Fast Inscription of Long Period Gratings in Microstructured Polymer Optical Fibers

We demonstrate 20 dB long period grating (LPG) fast inscription in microstructured polymer optical fibers (mPOFs) using a point-by-point technique obtaining an LPG total length of 25 mm. Two 248 nm UV laser pulses of 15 ns duration have been employed for every inscription point, which means a time reduction by over 21 times compared with the fastest inscription time already reported in literature. The device has been fabricated in a single-mode mPOF with a core that has been doped with benzyl dimethyl ketal for photosensitivity enhancement. Moreover, we characterize the strain and temperature responses and the stability of the fabricated gratings response under different conditions in order to assess the viability for different applications.

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Fast and stable gratings inscription in POFs made of different materials with pulsed 248 nm KrF laser

This paper presents fiber Bragg grating (FBG) inscription with a pulsed 248 nm UV KrF laser in polymer optical fibers (POFs) made of different polymers, namely polymethyl methacrylate (PMMA), cyclic-olefin polymer and co-polymer, and Polycarbonate. The inscribed gratings and the corresponding inscription parameters are compared with grating inscribed in POFs made of the aforementioned materials but with the hitherto most used laser for inscription, which is a continuous wave 325 nm UV HeCd laser. Results show a reduction of the inscription time of at least 16 times. The maximum time reduction is more than 130 times. In addition, a reflectivity and a bandwidth close to or higher than the ones with the 325 nm laser were obtained. The polymer optical fiber Bragg gratings (POFBGs) inscribed with the 248 nm laser setup present high stability with small variations in their central wavelength, bandwidth, and reflectivity after 40 days.

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Optical measuring system with an interrogator and a polymer-based single-mode fibre optic sensor system

The present invention relates to an optical measuring system comprising a polymer-based single-mode fibre-optic sensor system (102), an optical interrogator (101), and an optical arrangement (103) interconnecting the optical interrogator (101) and the polymer-based single-mode fibre-optic sensor system (102). The invention further relates to an optical interrogator adapted to be connected to a polymer-based single-mode fibre-optic sensor system via an optical arrangement. The interrogator comprises a broadband light source arrangement (104) and a spectrum analysing arrangement which receives and analyses light reflected from the polymer-based single-mode fibre-optic sensor system.

Annealing and etching effects on strain and stress sensitivity of polymer optical fibre Bragg grating sensors

Thermal annealing and chemical etching effects on the strain and stress sensitivity of polymer optical fibre based sensors are investigated. Bragg grating sensors have been photo-inscribed in PMMA optical fibre and their strain and stress sensitivity has been characterised before and after any annealing or etching process. The annealing and etching processes have been tried in different sequence in order to investigate their impact on the sensor's performance. Results show with high confidence that fibre annealing can improve both strain and stress sensitivities. The fibre etching can also provide stress sensitivity enhancement, however the strain sensitivity changes seems to be random.
Bandpass transmission filters based on phase shifted fiber Bragg gratings in microstructured polymer optical fibers

In this contribution we report on the fabrication of novel bandpass transmission filters based on PS-FBGs in microstructured polymer fibers at telecom wavelengths. The phase mask technique is employed to fabricate several superimposed gratings with slight different periods in order to form Moiré structures with a single or various π phase shifts along the device. Simulations and experimental results are included in order to demonstrate very narrowband transmission filters. Experimental characterization under strain and temperature variations is provided in a non-annealed fiber and time stability of the fabricated devices has been also measured under different pre-strain conditions.

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BDK-doped core microstructured PMMA optical fiber for effective Bragg grating photo-inscription

An endlessly single-mode doped microstructured poly(methyl methacrylate) (PMMA) optical fiber is produced for effective fiber Bragg grating (FBG) photo-inscription by means of a 400 nm femtosecond pulsed laser and the phase mask technique. The fiber presents a uniform benzyl dimethyl ketal (BDK) distribution in its core without drastic loss increase. It was produced using the selected center hole doping technique, and the BDK dopant acts as a photoinitiator. In this Letter, we report a rapidly growing process of the grating reflection band. For an 11 mW mean laser power, the FBG reflectivity reaches 83% in only 40 s.

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Effects of pre-strain on the intrinsic pressure sensitivity of polymer optical fiber Bragg-gratings

We experimentally demonstrate a scheme for improving the intrinsic pressure sensitivity of fiber Bragg-gratings (FBGs) inscribed in polymer optical fibers by applying pre-strain in order to suppress the pressure induced mechanical contraction of the fiber. This contraction would otherwise contribute to a blueshift of the Bragg-wavelength, counteracting the dominant redshift caused by the stress-optic effect, which effectively reduces the pressure sensitivity of the FBG. By applying this technique we are able to improve the sensitivity of the FBG from 2.8 pm/bar to 7.3 pm/bar. © (2017) COPYRIGHT Society of Photo-Optical Instrumentation Engineers (SPIE). Downloading of the abstract is permitted for personal use only.

Fibre Bragg Grating and Long Period Grating Sensors in Polymer Optical Fibres

The work presented in this thesis focuses on improving the fabrication of Fibre Bragg Gratings (FBGs) and Long Period Gratings (LPGs) in microstructure polymer optical fibres (mPOF). It also focuses on exploring new options for biomedical and acoustic sensing with the purpose of expanding the range of applications and pushing the limits. The first part of the work focuses on the fabrication of FBGs in polymer optical fibres. FBGs are a periodic perturbation of the refractive index of the optical fibre core which act as a wavelength specific reflector. The fibres used are made of Polymethyl methacrylate (PMMA) polymer, they are microstructured with a hexagonal 3-ring air-hole structure. FBG is inscribed through a Phase Mask technique where a Phase Mask is a piece of glass with a periodically corrugated surface on the nanometric scale. When the laser light passes through it, it creates diffraction orders which will interfere with each other and together form a periodic pattern. PMMA is an intrinsically photosensitive material, which changes its refractive index upon radiation at UV wavelengths. The PMMA fibre is positioned just below the phase mask so its core refractive index is periodically altered creating a Bragg grating with peak reflection wavelengths at 650 nm or 850 nm, depending on the phase mask. As part of this work the FBG inscription system was optimised. The optimisation routine is presented and after the optimisation inscription time is reduced to just a few minutes, a considerable improvement with respect to previous inscriptions. The influence of the laser intensity on the inscription of the gratings is also demonstrated. For step index fibres the inscription is a straightforward process. For microstructured PCFs however, the holey cladding region is making it difficult for inscription light to reach the core. The hexagonal holey structure in the cladding is shown to have certain angles, where the strong grating is formed in a short time. At the unwanted angles, grating was not formed at all, or being of a very poor
quality, proving the importance of fibre orientation for the inscription. As polymers are viscoelastic materials, they have properties of both viscous and elastic materials. Therefore, the investigation of long-term strain behaviour of a free-standing, unembedded polymer optical FBG (POFBG) sensor is presented. It shows that after straining polymer fibre sensor at certain strain level, the relaxation of the fibre happens in two phases, defining two wavelength ranges. The two ranges are called fast relaxation range ($\Delta \Lambda_{fast}$) and slow relaxation range ($\Delta \Lambda_{slow}$). $\Delta \Lambda_{fast}$ is the part with higher strains and in this range fibre behaves generally elastically – it responds instantaneously to the changes in the applied strain. The $\Delta \Lambda_{slow}$ is the wavelength range at lower strain levels, near the complete relaxation of the fibre, and in it the fibre is behaving generally viscously. Fibre sensor operating in the slow range cannot relax fast enough and experiences a time lag. The amount that these two ranges take of the total strain range depends on four factors: strain amount, strain duration, relaxation duration, and the number of cycles that sensor was strained and relaxed. Their dependency is reciprocal - as one increases the other one decreases: the $\Delta \Lambda_{slow}$ increases with strain amount, strain duration, increasing number of cycles, and it decreases with relaxation duration. For strains up to 0.9%, fast relaxing $\Delta \Lambda_{fast}$ range takes no less than 65% of the total strain range. Increase in $\Delta \Lambda_{slow}$ due to cyclic straining and relaxing seems to reach an equilibrium value, suggesting that $\Delta \Lambda_{fast}$ would never cover the whole strain range. When increasing the strain to 4.9%, the relative amount of $\Delta \Lambda_{slow}$ grows with respect to $\Delta \Lambda_{fast}$, but so does the absolute amount of $\Delta \Lambda_{fast}$. With the proper prestrain covering $\Delta \Lambda_{slow}$, the free standing FBG fibre sensor could operate in “real-time” entirely in $\Delta \Lambda_{fast}$. It would have the highest sensing range around 3%. In the last part of the FBG section, a simple fibre FBG microphone is investigated, and the influence of a membrane amplifier on sound detection is also investigated. In the last part of the thesis the LPG inscription system is shown. In this system a high power CO$_2$ laser is used for the inscription. An LPG is also a periodic perturbation of the guided core mode in fibre, but unlike FBG which reflects the core mode, the LPG couples the core mode to a cladding mode outside the core. We have shown that the LPG grating can be formed through two mechanisms in polymer fibres using a CO$_2$ laser. One is etching and the other one is perturbation of the microstructured region. After inscription of LPGs, the concept of a biocompatible distributed medical endoscope is presented, where an all-plastic LPG based device is produced. A transducer pod is made which translates the outside pressure into strain on the fibre. The transducer consisted of a 3D printed skeleton through which the fibre is pulled. A latex material is then wrapped around it and all the holes were sealed in order to prevent the air from leaking out. The pod transducer was tested for forces acting on its arms, and subsequently put into a pressure chamber. It showed good initial results for pressures up to 150 mBars, proving itself suitable as a potential biocompatible endoscope.
Simultaneous measurement of temperature and humidity with microstructured polymer optical fiber Bragg gratings

A microstructured polymer optical fiber (mPOF) Bragg grating sensor system for the simultaneous measurement of temperature and relative humidity (RH) has been developed and characterized. The sensing head is based on two in-line fiber Bragg gratings recorded in a mPOF. The sensor system has a root mean square deviation of 1.04 % RH and 0.8 °C in the range 10 to 90% RH and 20 to 80 °C. The proposed sensor system is easy to fabricate, cheap and compact.
Thermal and chemical treatment of polymer optical fiber Bragg grating sensors for enhanced mechanical sensitivity

An investigation of the thermal annealing effects on the strain, stress, and force sensitivities of polymer optical fiber Bragg grating sensors is performed. We demonstrate for the first time that the fiber annealing can enhance both stress and force sensitivities of Bragg grating sensors, with the possible cause being the molecular relaxation of the polymer when fiber is raised above the β-transition temperature. A simple, cost-effective, but well controlled method for fiber annealing is also presented in this work. In addition, the effects of chemical etching on the strain, stress, and force sensitivities have been investigated. Results show that fiber etching too can increase the force sensitivity, and it can also affect the strain and stress sensitivities of the Bragg grating sensors.

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Zeonex-PMMA microstructured polymer optical FBGs for simultaneous humidity and temperature sensing

In this Letter, we report for the first time, to the best of our knowledge, the fabrication and characterization of a Zeonex/PMMA microstructured polymer optical fiber (mPOF) Bragg grating sensor for simultaneous monitoring of relative humidity (RH) and temperature. The sensing element (probe) is based on two separate in-line fiber Bragg gratings (FBGs) inscribed in the fabricated mPOF. A root mean square deviation of 0.8% RH and 0.6°C in the range of 10%-90% RH and 20°C-80°C was found. The developed mPOFBG sensor constitutes an efficient route toward low-cost, easy-to-fabricate and compact multi-parameter sensing solutions.

