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Erik Loopstra and Vadim Banine receive European Inventor Award

ASML engineers recognized for contribution to EUV lithography.

Prominent engineers in the field of extreme ultraviolet lithography (EUVL) have been awarded one of the 2018 European Inventor Awards by the European Patent Office (EPO), in recognition of their work.

The six European Inventor Awards are presented annually by the EPO to recognize outstanding inventors from Europe and around the world who have made an exceptional contribution to social development, technological progress and economic growth.

Vadim Banine, from Dutch photolithography developer ASML, and Erik Loopstra, of ASML and its partner Zeiss, won the Popular Prize award, which is decided by a public vote. The pair have been working in the field for 20 years, and played a major role in the technology's successful arrival as a market-ready process in 2017.

Banine and Loopstra's inventions in EUVL have been instrumental in reducing radiation wavelength by a factor of 14 to 13.5 nanometres, well below the one-time barrier of 193 nanometers, according to the award citation. Global microchip manufacturers are now adopting ASML's EUVL technology for large-scale production.

Credit: EPO.

Vadim Banine and Erik Loopstra receive the European Inventor Award 2018 in the Popular Prize category.

"The public vote for Erik Loopstra and Vadim Banine honours their contributions to helping chart the future of computer-chip production," said EPO President Benoît Battistelli. "Smaller, more powerful microchips will likely drive developments in fields ranging from consumer electronics to autonomous driving and artificial intelligence. We can see how European advances in chip technology can have a big impact on the digital economy."

Banine, Loopstra and their teams developed an EUVL process which, instead of using direct laser light to etch the silicon, aims a high-powered laser at tiny droplets of tin. Exposed to the laser's heat, the metal droplets melt into plasma and emit radiation in the extreme UV, at a wavelength of 13.5 nanometers. This wavelength is perfect for etching ultra-delicate structures onto silicon.

Achieving this goal required the manufacture of ultra-smooth mirrors with flawless surfaces, for which Zeiss invented an entirely new material, as well as the design of a process able to operate in a vacuum.

In production lines, the technology will not be used to create entire chips, but only for the most detailed and precise layers. These layers will then be assembled onto finished semiconductors along with about 100 so-called "exposure layers," which are created with other types of lithography.

High numerical aperture optics

EUVL's impact on chip manufacture may be considerable, although at February's SPIE Advanced Lithography conference the company indicated that the full extent ot the technology's influence over the coming decade remained uncertain.

Speaking at that event, ASML described how EUV tools fitted with the latest laser-powered sources had demonstrated "best-ever productivity levels" of 140 wafers per hour, up from 126 wafers per hour in late 2017 and 104 wafers per hour earlier that year. This is thanks to a new design of the high-power carbon dioxide laser system, that generates EUV radiation in the lithography tool's source chamber when it meets the series of tin droplets.

The next evolution of the EUVL process, currently under development by ASML and Zeiss, will involve high numerical aperture optics, said to be an extension of the existing lithography operation that will enable geometric chip scaling during the next decade. High-NA optics offer a resolution and overlay capability which is 70 per cent better than today's most advanced EUV systems, according to ASML.

In late 2016 ASML made a €1 billion investment in Carl Zeiss SMT, a semiconductor manufacturing subsidiary of the optics company, specifically as part of its development of High-NA optics for EUVL.

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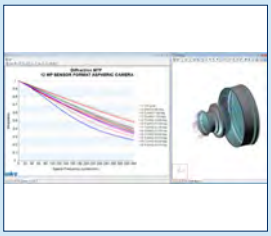

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Schott acquires Primoceler, laser glass-bonding specialist

Finnish company's unique laser-based bonding technique promises better packaging for MEMs to medical devices.

Schott, the specialty glass and glass-ceramics giant, owned by the Carl Zeiss Foundation, has entered into an agreement to acquire Primoceler Oy, a Finnish pioneer in glass micro bonding, based in Tampere.

Primoceler's hermetic packaging technology is said to create new possibilities for protection of sensitive electronics in medical implants, MEMS devices and other reliability-critical applications. With this acquisition, Schott says it is "strategically enhancing its longstanding core competence in the field of hermetic packaging".

The transaction is expected to be completed before the end of 2018, subject to required approvals. Financial details were not revealed but the acquired company will in future trade under the name Schott Primoceler Oy as part of Schott's Electronic Packaging division.

Schott's Electronic Packaging division offers a complete range of hermetic packaging technologies to protect sensitive electronics in automotive, aerospace, medical, and energy applications. Hermetic packaging refers to the sealing of electrical contacts with glass or ceramics.

The challenge in making such insulators, which prevent the intrusion of moisture and other contaminants, lies in achieving a perfect bond between the electrical metal conductors and glass, which Schott has achieved over the course of many decades.

