The aesthetic nature of the birthing room environment may alter the need for obstetrical interventions – an observational retrospective cohort study

The concept of sensory delivery rooms was introduced in 2013. These rooms offer programmable calming lights, restful blurred pictures displayed on a wall-sized big screen, and sound effects. The primary aim of this observational study was to analyse the risk of obstetrical interventions among women giving birth for the first-time in a sensory delivery room vs. a standard delivery room. We included nulliparous, term pregnant women having a single baby with a cephalic presentation who were in spontaneous labour and gave birth between March 1st 2014 and July 1st 2015 in North Zealand Hospital, Hillerød. A total of 789 women were included in the study, 313 gave birth in a sensory room and 476 in a standard delivery room. The risk of a caesarean delivery was significantly decreased when giving birth in a sensory room compared with a standard delivery room (OR, multiple adjusted: 0.44; 95% CI 0.22–0.87); furthermore, the use of oxytocin infusion was also reduced (OR, multiple adjusted: 0.71; 95% CI 0.50–1.03). This observational cohort study suggests that giving birth in a sensory delivery room could lower the risk of caesarean delivery, potentially reducing the number of such deliveries by one for every 23 patients.
UV light assisted antibiotics for eradication of in vitro biofilms

The overuse of antibiotics is accelerating the bacterial resistance, and therefore there is a need to reduce the amount of antibiotics used for treatment. Here, we demonstrate in vitro that specific wavelengths in a narrow range around 296 nm are able to eradicate bacteria in the biofilm state (grown for 24 hours) more effectively, than antibiotics and the combination of irradiation and antibiotics is even better, introducing a novel concept light assisted antibiotics. The investigated wavelength range was 249 nm to 338 nm with an approximate step of 5 nm. The novel concept that consists of a UV irradiation treatment followed by a tobramycin treatment can significantly reduce the amount of antibiotics needed for eradicating mature bacterial biofilms. The efficiency of the proposed light assisted antibiotics method was compared to combinatory antibiotic treatment and highly concentrated antibiotic monotherapy. The eradication efficacies, on mature biofilms, achieved by light assisted antibiotic and by the antibiotic monotherapy at approximately 10-fold higher concentration, were equivalent. The present achievement could motivate the development of light assisted antibiotic treatments for treating infections.

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Corresponding author: Petersen, P. M.
Contributors: Argyraki, A., Markvart, M., Stavnsbjerg, C., Kragh, K. N., Ou, Y., Bjørndal, L., Bjarnsholt, T., Petersen, P. M.
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Source: Scopus
Source-ID: 85056142811
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Dynamics of a green high-power tunable broad-area GaN diode laser with external-cavity feedback
Different dynamic behaviors, such as regular pulse package oscillation, irregular pulse package oscillation, and chaos are observed in a green high power broad-area GaN diode laser system with a grating external-cavity feedback.

Diode laser systems based on nonlinear frequency conversion
In this chapter, we will give a short introduction to nonlinear frequency conversion with second-order nonlinear optics to provide the basic background to the topic and highlight the important parameters to consider when designing a light source based on frequency conversion. In the following section, the different commonly used implementations of nonlinear frequency conversion will be introduced and some examples of demonstrated laser sources will be given. Finally, we will provide an outlook for the development of frequency converted diode laser light sources and briefly discuss some of the applications.

Dynamics of a green high-power tunable external-cavity broad-area GaN diode laser
Although external-cavity feedback with a grating is widely used to achieve a tunable high-power narrow-linewidth broad-area diode laser (BAL) system, the dynamics of such a system is seldom studied. In this paper, the temporal dynamics of a tunable high-power green external-cavity diode laser system based on a GaN BAL and Littrow external-cavity is investigated experimentally. The regular pulse package oscillation (PPO) is observed just above the threshold. The oscillating period of the pulse package decreases with the increasing injected current. As the current increases further, the pulse package oscillates irregularly, and finally changes to a chaotic state. The PPO is observed, for the first time to our knowledge, in a BAL with an external-cavity grating feedback.
Efficiency enhancement of InGaN amber MQWs using nanopillar structures

We have investigated the use of nanopillar structures on high indium content InGaN amber multiple quantum well (MQW) samples to enhance the emission efficiency. A significant emission enhancement was observed which can be attributed to the enhancement of internal quantum efficiency and light extraction efficiency. The size-dependent strain relaxation effect was characterized by photoluminescence, Raman spectroscopy and time-resolved photoluminescence measurements. In addition, the light extraction efficiency of different MQW samples was studied by finite-difference time-domain simulations. Compared to the as-grown sample, the nanopillar amber MQW sample with a diameter of 300 nm has demonstrated an emission enhancement by a factor of 23.8.
Introduction to semiconductor light sources and their biomedical applications
The present chapter serves as a brief introduction to semiconductor light sources mainly laser diodes and light emitting diodes, and the basic physical properties of their semiconductor materials. The chapter also discusses the main reasons for semiconductor light sources being attractive for biomedical applications which range from patient diagnostics imaging to direct treatment such as using photodynamic therapy. It is expected that this specific application area will grow significantly in the future, and that it will be an increasingly important physical properties part of the semiconductor industry.

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Contributors: Andersen, P. E., Petersen, P. M.
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LED Technology for Dental Applications
LEDs have a large potential in many dental and oral applications. Areas such as photo polymerization, fluorescence imaging, photodynamic therapy, and photoactivated disinfection are important future candidates for LED based diagnostics and treatment in dentistry.

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Contributors: Argyraki, A., Ou, Y., Soerensen, L. H., Petersen, P. M.
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Room-Light 1:1-Light Simulation Using a Mock-Up of Patient Bedrooms in the Projected New Psychiatric Hospital Bispebjerg

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Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, University of Copenhagen
Contributors: Volf, C., Dam-Hansen, C., Petersen, P. M., Svendsen, S. D., Elvekjaer, J., Johnsen, K., Martiny, K.
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Publication information
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Saturation in ceramic phosphors illuminated by a blue laser diode

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Semiconductor Lasers and Diode-based Light Sources for Biophotonics
Semiconductor lasers are small, reliable, low cost, high-performance and user-friendly optical devices which make them highly suitable for a variety of biomedical applications. This edited book gathers experts in the field to cover the fundamentals and technology advances of semiconductor lasers and diode-based lasers with a focus on their applications in medical optics and biophotonics including edge-emitting semiconductor lasers and light emitting diodes, Q-switched and mode-locked lasers, quantum cascade lasers, semiconductor disk lasers, near-infrared spectroscopy systems for biomedical applications, bio-medical Raman spectroscopy, nonlinear imaging and optical coherence tomography.

