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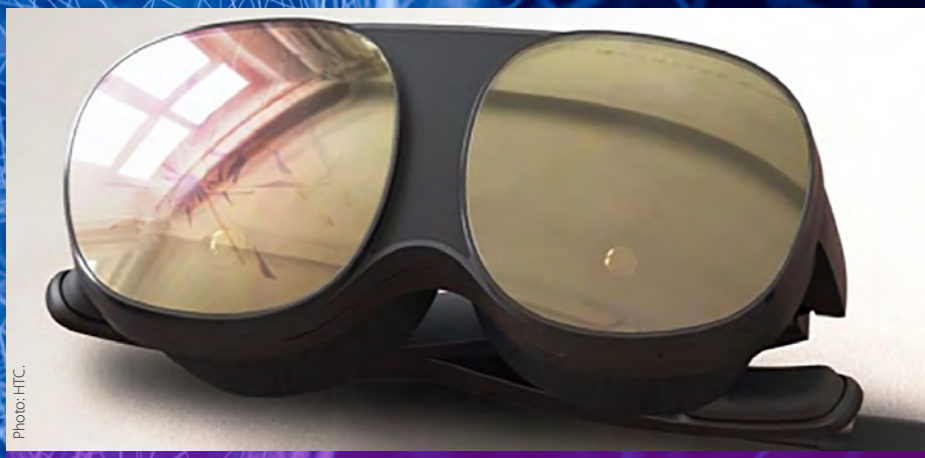

Photo: HTC.

Emerging optics to displace Fresnel lenses in XR headsets

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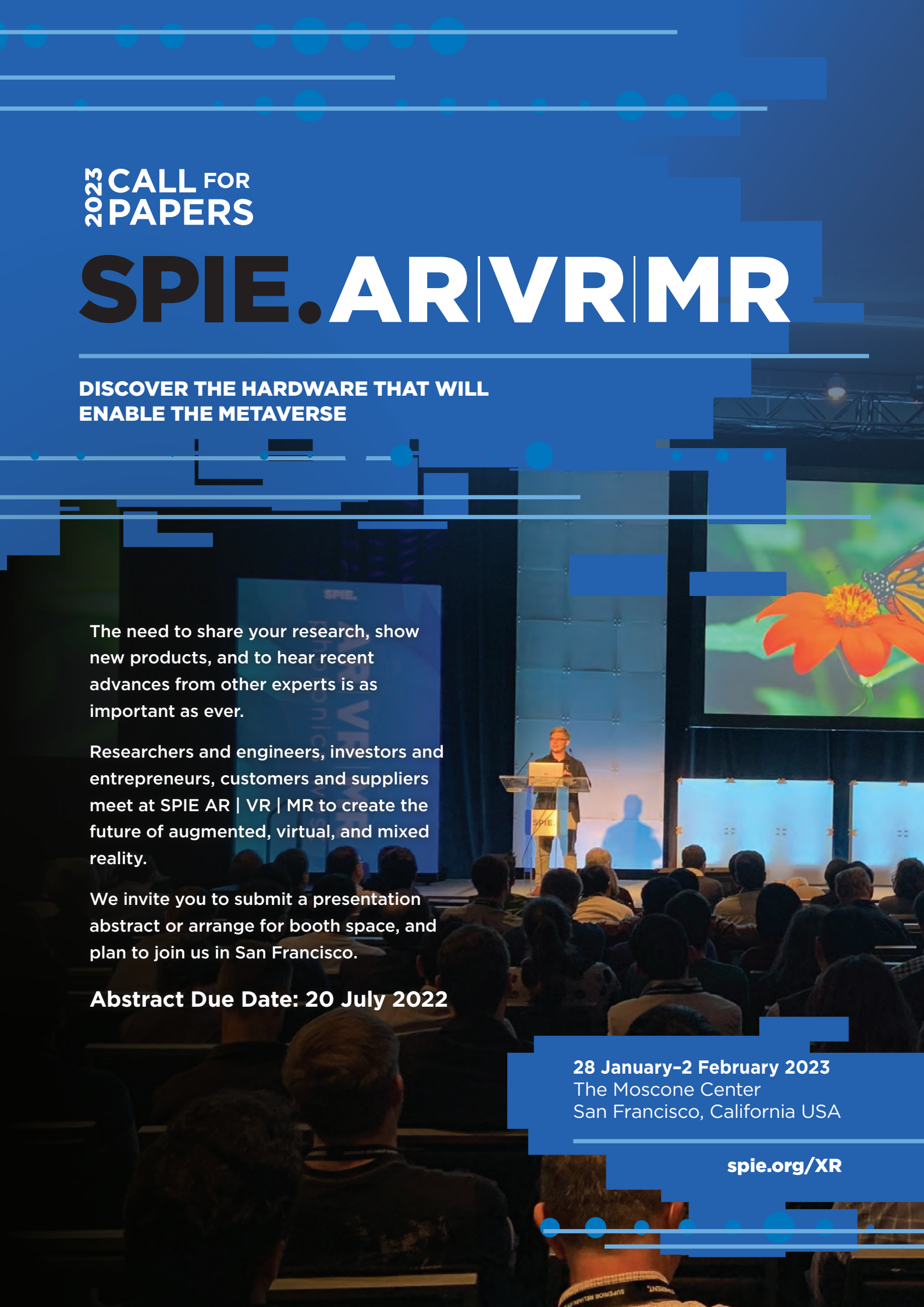

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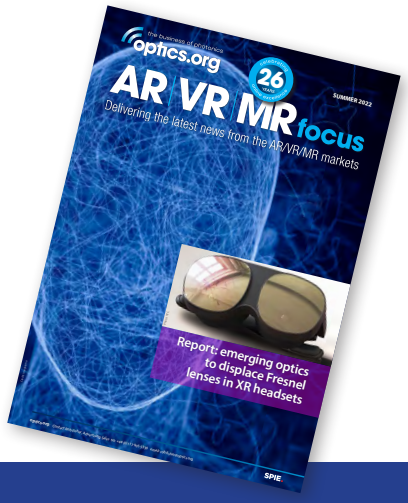
‘XR’ optics displacing conventional Fresnel lenses, says analyst

New types of optics are set to displace conventional Fresnel lenses in XR headsets. Analysis by IDTechEx also predicts 24% compound market growth of the so-called “XR optics industry” from now through to 2032. The analyst says that the first wave of these newer designs focuses on compactness, using technologies such as so-called “pancake” lenses – short, wide components already used in photography *(see page 4)*.



Issue highlights

ams Osram has developed a VCSEL upgrade for driver monitoring applications; the ICARUS proof-of-concept features a dot pattern projector to enable depth sensing *(page 6)*.

Corning is backing DigiLens in the latest funding milestone. A $50 million venture round sees the glassmaking giant invest in DigiLens’s Bragg grating technology for extended reality devices *(page7)*.

Military and aerospace technology giant BAE Systems has unveiled a lightweight LiteWave head-up display. The HUD designed for commercial and military pilots is 70% smaller. Furthermore, BAE is developing software to configure networks for “mission-critical” communications said to be 80% faster to install *(page 8)*.

IQE is to develop epiwafers for Porotech’s multicolor micro-LEDs. The compound semiconductor foundry is also commercializing new, larger wafers to boost VCSEL production *(page 9)*.

MIT has developed a novel fabrication method for certain types of mirrors and wafers. The NASA-funded photolithography technique could be “game-changer” for optical applications, say the partners *(page 10)*.

