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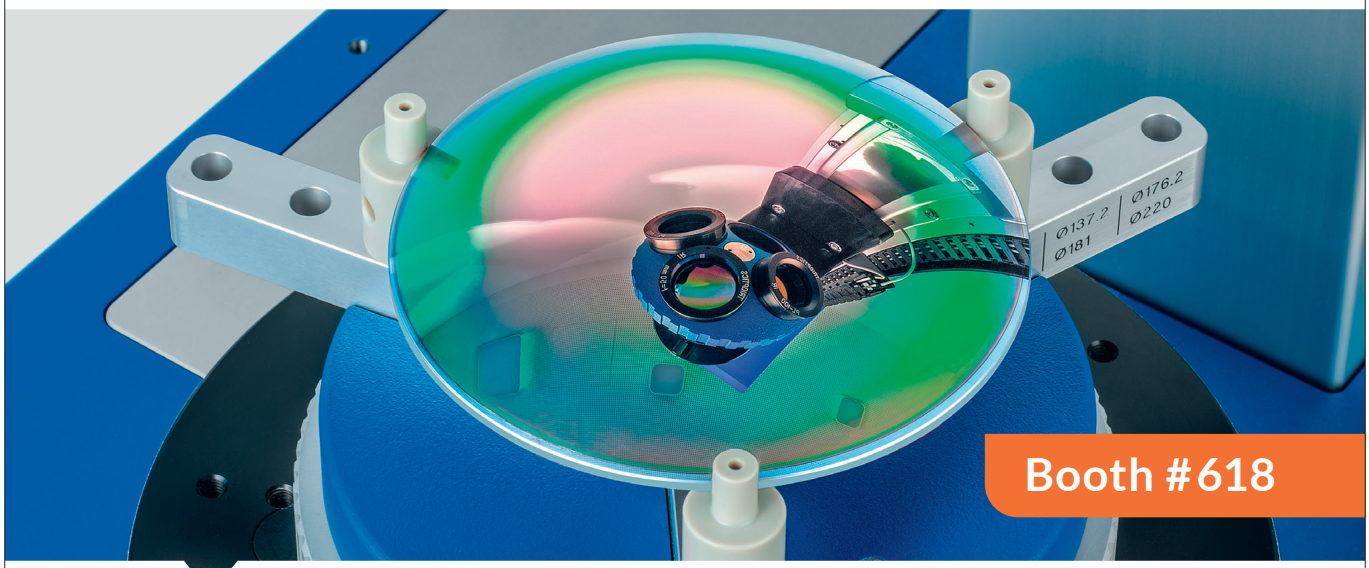

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Nuburu, Coherent, and nLight contracted for laser weapons development

US firms to share $75M award along with Rolls-Royce Liberty Works, General Atomics, Dynetics, and Lockheed Martin Aculight.

Blue laser developer Nuburu is among seven US-based companies recently contracted by the Department of Defense (DOD) to further develop solid-state high-energy laser weapons.

The Colorado company, which floated on the US stock market earlier this year, is taking part in a $75 million effort to make and deliver prototypes and equipment for so-called directed energy weapons.

The other companies contracted under the same award include divisions of Rolls-Royce, General Atomics, Dynetics, and Lockheed Martin, as well as Coherent and nLight. The program runs for five years.

Automated manufacturing

Nuburu's CEO and co-founder Mark Zediker said in a release announcing its participation: "Nuburu has the ability to manufacture laser diode, fiber-optic and optical subsystems in the US, making us well positioned to support the DOD with its needs regarding this critical next-generation national security issue.

"We are proud to use our automated manufacturing capabilities and a workforce entirely based in the US to provide high-power laser subsystems for our customers."

The other companies involved have all been regular participants in previous laser weapon development efforts, with Lockheed Martin's Aculight subsidiary, nLight, and Coherent-owned Nufern all playing significant roles.

Back in 2019, the US Army agreed a contract with Dynetics, Lockheed, and Rolls-Royce Liberty Works to provide a 100 kilowatt laser weapon that could be mounted on a truck.

And last year Lockheed said that it had delivered a 300 kilowatt electrically driven laser - the most powerful it has ever produced - based on spectral beam combining of several lasers emitting at slightly different wavelengths.

Nuburu's blue lasers have typically been aimed at industrial applications including welding and laser additive manufacturing, with particular utility processing colored metals like copper and certain alloys. Now the company has been selected to take part in a US Department of Defense effort to further develop laser weapons.

This latest DOD award, confirmed in mid-March, is being made via the Naval Surface Warfare Center's Dahlgren Division in Virginia, which has been involved in several previous laser weapons development initiatives.

Additional funding sought

Meanwhile, Nuburu last week released further details about its latest financial position in a "10-K" annual report filed with the US Securities & Exchange Commission (SEC).

The filing states that Nuburu received net proceeds of $3.2 million in late January when it completed its special-purpose acquisition company (SPAC) business combination with Tailwind Acquisition Corp.

That filing followed a separate update from the firm suggesting that annual sales would rise to more than $3 million this year, more than double the 2022 figure.

"We continue to review and make necessary adjustments to our product development roadmap to be aligned with our current and prospective customer relationships and to best utilize our company resources," added Zediker.

"As such, we expect our 2023 revenues to be weighted towards the second half of the year. We anticipate that momentum will provide the critical foundation for additional revenue acceleration in 2024."

With cash outflow of around $25 million now expected in 2023, the company is also looking at ways to raise additional cash.

Nuburu's CFO Brian Knaley commented: "As we've completed our transition to being a public company and look to solidify our competitive position, we expect to engage with the financial markets to strengthen our balance sheet.

"We intend to utilize additional funding sources to allow Nuburu to accelerate our growth trajectory by enabling us to further invest in technology and other resources designed to drive our growth in 2023 and beyond."

https://optics.org/news/14/4/6

BAE's laser-guidance counter-drone system passes field testing

U.S. Defense division's successful test strikes pave the way for international fielding.

The U.S. Department of Defense's Joint Counter-Small Unmanned Aircraft Systems Office (JCO) has successfully tested BAE Systems' latest APKWS laser-guidance kits in a counter-unmanned aircraft systems (C-UAS) mission. BAE says the testing against Class-2 UAS "paves the way for fielding of the precision-guided rockets to partner nations around the globe".

APKWS (Advanced Precision Kill Weapon System) transforms unguided rockets into smart munitions for precision strikes on soft and lightly armored targets. A newly developed proximity fuze for the standard M151 warhead allows the laser-guidance kits to target Class 2 and Class 3 drones, which typically weigh less than 25 kg (55 pounds).

The fuze retains the legacy point denotation capability for maximum flexibility of the weapon in the field. APKWS now enables rockets to engage and destroy drones at a fraction of the cost of existing C-UAS systems with unprecedented precision.

'100 percent effectiveness'

During the Department of Defense-led exercise at Yuma Proving Ground, Arizona, the 70mm APKWS-guided rockets demonstrated 100 percent effectiveness when fired against 11 kg to 23 kg (25 to 50 pounds) drones traveling at more than 160 kmh (100 mph). The APKWS C-UAS solution is platform agnostic, permitting multiple options to accelerate fielding.

Aimee D'Onofrio, a director of Precision Guidance and Sensing Solutions at BAE Systems, commented, "This is a solution that comes at a remarkably affordable price point, and with APKWS already at full-rate production, we can ramp up to 25,000 units per year to make an immediate impact."

APKWS laser-guidance kits are produced at BAE Systems' state-of-the-art manufacturing facility in Hudson, New Hampshire. The kits are available to all U.S. armed forces, as well as allies via Foreign Military Sales.

https://optics.org/news/14/3/47

Image: BAE Systems.

