

## New LUX members abuzz about Consortium's prospects

The LUX Photonics Consortium's Faculty Member Welcome Session on 12 July saw a warm reception for the newest faculty members. There are currently close to 20 members from NTU and the National University of Singapore (NUS), and recruitment is on-going with faculty from all local institutes of higher learning.

At the session held at the National Research Foundation (NRF), LUX Chairman Prof Tjin Swee Chuan introduced the Consortium to the new members and updated them on the latest news, such as the recently-signed Memorandum of Understanding with the European Photonics Industry Consortium, and upcoming activities like an Industry & Faculty Members Networking.

In his welcome address, Mr. George Loh, program director at the NRF, Prime Minister's Office, Singapore, suggested that member's research projects – such as those in the NRF Competitive Research Programme – be shared between PhD and postdoc students of Principal Investigators (PIs) so there would be synergistic effects. He added that PIs could also try to initiate new projects with the industry by discussing their research outcomes with companies.

There were also introductions by the various faculty members who are an integral part of the Consortium with their

subject matter expertise and potential to provide training courses and access to equipment and facilities, as well as speak at technical seminars and workshops. Members can also contribute by sharing their ideas and seeking industry partnerships. Each member shared their main research focus area, their current projects, as well as proposed three new areas or topics for potential industry collaboration.

One of them was Assoc Prof (Adj) Guillaume Georges Vienne, who spoke about his recent projects on light-matter interaction (laser processing), metamaterials and metasurfaces, and nonlinear optical processing.

Guillaume thoroughly enjoyed the occasion, enthusing: "While I'd heard of some of my fellow new faculty members through colleagues or via their publications, I was glad to meet so many local photonics players in one place. It was a pleasure to hear their presentations and to discuss later over a good lunch."

Another new faculty member present was Assoc Prof Xu Qing-Hua from the NUS, who discussed his research on the nonlinear optical properties of novel nanocomposite materials and their applications in biomedical and energy areas.

## Message from the Chairman/ Co-director:

A lot has happened in the past months following the inaugural issue of *Illuminate* newsletter. I am delighted to share some of these exciting activities in this second issue. The LUX Photonics Consortium membership has grown considerably with the addition of faculty members from local IHLs (NTU & NUS) who bring their photonics research expertise to the Consortium. Translation research by academics in support of industry is an integral part of the LUX Consortium. A session was held at NRF in July to welcome our Faculty members; they were briefed on the mission and vision of the Consortium, the benefits and Consortium activities, as well as their role in the Consortium. We hope to further expand our pool of research talent in response to the needs of industry.

Continuing our successful run of Technical Seminars on Fibre Technologies, world renowned scientist and serial entrepreneur Prof Sir David Payne gave his insights in manufacturing in photonics and the challenges. Prof Nikolay Zheludev also talked about recent advances in super-oscillatory technologies. Through this technical seminar series, we hope to increase interactions between academia and industry, and forge a closer collaborative partnership.

Lastly, I would like to congratulate Prof Sir David Payne, Co-Director of TPI and Director of the Optoelectronics Research Centre at the University of Southampton on receiving the Honorary Doctor of Engineering degree from NTU, and Prof Hong Minghui from NUS, on receiving the Institution of Engineers Singapore (IES) Prestigious Engineering Achievement Award.



LUX Chairman Prof Tjin Swee Chuan introduces the 13 local and international companies that make up the Consortium's founding industry members.

He commented: "LUX brings academia and industry together for the common purpose of innovating new products or technologies that are enabled by photonics. I joined the Consortium to better network with the community and develop collaborations with peers and industry partners in Singapore."

Meanwhile, NTU's Asst Prof Cuong Dang talked about potential industry collaborations such as a human-centred lighting system that will produce light closest to natural light and which is optimized for human users according to their mood, task-at-hand and physiology.

He joined the Consortium in order to "know much more about the photonics industry and what they are looking for",

so he can adjust his research to meet the industry's demands.

Adds Asst Prof Cuong: "This connection between academic capabilities and industrial needs is very important but usually very difficult to establish, not just in Singapore but also in many parts of the world."

Assoc Prof Zhou Guangya's three mooted areas for potential industry partnerships are in miniature tuneable optics, nano-photonics and nano-mechanical sensors, and microelectromechanical systems (MEMS) and nanoelectromechanical systems (NEMS) for imaging.