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Contributors: Andersen, P. E. (ed.), Petersen, P. M. (ed.)
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Publisher: Institution of Engineering and Technology
Original language: English
Research output: Book/Report › Book – Annual report year: 2018 › Research › peer-review

Tunable High-Power External-Cavity GaN Diode Laser Systems in the Visible Spectral Range
In this chapter, both blue and green high-power tunable diode laser systems based on GaN broad-area diode laser (BAL) in Littrow external cavity are demonstrated. For blue diode laser system, for high-power application, an output power around 530 mW over a 1.4 nm tunable range is obtained; for wide tunable range application, an output power around 80 mW over a 6.0 nm tunable range is obtained. For the green diode laser system, for high-power application, an output power around 480 mW with a tunable range of 2.1 nm is achieved; for wide tunable range application, an output power of 50 mW with a tunable range of 9.2 nm is achieved. The tuning range and output power optimization of an external-cavity diode laser system is investigated based on the experimental results obtained in the blue and green external-cavity GaN diode laser systems. The obtained results can be used as a guide for selecting gratings for external-cavity diode lasers for different requirements. The temporal dynamics of the green diode laser system is studied experimentally, and pulse package oscillation is observed, for the first time to our knowledge, in a BAL with an external-cavity grating feedback.

General information
Publication status: Published
Two-color interpolation of the absorption response for quantitative acousto-optic imaging

Diffuse optical tomography (DOT) is a reliable and widespread technique for monitoring qualitative changes in absorption inside highly scattering media. It has been shown, however, that acousto-optic (AO) imaging can provide significantly more qualitative information without the need for inversion algorithms due to the spatial resolution afforded by ultrasound probing. In this Letter, we show how, by using multiple-wavelength AO imaging, it is also possible to perform quantitative measurements of absorber concentration inside scattering media. (C) 2018 Optical Society of America
3.5 W of diffraction-limited green light at 515 nm from SHG of a single-frequency tapered diode laser

Multi-Watt efficient compact green laser sources are required for a number of applications e.g. within biophotonics, laser pumping and laser displays. We present generation of 3.5 W of diffraction-limited green light at 515 nm by second harmonic generation (SHG) of a tapered diode laser, itself yielding more than 9 W at 1030 nm. SHG is performed in single pass through a cascade of two nonlinear crystals with re-focusing and dispersion compensating optics between the two nonlinear crystals. The laser is single-frequency and the output power is stabilized to better than ±0.4%.
impact of daylight on the length of hospital stay and improvement of depression. Methods: For a period of 1 year, we collected data on sociodemographics, length of stay, vitamin D, and depression severity for patients in an inpatient affective disorders unit. The ward is located with one facade that faces southeast (SE); the opposite one faces northwest (NW) and receives far less light and no direct sunlight during winter. Results: SE-facing rooms received far more daylight than NW-facing rooms. The length of stay was significantly lower in the SE rooms, i.e., 29.2 (+/− 26.8) versus 58.8 (+/− 42.0) days in the NW rooms (p = 0.01). There was a statistically nonsignificant greater reduction of 52.2% in depression severity for the patients staying in the SE rooms compared to 42.2% in the NW rooms, which may nevertheless be clinically relevant. Conclusion: Due to the study design, no causality for the observed difference in length of stay can be given, but the results support findings in previous studies of the importance of architectural orientation providing natural daylight as a factor for improvement.

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Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, Copenhagen University Hospital
Contributors: Gbyl, K., Madsen, H. O., Svendsen, S. D., Petersen, P. M., Hageman, I., Volf, C., Martiny, K.
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Effective optimization of surface passivation on porous silicon carbide using atomic layer deposited Al2O3
Porous silicon carbide (B–N co-doped SiC) produced by anodic oxidation showed strong photoluminescence (PL) at around 520 nm excited by a 375 nm laser. The porous SiC samples were passivated by atomic layer deposited (ALD) aluminum oxide (Al2O3) films, resulting in a significant enhancement of the PL intensity (up to 689%). The effect of thickness, annealing temperature, annealing duration and precursor purge time on the PL intensity of ALD Al2O3 films was investigated. In order to investigate the penetration depth and passivation effect in porous SiC, the samples were characterized by X-ray photoelectron spectroscopy (XPS) and time-resolved PL. The optimized passivation conditions (20 nm Al2O3 deposited at 160°C with purge time of 20 s, followed by an annealing for 5 min at 350 °C) for porous SiC were achieved and the results indicate that surface passivation by ALD Al2O3 thin films is a very effective method to enhance the luminescence efficiency of porous SiC.

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Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, Meijo University
Contributors: Lu, W., Iwasa, Y., Ou, Y., Jinno, D., Kamiyama, S., Petersen, P. M., Ou, H.
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Scopus rating (2017): CiteScore 3.01 SJR 0.863 SNIP 0.736
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Effect of dopants on the morphology of porous SiC

Porous SiC samples with different doping level were fabricated and investigated by using anodic oxidation method. The morphology of the porous structures was explained by space charge layer width, which was affected by the free carrier-dopants concentration.

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Keywords: Porous, Dopants, Space charge layer, Morphology

Efficient generation of 3.5W laser light at 515nm by frequency doubling a single-frequency high power DBR tapered diode laser

More than 3.5 W of green light at 515 nm is generated by frequency doubling a single-frequency high power DBR tapered diode laser. The frequency doubling is performed in a cascade of PPMgLN and PPMgSLT crystals in order to reach high power and avoid thermal effects present in PPMgLN at high power. The green light is diffraction limited (M2 <1.1) and single-frequency operation is demonstrated with a linewidth less than 2 pm.

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Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, Copenhagen Center for Health Technology, Leibniz-Institut für Höchstfrequenztechnik
Contributors: Jensen, O. B., Hansen, A. K., Müller, A., Sumpf, B., Petersen, P. M., Andersen, P. E.
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High power diode lasers converted to the visible

High power diode lasers have in recent years become available in many wavelength regions. However, some spectral regions are not well covered. In particular, the visible spectral range is lacking high power diode lasers with good spatial quality. In this paper, we highlight some of our recent results in nonlinear frequency conversion of high power near infrared diode lasers to the visible spectral region.

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Contributors: Jensen, O. B., Hansen, A. K., Andersen, P. E., Christensen, M., Müller, A., Tawfieq, M., Sumpf, B., Petersen, P. M.
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How to treat Alzheimer’s with new LED light technology
We have developed a new therapeutic LED lamp that modulates with 40 Hz the neuron responses in different parts of the brain without affecting the human vision. The lamp may in the future be used to treat patients with Alzheimer’s disease.

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Publication status: Published
Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, University of California at Berkeley
Contributors: Nguyen, N. M., Petersen, P. M., Broeng, J.
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Electronic versions:
program_20175.pdf

Inactivation of Pseudomonas aeruginosa biofilm after ultraviolet light-emitting diode treatment: a comparative study between ultraviolet C and ultraviolet B

The objective of this study was to test the inactivation efficiency of two different light-based treatments, namely ultraviolet B (UVB) and ultraviolet C (UVC) irradiation, on Pseudomonas aeruginosa biofilms at different growth stages (24, 48, and 72 h grown). In our experiments, a type of AlGaN light-emitting diodes (LEDs) was used to deliver UV irradiation on the biofilms. The effectiveness of the UVB at 296 nm and UVC at 266 nm irradiations was quantified by counting colony-forming units. The survival of less mature biofilms (24 h grown) was studied as a function of UV-radiant exposure. All treatments were performed on three different biological replicates to test reproducibility. It was shown that UVB irradiation was significantly more effective than UVC irradiation in inactivating P. aeruginosa biofilms. UVC irradiation induced insignificant inactivation on mature biofilms. The fact that the UVB at 296 nm exists in daylight and has such disinfection ability on biofilms provides perspectives for the treatment of infectious diseases.
**Investigation of saturation effects in ceramic phosphors for laser lighting**