Laser-guidance system undergoing tests by U.S. DOD's counter-drone office.

US Naval Research Lab launches Space Wireless Energy Laser Link

"SWELL" project to demonstrate laser "power beaming" in space – as part of the DOD's latest mission to the ISS.

The U.S. Naval Research Laboratory has this month launched the Space Wireless Energy Laser Link. "SWELL" is designed to demonstrate laser "power beaming" in space as part of the U.S. Department of Defense's Space Test Program H9 mission to the International Space Station (ISS).

SWELL is one of several experiments that have been launched aboard the SpaceX Dragon cargo vehicle to the ISS for the yearlong mission to collect data during a laser power beaming link in space conditions.

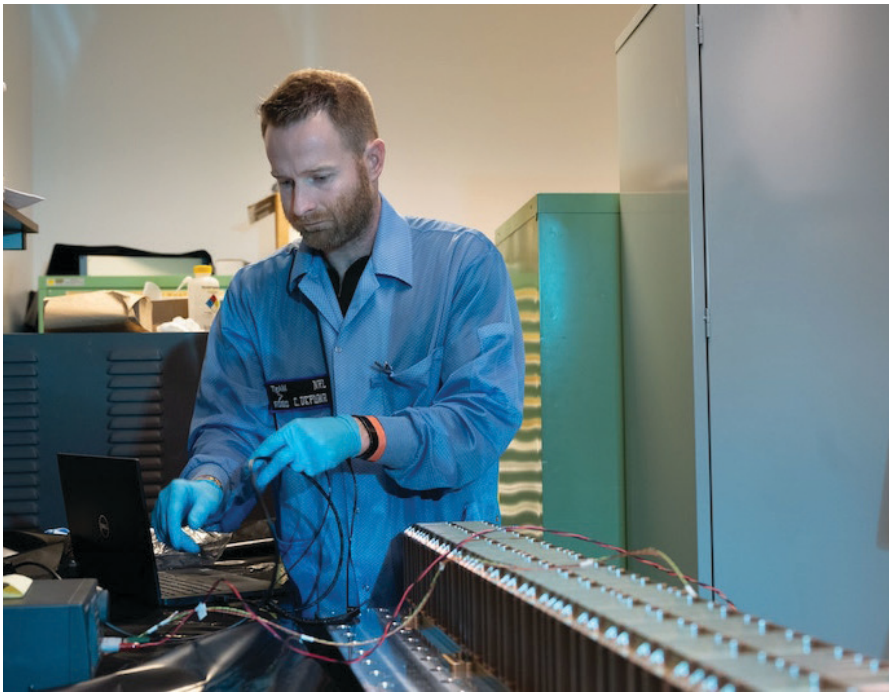
The experiment, which is sponsored by the Office of the Under Secretary of Defense for Acquisition & Sustainment and supported by the Operational Energy Capability Improvement Fund, will explore challenges for power beaming's viability for space applications, and also highlight the possibilities for using power beaming to address energy challenges on Earth.

Paul Jaffe, Ph.D., Electronics Engineer and SWELL Principal Investigator, commented, "With this modest experiment, we will identify key focus areas for developing links of greater power and longer distance for space. By employing laser transmitters and photovoltaic receivers, power beaming links will be established that will pave the way for rapid, resilient, and flexible energy delivery systems."

Power beaming

Power beaming is a means of delivering energy in the form of electromagnetic waves that does not require the transport of mass, so energy can be sent almost instantly. Its feasibility and safety have been proven on the ground, and now these efforts are expanding to space, states the Naval Research Laboratory.

STP-Houston 9 mission taking eight DoD Space Test Program payloads to the ISS.



U.S. Navy photo by Jonathan Sunderman.

Christopher DePuma, U.S. NRL electronics engineer, conducts a functional test of the laser power beaming link on Space Wireless Energy Laser Link (SWELL) in Washington, D.C.

STP-Houston 9 mission taking eight DoD Space Test Program payloads to the ISS.

"This is the next step in extending this capability for space, lunar, and planetary applications," said Chris DePuma, SWELL Program Manager. "Power beaming is poised as a critical enabler for power distribution on the moon and elsewhere in space."

Photo courtesy of NASA.

The Space Test Program-Houston 9 mission containing eight DoD Space Test Program experimental payloads is heading to the ISS aboard a Cargo Dragon spacecraft on the SpaceX's Commercial Resupply Service (CRS)-27. The payload was due to be installed on the ISS on March 19.

The yearlong SWELL experiment is expected to provide data that shows how the [power beaming] hardware functions in the space environment and show which constraints are likely to affect the deployment of future operational systems.

By eliminating the need for moving fuel or batteries, or for stringing wires, SWELL could be a compelling option for the utilization of lunar resources and development on the Moon.

"Power beaming might also be used for distributing power for and around Earth, including from satellites that collect solar energy in space," Jaffe said. "SWELL is the next step into this new frontier."

About the U.S. NRL

NRL is a scientific and engineering command dedicated to research that drives innovative advances for the U.S. Navy and Marine Corps from the seafloor to space and in the information domain. NRL is located in Washington, D.C. with major field sites in Stennis Space Center, Mississippi; Key West, Florida; Monterey, California, and employs approximately 3,000 civilian scientists, engineers and support personnel.

https://optics.org/news/14/3/41

Mitsubishi Electric, L3Harris win weather satellite contracts

Technology firm to build 'Himawari-10' geostationary craft for the Japan Meteorological Agency.

The Japan Meteorological Agency (JMA) has awarded a contract to build its newest geostationary weather satellite - featuring a hyperspectral sounder - to Mitsubishi Electric.

Known as "Himawari-10", the satellite will become the fourth in succession to be constructed by the Japanese technology giant since "Himawari-7", and will feature imaging and sounding instruments provided by US defense contractor L3Harris.

"Himawari-10 will be equipped with a visible infrared imager and a hyperspectral infrared sounder, both built by L3Harris Technologies of the US, and a space environment sensor from the National Institute of Information and Communications Technology of Japan (NICT)," announced Mitsubishi Electric.

"The imager, which offers observation wavelength bands and resolutions superior to those of the Himawari-8 and 9, will gather two-dimensional information about cloud and water-vapor distribution, and land, sea and cloud temperatures based on frequent measurement of visible to infrared rays emitted from the earth's surface."

Vertical resolution

L3Harris' cross-track infrared sounder (CrIS) instrument is able to observe more than 2000 wavelength channels across the infrared spectrum, providing moisture and temperature information with much more detailed vertical resolution compared with earlier equipment.

A Fourier transform spectrometer, CrIS provides atmospheric soundings with 2211 spectral channels over three wavelength ranges: LWIR (9.14-15.38μm), MWIR (5.71-8.26μm) and SWIR (3.92- 4.64 μm), explains the firm on its web site.

CrIS also has an 8-centimeter clear aperture and uses plane mirror interferometer technology to scan a 2200-km swath width, with an 8-second repeat interval.

In November 2022, the hyperspectral sounder was launched aboard the US National Oceanographic and Atmospheric Administration (NOAA) Joint Polar Satellite System-2 weather satellite.

"This technology improves NOAA's prediction of hurricanes, tornadoes and other extreme weather events and the accuracy of weather models three-to-seven days in advance by providing more precise temperature and water vapor information," said the firm at the time.

$765M NASA contract

Coincidentally, L3Harris has also just been awarded a contract to build a next-generation geostationary weather imager for the NOAA, with enhanced capabilities to assist in forecasting severe weather and environmental events .

