

LUX shines bright with new members, technologies

The LUX Photonics Consortium's first gathering for LUX members in 2018 saw seven new Industry members introduced, along with sharing on new technologies and solutions, and Competitive Research Programmes (CRPs).

Over 60 guests, including LUX Industry and Faculty members as well as representatives from the National Research Foundation Singapore, Singapore Economic Development Board (EDB), Enterprise Singapore, Netherlands Embassy in Singapore and Embassy of France in Singapore, attended the event held on 13 March at NTU's Nanyang Executive Centre.

In his opening address, LUX Chairman Prof Tjin Swee Chuan presented the new LUX introductory video and proudly announced that, with the addition of new members, the Consortium has grown to 44 Faculty and 35 Industry members.

He then congratulated Asst Prof Cuong Dang and GDS Instruments as well as Asst Prof Yoo Seong Woo and ST Electronics (Info-Comm Systems), the two recipients of the first grant call for the LUX Photonics Consortium Industry-IHL Collaboration Seed Grant.

Aimed at encouraging industry members to adopt technology and IPs developed at universities, namely NTU and NUS, via small-scale collaborative projects, the grant call was launched last November and closed in January. Within a short timeframe of 2 months, the awardees were announced in March.

Prof Tjin then announced the opening of the second round of grant call, for which the closing date for all submissions is 31 August.



In his opening address, LUX Chairman Prof Tjin Swee Chuan welcomed the seven new LUX Industry Members, which brings the total to 35 member companies.

There were also presentations from the seven new **Industry Members (below)**.

-  Hakuto Singapore, a subsidiary of the Tokyo Stock Exchange-listed Hakuto Co., Ltd (Japan), which has over 40 years' experience in the electronics and photonics field. The company is a distributor of products such as UV-VIS-IR Light Sources & Photodiodes, Mini-Spectrometers and Quantum Cascade Lasers.
-  ULVAC, which has the most comprehensive portfolio of vacuum technologies globally. Founded in 1952 in Japan, the company has over 6,000 employees and a presence in over 100 countries today. ULVAC has more recently been involved in areas including energy-saving and creation, MEMS sensors and next generation displays.
-  Pro-health Water Technologies, a Singapore start-up. Its' technology can convert water purified via the reverse osmosis process, which filters out the key minerals of calcium and magnesium, to water that has a good balance of calcium, magnesium, potassium and sodium.

Message from the Chairman/Co-director:

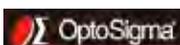
This is our 8th issue of ILLUMINATE, a good two years since our first issue back in May 2016. TPI and LUX have certainly come a long way in making themselves known to the academic and industrial community at large, while taking steady steps towards establishing a strong photonics presence in Singapore.

Four individuals in TPI have received recognitions in recent months. First, I would like to congratulate my fellow co-director of TPI, Professor Nikolay Zheludev, on being elected as Fellow of the Royal Society (FRS). Nikolay is the first NTU professor to have gained such a prestigious honour, putting him in a very special league of scientists (that include Albert Einstein and Stephen Hawking) to have received this fellowship. Asst Prof Steve Cuong Dang and Assoc Prof Murukeshan Vadakke Matham have received good media coverage from The Straits Times and Channel NewsAsia on their highly impactful research, in ground glass reverse engineering for lensless cameras and GonioPEN for glaucoma diagnosis respectively. Assoc Prof Yong Ken Tye's team recently received a gold medal for their research on heavy metal ion detection in water at the 46th International Exhibition of Inventions in Geneva, Switzerland. At NUS, Professor Hong Minghui has also been elected as Fellow of the Academy of Engineering Singapore (FSEng). My heartiest congratulations to them – their hard work and effort have certainly paid off.

