



LUX showcases 12 new technologies at TechInnovation 2021

LUX participated in [TechInnovation 2021](#), a technology-to-industry matching event organized by IPI Singapore, from 28 to 30 September.

The 10th edition of TechInnovation, coinciding with IPI Singapore's 10th anniversary, was a fully digital event themed "A Sustainable & Resilient Future". LUX's [TechInnovation page](#) was linked to that of the [Consortium Management Office \(CMO\)](#), under A*STAR.

The CMO is a National Coordinating Office that facilitates broader ecosystem access to capabilities of Tech Consortia, with each Consortia focused around an emerging technology area (such as LUX in the photonics space). LUX was one of the eight Consortia showcasing their technologies at this year's TechInnovation.

Here are the new technologies LUX demonstrated at TechInnovation

Gas Leak Imaging with Single Pixel Imaging Technology – Assoc Prof Cuong Dang, NTU

This technology offers an imaging solution without an expensive detector array. Instead, two types of cameras (passive camera – imaging with external IR light sources; and an active mode relying on active IR laser patterns) are combined with a proprietary algorithm that enhances frame rate of the real-time images captured. The solution offers greater efficiency in detecting gas leaks and can provide real-time images of leaks, while being six times cheaper than current gas imaging technique (thermal imaging camera).



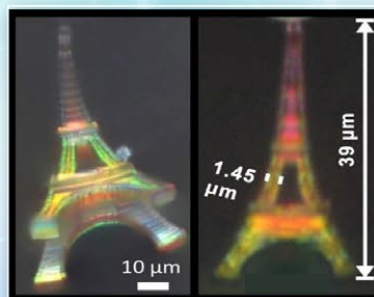
Gas leak detection in oil and gas operations

It can be deployed in industries including upstream oil and gas production (e.g. drill wells, extraction of chemical supply), midstream sector (e.g. pipelines, tank farms) and downstream sector (e.g. refining of petroleum crude oil, processing and purifying of raw natural gas). Applications include Optical Gas Imaging (OGI) devices in oil and gas operations and the detection of methane gas leaks.

Nanofabrication Platform for Nano-Optical Elements – Assoc Prof Joel Yang, SUTD

In this technology offer, high-resolution patterning via 2D and 3D printing approaches (i.e. Electron Beam Lithography, and advanced femtosecond laser Two-photon Polymerization Lithography), and advanced algorithms including Deep Neural Network, allow for the development of functional optical materials. 3D printing of optical elements with extreme resolution (feature size: down to 300 nm) and high-resolution 2D lithography (feature size: down to 10 nm) can be achieved.

The many applications for functional optical materials include: anti-counterfeiting (e.g. optical security labels on different surfaces); displays, Electronic-Paper, AR/VR, holograms; sensors and spectrometers; optical data storage; fade-resistant colour prints/paints; sustainable cosmetics; and miniaturization of components.



3D color microprint can be used for anti-counterfeit in luxury goods and currency.

Message from the Chairman/Co-director:

Season's greetings! The photonics community has shown great resilience and adaptability in 2021 and I am happy that we were able to hold some hybrid events this year, providing opportunities to meet others in person again.

One hybrid event that LUX recently participated in was last month's Industrial Transformation ASIA-PACIFIC (ITAP) – a HANNOVER MESSE event, where up to 1,000 people were allowed to be physically present at any one time. I hope you took advantage of the offers, such as complimentary conference passes, which LUX was able to provide you as a supporting organisation of ITAP 2021. It was also great to see LUX members Innovave Tech, JM Vistec, Phaos Technology and Physik Instrumente take part as exhibitors.

Indeed, it was certainly a busy conclusion to 2021 and we recently welcomed six new Industry members (AGC Asia Pacific, Industry Vision Technology, JM VisTec System, Origgin Ventures, Sunyu Photonics and Syswell Technology). We also took part in TechInnovation 2021 in September and presented a total of 12 technologies at the technology-to-industry matching event.

You can read more about these events, our new members and other exciting developments in this issue of *Illuminate*.

Last but not least, let me take this opportunity to wish everyone a Happy New Year!

