

Centre for Disruptive Photonics Secures THREE Major NRF Grants Totalling S\$24 Million

Message from the Chairman/Co-director:

Prof. Nikolay Zheludev, CDPT Director:

"I am delighted that the Centre for Disruptive Photonics (CDPT) at The Photonics Institute (TPI) has secured three major National Research Foundation (NRF) grants under the 23rd Competitive Research Programme (CRP) grant call. Collectively the proposals led by Ranjan Singh, Baile Zhang and Nikolay Zheludev will bring S\$24 million of competitive research funding to Nanyang Technological University."

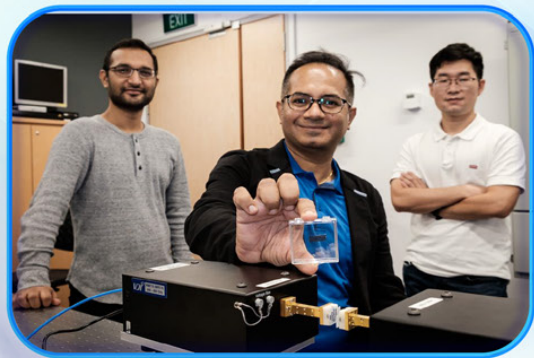
"All three research Programmes will develop new ideas in topological photonics into practical technologies for telecommunication, lasers and microscopy. The conceptual base for all three CRP projects has been developed within the current S\$9 million Ministry of Education (MOE) Tier 3 Programme on 'Quantum and Topological Nanophotonics' at CDPT. The recently announced grants complement the success of Weibo Gao, also a Tier 3 programme PI, who last year secured S\$5 million CRP funding for developing spintronics quantum technologies."

"The CDPT accomplishment demonstrates a perfect and timely transition from the blue-sky fundamental research supported by the MOE Tier 3 Programme to application-driven research of the NRF RCP programmes."

The three 23rd CRP grant call funded projects are:

On-chip Terahertz Topological Photonics for 6G communication

- Ranjan Singh, A. S. Madhukumar, A. Alphones, Yidong Chong and Wang Nan



Assoc Prof Ranjan Singh and his team has built a new chip using a concept called photonic topological insulators. Made from silicon, it can transmit terahertz waves at ultrahigh speeds.

electronic and photonics components to enable THz wireless communications for handheld or portable devices. Potential applications include massive IoT, mobile edge computing, holographic communications, smart home and offices.

Active topological photonics towards robust lasers and efficient sensors

- Baile Zhang, Chong Yidong, Wang Qijie, Luo Yu and Sun Handong

This research programme will introduce a fundamentally new, so-called "topological" concept, to develop lasers with unprecedented robustness and sensors with unprecedented sensitivity.

Carrier waves operating at terahertz frequencies (0.1-10 THz) are vital for achieving the desired data rates of 6G communication as they offer huge spectral bandwidth. However, one major challenge is the lack of efficient on-chip devices for the manipulation and control of THz waves.

The team is seeking to develop highly miniaturized, low-cost and efficient on-chip THz systems to enable high-speed medium range (up to 10 m) wireless links. They propose to utilize the concept of photonics topological insulator (PTI) to develop an on-chip THz platform, which can house both

The COVID19 pandemic is far from over and will linger for some time. It changes the way we work, learn and socialise. It creates a new normal in telecommuting and fast track digitalization in our daily lives. Mass networking has never been the same in the current situation and we have to adapt and adopt the new norm of virtual networking. LUX's quarterly networking event had gone online for the first time in June. It was heartening and encouraging to have the strong support of our members. Our first virtual networking event had attracted more than 100 participants. It was well received by members from Singapore, Malaysia, USA and Canada.

At the virtual networking event, we welcomed 6 new industry members – Edmund Optics, Endofotonics, Global TechSolutions, Lumerical, Tessolve and T-SMART; and 4 new faculty members from NUS, SUTD and ASTAR. We congratulated members Assoc Prof Wang Hong and CompoundTek for the successful award of Industry Alignment Fund (IAF). More details of the research partnership can be found in the article in this issue. We announced the award of 4 LUX seed grant projects, the largest number of seed grant projects awarded so far. Our regular Tech Talks by faculty members have gone online as well; we have initiated video recording of technical talks at the virtual event and posted them on our website for the broader audience. Going forward, all Tech Talks will be posted on our website to promote research and industry collaborations.