The NUS don is ready to contribute to the Consortium, saying: "Perhaps I can be a consultant to other members if my expertise is needed. I can also offer usage of my lab facilities."

And where does he hope to see the consortium in five years? "Of course, that it has continued to grow with more faculty and industry members."

"Also, that it is an established platform for industry members to present to faculty members their technical needs and problems as well as product directions and roadmaps, and for faculty members to present their recent research to the industry members."

# Technical Seminar Series

## Shedding light on fibre technologies

The Innovation Centre's Theatre @ The Nest was the setting for a recent illuminating technical seminar themed "Fibre Technologies – from cutting-edge research leading to industry applications".

The audience at the LUX Photonics Consortium-The Photonics Institute (TPI) event on 26 July numbered about 50 and included representatives from the National Research Foundation, Prime Minister's Office, Singapore, and industry members from LUX Photonics Consortium, as well as university researchers and students.

And they were certainly captivated by the thought-provoking talks by distinguished speakers Prof Sir David Payne and Prof Nikolay Zheludev.

Prof Payne, whose work in fibres fabrication in the 1970s resulted in most of the special fibres used today, spoke on the topic of "Light Works – Manufacturing with Photonics".

A world-renowned scientist who was awarded an Honorary Degree of Doctor of Engineering for his revolutionary work in optoelectronics at this year's NTU Convocation, David's talk focused on the photonics manufacturing industry and the challenges facing it.

He also touched on increasing competition from the likes of the Institute for Manufacturing Innovation, which is dedicated to the development of integrated photonics technologies and set to receive more than \$100million in funding from the United States government.

Using research done by the University of Southampton's Optoelectronics Research Centre as an example, Sir David described how optically-written 5D in quartz glass could be a far superior archival storage medium to the current alternatives of Blu-ray, DVD and CD in terms of capacity and durability, and would be invaluable in a world where at least a million terabytes of data are generated daily.

Prof Zheludev, TPI co-director and 2015 recipient of the Institute of Physics' prestigious Young Medal and Prize for his global leadership and pioneering efforts in nanophotonics and optical metamaterials, then spoke about "Recent advances in super-oscillatory technologies: focusing of light and imaging".



With over 650 published conference and journal papers and more than 40 patents under his belt, Prof Sir David Payne was able to provide valuable insights into the photonics manufacturing industry.

Comparison				
	CD	DVD	Blue-ray	5D
Capacity	0.7 GB	4.7 GB	23.5GB	360TB per disc
Longevity	5 years	7 years	7 years	10 <sup>^</sup> 20 years
Speed	1.2 Mbit/s (1x)	10.5 Mbit/s (1x)	36 Mbit/s (1x)	20 Mbit/s

Current 5D writing speed: 12 Kbits/s  
 Current capacity: 100 GB/disc  
 5 bits per dot

Advantages of 5D in quartz glass: High capacity  
 Long life time

Advantages of 5D storage medium compare to current technologies.



Prof Nikolay Zheludev, a world-leader in the field of nanophotonics and metamaterials, describes optical super-resolution imaging via optical super-oscillations.



He described how optical super-oscillations, first observed in 2007, may offer a means of achieving optical super-resolution imaging and reviewed recent attempts to create optical super-oscillations using binary masks, spatial light modulators and planar metamaterial masks. Prof Zheludev then outlined the merits and limits of super-oscillatory imaging.

At the end of the talks, participants were given a chance to pose their burning questions to the speakers, before being treated to a delicious spread of Nyonya delicacies at the networking session that concluded the event.

## Featured Research Capability

### Finally, a Singapore home for optical fibre R&D

NTU is home to the only optical fibre fabrication facility in Singapore, and has strong ties with the University of Southampton's Optoelectronics Research Centre (ORC), which is renowned for its expertise in fibre technology and understanding of photonics.

Little wonder then, that despite having only been officially launched two years ago, the Centre for Optical Fibre Technology (COFT) is well-placed to capitalise on a growing demand for fibre-optics sensors and lasers.

That is where COFT – the newest of five centres under The Photonics Institute (TPI) – comes in. A joint endeavour between DSO National Laboratories, the Agency for Science, Technology and Research (A\*STAR) and Nanyang Technological University (NTU), it was founded to develop core capabilities and technologies for specialty optical fibre fabrication and characterisation.

Says COFT's Director, Prof Shum Ping: "The development of such optical fibres is vital to advancing fibre-based devices, as off-the-shelf commercial fibres often cannot provide the necessary requirements for advanced applications."