For LUX, the consortium has now grown to 42 industry members and 49 faculty members. We would like to welcome the latest round of new members onboard – ST Electronics, Acexon Technologies, The Freyr Group, Moveon Technologies, Palomar Technologies and Transcelestial Technologies. A couple of months back, I went along with seven of our member companies to visit several photonics companies and research institutes in Berlin, organised by EPIC, as well as attend the EPIC AGM. What impressed me most was Europe's systematic approach towards organising and aligning their research and industry ecosystem. I am glad to hear many positive feedbacks our members had from the trip, in terms of the extensive interactions and useful leads generated for them.

To sustain the momentum in Photonics, TPI and LUX will be hosting a technical conference on 26 Nov 2018 in NTU. We hope to see you there.

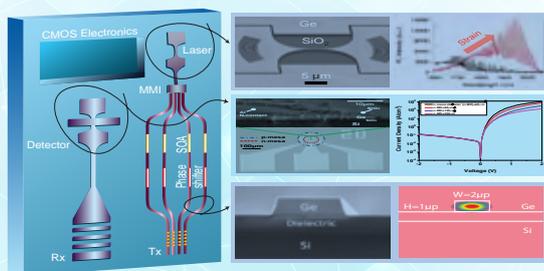
-  Silterra, based in Malaysia, is a 200mm semiconductor wafer foundry that offers full range of process technologies covering its core business in Advanced CMOS technology to cutting edge differentiated technologies in MEMS, silicon photonics, Bipolar-CMOS-DMOS, power MOSFETs and biophotonics.
-  Shimadzu Asia Pacific, a subsidiary of the Shimadzu Corporation. It was established in 1989 in Singapore as a distribution centre to provide analytical solutions, scientific equipment, testing machines, balances and medical equipment to a wide range of laboratories.

-  SIGMAKOKI, a JASDAQ-listed company and global supplier of quality laser components (optics, optomechanics and motion control) and application systems. "OptoSigma" is the company's global brand.
-  Photizo, which specializes in the development and integration of intelligent IoT infrastructure and smart lighting solutions to make Smart Cities a reality.

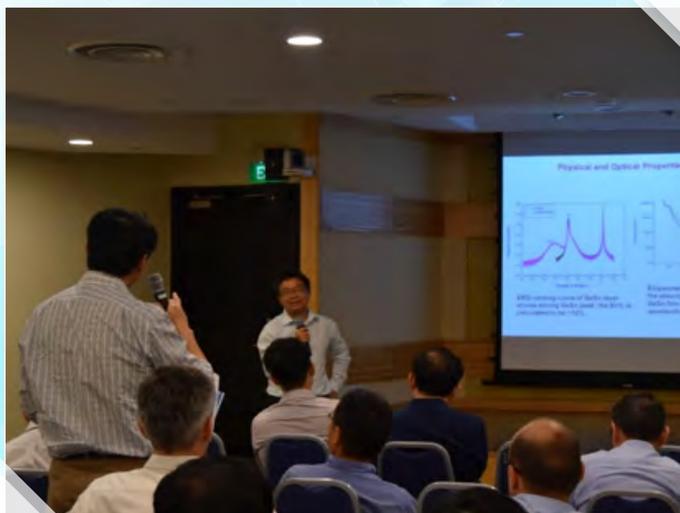
Technical Talks showcasing exciting technologies a highlight of the event

Technical Talk 1 | Germanium-Based Materials for Silicon-compatible Near-IR and Mid-IR Light Source

Assoc Prof Tan Chuan Seng discussed how he is developing a fully-integrated transceiver chip via a germanium-on-insulator (GOI) on silicon platform approach.



- The advantages of silicon include scalability and manufacturability (cost). Meanwhile, germanium is silicon-compatible and has excellent optical properties (such as absorption).
- One issue is that Germanium is inherently an indirect bandgap material and hence light emission is not efficient. The CRP proposes two approaches to realize the light source: Interband strained-Ge laser & Intersubband GeSn Laser.
- Assoc Prof Tan hopes the team's work will solve issues of reliability, cost and scalability for this technology to be applicable in communication and sensing.



Assoc Prof Tan Chuan Seng presenting his Competitive Research Programme (CRP) work on germanium-on-insulator (GOI) on silicon platform.