Metalenz meta-optics have been deployed in a new time-of-flight sensor. The market debut of this commercialized technology comes through partnership with STMicroelectronics *(page 12)*.

Germany’s fabled Fraunhofer Group of research institutes is opening new Center for Sensor Intelligence in Germany. The aim is to address the innovation chain in the field of intelligent sensor technology, and bring together core areas of expertise. *(page 13)*.

In an artificial intelligence innovation developed at Los Alamos National Laboratory (New Mexico, USA), printing circuits on rare nanomagnets is putting a new spin on computing; theoretical models describing “spin glasses” are broadly used in a range of complex systems, including brain function and stock-market dynamics *(page 14)*.

Plus the latest product launches from across the industry.

Matthew Peach, Editor in Chief.
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This Issue

plus the latest product launches from within the industry

Image: BAE Systems.

BAE unveils lightweight LiteWave head-up display

HUD for commercial and military pilots is 70% smaller and 80% faster to install.

See article page 8.

Emerging optics to displace Fresnel lenses in XR headsets

IDTechEx analysis also predicts 24% compound market growth of XR optics industry through 2032.

Innovative new optical components based on "birdbath", holographic, and dynamic focus tuning effects are being tipped to replace Fresnel lenses in extended reality (XR) headset designs over the coming decade.

That is one of the conclusions from a new report released by the technology-focused market research company IDTechEx, which also predicts that the market for optics used in augmented, virtual, and mixed (AR/VR/MR) headsets and eyewear will grow rapidly over the next decade.

Currently, the vast majority of VR headsets use relatively inexpensive Fresnel lenses to magnify images and bring them into focus. But although cheap and lightweight, these designs produce a number of optical artifacts that compromise the quality and comfort of the virtual experience.

Newer optical technologies promise to solve many of these issues, while adding functionality for a more immersive experience and making headsets smaller - but each faces technical challenges of their own.

Pancake progress

IDTechEx says that the first wave of these newer designs focuses on compactness, using technologies such as so-called "pancake" lenses - short, wide components already used in photography.

"Polarization-based pancake lenses saw their first entry into Western headset markets in 2021 with HTC's Vive Flow, with further releases from Shiftall/Panasonic and possibly Meta expected in 2022." reports the analyst firm.

"These lenses promise more compact designs by folding the optical path, allowing dioptric correction, and are devoid of Fresnel artifacts."

However, there are some drawbacks with pancake lenses, notably a lower optical efficiency, although IDTechEx points out that later iterations are expected to solve the vergence-accommodation conflict, thus maximizing immersion while eliminating the effect that can cause VR headset wearers to suffer from motion sickness.

Recent developments have also seen microdisplay developer Kopin produce all-plastic pancake optics that are said to reduce problems with birefringence.

Another example of a compact optical design is catadioptric freeform prism lenses, which IDTechEx also tips to make an impact this year.

When it comes to enabling immersive AR/MR, and overlaying a created reality onto the

continued on next page

Photo: HTC.

HTC's 'Vive Flow' eyeglasses for VR use so-called "pancake" lenses to reduce the size and weight of the design - and also feature binocular-like adjustable diopter lenses for personalized focusing.

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Emerging optics to displace Fresnel lenses in XR headsets

real world, the market research firm believes that a consensus is emerging, and that optical waveguides are making the most headway.

"Surface relief diffractive waveguides, as used in Hololens and Magic Leap devices, have made early strides," says the firm. "Manufactured via processes inherited from the silicon industry, these enable relatively slim and compact devices but suffer from high costs, image quality issues and poor efficiency."

Alternatives include holographic diffractive waveguides and reflective waveguides, which IDTechEx says promise to "revolutionize" manufacturability and "redefine" image quality respectively - although these are yet to gain significant market traction.

Birdbaths, etendue, and entropy

Other optical combiner possibilities, including so-called "birdbath" and freespace holographic approaches, are candidates for AR/MR headset designs, particularly where cost or compactness are the main priority.

Meanwhile, the report looks at the status of ancillary lenses for waveguides, which can match spectacle prescriptions and also promise to solve the vergence-accommodation conflict.

Key areas of development include maximizing both the field of view (to improve the sense of immersion) and the so-called "eyebox" (for comfort and usability) - although achieving this is very difficult because of the problem of etendue.

"Etendue characterizes how 'spread out' the light is in an optical system by area and angle," explains IDTechEx. "It may be thought of as the result of entropy in optical systems - it is a measure of disorder and it never decreases in a system where optical power is conserved.

"Every time light passes through a real and so imperfect optical element (for example a lens, waveguide or aperture), etendue will grow due to diffraction, aberrations etc."

It means that in an AR/MR system, the exit pupil of the projection system, or entrance pupil to the optical system, is generally smaller than the required exit pupil of the combiner.

"In this case, both exit pupil and image must be magnified - but etendue limits this. Furthermore, expansion of the exit pupil over a greater area results in lower optical efficiency."

The issue of etendue is regarded as less significant for a VR system, however, because in this case the display and exit pupil are of a relatively similar size, making it easier to maximize the field of view and eyebox.

Focus-tunable lens arrays

One long-term prospect for XR devices could be dynamically focus-tunable geometric phase lens arrays, using holography or metasurfaces. Although these are still years from deployment currently, IDTechEx has noted interest and patent activity from the likes of Meta, Valve, and Apple.

"This once-static field has transformed into a hotbed for innovation," states the report, adding that the market for XR optics will grow at a compound average rate of 24 per cent over the next decade - thus ending up nearly an order of magnitude larger.

- For more details on the IDTechEx report 'Optics for Virtual, Augmented and Mixed Reality 2022-2032: Technologies, Players and Markets', visit **www.idtechex.com**.

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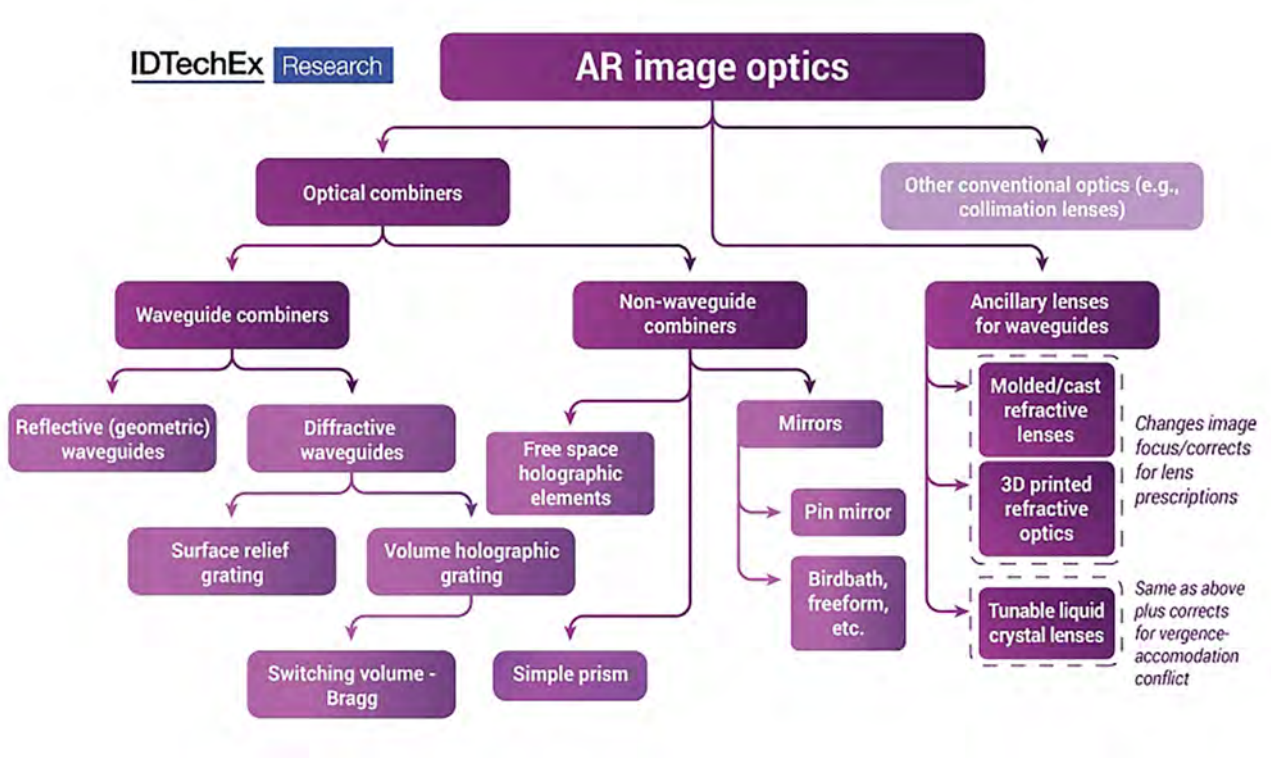

