

Photonics in Lithuania

Laser technologies are one of Lithuania's strongest and most intensive value-added industrial sectors. Since its beginning in fundamental research nearly 60 years ago, it has grown into a fully self-sustaining ecosystem, providing optics, ultrashort pulse lasers, laser technologies and systems to the global market.



© Go Vilnius. Panorama at night. Neris river

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History of lasers in Lithuania

Laser research activities started six decades ago when the first students were sent to Moscow to learn non-linear optics and laser physics in 1962. Laser applications started in 1966 for semiconductor research, while in 1983, the first commercial company EKSMA was established to produce picosecond lasers.

Most of the fundamental research in the laser field was directed by prof. Algis Piskarskas, a founding father of Lithuanian laser science. Activities at Vilnius University and the former Institute of Physics resulted in a significant number of disruptive innovations and commercial products, such as the optical parametric chirped pulse amplification (OPCPA) technology proposed in 1992 by researchers at Vilnius University and described by the Nobel committee as an 'important offspring' of the chirped parametric amplification, for which Gérard Mourou and Donna Strickland were awarded the Nobel Prize in 2018.

Scientific laser

The scientific laser market is a historically strong point for the Lithuanian laser industry. Due to the impressive scientific expertise of researchers and engineers in new, beyond-the-state-of-the-art product developments, 95 out of the world's top 100 universities are using lasers made in Lithuania. In addition, the "seal of excellence" is approved by applying the laser product, made in our country, in CERN, NASA, DESY, SLAC, ELI and other world-class facilities.

ELI-ALPS in Szeged, Hungary - one of the three pillars of the Extreme Light Infrastructure intended to deepen knowledge in fundamental physics on the attosecond timescale. The use of novel concepts overcame current technological limitations in laser intensity upscaling. The main technological backbone of ELI-ALPS is the SYLOS laser which employs OPCPA technology and operates at few-cycle to sub-cycle laser pulses. The SYLOS laser has been designed and manufactured by a consortium of two Lithuanian companies - Ekspla and Light Conversion. The two biggest Lithuanian laser companies have pooled their knowledge and technologies together and created the biggest laser among the fastest - and therefore the fastest among the biggest. Achievements have been selected as a finalist for the Berthold Leibinger Innovationspreis in 2018.

Recently, the third generation SYLOS 3 laser is in assembly. The system has been upgraded to produce an even shorter pulse duration: <8 fs laser pulses with a peak power of 15 TW at a 1 kHz repetition rate. "Unlike other TW level systems available in the market, which are operating at a

single shot or low-frequency regime, SYLOS 3 will be running at a 1 kHz repetition rate”, mentioned Kestutis Jasiūnas, CEO of Ekspla. Today OPCPA is the leading method for generating high-intensity laser radiation as it prevails compared to conventional (Ti: Sapphire laser-based) femtosecond technology in terms of pumping efficiency, contrast, bandwidth, and as a consequence, the degree of control of the generated radiation. “Despite being complex, the system will ensure exceptional stability”, – added Martynas Barkauskas, CEO of Light Conversion; – “SYLOS 3 will deliver ~120 mJ pulses with ≤ 250 mrad CEP stability and energy stability $\leq 1\%$.”

Lasers for Industry

Laser physics and applications coexist all the time in parallel in Lithuania. That is an active dipole which charges the whole laser community to new discoveries and laser application areas. Long-term, well-established relations among companies and researchers at universities and research institutions evident the critical mass required to gain new markets and applications.

The last decade was marked by intensive penetration into the industrial laser market, where nearly half of the total sales are currently taking place. This segment is presented not only by reliable 24/7 ultrashort pulse laser sources as industrial tools for delicate material processing. Solid expertise and a group of companies and researchers have been accumulated in the field of laser microfabrication with ultrashort pulse lasers. The output is laser processing technologies and systems applied in electronic, consumables, automotive or bio-medical industries.

Laser machines are a promising market for our products. The main issue for an even stronger presence in the industrial market is the lack of large end-users in the country. Therefore, laser companies and the Lithuania Laser Association intensively work to expose our visibility in global markets. Laser and photonics products are exported to more than 80 countries, with leading high-tech ones USA, Germany and Japan as well as the “world’s factory” China since the main manufacturing facilities for consumables and electronics are still working here. We are rediscovering the leading manufacturing markets (South Korea, Taiwan, ...).