Valued at $765 million, the contract with NASA is for the NOAA's Geostationary Extended Observations (GeoXO) satellite system. It should significantly improve the accuracy and timeliness of weather forecasting in the Western Hemisphere when it launches, around a decade from now.

"The addition of two new spectral bands and enhanced spatial resolution will improve space-based severe weather monitoring as well as short-term weather predictions and wildfire tracking," L3Harris said.

Slated to begin launching in 2032, the GeoXO mission will provide the mainstay of NOAA's geostationary observation through 2055.

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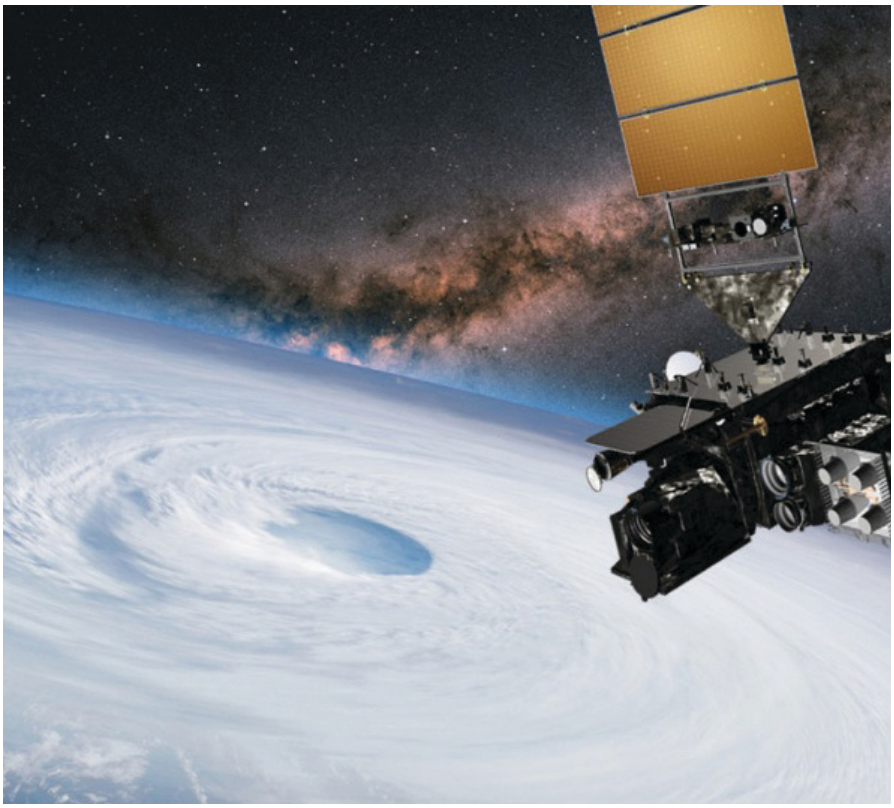

Image: Business Wire.

In partnership with NOAA, L3Harris has developed new weather sensor technology for the GeoXO mission, providing detailed, real-time information expected to improve severe weather monitoring from space, as well as short-term weather predictions and wildfire tracking.

Lockheed Martin achieves 'first light' in latest laser weapon demonstration

Lab specified to verify beam quality of firm's 50 kW-class laser architecture designed for the U.S. Army.

Lockheed Martin has achieved "first light" from its Directed Energy Interceptor for Maneuver Short-Range Air Defense System (DEIMOS) system, which verifies that the high energy weapon laser's optical performance parameters align with the system design parameters.

The 50 kW-class DEIMOS system is a ruggedized, tactical laser weapon system that can be integrated into the U.S. Army's Stryker combat vehicle to "deliver robust directed energy capability to the U.S. Army's challenging maneuver-short range air defense (M-SHORAD) mission."

Rick Cordaro, VP, Lockheed Martin Advanced Product Solutions, commented, "The 50 kW-class laser weapon system brings another critical piece to help ensure the U.S. Army has a layered air defense capability. DEIMOS has been tailored from our prior laser weapon successes to affordably meet the Army's larger modernization strategy for air and missile defense and to improve mission success."

'Crucial milestone'

Lockheed Martin says its DEIMOS first light demonstration "is a crucial milestone along the path to helping the Army perform its DE M-SHORAD mission, which is intended to deliver a maneuverable laser system capable of negating unmanned aerial systems, rotary-wing aircraft and rockets, artillery and mortars."

First light measures the expected beam quality of the system while testing end-to-end performance of our game-changing, low-cost Spectral Beam Combination (SBC) architecture. The key feature of the company's SBC is that power can be scaled while retaining the excellent beam quality of the individual fiber lasers.

In 2022, Lockheed Martin demonstrated Layered Laser Defense (LLD) capability by defeating two surrogate cruise missiles at tactically relevant ranges. The company says this LLD capability has the following characteristics:

- Shares many common elements with the DEIMOS system architecture, such as allowing for a single operator to engage and destroy SHORAD targets;
- Can be seamlessly integrated into various platforms; and
- Can fit on tactical platforms such as a Stryker vehicle because it was designed with constraints in terms of size, weight and power (SWaP).

Utilizing a philosophy of "build a little, test a little, learn a lot," Lockheed Martin says it will be expanding the DEIMOS test program in 2023, culminating with field integration tests in 2024. This thorough approach is designed to reduce risk, to enable soldier touchpoints and to provide proof points of compelling mission capabilities.

The U.S. Army's Rapid Capabilities and Critical Technologies Office is leading the DE M-SHORAD prototyping effort and is expected to transition the program to the Program Executive Office Missiles & Space in 2024.

https://optics.org/news/14/1/34

Image: Lockheed Martin.

Lockheed Martin has achieved "first light" from the Directed Energy Interceptor for Maneuver Short-Range Air Defense System (DEIMOS) system.

European consortium launches €19M infrared sensor project

'HEROIC' effort coordinated by Lynred aims to achieve European sovereignty for military applications.

France-based infrared sensor maker Lynred has officially kicked off a new European project to develop high-performance devices for use in future defense systems.

The Grenoble company is coordinating the €19 million, four-year effort, which also includes its rivals Xenics, in Belgium, and the German firm AIM Infrarot-Module, among ten participants in all.

Infrared sovereignty

Short for High Efficiency Read-Out Integrated Circuit, the "HEROIC" project is set to receive €18 million from the European Defence Fund, in a bid to consolidate the supply chain needed to produce the devices in Europe and thereby establish technological sovereignty.

"HEROIC is the first collaboration of its kind to bring together European infrared manufacturers, several of whom are competitors, to strategically tackle a common problem," Lynred announced.

"The project's main objectives are to increase access to, and dexterity in, using a new European-derived advanced CMOS technology that offers key capabilities in developing the next generations of high-performance infrared sensors - these will feature smaller pixels and advanced functions for defense applications.

"One overall aim is to enable Europe to gain technological sovereignty in producing high-performance infrared sensors."

Aside from the three sensor manufacturers, the consortium features four system integrators, in the form of Spain's Indra, Miltech Hellas in Greece, the Norwegian firm Kongsberg, and Poland-based PCO.

Also taking part are research institutions CEA-Leti and the University of Seville, alongside the specialist chip developer Ideas, which is based in Norway.

Post-2030 systems

In a release, Lynred's chief strategy officer David Billon-Lanfrey said that the project represented the first phase of an effort by European sensor manufacturers to gain access to a superior CMOS technology compatible with various infrared detectors and device architectures, and to make that technology available within a robust European supply chain.