Image: IDTechEx.

AR optics options: IDTechEx has identified a range of waveguide and non-waveguide optics technologies that promise to usurp Fresnel lenses in future AR/VR/MR headset and eyewear designs.

ams Osram shows off VCSEL upgrade for driver monitoring

'ICARUS' proof-of–concept features a dot pattern projector to enable depth sensing.

Photonic component and sensor firm ams Osram has unveiled a proof-of-concept version of a new laser-based driver monitoring system able to spot "micro-sleeps" indicating dangerous levels of drowsiness.

Revealed at the Automotive Engineering Exposition, taking place in Yokohama, Japan, this week, the "ICARUS" system uses vertical cavity surface-emitting lasers (VCSELs) and a dot pattern projector.

The company says that the setup will support emerging vehicle features like augmented reality (AR) head-up displays and facial security authentication, as well as spotting when drivers become drowsy and warning them.

Depth map

Described as a simple and low-cost upgrade from existing near infrared-based driver monitoring hardware, requiring only the addition of a dot pattern projector to enable depth sensing, ICARUS is based on structured light sensing.

"It uses an ams Osram depth-extraction algorithm which offers scope for even higher performance in future for customers which support custom product development," claims the firm.

"The system is implemented with automotive VCSEL near-infrared (NIR) flood and dot pattern projectors from ams Osram."

ICARUS works by generating a depth map of the driver's face to determine the precise position of their eyes and head, with a claimed depth accuracy better than ±0.5% at 45-70 cm.

The company explains that high-value driver monitoring functions can be based on this three-dimensional position information, for example picking up so-called "micro-sleeps" - usually accompanied by a brief nod of the head - and other signs of driver drowsiness that pose an obvious risk.

"ICARUS shows automotive OEMs that there is a straightforward, low-cost upgrade path from DMS [driver monitoring system] designs which use 2D NIR sensing to a full-featured, high-value 3D sensing system," said ams Osram. "The upgrade requires only the addition of an NIR dot pattern projector and supporting depth extraction software."

Structured light

Firat Sarialtun, the manager for in-cabin sensing at the company, added: "Structured light sensing technology is proven in the consumer market, where it is used for instance for secure face authentication in mobile phones.

"Previously in the automotive world, however, 3D sensing has only been implemented with dedicated indirect time-of-flight (iToF) cameras. The ICARUS system shows that the automotive industry can take advantage of the experience of 3D sensing which ams OSRAM has gained in the consumer world, and apply it to upgrade existing 2D NIR-based DMS systems simply and at low cost, with the addition of just a single laser component."

- Osram has also just launched the latest version of its "Oslon Optimal" LEDs, which are aimed at horticultural applications.

So far, the new emitters are available at "hyper red" (660 nm) and "far red" (730 nm) wavelengths. "Deep blue" and "horti white" (featuring reduced red output) versions are expected to launch before the end of September.

"The mix of colors and white provides fixture manufacturers with the flexibility to address the spectral requirements of any horticulture application," states the firm, adding that the design will be particularly well suited to use in lighting fixtures for vertical farms and high-density greenhouses, where tight clustering of LEDs is typical.

Author
Mike Hatcher, Business Editor, optics.org

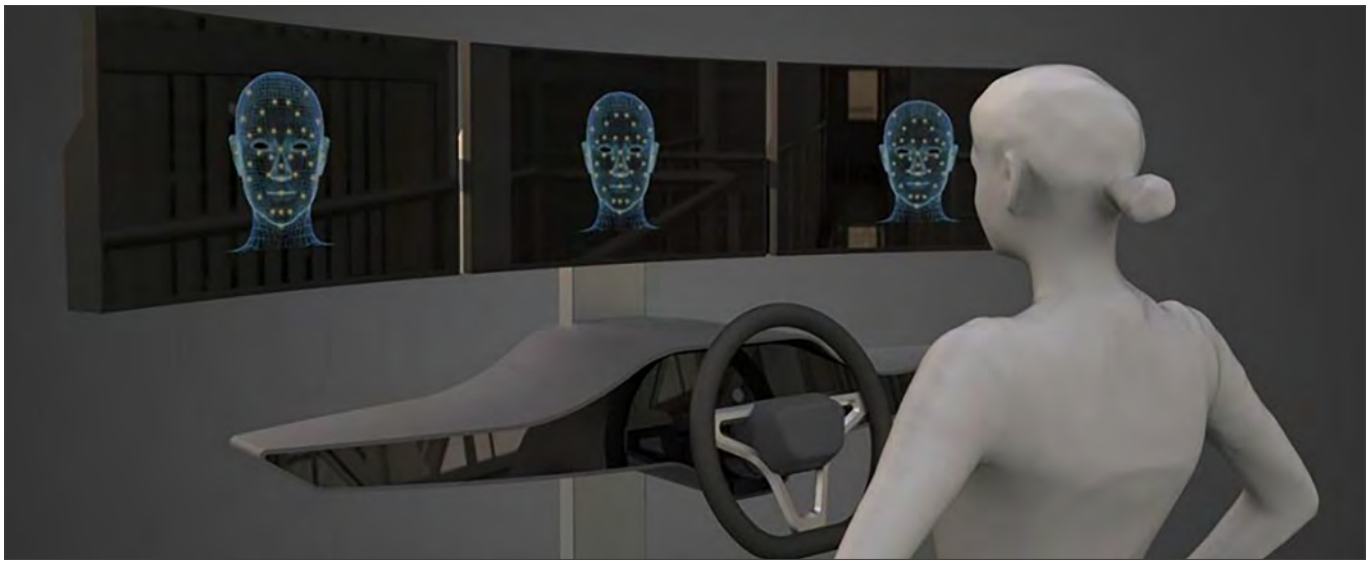

Image: ams Osram.

ams Osram says that the ICARUS system for driver monitoring could be mounted in either the instrument cluster or A-pillar of the vehicle.

Corning backs DigiLens in latest funding milestone

$50M venture round sees the glassmaking giant invest in Bragg grating technology for 'extended reality' devices.