We report observation of saturation effects in a Ce:LuAG and Eu-doped nitride ceramic phosphor for conversion of blue laser light for white light generation. The luminous flux from the phosphors material increases linearly with the input power until saturation effects limit the conversion. It is shown, that the temperature of the phosphor layer influences the saturation power level and the conversion efficiency. It is also shown that the correlated color temperature (CCT), phosphor conversion efficiency and color rendering index (CRI) are dependent both on incident power and spot size diameter of the illumination. A phosphor conversion efficiency up to 140.8 lm/W with CRI of 89.4 was achieved. The saturation in a ceramic phosphor, when illuminated by high intensity laser diodes, is estimated to play the main role in limiting the available luminance from laser based lighting systems.
Light interventions: a novel approach for sustaining sleep quality and quantity of elite swimmers under conditions of shifted circadian rhythm

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Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, Team Denmark
Contributors: Argyraki, A., Andersen, J. H., Johansen, L., Adler, A. T., Broeng, J., Petersen, P. M.
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Source-ID: 141047230
Research output: Chapter in Book/Report/Conference proceeding – Annual report year: 2017 › Research › peer-review

Light interventions: a novel approach for sustaining sleep quality and quantity of elite swimmers under conditions of shifted circadian rhythm

For the 2016 Olympics at Rio De Janeiro the Danish swimmers was facing a very important problem, how to maintain a good sleep quality, quantity and high performance potential, while being subject to large shift in circadian rhythm. In the present study we suggest an alternative approach for sustaining sleep quality and quantity, namely light interventions. A light program, comprising of alternating blue enhanced white light and blue suppressed white light, was designed to complement the activities of elite Danish swimmers after arriving to preparation/training camp; mimicking the conditions expected in the 2016 Summer Olympics in Rio (5-10 hours shift in circadian rhythm). The sleep patterns of the swimmers were monitored throughout two different phases: the baseline period, registered both before and after the intervention; and the preparation period (intervention). Sleep duration, efficiency, latency, percentages of light, deep or REM sleep were the variables under investigation. The sleep output was modeled (ANOVA) with subject as a random effect and phase as fixed effect. It was observed that the light program during the intervention phase significantly enabled the conservation of sleep quantity and quality of the swimmers, despite the shifted circadian rhythm. The hypothesis of no effect of phase of experiment on sleep duration, efficiency, latency, percentage of light, deep and REM sleep were all accepted with p. values 0.17, 0.53, 0.90, 0.38, 0.57 and 0.52, respectively. The swimmers commented only positively the light interventions and decided to use them at Olympics 2016. No side effects were observed. Light interventions could become an alternative simple tool for coaches and elite swimmers to improve sleep patterns in occasions of disturbed circadian rhythm conditions (different time zones, uncomfortable competition times). Contrary to other methods for improving sleep pattern (e.g. sleeping pills) light interventions carry minimal risk for severe side effects.

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New dental applications with LEDs

Visible and ultraviolet LEDs will in the future give rise to new dental applications. Fluorescence imaging, photodynamic therapy and photoactivated disinfection are important future candidates for diagnostics and treatment in dentistry.

General information
Publication status: Published
Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems
Phosphor converted laser diode light source for endoscopic diagnostics

In order to provide light sources for endourology and on-site testing of the light source, we are developing a portable endoscope light source prototype based on a phosphor converted laser diode. A small emitting area from the phosphor material excited by a laser diode enables coupling of the generated white light into thin optical fibres. The development involves designing optics for optimizing the light extraction efficiency and guiding of light to the area of interest. In this paper we compared the developed light source to the current standard in endoscopy – xenon arc lamps. Detailed spectral analysis of illuminance, CRI and CCT at two power levels and two distances for both the PC-LD and the xenon light source was performed. The obtained results verified that the developed light source is suitable for endoscopy illumination and the first pre-clinical trials will be performed shortly.

General information
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Publication date: 2017

Phosphor converted laser diode light source for endoscopic diagnostics

Highly efficient endoscopic white light sources may be enabled by use of phosphor converted blue laser diodes. This light source offers the advantages of a more compact and ergonomic design, lower cost, possibility of tailoring the spectral content and more uniform illumination in comparison with current technology, as well as providing the possibility of shadow formation within the operative field.

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UVB irradiation has a greater efficacy than photodynamic therapy on Enterococcus faecalis

General information
Publication status: Published
White light emission from fluorescent SiC with porous surface

We report for the first time a NUV light to white light conversion in a N-B co-doped 6H-SiC (fluorescent SiC) layer containing a hybrid structure. The surface of fluorescent SiC sample contains porous structures fabricated by anodic oxidation method. After passivation by 20nm thick Al2O3, the photoluminescence intensity from the porous layer was significantly enhanced by a factor of more than 12. Using a porous layer of moderate thickness (~10µm), high-quality white light emission was realized by combining the independent emissions of blue-green emission from the porous layer and yellow emission from the bulk fluorescent SiC layer. A high color rendering index of 81.1 has been achieved. Photoluminescence spectra in porous layers fabricated in both commercial n-type and lab grown N-B co-doped 6H-SiC show two emission peaks centered approximately at 460nm and 530nm. Such blue-green emission phenomenon can be attributed to neutral oxygen vacancies and interface C-related surface defects generated during anodic oxidation process. Porous fluorescent SiC can offer a great flexibility in color rendering by changing the thickness of porous layer and bulk fluorescent layer. Such a novel approach opens a new perspective for the development of high performance and rare-earth element free white light emitting materials.

Lamp for sunshine simulation

A lamp system is provided, comprising a lamp with a lamp housing accommodating a plurality of light sources for emission of visible light, including blue light, a time keeping unit, a light sensor for sensing intensity of light incident upon it, and a light controller configured for controlling the plurality of light sources in response to the intensity of light sensed by the light sensor and the time provided by the time keeping unit, characterized in that the lamp emits blue light for a selected time period, wherein the blue light has a luminous flux ranging from 50 lux to 200 lux and, preferably, an irradiance that is larger than 5 mW/nm/m² in a selected wavelength range, such as in the wavelength range from 440 nm to 500 nm, as measured at a distance of 3 metres from the lamp.
340 nm pulsed UV LED system for europium-based time-resolved fluorescence detection of immunoassays

We report on the design, development and investigation of an optical system based on UV light emitting diode (LED) excitation at 340 nm for time-resolved fluorescence detection of immunoassays. The system was tested to measure cardiac marker Troponin I with a concentration of 200 ng/L in immunoassay. The signal-to-noise ratio was comparable to state-of-the-art Xenon flash lamp based unit with equal excitation energy and without overdriving the LED. We performed a comparative study of the flash lamp and the LED based system and discussed temporal, spatial, and spectral features of the LED excitation for time-resolved fluorimetry. Optimization of the suggested key parameters of the LED promises significant increase of the signal-to-noise ratio and hence of the sensitivity of immunoassay systems.