Technical Talk 2 | Mid-infrared and Terahertz waves for non-invasive sensing, communication, and environmental monitoring

In his presentation, Assoc Prof Wang Qi Jie observed how high-performance photonic-based mid-infrared and Terahertz spectroscopy sensors in the important 3 to 300 micron spectral region could enable a broad range of applications.

- Recent advances in mid-infrared lasers (quantum cascade lasers) and detectors are key.
- Assoc Prof Wang's team is working on a broadly tunable single-mode quantum cascade laser, which will have wide tuning bandwidth and high accuracy, yet be small in size and affordable.
- Potential applications include sensing & spectroscopy, biomedical sciences, communications, quality control of food, environmental monitoring and process control, imaging and security screening, and defence.



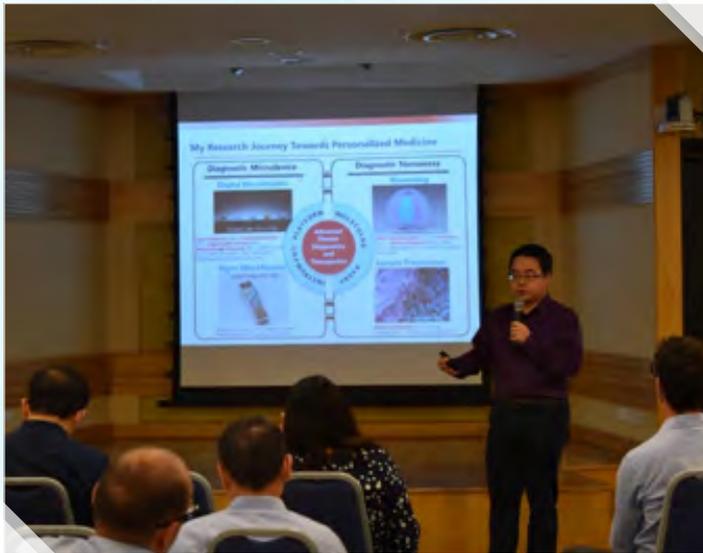
Assoc Prof Wang Qijie hopes that his CRP work on high-performance mid-infrared lasers and photodetectors will bring about benefits like a further reduction in size and cost, and system integration.

Technical Talk 3 | Beyond Conventional Medicine with Micro/Nanotechnology

Asst Prof Zhang Yi, whose lab looks at technologies for disease diagnostics and therapeutics, shared how he is seeking to develop point-of-care diagnostics to reduce costs and turnaround time (from sample to results) for patients.



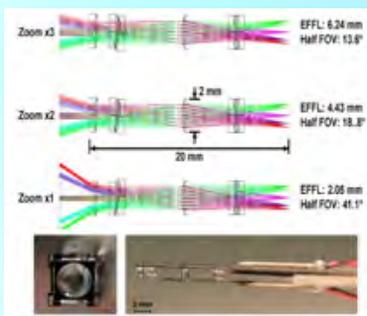
- His work focuses on the droplet manipulation techniques, involving surface energy traps, and applications of magnetic digital microfluidics in diagnostics and biosensing. Magnetic digital microfluidics can be used for point-of-care diagnostics in low-resource settings.
- He has also explored paper-based microfluidics as a low-cost solution for rapid diagnostics in low-resource settings and fluorescent single molecule detection technology for high-sensitivity biosensing.



Asst Prof Zhang Yi shared his work on technologies for disease diagnostics and therapeutics.

Technical Talk 4 | Miniature Solid Tunable Lens Technology and Its Applications

Assoc Prof Zhou Guangya discussed liquid-free varifocal lenses as a perfect fit for applications including mini cameras for ultra-compact endoscopes, smart phones, and micro air vehicles.



- Typically, such optical systems must be dynamic in order to provide users with functionalities such as auto-focusing, optical zooming, and luminous flux and/or depth of field control.
- Miniature solid varifocal lenses combining free-form optics with microsystems technology are compact, robust and allow for ease of large optical power variations.
- The free-form surface elements also offer more freedom in design for optical aberration correction.