Corning has become the latest blue-chip firm to invest in DigiLens, the Silicon Valley company developing holographic waveguides based on Bragg gratings.

NYSE-listed Corning, ranked high among the world's largest glass producers, joined Samsung and the venture wings of Mitsubishi Chemical and Universal Display Corporation in support of DigiLens' series D round now said to have raised more than $50 million.

In previous funding rounds DigiLens has garnered support from the likes of Sony, Panasonic, Foxconn, and auto parts giant Continental.

The company says that the latest injection of cash will be used to strengthen its licensing business model for deploying the waveguides in augmented, virtual, and mixed reality (AR/VR/MR) smart glasses - seen by some as the next major step in the evolution of computing and mobile devices.

Broader design space

DigiLens CEO Chris Pickett said: "As the contours of the next computing category begin to gain better definition among industry participants, you'll see a core technology industry standard take hold as investors place bets through their corporate and business investment activities.

"This series D round demonstrates our strong strategic foundation in the emerging XR [extended reality] sector. Our diverse set of partners from multiple different industries and backgrounds is taking another step to separate DigiLens from everyone else."

Pickett adds that the company is currently working on projects featuring its volume Bragg grating technology that will appear in the market over the next 12 months.

"These advances will showcase that we're the only solution that is going to work when efficiency, uniformity and cost are considered," he added. "Then, with our next-generation technology, we'll have a step function in performance that will extend our lead even more."

Image: DigiLens.

Launched at the CES event earlier this year, DigiLens' "Crystal30" waveguide - based on volume Bragg gratings - is said to reduce so-called "eye glow" to a level five times lower than with the Hololens 2 VR headset.

That waveguide technology is touted as offering a significant gain in performance while enabling an even lower cost point.

"It represents a breakthrough in diffractive grating technology, effectively broadening the design space that dictates how the technology can be used for near-to-eye displays," explains DigiLens.

"The novel surface relief structures themselves have no residual bias layer between the gratings and the supporting substrate and are made up of a strong polymer instead of a messy resin."

Crucially, the grating structures are said to be simple to manufacture with the firm's existing holographic recording process, allowing them to be slanted easily to suit a broad range of requirements while generating high-contrast images.

Larger field of view

DigiLens also says that, compared to traditional surface relief gratings, its new approach does not limit the range of height-to-width aspect ratios - something that should lend flexibility to both fabrication and design challenges.

The result should be much larger fields of view through a waveguide, or a reduction in the number of substrates needed to create a full-color waveguide lens.

Although smart glasses have yet to take off in a major way, DigiLens sees "extended reality" - a blanket term covering AR/VR/MR - as the next evolutionary step in computing from laptops, tablets, and smart phones.

"DigiLens' volume Bragg gratings are positioned to become the de facto optical standard for smart glass experiences because its technology is four times better than the closest competitor for eye glow and provides the best balance of thin, lightweight, high-performance, low cost, and highly manufacturable waveguide displays for all types of XR devices," boasts the firm.

Alistair Grant, its SVP of optical engineering, added: "With our volume Bragg gratings, DigiLens has a scalable and cost-effective optics offering ready today, and with the promise we have seen with our next-generation waveguide technologies we're set to provide the needed wide field of view and thin optical solutions of tomorrow.

"With partners like Corning for glass substrates and Mitsubishi Chemical for plastic substrates, OEMs in the personal computing industry now have the ability to create smart glasses tailored for enterprise, government, and consumer use cases."

News of the Corning investment follows the launch of DigiLens' second-generation waveguide at the Consumer Electronics Show (CES) in January.

The new "Crystal30" waveguide is described as the most efficient diffractive waveguide currently on the market, and compatible with both indoor and bright-light outdoor environments.

Author:
Mike Hatcher, Business Editor, optics.org

BAE unveils lightweight LiteWave head-up display

HUD for commercial and military pilots is 70% smaller and 80% faster to install.

LiteWave is a laptop-sized HUD developed by BAE Systems, which is designed to be mounted above a pilot's head to present critical information, such as direction, altitude and speed, directly in their line of sight.

manufactured at BAE's Electronic Systems site in Rochester, UK, which has innovated and invested in cockpit displays for over 60 years.

The location has produced more than 15,000 HUDs, which are in service on more than 50 different aircraft types globally, such as the Eurofighter Typhoon, F-16 Fighting Falcon and F-22 Raptor.

Image: BAE Systems.

LiteWave is designed for use in commercial and military aircraft.

Being 70% smaller and lighter than a traditional HUD, LiteWave can be fitted in aircraft – whether civilian or military – with even the most limited cockpit space, BAE says; it's also up to 80% faster to install and its simple design makes maintenance quicker and cheaper, says the developer.

Powered by BAE's patented waveguide technology, LiteWave can be adjusted to suit any individual flying position and allows the pilot to maintain optimal situational awareness, even during poor weather or at night.

"LiteWave can be fitted into virtually any cockpit in the world", said Lee Tomlinson, director of HUD products at BAE Systems' Electronic Systems business. "Our engineers have created a digital display that is smaller, lighter and uses less power than any other HUD."

LiteWave is now available to begin flight trials for future customers on commercial and military aircraft. The HUD is

Software to configure networks for 'mission-critical' comms

BAE has also received a $24 million contract from the U.S. Defense Advanced Research Projects Agency to develop software to autonomously configure tactical networks for mission-critical communications as part of the Mission-Integrated Network Control program.

The MINC program seeks to build and demonstrate an integrated, advanced capability that creates a secure communications network to support multi-domain operations. BAE's FAST Labs research and development organization will develop the algorithms and software to configure, and control available resources to optimize the flow of information.

Brian Decleene, chief scientist at FAST Labs, said, "As a result of this program, we'll enable the operator to deliver the right information to the user across multiple domains and improve mission outcome."

Author:
Matthew Peach, Editor in Chief, optics.org

Image: DARPA / U.S. Army.

Mission-Integrated Network Control (MINC) program.

IQE to develop epiwafers for Porotech's multicolor micro-LEDs

Compound semiconductor foundry is also commercializing new, larger wafers to boost VCSEL production.

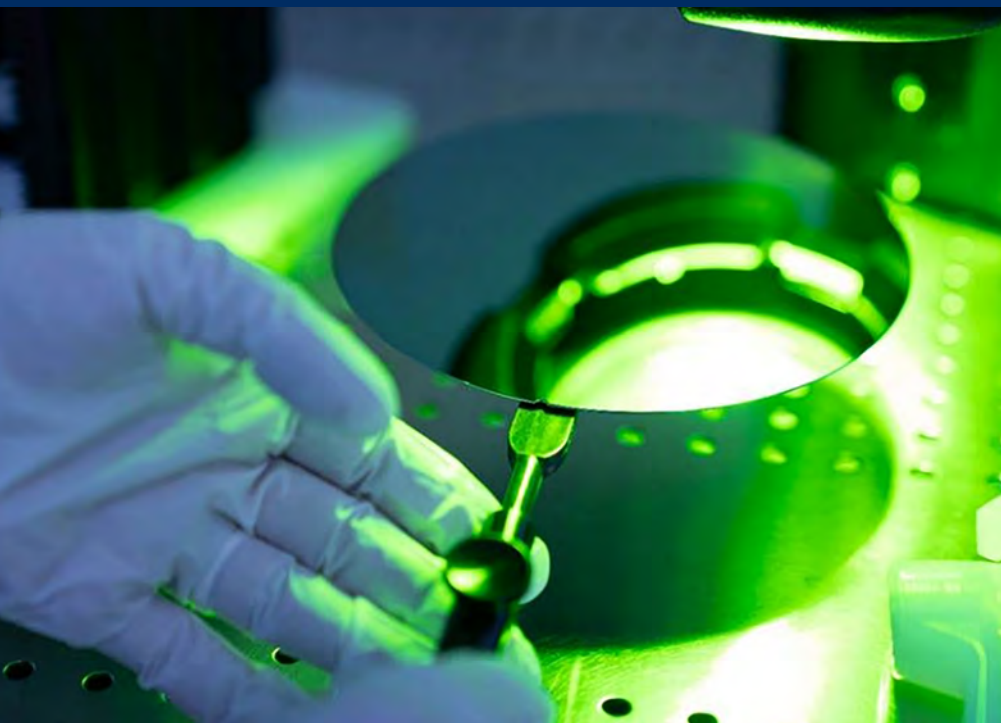

Image: Porotech.