The impressive growth of the laser industry by 16.2% CAGR is continuing from 2009 through 2021, and expansion of the community to more than 60 companies took place, mainly by spin-offs from research laboratories, broadening the spectrum of laser products and applications. Today, the Lithuanian laser sector presents roughly 200 M€ industry providing more than 1400 highly skilled jobs at a value-added per employee that is more than three times larger than the national average.

Close to 20 Lithuanian companies are active members of EPIC – European Photonics Industry Consortium. EPIC Annual General Assembly took place in Vilnius in April 2022, one of the first events after the pandemic. Delegates were welcomed by the Prime Minister of Lithuania Ms Ingrida Šimonytė. That was an excellent opportunity to show our achievements and search for new partners, customers or investors. The companies successfully raise external funding for business scale-up ●●●



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Ekspla: FemtoLux30 - gold honoree at the 2022 Laser Focus World Innovators Awards

and new product development. LITEK and TOOLas clusters are part of the laser and photonics ecosystem, accelerating of new companies and promoting photonics-related solutions for industry digitalisation.

Key competencies of Lithuanian laser and photonics companies

- Reliable 24/7 ultrashort pulse lasers for industry;
- High-intensity TW and PW class laser systems;
- Tunable wavelength laser devices (OPO, OPA);
- Optical components and systems;
- Opto-mechanics;
- Optical coatings;
- High-power electronics;
- Laser technologies for material processing;
- Equipment for laser processing;
- Laser-based services;
- Nonlinear laser spectroscopy;
- Optical and quantum communication;
- Optical measurements;
- Laser systems for medical diagnostics and therapy.

The latest news from our companies

Optical coatings and components

EKSMA OPTICS just moved into a new facility with a total area of 7,300 sq. m with the most advanced climate control system. Expanded manufacturing area includes >1,000 sq. m of cleanroom dedicated to laser optics manufacturing and optical systems assembling processes. Investments are made in new production equipment for laser-grade spherical and aspherical lenses, dielectric coatings deposition equipment for laser optics and crystals and quality control. The company is now able to make not only aspherical but also free-shape optics.

ALTECHNA has fully accumulated Altechna Coating and is moving to a new 3,100 sq. m facility. They are executing a €6.6 M investment plan to acquire technology equipment and manufacturing infrastructure. The new capabilities will enable the company to scale up with demand and create a competitive advantage in technology and cost for customers.

OPTOMAN is focused on Ion-Beam Sputtering (IBS) technology which provides the highest possible accuracy, repeatability and quality of optical coatings. Low GDD ultrafast mirrors are designed to handle high peak power at reflectance greater than 99.8%. This makes these mirrors ideal for femtosecond laser systems, like the Ti: Sapphire, where pulse broadening is a concern. Mirrors optimised for high-power pulsed and CW lasers, exhibit LIDT as high as 80 J/cm² @ (1064 nm, 10 ns, S-on-1).

Lasers

LIGHT CONVERSION – the world leader in femtosecond lasers and OPO - has officially opened an 11,200 sq. m unit at its headquarters in Vilnius this year, expanding into a total area of about 18,000 sq. m. The state-of-the-art building houses research and development and vertically integrated laser production: CNC machines, micro-optics, electronics and clean rooms for final product assembly. A cutting-edge intralogistics system will be used to handle components between production steps. The expansion will boost the production volume to meet the growing demand for femtosecond lasers, wavelength-tunable sources, and medical systems.

For the third year in a row, Light Conversion is honoured in the Laser Focus World Innovation Awards. The gold honoree in 2022 was awarded to HARPIA-TG - a transient grating spectrometer for carrier diffusion coefficient and lifetime measurements received. It operates as a non-invasive and non-destructive pump-probe spectrometer exciting the specimens with a periodical laser interference field, creating the transient grating – spatial refractive index modulation. Relaxation of the grating provides information on carrier diffusion. The latest model of femtosecond lasers PHAROS, PHAROS-UP, offers a sub-100 fs output without the need for external compression. It was awarded a silver honoree this year.