In the academia community, TPI centres continue to push the boundary for blue sky research. The Centre for Disruptive Photonics Technology (CDPT) has successfully secured 3 Competitive Research Programme (CRP) grants from National Research Foundation (NRF). These grants are the results of the CDPT's Ministry of Education (MOE) Tier 3 Programme on 'Quantum and Topological Nanophotonics'. I would like to congratulate Prof Nikolay and his colleagues for these awards.

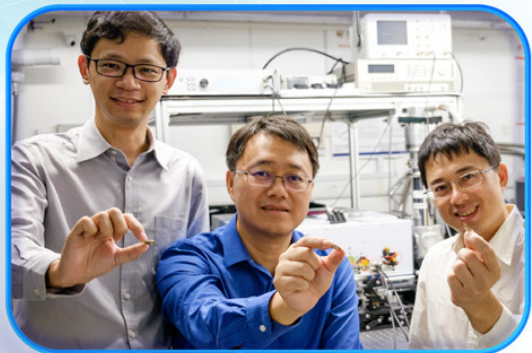
Coming up, our 3rd quarter networking event on 9 SEP is going to be a virtual event. Our annual Photonics@SG 2020 conference on 20 NOV will likely to be virtual as well. As we embrace the new norm, do stay healthy and I look forward to meet you in person soon.

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



Such robust lasers and detectors over the broad electromagnetic spectrum – from terahertz to ultraviolet – can be incorporated into next-generation photonics products, such as LiDAR for autonomous navigation and chemical sensors for food processing, which are highly relevant for Singapore's advanced manufacturing ecosystem.

Local industry partners (Venture, STAr Technologies, Sintec Optronics) have been identified to help develop commercial products based on the technology generated.



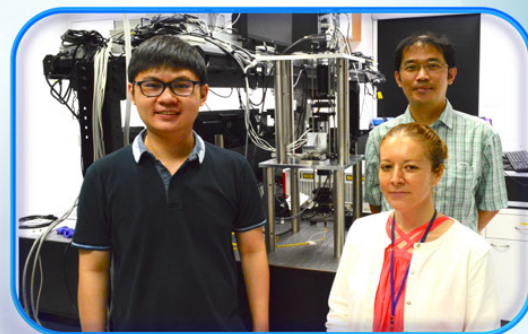
From left: Assoc Prof Baile Zhang, Prof Wang Qijie and Assoc Prof Chong Yidong are three of the NTU scientists working on this CRP grant call funded project.

Deeply Subwavelength Superoscillatory Imaging

- Nikolay Zheludev, Zexiang Shen and Bo An

The programme's key objective is to develop a new principle of imaging that combines recent advances in topological optics with data analysis based on artificial intelligence methodology.

Far-field label-free super-resolution imaging is the grand challenge for photonics and the final frontier for optical imaging. The team is seeking to develop a breakthrough non-invasive imaging technology with resolution beating the "diffraction limit" of conventional microscopes on orders of magnitude that will allow optical far-field non-contact label-free optical imaging with close to molecular resolution. This will have ground-breaking consequences for biology, medicine, nanotechnology, chip manufacturing and fundamental science.



Prof Zheludev's research team includes Dr Chan Eng Aik (left), who works on artificial intelligence and neuron network; Dr Rendon-Barraza Carolina, who specialises in experiment and characterisation; and Dr Yuan Guanghui (back row), who is involved in design and fabrication.

NTU and CompoundTek seek to develop first commercial Si-photonic tunable laser product

LUX members, Assoc Prof Wang Hong from Nanyang Technological University (NTU) and CompoundTek Pte Ltd have come together in a partnership to develop 0-, C- and L-band Silicon Photonic Tuneable Lasers for Communication and explore other emerging applications. The partnership has received support from public fund targets at supporting research & industry collaboration between industries with Institute of Higher Learning (IHL) such as NTU.