Based around porous gallium nitride material, which can be engineered to emit light across the visible spectrum, the Porotech approach promises to greatly simplify the production of tiny red-green-blue light emitters for emerging applications in novel displays - including for AR/VR/MR platforms.

IQE, the UK-headquartered foundry for advanced semiconductor wafers, has entered the emerging market for micro-LEDs, through a development partnership with the startup company Porotech.

A 2020 spin-out from the University of Cambridge, Porotech is working on novel light emitters that are based on porous gallium nitride (GaN) semiconductors, and which can be engineered to produce light at wavelengths across the visible spectrum.

It means that a single material system can be used to produce full-color microdisplays, rather than from a combination of GaN devices emitting blue light, and other material systems for red and green emitters.

Expitaxy expertise

IQE says that the focus of the partnership is to "develop, scale and commercialize" Porotech's approach on 200 mm- or 300 mm-diameter epiwafers to create ultra-high-density and efficient micro-LEDs.

The devices are being aimed at future applications in augmented, mixed, and virtual reality (AR/MR/VR) headsets or glasses, wearable devices, and novel kinds of displays.

"The intention is for IQE to be Porotech's epitaxial wafer foundry partner, providing GaN MOCVD [metal-organic chemical vapor deposition] capacity for the volume production of 'PoroGaN' microdisplay technology platforms," announced the London-listed firm.

IQE's CEO Americo Lemos, who recently took over from the company's founder and long-time chief Drew Nelson, added: "We believe the micro-LED market presents a significant opportunity for our business."

Porotech CEO Tongtong Zhu commented that IQE's long-standing expertise in MOCVD epitaxial growth technologies, as well as its mass production capability, would be a perfect match for manufacturing very small high-brightness micro-LED pixels.

News of the partnership comes just a couple of months after the startup, which Zhu co-founded with Cambridge professor Rachel Oliver and researcher Yingjun Liu, closed a series A round of venture funding worth $20 million.

Representatives from Porotech are also attending the major "Display Week" event taking place in California this week, where they will present the PoroGaN technology and its "DynamicPixelTuning" feature for creating full-color displays.

VCSEL wafer expansion

IQE added that it has also developed new and larger epiwafers that will help to ramp the production of vertical-cavity surface-emitting lasers (VCSELs), and reduce the cost of manufacturing the devices.

The new 200 mm-diameter wafers will offer a step-change in terms of the economy of scale when making VCSELs. The tiny laser emitters are currently manufactured on 150 mm-diameter epiwafers by major producers such as Lumentum and II-VI, having only migrated from smaller wafer platforms relatively recently.

By moving to 200 mm wafer production, it should also become much easier to integrate the devices within silicon manufacturing processes, since silicon semiconductors are typically fabricated on either 200 mm-diameter or 300 mm-diameter wafers.

As IQE points out, the market for 3D sensing in smart phones was only made economical when VCSEL epiwafers were initially scaled from 100 mm to 150 mm wafer production.

"The introduction of 200 mm [wafers] creates opportunities beyond the smart phone, into a broad range of intelligent connected devices," stated the firm.

Its CEO Lemos claimed: "This is a critical milestone and establishes IQE as the global leader in scaling compound semiconductor technology to larger diameters."

He thinks that the advance will help to expand the market for both photonics and radio-frequency applications, enabling IQE to meet growing demand as a result of macroeconomic trends such as the uptake of 5G communications and the emergence of the so-called "metaverse".

Author:
Mike Hatcher, Business Editor, optics.org

MIT develops novel fabrication method for mirrors and wafers

NASA-funded photolithography technique could be 'game-changer' for optical applications, they say.

Technologies that depend on lightweight, high-precision optical systems, like space telescopes, X-ray mirrors, and display panels, have developed significantly over the past several decades, but more advanced progress has been limited by seemingly simple challenges.

For example, the surfaces of mirrors and plates with microstructures that are necessary in these optical systems can be distorted by stressed surface coating materials, degrading optics quality. Traditional optical fabrication methods struggle to meet exacting shape requirements.

Now, MIT researchers Youwei Yao, Ralf Heilmann, and Mark Schattenburg of the Space Nanotechnology Laboratory (SNL) within MIT's Kavli Institute for Astrophysics and Space Research, as well as recent graduate Brandon Chalifoux (PhD '19), have devised new methods to work past this barrier.

Research scientist Yao describes the new approach to reshaping thin plate in a way that eliminates distortion materials in a paper in Optica, of which he is lead author. Thin plate shaping is typically used for high-level, complex systems, like deformable mirrors or wafer-flattening processes during semiconductor manufacturing, but this innovation means future production will be more precise, scalable, and cheap.

Broader applications

Yao and the rest of the team believe that these thinner and more easily deformable surfaces can be useful in broader applications, such as augmented reality headsets and larger telescopes that can be sent into space at lower cost. "Using stress to deform optical or semiconductor surfaces is not new, but by applying modern lithographic technology, we can overcome many of the challenges of existing methods," said Yao.

The team's work builds on the research of Brandon Chalifoux, who is now an assistant professor at the University of Arizona. Chalifoux worked with the team on earlier papers to develop a mathematical formalism to connect surface stress states with deformations of thin plates, as part of his doctorate in mechanical engineering.

In this new approach, Yao has developed a novel arrangement of stress patterns for precisely controlling general stress. Substrates for optical surfaces are first coated on the backside with thin layers of high-stress film, made of materials like silicon dioxide. Novel stress patterns are lithographically printed into the film so that researchers can change the properties of the material in specific areas.