"Acquiring the latest advanced CMOS technology with a node that no consortium partner has had an opportunity to access is pivotal to the sustainable design of a next-generation Read-Out Integrated Circuit (ROIC)," added Billon-Lanfrey.

"Its commonly specified platform will allow each consortium partner to pursue its respective technological roadmap and more effectively meet the higher performance expectations of post-2030 defense systems."

Rainer Breiter, the VP of infrared module programs at AIM, added: "The HEROIC project will enable AIM to develop advanced ROICs based on European silicon CMOS technology, as an important building block in its next-generation infrared sensors.

"We are looking forward to working together with our partners in this common approach to access the latest advanced CMOS technology."

Widely used in military applications, infrared sensors are particularly useful for recognizing and identifying objects or targets in the dark and in adverse weather conditions, with deployments across thermal imagers, surveillance systems, targeting systems, and observation satellites.

Reduced pitch sizes

It is expected that next-generation infrared systems will need to exhibit longer stand-off detection capability, as well as larger fields of view and faster frame rates. Lynred says that this will require higher-resolution formats, with pixel pitch sizes reduced from today's standard of 15 µm and 10 µm down to 7.5 µm and below.

"This will need to be obtained without increasing the small footprint of the infrared sensor, thus maintaining reasonable system costs and mechanical/electrical interfaces," adds the Grenoble firm. "These requirements make the qualification of a new CMOS technology mandatory to achieving higher performance at the infrared sensor level."

Xenics CEO Paul Ryckaert said that the Belgian firm saw the HEROIC project as a cornerstone of its strategy in short-wave infrared (SWIR) sensor development for defense applications. "Thanks to this project, the consortium partners will shape the future of European CMOS developments and technologies for infrared sensors," he added.

The project is said to have emerged after a workgroup meeting covering infrared technologies within the European Defence Agency that took place in 2019. "Lynred took the initiative to define a Europe-wide project and created a consortium to consolidate the infrared ecosystem in Europe," stated the French company.

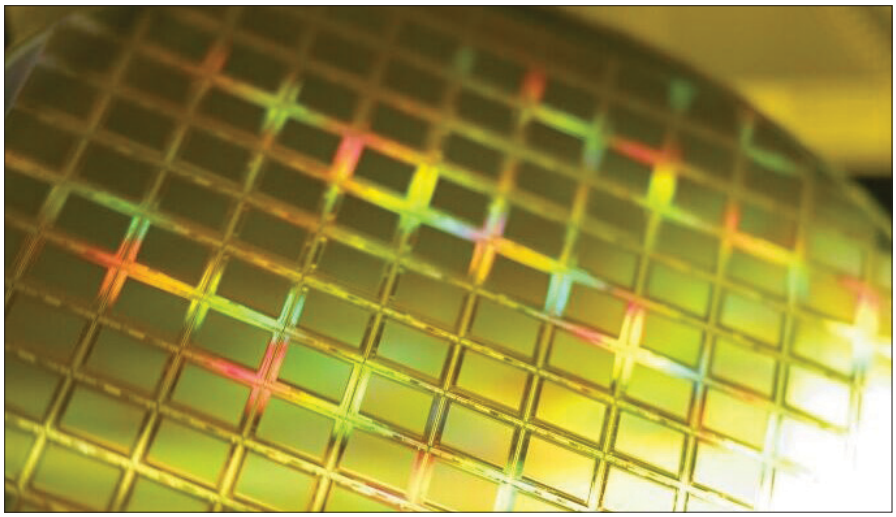

Image: Lynred.

The four-year 'HEROIC' project will see European companies gain joint access to advanced CMOS technology required to design new infrared sensors for deployment in defense systems beyond 2030.

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UCL uses short-wave IR imaging to identify tumors

Platform combining NIR and SWIR could be used for fluorescence-guided neuroblastoma surgery.

Differentiating between tumors and healthy tissue is a key part of cancer surgery, and optical imaging techniques are set to play a significant role in the determination.

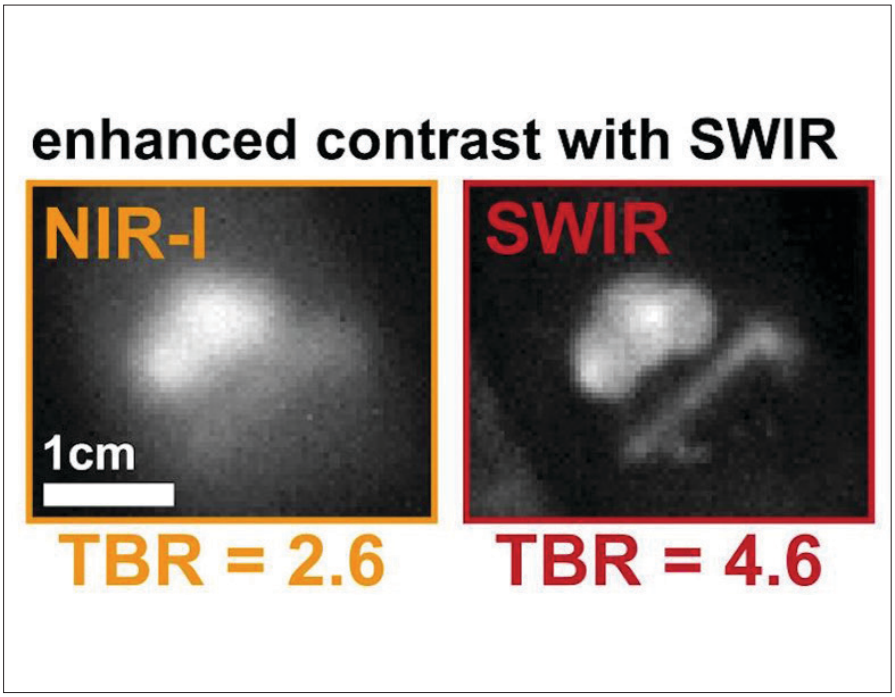
Several approaches make use of more than one wavelength of illumination, to maximize the imaging data returned to clinicians and exploit the different spectral and fluorescence responses demonstrated by different tissues and cell structures.

These have included the use of hyperspectral cameras, as in the platform designed by the HELICoiD project to image human brain cancers; and the WUSTL dual-wavelength near-IR (NIR) technique capitalizing on the wavelength-dependent attenuation of light in tissue to determine fluorophore depth.

A project at University College London has now demonstrated a multispectral NIR and shortwave IR (SWIR) fluorescence imaging device, said by the researchers to be the first of its kind. The device, initially intended for the treatment of neuroblastoma tumors in children, was described in Cancer Research.

"Fluorescence-guided surgery uses near-infrared dyes emitting from 700 to 950 nanometers, where tissue shows diminished autofluorescence compared to visible light wavelengths, enabling higher target-to-background ratios," commented the team in its paper. "However, there is growing interest in the window of 1000 to 1350 nanometers, the short-wave infrared region, where autofluorescence, absorption and scattering are further reduced."

The project noted that at present there is a lack of clinically approved SWIR fluorophore dyes, but the decreased cost of InGaAs sensors used in the imaging



Credit: UCL/Laura Privitera LinkedIn.

SWIR delivers enhanced contrast and improved tumor-to-background signal ratio from tumor tissues.

of these wavelengths has stimulated development of devices capable of measuring SWIR fluorescence, leading to a corresponding wish to investigate the technology for clinical use.

Ever-increasing need for novel technologies

UCL synthesized a suitable SWIR dye for its study by conjugating two NIR dyes, including one known to be also active in the SWIR range, to a dinutuximab-beta protein. A bespoke imaging platform was designed in which tissue was illuminated by light at a set of wavelengths between 785 and 1350 nanometers, creating both NIR and SWIR fluorescence, with the latter being collected by a cryogenically cooled InGaAs camera.