Primoceler benefits

Primoceler has developed a "glass-only" micro bonding method based on laser technology that can be completed without any heat or added materials.

This innovative bonding process allows for the manufacture of vacuum-tight, ultra-miniature electronic or optical devices with superior reliability. The company states, "Even electronics with extreme heat sensitivities can be safely encapsulated. Glass micro bonding enables entirely new packaging concepts for devices that demand high reliability including medical implants, aerospace, automotive, optical devices, and micro-electro-mechanical systems, such as for the Internet of Things."

Photo: Primoceler.

Primoceler is a self-styled pioneer in glass micro bonding.

Ville Hevonkorpi, CEO of Primoceler, commented, "This new partnership with such a global leader positions us excellently to serve our customers around the world and scale up our production. We have enjoyed a business relationship with Schott for years and are happy to develop this further."

Peter Kniprath, Head of Schott's Electronic Packaging business unit, said, "Electronics are entering more and more areas of daily life. Consequently, demands for safety and durability have increased. Schott Primoceler will focus on tackling these challenges and working with our customers towards completely new applications."

How it works

Primoceler's hermetic packaging portfolio is based on its laser-based glass micro bonding technology. This process enables the manufacture of vacuum-tight, ultra-miniature electronic and optical devices with high reliability. This bonding method can be completed without any heat or added materials, allowing device packaging for sensitive electronics made with only transparent materials, such as glass.

The technique is also said to offer "excellent

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Schott acquires Primoceler, laser glass-bonding specialist

Photo: Primoceler.

Advances in glass packaging have led to the development of smarter medical implants.

biocompatibility" with new glass types; the technology creates new possibilities for wafer level chip scale packaging for a range of applications, including medical implants, MEMS devices, and other reliability-critical electronic and optical devices.

By directly laser bonding glass-to-glass or glass-to-silicon, devices can be manufactured without a gap between the layers, leading to ever-smaller wafer and chip scale devices and medical implants. In addition, the process allows for creation of specified conditions inside the encapsulation cavity, including integration of certain gases or even a complete vacuum.

This approach to glass micro bonding does not require any heat and can be done at room temperature, creating the possibility for electronics with extreme heat sensitivities to be safely encapsulated. The bonding process also does not require any additive materials, which means less risk for material failure or outgassing, and therefore enhanced reliability of the packaged components.

For the past 40 years, titanium has been the packaging material of choice for medical implants. However, the use of glass wafers has increased rapidly in recent times. The core reasons are the superior properties glass offers as a packaging material, including its biocompatibility. Its transparency to radio frequencies opens up new possibilities for active and passive medical implants, since glass packages could enable efficient recharging, data transfer, and reprogramming of implants. Furthermore, transparency to visible light makes full-glass micro packages suitable for a wide range of optical applications.

Biocompatible full-glass micro packages offer new possibilities for the next generation of medical implants, such as retinal implants and neuro stimulators, blood pressure sensors, and devices for cardiac rhythm management, including cardiac resynchronization therapy and implantable cardioverter defibrillator devices.

http://optics.org/news/9/7/18

Spex HMD headset allows enhanced vision for high-precision tasks

New device brings virtual and augmented reality to an all-day wearable device.

Spex, a division of Toronto-based wearable medical device developer eSight, has released a new hardware and software platform intended to combine the best current augmented reality (AR) and virtual reality (VR) features in a head-mounted device that can be worn all day.

The Spex HMD was unveiled at the Augmented World Expo earlier in June 2018, and is said to be the first AR headset platform applying enhanced vision to a range of existing tasks where precision is required, but without obstructing natural vision.

"SPEX HMD represents the evolution of our healthcare technology platform to now make it applicable to a broad range of commercial, medical and industrial applications," said Brian Mech of eSight Corporation. "SPEX is a proven hardware and software platform that enables application developers to rapidly deliver high-quality, mobile, mission-critical applications."

The Spex platform includes a 21.5 megapixel HD camera combined with high-quality lenses and automatic focus, producing a system with an overall visual acuity of 0.6 arc minutes, said to be better than the human eye can achieve. High-resolution OLED screens and custom optics display images to the wearer, with higher contrast than other AR systems and better angular resolution than standard VR headsets, according to the company.

Four potential applications were mentioned specifically by the company at the product launch as being likely to benefit from the new platform. One is the medical arena, where clinicians could use Spex HMD to assist with the identification of areas of interest and improve the accuracy of surgical interventions.

Other uses include maintenance and repair of industrial systems in the field, where two-way audio and video exchanges between remote experts and on-site technicians will be of value; or in interactive training, where a tutor can remotely manage the experience for trainees.