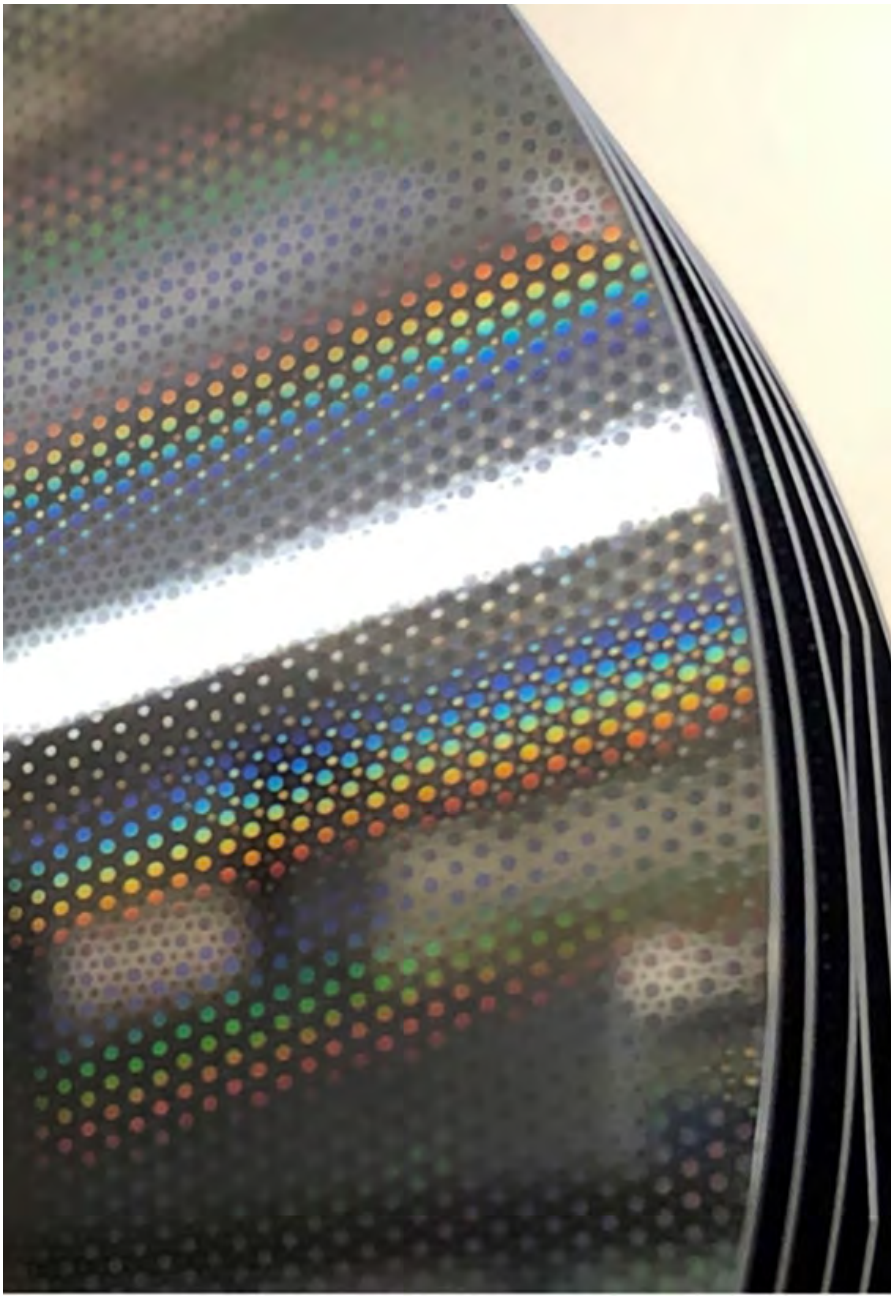

Image: Youwei Yao / MIT.

Silicon mirrors with stress correction patterns etched into a thermal oxide layer.

Selectively treating the film coating in different areas controls where stress and tension is applied across the surface. And because the optical surface and the coating are adhered together, manipulating the coating material also reshapes the optical surface accordingly.

"You're not adding stress to make a shape, you're selectively removing stress in

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MIT develops novel fabrication method for mirrors and wafers

specific directions with carefully designed geometric structures, like dots or lines," said Schattenburg, senior research scientist and director of the Space Nanotechnology Laboratory. "That's just a certain way to give a target stress relief at a single place in the mirror which can then bend the material."

Correcting space mirrors

Since 2017, the SNL team has worked with NASA Goddard Space Flight Center (GSFC) to develop a process to correct the shape distortion of X-ray telescope mirrors caused by coating stress. The research originated from a project of building X-ray mirrors for NASA's Lynx next-generation X-ray telescope mission concept, which requires tens of thousands of high-precision mirrors.

"My team at GSFC has been making and coating thin X-ray mirrors since 2001," said William Zhang, X-ray optics group leader at GSFC. "As the quality of X-ray mirrors has improved continually in the last several decades following technological advancements, distortion caused by coatings has become an increasingly serious problem."

Yao and his team developed a lithographic stress patterning method, successfully combining several different techniques, to achieve excellent removal of distortion when applied to X-ray mirrors made by the group.

After this initial success, the team decided to extend the process to more general applications, such as free-form shaping of mirrors and thin substrates, but they met a major obstacle. "Unfortunately, the process developed for GSFC can only precisely control a single type of surface stress, the so-called 'equibiaxial,' or rotationally uniform, stress," said Chalifoux.

"Equibiaxial stress states can only achieve bowl-like local bending of the surface, which cannot correct potato-chip or saddle shape distortions. To achieve arbitrary control of surface bending requires control of all three terms in the so-called 'surface stress tensor.'"

Stress tensor mesostructures

To achieve full control of the stress tensor, Yao and his team further developed the technology, eventually inventing what they call stress tensor mesostructures (STMs), which are quasi-periodic cells arrayed on the back surface of thin substrates, composed of gratings superimposed on stressed coatings.

"By rotating the grating's orientation in each unit cell and changing the area fraction of selected areas, all three components of the stress tensor field can be controlled concurrently with a simple patterning process," said Yao.

The team spent more than two years developing this concept. "We encountered a series of difficulties in the process," Schattenburg says. "Free-form shaping of silicon wafers with nanometer precision requires a synergy of metrology, mechanics, and fabrication.

By combining the lab's decades of experience in surface metrology and microfabrication with graduate-student-developed thin plate modelling and optimization tools, we were able to demonstrate a general substrate shape control method that is not limited to only bowl-like surface bending."

The work was funded by NASA.

Space Nanotechnology Laboratory

MIT's Space Nanotechnology Laboratory is located in the MIT Kavli Institute for Astrophysics and Space Research. The SNL, along with its companion laboratory, the NanoStructures Laboratory, is a member of the Microsystems Technology Laboratories, a consortium of campus microfabrication facilities with shared interests.

Its experience and expertise lies in the fields of nanofabrication, nanometer-accuracy X-ray optics fabrication, assembly and metrology, ultra-high resolution lithography, nanometrology, and nano-accuracy diffraction grating fabrication.

The SNL maintains active collaborations with groups in MIT's Departments of Mechanical, Electrical, Aero/Astro Engineering, and Physics and is interested in expanding these contacts.

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Metalenz meta-optics arrive in time-of-flight sensor

Market debut of commercialized technology comes through partnership with STMicroelectronics.