Assoc Prof Zhou Guangya presented liquid free varifocal lenses for applications such as ultra-compact endoscopes.

Technical Talk 5 | Programmable Photonics Materials

According to Asst Prof Robert Simpson, plasticity will be key as the fields of machine learning neural networks and the Internet of Things merge to create interconnected intelligent networks. Hence, future photonic devices must be both reprogrammable and multifunctional.

- Key enabling materials will likely be liquid crystals, electro-elastomers, piezoelectrics and phase change materials.
- Asst Prof Simpson also introduced a new phase change material, which is transparent in the visible and infrared, exhibits refractive switching on a nanosecond time scale, and once switched is stable for years at room temperature.



Asst Prof Robert Simpson presenting his talk on programmable photonics materials.

'Royal' honour for Prof Nikolay Zheludev



The Photonics Institute Co-Director Prof Nikolay Zheludev has become the first NTU professor to be elected a Fellow of The Royal Society, which is a Fellowship of many of the world's most eminent scientists including the likes of Albert Einstein, Isaac Newton and Stephen Hawking.

Prof Zheludev was elected to the world's oldest scientific academy for his pioneering work in the closely interlinked fields of metamaterials and nanophotonics. He has played a key role in the development of new concepts whereby precise nanoscale structuring of matter enhance and radically change its optical properties.

Nanostructured matter has been used by Prof Zheludev to create electromagnetic environments that are better suited to the study of new fundamental phenomena of light-matter interaction and light generation processes. His work has enhanced the photonics toolkit, lending itself to many applications ranging from optical information processing to imaging.

Prof Zheludev's election on 9 May sees him join the ranks of about 1,500 other Fellows. The don, who received his degrees from Moscow State University, was previously awarded the Thomas Young medal for "global leadership and pioneering, seminal work in optical metamaterials and nanophotonics". He is also a professor at the University of Southampton and deputy director of its Optoelectronics Research Centre.

A jolly good fellow



LUX Faculty Member Prof Hong Minghui has been elected a Fellow of the Academy of Engineering, Singapore, which was founded to provide leadership among engineering professionals, advance engineering education and promote engineering excellence in Singapore. Fellows are elected via a rigorous peer-review process on the basis of their leadership and career achievements in the engineering field across all disciplines, and there are about 90 Fellows currently.

Specialising in optical engineering, Prof Hong has co-authored 10 book chapters, 26 patents granted, and over 400 scientific papers, as well as delivered more than 60 talks in international conferences. The don from the National University of Singapore's Department of Electrical and Computer Engineering (ECE) has served as an editor of several journals including Light: Science and Applications by Nature Publishing Group. He is also director of the University's Optical Science and Engineering Center.

He is a Fellow of The Optical Society (OSA), Fellow of International Society for Optics and Photonics (SPIE), Founding Fellow and Vice President of International Academy of Photonics and Laser Engineering, and Fellow and Council Member of Institute of Engineers, Singapore. Prof Hong also serves as Chairman of Phaos Technology Pte. Ltd., a spin-off company to commercialize the technologies being developed in ECE and which is supported by the National Research Foundation's Competitive Research Programme.

NTU team strikes gold at prestigious International Exhibition of Inventions

A team from NTU's School of Electrical and Electronic Engineering has clinched a gold medal with the jury's commendation at the 46th International Exhibition of Inventions in Geneva, Switzerland, for their device that can detect heavy metal ions in water via a surface modified microfibre.

In what is arguably the most important inventions exhibition in the world, under the patronage of the World Intellectual Property Organisation (WIPO), over 800 exhibitors from 40 countries took part in the event held from 11-15 Apr and displayed more than 1,000 new inventions and products.