Combining surface plasmonic and light extraction enhancement on InGaN quantum-well light-emitters

Surface plasmon coupling with light-emitters and surface nano-patterning have widely been used separately to improve low efficiency InGaN light-emitting diodes. We demonstrate a method where dielectric nano-patterning and Ag nanoparticles (NPs) are combined to provide both light extraction and internal quantum efficiency enhancement for InGaN/GaN quantum-well light-emitters. By fabricating dielectric nano-rod pattern on the GaN surface, an optical coating that improves the light extraction is obtained, and furthermore has a low refractive index which blue-shifts the plasmonic resonance of Ag NPs towards...
the emission wavelength. We investigate emission components from both the GaN and sapphire surface of the semiconductor crystal and show that Ag NPs on dielectric nano-pattern compared to a planar surface, result in a stronger enhancement.

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Organisations: Diode Lasers and LED Systems, Department of Photonics Engineering, Centre of Excellence for Silicon Photonics for Optical Communications, Tokyo University of Science, Meijo University
Contributors: Fadil, A., Ou, Y., Iida, D., Kamiyama, S., Petersen, P. M., Ou, H.
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Web of Science (2016): Impact factor 7.367
Web of Science (2016): Indexed yes
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**Comparison of UVB and UVC Irradiation disinfection efficacies on Pseudomonas Aeruginosa biofilm**

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Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, University of Copenhagen
Contributors: Argyraki, A., Markvart, M., Nielsen, A., Bjarnsholt, T., Bjarndal, L., Petersen, P. M.
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Research output: Contribution to conference › Poster – Annual report year: 2016 › Research › peer-review

Disinfection routines are important in all clinical applications. The uprising problem of antibiotic resistance has driven major research efforts towards alternative disinfection approaches, involving light-based solutions. Pseudomonas aeruginosa (P. aeruginosa) is a common bacterium that can cause skin, soft tissue, lungs, kidney and urinary tract infections. Moreover, it can be found on and in medical equipment causing often cross infections in hospitals. The objective of this study was to test the efficiency of two different light-based disinfection treatments, namely UVB and UVC irradiation, on P. aeruginosa biofilms at different growth stages. In our experiments a new type of UV light emitting diodes (LEDs) were used to deliver UV irradiation on the biofilms, in the UVB (296nm) and UVC (266nm) region. The killing rate was studied as a function of dose for 24h grown biofilms. The dose was ramped from 72J/m2 to 10000J/m2. It was shown that UVB irradiation was more effective than UVC irradiation in inactivating P. aeruginosa biofilms. No colony forming units (CFU) were observed for the UVB treated biofilms when the dose was 10000 J/m2 (CFU in control sample: 7.5 x 10^4). UVB irradiation at a dose of 20000J/m2 on mature biofilms (72h grown) resulted in a 3.9 log killing efficacy. The fact that the wavelength of 296nm exists in daylight and has such disinfection ability on biofilms gives new perspectives for applications within disinfection at hospitals.

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Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, University of Copenhagen
Does correlated color temperature affect the ability of humans to identify veins?

In the present study we provide empirical evidence and demonstrate statistically that white illumination settings can affect the human ability to identify veins in the inner hand vasculature. A special light-emitting diode lamp with high color rendering index (CRI 84–95) was developed and the effect of correlated color temperature was evaluated, in the range between 2600 and 5700 K at an illuminance of 40 9 lx on the ability of adult humans to identify veins. It is shown that the ability to identify veins can, on average, be increased up to 24% when white illumination settings that do not resemble incandescent light are applied. The illuminance reported together with the effect of white illumination settings on direct visual perception of biosamples are relevant for clinical investigations during the night. © 2015 Optical Society of America

Fabrication and surface passivation of porous 6H-SiC by atomic layer deposited films

Porous 6H-SiC samples with different thicknesses were fabricated through anodic etching in diluted hydrofluoric acid. Scanning electron microscope images show that the dendritic pore formation in 6H-SiC is anisotropic, which has different lateral and vertical formation rates. Strong photoluminescence was observed and the etching process was optimized in terms of etching time and thickness. Enormous enhancement as well as redshift and broadening of photoluminescence spectra were observed after the passivation by atomic layer deposited Al2O3 and TiO2 films. No obvious luminescence was observed above the 6H-SiC crystal band gap, which suggests that the strong photoluminescence is ascribed to surface state produced during the anodic etching.
Glass Quality and Health in Public Housing

Green high-power tunable external-cavity GaN diode laser at 515 nm
A 480 mW green tunable diode laser system is demonstrated for the first time to our knowledge. The laser system is based on a GaN broad-area diode laser and Littrow external-cavity feedback. The green laser system is operated in two modes by switching the polarization direction of the laser beam incident on the grating. When the laser beam is p-polarized, an output power of 50 mW with a tunable range of 9.2 nm is achieved. When the laser beam is s-polarized, an output power of 480 mW with a tunable range of 2.1 nm is obtained. This constitutes the highest output power from a tunable green diode laser system.
High-flux focusable color-tunable and efficient white-light-emitting diode light engine for stage lighting

A color mixing light-emitting diode (LED) light engine that can replace 2-kW halogen–Fresnel spotlight with high-luminous flux in excess of 20,000 lm is reported for applications in professional stage and studio lighting. The light engine focuses and mixes the light from 210 LEDs of five different colors through a microlens array (MA) at the gate of ∅50 mm. Hence, it produces homogeneous color-mixed tunable white light from 3000 to 6000 K that can be adjustable from flood to spot position providing 10% translational loss, whereas the corresponding loss from the halogen–Fresnel spotlight is 37%. The design, simulation, and optimization of the light engine is described and compared to the experimental characterization of a prototype. The light engine is optimized through the simulated design of reflector, total internal reflection lens, and MA, as well as the number of LEDs. An optical efficiency of 59% and a luminous efficacy of 33 lm/W are achieved, which is three times higher than the 2-kW halogen–Fresnel spotlight. In addition to having color rendering of color rendering index Ra > 85 and television lighting consistency index 12 > 70, the dimmable and tunable white light can be color controlled during the operational time.

General information
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Organisations: Department of Photonics Engineering, Optical Microsensors and Micromaterials, Diode Lasers and LED Systems, Brother, Brother & Sons ApS
Contributors: Chakrabarti, M., Pedersen, H. C., Petersen, P. M., Poulsen, C., Poulsen, P. B., Dam-Hansen, C.
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Copyright 2016. Society of Photo Optical Instrumentation Engineers. One print or electronic copy may be made for personal use only. Systematic reproduction and distribution, duplication of any material in this paper for a fee or for commercial purposes, or modification of the content of the paper are prohibited.
Hybrid surface structures for efficiency enhancement of fluorescent SiC for white LED application

Hybrid structures contain structures in both micro- and nano-meter scale have been fabricated on fluorescent SiC by applying a fast fabrication method. Luminescence efficiency of f-SiC was enhanced significantly compared with normal nanostructures.

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Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, Centre of Excellence for Silicon Photonics for Optical Communications, Linköping University
Contributors: Ou, Y., Xiong, M., Lu, W., Fadil, A., Jokubavicius, V., Syväjärvi, M., Petersen, P. M., Ou, H.
Number of pages: 1
Publication date: 2016
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Event: Paper presented at 4th International workshop on LEDs and solar applications, Nagoya, Japan.