With a programme size of over \$1 million for three years, the industry-faculty partnership seeks to:

- Design and integrate compound semiconductor optical amplifier (SOA) with tuneable Si-photonics reflector for single-chip silicon photonic tuneable lasers
- Demonstrate and prototype Si-photonic tuneable lasers targeting 0- and C-band fibre communication applications
- Extend the Si-photonic tuneable lasers towards longer wavelength for other emerging applications



CompoundTek's collaboration with the broader research & innovation community has enabled the company to bring to market innovative, resource-optimised solutions, such as its Si Photonics Test Centre, a first in Southeast Asia.

Ultimately, the project hopes to develop full series 0- and C-band Si tunable laser products for fibre communication systems. This will be the first commercial tunable laser product using silicon photonics technology.

Says Assoc Prof Wang: "We will provide our deep know-how in the design of Si-photonics and full characterisation capability in the wavelength range from 0- and C-Band to Mid-infrared, while CompoundTek's well-established Si-photonic process platform will allow us to quickly validate our new designs and concepts."

With silicon photonics being an integration of electronics and photonics, The Photonics Institute (TPI) Co-Director, Prof Tjin Swee Chuan and NTU's School of Electrical and Electronic Engineering [EEE] Chair, Prof Tan Yap Peng are confident that the university's specialisation and expertise in this area will be invaluable.

Says Prof Tjin: "The manufacturing capabilities borne from this project will bring Singapore to the forefront of silicon photonics commercialization."

Prof Tan adds: "By partnering CompoundTek, we aim to establish a whole ecosystem supply chain from design and fabrication to testing and packaging of wavelength tunable lasers."

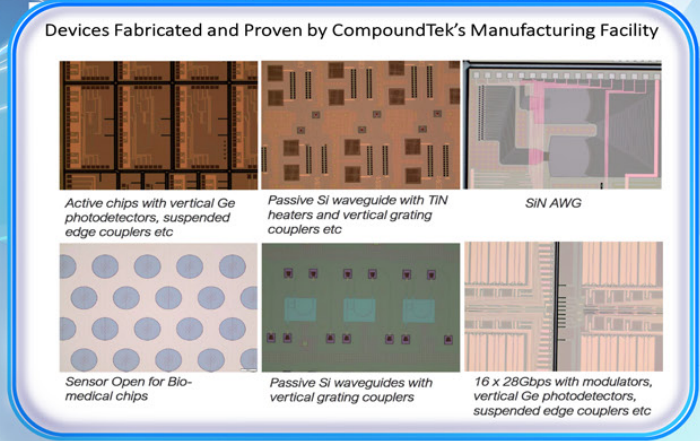
CompoundTek founder and CEO Raj Kumar shares that – besides providing process capabilities beyond Assoc Prof Wang's lab – the company can offer insights to market demands, gaps and opportunities gleaned from its international network of customers and partners, which span several industries.

Says Raj Kumar: "We believe this partnership fundamentally catalyses Singapore's photonics ecosystem, making it a more attractive destination in a global marketplace that is ripe for growth as smart city and urbanisation applications gather momentum."

"From telecom to data centres to Lidar, to bio-healthcare and quantum computing, industry players are actively seeking effective solutions to prototyping and design, testing right up to commercialisation."

"Assoc Prof Wang's and our combined expertise addresses these needs, potentially shaving off years and R&D investment (costs) for customers so that they can focus and optimise their go-to-market strategy."

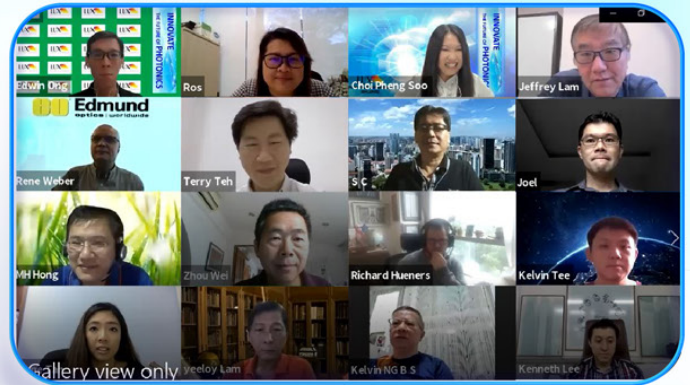
CompoundTek also hopes that Assoc Prof Wang's research will help further advance its silicon photonics R&D technology footprint, empowering the company to expand its niche services portfolio to a global customer base.



