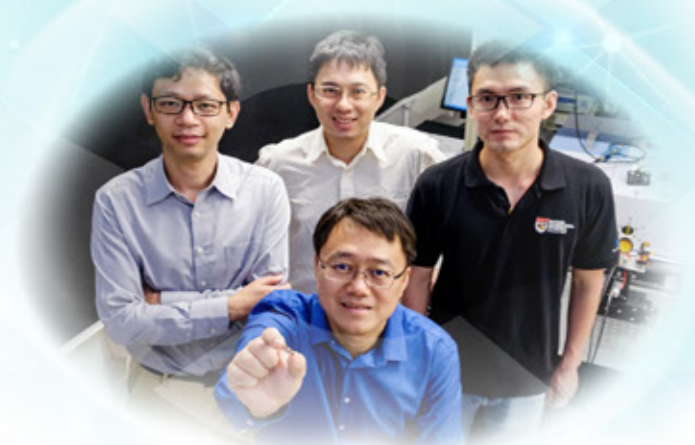


First electrically-driven 'topological' laser overcomes imperfections associated with conventional lasers

Electrically-driven semiconductor lasers are compact and thus practical for real applications – such as barcode readers, laser printers and fibre optic communications – as they use a mature and compact electrical power supply to pump the lasers.

Unfortunately, their manufacture is a demanding process and current laser designs do not work well if any defects are introduced into the structure of the laser during these processes.

To overcome this problem, a team of scientists and engineers from NTU and the University of Leeds (UL) worked with a type of electrically-driven laser called a quantum cascade laser (QCL), based on advanced semiconductor wafers developed at the UL, to create the world's first electrical-driven 'topological' laser.



Prof Wang Qijie (front row), Assoc Prof Zhang Baile, Assoc Prof Chong Yi Dong, and researcher Zeng Yongquan (left to right, back row). Photo credit: NTU

It can route light particles around corners and cope with defects and disorders created during the fabrication process.

The team's laser also emits light at terahertz (THz) frequencies, compared to previous demonstrations of topological lasers that required an external laser source for optical pumping and operated in the conventional optical frequency regime.

Says lead scientist Prof Wang Qijie, NTU professor and LUX faculty member: "Every batch of manufactured laser devices has some fraction that fails to emit laser light due to imperfections introduced during fabrication and packaging. This was one of our motivations for exploring topological states of light, which are much more robust than ordinary light waves."

In the "topological states" concept from theoretical physics, electrons flowing in certain materials are able to flow around corners or imperfections without scattering or leaking.

Message from the Chairman/Co-director:

2020 has been a challenging period for all of us across the globe, with the COVID-19 pandemic continuing to evolve and impact our lives.

Early detection plays an important role in curbing the spread of this contagious disease. To that end, our LUX Industry members LightHaus and Wavelength Opto-Electronic have contributed in their own way to our efforts to fight COVID-19.

LightHaus has developed a Fever Monitoring System that has features such as a self-service kiosk, contactless measurement and an automated label printer. The technology can help to reduce human interaction in temperature screenings, which are now commonplace.

Meanwhile, Wavelength Opto-Electronic's thermal lenses are used in fever detection devices to identify individuals with fever instantly and safely. These lenses operate in the long-wave infrared region and are less sensitive to dust/smoke.

Earlier this year, before the situation worsened, I was invited to attend the Global Photonics Markets Workshop at Photonics West by SPIE Director of Industry Development Stephen Anderson. It was a highly engaging and fruitful sharing session on the size and impact of photonics business activity across the regions and countries represented by the various participants.

I presented on the Singapore photonics landscape and our involvement in the Joint Industry Sector Planning (JISP). I shared how we are working closely with EDB and A*STAR on the Lasers & Optics Technology Roadmapping process and to develop programmes to further develop these capabilities within Singapore's Institute of Higher Learning (IHL), in collaboration with the industry.

I also had the pleasure of hosting representatives of Optitec, a photonics cluster in France and MoU partner of LUX, to dinner when they visited Singapore. We can help facilitate exploration meetings for LUX members interested in photonics for defence applications, so do let us know if you are interested.