*Prof Tjin Swee Chuan
Chairman, LUX Photonics Consortium
Co-Director, The Photonics Institute*





Detection of volatile organic compound (VOC) such as toluene from industrial exposure

Chip-Scale Spectroscopic Sensors for IoT Applications – Assoc Prof Vincent Lee, NUS

The world's first chip-scale photodetector-integrated sensor in the MIR beyond 4 μm can distinguish and quantify numerous chemical and biological molecules (as this broad working wavelength extensively overlaps with the absorption fingerprints of most of these molecules) and their mixtures on-chip. CMOS compatibility means the sensor can potentially be mass-produced in wafer-scale at low cost, while chip-scale integration minimizes the sensor size and power consumption.

Applications include environmental monitoring (e.g. detection of various greenhouse gases, monitoring of air quality in the home), industrial process control for the prevention of accidents, and healthcare (e.g. detection of volatile organic compound biomarkers in exhaled breath to diagnose diseases such as COVID-19 and lung cancer).



High power ceramic laser used in material processing

Yttria-based Laser Ceramics Fabrication – Prof Tang Dingyuan, NTU

This technology offering proposes the use of Yttria-based laser ceramics to replace the YAG-based laser gain media in high power 1 μm , 2 μm and 3 μm solid-state lasers. With larger thermal conductivity and lower phonon energy than YAG, Yttria can potentially provide better laser performance, as well as high efficiency and optical quality.

While it is typically challenging to grow Yttria crystals, the research team has developed a unique low temperature vacuum sintering plus hot isostatic pressing method to do so, and with lower cost versus YAG-based laser gain media.

Applications for the transparent ceramics can be used for windows, lenses, transparent armors, phosphors, and scintillators. High power ceramic solid-state lasers can be used in industrial material processing such as cutting, welding and marking.

A Single-Pixel Mid-Infrared Spectrometer for Solid, Liquid, and Gas Sensing – Assoc Prof Zhou Guangya, NUS

The technology offering is a single-pixel mid-infrared spectrometer that operates in the 3000nm to 4000nm wavelength range, allowing it to sense methane, propane, benzene, and other hydrocarbons. The wavelength range can also be shifted to cover from 2000nm to 8000nm. In addition, the spectrometer can be used to test solid and liquid samples (e.g. to test the type of plastic).

Unlike a typical mid-infrared array detector, this spectrometer uses a single-pixel detector, which has a much lower cost. In short, it is a compact (measuring 20cm \times 20cm \times 10cm), cost-effective, and high-performance instrument. The spectrometer can be developed into an open-path gas analyser for the agrochemical, petrochemical, pharmaceutical, and polymer industries. It can also be used for environmental monitoring (e.g. urban air remote sensing and environmental sustainability management).

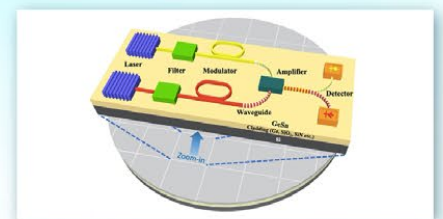


Environmental monitoring in industrial areas

GeSn/Ge Technology-Material Growth, Engineered Substrate and Devices – Prof Tan Chuan Seng, NTU

This technology offering provides solutions including material growth of epitaxial GeSn/Ge films and black Si (b-Si); engineering of Ge-on-insulator (GOI) and GeSn-on-insulator (GSOI) substrates, as well as flexible nanomembranes; and device fabrication such as photodetector. The fabrication processes are CMOS-compatible, and suitable for large scale, low-cost production.

These solutions can be used in applications such as transceiver; light detection and ranging (LiDAR) system; LiFi receiver; molecular or gas sensor; analog light signal receiver; optical power receiver; active-pixel sensor; and solar cells.



GeSn/Ge Technology enables ultra-compact device footprint

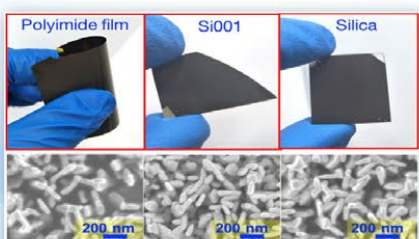


Smart textile that can sense and monitor body conditions

Multi-functional Fibers for Flexi-Wearable Fabrics – Assoc Prof Wei Lei, NTU

The technology is a wearable fabric in which many components can be integrated in a single flexible fiber, while it remains washable, durable and mechanically stable. Sensors and actuators in the wearable fabric will enable it to "see", "hear", sense stimuli, communicate, store and convert energy, modulate temperature, monitor health, and more.