Investigation of the effect of UV-LED exposure conditions on the production of vitamin D in pig skin

The dietary intake of vitamin D is currently below the recommended intake of 10-20 µg vitamin D/day. Foods with increased content of vitamin D or new products with enhanced vitamin D are warranted. Light-emitting diodes (LEDs) are a potential new resource in food production lines. In the present study the exposure conditions with ultraviolet (UV) LEDs were systematically investigated in the wavelength range 280-340 nm for achieving optimal vitamin D bio-fortification in pig skin. A wavelength of 296 nm was found to be optimal for vitamin D3 production. The maximum dose of 20 kJ/m2 produced 3.5-4 µg vitamin D3/cm2 pig skin. Vitamin D3 produced was independent on the combination of time and intensity of the LED source. The increased UV exposure by UV-LEDs may be readily implemented in existing food production facilities, without major modifications to the process or processing equipment, for bio-fortifying food products containing pork skin.

General information
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Organisations: National Food Institute, Research group for Bioactives – Analysis and Application, Department of Photonics Engineering, Diode Lasers and LED Systems
Contributors: Barnkob, L. L., Argyraki, A., Petersen, P. M., Jakobsen, J.
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Web of Science (2016): Indexed yes
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Laser diode based lighting for biomedical applications

Photoluminescence Enhancement in Nanotextured Fluorescent SiC Passivated by Atomic Layer Deposited Al2O3 Films
The influence of thickness of atomic layer deposited Al2O3 films on nano-textured fluorescent 6H-SiC passivation is investigated. The passivation effect on the light emission has been characterized by photoluminescence and time-resolved photoluminescence at room temperature. The results show that 20nm thickness of Al2O3 layer is favorable to observe a large photoluminescence enhancement (25.9%) and long carrier lifetime (0.86ms). This is a strong indication for an interface hydrogenation that takes place during post-thermal annealing. These results show that an Al2O3 layer could serve as passivation in fluorescent SiC based white LEDs applications.

Photoluminescence enhancement in porous SiC passivated by atomic layer deposited Al2O3 films
Porous SiC co-doped with B and N was passivated by atomic layer deposited (ALD) Al2O3 films to enhance the photoluminescence. After optimizing the deposition conditions, as high as 14.9 times photoluminescence enhancement has been achieved.
Saturation effects of phosphor converted laser diodes

General information
Publication status: Published
Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems
Contributors: Krasnoshchoka, A., Jensen, O. B., Thorseth, A., Dam-Hansen, C., Petersen, P. M.
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Peer-reviewed: Yes
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Surface passivation of nano-textured fluorescent SiC by atomic layer deposited TiO2

Nano-textured surfaces have played a key role in optoelectronic materials to enhance the light extraction efficiency. In this work, morphology and optical properties of nano-textured SiC covered with atomic layer deposited (ALD) TiO2 were investigated. In order to obtain a high quality surface for TiO2 deposition, a three-step cleaning procedure was introduced after RIE etching. The morphology of anatase TiO2 indicates that the nano-textured substrate has a much higher surface nucleated grain density than a flat substrate at the beginning of the deposition process. The corresponding reflectance increases with TiO2 thickness due to increased surface diffuse reflection. The passivation effect of ALD TiO2 thin film on the nano-textured fluorescent 6H-SiC sample was also investigated and a PL intensity improvement of 8.05% was obtained due to the surface passivation.

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Number of pages: 4
Publication date: 2016
Peer-reviewed: Yes
Tunable high-power narrow-linewidth green external-cavity GaN diode laser
A tunable high-power green external-cavity diode laser is demonstrated. Up to 290 mW output power and a 9.2 nm tuning is achieved. This constitutes the highest output power from a tunable green diode laser system.

Tuning range and output power optimization of an external-cavity GaN diode laser at 455 nm
In this paper we discuss how different feedback gratings affect the tuning range and the output power of external feedback diode laser systems. A tunable high-power narrow-spectrum external-cavity diode laser system around 455 nm is investigated. The laser system is based on a high-power GaN diode laser in a Littrow external-cavity. Both a holographic diffraction grating and a ruled diffraction grating are used as feedback elements in the external cavity. The output power, spectral bandwidth, and tunable range of the external cavity diode laser system are measured and compared with the two gratings at different injected currents. When the holographic grating is used, the laser system can be tuned over a range of 1.4 nm with an output power around 530 mW. When the ruled grating is used, the laser system can be tuned over a range of 6.0 nm with an output power around 80 mW. The results can be used as a guide for selecting gratings for external-cavity diode lasers for different requirements. (C) 2016 Optical Society of America
Laser Apparatus with Cascade of Nonlinear Frequency Mixers
A laser apparatus comprising: a first laser source operable to generate a first laser beam having a least a beam component having a first frequency
a second laser source operable to generate a second laser beam having a least a beam component having a second frequency
a beam combiner operable to combine the first and second laser beams into a combined initial laser beam comprising at least a frequency component having the first frequency, and a frequency component having the second frequency
one or more nonlinear frequency mixers operable to perform a frequency mixing process of a frequency component having the first frequency and a frequency component having the second frequency and resulting in at least a frequency component having a third frequency equal to a sum or difference of the first and second frequencies
wherein the laser apparatus is configured to direct the combined initial laser beam through a first one of the one or more nonlinear frequency mixers resulting in a first frequency-mixed beam, the first frequency-mixed beam comprising a frequency component having the first frequency, a frequency component having the second frequency, and a frequency component having the third frequency
wherein the laser apparatus is further configured to direct the resulting first frequency-mixed beam along an intermediate beam path to a subsequent nonlinear frequency mixer chosen from the first and another one of the one or more nonlinear frequency mixers, resulting in a second frequency-mixed beam comprising at least an output frequency component having at least said third frequency
a dispersive element configured to adjustably change an optical path length of the intermediate beam path of the first frequency-mixed beam so as to compensate for dispersion along at least the intermediate beam path.

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Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, Department of Applied Mathematics and Computer Science
Contributors: Hansen, A. K., Jensen, O. B., Andersen, P. E., Petersen, P. M.
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5.5 W of Diffraction-Limited Green Light Generated by SFG of Tapered Diode Lasers in a Cascade of Nonlinear Crystals
Diode-based high power visible lasers are perfect pump sources for, e.g., titanium:sapphire lasers. The combination of favorable scaling laws in both SFG and cascading of nonlinear crystals allows access to unprecedented powers in diode-based systems.