Finally, I would like to inform you that we have postponed the Canadian delegation visit and our LUX Quarterly Networking event to June, or later, in light of the current COVID-19 situation. I am pleased, however, to share that we have some new LUX industry members: Edmund Optics, Endofotonics, Lumerical, and Tessolve.

We are closely monitoring the situation and will keep you updated. Hopefully, it will improve and we can meet each other, and welcome our new members in person, at an upcoming networking session.

Do stay safe and healthy, and I hope you enjoy reading our first issue of the newsletter for 2020.

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



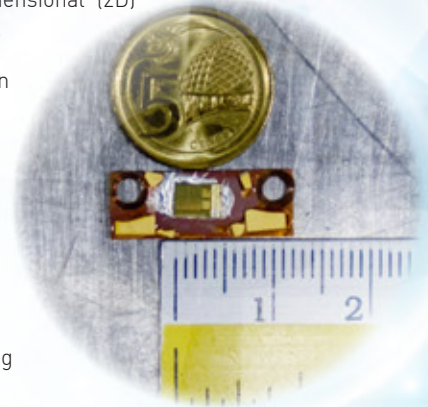
Prof Wang and his colleagues, Assoc Prof Zhang Baile, Assoc Prof Chong Yi Dong, and researcher Zeng Yongquan, developed a design containing a valley photonic crystal, inspired by electronic topological materials known as two-dimensional (2D) valleytronic insulators, to achieve topological states on a laser platform without using magnetic materials.

Adds Prof Wang: "The electrically-driven topological laser is realised by patterning topological structure on the semiconductor gain material (multiple-quantum-wells of the THz QCL). When the electrodes are created on the top and bottom, a current will be injected and passes through the gain material to create population inversion for laser transitions."

He sees potential for the technology to be used with QCLs in the mid-infrared region for applications like gas sensing, spectroscopy and LiDAR, as well as in the THz region for applications like security screening and biomedical imaging.

Prof Wang says: "The most exciting part of this research is that it is the first time that we design and observe clearly in experiments that light wave can pass across sharp corners and defects without being scattered and with literally no loss."

"The most important implication is that such lasers are 'robust', so there are many opportunities – in the design of future lasers and, broadly speaking, in the development of other photonic devices."



Semiconductor topological laser (placed between a 5-cent coin and ruler). Photo credit: NTU

The advantages of Quantum Cascade Lasers (QCL)

Prof Wang discusses their many potential applications and benefits.

1. Gas Sensing Applications

- No need for multiple gas sensors – QCL mid-infrared laser spectroscopy can be used for 'universal' applications.
- Three or more gases can be measured simultaneously with 10 ppm sensitivity in about 10 seconds.
- Many uses from industry process controls to indoor and outdoor air quality control.

2. Mid-infrared LiDAR Applications

- Spectroscopic (4D) information (instead of just 3D) of surrounding areas can be obtained.
- Light transmission over long distances with less scattering losses.
- Watt-level output power at room temperature, safe for the eyes, enable long-distance LiDAR applications.

3. Next-gen Communications

- Electrically-driven compact THz semiconductor source at room temperature.
- 6G communications: Very high internal modulation speed at tens of GHz.
- High-speed communication link with integrated high speed (→100GHz) photodetectors.

New Industry Members Introduction



Endofotonics has successfully developed the SPECTRA IMDx™ system, the world's first real-time in-vivo Raman spectroscopy platform, that improves early stomach cancer detection rate.

Based on GLOBOCAN 2018 data, stomach cancer is the 3rd leading cause of cancer-related death with an estimated 800,000 deaths in 2018 worldwide¹. Patients have high survival rate if diagnosed at early stage. However, around 80% of stomach cancer patients are diagnosed at stage 4, the most advanced stage, where survival rate is less than 5%². Endofotonics aim to improve detection of stomach cancer at early stage hence drastically increasing the survival rate.



Combining Raman spectroscopy and machine learning, SPECTRA IMDx™ provides an objective assessment of the stomach tissue and detects cancerous lesions in real-time. This helps doctors identify early stomach cancer lesions that are usually difficult to identify, hence enabling timely medical intervention.

SPECTRA IMDx™ system consists of the IMDx™ Cart with touchscreen graphic user interface and the IMDx™ Probe. This patented miniaturized probe is compatible with all endoscopes with standard 2.8mm instrument channel, enabling in-vivo applications.