LUX's First Online Networking Event Well Received by Members

LUX's second quarter networking event was carried out online via the Zoom platform for the first time. The event held on 24 June was well received by members, embracing the new norm of virtual networking, attracted more than 100 participants for the half-day event.

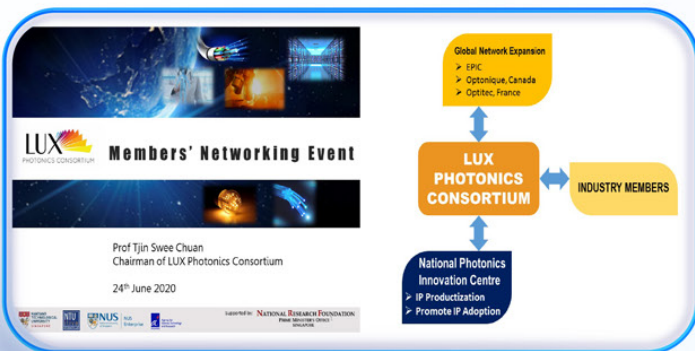
Indeed, the current COVID19 restriction forbid physical mass gathering and drives the adoption of digital technology and virtual networking. While many members expressed the preference for face to face networking, the virtual networking event also enabled members from different country and time zone to meet and network. There were 32 companies including a few invited non-member companies attended the event. Research community from NTU, NUS, SUTD and ASTAR as well as our partners from National Research Foundation (NRF) and Enterprise Singapore (ESG) gave their full support too.



More than 100 participants attended the online networking event

LUX Chairman Prof Tjin started off the event with an update on the consortium. He shared that LUX is putting up a proposal to setup a "National Photonics Innovation Centre" for IP translation and adoption by the local photonics industry. This is certainly a piece of good news to the local photonics community, especially for the SMEs to leverage on innovative technologies from universities to increase their competitive edge.

Six industry members (Edmund Optics, Endofotonics, Global TechSolutions, Lumerical, Tessolve and T-SMART) and four new faculty members from NUS, SUTD and ASTAR were introduced to the members. Prof Tjin also congratulated Prof Wang Hong and CompoundTek for their Industry Alignment Fund (IAF) grant award and announced the LUX Seed Grant 4th & 5th Call results. LUX Seed Grant 6th Call was open for proposals and closing date set at 31 Oct 2020.



National Photonics Innovation Centre being part of the LUX Master Plan

LUX Seed Grant Awardees

- Asst Prof Yoo Seongwoo and Technolite
- Prof Wang Qijie and LightHaus Photonics
- Assoc Prof Zhou Wei and Precision Laser Solutions
- Asst Prof Steve Cuong Dang and Global TechSolutions

Open call for LUX Seed Grant 6th Call

Closing Date : 31 October 2020

Please download the application form/proposal template from LUX website: luxphotonicsconsortium-sg.org

Executives from member companies took the opportunity to introduce their companies to the community. Mr Rene Weber, General Manager of Edmund Optics; Mr Mike Yeager, VP of Business Development from Lumerical; Mr Kenneth Lee, Managing Director of Global TechSolutions; Mr Kingsly Christopher, Director of Engineering from Tessolve; Mr Peter Cheng, CEO of Endofotonics took turns to present.

Tech Talks from faculty members were one of the highlights of the event. Prof Wang Hong from NTU shared about the recent progress on Si-Photonics research activities at NTU and the research collaboration partnership with member CompoundTek. Prof Joel Yang from SUTD talked about "Nanoscale Optics for Colourful Microprints and Holograms" and its applications. Prof Kim Munho from NTU presented his research in "Single crystalline nanomembranes for future high performance flexible electronic/photonic applications". Scan the QR code to view the Tech Talks video.

Tech Talk Highlights



From Lab to Fab - Recent Progress on Si-Photonics Research Activities at NTU
Assoc Prof Wang Hong, NTU
 In this talk, recent progress on the Si photonics research by NTU research team and CompoundTek Pte Ltd will be presented. The potential of Si-photonics technologies for future mass production will be discussed.