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Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems
Contributors: Hansen, A. K., Jensen, O. B., Andersen, P. E., Petersen, P. M.
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Publication date: 2015
Concept for power scaling second harmonic generation using a cascade of nonlinear crystals

Within the field of high-power second harmonic generation (SHG), power scaling is often hindered by adverse crystal effects such as thermal dephasing arising from the second harmonic (SH) light, which imposes limits on the power that can be generated in many crystals. Here we demonstrate a concept for efficient power scaling of single-pass SHG beyond such limits using a cascade of nonlinear crystals, in which the first crystal is chosen for high nonlinear efficiency and the subsequent crystal(s) are chosen for power handling ability. Using this highly efficient singlepass concept, we generate 3.7 W of continuous-wave diffraction-limited 2 (1.25) M = light at 532 nm from 9.5 W of non-diffraction-limited 2 (7.7) M = light from a tapered laser diode, while avoiding significant thermal effects. Besides constituting the highest SH power yet achieved using a laser diode, this demonstrates that the concept successfully combines the high efficiency of the first stage with the good power handling properties of the subsequent stages. The concept is generally applicable and can be expanded with more stages to obtain even higher efficiency, and extends also to other combinations of nonlinear media suitable for other wavelengths.

Development of LED Light Sources for Improved Visualization of Veins: a statistical approach

The present statistical study investigates the difference of diffuse reflectances between skin and vein (defined as contrast indicator) under different visible wavelengths of a population of 39 adult participants. The purpose of the study is to examine if there is a group of wavelengths-color combinations that could explain most of the variance (of the contrast indicator) in the data set. Moreover the effect of gender and age on the contrast indicator is explored.
Dielectric coating and surface plasmon enhancement of multi-color quantum-well structures

We fabricate a multi-colored quantum-well structure as a prototype towards monolithic white light-emitting diodes, and modify the emission intensities of different colors by introducing dielectric and Ag nanoparticle coating.

Fabrication and improvement of nanopillar InGaN/GaN light-emitting diodes using nanosphere lithography

Surface-patterning technologies have enabled the improvement of currently existing light-emitting diodes (LEDs) and can be used to overcome the issue of low quantum efficiency of green GaN-based LEDs. We have applied nanosphere lithography to fabricate nanopillars on InGaN/GaN quantum-well LEDs. By etching through the active region, it is possible to improve both the light extraction efficiency and, in addition, the internal quantum efficiency through the effects of lattice strain relaxation. Nanopillars of different sizes are fabricated and analyzed using Raman spectroscopy. We have shown that nanopillar LEDs can be significantly improved by applying a combination of ion-damage curing techniques, including thermal and acidic treatment, and have analyzed their effects using x-ray photoelectron spectroscopy.
Highly efficient single-pass sum frequency generation by cascaded nonlinear crystals

The cascading of nonlinear crystals has been established as a simple method to greatly increase the conversion efficiency of single-pass second-harmonic generation compared to a single-crystal scheme. Here, we show for the first time that the technique can be extended to sum frequency generation, despite differences in the phase relations of the involved fields. An unprecedented 5.5 W of continuous-wave diffraction-limited green light is generated from the single-pass sum frequency mixing of two diode lasers in two periodically poled nonlinear crystals (conversion efficiency 50%). The technique is generally applicable and can be applied to any combination of fundamental wavelengths and nonlinear crystals.

General information
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Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, Department of Physics, Ferdinand-Braun-Institut
Contributors: Hansen, A. K., Andersen, P. E., Jensen, O. B., Sumpf, B., Erbert, G., Petersen, P. M.
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Scopus rating (2015): CiteScore 3.53 SJR 2.397 SNIP 1.53

High-power non linear frequency converted laser diodes

We present different methods of generating light in the blue-green spectral range by nonlinear frequency conversion of tapered diode lasers achieving state-of-the-art power levels. In the blue spectral range, we show results using single-pass second harmonic generation (SHG) as well as cavity enhanced sum frequency generation (SFG) with watt-level output powers. SHG and SFG are also demonstrated in the green spectral range as a viable method to generate up to 4 W output power with high efficiency using different configurations.

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Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, Norlase ApS
Contributors: Jensen, O. B., Andersen, P. E., Hansen, A. K., Marti, D., Skovgaard, P. M. W., Petersen, P. M.
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LED-lys til ældre: Lys, trivsel og alder - Hvordan hænger det sammen?

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Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, Glostrup University Hospital, Danish Building Research Institute, Lightscapes ApS, Philips Lighting A/S, Viso Systems ApS, Gate 21, Copenhagen University Hospital
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Scalable nanostructuring on polymer by a SiC stamp: optical and wetting effects

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Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems
Contributors: Argyraki, A., Lu, W., Petersen, P. M., Ou, H.
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Scalable nanostructuring on polymer by a SiC stamp: optical and wetting effects
A method for fabricating scalable antireflective nanostructures on polymer surfaces (polycarbonate) is demonstrated. The transition from small scale fabrication of nanostructures to a scalable replication technique can be quite challenging. In this work, an area per print corresponding to a 2-inch-wafer, is presented. The initial nanopatterning is performed on SiC in a 2-step process. Depending on the nanostructures the transmission of the SiC surface can be increased or suppressed (average height of nanostructures ~300nm and ~600nm, respectively) while the reflectance is decreased, when compared to a bare surface. The reflectance of SiC can be reduced down to 0.5% when the ~600nm nanostructures are applied on the surface (bare surface reflectance 25%). The texture of the green SiC color is changed when the different nanostructures are apparent. The ~600nm SiC nanostructures are replicated on polymer through a process flow that involved hot embossing and galvanization. The resulted polymer structures have similar average height and exhibit more rounded edges than the initial SiC nanostructures. The polymer surface becomes antireflective and hydrophobic after nanostructuring. The contact angle changes from 68 (bare) to 123 (nanostructured) degrees. The optical effect on the polymer surface can be maximized by applying a thin aluminum (Al) layer coating on the nanostructures (bare polymer reflectance 11%, nanostructured polymer reflectance 5%, Al coated nanostructured polymer reflectance 3%). The optical measurements were performed with an integrating sphere and a spectrometer. The contact angles were measured with a drop shape analyzer. The nanostructures were characterized with scanning electron microscopy.
Wavelength-conversion efficiency enhancement in nano-textured fluorescent 6H-SiC passivated by atomic layer deposited titanium oxide

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Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, Linköping University
Contributors: Lu, W., Ou, Y., Jokubavicius, V., Fadil, A., Syväjärvi, M., Petersen, P. M., Ou, H.
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Compact green-diode-based lasers for biophotonic bioimaging
Diode lasers simultaneously offer tunability, high-power emission, and compact size at fairly low cost and are increasingly preferred for pumping titanium:sapphire lasers.

General information
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Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, Leibniz-Institut für Höchstfrequenztechnik, Medical University of Vienna
Contributors: Jensen, O. B., Hansen, A. K., Petersen, P. M., Müller, A., Sumpf, B., Unterhuber, A., Drexler, W., Andersen, P. E.
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A high power directly diode pumped Ti:sapphire laser with synchronized Yb-fiber amplifier for nonlinear optical microscopy and optical coherence tomography

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A new approach to sum frequency generation of single-frequency blue light in a coupled ring cavity

We present a generic approach for the generation of tunable single-frequency light and demonstrate generation of more than 300 mW tunable light around 460 nm. One tapered diode laser is operated in a coupled ring cavity containing the nonlinear crystal and another tapered diode laser is sent through the nonlinear crystal in a single pass. A high conversion efficiency of more than 25% of the single-pass laser is enabled by the high circulating power in the coupled cavity. The system is entirely self-stabilized with no need for electronic locking.