Endofotonics is a medtech organisation dedicated to using its proprietary Raman spectroscopy platform technology to improve early cancer detection helping to reduce cancer burden in patients. Founded in 2013, the company is headquartered in Singapore and has a subsidiary in Shanghai, China. Endofotonics is ISO 13485:2016 certified.

In the near future, Endofotonics' platform technology will be expanding indications for use in other organs as well. For more information, please visit: <http://www.endofotonics.com/>

¹ <https://gco.iarc.fr/today/data/factsheets/cancers/7-Stomach-fact-sheet.pdf>

² <https://www.cancer.net/cancer-types/stomach-cancer/statistics>

Edmund Optics® (EO) is a leading global supplier of optics, imaging, and photonics technology that has served a variety of markets including Life Sciences, Biomedical, Industrial Inspection, Semiconductor, R&D, and Defense since 1942. EO designs and manufactures a wide array of optical components, multi-element lenses, imaging systems, and optomechanical equipment, while supporting OEM applications with volume production of stock and custom products. With locations in more than seven countries across the globe, EO employs over 1,000 employees and continues to expand.

EO takes pride in helping customers from prototype to volume production, and specializes in creating cost-effective solutions that meet our customer's specifications, timelines, and budgets. Whether requirements include stock optics, a build-to-print custom optical component, expert application engineering to optimize the design, or a completely custom design to customer-supplied requirements, our engineers can create ideal solutions for each unique optical challenge. Every step of the way, Edmund Optics® is committed to ensuring product and procedural quality.



Over 34,000 products available off-the-shelf

Edmund Optics Singapore is manufacturing and technology hub for EO, producing high precision optics including Aspheres, beamsplitters and prisms. It features state-of-the-art production and metrology equipment, which complements our expert knowledge in design and manufacturing. For more information, visit <https://www.edmundoptics.com.sg/>.


TESSOLVE
 A Hero Electronix Venture

Tessolve (a Hero Electronix Venture) is a leading end-to-end solution provider, from chip design, Test and PCB engineering through Embedded systems development.

Tessolve continues to grow at a rapid pace with 2100+ employees and 27% CAGR growth with operations in the USA, Europe, India, and south-east Asia. Tessolve boasts of 600+ Chip designers, 900+ Test and Product Engineers, 200 PCB Designers, 100+ Embedded system engineers and worldwide Test Centres allowing us to provide innovative and robust test solutions.

Tessolve provides solutions to many industries including Automotive, Avionics, Computing, Imaging, Medical, Mobile and Sensors. Tessolve partners with customers to make great ideas into great products. Tessolve's roadmap includes further specialization in some of the high growth sectors such as 5G, Automotive ICs, Silicon Photonics, Artificial Intelligence, IoT & Lighting Solutions.

Tessolve has partnered with industry leading semiconductor companies in building state-of-art Industry's First 7nm based Optical Modules, Characterizing SiPh components (GePD nip, Wave Guide and Grating Coupler) the device designed for datacentre and cloud infrastructure.

Moreover, Tessolve has a record of contribution for making the Silicon Photonics Platform for Next- Generation Transceivers, mainly for Applications like optical links for datacentre networks. For more details, visit <https://www.tessolve.com/>



Industry News

SINTEC OPTRONICS and Raycus: Opening of "Fiber Laser Service Centre" FLSC in Singapore

Sintec Optronics has recently established their Fiber Laser Service Center (FLSC) here in Singapore with Raycus, on the 31 Jan 2020. This FLSC will provide full repair service for Raycus fiber lasers in Southeast Asia. The centre capabilities include fiber laser fault analysis, fiber cleaving (straight and angled), fiber splicing (SM & PM), fiber tapering, fiber recoating, refurbishing, attaching of fiber connectors, power supply & control etc. As the authorised distributor of Raycus, the FLSC will provide fast service and technical support for their users. Repair capabilities include the following models:



- 10-100W Q-Switched Pulse Fiber Lasers with high peak power, high single-pulse energy, ~120ns pulse width. Applications include marking, precision processing, graphic engraving of non-metal, gold, silver, copper, aluminum, stainless materials.
- Short-Pulse Fiber Lasers features high average power (10-100W), 2-350ns adjustable pulsewidth, adjustable frequencies 10-1000kHz. Applications include processing solar photovoltaic, thin film cutting, sheet material cutting, welding, surface cleaning, etc.
- Single Mode CW fiber lasers with power range 300W-4,000W, with $M^2 \leq 1.3$, and High-Power Multimode Continuous Fiber Lasers ranging 1,500W-12,000W. These have 20m fiber cable for simpler integration into machines. Applications include: cutting, welding, holing, medical device processing, etc.
- Quasi-Continuous Wave (QCW) Fiber Lasers ranges from 75W to 600W. These are good alternative to YAG lasers for spot welding, seam welding, boring and industrial needing wider pulse and high peak power.

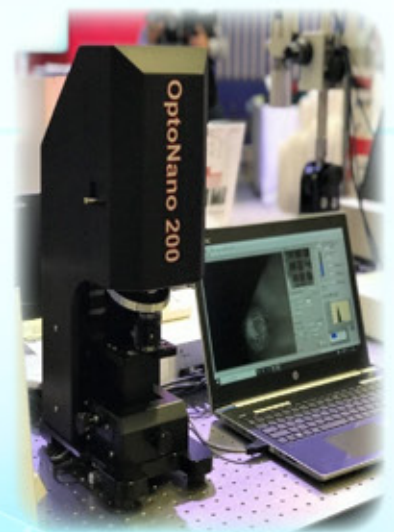
PHAOS TECHNOLOGY Launches Disruptive Microsphere-assisted Microscopy Technology in Collaboration with SIGMAKOKI

Phaos Technology Pte. Ltd., has launched its first disruptive microsphere-assisted microscopy technology, OptoNano200, together with SIGMAKOKI Co., Ltd. (Japan), a global leading optical component manufacturer at Photonics West 2020, the leading event for the worldwide photonics industry, on 4 Feb 2020, in San Francisco, California, USA.

The OptoNano200 uses microsphere to upgrade the magnification of microscopes by up to 4 times using miniature glass spheres, in a cost-efficient way. It has brought light upon the potential to revolutionize the microscopy industries by enabling a microscope to achieve nanoscale magnification and observation at a greatly reduced cost; and enabling non-contact mode of observation of nanoscale object without the need of specimen treatment. Such a process would be an exceptional breakthrough for life science, biomedical and semiconductor applications.

For life science and biomedical observations, it is critical to keep specimen uncontaminated and intact to ensure reliable results. For semiconductor applications, with the greatly reduced cost and omitting treatment process of samples, the current specially equipped lab-only observation method could be turned into production-line applications.

Phaos Technology and SIGMAKOKI will continue to develop the OptoNano product range, and a new version of OptoNano100 with ability to see objects smaller than 100nm will be ready for market in early 2021.



WAVELENGTH OPTO-ELECTRONIC Launches OptiNspec Surface Inspection System for Automated Lens Inspection

Surface quality is a key specification used when ordering or manufacturing optical lenses. The U.S. Military standard, MIL-PRF-13830B which is widely used, defined the surface quality as a scratch-dig grade pair (e.g. 60-40).

The standard defined the grade as the relative brightness and size of a defects compared with a comparison artefact. This is highly subjective and depend on both parties using similar comparison artefacts. This commonly led to disagreement between parties. At the same time, well-trained and experienced inspectors are getting harder to recruit.

The OptiNspec surface inspection system from Wavelength Opto-Electronic, which was showcased at the Photonics West 2020 from 4-6 Feb 2020, is the perfect solution addressing the above concerns. It allows users to mass inspect flat and spherical optics, generating data with an integrated graphical user interface software. The inspection process will detect scratch and dig, bubbles, coating, stains and impurity flaws.

There are several customisable models available to suit customer's needs. AOF101 is a full size machine that support inspection of a batch of flat optics on a tray up to 300mm x 300mm, with built in clean work bench for cleaning, loading and unloading of lenses. On the other hand, the AMF104 is a table-top machine that support inspection of a tray of micro flat optics in gel box up to 2"x3". With this cutting edge technology and automation, it has replaced the traditional need for subjective manual inspection and improve productivity.