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3-D printed sensing patches with embedded polymer optical fibre Bragg gratings

The first demonstration of a polymer optical fibre Bragg grating (POFBrG) embedded in a 3-D printed structure is reported. Its cyclic strain performance and temperature characteristics are examined and discussed. The sensing patch has a repeatable strain sensitivity of 0.38 pm/με. Its temperature behaviour is unstable, with temperature sensitivity values varying between 30-40 pm/°C.
Annealing effects on strain and stress sensitivity of polymer optical fibre based sensors
The annealing effects on strain and stress sensitivity of polymer optical fibre Bragg grating sensors after their photoinscription are investigated. PMMA optical fibre based Bragg grating sensors are first photo-inscribed and then they were placed into hot water for annealing. Strain, stress and force sensitivity measurements are taken before and after annealing. Parameters such as annealing time and annealing temperature are investigated. The change of the fibre diameter due to water absorption and the annealing process is also considered. The results show that annealing the polymer optical fibre tends to increase the strain, stress and force sensitivity of the photo-inscribed sensor.
Aviation Fuel Gauging Sensor Utilizing Multiple Diaphragm Sensors Incorporating Polymer Optical Fiber Bragg Gratings

A high-performance fuel gauging sensor is described that uses five diaphragm-based pressure sensors, which are monitored using a linear array of polymer optical fiber Bragg gratings. The sensors were initially characterized using water, revealing a sensitivity of 98 pm/cm for four of the sensors and 86 pm/cm for the fifth. The discrepancy in the sensitivity of the fifth sensor has been explained as being a result of the annealing of the other four sensors. Initial testing in JET A-1 aviation fuel revealed the unsuitability of silicone rubber diaphragms for prolonged usage in fuel. A second set of sensors manufactured with a polyurethane-based diaphragm showed no measurable deterioration over a three month period immersed in fuel. These sensors exhibited a sensitivity of 39 pm/cm, which is less than the silicone rubber devices due to the stiffer nature of the polyurethane material used.
Bragg grating photo-inscription in doped microstructured polymer optical fiber by 400 nm femtosecond laser pulses. In this paper, we report the manufacturing of high-quality endlessly single-mode doped microstructured poly(methyl methacrylate) (PMMA) optical fibers. Bragg gratings are photo-inscribed in such fibers by means of 400 nm femtosecond laser pulses through a 1060-nm-period uniform phase mask. Preliminary results show a rapid growing process of the reflection band. To preserve a good spectral shape, the photo-inscription process was limited to ~20 seconds, yielding an FBG reflectivity close to 40 %.
Compact multichannel demultiplexer for WDM-POF networks based on spatially overlapped FBGs

The fabrication of spatially overlapped fibre Bragg gratings over microstructured polymer optical fibre allows to demonstrate low-cost and compact multichannel wavelength division demultiplexers. Coarse and dense wavelengths in high-capacity optical systems have been demonstrated for reduced size environments with the advantages of polymer fibres.
We describe the fabrication of a polycarbonate (PC) micro-structured polymer optical fiber (mPOF) and the writing of fiber Bragg gratings (FBGs) in it to enable strain and temperature measurements. We demonstrate the photosensitivity of a dopant-free PC fiber by grating inscription using a UV laser. We further show that PC Bragg gratings can be extended to at least 3% without affecting the initial functionality of the micro-structured fiber. The response of PC FBGs to temperature up to 125°C is also investigated. Polycarbonate has good mechanical properties and its high temperature resistance might extend the range of application of polymeric FBGs.
Embedding silica and polymer fibre Bragg gratings (FBG) in plastic 3D-printed sensing patches

This paper reports the first demonstration of a silica fibre Bragg grating (SOFBG) embedded in an FDM 3-D printed housing to yield a dual grating temperature-compensated strain sensor. We also report the first ever integration of polymer fibre Bragg grating (POFBG) within a 3-D printed sensing patch for strain or temperature sensing. The cyclic strain performance and temperature characteristics of both devices are examined and discussed. The strain sensitivities of the sensing patches were 0.40 and 0.95 pm/με for SOFBG embedded in ABS, 0.38 pm/με for POFBG in PLA, and 0.15 pm/με for POFBG in ABS. The strain response was linear above a threshold and repeatable. The temperature sensitivity of the SOFBG sensing patch was found to be up to 169 pm/°C, which was up to 17 times higher than for an unembedded silica grating. Unstable temperature response POFBG embedded in PLA was reported, with temperature sensitivity values varying between 30 and 40 pm/°C.
Fabrication and characterization of polycarbonate microstructured polymer optical fibers for high-temperature-resistant fiber Bragg grating strain sensors

Here we present the fabrication of a solid-core microstructured polymer optical fiber (mPOF) made of polycarbonate (PC), and report the first experimental demonstration of a fiber Bragg grating (FBG) written in a PC optical fiber. The PC used in this work has a glass transition temperature of 145°C. We also characterize the mPOF optically and mechanically, and further test the sensitivity of the PC FBG to strain and temperature. We demonstrate that the PC FBG can bear temperatures as high as 125°C without malfunctioning. In contrast, polymethyl methacrylate-based FBG technology is generally limited to temperatures below 90°C.

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Fuel level sensor based on polymer optical fiber Bragg gratings for aircraft applications

Safety in civil aviation is increasingly important due to the increase in flight routes and their more challenging nature. Like other important systems in aircraft, fuel level monitoring is always a technical challenge. The most frequently used level sensors in aircraft fuel systems are based on capacitive, ultrasonic and electric techniques, however they suffer from intrinsic safety concerns in explosive environments combined with issues relating to reliability and maintainability. In the last few years, optical fiber liquid level sensors (OFLLSs) have been reported to be safe and reliable and present many advantages for aircraft fuel measurement. Different OFLLSs have been developed, such as the pressure type, float type, optical radar type, TIR type and side-leaking type. Amongst these, many types of OFLLSs based on fiber gratings have been demonstrated. However, these sensors have not been commercialized because they exhibit some drawbacks: low sensitivity, limited range, long-term instability, or limited resolution. In addition, any sensors that involve direct interaction of the optical field with the fuel (either by launching light into the fuel tank or via the evanescent field of a fiber-guided mode) must be able to cope with the potential build up of contamination – often bacterial – on the optical surface. In this
paper, a fuel level sensor based on microstructured polymer optical fiber Bragg gratings (mPOFBGs), including poly
(methyl methacrylate) (PMMA) and TOPAS fibers, embedded in diaphragms is investigated in detail. The mPOFBGs are
embedded in two different types of diaphragms and their performance is investigated with aviation fuel for the first time, in
contrast to our previous works, where water was used. Our new system exhibits a high performance when compared with
other previously published in the literature, making it a potentially useful tool for aircraft fuel monitoring.

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**Intrinsic pressure response of a single mode cyclo olefin polymer fiber bragg grating**

The intrinsic pressure response of a Fibre Bragg Grating (FBG) inscribed in a single-mode cyclo olefin polymer (COP)
macrostructured polymer optical fibre (mPOF) in the range 0-200 bar is investigated for the first time. In order to efficiently
suppress the effects from changes in temperature and relative humidity the pressure calibration is performed in a gas free
environment with the FBG submerged in water. As a result of the incompressible nature of water no temperature effects
due to rapid pressure changes are observed. We find a highly linear, hysteresis-free response with a sensitivity of 2.982 ±
0.002 pm/bar. The corresponding fractional sensitivity is found to be 34.5·10^{-6} MPa^{-1} which is of the same order of
magnitude as the results obtained for a multimode PMMA mPOF-FBG at 1562 nm previously reported in the literature.
The resulting pressure resolution of our sensor is estimated to be 2 bar based on a root mean square deviation of 6 pm.

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Passive and Portable Polymer Optical Fiber Cleaver

Polymer optical fiber (POF) is a growing technology in short distance telecommunication due to its flexibility, easy connectorization, and lower cost than the mostly deployed silica optical fiber technology. Microstructured POFs (mPOFs) have particular promising potential applications in the sensors and telecommunications field, and they could specially help to reduce losses in polymer fibers by using hollow-core fibers or reduce the modal dispersion by providing a large mode area endlessly single-mode. However, mPOFs are intrinsically more difficult to cut due to the cladding hole structure and it becomes necessary to have a high quality POF cleaver. In the well-known hot-blade cutting process, fiber and blade are heated, which requires electrical components and increases cost. A new method has recently been identified, allowing POF to be cut without the need for heating the blade and fiber, thus opening up the possibility of an electrically passive cleaver. In this letter, we describe the implementation and testing of a high quality cleaver based on a mechanical system formed by a constant force spring and a damper, which leads to the first reported electrical passive and portable cleaver.
Sensitivity enhancement using annealed polymer optical fibre based sensors for pressure sensing applications

Thermal annealing can be used to induce a permanent negative Bragg wavelength shift for polymer fibre grating sensors and it was originally used for multiplexing purposes. Recently, researchers showed that annealing can also provide additional benefits, such as strain and humidity sensitivity enhancement and augmented temperature operational range. The annealing process can change both the optical and mechanical properties of the fibre. In this paper, the annealing effects on the stress and force sensitivities of PMMA fibre Bragg grating sensors are investigated. The incentive for that investigation was an unexpected behaviour observed in an array of sensors which were used for liquid level monitoring. One sensor exhibited much lower pressure sensitivity and that was the only one that was not annealed. To further investigate the phenomenon, additional sensors were photo-inscribed and characterised with regard their stress and force sensitivities. Then, the fibres were annealed by placing them in hot water, controlling with that way the humidity factor. After annealing, stress and force sensitivities were measured again. The results show that the annealing can improve the stress and force sensitivity of the devices. This can provide better performing sensors for use in stress, force and pressure sensing applications.

General information
State: Published
Organisations: Fibers & Nonlinear Optics, Department of Photonics Engineering, Fiber Sensors and Supercontinuum Generation, Department of Informatics and Mathematical Modeling, Aston University
Authors: Pospori, A. (Ekstern), Marques, C. A. F. (Ekstern), Saez-Rodriguez, D. (Ekstern), Nielsen, K. (Intern), Bang, O. (Intern), Webb, D. J. (Ekstern)
Publication date: 2016

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Title of host publication: Proceedings of SPIE
Single mode step-index polymer optical fiber for humidity insensitive high temperature fiber Bragg grating sensors
We have fabricated the first single-mode step-index and humidity insensitive polymer optical fiber operating in the 850 nm wavelength ranges. The step-index preform is fabricated using injection molding, which is an efficient method for cost effective, flexible and fast preparation of the fiber preform. The fabricated single-mode step-index (SI) polymer optical fiber (POF) has a 4.8μm core made from TOPAS grade 5013S-04 with a glass transition temperature of 134°C and a 150 µm cladding made from ZEONEX grade 480R with a glass transition temperature of 138°C. The key advantages of the proposed SIPOF are low water absorption, high operating temperature and chemical inertness to acids and bases and many polar solvents as compared to the conventional poly-methyl-methacrylate (PMMA) and polystyrene based POFs. In addition, the fiber Bragg grating writing time is short compared to microstructured POFs.

General information
State: Published
Organisations: Department of Photonics Engineering, Fiber Sensors and Supercontinuum Generation, Department of Mechanical Engineering, Manufacturing Engineering
Authors: Woyessa, G. (Intern), Fasano, A. (Intern), Stefani, A. (Intern), Markos, C. (Intern), Nielsen, K. (Intern), Rasmussen, H. K. (Intern), Bang, O. (Intern)
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Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.976 SNIP 1.755 CiteScore 3.78
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
The effect of humidity on annealing of poly (methyl methacrylate) (PMMA) based microstructured polymer optical fiber Bragg gratings (mPOFBGs) and the resulting humidity responsivity are investigated. Typically annealing of PMMA POFs is done in an oven without humidity control around 80°C and therefore at low humidity. We demonstrate that annealing at high humidity and high temperature improves the performances of mPOFBGs in terms of stability and sensitivity to humidity. PMMA POFBGs that are not annealed or annealed at low humidity level will have a low and highly temperature...
dependent sensitivity and a high hysteresis in the humidity response, in particular when operated at high temperature. PMMA mPOFBGs annealed at high humidity show higher and more linear humidity sensitivity with negligible hysteresis. We also report how annealing at high humidity can blue-shift the FBG wavelength more than 230 nm without loss in the grating strength.