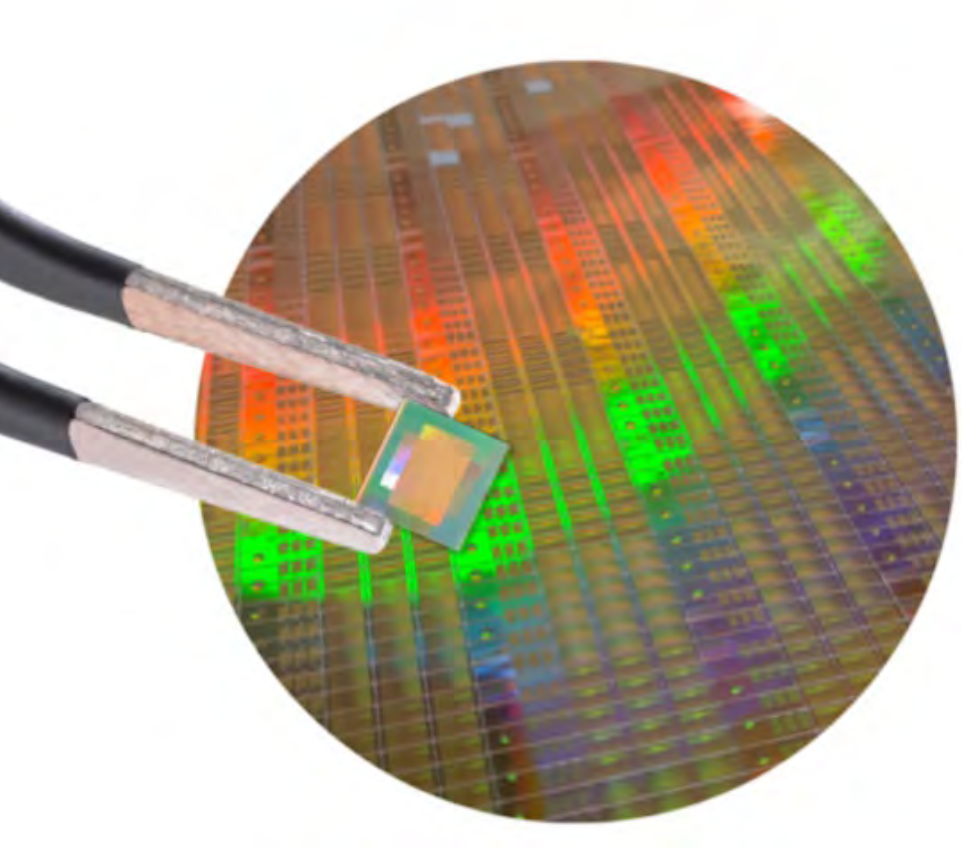
A time-of-flight sensor from STMicroelectronics marks the commercial introduction of Metalenz metasurface technology.

The metasurface component within the VL53L8 direct time-of-flight (dToF) sensor is the product of a partnership between STMicroelectronics and Metalenz that was disclosed in June 2021.

This marks the first time metasurface technology is commercially available and being used in consumer devices, according to the companies, and is intended to point towards improvements in performance, power, size, and cost that meta-optics could bring to several applications.

"More than a decade of foundational research has brought us to this point," commented Rob Devlin, co-founder and CEO of Metalenz.

"We have multiple wins that mark the first application of our platform technology and we are now designing entire systems around its unique functionality. Our meta-optics enable exciting new markets and new sensing capabilities in mobile form factors and at a competitive price."



Credit: Metalenz.

Technology developed at the Harvard SEAS lab of Federico Capasso is licensed to Metalenz.

Metalenz was founded in February 2021 as a spin-out from Harvard SEAS, with an exclusive worldwide license to a portfolio of innovations in flat optics developed in the Harvard lab of Federico Capasso. It launched with $10 million in investment from Intel Capital, 3M Ventures and others.

Speaking at the time, Capasso commented that the metalens platform "has the potential to drive a revolution in imaging and sensing, from the ubiquitous cameras in cell phones, cars, and self-driving vehicles to AR/VR, and in the future to widespread use in drones and CubeSats. I am grateful to Harvard OTD for encouraging and supporting, all along, the creation of Metalenz."

Planar optics on a chip

In June 2021, market analysis by Lux Research into the commercial prospects for optical metamaterials concluded that their commercial deployment was imminent, and that a market worth several billion dollars would develop by 2030. Metalenz was specifically identified as one of the companies driving that prospect, along with Canadian firm Meta and gradient index (GRIN) lens developer Vadient Optics.

In January 2022 Metalenz unveiled PolarEyes, a prototype platform employing the company's metasurface technology to reduce the size and complexity of polarized light cameras through "shrinking a polarization sensor by over 5000x." Such polarization cameras could be valuable in several consumer-facing sectors such as facial recognition and autonomous vehicle sensors.

Broad industrial applications

Meanwhile the new dToF sensor is a first step towards broad industrial applications for similar metaoptics breakthroughs, according to vendor STMicroelectronics. Metalenz technology allows the device to incorporate planar optics on a chip, fabricated using standard semiconductor processes in the same foundries that produce microelectronics and CMOS image sensors.

"The introduction of products embedding Metalenz metasurface optics enables significant power efficiency, optical performance, and module-size optimization that all bring benefit across consumer, industrial, and automotive markets," said Eric Aussedat of ST's Imaging Sub-Group.

"Initially targeting applications using near-infrared wavelengths, especially for 3D sensing, the products we're introducing with Metalenz are perfectly suited for applications like face authentication, camera assist, consumer LIDAR, and AR/VR, where depth mapping is needed."

Author

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Fraunhofer Group opens new Center for Sensor Intelligence in Germany

To address the innovation chain in the field of intelligent sensor technology, and bring together core areas of expertise.

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Saarland's Minister President Tobias Hans and the President of the Fraunhofer-Gesellschaft, Prof. Reimund Neugebauer, signed an agreement today to establish the Fraunhofer Center for Sensor Intelligence.

The German region of Saarland's Minister President Tobias Hans and the President of the Fraunhofer-Gesellschaft, Prof. Reimund Neugebauer, have signed an agreement to establish the Fraunhofer Center for Sensor Intelligence (ZSI). Its aim is to "address the entire innovation chain in the pioneering field of intelligent sensor technology, bring together core areas of expertise from the regional research landscape and develop them further," said the launch statement.

The center will be housed in a new building on the campus of Saarland University as part of a joint project between the Fraunhofer Institute for Biomedical Engineering IBMT and the Fraunhofer Institute for Nondestructive Testing (IZFP).

Measurement data captured by smart sensors enables knowledge-based decisions. To put it simply, a sensor can make decisions, control processes or trigger actions by itself. This is particularly important when it comes to optimizing industrial and medical technology manufacturing processes.

The opening of the sensor center will see the emergence of a highly innovative field of research involving intelligent sensor technology that builds on the core areas of expertise of the two Saarland-based Fraunhofer institutes: Fraunhofer IZFP and Fraunhofer IBMT.

The center's application-oriented approach to research is set to demonstrate the potential of these sensor systems in the sectors of materials, production and healthcare. In addition, the joint research and demonstration center will address the specific issues associated with industrial digitalization and develop solutions for Saarland's economy in the field of complex sensor systems.

The agreement also represents a key investment in Saarland as a research location. The joint growth initiative is a central development measure in the context of Saarland's innovation strategy in the key areas of informatics, smart production & automotive and life science & material science.

Minister President Tobias Hans highlighted the opportunities that Fraunhofer ZSI will create for this research location: "Fraunhofer IZFP and IBMT are key elements of our research landscape. This cooperation to establish the new Fraunhofer center will provide considerable impetus for implementing our innovation strategy and tackling the current challenges of structural transformation, for example, through the introduction of highly innovative, automated processes in the automotive sector."

Hans added, "This approach will safeguard industrial jobs, create new, modern jobs for Saarland's economy and provide new arguments for settling in the region, far beyond the high-tech jobs at Fraunhofer ZSI. The integration of Fraunhofer ZSI into the existing research landscape on the campus of Saarland University will create a unique competence cluster for digital transformation. We support this joint growth initiative and Fraunhofer's deep commitment to the state of Saarland. In this way, we are creating a center of excellence for a research topic of international importance, but with a clear focus on the digital transformation of Saarland's economy."

Prof. Reimund Neugebauer, President of the Fraunhofer-Gesellschaft, commented, "Whether it's in the pharmaceutical industry, mechanical engineering or materials research: The further development of intelligent sensors is a key prerequisite for the additional optimization of numerous technologies and processes to strengthen and expand our position in the face of international competition."