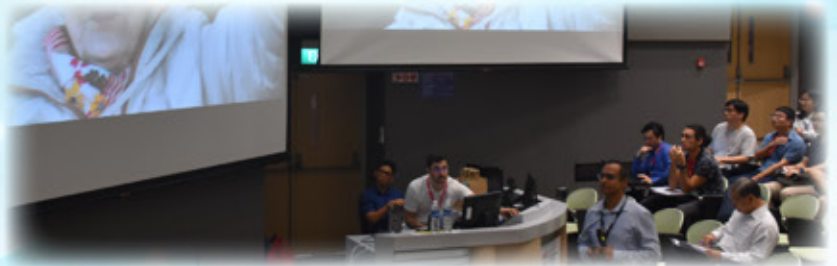
NTU EEE-Graduate Research Showcase shines with LUX's support

Nanyang Technological University (NTU) held the second EEE Graduate Research Showcase (EEE-GRS) on the 20th January 2020. This event was organized by the School of Electrical and Electronics Engineering and its graduate student club (EEEGSC), and LUX is honored to be the supporting organisation. EEE-GRS aimed to help graduate students to showcase their research works to the NTU community and also industries.

The event started with two industrial keynote speeches from Dr Simon See, Director and Chief Solutions Architect, Nvidia AI Technology Center; and Mr Prashant Raghu, Director of Process Engineering, Micron. Graduate students also presented their research works via oral and poster presentations. There were 60 poster presentations covering research areas such as Artificial Intelligence, beamforming antennas, specialty optical fiber, automatic speech analysis, flexible transducer array, and non-invasive subcellular resolution imaging, just to name a few. Towards the end of the event, the top 3 oral and poster presentations were awarded by a panel of leading academics and industry experts.



Dr Simon See, Director and Chief Solutions Architect, Nvidia AI Technology Centre



Mr Prashant Raghu, Director of Process Engineering, Micron

Around 24 exhibition booths were planned for industrial companies, and NTU cooperation labs to showcase their works and find opportunities for collaboration with graduate students. The one-day event was attended by more than 300 participants from the university and industries. LUX Photonics Consortium being a supporting organisation helped promote the event to the photonics community, where eight LUX member companies participated in setting up exhibition booths. They were AMF, Denselight Semiconductors, Edmund Optics, Globalfoundries, Huawei, iLaser, Physik Instrumente and Wavelength Opto-Electronic.



LUX's Presence at SPIE. PHOTONICS WEST

LUX Chairman Invited to Photonics West "Global Photonics Markets Workshop" Forum Discussion

LUX Chairman Prof Tjin Swee Chuan was invited by SPIE Director of Industry Development, Stephen Anderson to Photonics West "Global Photonics Markets Workshop" on 2 Feb 2020 at the The Moscone Center, San Francisco, California, USA. Touted as the world's leading photonics technologies event, the annual event attracted 22,000 attendees to hear the latest research and find the latest technologies to enable advancements in biomedical optics, biophotonics, scientific and industrial lasers, optoelectronics, microfabrication, MOEMS-MEMS and displays.

The workshop provided a forum for sharing experiences and discussing the motivations and lessons learned from those who have been involved in efforts to measure the size and impact of the photonics business activity in their region or country. Prof Tjin took the opportunity to share Singapore's experience in shaping the photonics landscape and the Joint Industry Sector Planning (JISP) exercise which chart the technology roadmap for Lasers and Optics in Singapore.

LUX's Members Participated at Photonics West Exhibition

Apart from the Industry Program where LUX Chairman attended, there were three co-located conferences featuring 5200 presentations and two world class exhibitions, including the Photonics West Exhibition spreading over 6 halls, where 15 of our member companies exhibited from 4-6 Feb 2020.



Four of our members - AMF, Eureka Robotics, PLC Industries & Wavelength Opto-Electronic exhibited under the SG Pavilion, organised by Singapore Precision Engineering and Technology Association (SPETA) and supported by Enterprise Singapore (ESG). Facilitated by LUX and SPETA, these member companies enjoyed up to 70% subsidy for booth space, the Singapore branding and network from the ESG partners in the US. We hope more members can participate in the SG Pavilion in Photonics West next year!