Tests on tissue phantoms indicated that the NIR/SWIR platform achieved a minimum detection volume of 0.9 mm3 and depth penetration up to 3 millimeters. A pilot study to assess the tumor uptake of the marker in mice then confirmed that SWIR fluorescence imaging enabled higher tumor-to-background signal ratio and superior depth penetration compared with in vivo NIR imaging alone, according to the project.

The next steps will see UCL and Great Ormond Street Hospital working to fast-track the technology into the operating theater within the next 12 months, to benefit children with neuroblastoma tumors.

"Paediatric surgical oncology faces an ever-increasing need for novel technologies and devices that can help visualize tumours intraoperatively," commented Laura Privitera, lead author of the study. "Fluorescence-guided surgery is a game-changing innovation that will help surgeons to obtain safer and more complete resection. I look forward to seeing this technology translated into the clinical environment."

https://optics.org/news/14/3/38

Northrop Grumman contracted to make US Marines' new targeting system

"NGHTS" will feature three sensor types: color day imager, low-light imager, plus thermal imager for total darkness operations.

The U.S. Marine Corps has awarded military and aerospace technology manufacturer Northrop Grumman the initial production and operations contract for the military "Next Generation Handheld Targeting System" (NGHTS). NGHTS is a compact targeting system that provides advanced precision targeting and is capable of operation in GPS-denied environments.

Terms of the deal were not disclosed.

Integrating three types of optical sensor, NGHTS' advanced technology is set to "significantly enhance warfighters' ability to safely complete their missions," said Bob Gough, vice president of navigation, targeting and survivability, at Northrop Grumman.

He added, "NGHTS is lightweight and combines four systems into one portable device with state-of-the-art imaging, targeting, ranging, designating and networking. This compact, multi-sensor electro-optical/infrared device will lighten Marines' loads and keeps them connected while adding precision and safety to their missions."

Laser imaging

NGHTS performs rapid target acquisition, laser terminal guidance operation and laser spot imaging functions using its advanced range finder and designator. With NGHTS, ground forces have the option to call in a target, transmit the precise location or use laser designation where previously the only option was to call in target coordinates on a field radio.

This single, ergonomic handheld product packed with advanced targeting capabilities will enable the Marines to quickly acquire and perform guidance against targets and generate target location data during combat operations.

NGHTS features three sensors: a color day imager, a low-light imager and a thermal imager for creating images in total darkness. It also includes a high-precision GPS receiver and a celestial compass that provides azimuth readings (the angular measurement in a spherical coordinate system) for a target's heading relative to NGHTS to within fractions of a degree. NGHTS allows for further targeting ranges than current legacy systems.

The manufacturer added that NGHTS will provide "superior observation from even the most environmentally and physically onerous locations; During twilight, one of the most challenging times of day to see targets, the proposed Graphical User Interface will provide a clear image."

This improved user experience allows the warfighter to conduct accurate target location and laser guidance during combat operations no matter the conditions. Weighing less than 10 pounds (4.5 kg), the durable unit will be tested under extreme conditions of temperature, vibration, salt-fog and altitude.

To create efficiencies and prioritize sustainment, Northrop Grumman designed various parts for NGHTS that can be 3D printed in the field rather sending them elsewhere for repair.

https://optics.org/news/14/2/34

Credit: Northrop Grumman.

The U.S. Marine Corps awarded Northrop Grumman a production and operations contract for the Next Generation Handheld Targeting System (NGHTS). NGHTS is a laser-based device that provides the Marines with an enhanced capability to identify and designate targets from extended ranges.

NeoSpectra near-IR analysis monitors nutrients in animal feed

Developers Si-Ware strike deal to supply platform for on-site analysis at North American dairy farms.

Si-Ware Systems has announced a deal with agriculture feed specialist Cargill Animal Nutrition that will see Si-Ware's near-IR analysis platform used in North American dairy farms.

Credit: Si-Ware Solutions.

NeoSpectra can assess the composition of raw materials, compound feed, and silages.

The agreement covers use of Si-Ware's NeoSpectra platform by Cargill's North American dairy teams for the on-site analysis of forages, feeds, and feed ingredients, as part of Cargill's provision of research capabilities, feed products and services to the farming sector.

"We are very excited to partner with NeoSpectra to bring this innovative nutrient analysis platform to the dairy industry," said Kristen Burkhardt from Cargill. "We are committed to providing our customers with the best quality feed to reach their goals, and this partnership will help us to continue to deliver on that promise with real-time, accurate insights."

The Cargill deal for dairy farms is a continuation of Si-Ware's licensing program for the NeoSpectra near-IR platform, which has seen parallel agreements made with global feed-additive specialists AB Vista and Brazilian animal feed laboratory Labnutris in the past twelve months.

The roots of the NeoSpectra platform go back to Si-Ware's research into MEMS-based solutions for industrial and consumer applications, after the company's founding in 2004. In 2014 the company won a Prism Award at SPIE Photonics West in the Test, Measurement, Metrology category for its then-unnamed MEMS FTIR device, said at the time to be the world's first single-chip FTIR spectrometer.

The product was based on the company's silicon integrated micro-optical system technology (SiMOST), a proprietary approach allowing the device's optical components and its Michelson interferometer to be permanently aligned lithographically on-chip, assisting integration into qualitative and quantitative material analysis platforms.

Near-IR for use in the field

Si-Ware announced the ramping of production for its FTIR module in March 2016, at which point the fabless company and its foundry partner were targeting OEM customers looking to develop mobile spectrometer devices for instant analysis, using the platform's 1,100 to 2,500 nanometer spectral range for material characterization purposes.

"Over the last few decades, we have witnessed how high-volume semiconductor technologies including MEMS have played a disruptive role in many industries," commented Si-Ware co-founder and CTO Bassam Saadany at the time. "We believe that NeoSpectra ignites this disruption in the spectroscopy arena."

In 2019 the company expanded its product range to include a smaller model, NeoSpectra-Micro, based around a similar MEMS FTIR sensor, along with bespoke software and calibration tools.

Cargill will use the NeoSpectra platform to analyze the nutrient content of feed and feed ingredients quickly and accurately, helping dairy farmers to monitor what the cattle consume and ensuring consistency of nutrition. A recent Italian study comparing the use of near-IR systems with other methods found that the faster testing of feed allowed by hand-held optical devices could result in both lower feed costs and higher milk production.

"Our solutions will help Cargill ensure the nutritional value of their feed products, providing their customers with the information they need to make accurate and informed choices on the spot," said Si-Ware's Mostafa Medhat.

https://optics.org/news/14/2/31

AUTOHOLO monitors harmful algae in Gulf of Mexico

Florida Atlantic University platform uses digital holographic microscopy in open waters.

A project at Florida Atlantic University (FAU) has developed a laser-based platform designed to detect harmful blooms of Karenia brevis algae in ocean waters, a phenomenon known as red tide.

The algae can be a recurring problem in the coastal Gulf of Mexico, creating toxins that cause death in fish, dolphins, manatees and birds, as well as respiratory irritation in humans.

An ability to detect red tide blooms at all life stages and cell concentrations is critical to increasing predictive capabilities and developing potential mitigation strategies, according to the FAU project. But current microscopic techniques are limited in their application and expensive to deploy.

The answer could be AUTOHOLO, a novel autonomous, submersible, 3D holographic microscope and imaging system, designed to study marine particles and plankton in their natural environment.