Led by Assoc Prof Yong Ken Tye, who is also Director of the Centre for Bio Devices and Signal Analysis (VALENS), the team comprising research engineer Abdul Rahman bin Shaik Alauddin and PhD student Stephanie Yap Hui Kit competed under the "Energy - Environmental Protection" category. Out of 90 exhibitors in this category, the team was one of only 14 to have impressed an international jury team of 82 specialists, emerging with the recognition of gold medal with the jury's commendation for the innovative value of their invention. As this is the first time a team from Singapore has participated in this event, the achievement is something both NTU and Singapore can be proud of.

The team's device uses a surface modified microfibre with sub-wavelength tapered radius for straightforward sensing and real-time monitoring of heavy metal ion pollutants in water. Its advantages include high sensitivity, good selectivity, having long life-cycle of components and assemblies, as well as being lightweight and compact. A GPS ID tracking feature means it can be linked to a mobile app, allowing users to receive real-time feeds.

In addition, thanks to its high degree of surface functionalisation versatility and taper profile tuning capability to yield the desired limit of detection and detection range, it can easily be used to detect other forms of water pollutants.

The team was inspired by the critical water supply and drinking water quality problems facing the world, as well as Singapore's ongoing focus on developing sustainable water strategies.



Assoc Prof Yong Ken Tye (right) with research engineer Abdul Rahman bin Shaik Alauddin and PhD student Stephanie Yap Hui Kit at the 46th International Exhibition of Inventions in Geneva, Switzerland.

Berlin trip an enlightening experience for Singapore delegation

A delegation from Singapore, led by the LUX Photonics Consortium, got up close and personal with the thriving Berlin photonics scene in April.

The delegates consisted of representatives from seven LUX Industry Members, as well as from the National Research Foundation Singapore, Singapore Economic Development Board, Enterprise Singapore, LUX and The Photonics Institute.

The five-day trip, from 16 to 20 April, saw the Singapore delegates participate in the European Photonics Industry Consortium (EPIC) Annual General Meeting (AGM), which is usually exclusive to EPIC members. EPIC is an industry association that seeks to promote the sustainable development of organisations working in Europe's photonics space and foster a vibrant ecosystem.

It also provided ample opportunities for the Singapore companies to explore partnerships with their Europe counterparts, as well as learn more about their latest photonics technologies and solutions, particularly as many EPIC companies work in areas such as lasers, fibres and sensors.

Said Ms Chew Kai Hwa, R&D Director of Quantum Chemical Technologies: "Visiting some German companies in Berlin has given us a good insight on the level of technology these companies have already achieved. This event has also provided us with good insights into the European industry and we hope to forge some good collaborations with these companies in the near future."

The first three days of the trip saw the delegation visit nine photonics companies and research institutes: Fraunhofer IOF, ZEISS, Jenoptik, Fraunhofer HHI, LayTec, Fraunhofer IZM, AEMtec, art photonics and First Sensor. Some highlights of these centres are detailed below:

Fraunhofer IOF: Their technical expertise is in freeform optics technology, fibre lasers, optical technologies for human-machine interaction, and nanotechnology.

ZEISS (Carl Zeiss): A solutions provider in the areas of imaging, semiconductor manufacturing technology, microscopy, medical technology, as well as consumer products and vision care.

Jenoptik: A design, development and production company for optical and micro-optical systems, producing a wide range of optics products, as well as IR cameras and femto-second lasers.

Fraunhofer HHI: Engages in R&D in Sensing and Data such as THz sensors, Computation Capabilities in the form of video compression and machine learning, as well as Wireless Technologies spanning Communications, LiFi and the 5G Network.

LayTec: A provider of metrology-based equipment aimed at enabling advanced process control, resulting in high yield, high performance

manufacturing for industry and research.

Fraunhofer IZM: Focuses on packaging technology and the integration of multifunctional electronics into systems of various application fields.

AEMtec: Provides excellence in optoelectronics and sensor systems, offering high-end chip level technology services from product/process development to packaging.

art photonics: Produces speciality fibre products such as laser cables, fibre bundles and spectroscopy probes for a broad spectral range (300nm to 16µm), with applications in industries including medical, petrochemical and food.