**General information**

State: Published
Organisations: Department of Photonics Engineering, Fiber Sensors and Supercontinuum Generation
Authors: Woyessa, G. (Intern), Nielsen, K. (Intern), Stefani, A. (Intern), Markos, C. (Intern), Bang, O. (Intern)
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**Publication information**

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Scopus rating (2016): CiteScore 3.48 SJR 1.487 SNIP 1.589
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.976 SNIP 1.755 CiteScore 3.78
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.349 SNIP 2.166 CiteScore 4.18
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.358 SNIP 2.226 CiteScore 4.38
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 2.587 SNIP 2.145 CiteScore 3.85
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 2.579 SNIP 2.606 CiteScore 4.04
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.943 SNIP 2.466
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 3.092 SNIP 2.669
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 3.195 SNIP 2.393
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 3.27 SNIP 2.032
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 3.233 SNIP 2.326
Web of Science (2006): Indexed yes
Optical sensor for measuring humidity, strain and temperature.
The present invention relates to an optical sensor (100) adapted to measure at least three physical parameters, said optical sensor comprising a polymer-based optical waveguide structure comprising a first Bragg grating structure (101) being adapted to provide information about a first, a second and a third physical parameter, a second Bragg grating structure (102) being adapted to provide information about the second and the third physical parameter only, and a third Bragg grating structure (103) being adapted to provide information about the third physical parameter only. The invention further relates to a method for measuring the first, the second and the third physical parameter. Preferably, the first, the second and the third physical parameter, are humidity, strain and temperature, respectively.

General information
State: Published
Organisations: Department of Photonics Engineering, Fiber Sensors and Supercontinuum Generation
Authors: Nørregaard, J. (Intern), Nielsen, K. (Intern)
Publication date: 3 Dec 2015

Publication information
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Patent number: WO2015181155
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Priority number: EP20140169826
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WO2015181155A1.pdf
Main Research Area: Technical/natural sciences
Source: espacenet
Source-ID: WO2015181155
Publication: Research › Patent – Annual report year: 2016

Wireless Distributed Antenna MIMO
The present disclosure relates to system applications of multicore optical fibers. One embodiment relates to a base transceiver station for a wireless telecommunication system comprising a plurality of antenna units arranged in a MIMO configuration and adapted for transmission and/or reception of radio-frequency signals, an optical transmitter in the form of an electro-optic conversion unit for each of said plurality of antenna units, each electro-optic conversion unit adapted for converting an RF signal into an optical signal, a plurality of a single core optical fibers for guiding the optical signals, and at least one first space division multiplexing (SDM) unit adapted for multiplexing said single core optical fibers into respective individual cores of a multicore fiber, or into respective individual modes of a multimode fiber.
Angle dependent Fiber Bragg grating inscription in microstructured polymer optical fibers

We report on an incidence angle influence on inscription of the Fiber Bragg Gratings in Polymethyl methacrylate (PMMA) microstructured polymer optical fibers. We have shown experimentally that there is a strong preference of certain angles, labeled Gamma K, over the other ones. Angles close to Gamma K showed fast start of inscription, rapid inscription and stronger gratings. We have also shown that gratings can be obtained at almost any angle but their quality will be lower if they are not around Gamma K angle. Our experimental results verify earlier numerical and experimental predictions of Marshall et al. (C)2015 Optical Society of America

Bibliographical note
Also registered as: WO2014EP67157, EP20130179950
Main Research Area: Technical/natural sciences
Source: espacenet
Source-ID: WO2015018947
Publication: Research › Patent – Annual report year: 2015

Angle dependent Fiber Bragg grating inscription in microstructured polymer optical fibers
We report on an incidence angle influence on inscription of the Fiber Bragg Gratings in Polymethyl methacrylate (PMMA) microstructured polymer optical fibers. We have shown experimentally that there is a strong preference of certain angles, labeled Gamma K, over the other ones. Angles close to Gamma K showed fast start of inscription, rapid inscription and stronger gratings. We have also shown that gratings can be obtained at almost any angle but their quality will be lower if they are not around Gamma K angle. Our experimental results verify earlier numerical and experimental predictions of Marshall et al. (C)2015 Optical Society of America

Bibliographical note
Also registered as: WO2014EP67157, EP20130179950
Main Research Area: Technical/natural sciences
Source: espacenet
Source-ID: WO2015018947
Publication: Research › Patent – Annual report year: 2015

Angle dependent Fiber Bragg grating inscription in microstructured polymer optical fibers
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Bibliographical note
Also registered as: WO2014EP67157, EP20130179950
Main Research Area: Technical/natural sciences
Source: espacenet
Source-ID: WO2015018947
Publication: Research › Patent – Annual report year: 2015

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Bibliographical note
Also registered as: WO2014EP67157, EP20130179950
Main Research Area: Technical/natural sciences
Source: espacenet
Source-ID: WO2015018947
Publication: Research › Patent – Annual report year: 2015

Angle dependent Fiber Bragg grating inscription in microstructured polymer optical fibers
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Bibliographical note
Also registered as: WO2014EP67157, EP20130179950
Main Research Area: Technical/natural sciences
Source: espacenet
Source-ID: WO2015018947
Publication: Research › Patent – Annual report year: 2015

Angle dependent Fiber Bragg grating inscription in microstructured polymer optical fibers
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Bibliographical note
Also registered as: WO2014EP67157, EP20130179950
Main Research Area: Technical/natural sciences
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Publication: Research › Patent – Annual report year: 2015
Antiresonant guiding in a poly(methyl-methacrylate) hollow-core optical fiber

Strong antiresonant reflecting optical waveguiding is demonstrated in a novel poly (methyl-methacrylate) (PMMA) hollow-core fiber. The transmission spectrum of the fiber was characterized using a supercontinuum source and it revealed distinct resonances with resonant dips as strong as ~20 dB in the wavelength range 480-900 nm, where PMMA has low absorption. The total propagation loss of the fiber was measured to have a minimum of ~45 dB m⁻¹ at around 500 nm. The thermal sensitivity of the fiber is 256 ± 16 pm °C⁻¹, defined as the red-shift of the resonances per °C, which is three times higher than the sensitivity of polymer fiber Bragg gratings.
Antiresonant guidance, Polymer fiber, Hollow-core fiber, Fiber sensor
Challenges in higher order mode Raman amplifiers
A higher order Raman amplifier model that takes random mode coupling into account is presented. Mode dependent gain and signal power fluctuations at the output of the higher order mode Raman amplifier are discussed.

General information
State: Published
Authors: Rottwitt, K. (Intern), Nielsen, K. (Intern), Friis, S. M. M. (Intern), Usuga Castaneda, M. A. (Intern)
Number of pages: 3
Publication date: 2015

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ISBN (Print): 978-1-55752-937-4
Main Research Area: Technical/natural sciences
Conference: Optical Fiber Communications Conference and Exposition 2015, Los Angeles, CA, United States, 22/03/2015 - 22/03/2015
Source: PublicationPreSubmission
Source-ID: 110988430
Publication: Research - peer-review › Journal article – Annual report year: 2015

Compound parabolic concentrator optical fiber tip for FRET-based fluorescent sensors
The Compound Parabolic Concentrator (CPC) optical fiber tip shape has been proposed for intensity based fluorescent sensors working on the principle of FRET (Förster Resonance Energy Transfer). A simple numerical Zemax model has been used to optimize the CPC tip geometry for a step-index multimode polymer optical fiber for an excitation and emission wavelength of 550 nm and 650 nm, respectively. The model suggests an increase of a factor of 1.6 to 4 in the collected fluorescent power for an ideal CPC tip, as compared to the plane-cut fiber tip for fiber lengths between 5 and 45 mm.

General information
State: Published
Organisations: Department of Photonics Engineering, Fiber Sensors and Supercontinuum Generation, Medtronic R&D Diabetes Denmark A/S
Authors: Hassan, H. U. (Intern), Nielsen, K. (Intern), Aasmul, S. (Ekstern), Bang, O. (Intern)
Number of pages: 4
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CPC, FRET, Fluorescence, Equilibrium modal distribution
Electronic versions:
OFS_submitted_paper_Compound_parabolic_concentrator_optical_fiber_tip_for_FRET_based_fluorescent_sensors_.pdf
DOIs:
10.1117/12.2192508
Dielectric tube waveguides with absorptive cladding for broadband, low-dispersion and low loss THz guiding

Research on terahertz waveguides is experiencing a tremendous growth due to their importance for compact and robust THz systems. However, designing compact, broadband, mechanically stable and environmentally shielded THz waveguides is still a challenge due to high losses of both metals and dielectrics in this frequency range. Here we report on a novel twist on the classical tube waveguide where we deliberately introduce a thick and highly lossy cladding layer. By this we attenuate the field in the cladding and thus prevent interference with the core field. This mechanism breaks the well-known ARROW guiding mechanism, and as a result, extremely broad bandwidth and low dispersion can be achieved with a very simple design. Since the main part of the field propagates inside the air-core, the propagation loss is still kept at a very low level. Simulations, analytical modelling and experiments verify our findings. The proposed THz waveguide is robust, insensitive to external perturbation and easy to handle, and thus the design represents a significant advance of the field of THz dielectric waveguides suitable for the 0.3-1 THz band which in the future will be important for ultrafast wireless communication systems.

General information
State: Published
Organisations: Department of Photonics Engineering, Fiber Sensors and Supercontinuum Generation, Terahertz Technologies and Biophotonics
Authors: Bao, H. (Intern), Nielsen, K. (Intern), Bang, O. (Intern), Jepsen, P. U. (Intern)
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Main Research Area: Technical/natural sciences

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Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 4.63 SJR 1.625 SNIP 1.401
Web of Science (2016): Indexed yes
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Scopus rating (2015): SJR 2.057 SNIP 1.684 CiteScore 5.3
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 2.103 SNIP 1.544 CiteScore 4.75
Web of Science (2014): Indexed yes
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ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.458 SNIP 0.896 CiteScore 2.44
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Web of Science (2012): Indexed yes
ISI indexed (2011): ISI indexed no
Original language: English
Absorptive cladding, ARROW guiding mechanism, Broadband low-dispersion low loss terahertz guide, Classical dielectric tube waveguide, Field propagation, Ultrafast wireless communication system, Computational Biology, Analytical modeling simulation mathematical and computer techniques, Biomaterials, Models and Simulations
Fast Fiber Bragg Grating Inscription in the Undoped Microstructured Polymer Optical Fibers

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State: Published
Organisations: Department of Photonics Engineering, Fiber Sensors and Supercontinuum Generation
Authors: Bundalo, I. (Intern), Nielsen, K. (Intern), Bang, O. (Intern)
Number of pages: 1
Publication date: 2015
Event: Abstract from Danish Optical Society Annual Meeting 2014, Denmark.
Main Research Area: Technical/natural sciences

Relations
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Publication: Research › Conference abstract for conference – Annual report year: 2015

Fiber-optic liquid level monitoring system using microstructured polymer fiber Bragg grating array sensors: performance analysis
A highly sensitive liquid level monitoring system based on microstructured polymer optical fiber Bragg grating (mPOFBG) array sensors is reported for the first time. The configuration is based on five mPOFBGs inscribed in the same fiber in the 850 nm spectral region, showing the potential to interrogate liquid level by measuring the strain induced in each mPOFBG embedded in a silicone rubber (SR) diaphragm, which deforms due to hydrostatic pressure variations. The sensor exhibits a highly linear response over the sensing range, a good repeatability, and a high resolution. The sensitivity of the sensor is found to be 98 pm/cm of water, enhanced by more than a factor of 9 when compared to an equivalent sensor based on a silica fiber around 1550 nm. The temperature sensitivity is studied and a multi-sensor arrangement proposed, which has the potential to provide level readings independent of temperature and the liquid density.