Light Conversion: Dr Kipras Redeckas next to HARPIA transient grating spectrometer that received Gold Honoree in Laser Focus World Innovation Awards 2022





| New Eksma Optics facility

The laser expands the capabilities in micromachining applications as well as scientific applications such as spectroscopy and high-energy physics.

EKSPLA is entering the market with a new class femtosecond laser with a flexible pulse burst operation. FemtoLux 30 laser from Ekspla, was recognised as a gold honoree in the industrial laser systems category at the 2022 Laser Focus World Innovators Awards. The new femtosecond laser employs an innovative cooling system and sets new reliability standards among industrial femtosecond lasers. The FemtoLux 30 uses an innovative Direct Refrigerant Cooling method, which provides the highest heat transfer rates, high-temperature stability, small size and low weight. The FemtoLux 30 femtosecond laser has a tunable pulse duration from <350 fs to 1 ps and can operate from a single shot to 4 MHz. It is the perfect tool for display and electronics manufacturing, processing and marking of brittle materials, as well as for the highest quality microprocessing of various metals and polymers.

EKSPLA was the first company in Central and Eastern Europe to receive the Photonics Oscar - Prism Award for Photonics Innovation for the world's most advanced product in the scientific lasers category in 2011. In the same category in 2017, INTEGRATED OPTICS was nominated for its matchbox-sized solid-state lasers MatchBox.

In 2022, two Lithuanian companies were nominated to receive the Prism Award, selected among 120 companies from 18 countries.

LITILIT, which is a spin-off company of FTMC - Center for Physical and Technological Sciences and produces ultrashort-pulse fibre lasers, was nominated in the industrial lasers category. LITILIT commercialises a new approach to generate ultrashort pulses in fibre-based lasers. The method was developed in the FTMC Department of Laser Technology and transferred to the company under a license agreement.

OPTOGAMA, INTEGRATED OPTICS, QUANTUM LIGHT INSTRUMENTS, and QS LASERS are companies building specialised solid-state lasers for diverse applications like LIBS – laser-induced breakdown spectroscopy or quantum communication.

OPTOMAN

YOUR SIDEKICK FOR
LASER OPTICS DEVELOPMENT



YOUR LASER IS AS STRONG AS ITS WEAKEST LINK

Laser optics is a critical component in a laser system, so pay attention to its quality!

Coating absorption, poor surface quality, low batch-to-batch repeatability are the key drivers that lead to laser damage. Inherently stable ion beam sputtering (IBS) process accompanied with well-established operations and process control are the key, which unlocks new laser power levels.

OPTOMAN has addressed these challenges to be able to provide SuperHero Power IBS coatings with extremely low absorption losses, which go down to <1ppm. High laser power levels call for high-power measures. Measured laser-induced damage threshold (LIDT) values of OPTOMAN optics:

HIGH REFLECTANCE COATINGS:

- > 1 J/cm² @ 1030 nm, 500 fs, 10³-on-1
- > 11.20 J/cm² @ 355 nm, 6 ns, 10³-on-1
- > 0.484 J/cm² @ 343 nm, 300 fs, 10⁷-on-1

ANTI-REFLECTIVE COATINGS:

- > 40 J/cm² @ 1064 nm, 10 ns, 10³-on-1
- > 12.66 J/cm² @ 355 nm, 6 ns, 10³-on-1

POLARIZING COATINGS:

- > 18.7 J/cm² @ 1064 nm, 10 ns, 10³-on-1

About OPTOMAN:

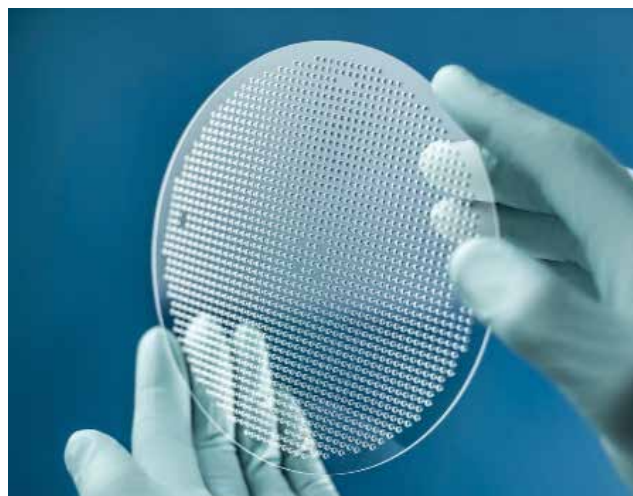
Born in 2017 in Vilnius, Lithuania, OPTOMAN is a coatings SuperHero, who designs, develops and manufactures advanced, high accuracy and repeatability IBS thin film coatings. By digging deep into each application, OPTOMAN provides custom, application-optimized optics for academia and industry.