Credit: Spex.

Spex HMD is evidence of the growing market for AR and VR devices, as the optical technology required improves.

Optical technology

In manufacturing industry, the platform could simplify order picking, inventory control and precision assembly jobs, by bringing the camera and display systems directly to the point-of-task for higher efficiency, accuracy and safety. Mobile security should also benefit, as the device could offer bi-directional streaming video for members of a team or other mobile personnel.

The Spex HD represents a development of eSight's existing VR and AR business, which is focused on devices able to help patients suffering from visual impairment. That goal involves the approximate recreation of human vision, and hence challenges such as low-latency and maximized peripheral vision. The company has previously commented that recent improvements in VR gaming headsets and smartphones have played a part in tackling these hurdles.

Current advances in optical technology have also been important for developers in the VR and AR space, such as the recent collaboration between waveguide manufacturer WaveOptics and lithography supplier EV Group to develop waveguides specifically for the AR market at an affordable price point.

This year's CES show featured a number of advances related to VR and AR technology, both for human-machine interfaces and consumer applications, while May's Display Week event included news of Schott's RealView high-index glass wafers, designed to enable a wide field of view in AR devices.

"To raise the bar and meet the requirements of this rapidly expanding market, manufacturers need superior optical wafers with qualities a full order of magnitude greater than what has previously appeared on the market," commented Rüdiger Sprengard of Schott at the show.

http://optics.org/news/9/6/17

Analysts see $5BN auto lidar market by 2023

Twin reports on lidar applications and the related intellectual property landscape highlight huge technological diversity.

The global market for lidar systems in automotive applications is set to explode over the next few years, reaching $5 billion by 2023.

That is one of the main conclusions from a pair of analyst reports just published by French market research firm Yole Développement, covering lidar applications and the related patent landscape.

It also comes despite electric vehicle disruptor Tesla and the Chinese autonomous truck firm TuSimple both indicating that they do not intend to use lidar in their vehicles. While the various radar, camera, thermal vision, and map-based approaches present a tough competitive environment for lidar in automotive, Yole's take is that "redundancy and complementarity" between the plethora of sensors will be mandatory for self-driving vehicles to reach their potential.

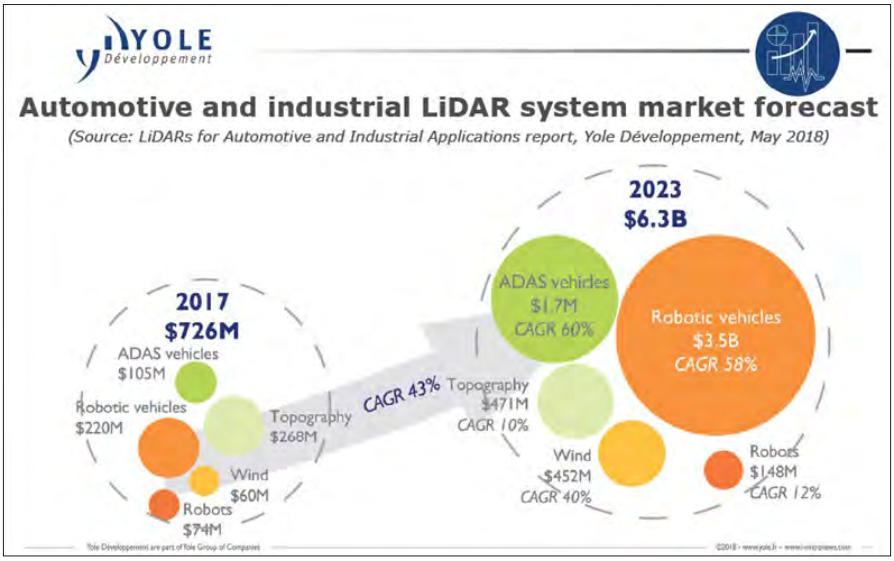

Image: Yole Développement.

The Yole team sees applications in the automotive sector dominating the overall market for lidar systems before long, with both ADAS and self-driving applications contributing heavily.

Market horizon

Though automotive lidar applications commanded a market worth less than $1 billion in 2017, the recent proliferation of venture investment in dozens of companies with a slew of different approaches to the technology indicates the high level of interest among auto companies who see lidar as a key element of future autonomous vehicles - as well as advanced driver assistance systems (ADAS) in the nearer-term.

Extending that horizon out 15 years, Yole analyst Alexis Debray is predicting that the market for automotive lidar systems will grow to a colossal $28 billion by 2032.

He estimates that upwards of $800 million has been invested in lidar technolopgy developers over the past two years – and highlights the particularly large sums attracted by early movers Quanergy Systems and Velodyne Lidar.

