology to realize low-carbon production. We will further work together on establishing a new cross-industry cooperation model, expanding the scope of regional energy resource integration and creating new output value." Dr. Liu also pointed out that it would take time and engage multiple fields

and industries to reach the 2050 net zero goals, and that the transition would have a major impact on economic development over the next 30 years.

CSC Chairman Chao-Tung Wong commented that co-production of steel and chemicals is one of the highlighted paths his company will take in moving towards carbon neutrality by 2050. CSC, he said, is particularly appreciative of the government's support of the steel and chemicals co-production initiative, as well as advanced technologies provided by ITRI. CSC will further cooperate with more partners in the petrochemical industry to accelerate the net zero transition and establish a new industrial ecosystem for carbon utilization.

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» Activity

ITRI's VLSI TSA Symposium will Kick Off in April 2023

Online registration for the 2023 International VLSI Symposium on TSA is open until March 31, 2023.

ITRI will host the 2023 International VLSI Symposium on Technology, Systems and Applications (VLSI TSA) on **April 17-20**, 2023 at the **Ambassador Hotel Hsinchu, Taiwan.**

Experts from top companies and prestigious academic institutions including TSMC, Intel, NVIDIA, Massachusetts Institute of Technology, UC Santa Barbara, the University of Tokyo, Cadence Design Systems, Inc., University of California, Los Angeles, CEA-Leti, and Siemens EDA will share their insights and latest research findings on hot issues, such as quantum computing, heterogeneous integration, energy efficient VLSI technologies, sensors and applications for automotive/drone, dielectric stacking and interface engineering, high power devices, advanced packaging technologies, novel channel logic and 3D-stacked transistors, compute-in-memory: from architecture to devices, security and encryption, and advanced process-induced design challenges and solutions.

Established in 1983, VLSI TSA is the premier event on VLSI in semiconductor-related fields

and attracts up to 1,000 participants every year. At this year's event, six esteemed experts will give excellent keynote speeches. Prof. John Martinis of UC Santa Barbara will share his insights on current technology of quantum computing. Mr. Robert Munoz of Intel will describe how and why chiplet-related industry collaboration efforts are key to more comprehensive reuse at industry scale, fundamentally reshaping how our industry collaborates to build future systems. Prof. Ken Takeuchi of the University of Tokyo will illustrate how Computation-in-Memory can realize energy efficient neuromorphic systems, especially at edge AI. Prof. Shih-Lien Lu of Warner Pacific University will examine the challenges and opportunities of security from the point of view of VLSI design and technology, focusing on different aspects of hardware security. Dr. Olivier Faynot, Head of Silicon Component Department at CEA-Leti will discuss ongoing developments that will impact power consumption related to data generation, transfer, compute and storage. Dr. Y.-C. Frank Wang of NVIDIA will also join the keynote session with the latest research findings at the 2023 VLSI TSA.

The 2023 VLSI TSA is planned as a hybrid event, comprising both an in-person symposium and on-demand video presentations that will be available after the physical event. The in-person symposium will take place from **April 17-20, 2023** at the Ambassador Hotel Hsinchu, Taiwan. Over 130 outstanding papers will be presented at the symposium. Following the physical event, one-month-long on-demand video presentations will be provided to attendees.

Online registration is open until **March 31, 2023**. In case of missing the deadline, participants may register on-site during April 17-20, 2023. Students can take advantage of up to a 70% discount on their registration fee.

For more information, please visit the symposium website at 2023 VLSI TSA.

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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 here.

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