Nanoscale Optics for Colorful Microprints and Holograms
Assoc Prof Joel Yang, SUTD
 We will share and discuss the technology to produce microscopic color prints at the highest possible resolutions, colorful 3D prints, and holograms. All achieved without the use of pigments or dyes. Would be happy to discuss potential applications of these concepts.



Single crystalline nanomembranes for future high performance flexible electronic/photonic applications
Asst Prof Kim Munho, NTU
 Fast flexible electronics that operate at radio frequencies (RF) could lead to a number of novel RF applications where rigid chip-based solid-state electronics cannot easily fulfill. Single-crystal semiconductor nanomembranes (NMs) that can be released from a number of wafer sources are mechanically flexible yet exhibit outstanding electronic properties that are equivalent to their bulky counterparts.



Industry News

Transcestial scores nearly US\$10 million in fresh funds



LUX industry member Transcestial, which is building a space laser network to deliver high-speed internet connectivity, has raised US\$9.6 million in a Series A funding round co-led by EDBI and Wavemaker Partners.



Transcestial CTO Mohammad Danesh (left) and CEO Rohit Jha (second from right) with Deputy Prime Minister Heng Swee Keat (second from left), Jonathan Hung, Advisor to Transcestial and Chairman, Singapore Space and Technology Limited; and Teo Chee Hean, Senior Minister and Coordinating Minister for National Security (right).

The round saw participation by new investors Airbus Ventures, global venture capital firms Partech and Tekton Ventures, and Cap Vista – the strategic investment arm of Singapore's Defence Science and Technology Agency.

Transcestial has developed Centauri, a mass-produced network device capable of delivering fibre-like speeds to customers. Centauri leverages the start-up's Wireless Laser Communication Technology to create a wireless distribution network between buildings, traditional cell towers, street-level poles and other physical infrastructure.

With the Series A funds, Transcestial plans to scale up production of Centauri to deliver the devices to customers in the next 12 months.



About the size of a shoe-box and weighing less than 3kg, Centauri is a rapidly-deployable, low-cost and high-speed solution, which can be used in dense residential areas that require bandwidth upgrades.

STAR Technologies and CompoundTek Collaborate on Silicon Photonics Wafer Testing



LUX industry members STAR Technologies and CompoundTek recently announced the partnership to collaborate on developing standards and solutions for cost effective and high volume silicon photonics wafer testing. Addressing the growing need for consistency and reliability for silicon photonics technology, the partnership aims to spearhead the development of standard processes and facilitate industry wide adoptions and innovations from design through to test and inspection.

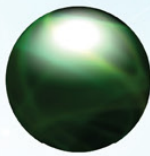
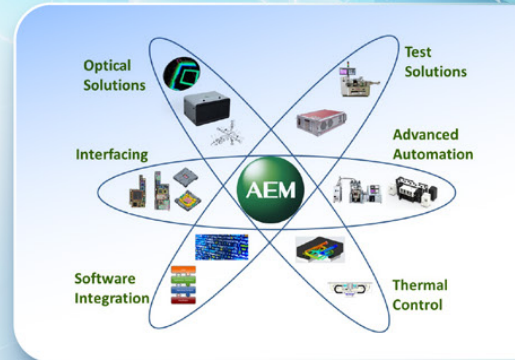
Silicon photonics is a nascent technology that has a broad range of applications, including LIDAR, quantum computing, and biosensing to name a few. The integration of optical components onto an integrated chip creates a host of new challenges in wafer-level testing of silicon photonics devices. Currently, silicon photonics testing is fragmented with no industry standards. Most of the companies have in-house bench solution which is good for small scale engineering characterisation during the design verification phase, but inefficient for the high-throughput and low-cost test required for the mass production phase. There is no independent silicon photonics wafer test service provider with a cost-efficient solution to address this market needs.

STAR Technologies and CompoundTek hope to bring these capabilities to help the industry to drive down associated product costs from prototyping to mass manufacturing, and accelerate their time to market. The full press release can be found at [STAR Technologies](#) and [CompoundTek](#) website.