He continued, "From research to product implementation, transfer and application, Fraunhofer ZSI will cover the entire innovation chain of intelligent sensor development, thus facilitating a real innovation drive. In addition, the new center will combine and expand the core areas of expertise of this outstanding regional research landscape. This will ensure that the region plays a leading international role in the field of intelligent sensors, with a focus on future-proof and sustainable technology."

The developers' plan is to establish Fraunhofer ZSI on the campus of Saarland University. The new building and its facilities, which will cost around 35 million euros, are to be funded from federal, state and EU Structural Funds (ERDF) resources. In addition, the budget for personnel and projects for the five-year start-up phase of Fraunhofer ZSI is expected to be around 29 million euros, which will be funded by the Fraunhofer-Gesellschaft, the state of Saarland and other third-party donors. After the five-year start-up phase, up to 80 additional jobs are expected to be created and Fraunhofer ZSI will operate sustainably under the established Fraunhofer financing model of the federal and state governments in a 90:10 ratio.

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Printing circuits on rare nanomagnets puts a new spin on computing

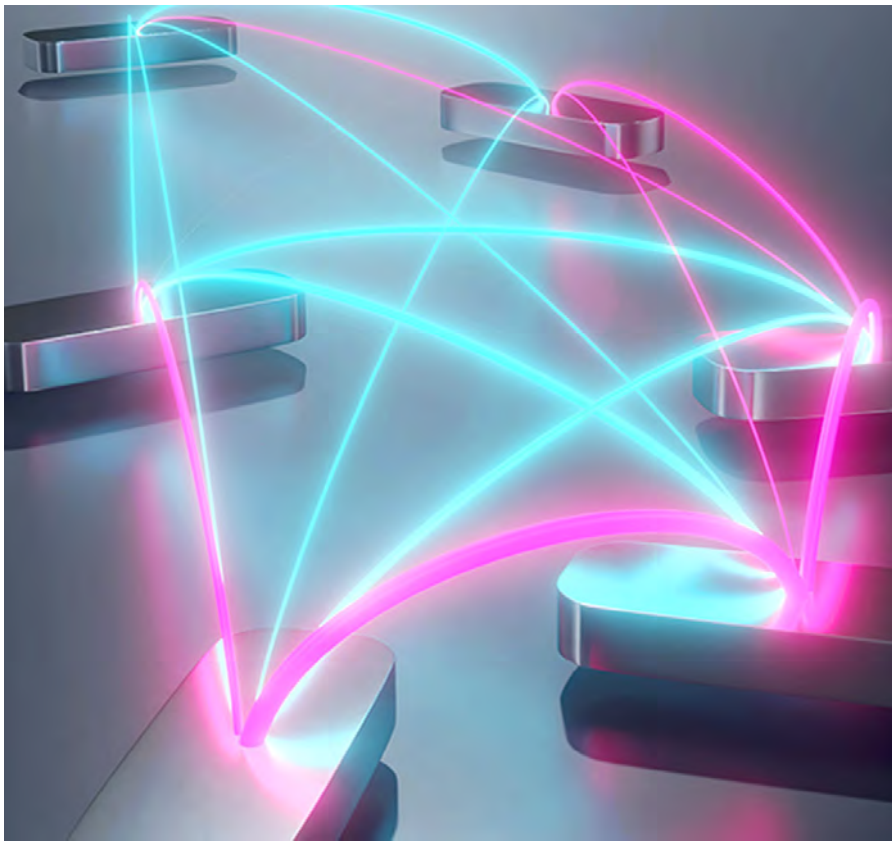
Theoretical models describing 'spin glasses' are broadly used in other complex systems, including brain function and stock-market dynamics.

New research artificially creating a rare form of matter known as spin glass could spark a new paradigm in artificial intelligence by allowing algorithms to be directly printed as physical hardware. The unusual properties of spin glass enable a form of AI that can recognize objects from partial images much like the human brain does and show promise for low-power computing, among other intriguing capabilities.

"Our work accomplished the first experimental realization of an artificial spin glass consisting of nanomagnets arranged to replicate a neural network," said Michael Saccone, a post-doctoral researcher in theoretical physics at Los Alamos National Laboratory (Los Alamos, NM) and lead author of the new paper in Nature Physics, entitled "Direct observation of a dynamical glass transition in a nanomagnetic artificial Hopfield network" (17 March, 2022). Saccone added, "The paper lays the groundwork we need to be able to use these physical systems practically."

Spin glasses are a way to think about material structure mathematically. Being free, for the first time, to tweak the interaction within these systems using electron-beam lithography makes it possible to represent a variety of computing problems in spin-glass networks, Saccone said.

At the intersection of engineered materials and computation, spin-glass systems are a type of disordered system of nanomagnets arising from random interactions and competition between two types of magnetic order in the material. They exhibit "frustration," meaning that they don't settle into a uniformly ordered configuration when their temperature drops, and they possess distinct thermodynamic and dynamic traits that can be harnessed for computing applications.



Credit: Jenna Maria Rantala, Aalto University.

At the intersection of engineered materials and computation, spin-glass systems comprise a disordered system of nanomagnets arising from random interactions and competition between two types of magnetic order in the material.

"Theoretical models describing spin glasses are broadly used in other complex systems, such as those describing brain function, error-correcting codes or stock-market dynamics," said Saccone. "This wide interest in spin glasses provides strong motivation to generate an artificial spin glass."

The research team combined theoretical and experimental work to fabricate and observe the artificial spin glass as a proof-of-principle Hopfield neural network, which mathematically models associative memory to guide the disorder of the artificial spin systems.

Spin glass and Hopfield networks have developed symbiotically, one field feeding off the other. Associative memory, whether in a Hopfield network or other forms of neural networks, links two or more memory patterns related to an object. If just one memory is triggered—for instance, by receiving a partial image of a face as input—then the network can recall the complete face. Unlike more traditional algorithms, associative memory does not require a perfectly identical scenario to identify a memory.

The memories of these networks correspond to ground states of a spin system and are less disturbed by noise than other neural networks. The research by Saccone and the team confirmed that the material was a spin glass, evidence that will allow them to describe the properties of the system and how it processes information. AI algorithms developed in spin glass would be "messier" than traditional algorithms, Saccone said, but also more flexible for some AI applications.

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LASER 2022:
Interactive opportunity to fly

High precision positioning solutions, motion control, and new lasers on show.

Credit: Physik Instrumente

Physik Instrumente presented precision motion solutions.

Physik Instrumente showcased its high precision positioning solutions at this year's LASER expo. The company offered attendees an interactive opportunity to fly, virtually catapulting them all the way from PI's trade booth to the Earth's orbit to explore how positioning solutions are driving communications.

PI's team highlighted how the firm's precise and accurate positioning systems are helping to harness the potential of optical technologies in the photonics industry. Visitors had the opportunity to dive into this world of systems applications, using augmented reality to explore how these pioneering technologies are pushing the boundaries of industries such as laser machine processing.

Motion control and new lasers

In addition, ACS Motion Control, a manufacturer of high-end modular controllers and drives for multi-axis systems, was also present to discuss that company's new motion controllers, servo drives and software.

NKT Photonics' new Koheras Harmonik frequency-converted fiber lasers give users access to a wide range of new wavelengths, up to 10 W of power, low noise, and a line width below 200 Hz, stated the company's launch document.

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