Reported in Harmful Algae, the study is the first to utilize holography to characterize red tide in the field and monitor harmful algal blooms (HABs), tackling limitations associated with current methods that usually rely on sample collections at fixed locations.

AUTOHOLO builds on previous research into characterizing oceanic particles using optical techniques at the FAU lab of Aditya Nayak, which concluded that holography is currently the only viable non-intrusive technique for fully characterizing oceanic particle distributions over a three-dimensional sample volume.

Put into practice in the AUTOHOLO device, the holographic technique illuminates a sample volume with a coherent and collimated beam of 532-nanometer light, and records the diffraction patterns resulting from interference between light scattered by particles in the volume and the undisturbed light beam. Numerical reconstruction from the holographic diffraction patterns produces in-focus images of all particles within the volume, giving 3D information on their shape, distributions and motion.

The current AUTOHOLO prototype involves two cylindrical tubes, six inches in diameter and 40 inches long. One houses the laser source along with beam expanding and alignment optics, and the other contains a 16MP camera sensor, power supply and control electronics. Data is stored onboard using 4TB solid state hard drives. The sample volume provided by the water-filled tube is "an order of magnitude higher than the volume sampled per hologram in commercially available holographic imagers," according to the designers.

Accurate analysis across large distances

"Our researchers designed the AUTOHOLO to be versatile enough to overcome challenges associated with small or fixed sample volumes as well as environments that are visually complex, to be used as a warning system for red tide," commented FAU's Stella Batalama.

In trials, the AUTOHOLO took field measurements in the coastal Gulf of Mexico during an active K. brevis bloom over the 2020-2021 winter season, using a custom-built towing system designed to help record data over large spatial ranges. Surface and sub-surface water samples were also collected and analyzed in the lab using benchtop holographic imaging and flow cytometry for validation.

A dataset of red tide cells created from the holographic images was used to train a customized convolutional neural network for automated classification.

Results across diverse datasets with red tide concentrations at varying levels showed that the AUTOHOLO delivered 90 percent accuracy in its analysis and confirmed its ability to characterize particle abundance over large spatial distances, potentially facilitating rapid characterization over large areas during bloom events.

"Red tide blooms can occupy varying depths in the water column, and surface focused single point sampling or sampling at limited discrete depths may under-sample or miss any population aggregating at a depth," said Malcolm McFarland from the FAU's Florida Center for Coastal and Human Health.

"In the future, the AUTOHOLO could be integrated into existing HAB monitoring networks to enhance the capability of detecting red tide in aquatic environments around the world."

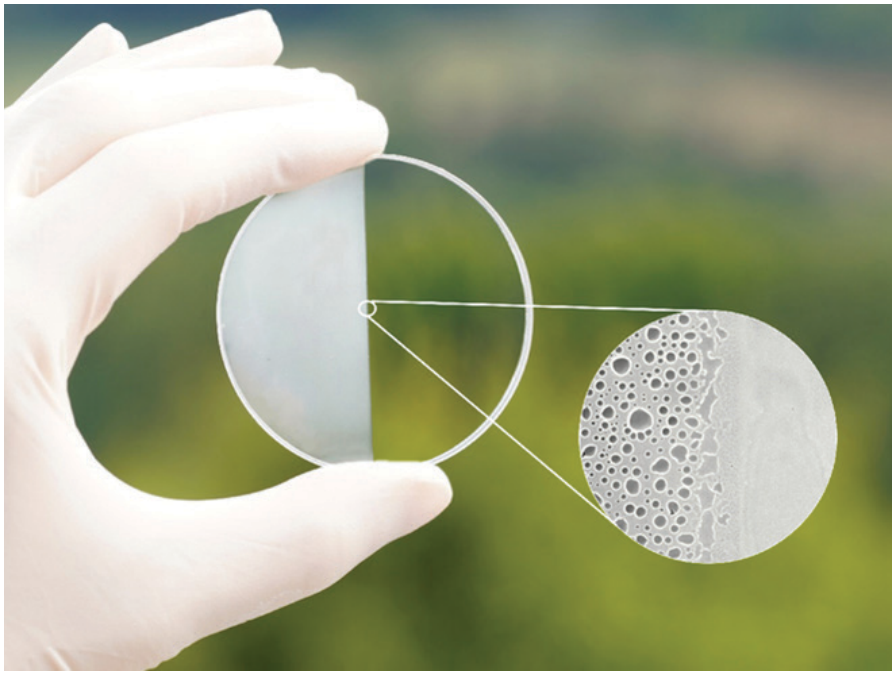
https://optics.org/news/14/4/4

Credit: FAU.

Stem the red tide: ocean analysis.

Optical coating approach prevents fogging and unwanted reflections

Technology helps sensor and camera systems perform optimally by keeping optics transparent.



Credit: Anne Gärtner, Fraunhofer Institute for Applied Optics and Precision Engineering and Friedrich Schiller University Jena.

Optical coating system combines antifogging and antireflective properties. The new technology could help boost the performance of lidar systems.

Researchers in Germany have developed an optical coating system that combines antifogging and antireflective properties. The new technology could help boost the performance of lidar systems and cameras.

"Walking into a warm room from the cold outside can cause glasses to fog up, blinding the user," said research team leader Anne Gärtner from Fraunhofer Institute for Applied Optics and Precision Engineering (IOF) and Friedrich Schiller University Jena, both in Jena, Germany.

She added, "The same can happen to sensors such as the lidar systems used in autonomous cars. It is important that surfaces remain highly transparent, even if fogging occurs, so that functionality is maintained."

Gärtner and colleagues describe in Applied Optics, how they combined a polymer coating that prevents fogging with porous silicon dioxide nanostructures that reduce reflections.

Although the coatings described in the paper were designed specifically for lidar systems, the technology can be tailored for many different applications.

"In our coating system the anti-fogging and anti-reflective properties are excellently combined, something which has not been previously feasible," said Gärtner. "Samples manufactured with this new coating technology have already been used successfully for a year in several airborne lidar prototypes operating in various climatic conditions around the world."

Seeing more clearly

The coating system described in the paper was developed in response to a need identified by Leica Geosystems, Heerbrugg, Switzerland. Leica Geosystems develops airborne lidar measurement systems that are used for terrain and city mapping.

When there are extreme temperature differences between the environment and the measuring system, fogging sometimes occurs on the optical surfaces, impairing functionality. Gärtner's team collaborated with Leica Geosystems to develop a solution that managed the fogging as well as undesirable light reflections.

"We used a polymer that prevents fogging on an optical surface by acting as a water reservoir," said Gärtner. "However, differences in the refractive indices of the polymer material and the surrounding air leads to unwanted reflections and ghost light. To prevent these reflections, we combined the antifog film with very small structures — up to 320 nm high — to create an anti-reflective effect together with water permeability."

To make the multifunctional coating system, the researchers applied "AR-plas2" technology, developed at the Fraunhofer IOF. It allows several nanostructures to be created on top of each other. The process involved etching a nanostructure into the antifog coating and then fabricating a second nanostructure on top.

With this technology, it is possible to adjust the refractive indices of the nanostructures to tailor the design of the double nanostructure to achieve very low reflection over a wide spectral range.

Laboratory tests showed that the resulting multi-layer system exhibited very low reflection over a wide spectral range, which would be impossible with a single nanostructure. Additionally, the nanostructures did not affect the coating's antifog properties.

Real-world applications

Because the structures are generated in a standard plasma-ion-assisted coating machine, the new approach can be easily incorporated into commercial manufacturing processes. In addition to being applied in several lidar prototype systems, the coating technology is already being used in cutting-edge smart phone cameras.