New Industry Members Introduction



AEM is a global leader offering application specific intelligent system test and handling solutions ranges from advanced integrated circuit (IC), MEMS, SSD and panels for semiconductor and electronics companies serving advanced computing, 5G and AI market, keeping AEM on the forefront of manufacturing innovation worldwide. AEM is a pioneer in MEMS test equipment, offering a range of advanced test solutions for MEMS devices including the world's only commercial Wafer-Level Chip Scale Packaging (WLCSPP) MEMS test solution. These solutions are well aligned with the growing MEMS based Silicon Photonics market. For Photonics applications, AEM specialized groups are able to design and customize optical and test solutions for inspection and measurements. AEM is open to collaborate with members of the LUX Photonics Consortium.



Component Technology

Component Technology started business as a distributor of production equipment to the Semiconductor Backend Industry in 1989. Among the products we handled back were die bonder and wire bonder. With our experience, we understand the problems in these processes. Hence when we decided to develop our own product, we worked on an automatic wire bond inspection solution. We have since become a leading solution provider in this field. We developed this technology in partnership with SIMTech. It becomes the world's first 3D wire bond inspection machine that performed effectively for our customers' quest to achieve zero defect. We use stereo vision triangulation technology to achieve 3D wire measurements. To achieve this, we also built our own lighting system. 2 patents will be filed jointly with A*Star.

Through continuous development, we added features to meet the automation requirement of the industry. With over a decade of research and development, we are a reliable provider of automated and cost-effective inspection solutions. We are able to provide full support to our customers because our product is fully developed and assembled by our internal teams. Our products currently include automatic vision inspection machines for Wafer, Lead frame, Die / Wire Bond and X-ray Image Analyser.



Post wire bond automatic inspection machine



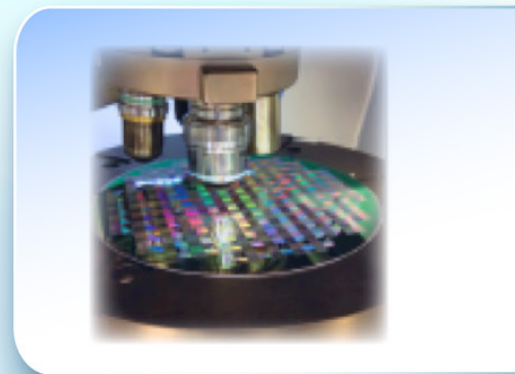
Global TechSolutions

Headquartered in 2008, Singapore, Global TechSolutions Singapore (GTSS) www.globaltechsolutions.com.sg is an imminent full suite solutions provider that collaborates with its partner in the advance semiconductor manufacturing industry from ideation to high volume implementation. A fully owned subsidiary of Korbett, it has significant presence in three major semicon cluster of Singapore, Taiwan (GTST) and China (GTSC).

GTSS provides solution via its equipment, software, engineering, parts and cost/productivity enhancement ideologies. GTSS is a chosen partner of the top Semiconductor Foundry and memory makers in the world. Collaborating with major institutions in Singapore, it is also working towards producing the first made in Singapore Semicon manufacturing equipment.

GTSS also offers a gamut of in-house capabilities that includes:

- Chamber heaters for heat induced processes
- High precision valves
- High precision robotics for volume manufacturing
- Equipment for metrology, thermal process, chemical/physical deposition, wet/dry etch and chemical/mechanical polishing
- Laser and optic devices
- Electrical controls and high voltage power supply units
- Wafer chucks



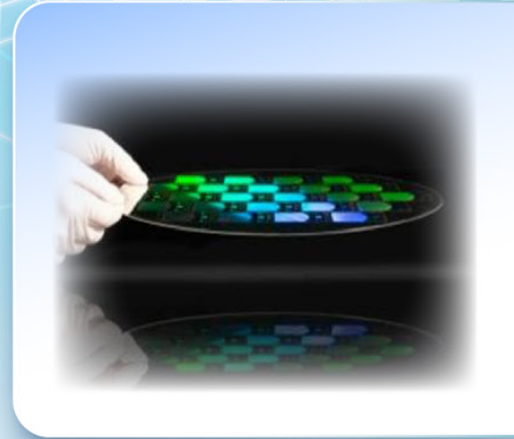
Photonics, Metrology & Lithography Equipment