Get in touch with OPTOMAN at info@optoman.com

With great laser power comes great responsibility for coaters!



Femtosecond laser testing at Light Conversion



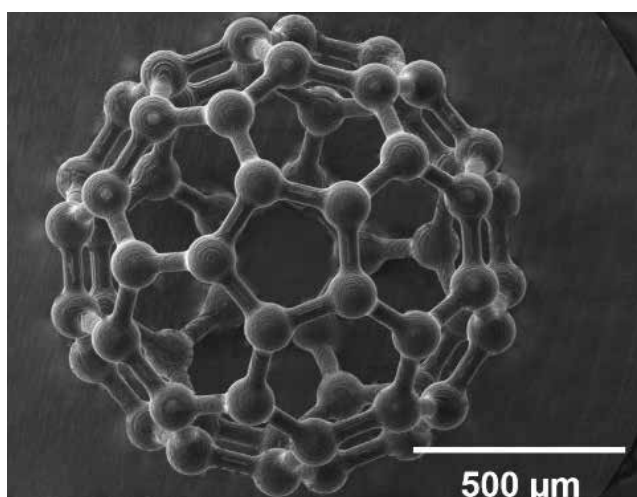
Holes drilled in glass wafer for interposer by Workshop of Photonics

Laser technologies

The integrated value chain from components to laser machines with technologies is another peculiarity of the Lithuanian laser community. A group of companies AKONEER (former ELAS), EVANA TECHNOLOGIES, FEMTIKA, WORKSHOP OF PHOTONICS, together with researchers at Vilnius University and FTMC develop technologies for microfabrication utilising advances provided by ultrashort pulses lasers: from laser-based service to complete laser machines for a factory floor.

DIRECT MACHINING CONTROL develops software for controlling complex multi-axis laser machining systems for producing electronic boards, surface texturing or additive manufacturing. Customers are all over the world: manufacturing giants or scientific institutions. The company was also nominated for the Prism Award in 2022.

Femtika: additive manufacturing at the nanoscale



LYNCIS provides industry-proved systems for automatic continuous chemical analytics of material streams without sampling, like ore grade sorting in mines. The measurements are based on LIBS technology with advanced data analysis, a machine learning approach and a full SCADA/PLC integration and Industry 4.0 solution.

Future directions

The goals set for the laser sector in 2010 have been achieved successfully by joining the supply chain of lasers for industry and providing fully integrated solutions - laser machines with technologies developed by us. Considering the new global market trends, the laser and photonics sector is expected to grow.

The Lithuanian laser sector is on diversification to other market segments, including biomedical, sensing, and optical communication. The new products in the biomedical field are dedicated to therapy like eye surgery, photoacoustic imaging and nonlinear microscopy. Quantum technologies mostly use lasers for secure communication and sensing, and a fresh start-up, ASTROLIGHT, is expanding fast in this new segment.

There is a growing need for very high-intensity lasers with emerging applications in the world, and we look not to miss the opportunity to be at the forefront:

- Therapy and medical diagnostics using laser-induced secondary radiation (X-ray, gamma, proton, FLASH therapy);
- Use of secondary radiation in diagnostics (for industry, customs, etc.)

The roadmap of the Laser and Photonics industry in Lithuania is in preparation with an ultimate goal of reaching 5% of GDP in 2030. ●



More information:
Lithuanian Laser and Photonics community.
Scan bar code, click on the scheme
and go directly to the companies' websites.

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ASSEMBLY

From a standard optical component to a customer-specific optical system, EKSMA Optics' focus is on delivering new solutions by integrating key technologies in optical manufacturing.

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