"COFT is uniquely positioned to provide these specialised fibres through working with individual researchers, groups or companies to understand their requirements, as well as designing and fabricating the fibres to suit their applications with our state-of-the art optical fibre fabrication and characterisation equipment."

### Developing a pool of talent for the Singapore photonics scene

Set up with the help of the ORC, COFT benefits from its close collaboration with the University of Southampton-based centre.

To date, eight COFT research staff have each spent at least a year at the ORC, where they received training that was invaluable in helping them to launch COFT when they returned home. One of them is Mr Daryl Ho, who joined COFT as a researcher straight after graduating from NTU.

He shares: "The opportunity to acquire new knowledge in a field different from my area of study and be a pioneer in starting a new initiative at NTU were strong motivations. However, the overriding factor was the offer of training in the United Kingdom from a renowned institution on the fibre fabrication process."



*COFT'S Director, Prof Shum Ping, envisions the Centre becoming a hub for optical fibre fabrication and fibre-based devices research.*

State-of-the-art facility housed in Nanyang Technological University (NTU) for the fabrication of specialty optical fibres for:

- High power fibre laser
- Sensing
- Biomedicine
- Defence
- Imaging



*Dr Sidharthan Raghuraman works on the Modified Chemical Vapour Deposition (MCVD) system, which is used for the fabrication of optical fibre preforms.*

Dr Sidharthan Raghuraman is another to have benefited from the ORC stint. He says: "I was fortunate enough to be part of the group sent to ORC, who are pioneers in the field of optical fibres."

"We received extensive training in all aspects of fibre fabrication and characterisation from the experts. The knowledge and confidence we gained from our stint at ORC enabled us to hit the ground running on our return to Singapore."

Dr Sidharthan is proud that, in a short space of time, the COFT team was able to "fabricate fibres which can rival the best that the industry can offer in terms of design, loss and performance".

Today, the Centre is capable of fabricating a full range of optical fibres - from passive and active silica fibre, to soft-glass and polymer fibres.



## A hub for optical fibre fabrication and fibre-based devices research

COFT's achievements to date include local fabrication of the following specialty fibres:

- Air-core erbium-doped fibre, which demonstrates, for the first time, broadband operation of an optical orbital angular momentum (OAM) erbium-doped fibre amplifier (EDFA) for lower-order OAM modes;
- Highly nonlinear Ge-doped fibre, demonstrating broadband supercontinuum generation with record high power;
- Hollow core fibre with split cladding design for anti-resonant effect;
- Rectangular core fibre with a large mode area that is induced to bend in only one direction.

These projects were spearheaded by principal investigator Asst Prof Yoo Seongwoo, a faculty member who is actively involved in the operations of the facility. Says Asst Prof Yoo: "It is essential that capabilities are developed quickly to fabricate a wide range of novel, high quality fibres. This would generate confidence among potential collaborators in COFT's ability to deliver fibres that meet their requirements."

Says Mr Ho, who assisted with the latter project in his role as a specialist in preform post-processing: "It was hugely gratifying to

watch the shape of the fibre core being moulded into a rectangular one after several rounds of post-processing."

"The properties of the rectangular core fibre make it useful for lasing purposes. High power fibre lasers have several real-world applications at present, including laser manufacturing, cutting, marking and engraving."

Looking ahead, Prof Shum wants to push on and shape COFT into a hub for optical fibre fabrication and fibre-based devices research, saying: "Our Centre gathers fibre-based technology and applications in Singapore under one roof and has partnered overseas universities and research groups to develop ways to manufacture special optical fibres and related technologies."

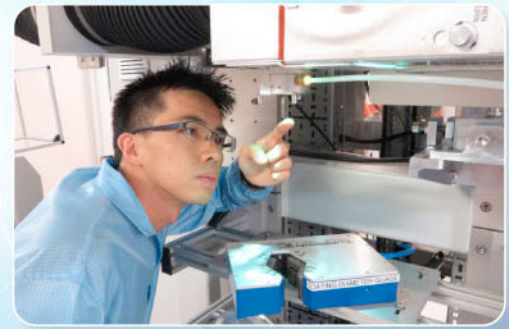
He believes that being under the TPI umbrella will aid this ambition, as COFT now receives more attention from members of the global academic and industry community. It can also "leverage on the critical mass of photonics research in NTU and foster interdisciplinary collaboration across research groups".