The NAGASE Group is a chemical trading firm comprises of more than 100 group companies worldwide consist of trading, manufacturing, and R&D. With a history of close to 200 years, we are equipped with expertise to help partners in tackling new challenges to enable new

businesses. Our slogan, Bringing It All Together, embodies the idea of bringing infinite possibilities (people, things, information, technology, ideas, world, and time) together. Our group companies include, Inkron, Nagase Chemtex, Pactech and EMS Inc that supplies leading-edge materials & technologies into Semiconductor, Photonics, Sensors and Optics manufacturing.

In photonics, we offer a range of products starting from frontend chemicals where we supply photoresist for high resolution/high step patterning. In the assembly process, we offer UV adhesives that are used for optical transceivers and camera modules. Coatings that are multi-functional for lens optics and high RI/low RI material for Nano imprint lithography. Recently, we also supported the market development of a new photosensitive glass substrate technology which has the ability to create micro-features enables photonics devices such as RF Bridges, Diode Sub-Mounts and Fiber Aligners that deliver exceptional accuracy, simplified integration and assembly, and reduce BOMs. We look forward to working with companies and institutes to support & advance the development of photonics.



World's first waveguides made on a glass substrate with a refractive index of 1.9 by Schott, EV Group, Waveoptics & Inkron.



Opto Precision Pte. Ltd. is an ISO 9001-2015 certified company and one of the best precision optics manufacturing companies in South East Asia. Established since 2004, our core products and services are Optical

Components, Advanced Coating Services, and Optics Assembly. We served industries in Autonomous driving Lidars, Wearable optics, Micro optics, sensors, micro projection, free space optics etc. Opto Precision is equipped with state-of-the-art German-made machines and we are capable in precision optics manufacturing that meet the most stringent specifications. We pride ourselves as one of the few companies in the world that has the expertise to provide coated free-form Polymer Optics.

Opto Precision is strategically located in Singapore since 2003, we have built up an excellent track record in providing our worldwide customers with:

- Consistent and Reliable High Quality Products
- Customer service Excellence
- Customization for your solutions
- Fast turnaround time at Competitive Pricing

To ensure our continued success, Opto Precision practices lean manufacturing and streamline operations that reduce cost and improve efficiency. We are deeply committed to work towards a sustainable manufacturing practices and all products produced in our facility are RoHS compliant, as we strive to be a green and environmentally responsible company. Opto Precision hopes to be the one-stop solution to the optical thin film industry and providing value to our clients and associates.



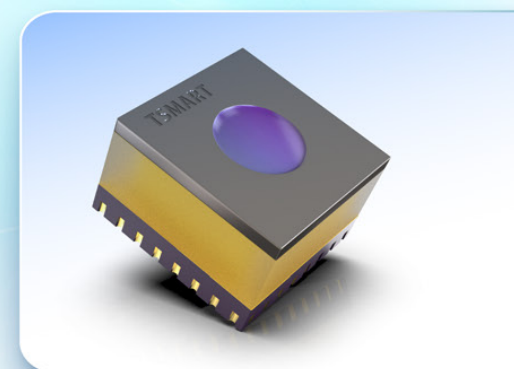
Optical Filters



T-SMART Pte Ltd is a manufacturing company in Singapore that was incorporated in 2019. The company provides novel and superior manufacturing technology to the traditional infrared temperature sensing architecture. T-SMART has been driven by the need to create

value and do it more creatively and intuitively. T-SMART's applications are designed to fulfil the need for predictive detections, solutions and analytics. Riding on the impressive spread of infrared technology across different application fields, users of T-SMART's product can be inspired to develop new applications, new motivations in technology, and help manage solutions of new ideals that were not realized before.

T-SMART will also be contributing to the COVID-19 combating efforts with its non-contact infrared device (NCID) (to be released later in 2020). The team pride itself in its creativity and ingenuity in the product design and its value add of educating the users on what a properly specified NCID can accomplish for the user. Specifically, for users to learn the importance of a precise monitoring tool that will not only save lives but also increase the user's awareness of how the right data provides and improves information about the effect of a virus on human body temperature.