Applications include wearable electronics for fitness purposes, sensing and monitoring, energy generation, as well as military and defence. The technology is scalable allowing for high-production yield and low-cost.



Biosensors used in lateral flow test such as the Covid-19 ART

Black Silver Biosensor Material – Assoc Prof Robert Simpson, SUTD

Plasmonic porous surfaces enable extraordinarily sensitive bio detectors to be developed – these can then be used in health monitoring applications such as for the diagnosis of viral infections or even early-stage diseases. However, it is difficult, expensive and inefficient to create these surfaces via existing methods.

The technology on offer is a cost-effective, industrially scalable, single-step process to fabricate an optical nanomaterial, named "Black Silver" that is highly sensitive to biomarkers that contact it. In addition, Black Silver can be easily coated onto other materials such as flexible plastics, metals, ceramics, crystals, and glass.

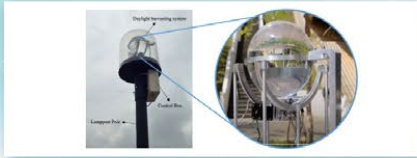


Non-invasive in-vivo ocular imaging (The Gonio Pen)

High-resolution Ocular Imaging System – Assoc Prof Murukeshan Vadakke Matham, NTU

The technology offer is a non-contact, sub-micron resolution imaging system, using Bessel beam based light-sheet imaging technology. As a non-invasive method for in vivo ocular imaging that can obtain 3D volumetric images of the trabecular meshwork of an intact eye, it can be used in ophthalmology (e.g. glaucoma diagnosis and monitoring).

Besides a lower device cost compared to existing high-resolution ocular imaging systems, the system does not require extensive expertise to operate. Furthermore, there is low risk of the patient being infected due to the non-contact nature of the system.



Compact lamp post sunlight harvesting system

Compact Lamp Post Mountable Sunlight Delivery System – Asst Prof Yoo Seongwoo, NTU

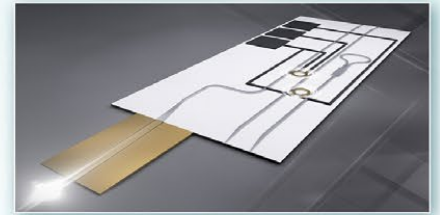
The technology offer is a daylight harvesting system with a static ball lens to collect solar energy and a single, movable optical fiber for light transmission. The compact device is designed for use in dense urban cities and can be mounted on lampposts or rooftops.

It channels sunlight underground during the day and functions as a streetlamp at night, and can also be used to assist car park lighting. Benefits include electricity savings and low maintenance cost.

Cutting-Edge Hybrid Silicon Lasers and Silicon Photonics Platform – Assoc Prof Wang Hong, NTU /CompoundTek

Low-loss silicon photonics enable hybrid silicon lasers with cutting edge performance and that operate across multiple application-rich wavelength regions: O-band, C-band, L-band, 1647 – 1690 nm, 1881 – 1947 nm and 1955 – 1992 nm. In this technology offering, a state-of-the-art silicon photonic platform capable of ultra-low waveguide propagation losses and high data transmission capabilities is also demonstrated.

The wide range of potential applications includes optical communications, artificial intelligence, quantum photonics, LIDAR and optical spectroscopy.



Silicon Photonics Platform

LEDs for Enabling Wireless Communications and Internet-of-Things - Dr Teo Ee Jin, ASTAR

This technology offering demonstrates a system for Li-Fi communications, featuring optical transceivers and LEDs that function as both emitter and detector. The team is able to surf the internet using LED communications and stream high-definition video in real-time with low latency. It has also successfully transmitted sensor data over a distance of more than 70m.