Mr Ho agrees, adding that COFT will also benefit from TPI's close links to the LUX Photonics Consortium, a joint initiative by NTU and the National University of Singapore, and supported by the National Research Foundation, Prime Minister's Office, Singapore.

"Such connections can only be beneficial for COFT as they create potential opportunities for us to work closely with industry partners to deliver fibres of greater purpose and impact to society. At the same time, companies within the industry are made aware of the technologies and capabilities available at COFT."

He is excited about the potential for growth in Singapore's photonics scene, enthusing: "Light has the potential to be the next frontier of engineering and may even replace existing electronic technologies in several ways, such as in circuitry and components."

"With efforts being made to encourage closer cooperation between the industry and research community, a bright future lies ahead for the field of photonics."



Mr Daryl Ho specialises in the drawing of optical fibres using the Fibre Draw Tower at COFT.

## Industry News

# DenseLight looks forward to a fruitful journey of membership with LUX Photonics Consortium after acquisition by POET Technologies Inc

Shortly after news of POET's acquisition of DenseLight Semiconductors was released on 28th April, we met with Dr Suresh Venkatesan, POET's Chief Executive Officer, for an introduction to the LUX Photonics Consortium, as well as a visit to NTU's The Photonics Institute (TPI) to better understand the company's plans and its roadmap in Singapore.

"The acquisition of DenseLight Semiconductor reflects a new chapter in our history, and serves as a significant step in realizing the promise of our product roadmap and strategic plan that we established in September 2015", said Dr Suresh Venkatesan, POET's Chief Executive Officer. "This synergistic combination can provide our customers a broader range of differentiated photonics technologies. The resulting enhancement of our design, test and packaging capabilities also promises to optimize time-to-revenue for our

customers. POET now has a larger product portfolio to enhance our mission of enabling integrated photonics products for our expanded end markets."

POET intends to expand the operations of DenseLight's existing manufacturing facilities in Singapore. This strategic acquisition will result in many ancillary benefits to the combined company. DenseLight's test and reliability capabilities will be particularly valuable in accelerating New Product Introduction (NPI). Additionally, POET expects to benefit from access to DenseLight's team of experienced engineers and employees.

At the visit to TPI in NTU on 13th May, Dr Suresh Venkatesan remarked that there is a wide range of photonics research expertise and capability in Singaporean universities, and that he is impressed by the Centre of Disruptive Photonics Technology (CDPT)

and Centre of Excellence for Semiconductor Lighting and Displays (LUMINOUS!), both under the TPI. Dr Suresh Venkatesan also applauded the work of LUX Photonics Consortium which seeks to strengthen and leverage industry-university ties to develop new applications in the photonics industry and he looks forward to a fruitful journey of DenseLight's membership with the Consortium.



Visit to NTU's The Photonics Institute (TPI) by POET Technologies Inc.'s CEO, Dr Suresh Venkatesan, and Management Team of DenseLight Semiconductor: Mr Jerry Rodrigues, Dr Lam Yee-Loy and Dr Chan Yuen-Chuen, hosted by Dr Soo Choi Pheng, LUX Photonics Consortium, in May 2016. Left to right: Dr Chan Yuen-Chuen, Dr Lam Yee-Loy, Dr Suresh Venkatesan, Mr Jerry Rodrigues, and Dr Soo Choi Pheng.



# Industry Collaborations

## Re-innovating LED Illumination

Cities are filled with majestic and brightly lit skyscrapers vying for attention. But on the flipside, if a few out of hundreds of tiny LED chips burn out on a building's architectural façade lighting, the resulting uneven illumination could make it look sloppy and outdated.

A typical LED strip of one meter consists of 100 LED chips that are spaced at equal intervals for even illumination. However, LED chips are notoriously unreliable, and it is common for a few to fail before others, causing irregular illumination along the whole strip. In worst-case scenarios, owners have to replace the whole strip, thus increasing unnecessary cost. Furthermore, LED strips are limited in flexibility, which could affect the appearance of the building, or make it hard to install along curved surfaces.

However, a collaborative project by The Photonics Institute (TPI) and Technolite could make unreliable LED illumination a thing of the past. This partnership aims to solve the problem of LEDs with an innovative solution, which results in uniform distribution of LED light, higher luminance and better flexibility.