The researchers are now exploring how the coating system could be transferred to other areas such as adaptive lighting systems in the automotive sector or the development of quantum computers.

https://optics.org/news/14/1/28

Ouster sues Hesai for patent infringement

US-based lidar firm requests ban on imports of devices made by its Chinese rival.

Ouster, the San Francisco lidar company that recently acquired Velodyne Lidar, has filed a patent infringement lawsuit seeking to ban US imports of products made by rival supplier Hesai Technology.

Shanghai-headquartered Hesai, which raised $190 million in a Nasdaq listing earlier this year, is accused of infringing five of Ouster's US patents - with the firm requesting an investigation by the US International Trade Commission (ITC).

Each of those patents names Ouster CEO Angus Pacala as a co-inventor, and was awarded between November 2021 and August 2022.

Ouster's complaint requests that the ITC issues a limited exclusion order and a cease-and-desist order against Hesai to bar US imports of Hesai's lidar devices, components, and products.

Both of the companies sell digital lidar sensors aimed at automotive and industrial markets. Hesai's "AT128" sensors are based around 905 nm vertical-cavity surface-emitting lasers (VCSELs), and the company is known to have worked with major VCSEL manufacturer Lumentum and the Chinese car firms Changan and SAIC.

Along with the ITC case, Ouster has lodged a patent infringement complaint against Hesai in the US District Court for the District of Delaware, seeking an injunction and monetary damages. Hesai is yet to respond to the lawsuits publicly.

Digital lidar

Outlining the reasoning behind its lawsuits, Ouster stated that it had "invented digital lidar technology following an engineering breakthrough, resulting in a high-resolution sensor with a simplified architecture based on two silicon chips".

"Ouster's highly flexible digital platform can be manufactured at scale and unlocks the largest market opportunity with a combination of high-performance and low cost," added the firm. "As a result, Ouster has quickly become a market leader in lidar."

Photo: Hesai Technology.

Hesai's "AT128" long-range automotive lidar, which is based around VCSEL sources. It has a claimed ranging capability of 200 meters for 10% reflectivity objects, and a 1200x128 overall resolution.

In its most recent financial results announcement - the first since Ouster and Velodyne completed their merger - Ouster posted an operating loss of $145 million on annual sales of $41 million in 2022, with the company stressing the need for significant cost-cutting measures.

Ouster says that it holds one of the largest patent families in the lidar industry, reflecting its past investments in both rotating and non-rotating solid-state lidar systems.

"Ouster's complaint sets forth how, after the market shifted toward Ouster's digital lidar, Hesai stole Ouster's revolutionary patented technologies and incorporated them into Hesai's competing products," it claims.

"We set out to build a lidar company based on a digital approach because we knew that it would make lidar performant, affordable, and ubiquitous. Ouster intentionally built one of the strongest patent portfolios in the industry," said Pacala.

"As companies attempt to copy our digital approach, we will continue to vigorously enforce our intellectual property until the infringing products are barred."

Ouster also noted that Velodyne Lidar had previously brought a patent infringement lawsuit against Hesai in 2019, with the Chinese firm said to have settled that complaint with the payment of "millions of dollars upfront and ongoing royalties".

In July 2020, Velodyne and Hesai issued a joint statement announcing that the two companies had dismissed pending legal proceedings, and entered into a long-term global cross-licensing relationship encompassing a broad range of 360° surround-view lidar sensors.

- The US patents cited in the latest lawsuit are:

  11,175,405: Spinning lidar unit with micro-optics aligned behind stationary window

  11,178,381: Optical system for collecting distance information within a field

  11,190,750: Optical imaging system with a plurality of sense channels

  11,287,515: Rotating compact light ranging system comprising a stator driver circuit imparting an electromagnetic force on a rotor assembly

  11,422,236: Optical system for collecting distance information within a field

https://optics.org/news/14/4/19

SWIR imaging market 'worth $2.9BN by 2028'

Yole Intelligence says that the war in Ukraine and tensions over Taiwan will push defense applications beyond prior expectations.

Analysts at France-based Yole Intelligence say the current niche market for short-wave infrared (SWIR) imaging technology will grow rapidly over the next five years, and will be worth $2.9 billion by 2028.

In a new report on the segment, which is currently dominated by applications in defense, research, and industry, Yole's Alex Clouet suggests that SWIR technology could begin replacing near-infrared (NIR) imagers in high-end smart phones, where the technology is used for secure identification.

Together with higher growth than previously expected in the military arena, plus innovation in key component materials expected to reduce costs, the upshot is expected to be a compound annual growth rate in excess of 40 per cent over the next few years.

Growth potential

Although definitions of SWIR and NIR spectral ranges differ, the term SWIR is often used to refer to wavelengths between 1400 nm and 3000 nm, whereas NIR relates to the 780-1400 nm band.

According to the report, the SWIR imaging market was worth just over $300 million last year, with defense, aerospace, and research applications accounting for more than two-thirds of that total.

"The defense segment will experience higher growth than previously expected, reaching $405 million in 2028 from $228 million in 2022, pulled by geopolitical tensions such as the Ukraine war and tensions around Taiwan and an increasing number of countries becoming interested in SWIR technologies," Yole says.

The current focus means that defense-oriented players such as Israel's SCD, Sensors Unlimited, and Teledyne FLIR dominate the scene. But as the technology begins to find use in a larger number of industrial and consumer applications, that is likely to change.

"Many smaller players have significant growth potential, like Sony, or companies making quantum-dot-based cameras, such as SWIR Vision Systems and Emberion, which have a price advantage on high-resolution and extended spectral range products," Yole stated.

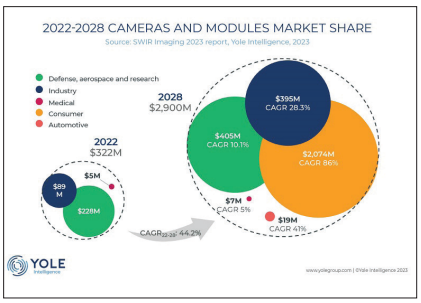


Image: Yole Intelligence.

Military applications are the mainstay of the current SWIR market, but technological innovation and mass production are expected to usher in significant consumer use over the next five years.

"Newcomers bring new disruptive technologies, like STMicroelectronics, TriEye, or Artilux, to address consumer or automotive markets."

Emberion, which is a spin-out from Nokia with facilities in Cambridge, UK, uses both colloidal quantum dots and graphene in its devices - claiming improvements in signal-to-noise, breadth of spectral response, and operating temperature.

"Traditional CMOS image sensor suppliers can be game-changers due to their high-volume production capacity and unique design and integration know-how," observes Yole.

"However, among them, only Sony and STMicroelectronics have already developed SWIR imaging technology - even though others may show signs of interest, such as Samsung and OmniVision.

"The SWIR ecosystem waits for greater interest from these players to accelerate technological and market disruption."

Material innovation

Nevertheless, the technology is expected to make an impact in consumer goods, with Yole's figures suggesting the emergence of a significant consumer market over the next five years.

"In 2026, SWIR can start replacing NIR imagers in flagship smart phones for under-display integration of facial recognition modules," reckons Clouet, adding that the resulting market for complete 3D-sensing modules will just surpass $2 billion by 2028.

Beyond that - and depending on the level of innovation and cost reductions in key components - the technology might end up being integrated into lower-end smart phones and augmented and virtual reality (AR/VR) headsets to improve the performance of tracking cameras, 3D sensing, and outdoor multispectral imaging.