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Contributors: Jensen, O. B., Petersen, P. M.
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Development of New LED Light Sources for Improved Visualization of Bio-samples

General information
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Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, Optical Microsensors and Micromaterials
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Research: peer-review

Dynamic behaviors of a broad-area diode laser with lateral-mode-selected external feedback

In this paper, we investigate the dynamics of a BAL with lateral-mode selected external feedback experimentally by measuring the far-field profile, intensity noise spectrum and time series of the output beam. The mode-selection is achieved by adjusting a stripe mirror at the pseudo far-field plane. Different dynamic behaviors are observed when different lateral modes are selected. When the mirror is aligned correctly and high-order modes are selected, in most of the cases periodic dynamics of the output power corresponding to a single roundtrip external-cavity loop is observed, but the dynamic behavior disappears in some case; when the zero-order mode is selected, periodic dynamics corresponding to a double roundtrip external-cavity loop is observed. When the stripe mirror is not aligned perfectly, a dynamic behavior like pulse-package oscillations is observed: a periodic oscillated output with a frequency of the single roundtrip external-cavity loop modulated by periodic low-frequency fluctuation. This is the first observation of pulse-package oscillation in a diode laser with long-cavity feedback, to our knowledge.
Dynamics of a broad-area diode laser with lateral-mode-selected long-cavity feedback

The temporal dynamics of a broad-area diode laser with lateral-mode-selected long-cavity feedback is studied experimentally. Different dynamics are observed when different lateral modes are selected. When the feedback mirror is aligned perfectly and high-order modes are selected, in most of the cases, the output of the laser shows a periodic oscillation corresponding to a single roundtrip external-cavity loop, but the dynamic behavior disappears in some case; when the zero-order lateral-mode is selected, periodic oscillation corresponding to a double roundtrip external-cavity loop is observed. When the feedback mirror is aligned non-perfectly, pulse-package oscillation is observed, for the first time to our knowledge, in a diode laser with long-cavity feedback.
Future Solid State Lighting Based on Light Emitting Laser Diodes

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**Future Solid State Lighting using LEDs and Diode Lasers**

Lighting accounts for 20% of all electrical energy usage. Household lighting and commercial lighting such as public and street lighting are responsible for significant greenhouse gas emissions. Therefore, currently many research initiatives focus on the development of new light sources which shows significant savings. Solid state lighting (SSL) based on LEDs is today the most efficient light source for generation of high quality white light. Diode lasers, however, have the potential of being more efficient than LEDs for the generation of white light. A major advantage using diode lasers for solid state lighting is that the high efficiency can be obtained at high light lumen levels in a single element emitter and thus less light sources are required to achieve a desired light level. Furthermore, the high directionality of the generated light from laser diodes increases the energy savings in many applications.

Within the coming years, it is expected that the efficiency of blue laser diodes will approach the efficiency of infrared diode lasers. This will enable high efficiency white light generation with very high lumen per watt values.

SSL today is mainly based on phosphor converted blue light emitting diodes (LEDs). Blue emitting 445-460 nm LED chips with conversion in phosphorescent materials have undergone tremendous development in the last decade with ultra high efficiencies. However, the technology suffers from a decrease in efficiency at high input current densities, known as the "efficiency droop". This efficiency droop restricts operation to relatively low output lumen levels for single element emitters. The cause of the efficiency droop is still not completely clear and thus a solution is not easily found. In the literature it has been suggested that carrier overflow in the quantum wells and non-radiative recombination could be the origins. Recently, Auger recombination was proposed as the dominant mechanism for efficiency droop.

In the talk we discuss the mechanisms of the efficiency droop in LEDs and we show how this problem can be eliminated in laser diodes. With the introduction of diode laser based lighting, high luminous flux levels and high efficiency can be available at the same time. Laser diodes operate in a fundamentally different regime using stimulated emission for light generation as opposed to spontaneous emission in LEDs The recent progress in solid state lighting based on diode lasers will be reviewed and we will present a new diode laser architecture that emits as high as 2100 lumen green light with an efficiency of 70 lm/W.

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Contributors: Petersen, P. M.
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Research output: Chapter in Book/Report/Conference proceeding › Conference abstract in proceedings – Annual report year: 2014 › Research › peer-review

**Generation of 3.5 W of diffraction-limited green light from SHG of a single tapered diode laser in a cascade of nonlinear crystals**

Many applications, e.g., within biomedicine stand to benefit greatly from the development of diode laser-based multi-Watt efficient compact green laser sources. The low power of existing diode lasers in the green area (about 100 mW) means that the most promising approach remains nonlinear frequency conversion of infrared tapered diode lasers. Here, we describe the generation of 3.5 W of diffraction-limited green light from SHG of a single tapered diode laser, itself yielding 10 W at 1063 nm. This SHG is performed in single pass through a cascade of two PPMgO:LN crystals with re-focusing and dispersion compensating optics between the two nonlinear crystals. In the low-power limit, such a cascade of two crystals has the theoretical potential for generation of four times as much power as a single crystal without adding
significantly to the complexity of the system. The experimentally achieved power of 3.5 W corresponds to a power enhancement greater than 2 compared to SHG in each of the crystals individually and is the highest visible output power generated by frequency conversion of a single diode laser. Such laser sources provide the necessary pump power for biophotonics applications, such as optical coherence tomography or multimodal imaging devices, e.g., FTCARS-OCT, based on a strongly pumped ultrafast Ti: Sapphire laser.

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**Power Scaling of Nonlinear Frequency Converted Tapered Diode Lasers for Biophotonics**
Diode lasers have proven to be versatile light sources for a wide range of applications. Nonlinear frequency conversion of high brightness diode lasers has recently resulted in visible light power levels in the watts range enabling an increasing number of applications within biophotonics. This review provides an overview of the developments within nonlinear frequency converted high power laser diodes in the visible spectral range. Single-pass nonlinear frequency doubling is presented as a nonsophisticated method to achieve watt-level output powers and possible routes to higher power and efficiency are included. Application examples within pumping of mode-locked Ti:sapphire lasers and implementation of such lasers in optical coherence tomography are presented showing the application potential of these lasers.

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Slutrapport for Hybrid belysning på skolebænken

Denne rapport indeholder en beskrivelse af arbejdet udført i og resultaterne af forsknings- og udviklingsprojektet "Hybrid belysning på skolebænken" og udgør slutrapportering for dette projekt.

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Surface plasmon coupling dynamics in InGaN/GaN quantum-well structures and radiative efficiency improvement

Surface plasmonics from metal nanoparticles have been demonstrated as an effective way of improving the performance of low-efficiency light emitters. However, reducing the inherent losses of the metal nanoparticles remains a challenge. Here we study the enhancement properties by Ag nanoparticles for InGaN/GaN quantum-well structures. By using a thin SiN dielectric layer between Ag and GaN we manage to modify and improve surface plasmon coupling effects, and we attribute this to the improved scattering of the nanoparticles at the quantum-well emission wavelength. The results are interpreted using numerical simulations, where absorption and scattering cross-sections are studied for different sized particles on GaN and GaN/SiN substrates.