Michael Chia, the Managing Director of Technolite, says that TPI has helped his company "realise this dream [of

re-innovating LED illumination] much earlier". He explains that while Technolite has the commercial experience to identify products for the market, the company was previously limited by technical and scientific expertise.

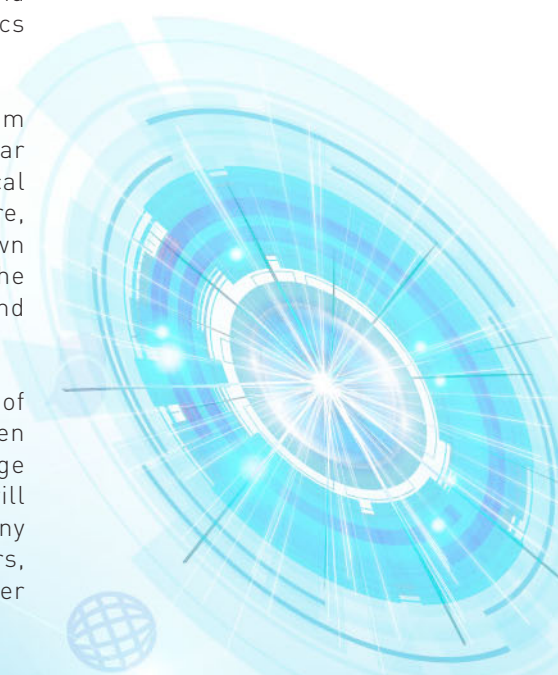
"We needed a capable research institute to assist our quest for development," Chia says. With the help of the extensive knowledge and capability of NTU Professors, coupled with the Industry-IHL-Partnership grant from the National Research Foundation (NRF), Chia's dream is fast becoming a reality. The collaboration has been seeded and launched quickly with the LUX Photonics Consortium.

In fact, the LUX Photonics Consortium could pave the way for similar collaborations between local universities and SMEs in the future, giving birth to more home-grown innovations that could change the market, both in Singapore and internationally.

"I am proud of this project because of the close collaboration between academia and the industry," says George Loh from the NRF. "[The project] will benefit not only the company [Technolite] but also many customers, who will have access to newer and better

products and services."

This cutting edge technology has huge implications in the architectural lighting market, with projected revenue of USD 6.1 billion in 2020. Its importance is emerging in Singapore, as a way to promote high value-added manufacturing, creating more employment opportunities locally. From key manufacturing technologies to new innovative designs, the possibilities are limitless.



*Capital Green, Singapore, a commercial facade lighting project by TECHNOLite Pte Ltd.*

# Awards

**TPI Co-Director Professor Sir David Payne recently received the Honorary Degree of Doctor of Engineering from NTU for his revolutionary work in optoelectronics.**

A world-renowned scientist from the University of Southampton and the Director of the university's Optoelectronics Research Centre (ORC), Professor Payne's work in fibre fabrication has had a great impact on telecommunications and laser technology over the last forty years. This has resulted in almost all the special fibres in use today including fibre lasers which are currently undergoing rapid growth for application in manufacturing and defence.

**LUX Faculty member Prof Hong Minghui from NUS was recently awarded the Institution of Engineers Singapore (IES) Prestigious Engineering Achievement Award, for his research project in developing a Super-resolution and High-sensitivity Optical Nanoscope.**

The project is a Competitive Research Programme (CRP) project funded by NRF to develop a super-resolution technique which can overcome the diffraction limit and observe nano-scale features under white light. Prof Hong and his team developed the optical microsphere nanoscope which introduces an additional micro-scale sphere lens between the sample and the objective lens in conventional microscope, and achieved super-resolution effect.

The award is given to an organisation or persons responsible for an outstanding engineering project in Singapore, which have made a significant contribution to engineering progress and the quality of life in Singapore.

*"We are very grateful that this research is funded by NRF through the CRP programme. It is a great honour that our research outcomes are recognised by the IES as one of the most outstanding*

Professor Payne also worked closely with NTU faculty like Professor Tjin Swee Chuan and Professor Nikolay Zheludev in setting up of The Photonics Institute (TPI) and Centre for Optical Fibre Technology (COFT). These were critical in building Singapore's capabilities in photonics and optics research. His involvement in TPI and COFT helped to raise their awareness and attracted the interest of international collaborators.