SG Pavilion exhibition area



SG Pavilion exhibition area



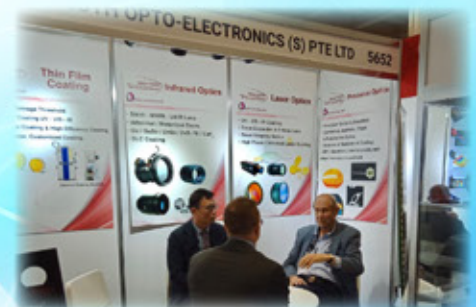
AMF: Ms Kavitha Buddharaju (Co-Founder, Senior Manager Business Development) and Mr Franck Gerard (Business Development Manager)



Eureka Robotics, left to right: Mr Hung Pham, Mr Elfred Wee, Prof Pham Quang Cuong (Founder)

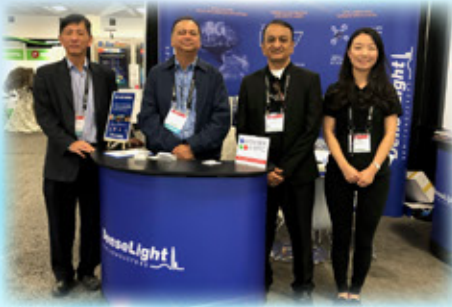


PLC Industries: Mr Marc Tan (COO), second from right



Wavelength Opto-Electronic: Dr Robert Huang (CEO), left.

The other eleven LUX members - Coherent, Denselight Semiconductors, Edmund Optics, II-VI, Lumerical, Moveon Technologies, OptoSigma, Phaos Technology, Palomar Technologies, PI & WEO Corporation either exhibited under their corporate flag or independently. Below are some photos of the members and their booths.



Denselight Semiconductors, left to right: Dr Lam Yee Loy (CTO), Mr Rajan Rajgopal (President), Mr Soma Sankaran (VP Sales & Marketing), Ms Audrey Lee (Customer Service Representative)



Lumerical: Dr Xu Wang (Senior Manager, Applications Team), right and colleague.



Moveon Technologies: Mr Chee Teck Lee (CEO), second from right and colleagues.



Prof Hong Minghui (Chairman and Director, Phaos Technology), left and Mr. Yosuke Kondo (President and CEO, SIGMAKOKI Co., Ltd.), right.



Palomar Technologies: Mr Evan Hueners (Operations Manager), third from right.



WEO Corp: Mr Donald Ng (Sales Director), right, Ms Lynda Pang (Sales and Marketing), second from right and colleagues.

Photonics for Defence & Security Application: A meet-up with European Delegation, Optitec, France

On 10 February, LUX had a good exchange of ideas on the planning of their next delegation visit to Singapore with the possible participation from member companies of Optitec and their partnering clusters including Minalogic, Estonian Defence Industry Association and Denmark's defence and Security cluster, CenSec.

Our relationship with Optitec dates back to October 2018, when we signed an MoU with them after their participation of the "Franco-Singaporean Optics-Photonics Exploratory Mission", jointly organized by Business France, the Embassy of France in Singapore, and LUX Photonics Consortium.

Being a major photonics cluster in France, Optitec, they have kicked-off a project entitled "Key Enabling Technologies (KETs) for Dual-Use" – with their European partner: Minalogic, Danish defence & security cluster CenSec and Estonian Defence Industry Association.

Under this project, they identify Singapore, alongside with US, Canada, and United Arab Emirates, as the targeted country to create partnership synergies between SMEs from both sides who can be technical strong and active in the field of Key Enabling Technologies (photonics, nano & micro technologies, software, etc.) with applications in the security and defense sector.

During the delegation visit, LUX facilitated meetings for our members AMF, LightHaus and Tessolve to explore possible collaboration with the clusters.

If you are interested to explore and achieve the following:

- To establish initial contact with actors from security and defence sectors in order to discuss possibilities of collaboration with European institutional/industrial actors;
- To evaluate future opportunities for creating partnership synergies with innovative European SMEs, which are these clusters members.

Please feel free to contact LUX Photonics Consortium to obtain the initial list of the European SMEs and start the dialogue of possible collaboration.



Left to right: Ms Regina (EU & International Affairs Manager, Optitec), Prof Tjin (Chairman, LUX), Ms Choi Pheng (Program Director, LUX), Ms Helen (Cluster Manager, Estonian Defence Industry Association), and Mr Ziga (Director, Optitec).