Clouet also sees applications emerging in the automotive sector, where SWIR could provide enhanced vision in low light and adverse weather conditions, as well as 3D sensing capability - although this market would still be in its infancy by 2028.

Among the technological innovations that may lead to more efficient and lower-cost imaging systems, Yole highlights the potential of quantum dots, organic photodiodes, and the germanium-on-silicon material system as some potentially key developments in sensors.

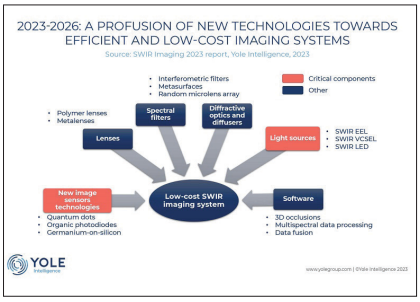


Image: Yole Intelligence.

Innovation in the sensor and light-source element of SWIR imaging systems will be the most critical for lowering the cost of the technology, but lenses, filters, and software will also play a role.

At the optical component level, polymer and metasurface lenses, diffractive optics and optical diffusers, and spectral filters could also contribute to lower costs.

- Yole's report, SWIR Imaging 2023, is available now via the company's web site.

https://optics.org/news/14/4/15

Photonis eyes methane sensing with deal to buy Telops

French firm continues acquisition strategy with deal to buy Canadian provider of infrared and hyperspectral imagers.

Photonis, the France-headquartered maker of imagers and other types of detectors for industrial and defense applications, is set to acquire the infrared camera firm Telops.

Photo: Telops.

Telops field applications scientist Marc-André Gagnon travelled with a team of French scientists from the Université Blaise Pascal to climb the Stromboli volcano, gathering hyperspectral thermal imaging data of its eruption with the Telops Hyper-Cam. Passive infrared hyperspectral imaging allows the detection and identification of multiple gases like sulfur dioxide and silicon fluoride (SiF4) escaping from craters and fumaroles, from a remote location, without the need for additional equipment.

Based in Québec City, Canada, Telops produces high-performance hyperspectral imaging systems and infrared cameras for defense, industrial, and academic markets.

It employs around 100 people across several locations - including an office just outside Paris.

The deal, which is expected to complete in the next few weeks, follows Photonis' recent acquisition of the Belgian short-wave infrared (SWIR) camera maker Xenics.

Methane detection

Photonis says that the merged group will provide "unique high-end imaging products" to business-to-business customers thanks to wide-ranging expertise in component manufacturing, a broad geographical reach, and advanced technological capabilities.

CEO Jérôme Cerisier said: "With this acquisition, we continue to extend our technology expertise by adding hyperspectral capabilities to our portfolio. It will open the way to enter the North American methane detection market with key assets, and contribute to our pursuit of building a safer world."

Telops CEO Jean Giroux added:

"By combining our strengths with Photonis Group, Telops will benefit from the Photonis expertise and international footprint which will allow us to accelerate our growth. We will consolidate our position on the European market and continue to meet new technological challenges."

Financial support

As with the Xenics deal, the addition of Telops is being financed by Pemberton, CIC, and BNP Paribas banks. LCL and Société Générale are also involved in the Telops acquisition.

Existing Photonis products include camera technologies stretching from the ultraviolet to long-wave infrared (LWIR) spectral regions, as well as night vision equipment for military and commercial use. The company also provides a range of sensors for detecting X-rays, neutrons, ions and electrons.

Founded in 2000, Telops sells a range of imagers including a passive infrared hyperspectral system that combines high spatial and spectral resolution and is suitable for both ground-based and airborne gas monitoring.

"It provides real-time radiometrically calibrated data for gas and mineral detection and identification," says the firm. "It is offered in ground-based format, but also as a compact airborne hyperspectral imaging system: the Hyper-Cam Airborne Mini.

"This lightweight imaging sensor is a versatile tool for hyperspectral infrared surveys, and a unique instrument for real-time gas detection, identification and quantification."

https://optics.org/news/14/4/13

Telops video showcasing the Hyper-Cam Mini xLW:

Fraunhofer IOSB and Lufthansa assess airplane wings in midair

Performing flow analyses with 3D models to optimize aerodynamics.

Making aircraft more fuel-efficient is one of the aviation industry's most important goals. To this end, Lufthansa Technik uses AeroSHARK, a technology inspired by sharkskin, which significantly reduces frictional drag and thus emissions.

To attach the coating optimally, however, it is necessary to conduct flow simulations which take the actual wing shape during flight into account. Measuring this is a challenge – and a specialty of the Fraunhofer Institute of Optronics (IOSB), as successful measurements flights by Lufthansa Technik have shown.

One of the tasks of aeronautical engineers is the optimization of aircraft aerodynamics. To do this, they perform flow analyses with 3D models of the aircraft. A classical 3D model of the stationary aircraft can be created in the hangar using established metrological methods. However, this is not sufficient to understand how the wings behave during flight since part of the tank load is in the wings and is consumed during a flight.

The aerodynamic uplift and the change in tank load influence the curvature: The wings deflect upward by several meters, depending on the flight section. Using models that reflect the actual aircraft shape during flight, computer-aided flow simulations (CFD) of the sharkskin technology can be carried out to determine its optimum position and orientation.

© Lufthansa Technik

Photogrammetry allows the creation of 3D models based on images from a single camera. © Swiss Air photo: Reto Hoffmann. In the hangar, the measuring marks are placed precisely and glued to the wings. The black measuring marks are necessary to be able to measure distances with just one camera. The rest is maths.

Dr. Karsten Schulz heads the Scene Analysis department at IOSB and explained why an innovative approach is needed. He said, "Usually, at least two cameras are needed to create such a 3D model. However, the conditions for stereophotogrammetry are often not met, for example because it is not possible in the passenger cabin to correctly align multiple cameras with a view onto a wing. Our new measurement method enables accurate measurement with only one camera. This is an innovation for model creation in difficult use cases."

© Lufthansa Technik.

The black measuring marks are necessary to be able to measure distances with just one camera. The rest is maths.

Camera in the cabin

A particular challenge of in-flight measurement is that it has to take place during scheduled flight operations in order to save costs and resources. The measurement equipment has to be placed in the cabin and measurements have to be taken through window panes, the effect of which is not always known in advance.

Since distances cannot be determined with a single camera, existing solutions envisage the use of multi-camera systems. However, the installation of such complex systems in wide-bodied aircraft on scheduled flights with passengers is a hopeless undertaking due to the required space.

The monocular approach developed at Fraunhofer IOSB solves this problem: The missing distance information is obtained by additional measurements on the ground. For this purpose, the upper surface of the wing is covered with numerous measurement marks whose positions are measured with the help of a tachymeter.

A single camera permanently mounted in the aircraft cabin records and locates these marks several times an hour in different flight conditions. The rest is mathematics: A model for wing deflection is based on the assumption that arc lengths do not change during bending; at the same time, length changes due to temperature fluctuations can be taken into account mathematically.

"We were able to successfully apply our patent-pending photogrammetry method with the support of an expert from Karlsruhe Institute of Technology (KIT)," said Dr. Jochen Meidow, head of on-site surveying and a scientist at IOSB.

Dr. Meidow added, "On a regular flight from Zurich to San Francisco and back, we were able to obtain the 3D model of the wing of a Boeing 777-300ER and make it available to Lufthansa Technik. Our method can also be used in other contexts where exact measurement is difficult - interested parties with individual problems are welcome to contact us."

Details of this photogrammetric approach have been published in the Journal of Photogrammetry, Remote Sensing and Geoinformation Science.

https://optics.org/news/14/4/11