TCUBE enables high performance temperature measurement

LUX Member Companies a Positive Light Amidst COVID-19 Pandemic



From supplying components for devices used in temperature screening and COVID-19 testing, to supporting our healthcare heroes, LUX member companies have been hard at work during the COVID-19 crisis.



In July, **OptoSigma** delivered 560 care packages to Ren Ci's three branches. The company wanted to thank our healthcare workers and cheer them on in their selfless fight against COVID-19, as well as celebrate Nurses Day.

OptoSigma CEO Mr Kelvin Ng's father had once been a beneficiary of the Ren Ci healthcare group, so the organisation naturally came to mind. The OptoSigma Southeast Asia Office put together the care packages, which comprised a Thank You card as well as the OPMA and KOPMA bear mascots symbolising courage, fortitude and strength. The bears were designed by the company's designer, Sumie Ariga and freshly delivered from its headquarters in Japan.

Fellow LUX member **Wavelength Opto-Electronic** offers various solutions to combat the spread of COVID-19. These include thermal lenses, thermal scanners, and a UV steriliser.

The thermal lenses operate in the long-wave infrared region uncooled so they are less sensitive to dust/smoke and can be used for thermal



imaging, such as in the devices used at airports to identify individuals with fever instantly and safely.

Meanwhile, thermal scanners are used at the likes of supermarkets, schools, shopping malls, offices and warehouses. Lastly, the company's 254nm UV steriliser – controlled wirelessly via remote – allows for safe sterilisation with UV rays from a distance.

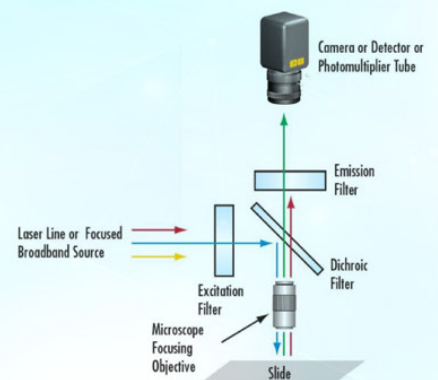
Edmund Optics plays its part in fighting the COVID-19 pandemic by supplying infrared components for infrared fever detection systems as well as optics for fluorescence-based antibody detection.



VERI-Q PCR 316 (Photo credit: Edmund Optics)

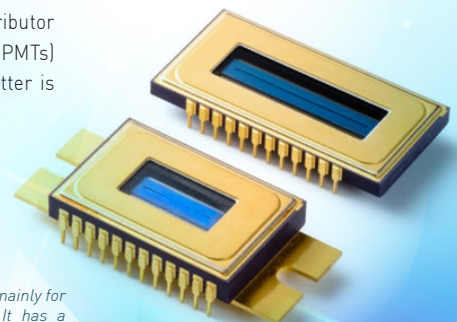
The company's optical components are also used in polymerase chain reaction (PCR) diagnostic devices. PCR tests are considered the "gold standard" of COVID-19 tests by the Centers for Disease Control and Prevention (CDC) in the United States. They detect traces of the virus' genetic material on a sample most often collected via a nose or throat swab.

At present, Edmund Optics supplies components for a rapid, highly-sensitive molecular diagnostic device called the VERI-Q PCR 316. Developed by South Korean healthcare diagnostics company, MiCo BioMed, the device can detect COVID-19 within one hour and is of great help when it comes to testing at airports and borders.



The optical design of fluorescence-based PCR screening systems like VERI-Q PCR 316 resembles this setup of a simple fluorescence microscope.

Finally, LUX member **Hakuto** was considered an essential service during the recent Circuit Breaker as a distributor for the manufacturing sector. Hakuto Singapore has helped to supply products such as photomultiplier tubes (PMTs) and photodiode arrays with amplifier, both of which are used in PCR and antibody testing devices. The latter is another key way that governments across the globe are testing citizens for COVID-19.



Photodiode arrays with amplifier: a type of CMOS linear image sensor designed mainly for long area detection systems using an equal-magnification optical system. It has a photodiode array chip for light detection and a CMOS chip for signal processing and readout.

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