FUN GLASS days

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Information and registration

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High strength Fiber Bragg gratings for sensor applications

Dr. Christian Voigtländer, FBGS Technologies GmbH, www.fbgs.com

Fiber Bragg gratings as multi-notch spectral filter components

Thorsten A. Goebel, Friedrich-Schiller-Universität Jena, Institute of Applied Physics, www.iap.uni-jena.de

Advanced laser based glass structuring for microfluidic diagnostics

Dr. Felix Dreisow, SCHOTT Technical Glass Solutions GmbH, www.SCHOTT-MINIFAB.com

Inscribing Modifications by Tailored Ultrashort Pulsed Beams for Glass Separation

Dr. Malte Kumkar“, , TRUMPF Laser GmbH, www.trumpf.com

New developments in optical fibers for femtosecond lasers”

Dr. Arno Klenke, Helmholtz Institute Jena, www.hi-jena.de & Friedrich-Schiller-Universität Jena, Institute of Applied Physics, www.iap.uni-jena.de

FUNGLASS DAYS – “Ultrashort pulse laser processing of glass”

Dr. Arno Klenke, “New developments in optical fibers for femtosecond lasers”,
Helmholtz Institute Jena, www.hi-jena.de & Friedrich-Schiller-Universität Jena, Institute of Applied Physics, www.iap.uni-jena.de

ABSTRACT

The performance increases of femtosecond fiber laser systems over the last decades have opened up new exciting applications in industry and science. The basic fiber geometry and waveguiding properties enable operating at high average powers up to the multi-kW range. By incorporating advanced fiber core designs, the diameter of the waveguide can be increased without sacrificing the excellent beam quality of optical fibers while allowing to increase the output pulse energies. In the last years, Thulium doped fiber lasers have followed the path of the so-far mostly Ytterbium-doped fibers, opening new possibilities for applications from the mid-infrared wavelength region down to the soft x-Ray water window wavelength region. For further power scaling opportunities, parallelization of the laser process in multiple amplification channels followed by coherent beam combination has become in major focus. The presentation will demonstrate systems based on multiple amplifiers and the very recent developments using multicore fibers for compact yet powerful laser systems.

BIO

Arno Klenke, *Helmholtz-Institute Jena & Institute of Applied Physics, Jena, Germany*

He received his PhD in physics at the Friedrich-Schiller University Jena in 2016 for his work on coherent beam combination of multiple fiber amplifiers for femtosecond operation. Since then, he has pushed forward the parallelization of laser systems for performance scaling from amplifiers to non-linear pulse compression. His recent work Is focused on the development of multicore fibers for next generation laser systems.

FUNGLASS DAYS – “Ultrashort pulse laser processing of glass”

Dr. Christian Voigtländer, “High strength Fiber Bragg gratings for sensor applications”,
FBGS Technologies GmbH, www.fbgs.com

ABSTRACT

Fiber optic sensing tracks the attention in more and more industrial applications. The advantage of fiber optics sensors relies in small size, robustness, immunity against electromagnetic fields, and the capability of multiplexing several sensors in a single fiber. The sensing technique with point sensors relies on the use of Fiber Bragg gratings (FBGs). The gratings are based on periodic refractive index modifications of the fiber core. For the fabrication of the FBGs UV-Lasers and femtosecond pulsed lasers are used. The advantage of working with ultrashort laser pulses is the possibility to write the gratings through polymer jacket of the fiber without reducing the mechanical stability. By tailoring the grating parameters various fiber optic sensing applications can be addressed. One approach is based on narrow band gratings for the wavelength division multiplexing (WDM) technique. Here a high number of gratings with different grating periods can be fabricated in a single fiber resulting many sensing points. Another approach uses gratings with equal reflection wavelength in a single fiber acting as a weak enhanced back-reflection mirror.