General information
State: Published
Organisations: Fibers & Nonlinear Optics, Department of Photonics Engineering, Fiber Sensors and Supercontinuum Generation, Aston University
Authors: Marques, C. A. F. (Ekstern), Pospori, A. (Ekstern), Saez-Rodriguez, D. (Ekstern), Nielsen, K. (Intern), Bang, O. (Intern), Webb, D. J. (Ekstern)
Number of pages: 4
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Conference: 24th International Conference on Optical Fibre Sensors, Curitiba, Brazil, 28/09/2015 - 28/09/2015
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Electronic versions: 96345V.pdf
DOIs: 10.1117/12.2193898

Bibliographical note
High performance liquid-level sensor based on mPOFBG for aircraft applications

A high performance liquid-level sensor based on microstructured polymer optical fiber Bragg grating (mPOFBG) array sensors is reported in detail. The sensor sensitivity is found to be 98pm/cm of liquid, enhanced by more than a factor of 9 compared to a reported silica fiber-based sensor.

Humidity insensitive step-index polymer optical fibre Bragg grating sensors

We have fabricated and characterised a humidity insensitive step index(SI) polymer optical fibre(POF) Bragg grating sensors. The fibre was made based on the injection molding technique, which is an efficient method for fast, flexible and cost effective preparation of the fibre preform. The fabricated SIPOF has a core made from TOPAS with a glass transition temperature of 134 degrees C and a cladding from ZEONEX with a glass transition temperature of 138 degrees C. The main advantages of the proposed SIPOF are the low water absorption and good chemical resistance compared to the conventional poly-methyl-methacrylate (PMMA) based SIPOFs. The fibre has a minimum loss of similar to 6dB/m at 770nm.
Long term strain behavior of PMMA based polymer optical fibers

We are reporting on the viscoelasticity of PMMA based Fiber Bragg Grating (FBG) strain sensors when exposed to repeated sequences of long term strain and relaxation with various duty-cycles. In terms of the FBG wavelength and how it follows the strain cycle, we have shown that in the small strain regime (up to 1%) an elastic-dominated fast relaxing range, which is followed by a mainly viscous relaxation, depends both on the strain level and on the strain duration. For a small ratio of the strain-relax durations, this fast relaxation range stays almost the same. However, with increasing strain duration, for the same relaxation time, this range will be shortened, which might influence the sensing capabilities of the fiber sensor.

Pmma fiber viscoelasticity in extremely low frequency regime

We are reporting on the viscoelasticity of PMMA based Fiber Bragg Grating (FBG) strain sensors when exposed to repeated sequences of long term strain and relaxation with various duty-cycles and frequencies much smaller than 1 Hz. Monitoring the FBG wavelength and how it follows the applied strain, we have shown that after being strained up to 1%, the fiber will rapidly contract elastically to a certain amount after which a viscous-dominated relaxation takes place. The amount of elastic versus viscous relaxation depends both on the level of applied strain and on the duration of the strain. For a big duration of the strain with respect to relaxation, this fast relaxation wavelength range stays almost the same. However, with increasing relaxation duration and keeping the same strain duration, elastic relaxation wavelength range
will be shortened for up to 18% (1%) when strained for 0.5% (1%), which could, in certain applications, influence the sensitivity range of sensors based on plastic fibers.

**General information**

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Organisations: Department of Photonics Engineering, Fiber Sensors and Supercontinuum Generation, Fibers & Nonlinear Optics, Department of Informatics and Mathematical Modeling  
Authors: Bundalo, I. (Intern), Nielsen, K. (Intern), Bang, O. (Intern)  
Pages: 257-260  
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Main Research Area: Technical/natural sciences  
Source: FindIt  
Source-ID: 2304179761  
Publication: Research - peer-review › Article in proceedings – Annual report year: 2016

**Polymer optical fiber compound parabolic concentrator tip for enhanced coupling efficiency for fluorescence based glucose sensors**

We demonstrate that the light excitation and capturing efficiency of fluorescence based fiber-optical sensors can be significantly increased by using a CPC (Compound Parabolic Concentrator) tip instead of the standard plane-cut tip. We use Zemax modelling to find the optimum CPC tip profile and fiber length of a polymer optical fiber diabetes sensor for continuous monitoring of glucose levels. We experimentally verify the improved performance of the CPC tipped sensor and the predicted production tolerances. Due to physical size requirements when the sensor has to be inserted into the body a non-optimal fiber length of 35 mm is chosen. For this length an average improvement in efficiency of a factor of 1.7 is experimentally demonstrated and critically compared to the predicted ideal factor of 3 in terms of parameters that should be improved through production optimization.

**General information**

State: Published  
Organisations: Department of Photonics Engineering, Fiber Sensors and Supercontinuum Generation, Medtronic R&D Diabetes Denmark A/S  
Authors: Hassan, H. U. (Intern), Nielsen, K. (Intern), Aasmul, S. (Ekstern), Bang, O. (Intern)  
Number of pages: 13  
Publication date: 2015  
Main Research Area: Technical/natural sciences

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Web of Science (2018): Indexed yes  
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Web of Science (2017): Indexed yes  
BFI (2016): BFI-level 1  
Scopus rating (2016): CiteScore 3.8 SJR 1.315 SNIP 1.526  
BFI (2015): BFI-level 1  
Scopus rating (2015): SJR 1.432 SNIP 1.647 CiteScore 4.07  
Web of Science (2015): Indexed yes  
BFI (2014): BFI-level 1  
Scopus rating (2014): SJR 1.754 SNIP 1.798 CiteScore 3.86  
BFI (2013): BFI-level 1
Production and Characterization of Polycarbonate Microstructured Polymer Optical Fiber Bragg Grating Sensor

We present the fabrication and characterization of a polycarbonate (PC) microstructured polymer optical fiber (mPOF) and the writing of a fiber Bragg grating (FBG) in it to obtain a polymer optical FBG sensor. The manufacturing process of the PC mPOF consists of multiple consecutive stages, such as casting of polymer granulates into a solid rod, machining and drilling of a 3-ring hexagonal lattice of holes into it, and finally drawing into fiber. We demonstrate that the obtained PC mPOF is photosensitive and FBGs can be conveniently inscribed into it, thereby enabling FBG-based temperature and strain sensing. The PC optical fibers are for some applications an attractive alternative to conventional materials used in POF fabrication, such as polymethyl methacrylate (PMMA). In general, PC can be used at temperature up to 120 °C and breaks at considerably higher strains than PMMA.

Simple Room Temperature Method for Polymer Optical Fibre Cleaving

In this paper, we report on a new method to cleave polymer optical fibre. The most common way to cut a polymer optical fibre is chopping it with a razor blade; however, in this approach both the fibre and the blade must be preheated in order to turn the material ductile, and thus, prevent crazing. In this paper, we make use of the temperature-time equivalence in polymers to replace the use of heating by an increase of the cleaving time and use a sawing motion to reduce fibre end face damage. In this way, the polymer fibre can be cleaved at room temperature in seconds with the resulting end face being of similar quality to those produced by more complex and expensive heated systems.
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<th>Year</th>
<th>BFI</th>
<th>Scopus Rating</th>
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<td>2017</td>
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<td>SJR 1.689 SNIP 1.955 CiteScore 4.15</td>
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<td>2015</td>
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Tapering of Polymer Optical Fibers for Compound Parabolic Concentrator Fiber Tip Fabrication

We propose a process for Polymer Optical Fiber (POF) Compound Parabolic Compound (CPC) tip manufacturing using a heat and pull fiber tapering technique. The POF, locally heated above its glass transition temperature, is parabolically tapered down in diameter, after which it is cut to the desired output diameter and finally polished to obtain the special CPC tip. The physical mechanism responsible for giving a CPC shape to the POF tip is also investigated. The fabrication process is shown to be sensitive to several manufacturing parameters, such as temperature of the heat source, thermal flux from the heat source, and heating time. We further consider the influence of the heating time latter parameter on the geometry of the obtained CPC fiber tips.

General information
State: Published
Organisations: Department of Photonics Engineering, Fiber Sensors and Supercontinuum Generation, Department of Mechanical Engineering, Manufacturing Engineering, Medtronic R&D Diabetes Denmark A/S
Authors: Hassan, H. U. (Intern), Fasano, A. (Intern), Nielsen, K. (Intern), Aasmul, S. (Ekstern), Rasmussen, H. K. (Intern), Bang, O. (Intern)
Number of pages: 4
Publication date: 2015

Host publication information
Title of host publication: Proceedings of the 24th International Conference on Plastic Optical Fibers
Main Research Area: Technical/natural sciences
Compound parabolic concentrator,, Polymer optical fiber, Fluorescence-based sensors, Viscoelastic materials, Polymers
Electronic versions:
POF_conference_submitted.pdf
Source: PublicationPreSubmission
Source-ID: 118099456
Publication: Research - peer-review › Article in proceedings – Annual report year: 2015

The effect of humidity on annealing of polymer optical fibre bragg gratings

The effect of humidity on annealing of PMMA based microstructured polymer optical fiber (mPOF) Bragg gratings is studied. Polymer optical fibers (POFs) are annealed in order to release stress formed during the fabrication process. Un-annealed fibers will have high hysteresis and low sensitivity to humidity, particularly when operated at high temperature. Typically annealing of PMMA POFs is done at 80°C in an oven with no humidity control and therefor at low humidity. The response to humidity of PMMA FBGs annealed at different levels of humidity at the same temperature has also been studied. PMMA FBGs annealed at high humidity have response with no hysteresis and an improved sensitivity which are independent of temperature compared to FBGs annealed at the same temperature but at lower humidity. In addition, PMMA FBG annealed at high humidity showed a permanent blue shift more than 200nm, which is a record of tuning POF FBGs.

General information
State: Published
Organisations: Department of Photonics Engineering, Fiber Sensors and Supercontinuum Generation, Fibers & Nonlinear Optics, Department of Informatics and Mathematical Modeling
Authors: Woyessa, G. (Intern), Nielsen, K. (Intern), Bang, O. (Intern)
Pages: 39-42
Publication date: 2015

Host publication information
Title of host publication: Proceedings of 24th International Conference on Plastic Optical Fibers
Time-dependent variation of fiber Bragg grating reflectivity in PMMA-based polymer optical fibers

In this Letter, we investigate the effects of viscoelasticity on both the strength and resonance wavelength of two fiber Bragg gratings (FBGs) inscribed in microstructured polymer optical fiber (mPOF) made of undoped PMMA. Both FBGs were inscribed under a strain of 1% in order to increase the material photosensitivity. After the inscription, the strain was released, and the FBGs spectra were monitored. We initially observed a decrease of the reflection down to zero after which it began to increase. After that, strain tests were carried out to confirm the results, and finally the gratings were monitored for a further 120 days, with a stable reflection response being observed beyond 50 days. (C) 2015 Optical Society of America

General information
State: Published
Organisations: Department of Photonics Engineering, Fiber Sensors and Supercontinuum Generation, Aston University
Authors: Saez-Rodriguez, D. (Ekstern), Nielsen, K. (Intern), Bang, O. (Intern), Webb, D. J. (Ekstern)
Pages: 1476-1479
Publication date: 2015
Main Research Area: Technical/natural sciences

Publication information
Journal: Optics Letters
Volume: 40
Issue number: 7
ISSN (Print): 0146-9592
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.54 SJR 1.864 SNIP 1.658
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.142 SNIP 1.642 CiteScore 3.53
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.497 SNIP 2.056 CiteScore 3.86
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.458 SNIP 2.095 CiteScore 3.95
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 2.596 SNIP 1.95 CiteScore 3.52
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 2.518 SNIP 2.475 CiteScore 3.69
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
Bragg grating writing in PMMA microstructured polymer optical fibers in less than 7 minutes

We demonstrate fiber Bragg grating (FBG) writing in PMMA microstructured Polymer Optical Fibers (mPOFs) using UV Phase Mask technique with writing times shorter than 10 min. The shortest writing time was 6 minutes and 50 seconds and the longest writing time was 8 min and 50 sec. The FBGs were written in a 125 μm PMMA mPOF having 3-rings of holes, the reflection peaks were centred at 632.6 nm and have a reflectivity as high as 26 dB. We also demonstrate how the writing dynamics depends on the intensity of the writing beam.