"Such investments testify to lidar technologies' immaturity," reports the Yole team. "Startups, industrial players, Tier1s, and automotive OEMs are all investing in different approaches with no guarantee of success - but this is the price they must pay for a chance to be part of the automotive-grade market for lidar technologies, seen by many as the 'holy grail'."

Another of the Yole report's key findings is the sheer diversity of developmental technologies – something also reflected in Knowmade's assessment of related intellectual property (IP).

"Most current products, such as those proposed by Velodyne, use a macro-mechanical scanning of laser beams at wavelengths between 830 and 940 nm," reports the team. "However, MEMS scanners are expected to be the next evolution of automotive lidar, promising to be smaller and cheaper."

The anticipated next step after that is the optical phased-array, as proposed by Quanergy among others, with the advantage of featuring no moving parts.

"This technology stems from optical fiber communications," states Yole. "Some players like Continental and Xenomatix propose flash lidar, in which the whole scene is illuminated simultaneously with no moving part. Other players propose different solutions: Cepton and Luminar have revealed mechanical scanning technologies, while Neptec employs Risley prisms."

1550 nm advantages

Another critical differentiator is the wavelength of light employed: although many developers use near-infrared light sources at 830-940 nm because the corresponding emitter and detector components are widely available, others are working at 1550 nm. That is partly because eye safety rules permit much higher (x100) laser powers, but also because dust robustness is better. "These players include Blackmore, Neptec, AEye, and Luminar," reports Yole.

The temporal realm presents another point of diversity. Most lidar developers use pulsed lidar to deliver time-of-flight data for ranging of objects in the road, but some are

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Analysts see $5BN auto lidar market by 2023

investigating continuous-wave methods that allow for heterodyne detection, and better sensitivity.

"IFM and Benewake are investigating the phase-shift ranging method, while Blackmore and Oryx are investigating the frequency modulation ranging method," Yole's team says.

On the patent front, Paul Leclaire from Knowmade discovered that Japanese companies dominate the landscape: Denso, Mitsubishi, Nissan, and Toyota all feature among the top-five patent assignees, although they are increasingly being challenged by a range of electronics, materials, and embedded system providers – including startups.

"Lidar-related patent activity began in the late 1980s amongst Japanese automotive players," reports Knowmade. "This first wave of IP players, composed of Japanese and European car manufacturers and suppliers, contributed to the development of lidar for ADAS applications."

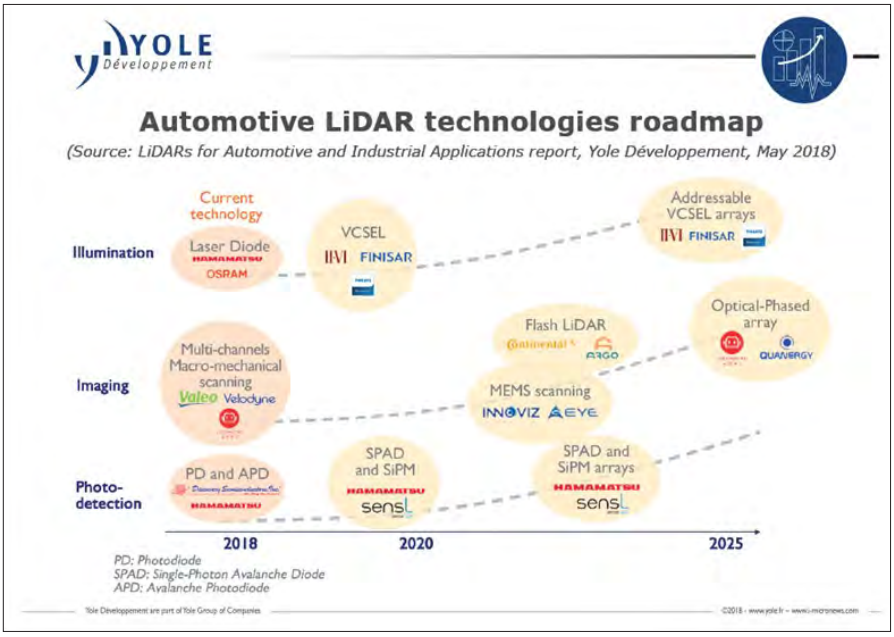

Image: Yole Développement.

Yole's analysts see VCSELs and VCSEL arrays playing an increasingly important role in automotive lidar systems as the sector matures.

Since 2010, however, that landscape has seen a strong increase, with the Knowmade team saying that the swift development of autonomous vehicles has opened many opportunities, and a variety of newcomers challenging the established IP holders.

- The **Yole Développement** and **Knowmade** reports are available now.

http://optics.org/news/9/5/18