First Sensor: A leading provider of sensor technology, targeting the industrial, medical and mobility markets. The company has a long-standing experience in Avalanche Photodiodes (APDs), making them well-positioned to capitalise on the growing LIDAR market.

The Singapore delegates were highly impressed with the technologies displayed by the companies and research institutes. At the last stop, First Sensor, the delegates delivered brief presentations on their respective organisations to EPIC members who had joined the visit.

Just as beneficial was the opportunity to participate in the EPIC AGM, which was attended by over 200 member companies from across Europe. 65 percent of the company representatives present at the event – which also marked EPIC's 15th anniversary – were decision-makers, such as CEOs, CTOs, Presidents, or Managing Directors.

Held at the Grand Hyatt Berlin, there were presentations from new EPIC members, as well as keynote presentations from renowned EPIC companies. One such company was NKT Photonics, which discussed the ultrafast fibre laser revolution – higher power and shorter pulses for medical and industrial micro-processing. Another company was ficonTec, which talked about lowering the cost of Integrated Photonics Chips through advanced automated assembly and testing. The LUX delegation also made the most of the networking breaks in between the talks to establish new partnerships.

Said Mr Chance Wanlass, Founder of The Freyr Group: "As a company launching a new photonics-based solar technology, part of The Freyr Group's challenge is finding the outside intellectual & material resources necessary for realizing our vision."

"As new LUX members we had the opportunity to attend the 15th EPIC AGM in Berlin. At EPIC we found everything we needed and much more. The institutions and businesses we met there have already enabled us to cut millions in anticipated R&D costs and saved two years of time. It was by far our most fruitful conference."



The LUX delegation given a tour of Fraunhofer IZM's cleanroom wafer fabrication processes, such as photolithography.



Having dinner together in Jena after the company visits, arranged courtesy of EPIC.

Innovation Spotlight

Sharp, colour images with no lens, nor colour filters?



This is now a possibility thanks to a new NTU-developed camera technology that uses only a piece of ground glass and a monochrome sensor.

It creates multi-coloured images by 'reverse engineering' the light that is scattered by the ground glass, thus obtaining the original image projected on to it.

Different wavelengths of light are scattered differently, so the NTU scientists developed an algorithm to reconstruct the image. They built a library of 'speckle patterns' linked to each wavelength, including those in the infrared and ultraviolet spectrums.

Indeed, being able to capture any range of light spectrum trumps existing cameras on the market, which are pre-fixed.

The ability to reconstruct images in the infrared and ultraviolet spectrums also offers possibilities for the technology to be used in imaging purposes for medicine, surveillance, forensics and astrophysics.

The lack of a lens – which is typically bulky in size and expensive to make – opens up other possible applications. For one, smart phones and compact cameras could be made slimmer if the lens and colour filters were replaced by ground glass.

NTUitive has filed a patent for this new technology and the research team, which is led by Asst Prof Steve Cuong Dang from NTU's School of Electrical and Electronic Engineering, will be engaging industry partners to see how they can adapt their technology for real-world applications.

New 'pen camera' to help tackle a leading cause of blindness



Meet the GonioPEN, developed by NTU scientists and clinicians from the Singapore Eye Research Institute (SERI) to make it easier for doctors to diagnose patients with glaucoma, which is found in about three per cent of people aged over 40 in Singapore – or over 65,000 people here. There are no early symptoms for glaucoma, but a build-up of pressure inside the eye can be an indicator.

Currently, gonioscopes are used in eye examinations. These glass scopes must be pressed against a patient's eyeball so the doctor can look at his or her eye's drainage canal to diagnose the cause. The experience can be an uncomfortable one for the patient.

On top of that, visual diagnosis can only be made via a microscope paired with the gonioscope. The current gonioscopy method takes up to 15 minutes and a skilled specialist must be present to diagnose the problem on the spot. Hence, it is not done in clinics as a routine, leaving glaucoma largely undiagnosed.