General information
State: Published
Organisations: Department of Photonics Engineering, Fiber Sensors and Supercontinuum Generation
Authors: Bundalo, I. (Intern), Nielsen, K. (Intern), Markos, C. (Intern), Bang, O. (Intern)
Pages: 5270-5276
Publication date: 2014
Main Research Area: Technical/natural sciences

Publication information
Journal: Optics Express
Volume: 22
Issue number: 5
ISSN (Print): 1094-4087
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Design and Optimization of Air-Doped 3-dB Terahertz Fiber Directional Couplers

We present a thorough practical design optimization of broadband low loss, terahertz (THz) photonic crystal fiber directional couplers in which the two cores are mechanically down-doped with a triangular array of air holes. A figure of merit taking both the 3-dB bandwidth and loss of the coupler into account, is used for optimization of the structure parameters, given by the diameter and pitch of the cladding (d and Λ) and of the core (d_c and Λ_c) air-hole structure. The coupler with Λ = 498.7 μm, d_c = 324.2 μm, Λ_c = 74.8 μm, and d_c = 32.5 μm is found to have the best performance at a center frequency of 1THz, with a bandwidth of 0.25 THz and a total device loss of 9.2 dB. The robustness of the optimum coupler to structural changes is investigated. © 2014 Optical Society of America.

General information
State: Published
Organisations: Department of Photonics Engineering, Fiber Sensors and Supercontinuum Generation, Department of Mechanical Engineering, Manufacturing Engineering, Terahertz Technologies and Biophotonics
Authors: Bao, H. (Intern), Nielsen, K. (Intern), Rasmussen, H. K. (Intern), Jepsen, P. U. (Intern), Bang, O. (Intern)
Number of pages: 2
Publication date: 2014

Host publication information
Title of host publication: Proceedings of 2014 Conference on Lasers and Electro-Optics (CLEO)
Publisher: IEEE
Main Research Area: Technical/natural sciences
Conference: Conference on Lasers and Electro-Optics 2014, San Jose, CA, United States, 08/06/2014 - 08/06/2014
Source: PublicationPreSubmission
Source-ID: 96583099
Publication date: 2014

Design and optimization of mechanically down-doped terahertz fiber directional couplers

We present a thorough practical design optimization of broadband low loss, terahertz (THz) photonic crystal fiber directional couplers in which the two cores are mechanically down-doped with a triangular array of air holes. A figure of merit taking both the 3-dB bandwidth and loss of the coupler into account, is used for optimization of the structure parameters, given by the diameter and pitch of the cladding (d and Λ) and of the core (d_c and Λ_c) air-hole structure. The coupler with Λ = 498.7 μm, d_c = 324.2 μm, Λ_c = 74.8 μm, and d_c = 32.5 μm is found to have the best performance at a center frequency of 1THz, with a bandwidth of 0.25 THz and a total device loss of 9.2 dB. The robustness of the optimum coupler to structural changes is investigated. © 2014 Optical Society of America.

General information
State: Published
Organisations: Department of Photonics Engineering, Fiber Sensors and Supercontinuum Generation, Fibers & Nonlinear Optics, Department of Mechanical Engineering, Manufacturing Engineering, Terahertz Technologies and Biophotonics
Authors: Bao, H. (Intern), Nielsen, K. (Intern), Rasmussen, H. K. (Intern), Jepsen, P. U. (Intern), Bang, O. (Intern)
Pages: 9486-9497
Publication date: 2014
Main Research Area: Technical/natural sciences

Publication information
Journal: Optics Express
Volume: 22
Issue number: 8
ISSN (Print): 1094-4087
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.48 SJR 1.487 SNIP 1.589
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
In this paper we report, for the first time to our knowledge, an increase of the photosensitivity of a microstructured polymer optical fibre (mPOF) made of undoped PMMA due to applied strain during the fabrication of the gratings. In the work, fibre Bragg gratings (FBGs) have been fabricated in undoped PMMA mPOFs with a hexagonal structure of three rings in the inner cladding. Two sets of FBGs were inscribed at two different resonant wavelengths (827 nm and 1562 nm) at different
strains using an UV He-Cd laser at 325 nm focused by a lens and scanned over the fibre. We observed an increase of the
reflection of the fibre Bragg gratings when the fabrication strain is higher. The photosensitivity mechanism is discussed in
the paper along with the chemical reactions that could underlie the mechanism. Furthermore, the resolution limit of the
material was investigated.

**General information**

State: Published
Organisations: Department of Photonics Engineering, Fiber Sensors and Supercontinuum Generation, Aston University
Authors: Sáez-Rodríguez, D. (Ekstern), Nielsen, K. (Intern), Bang, O. (Intern), Webb, D. J. (Ekstern)
Publication date: 2014

**Host publication information**

Title of host publication: Proceedings of SPIE
Volume: 9128
Publisher: SPIE - International Society for Optical Engineering
Article number: 91280P

Series: Progress in Biomedical Optics and Imaging
ISSN: 1605-7422
Main Research Area: Technical/natural sciences

**Photosensitivity mechanism of undoped poly(methyl methacrylate) under UV radiation at 325 nm and its spatial resolution limit**

In this Letter, we provide evidence suggesting that the main photosensitive mechanism of an undoped poly(methyl
methacrylate)-based microstructured optical fiber under UV radiation at 325 nm is a competitive process of both
photodegradation and polymerization. We found experimentally that increasing strain during photo-inscription leads to an
increased photosensitivity, which is evidence of photodegradation. Likewise, refractive index change in the fiber was
measured to be positive, which provides evidence for further polymerization of the material. Finally, we relate the data
obtained to the spatial recording resolution of the samples. © 2014 Optical Society of America.

**General information**

State: Published
Organisations: Department of Photonics Engineering, Fiber Sensors and Supercontinuum Generation, Aston University
Authors: Sáez-Rodríguez, D. (Ekstern), Nielsen, K. (Intern), Bang, O. (Intern), Webb, D. (Ekstern)
Number of pages: 4
Pages: 3421-3424
Publication date: 2014
Main Research Area: Technical/natural sciences

**Publication information**

Journal: Optics Letters
Volume: 39
Issue number: 12
ISSN (Print): 0146-9592
Ratings:

- BFI (2018): BFI-level 2
- Web of Science (2018): Indexed yes
- BFI (2017): BFI-level 2
- Web of Science (2017): Indexed yes
- BFI (2016): BFI-level 2
- Scopus rating (2016): CiteScore 3.54 SJR 1.864 SNIP 1.658
- Web of Science (2016): Indexed yes
- BFI (2015): BFI-level 2
- Scopus rating (2015): SJR 2.142 SNIP 1.642 CiteScore 3.53
- Web of Science (2015): Indexed yes
- BFI (2014): BFI-level 2
Fiber Bragg grating (FBG) writing in PMMA microstructured Polymer Optical Fibers (mPOFs) using the UV Phase Mask technique is a time consuming process requiring about 40 minutes to inscribe a grating in an undoped fiber. Here we demonstrate the FBG inscription with the writing times shorter than 10 min. By careful aligning and increasing the beam intensity in the core of the fiber, writing times as short as 6 minutes and 50 second were achieved. The FBGs were written in a 125 μm PMMA mPOF having 3-rings of holes, the reflection peaks were centred at 632.6 nm and have a reflectivity as high as 26 dB. We also demonstrate how the writing dynamics depends on the intensity of the writing beam.
POF based glucose sensor incorporating grating wavelength filters

Medtronic has already developed a plastic fiber based optical sensor to detect the concentration of glucose both in vivo and in-vitro. The glucose sensor is based on a competitive glucose binding affinity assay consisting of a glucose receptor and glucose analog (ligand) contained in a compartment made up of permeable membrane for exchanging of only small molecules such as glucose, salts etc. (Fig 1). The binding between the glucose binding protein labeled with fluorophore and glucose like molecules labelled with dye, is reversible. In the presence of glucose, the glucose analog competes with the glucose on binding to the protein. The system reaches an equilibrium, which correlates with the glucose concentration. The assay chemistry makes donor and acceptor pair for FRET (Förster Resonance Energy Transfer). FRET results in decrease in donor emission intensity. Higher the concentration of glucose, more donor acceptor pairs got separated resulting in decrease in donor emission intensity. This change in optical signal is correlated to glucose concentration. (Fig.1) Medtronic Diabetes and DTU FOTONIK has been working together under the consortium of Marie Curie Research Framework called TRAINING AND RESEARCH IN POLYMER OPTICAL DEVICES; TRIPOD. Within the domain of TRIPOD, research is conducted on "Plastic Optical Fiber based Glucose Sensors Incorporating Grating Wavelength Filters". Research will be focused to optimized fiber tips for better coupling efficiency, reducing the response time of sensor, improve the mechanical stabilization of assay compartment by exploring the side excitation and side coupling method, ease of manufacturing and feasibility of Polymer Fiber Bragg gratings as filters. During the project, fibers will be drawn and fiber bragg gratings will be inscribed at DTU Fotonik and they will be characterized for glucose sensor at Medtronic Diabetes.

THz Tube Waveguides With Low Loss, Low Dispersion, and High Bandwidth

We propose, model and experimentally characterize a novel class of terahertz hollow-core tube waveguides with high-loss cladding material, resulting in propagation with low loss, low dispersion, and high useful bandwidth.

General information
State: Published
Organisations: Department of Photonics Engineering, Fiber Sensors and Supercontinuum Generation, Technical University of Denmark
Authors: Bundalo, I. (Intern), Nielsen, K. (Intern), Markos, C. (Intern), Bang, O. (Intern)
Pages: 91280O
Publication date: 2014
THz waveguides, devices and hybrid polymer-chalcogenide photonic crystal fibers

In this contribution, we review our recent activities in the design, fabrication and characterization of polymer THz waveguides. Besides the THz waveguides, we finally will also briefly show some of our initial results on a novel hybrid polymer photonic crystal fiber with integrated chalcogenide glass layers.

General information
State: Published
Organisations: Department of Photonics Engineering, Fiber Sensors and Supercontinuum Generation, Fibers & Nonlinear Optics, Department of Management Engineering, Department of Mechanical Engineering, Manufacturing Engineering
Authors: Bao, H. (Intern), Markos, C. (Intern), Nielsen, K. (Intern), Rasmussen, H. K. (Intern), Jepsen, P. U. (Intern), Bang, O. (Intern)
Pages: 2047-2051
Publication date: 2014

THz Waveguides, Devices and Hybrid Polymer-chalcogenide Photonic Crystal Fibers

In this contribution, we review our recent activities in the design, fabrication and characterization of polymer THz waveguides. Besides the THz waveguides, we finally will also briefly show some of our initial results on a novel hybrid polymer photonic crystal fiber with integrated chalcogenide glass layers.

General information
State: Published
Organisations: Department of Photonics Engineering, Fiber Sensors and Supercontinuum Generation, Terahertz Technologies and Biophotonics
Authors: Bao, H. (Intern), Nielsen, K. (Intern), Bang, O. (Intern), Jepsen, P. U. (Intern)
Number of pages: 2
Publication date: 2014

UV-Induced prevention of biofilm formation inside medical tubes and catheters

Biofilm formation inside medical tubes and catheters may often cause unwanted infections, illness and impaired wound healing during medical treatment, resulting in extended hospitalization and - in worst case - life threatening conditions of the patients. In fact, it is estimated, that the infection risk connected with the use of medical tubes and catheters is the...
direct cause of more than 60% of all infections acquired in European hospitals. Once formed, the biofilm is generally very tough to suppress by either the body's immunity system or by use of antibiotics, which may even favor the population of multi resistant bacterial cultures. Prevention of biofilm formation inside the tube or catheter, without risk of developing multiresistance, may be achieved by creating a UV-exposed environment in the interior. This may be realized by transforming the tube itself into an optical waveguide supporting UV-light propagation or by other means integrating optical fiber technology into the tube walls, such as to gradually release UV-light into the interior, efficiently killing off bacteria present inside.