BIO

Christian Voigtlaender *is a specialist in laser materials processing of glass and in fiber optics. He is R&D Manager in the company FBGS Technologies GmbH since 2015. He mainly investigates the inscription of fiber optics sensors especially for sensing applications. He received his Ph.D. in Physics from the Friedrich Schiller University (Jena, Germany) in the Institute of Applied Physics in 2015. In his thesis he investigated the inscription of femtosecond pulse written fiber Bragg gratings.*

FUNGLASS DAYS – “Ultrashort pulse laser processing of glass”

Thorsten A. Goebel, “Fiber Bragg gratings as multi-notch spectral filter components”,

Friedrich-Schiller-Universität Jena, Institute of Applied Physics, www.iap.uni-jena.de

ABSTRACT

With the expanding application of fiber optics over the last decades, the ability of selectively reflecting and filtering light inside fibers has become very crucial. A prominent example for fiber integrated components providing the before mentioned properties are fiber Bragg gratings (FBGs). FBGs typically consist of a periodic refractive index profile inside the fiber core leading to a reflection with its resonance wavelength mainly depending on the period. This allows the realization of desired in-fiber reflectors with tailored reflection properties. Furthermore, the reflected light is missing in transmission, enabling wavelength-selective transmission filters. This presentation shows the realization of complex grating structures, which lead not only to a single resonance but to many resonances inside a single grating. To achieve multiple resonances, a complex grating structure is required, so-called aperiodic FBGs. The idea behind aperiodic FBGs is presented along with a possible realization example based on the ultrashort pulsed structuring of glass fibers by the highly flexible line-by-line technique.

In addition, the presentation will discuss the filter requirements based on the following application example: The ground-based observation of faint stars and galaxies in the near infrared is limited by the appearance of hydroxyl emission lines in the earth’s upper atmosphere. Especially in low-resolution spectroscopy, those lines produce scattering inside the spectrograph due their strong brightness. Selectively filtering the light prior entering the spectrograph reduces the stray light and, thus, enhancing the signal-to-noise ratio.

BIO

Thorsten A. Goebel *received his bachelor and master’s degree at the Friedrich Schiller University Jena in 2014 and 2016, respectively. Since then, he is working on fiber Bragg gratings. First with a focus on sensing application, later in his Ph.D. study with an application focus on selective light filtering. T. A. Goebel is a student in the International Max Planck Research School – Physics of Light, a graduate program located at the Max Planck Institute in Erlangen with joint partners in Erlangen and Jena. He is going to graduate in 2022.*

FUNGLASS DAYS – “Ultrashort pulse laser processing of glass”

Dr. Felix Dreisow, “Advanced laser based glass structuring for microfluidic diagnostics”,
SCHOTT Technical Glass Solutions GmbH, www.SCHOTT-MINIFAB.com

ABSTRACT

Glass is a material of great importance in industrial manufacturing. The methods of structuring glass compared to other materials, e.g. metals or polymers are rather limited to a few processes because of the brittle character and the tendency to fracture. Laser processing of glass especially with ultrashort-pulsed lasers has reached nowadays an advanced level allowing for cutting, welding, 3D material removal as well as surface functionalization. Glass is transparent and shows only weak absorption of laser radiation at typical solid-state laser wavelengths in the visible and near infrared range. Therefore, nonlinear absorption phenomena provides the basis of most of the laser material processing methods and allows for light absorption in transparent materials [1].

The laser provides a versatile tool for structuring glass. Laser cutting of glass panels extends a wide variety of thicknesses from bendable thin glass below 100µm up to rigid 10 mm sheets. Laser ablation is a technology, which allows for surface marking applications but also for creating almost arbitrary 2.5D profiles into glass surfaces. Another laser-based process - enabling SCHOTT’s FLEXINITY® product portfolio - can realize inner contours such as holes but also extremely flexible shapes (Fig. 1). Glass micro welding as rather novel method completes the extent of laser-based processes is provided by SCHOTT Primoceler. It enables efficiently fabricating complex glass products on a micro scale.