Professor Payne said, "Working with NTU, the leading young university in Asia, is a rewarding and breath-taking experience. Receiving the honorary doctorate is a delight because this honour is a reflection of all those in The Photonics Institute who have helped

*engineering projects in Singapore."* Beamed a delighted Prof Hong. He added that "the project is very promising for commercialisation soon" with unique attributes, being a simple add-on to an existing microscope that will allow it to surpass the conventional resolution limit. Moreover, the sample can be imaged without pretreatment. It will thus have wide applications in our daily lives, as well as in high-end research laboratories.

To top off this achievement, Prof Hong was also appointed the editor for Light: Science & Applications (LSA), a Nature Publishing group journal, from July 2016 to June 2018. This journal is an open access fully peer-reviewed publication, with an Impact Factor of 13.600 for 2015.



*Prof Hong (second from left) with his team at the IES Prestigious Engineering Achievement Award Ceremony.*

create a global institute in such a short time. Photonics in Singapore is now truly on the map. Moving on, NTU strives to do even better and if I can assist in developing its global influence, it will be an even greater privilege."



*Professor Sir David Payne being presented an Honorary Degree, Doctor of Engineering, from Nanyang Technological University (NTU) in Singapore for his revolutionary work in optoelectronics.*

LSA is one of the highest profile and highly regarded journals in the photonics field. Prof Hong revealed that he is in discussion to locate one of LSA's overseas offices in the Optical Science and Engineering Centre at NUS. This would be excellent recognition of the impact that local photonics research has on the world and would benefit our research community.

Prof Hong Minghui is the Director of Optical Science and Engineering Centre and a Full Professor in Electrical & Computer Engineering Department at NUS. He received his B.S. and M.S. from Xiamen University, China in 1985 and 1988, his M.Eng and PhD from NUS in 1996 and 2000 respectively. His research interest includes laser precision engineering (microprocessing & nanofabrication), optical micro/nano-imaging, spectroscopy, industrial process real-time monitoring, and their industrial applications. He is a Fellow of OSA, SPIE and IAPLE.

*\*[The impact factor (IF) of an academic journal is a measure of the frequency with which the article in a journal has been cited in a particular year or period, and it represents the relative importance of a journal within its field.]*



# Local Conferences and Exhibitions

## icOPEN 2017

The 5th International Conference on Optical and Photonic Engineering

The 5th International Conference on Optical and Photonic Engineering, icOPEN2017, and the 21st edition of Manufacturing Technology Asia (MTA) 2017 will be held on 4-7 April 2017 at the Singapore Expo.

TPI and LUX Photonics Consortium are proud to be the supporting and sponsoring organisers for icOPEN2017.

LUX Photonics Consortium and TPI members will get to enjoy member's rate for the Conference, so sign up soon!

Registration Fees	Early Bird Rate (Register and pay by 6 Mar 2017)	Registration Fees
Member's Rate*	SGD 800	SGD 900

\* A 7% Goods & Services Tax (GST) is applicable to all companies in Singapore.

icOPEN2017 is organised by The Optics and Photonics Society of Singapore (OPSS). For more information, visit [www.icopen.com.sg](http://www.icopen.com.sg)

## THE 21<sup>ST</sup> EDITION mta MANUFACTURING TECHNOLOGY ASIA 2017

MTA2017 will see the addition of **Optics and Photonics Innovation Hub**, a dedicated exhibition area showcasing innovative technologies in the fields of optics and photonics. LUX Photonics Consortium is proud to be the anchor exhibitor of the Optics and Photonics Innovation Hub. LUX Photonics Consortium industry members will enjoy special privileges to showcase their products, services and technologies at a very attractive and heavily subsidised rate. Register with us early to avoid disappointment!

Registration Fees	Early Bird Rate (Register and pay by 30 Sep 2016)	Special Rate (Register and pay by 30 Nov 2016)
Member's Rate*	SGD 100	SGD 500

\* A 7% Goods & Services Tax (GST) is applicable to all companies in Singapore.

Manufacturing Technology Asia is a bi-annual event focused on delivering advanced technologies for high-value manufacturing markets. It attracts buyers from high-value industries and sectors such as aerospace, complex equipment, electronics, energy, oil & gas/marine and offshore engineering, precision engineering and medical technology.

For Registration, please email: [lux\\_chairman@ntuitive.sg](mailto:lux_chairman@ntuitive.sg)

For more information, visit the website: [mta-asia.com](http://mta-asia.com)