General information
State: Published
Organisations: Department of Photonics Engineering, Fiber Sensors and Supercontinuum Generation
Authors: Pedersen, J. K. M. (Intern), Nielsen, K. (Intern), Bang, O. (Intern)
Number of pages: 1
Publication date: 2014

Host publication information
Title of host publication: Abstract Book - DTU Sustain Conference 2014
Place of publication: Kgs. Lyngby
Publisher: Technical University of Denmark (DTU)
Main Research Area: Technical/natural sciences
Conference: DTU Sustain Conference 2014, Lyngby, Denmark, 17/12/2014 - 17/12/2014
Publication: Research - peer-review » Conference abstract in proceedings – Annual report year: 2014

Connectorization of fibre Bragg grating sensors recorded in microstructured polymer optical fibre
We describe the production and characterization of FC/PC connectorised fibre Bragg grating sensors in polymer fibre. Sensors were recorded in few-moded and single mode microstructured fibre composed of poly (methyl methacrylate).

General information
State: Published
Organisations: Department of Photonics Engineering, Fiber Sensors and Supercontinuum Generation, Aston University
Authors: Abang, A. (Ekstern), Saez-Rodriguez, D. (Ekstern), Nielsen, K. (Intern), Bang, O. (Intern), Webb, D. J. (Ekstern)
Number of pages: 5
Publication date: 2013
Workshop: 5th European Workshop on Optical Fibre Sensors (EWOFS 2013), Kraków, Poland, 19/05/2013 - 19/05/2013
Main Research Area: Technical/natural sciences

Publication information
Journal: Proceedings of SPIE, the International Society for Optical Engineering
Volume: 8794
Article number: 87943Q
ISSN (Print): 0277-786X
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BFI (2018): BFI-level 1
BFI (2017): BFI-level 1
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.42 SNIP 0.245
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.187 SNIP 0.224 CiteScore 0.3
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.188 SNIP 0.231 CiteScore 0.3
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.2 SNIP 0.259 CiteScore 0.26
ISI indexed (2013): ISI indexed no
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.194 SNIP 0.243 CiteScore 0.27
ISI indexed (2012): ISI indexed no
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.197 SNIP 0.264 CiteScore 0.31
ISI indexed (2011): ISI indexed no
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.208 SNIP 0.241
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.211 SNIP 0.271
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.222 SNIP 0.289
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.227 SNIP 0.37
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.308 SNIP 0.701
Scopus rating (2005): SJR 0.158 SNIP 0.343
Web of Science (2004): Indexed yes
Web of Science (2002): Indexed yes
Original language: English
DOIs:
10.1117/12.2026796
Source: dtu
Source-ID: u::7949
Publication: Research - peer-review › Conference article – Annual report year: 2013

Fabrication and characterization of porous-core honeycomb bandgap THz fibers

We have fabricated a porous-core honeycomb fiber in the cyclic olefin copolymer (COC) Topas® by drill-draw technology [1]. A cross-sectional image of the fabricated fiber is shown in the left Panel of Fig. 1. Simulation of the electromagnetic properties of the fiber shows two wide bandgaps within the frequency range 0.1 to 2 THz, and numerous sharp resonant features are visible in the core power ratio, indicative of resonant coupling between the reflected field from the outer interface of the fiber and the core mode. The fiber is experimentally characterized with a commercial fiber-coupled THz-TDS system (Picometrix T-Ray 4000). The reference pulse before coupling into the fiber is shown in Fig. 1(a) and the time trace of the THz pulse after propagation through a 5-cm long segment of fiber is shown in Fig. 1(b) (blue curve). After adding some water on the outside of the fiber surface, the transmitted pulse experiences less pronounced oscillations at times later than 20 ps (red curve in Fig. 1(b)). Figs. 1(c) and (d) show the short-time Fourier transforms of the two time-domain traces in Fig. 1(b), overlaid with the calculated group delay in the two bandgaps (black squares). The frequencies below approximately 0.6 THz are attenuated by adding a layer of water on the outside of the fiber surface, while the transmission in the two band gaps in the 0.7-1.1 THz and 1.3-1.7 THz regions are unaffected by the water. This observation demonstrates that the absorptive water layer effectively strips the cladding modes from the fiber. The propagation loss is measured in a cut-back experiment. The fundamental bandgap at 0.75-1.05 THz is found to have losses lower than 1.5 dB/cm, whereas the loss is below 1.0 dB/cm in the reduced bandgap 0.78-1.02 THz, as shown in Fig. 1(g).

General information
State: Published
Organisations: Department of Photonics Engineering, Fiber Sensors and Supercontinuum Generation, Department of Mechanical Engineering, Manufacturing Engineering, Terahertz Technologies and Biophotonics
Authors: Bao, H. (Intern), Nielsen, K. (Intern), Rasmussen, H. K. (Intern), Jepsen, P. U. (Intern), Bang, O. (Intern)
Number of pages: 1
Publication date: 2013
Event: Abstract from International Workshop on Optical Terahertz Science and Technology (OTST 2013), Kyoto Terrsa, Japan.
Main Research Area: Technical/natural sciences
Electronic versions:
OTST2013 paper 169.pdf

Bibliographical note
Poster presentation.
Source: dtu
Source-ID: u::7948
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2013
Highly photosensitive polymethyl methacrylate microstructured polymer optical fiber with doped core

In this Letter, we report the fabrication of a highly photosensitive, microstructured polymer optical fiber using benzyl dimethyl ketal as a dopant, as well as the inscription of a fiber Bragg grating in the fiber. A refractive index change in the core of at least $3.2 \times 10^{-4}$ has been achieved, providing a grating with a strong transmission rejection of $-23$ dB with an inscription time of only 13 min. The fabrication method has a big advantage compared to doping step index fiber since it enables doping of the fiber without using extra dopants to compensate for the index reduction in the core introduced by the photosensitive agent.

General information
State: Published
Organisations: Department of Photonics Engineering, Fiber Sensors and Supercontinuum Generation, Department of Mechanical Engineering, Manufacturing Engineering, Aston University
Authors: Sáez-Rodríguez, D. (Ekstern), Nielsen, K. (Intern), Rasmussen, H. K. (Intern), Bang, O. (Intern), Webb, D. J. (Ekstern)
Pages: 3769-3772
Publication date: 2013
Main Research Area: Technical/natural sciences

Publication information
Journal: Optics Letters
Volume: 38
Issue number: 19
ISSN (Print): 0146-9592
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.54 SJR 1.864 SNIP 1.658
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.142 SNIP 1.642 CiteScore 3.53
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.497 SNIP 2.056 CiteScore 3.86
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.458 SNIP 2.095 CiteScore 3.95
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 2.596 SNIP 1.95 CiteScore 3.52
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 2.518 SNIP 2.475 CiteScore 3.69
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.669 SNIP 2.293
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 3.167 SNIP 2.665
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 3.408 SNIP 2.378
Web of Science (2008): Indexed yes
High-Tg TOPAS mPOF strain sensing at 110 degrees

We demonstrate a mPOF made of high-Tg TOPAS grade 5013 with $T_g = 135^\circ$C. We inscribe FBGs into the fiber and demonstrate strain sensing of 2.5% strain at 98°C, further we also demonstrate strain sensing at a record high temperature of 110°C. The Bragg wavelengths of the FBGs are around 860 nm, where the propagation loss is 5.1dB/m, close to the fiber loss minimum of 3.67dB/m at 787nm.

High-Tg TOPAS microstructured polymer optical fiber for fiber Bragg grating strain sensing at 110 degrees

We present the fabrication and characterization of fiber Bragg gratings (FBGs) in an endlessly single-mode microstructured polymer optical fiber (mPOF) made of humidity-insensitive high-Tg TOPAS cyclic olefin copolymer. The mPOF is the first made from grade 5013 TOPAS with a glass transition temperature of $T_g = 135^\circ$C and we experimentally
demonstrate high strain operation (2.5%) of the FBG at 98°C and stable operation up to a record high temperature of 110°C. The Bragg wavelengths of the FBGs are around 860 nm, where the propagation loss is 5.1dB/m, close to the fiber loss minimum of 3.67dB/m at 787nm.

**General information**

State: Published
Organisations: Fiber Sensors and Supercontinuum Generation, Department of Photonics Engineering, Department of Mechanical Engineering, Manufacturing Engineering
Authors: Markos, C. (Intern), Stefani, A. (Intern), Nielsen, K. (Intern), Rasmussen, H. K. (Intern), Yuan, S. W. (Intern), Bang, O. (Intern)
Pages: 4758-4765
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Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.48 SJR 1.487 SNIP 1.589
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.976 SNIP 1.755 CiteScore 3.78
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.349 SNIP 2.166 CiteScore 4.18
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.358 SNIP 2.226 CiteScore 4.38
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 2.587 SNIP 2.145 CiteScore 3.85
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 2.579 SNIP 2.606 CiteScore 4.04
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.943 SNIP 2.466
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 3.092 SNIP 2.669
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 3.195 SNIP 2.393
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 3.27 SNIP 2.032
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 3.233 SNIP 2.326
Cleaving of TOPAS and PMMA microstructured polymer optical fibers: Core-shift and statistical quality optimization

We fabricated an electronically controlled polymer optical fiber cleaver, which uses a razor-blade guillotine and provides independent control of fiber temperature, blade temperature, and cleaving speed. To determine the optimum cleaving conditions of microstructured polymer optical fibers (mPOFs) with hexagonal hole structures we developed a program for cleaving quality optimization, which reads in a microscope image of the fiber end-facet and determines the core-shift and the statistics of the hole diameter, hole-to-hole pitch, hole ellipticity, and direction of major ellipse axis. For 125μm in diameter mPOFs of the standard polymer PMMA we found the optimum temperatures to be 77.5°C for both blade and fiber. For 280μm in diameter mPOFs of the humidity insensitive polymer TOPAS® (grade 8007) the optimum temperature was 40° for both blade and fiber. A 100μm thick flat-edge blade was found to minimize the core-shift by the cleaving to only 298nm or 5% of the pitch for the PMMA mPOF at the optimal temperature.

General Information
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Organisations: Fiber Sensors and Supercontinuum Generation, Department of Photonics Engineering, Manufacturing Engineering, Department of Mechanical Engineering
Authors: Stefani, A. (Intern), Nielsen, K. (Intern), Rasmussen, H. K. (Intern), Bang, O. (Intern)
Pages: 1825-1833
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Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 1.65 SJR 0.633 SNIP 0.924
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 0.711 SNIP 0.987 CiteScore 1.62
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 0.719 SNIP 1.058 CiteScore 1.62
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 0.746 SNIP 1.175 CiteScore 1.78
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 0.813 SNIP 1.151 CiteScore 1.63
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 0.814 SNIP 1.21 CiteScore 1.62
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 0.935 SNIP 1.18
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.047 SNIP 1.218
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 1.139 SNIP 1.24
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.069 SNIP 1.069
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Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 1.335 SNIP 1.28
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 1.195 SNIP 1.247
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 1.243 SNIP 1.232
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 1.077 SNIP 0.887
Web of Science (2000): Indexed yes
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Electronic versions:
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Fabrication and characterization of porous-core honeycomb bandgap THz fibers
We present a numerical and experimental investigation of a low-loss porous-core honeycomb fiber for terahertz wave guiding. The introduction of a porous core with hole size of the same dimension as the holes in the surrounding honeycomb cladding results in a fiber that can be drawn with much higher precision and reproducibility than a corresponding air-core fiber. The high-precision hole structure provides very clear bandgap guidance and the location of the two measured bandgaps agree well with simulations based on finite-element modeling. Fiber loss measurements reveal the frequency-dependent coupling loss and propagation loss, and we find that the fiber propagation loss is much lower than the bulk material loss within the first band gap between 0.75 and 1.05 THz.