Li-Fi is useful in areas where radio frequency (RF) signals are weakened or cannot be received due to interference or restriction. This includes industrial Internet-of-Things, where RF may face interference from metallic environment, or for underwater monitoring and sensing (e.g. for marine inspection and maintenance of vessels, environment monitoring of climate change).



LiFi Wireless Communications

LUX Chairman presented at the EU-Singapore Industry Cluster Matchmaking Event

The inaugural EU-Singapore Industry Cluster Matchmaking event held virtually on 11-12 November was jointly organised by the European Commission and Enterprise Singapore (ESG), following the EU-Singapore Administrative Arrangement on Cluster Cooperation, signed between the Ministry of Trade and Industry, ESG and the European Commission. The event aims to promote collaboration between industry groupings from Singapore and the European Union (EU) on ecosystem development, mutual market access and co-innovation.

More than 100 representatives from EU clusters and Singapore Trade Associations and Chambers (TACS) and Centres of Innovation (COIs) attended the event graced by EU's Ambassador to Singapore, Ms Iwona Piórko and Singapore's Ambassador to the EU, Mr Lim Hong Huai.

LUX Photonics Consortium chairman, Prof Tjin Swee Chuan was invited to share the Consortium's experience and collaboration with various European photonics clusters such as European Photonics Industry Consortium (EPIC), German and French photonics clusters.

Said Prof Tjin: "The event was a useful platform to be introduced to EU organisations and companies, uncover potential collaboration opportunities and explore common areas of interest. LUX has built up a strong track record of collaboration with EU partners over the years. We are keen to explore discussions with new EU partners in optics and photonics for collaboration in co-innovation and commercial projects."

The participating cluster organisations representing ecosystems and companies include areas in Advanced Manufacturing and Engineering, Emerging Technologies, Transport and Mobility, Smart Cities and IoT, Digital Economy and Food & Agriculture.

Ms Maive Rute, Deputy Director-General of DG GROW (European Commission) said "Our EU-Singapore Free Trade Agreement (FTA) has already lowered barriers and increased market access for our businesses. Now we want to make sure that our companies successfully harness these opportunities. With more than a hundred participants, today's matchmaking event proves that our businesses want to tap into market opportunities, knowledge, talent and finance that Singapore and the EU can offer".

LUX Seed Grant Awards

Congratulations to LUX faculty and industry members - Assoc Prof Fan Weijun and Advinno Technologies, and Assoc Prof Wang Hong and CompoundTek; for being awarded the LUX Photonics Consortium Industry-IHL Collaboration Seed Grant (8th Call) in November.

The LUX Photonics Consortium Industry-IHL Collaboration Seed Grant was introduced in 2018 with the aim to encourage and seed industry-IHL collaboration for innovative technology translation and adoption. There are many novel research undertaken by faculty members which had been demonstrated in the lab, are ready for industry to productize it and perform feasibility study by leveraging on this grant. The Seed Grant call is open twice a year with the following pre-requisites:

- The technology and IPs have been demonstrated in the lab
- Industry Collaborator has to be a Full Industry member of LUX
- Principal Investigator* has to be a LUX Faculty member
- Industry cash and in-kind contribution is required
- Industry Collaborator has to sign up for an Evaluation license for the background IP
- Industry Collaborator must not be past Seed Grant awardee

**LUX Seed Grant
9th Call
is now OPEN!
Closing date: 31 March 2022**

The next LUX Seed Grant 9th Call is now open and the closing date is 31 March 2022. Members may approach us for further information or clarification.

Note: *The Seed Grant is currently applicable to both NTU and NUS faculty only.

LUX a supporting organisation for ITAP 2021

LUX was a supporting organisation for Industrial Transformation ASIA-PACIFIC (ITAP) – a HANNOVER MESSE event from 22-24 November – the “largest in-person fully-vaccinated trade event since the pandemic”. This is LUX’s fourth consecutive year participating at the leading Industry 4.0 event and LUX had a pavilion comprising 6 member companies at last year’s edition.

Themed ‘Stepping Up Capabilities with Industry 4.0’, this year’s event took place in a hybrid format, with up to 1,000 people allowed to be physically present at any one time. ITAP 2021 saw 15,000+ visitors (physical and digital) from over 50 countries and more than 100 Industry 4.0 solution providers present.