In contrast, the GonioPEN – which combines a high-resolution camera and LEDs for illumination – allows doctors or trained technicians to capture high-quality images of the eye drainage canal with minimal contact at the side of the cornea. It is connected to a computer via USB so images can be easily transmitted too.

Apart from being simple to use, the device is also compact in size and low in cost, particularly as a microscope is no longer required.

The project team is led by Assoc Prof Murukeshan Vadakke Matham, Director of NTU's Centre for Optical and Laser Engineering (COLE), in collaboration with Prof Aung Tin, SERI's Executive Director.

Industry News

POET Technologies and SilTerra to collaborate on Optical Interposer Platform

(POET Technologies's division Denselight Semiconductors and SilTerra are LUX Industry Members)

The two companies recently announced an agreement to work together on the co-development of certain fabrication processes and the manufacturing of POET's Optical Interposer Platform.

The partnership between POET, which specializes in integrated photonics, and SilTerra, a Malaysia-based semiconductor wafer foundry and new LUX Industry Member, seeks to accelerate the commercialization of the Optical Interposer. This will enable optical engines for single-mode transceiver modules and other high bandwidth devices.

Said POET's CEO, Dr. Suresh Venkatesan: "SilTerra offers POET a truly unique combination of advanced 90 nanometer lithography, cost-effective 8" silicon processing copper metallization and MEMS capabilities, all of which are needed for our Optical Interposer."

Firdaus Abdullah, SilTerra's CEO said, "POET's Optical Interposer is a major advance over other approaches to optical interconnects and facilitates the co-packaging of electronics and photonics devices in a single Multi-Chip-Module (MCM)."

The companies will also bring-up critical waveguide processes previously developed by POET for its Optical Interposer, and implement the process flows on newly purchased equipment at SilTerra's 8" silicon foundry in Kulim, Malaysia.

World's brightest self-emitting display panel lights up Display Week 2018

The next wave of watches, phones, heads-up-displays, and augmented reality products could be powered by a new micro LED display with high brightness and contrast. Unveiled by glō and Jasper Display Corp. (JDC) at the Display Week 2018 held in Los Angeles in May, the technology is made possible by pairing the industry's brightest Micro LEDs (10 μm), developed and integrated by glō, with JDC's new silicon backplane, the JD67E2.

The JD67E2 allows the Micro LED industry to take advantage of silicon that is tailor-made for high-performance Micro LED devices. The full-color capable JD67E2 die features a resolution of 1920 x 1080, pixel pitch of 8 μm, and offers excellent current uniformity – better than 1% across the array – via a proprietary current source pixel.

Besides increased brightness and contrast, JDC's patented, per-pixel pulse width modulation technology is perfect for Micro LEDs because digital switching allows for precise and consistent coloring as compared to an analog drive scheme: a single on-state current will deliver a single, stable color.

An additional benefit of the JD67E2 is that it is software configurable. As such, hardware developers can easily and independently set brightness (via PWM) and color (via current).

Local Conferences and Exhibitions

Industrial Transformation Asia-Pacific (ITAP), 16 ~ 18 October 2018, Singapore Expo



Members interested to exhibit, please contact ChoiPheng choipheng.soo@ntuitive.sg or Kim Hai khsim@ntu.edu.sg for more information.

Photonics @ SG 2018 - Photonics Conference organised by The Photonics Institute and LUX Photonics Consortium, 26 November 2018, NTU HSS Auditorium



Expounding on the theme of photonics materials for new technologies and applications, this year's conference and exhibition will feature Plenary and Keynote talks from renowned academics such as

- Prof Din Ping Tsai (National Taiwan University)
- Prof Sir Peter Knight (Imperial College UK)
- Prof Ben Eggleton (University of Sydney)
- Prof Satoshi Kawata (Osaka University)

Block your calendar and come join us for this exciting event that showcases the latest Optics and Photonics research and technologies! Attractive sponsorship packages are available for industry members. For more details, please contact Kim Hai khsim@ntu.edu.sg or Daryl darylho@ntu.edu.sg.