General information
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Organisations: Department of Photonics Engineering, Fiber Sensors and Supercontinuum Generation, Department of Mechanical Engineering, Manufacturing Engineering, Terahertz Technologies and Biophotonics
Authors: Bao, H. (Intern), Nielsen, K. (Intern), Rasmussen, H. K. (Intern), Jepsen, P. U. (Intern), Bang, O. (Intern)
Pages: 29507-29517
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Main Research Area: Technical/natural sciences

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Web of Science (2018): Indexed yes
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Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.48 SJR 1.487 SNIP 1.589
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.976 SNIP 1.755 CiteScore 3.78
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.349 SNIP 2.166 CiteScore 4.18
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.358 SNIP 2.226 CiteScore 4.38
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 2.587 SNIP 2.145 CiteScore 3.85
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 2.579 SNIP 2.606 CiteScore 4.04
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.943 SNIP 2.466
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 3.092 SNIP 2.669
Web of Science (2009): Indexed yes
Polymer fiber waveguides for terahertz radiation

Terahertz radiation offers many exciting applications noticeably in spectroscopy and it is showing promising results in imaging, mainly for security applications. In this project the study of using structured polymer fibers for THz waveguiding is presented. The inspiration for the THz fiber is taken from microstructured polymer optical fibers (mPOFs) used at optical wavelengths for sensing and communication. The fibers investigated can be divided into two groups, the solid core fibers and the hollow core fibers. The solid core fibers offer the broadest bandwidth with the best dispersion profile, while the hollow core fibers hold the promise for lowest loss but at the cost of lower bandwidth. In both cases the fabrication and characterization of the fibers is presented. The fibers are also investigated numerically and the numerical results are held up against the experimental results. The polymer material with lowest loss is Topas and all the solid core fibers are manufactured using this material. The polymer PMMA however has higher refractive index along with higher loss, and this higher refractive index is utilized to achieve a large bandwidth hollow core fiber with a low air-fill fraction. Finally, an example of an application is presented in the form of a broadband 3-dB directional fiber coupler. The device is numerically investigated and designed in such a way that it is manufacturable.
870nm Bragg grating in single mode TOPAS microstructured polymer optical fibre
We report the fabrication and characterization of a fiber Bragg grating (FBG) with 870 nm resonance wavelength in a single-mode TOPAS microstructured polymer optical fiber (mPOF). The grating has been UV-written with the phase-mask technique using a 325 nm HeCd laser. The static tensile strain sensitivity has been measured as 0.64 pm/μstrain, and the temperature sensitivity was -60 pm/°C. This is the first 870nm FBG and the first demonstration of a negative temperature response for the TOPAS FBG, for which earlier results have indicated a positive temperature response. The relatively low material loss of the fiber at this wavelength compared to that at longer wavelengths will considerably enhance the potential utility of the TOPAS FBG.

General information
State: Published
Organisations: Fiber Sensors and Supercontinuum Generation, Department of Photonics Engineering, Manufacturing Engineering, Department of Mechanical Engineering, Cyprus University of Technology, Aston University
Authors: Yuan, W. (Intern), Webb, D. J. (Ekstern), Kalli, K. (Ekstern), Nielsen, K. (Intern), Stefani, A. (Intern), Rasmussen, H. K. (Intern), Bang, O. (Intern)
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Main Research Area: Technical/natural sciences

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Scopus rating (2016): CiteScore 0.42 SNIP 0.245
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.187 SNIP 0.224 CiteScore 0.3
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.188 SNIP 0.231 CiteScore 0.3
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.2 SNIP 0.259 CiteScore 0.26
ISI indexed (2013): ISI indexed no
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.194 SNIP 0.243 CiteScore 0.27
ISI indexed (2012): ISI indexed no
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.197 SNIP 0.264 CiteScore 0.31
ISI indexed (2011): ISI indexed no
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.208 SNIP 0.241
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.211 SNIP 0.271
BFI (2008): BFI-level 1
Mode profiling of THz fibers with dynamic aperture near-field imaging
We present terahertz near-field mode profiling of different polymer THz fibers. Images with a resolution below the THz wavelength show the fundamental mode profile and higher order modes appearing at higher frequencies.

General information
State: Published
Organisations: Department of Photonics Engineering, Fiber Sensors and Supercontinuum Generation, Manufacturing Engineering, Department of Mechanical Engineering, Terahertz Technologies and Biophotonics, Philipps-Universität Marburg, Macquarie University
Authors: Stecher, M. (Ekstern), Dürrschmidt, S. F. (Ekstern), Nielsen, K. (Intern), Stefani, A. (Intern), Rasmussen, H. K. (Intern), Jepsen, P. U. (Intern), Bang, O. (Intern), Town, G. E. (Ekstern), Koch, M. (Ekstern)
Publication date: 2011

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Conference: 36th International Conference on Infrared, Millimeter and THz waves, Huston, TX, United States, 02/10/2011 - 02/10/2011
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10.1109/irmmw-THz.2011.6105088
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Source-ID: 315011
Publication: Research - peer-review › Article in proceedings – Annual report year: 2011
Optical fibre Bragg grating recorded in TOPAS cyclic olefin copolymer

A report is presented on the inscription of a fibre Bragg grating into a microstructured polymer optical fibre fabricated from TOPAS cyclic olefin copolymer. This material offers two important advantages over poly (methyl methacrylate), which up to now has formed the basis for polymer fibre Bragg gratings: TOPAS has a much lower water affinity and has useful properties for biosensing. The grating had a Bragg wavelength of 1569 nm and a temperature sensitivity of 236.5 ± 0.3 pm/°C.

General information
State: Published
Organisations: Fiber Sensors and Supercontinuum Generation, Department of Photonics Engineering, Manufacturing Engineering, Department of Mechanical Engineering, Cyprus University of Technology, Aston University
Authors: Johnson, I. (Ekstern), Yuan, S. W. (Intern), Stefani, A. (Intern), Nielsen, K. (Intern), Rasmussen, H. K. (Intern), Khan, L. (Ekstern), Webb, D. (Ekstern), Kalli, K. (Ekstern), Bang, O. (Intern)
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Main Research Area: Technical/natural sciences

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Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.442 SNIP 0.882 CiteScore 1.35
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.497 SNIP 1.011 CiteScore 1.31
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.522 SNIP 1.061 CiteScore 1.31
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.59 SNIP 1.155 CiteScore 1.45
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.631 SNIP 1.161 CiteScore 1.45
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.634 SNIP 1.098 CiteScore 1.44
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.637 SNIP 1.011
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.728 SNIP 1.072
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 0.843 SNIP 0.957
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.924 SNIP 1.169
In this Letter we propose a novel (to our knowledge) porous-core honeycomb bandgap design. The holes of the porous core are the same size as the holes in the surrounding cladding, thereby giving the proposed fiber important manufacturing benefits. The fiber is shown to have a 0.35-THz-wide fundamental bandgap centered at 1.05 THz. The calculated minimum loss of the fiber is 0.25 dB/cm.
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.142 SNIP 1.642 CiteScore 3.53
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.497 SNIP 2.056 CiteScore 3.86
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.458 SNIP 2.095 CiteScore 3.95
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 2.596 SNIP 1.95 CiteScore 3.52
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 2.518 SNIP 2.475 CiteScore 3.69
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.669 SNIP 2.293
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 3.167 SNIP 2.665
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 3.408 SNIP 2.378
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 3.489 SNIP 2.102
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 3.143 SNIP 2.334
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 3.251 SNIP 2.483
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 3.521 SNIP 2.718
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 3.708 SNIP 2.573
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 3.702 SNIP 2.39
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 3.62 SNIP 2.244
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 3.416 SNIP 1.705
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 4.044 SNIP 1.699

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Sensing characteristics of birefringent microstructured polymer optical fiber

We experimentally studied several sensing characteristics of a birefringent microstructured polymer optical fiber. The fiber exhibits a birefringence of the order $2 \times 10^{-5}$ at 1.3 μm because of two small holes adjacent to the core. In this fiber, we measured spectral dependence of phase and group modal birefringence, bending losses, polarimetric sensitivity to strain and temperature. The sensitivity to strain was also examined for intermodal interference observed in the spectral range below 0.8 μm. Finally, we showed that the material transmission windows shift as function of the applied strain. This shift has an exponential character and saturates for greater strain.

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Authors: Szczurowski, M. K. (Ekstern), Frazao, O. (Ekstern), Baptista, J. M. (Ekstern), Nielsen, K. (Intern), Bang, O. (Intern), Urbanczyk, W. (Ekstern)
Pages: 77533Z
Publication date: 2011
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Main Research Area: Technical/natural sciences

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BFI (2017): BFI-level 1
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.42 SNIP 0.245
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.187 SNIP 0.224 CiteScore 0.3
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.188 SNIP 0.231 CiteScore 0.3
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.2 SNIP 0.259 CiteScore 0.26
ISI indexed (2013): ISI indexed no
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.194 SNIP 0.243 CiteScore 0.27
ISI indexed (2012): ISI indexed no
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.197 SNIP 0.264 CiteScore 0.31
ISI indexed (2011): ISI indexed no
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.208 SNIP 0.241
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.211 SNIP 0.271
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.222 SNIP 0.289
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.227 SNIP 0.37
Web of Science (2007): Indexed yes
Broadband polymer microstructured THz fiber coupler with downdoped cores

We demonstrate a broadband THz directional coupler based on a dual core photonic crystal fiber (PCF) design with mechanically down-doped core regions. For a center frequency of 1.3 THz we demonstrate a bandwidth of 0.65 THz.

General information
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Organisations: Fiber Sensors and Supercontinuum Generation, Department of Photonics Engineering, Manufacturing Engineering, Department of Mechanical Engineering, Terahertz Technologies and Biophotonics
Authors: Nielsen, K. (Intern), Rasmussen, H. K. (Intern), Bang, O. (Intern), Jepsen, P. U. (Intern)
Publication date: 2010

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Title of host publication: 35. International Conference on Infrared, Millimeter, and Terahertz Waves
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Main Research Area: Technical/natural sciences
Conference: 35th International Conference on Infrared, Millimeter, and Terahertz Waves, Rome, Italy, 05/09/2010 - 05/09/2010
Electronic versions:
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Broadband terahertz fiber directional coupler

We present the design of a short broadband fiber directional coupler for terahertz (THz) radiation and demonstrate a 3 dB coupler with a bandwidth of 0.6 THz centered at 1.4 THz. The broadband coupling is achieved by mechanically downdoping the cores of a dual-core photonic crystal fiber by microstructuring the cores. This is equivalent to chemical downdoping but is easier to realize experimentally.