100 complimentary conference passes were extended to LUX members, who could also purchase the passes at a 20% discount. In addition, members enjoyed 11.11 promotions such as complimentary pre-event COVID-19 testing, and Grab and food vouchers.

LUX members Innovave Tech, JM Vistec, Phaos Technology and Physik Instrumente also exhibited at the event.

Industrial Transformation ASIA-PACIFIC
22- 24 NOVEMBER
PHYSICAL EXHIBITION @ SINGAPORE EXPO
ONLINE EVENT @ ITAP CONNECTED
HYBRID EVENT
STEPPING UP CAPABILITIES WITH INDUSTRY 4.0
A BIG THANK YOU TO OUR SUPPORTING ORGANISATION
LUX PHOTONICS CONSORTIUM SINGAPORE
REGISTER NOW



INNOVAVE TECH Innovave Tech



JM VISTEC JM Vistec



PHAOS TECHNOLOGY Phaos Technology



PI Physik Instrumente (PI)

New Industry Members Introduction



Industrial Vision Technology (S) Pte Ltd (Visiontec) was spun off from the Panasonic group in December 2003. It is a system integrator & Measurement & Inspection solution provider. Visiontec's is providing following products & tailored solution:

- Spectral tunable or broadband spectral lighting source such as solar simulator, simulating sun light in the Earth, Space, and Mars.
 - Solar cell I-V (Efficiency) Measurement System;
 - Light source characterization system, such as Supercontinuum generation (SCG) light source characterization system (0.3um to 20um);
 - Spectral Response & Quantum Efficiency measurement system for Detector, CCD Sensor & Photovoltaic Devices;
 - Defect Inspection System based on Photoluminescence Technology, for the inspection of Defects on SiC, GaN and GaAs Epi Wafer.
 - Provide the service of customized design of Test Jig & Fixture
- These technologies & products serve the semiconductor, Photovoltaic Solar Energy and Photonics related industries. www.visiontec.com.sg



Spectral Response Measurement system

Defect Inspection System for SiC Epi Wafer



JMVS was established in 2004 as a machine vision specialist in Singapore. Carrying over 20 renowned brands globally, distributing industrial components such as cameras, lenses, sensors, and frame grabbers etc. Our differentiation strategy is geared towards providing value-added services such as consultation, customization, software integration, vision solution and system to our clients.

JMVS's 3D Fringe Projection -an optical non-contact measurement instrument. With high speed and precision, used for 3D shape measurement of industrial products, robot 3D positioning and automatic grasping. Providing customisable service according to customer's requirements, modifying measurement range or detection accuracy to adapt to different industrial needs.

Our own confocal measurement patented technology -Confocal 3D Measurement System. Using only one image to measure 3D topography of the entire surface, suitable for high-speed 3D topography measurement and defect inspections. Applications include MEM system and 3D measurement of semiconductor components.

Our key development goal would be to come up with an image data fusion with multiple sensors input to consolidate into a single data structure able to be process by any controller.



Striving to constantly develop new solutions to solve any machine vision applications. JMVS believes in serving their clients with the utmost quality services, value-adding their technical competency to businesses.



Origgin Ventures focuses on the investment and commercialisation of defensible patents from the universities and research institutes. Our primary interests are in five areas: agri-food, advanced engineering, healthcare, information and communications technology, and sustainability. Our team members are from a wide range of technical and business background. Through our Venture Co-Creation approach, we provide the initial capital and hands-on support to create deep-tech start-ups, guide them to initial success and create value for our stakeholders. Since 2017, Origgin has successfully spun-off more than 30 deep-tech start-ups from universities and research institutes both in Singapore and abroad.





SUNYU Photonic is a high-tech company registered in Singapore as a joint venture with EHVA Inc (Canada), with core business focused within the Asia region.

We offer the first off-the-shelf or turnkey automated test and manufacturing solutions. These solutions include hardware, software and our comprehensive services enabling researchers, engineers and managers to perform their work more efficiently and cost-effectively.

Our unique hardware together with our software tools capable of testing one single die to the largest wafer with high accuracy, high throughput, and will automate the assembly of photonic components.