Laser structured glass finds its applications in various fields. In diagnostics, the market needs glass components with high surface quality, chemical resistance and geometric accuracy. The presentation provides an insight to the full process chain from raw glass to the final product by taking the example of a next generation sequencing flow cell.

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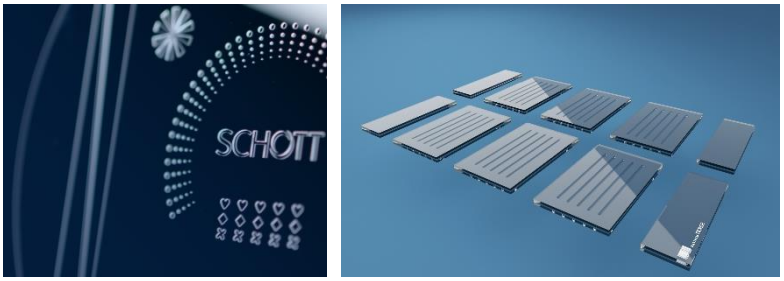

Figure 1. (left) Laser structured showing demonstration Flexinity® product capability, (center) glass microfluidic chip, (right) hermetically sealed opto-electronic packaging

References

[1] K. Itoh et al. *MRS Bulletin 31*, **2006**, 620-625

BIO

Felix Dreisow, *Schott Minifab, Jena, Germany. Since 2018, he is Scientific Advisor for Laser & Bonding Technology. He is specialist in laser materials processing with ultrashort lasers and is currently responsible for developing new processes for glass microstructuring. He was researcher and scientific coordinator at Fraunhofer Institute for Applied Optics and Precision Engineering (2016-2017). He did his Post-Doc (2010-2016), PhD (2007-2010) and Diploma (2006) at the Institute of Applied Physics at the Friedrich-Schiller-University Jena. His research topics were integrated waveguide arrays and industrial laser processes with ultrashort laser processes. Meanwhile he was with Macquarie University Sydney and Günter Köhler Institute for Joining Technology and Materials Testing (ifw Jena).*

FUNGLASS DAYS – “Ultrashort pulse laser processing of glass”

Dr. Malte Kumkar, “Inscribing Modifications by Tailored Ultrashort Pulsed Beams for Glass Separation”, TRUMPF Laser GmbH, www.trumpf.com

ABSTRACT

The ability to localize and dose the energy deposition induced by nonlinear absorption of ultrashort pulses inside of transparent materials paves the way towards diverse industrial applications. This gains attractiveness for separation of glass due to the potential of guiding the separation by inscribing modifications over the complete thickness by elongated beam profiles in a single pass. The modifications are typically dedicated for separation by different additional process steps, like applying mechanically or thermally induced stress or by selective etching.

One approach is based on nondiffracting e.g., Bessel-Gaussian beams. By adapting pulse duration, burst parameters and beam profile, it is meanwhile possible to control the modification even at elevated pulse energies, facilitating separation of glass with thickness exceeding 10 mm along curved contours. By further dedicated beam shaping, modification by nondiffracting beams can be extended for tilted incidence and nonplanar surfaces.

Another approach, based on 3D-mutispot profiles, is suitable for separation not just along complex contours but additionally with shaped edge, the generation of chamfers or bevel without additional processing steps.

BIO

Malte Kumkar *received his diploma in physics at the University Hannover in 1988, worked at the Festkoerper-Laser-Institut Berlin GmbH on laser, optics and application development and received his PhD from the Technical University Berlin in 1994. He developed laser engraving systems at MDC Max Daetwyler AG (Switzerland) and lasers for materials processing at HAAS-Laser GmbH (Germany). As managing director of the JTOE GmbH + Co. (Germany) he started the development of fiber laser modules for TRUMPF and JENOPTIK in 2007. Since 2011 he is advancing R&D on industrial laser applications at TRUMPF, currently working at TRUMPF Laser GmbH (Germany).*