General information
State: Published
Organisations: Fiber Sensors and Supercontinuum Generation, Department of Photonics Engineering, Manufacturing Engineering, Department of Mechanical Engineering, Terahertz Technologies and Biophotonics
Authors: Nielsen, K. (Intern), Rasmussen, H. K. (Intern), Jepsen, P. U. (Intern), Bang, O. (Intern)
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Main Research Area: Technical/natural sciences

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BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.54 SJR 1.864 SNIP 1.658
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.142 SNIP 1.642 CiteScore 3.53
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.497 SNIP 2.056 CiteScore 3.86
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.458 SNIP 2.095 CiteScore 3.95
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 2.596 SNIP 1.95 CiteScore 3.52
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 2.518 SNIP 2.475 CiteScore 3.69
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.669 SNIP 2.293
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 3.167 SNIP 2.665
Web of Science (2009): Indexed yes
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Polymer microstructured fibers for guiding of THz radiation: [invited]

Waveguides of various kinds for guided propagation and manipulation of light at terahertz (THz) frequencies are currently attracting considerable attention. There are several applications and perspectives which drive the development of techniques for waveguiding of broadband as well as narrowband THz radiation, including low-loss transport of THz signals [1] between high-speed devices, integrated components for manipulation of THz light [2], such as power splitters, polarization management, and frequency filters, and confinement of the electric field of a THz signal in a small volume, enabling spectroscopic investigations of minute sample quantities [3]. In this presentation we will describe our current efforts in the development, fabrication and characterization of a class of THz waveguides and components based on microstructured polymer optical fibers (mPOF’s) [4] designed for the THz frequency range [5]. Fabrication and characterization of tailored mPOF’s Similar to photonic crystal fibers for the near-infrared, we fabricate our mPOF structures in a fiber draw tower. Based on numerical simulations, a fiber cross section is first designed using standard and custom finite-element methods and FDTD methods, and based on the design, a preform is drilled in a low-loss polymer preform. This preform is heated to above the glass transition temperature of the polymer, and the preform is drawn to the desired dimensions in a single manufacturing step. Optical characterization of the fabricated fibers and components is carried out by THz time-domain spectroscopy, where the amplitude and phase of the transmitted signal through the sample is compared to a reference signal. In this manner we can characterize both loss and dispersion of the waveguide. In addition, near-field measurements across the facets of the fiber have allowed a direct visualization of the guided modes in the fiber [5]. We will discuss the optimal material choice for various kinds of polymer-based fibers, including solid-core and air-core photonic crystal fibers, and show examples of characterization of such components. We will also discuss the design of extremely broadband power splitters for the THz range with a uniform 3-dB splitting ratio of several hundred GHz.
Bendable, low-loss Topas fibers for the terahertz frequency range

We report on a new class of polymer photonic crystal fibers for low-loss guidance of THz radiation. The use of the cyclic olefin copolymer Topas, in combination with advanced fabrication technology, results in bendable THz fibers with unprecedented low loss and low material dispersion in the THz regime. We demonstrate experimentally how the dispersion may be engineered by fabricating both high- and low-dispersion fibers with zero-dispersion frequency in the regime 0.5-0.6 THz. Near-field, frequency resolved characterization with high spatial resolution of the amplitude and phase of the modal structure proves that the fiber is single-moded over a wide frequency range, and we see the onset of higher-order modes at high frequencies as well as indication of microporous guiding at low frequencies and high porosity of the fiber. Transmission spectroscopy demonstrates low-loss propagation (<0.1 dB/cm loss at 0.6 THz) over a wide frequency range.

General information
State: Published
Organisations: Fiber Sensors and Supercontinuum Generation, Department of Photonics Engineering, Department of Mechanical Engineering, Terahertz Technologies and Biophotonics
Broadband THz waveguiding and high-precision broadband time-resolved spectroscopy: [invited]
We demonstrate optical fibers designed for the THz frequency range, fabricated in a low-loss polymer. The polymer fibers display a broadband loss of 0.4 dB/cm over the 0.1-1 THz range, with a minimum loss of 0.1 dB/cm in the region near 500 GHz. The fibers, based on endlessly single-mode design, have tailored dispersion and may be bent into sharp bends. Due to the confinement of the THz field in the core of the fibers they are ideal for stable guiding of THz light in confined environments, and may serve as a useful basis for a wealth of fiber-based photonic components in the THz range, particularly in spectroscopic applications where tight confinement of the THz field is required. We further demonstrate a new spectroscopic technique for ultrafast time-resolved THz time-domain spectroscopy which simultaneously acquires both reference and sample data. By using this scheme we show that the influence of fluctuations on the laser parameters during data acquisition can be minimized, and highly reproducible quantitative data can be recorded and extracted in a very efficient manner. This technique may become especially important in the high THz range, where phase noise becomes critical for the accuracy of a measurement.

Compact Electrically tunable Waveplate Based on Liquid Crystal Photonic Bandgap Fibers
A compact tunable waveplate based on negative dielectric liquid crystal photonic bandgap fibers is presented. The birefringence can be tuned electrically to work as a quarter-wave or a half-wave plate in the wavelength range 1520nm-1600nm.
Dispersion-engineered and highly-nonlinear microstructured polymer optical fibres

We demonstrate dispersion-engineering of microstructured polymer optical fibres (mPOFs) made of poly(methyl methacrylate) (PMMA). A significant shift of the total dispersion from the material dispersion is confirmed through measurement of the mPOF dispersion using white-light spectral interferometry. The influence of strong loss peaks on the dispersion (through the Kramers-Kronig relations) is investigated theoretically. It is found that the strong loss peaks of PMMA above 1100 nm can significantly modify the dispersion, while the losses below 1100 nm only modify the dispersion slightly. To increase the nonlinearity of the mPOFs we investigated doping of PMMA with the highly-nonlinear dye Disperse Red 1. Both doping of a PMMA cane and direct doping of a PMMA mPOF was performed.

Dispersion-tailored, low-loss photonic crystal fibers for the THz range

We have fabricated a new type of photonic crystal fibers based on a cyclic olefin copolymer, transparent in the THz range. We characterize the propagation loss, dispersion, and spatial beam profile in fibers designed for low and high dispersion.
Low-loss and bendable THz fiber with tailored dispersion

A polymer THz fiber made of Topas and having a Photonic Crystal Fiber structure is demonstrated. It has low broadband loss and the dispersion of the fiber can be tailored by adjusting the structural parameters.

General information
State: Published
Organisations: Fiber Sensors and Supercontinuum Generation, Department of Photonics Engineering, Manufacturing Engineering, Department of Mechanical Engineering, Terahertz Technologies and Biophotonics, Delft University of Technology
Authors: Nielsen, K. (Intern), Rasmussen, H. K. (Intern), Adam, A. J. L. (Ekstern), Planken, P. C. (Ekstern), Bang, O. (Intern), Jepsen, P. U. (Intern)
Pages: 1-2
Publication date: 2009

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Conference: Conference on Lasers and Electro-Optics 2009, Baltimore, MD, 01/01/2009
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Source: orbit
Source-ID: 247261
Publication: Research - peer-review › Article in proceedings – Annual report year: 2009

Measurement of chromatic dispersion of microstructured polymer fibers by white-light spectral interferometry

We present a white-light spectral interferometric method for measuring the chromatic dispersion of microstructured fibers made of polymethyl methacrylate (PMMA). The method uses an unbalanced Mach-Zehnder interferometer with the fiber of known length placed in one of the interferometer arms and the other arm with adjustable path length. We record the spectral interferograms to measure the equalization wavelength as a function of the path length difference, or equivalently the differential group refractive index dispersion over a wide wavelength range. First, we verify the applicability of the method by measuring the wavelength dependence of the differential group refractive index of a pure silica fiber. We apply a five-term power series fit to the measured data and confirm by its differentiation that the chromatic dispersion of pure silica glass agrees well with theory. Second, we measure the chromatic dispersion for the fundamental mode supported by two different PMMA microstructured fibers, the multimode fiber and the large-mode area one.

General information
State: Published
Organisations: Fiber Sensors and Supercontinuum Generation, Department of Photonics Engineering, Technical University of Ostrava
Authors: Hlubina, P. (Ekstern), Ciprian, D. (Ekstern), Frosz, M. H. (Intern), Nielsen, K. (Intern)
Publication date: 2009

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Title of host publication: Optical Measurement Systems for Industrial Inspection : Proceedings of SPIE
Volume: 7389
Publisher: SPIE - International Society for Optical Engineering
Main Research Area: Technical/natural sciences
Conference: SPIE Europe Optical Metrology 2009, Munich, Germany, 01/01/2009
Source: orbit
Projects:

Polymer Optical Fiber Bragg Gratings for high sensitivity distributed biochemical sensors
Department of Photonics Engineering
Period: 01/09/2017 → 31/08/2020
Number of participants: 4
Phd Student:
Inglev, Rune (Intern)
Supervisor:
Janting, Jakob (Intern)
Nielsen, Kristian (Intern)
Main Supervisor:
Bang, Ole (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: Samfinansieret - Andet
Project: PhD

Design and fabrication of UV waveguiding polymer tube
Department of Photonics Engineering
Period: 01/09/2014 → 11/01/2018
Number of participants: 6
Phd Student:
Pedersen, Jens Kristian Mølgaard (Intern)
Supervisor:
Bang, Ole (Intern)
Main Supervisor:
Nielsen, Kristian (Intern)
Examiner:
Lindvold, Lars René (Intern)
Kalli, Kyriacos (Ekstern)
Webb, David John (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Samfinansieret - Andet
Project: PhD

Speciality and Microstructured Polymer Optical FBG Sensors
Department of Photonics Engineering
Period: 01/03/2014 → 23/08/2017
Number of participants: 7
Phd Student:
Woyessa, Getinet (Intern)
Supervisor:
Markos, Christos (Intern)
Nielsen, Kristian (Intern)
Main Supervisor:
Bang, Ole (Intern)
Examiner:
Lindvold, Lars René (Intern)
Kalli, Kyriacos (Ekstern)
Schuster, Kay (Ekstern)

**Financing sources**
Source: Internal funding (public)
Name of research programme: Marie Curie (EU-stipendium)
Project: PhD

**POF based Glucose Sensor Incorporating Grating Wavelength Filters**
Department of Photonics Engineering
Period: 15/01/2014 → 08/03/2017
Number of participants: 7
Phd Student:
Hassan, Hafeez Ul (Intern)
Supervisor:
Aasmul, Søren (Ekstern)
Nielsen, Kristian (Intern)
Main Supervisor:
Bang, Ole (Intern)
Examiner:
Jepsen, Peter Uhd (Intern)
Selleri, Stefano (Ekstern)
Sugden, Kate (Ekstern)

**Financing sources**
Source: Internal funding (public)
Name of research programme: Eksternt EU-finansieret
Project: PhD

**Fiber Bragg grating (FBG) strain sensors in all-solid microstructured polymer optical fibers**
Department of Photonics Engineering
Period: 01/03/2013 → 07/12/2016
Number of participants: 6
Phd Student:
Bundalo, Ivan-Lazar (Intern)
Supervisor:
Nielsen, Kristian (Intern)
Main Supervisor:
Bang, Ole (Intern)
Examiner:
Lægsgaard, Jesper (Intern)
Kalli, Kyriacos (Ekstern)
Webb, David John (Ekstern)

**Financing sources**
Source: Internal funding (public)
Name of research programme: Institut stipendie (DTU)

**Relations**
Publications:
Fibre Bragg Grating and Long Period Grating Sensors in Polymer Optical Fibres
Project: PhD

**Topas microstructured polymer optical fibers for biosensing and terahertz waveguides**
Department of Photonics Engineering
Period: 01/02/2008 → 20/04/2011
Number of participants: 7
Phd Student:
Nielsen, Kristian (Intern)
Activities:

456. Vilhelm und Else Heraeus Seminar
Period: 18 Apr 2010 → 21 Apr 2010
Kristian Nielsen (Participant)
Department of Photonics Engineering
Fiber Sensors and Supercontinuum Generation

Description

In the past 20 years the technique now known as Terahertz Time-Domain Spectroscopy (THz-TDS) has had a tremendous impact on the development of the terahertz research field. The technique has the capability of simultaneous measurement of the real and imaginary part of the transfer function of a sample over a wide frequency range, only limited by the technology of the generation and detection process of the THz light. With his functionality, THz-TDS results can be expressed as any of the complex optical quantities – the complex index of refraction ($n=n+iK$), the complex permittivity ($\varepsilon=\varepsilon'+i\varepsilon''$), or the complex conductivity ($\sigma'=\sigma''$). This very general capability leads to applications in a wide range of scientific disciplines, including solid-state physics, aqueous chemistry, and biophysics. In addition, the use of THz-TDS is being pursued in a wide range of application areas such as the food industry, non-destructive testing, imaging, and contact-free characterization of materials. In this presentation the principles of THz-TDS will be discussed, with examples of recent scientific applications of the technique, such as the use of THz-TDS in studies of Debye-like relaxation processes in aqueous solutions. The development of new photonic components for guiding of THz radiation, and in particular low-loss, dispersion-tailored polymer-based microstructured optical fibers, will also be addressed. The time-resolved nature of THz-TDS is a unique property which in a fundamental manner distinguishes THz-TDS from other spectroscopic techniques in the far infrared. We will discuss methods for broadband THz-frequency characterization of materials with a time resolution of less than one picosecond, with emphasis on accuracy in the data acquisition.

Place: Bad Honnef, Germany

Related event
456. Vilhelm und Else Heraeus Seminar: THz radiation: Generation, Detection and Applications
18/04/2010 → 21/04/2010
Bad Honnef, Germany
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.