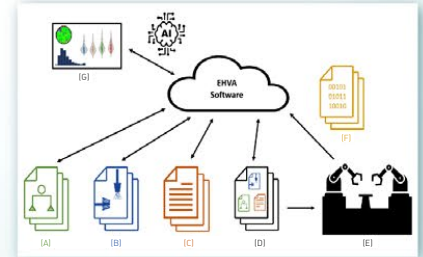
Our open-architecture software seamlessly handles component/test definitions, build recipes, test automation and can scale up with minimum effort and cost. Besides, data analysis, management and reporting can be done easily and intelligently by leveraging our Artificial Intelligence (AI)-assisted software.

Lastly, we help customers to accelerate the product time-to-market and time-to-volume-production by providing testing services, IP for metrology (PCM) structure and consultation on design-for-testability.

Gain agility and cost-effectiveness by leveraging our platform either as a solution or as a service.



E-PhAuto 12" tester which could test single die, multi-die, wafer with ease. Supporting edge coupling, grating coupling and free space coupling.



EHVA software perfectly modularize: (A) DUT/Components declaration (B) Station Configuration (C) Test Sequences (D) Test Plans (E) Automation Execution (F) Result/Data management (G) AI analysis and reporting

Industry News



Meridian's innovation a key part of new AI thermal sensing solution

Meridian Innovation – a LUX member, is developing and fabricating a new generation of cost-effective thermal imaging sensors and solutions for the mass market. Their long-wave infrared sensor is a key component in a new thermal sensing solution, recently launched by American Fortune 500 company - Arrow Electronics.

The integrated system is powered by STMicroelectronics' X-CUBE AI and will enable engineers and product designers to rapidly deploy AI and thermal sensing technologies and accelerate the development of smart, reliable, and inexpensive health-monitoring devices.

The AI-powered thermal sensing solution allows for fast, accurate temperature screening of multiple individuals at one time.

"We are experiencing an accelerating demand for our low cost thermal imaging solution. Having a lower resolution sensor array, coupled with AI, enables our customers to enhance the thermal image picture quality, resulting in a fraction of the costs with similar performance as compared to an expensive, higher resolution thermal imager" said Dr Piotr Kropelnicki, VP of Engineering of Meridian Innovation.

"Our current focus is on bringing our second generation SenXor™ product out to the market by mid of 2022. This 2nd generation product will address a lower cost structure, higher manufacturing capacity and a better sensor resolution as compared to our 1st generation product."



SenXor™ thermal image sensor



Demo session at Arrow Electronics AIOT event on 12 Oct 2021 at HKSTP



Eureka Moment for Robotics

NTU tech spin-off and LUX industry member Eureka Robotics' Dynamis software will soon be used worldwide in industrial robots offered by Denso Wave – part of the Toyota Group and a market leader in industrial robots – allowing these robots to achieve touch sensitivity and dexterity close to human hands.

The complex Artificial Intelligence algorithm was developed by Eureka Robotics co-founders, NTU Associate Professor Pham Quang Cuong and Dr Hung Pham. Dynamis enables industrial robots to have High Accuracy and High Agility (HAHA), whereas most robots currently have either high accuracy but low agility or low accuracy but high agility.

Said Prof Pham, who is also the Deputy Director of the Robotics Research Centre at NTU's School of Mechanical and Aerospace Engineering: "Today, Dynamis has made it easy for anyone to programme touch-sensitive tasks that are usually done by humans, such as assembly, fine manipulation, polishing or sanding."

"These tasks all share a common characteristic: the ability to maintain consistent contact with a surface. If our human hands are deprived of our touch sensitivity, such as when wearing a thick glove, we would find it very hard to put tiny Lego blocks together, much less assemble the tiny components of a car engine or of a camera used in our mobile phones."



Eureka Robotics co-founders, NTU Associate Professor Pham Quang Cuong (right) and Dr Hung Pham

Upcoming Events



Singapore Photonics Workshop

Lighting the Way Towards the Next Wave of Photonics Innovation



Date: 04 March 2022, Friday

Venue: NTU - Tan Chin Tuan Lecture Theatre

Session 1 – Flat Optics

Session 2 – Imaging Systems, Metrology & Sensors

Session 3 – Lasers and Fiber Optics



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