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Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, Tokyo University of Science, Huazhong University of Science and Technology, Chinese Academy of Sciences, Light Extraction ApS
Contributors: Fadil, A., Iida, D., Chen, Y., Ma, J., Ou, Y., Petersen, P. M., Ou, H.
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Degradation Processes in High-Power Diode Lasers under External Optical Feedback
The effect of moderate external feedback on the gradual degradation of 808 nm emitting AlGaAs-based high-power broad-area diode lasers is analyzed. Eventually the quantum well that actually experiences the highest total optical load remains unaffected by the aging, while severe impact to the waveguide by point defects is observed.

Dynamic miniature lighting system with low correlated colour temperature and high colour rendering index for museum lighting of fragile artefacts
Illumination of fragile and irreplaceable historical objects exhibited to the public presents challenges with regards to: good colour rendering, low photochemical degradation of sensitive materials and general energy consumption. We present a dynamic tri-colour LED lighting system for illumination of historical artefacts in display cases at museums and other exhibitions, which can replace 3-5 Watt incandescent light bulbs with a correlated colour temperature (CCT) from 2000 K to 2400 K. The solution decreases the energy consumption by up to 80 %, while maintaining colour rendering indices (Ra) above 90 and important special colour rendering indices R9 between 50 and 90, while decreasing the level of harmful short wavelength radiation by between 20 - 30 %.
Efficient concept generating 3.9 W of diffraction-limited green light with spectrally combined tapered diode lasers

We propose an efficient concept increasing the power of diode laser systems in the visible spectral range. In comparison with second harmonic generation of single emitters, we show that spectral beam combining with subsequent sumfrequency generation enhances the available power significantly. Combining two 1060 nm distributed Bragg reflector tapered diode lasers (M2 ≤ 5.2), we achieve a 2.5-3.2 fold increase of green light with a maximum power of 3.9 Watts in a diffraction-limited beam (M2 ≤ 1.3). Without any further stabilization the obtained power stability is within ± 2.6 %. The electro-optical and nonlinear conversion efficiencies at maximum performance are 5.7 % and 2.6 %/W, respectively. Due to the intrinsic wavelength stabilization of the diodes we achieve single-mode emission with a sidemode suppression <15 dB and a spectral width as narrow as 5 pm. These results increase the application potential of green diode laser systems, for example, within the biomedical field. In order to enhance the power even further, our proposed concept can be expanded combining multiple diode lasers.

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Generation of single-frequency tunable green light in a coupled ring tapered diode laser cavity

We report the realization of a tapered diode laser operated in a coupled ring cavity that significantly improves the coherence properties of the tapered laser and efficiently generates tunable light at the second harmonic frequency. The tapered diode laser is tunable with single-frequency output in the broad wavelength range from 1049 nm to 1093 nm and the beam propagation factor is improved from M2 = 2.8 to below 1.1. The laser frequency is automatically locked to the cavity resonance frequency using optical feedback. Furthermore, we show that this adaptive external cavity approach leads to efficient frequency doubling. More than 500 mW green output power is obtained by placing a periodically poled LiNbO3 crystal in the external cavity. The single frequency green output from the laser system is tunable in the 530 nm to 533 nm range limited by the LiNbO3 crystal. The optical to optical conversion efficiency exceeds 30%.

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How does external feedback cause AlGaAs-based diode lasers to degrade?
The effect of external feedback on the degradation of 808 nm emitting AlGaAs-based high-power broad-area diode lasers is studied. For this purpose, early stages of gradual degradation are induced by accelerated aging at high power levels. While the quantum well that actually experiences the highest total optical load remains unaffected, severe impact by point defects is observed on the cladding layers and the waveguide. Extended defects such as dislocations, however, are not observed in such early stages of degradation, which are accompanied by gradual power loss of a few percent only.
Method of stabilizing a laser apparatus with wavelength converter

A method of controlling beam quality and stability of a laser apparatus, the laser apparatus comprising, a diode laser (10) providing first radiation of at least a first wavelength, and a frequency conversion unit (12) configured to frequency-convert the first radiation from the diode laser and to output the frequency-converted radiation (213), the frequency-converted radiation having at least a second wavelength different from the first wavelength, the diode laser (10) comprising at least a first and a second section (222,223), a first contact (220) for injecting a first current (I1) into the first section (222), a second contact (221) for injecting a second current (I2) into the second section (223), and means for controlling a temperature of the diode laser; wherein the method comprises monitoring a first parameter indicative of the power content of a dominant lobe of the first radiation; iteratively determining a combination of respective values of the first current, the second current, and the temperature at which combination of respective values the monitored first parameter and a stability parameter indicative of a fluctuation over time of the monitored first parameter each fulfills a respective predetermined optimization criterion; and setting the first current, the second current, and the temperature to the determined combination of respective values.
Origin of low quantum efficiency of photoluminescence of InP/ZnS nanocrystals
In this paper, we study the origin of a strong wavelength dependence of the quantum efficiency of InP/ZnS nanocrystals. We find that while the average size of the nanocrystals increased by 50%, resulting in longer emission wavelength, the quantum efficiency drops more than one order of magnitude compared to the quantum efficiency of the small nanocrystals. By correlating this result with the time-resolved photoluminescence we find that the reduced photoluminescence efficiency is caused by a fast growing fraction of non-emissive nanocrystals while the quality of the nanocrystals that emit light is similar for all samples. Transmission electron microscopy reveals the polycrystalline nature of many of the large nanocrystals, pointing to the grain boundaries as one possible site for the photoluminescence quenching defects.

Resonant Plasmonic Enhancement of InGaN/GaN LED using Periodically Structured Ag Nanodisks
Ag nanodisks are fabricated on GaN-based LED to enhance emission efficiency. Nanosphere lithography is used to obtain a periodic nano-structure, and a photoluminescence enhancement of 2.7 is reported with Ag nanodisk diameter of 330 nm.
Simulation Tool for Designing off-Grid PV Applications for the Urban Environments

A barrier for exploiting use of standalone solar lighting for the urban environment seem to be lack of knowledge and lack of available tools for proper dimensioning. In this work, the first part of the development of powerful dimensioning tool is described and initial measurements are presented.

Simultaneous dual wavelength eye-tracked ultrahigh resolution retinal and choroidal optical coherence tomography

We demonstrate an optical coherence tomography device that simultaneously combines different novel ultrabroad bandwidth light sources centered in the 800 and 1060 nm regions, operating at 66 kHz depth scan rate, and a confocal laser scanning ophthalmoscope-based eye tracker to permit motion-artifact-free, ultrahigh resolution and high contrast retinal and choroidal imaging. The two wavelengths of the device provide the complementary information needed for diagnosis of subtle retinal changes, while also increasing visibility of deeper-lying layers to image pathologies that include opaque media in the anterior eye segment or eyes with increased choroidal thickness.
Single-frequency blue light generation by single-pass sum-frequency generation in a coupled ring cavity tapered laser

A generic approach for generation of tunable single frequency light is presented. 340 mW of near diffraction limited, single-frequency, and tunable blue light around 459 nm is generated by sum-frequency generation (SFG) between two tunable tapered diode lasers. One diode laser is operated in a ring cavity and another tapered diode laser is single-passed through a nonlinear crystal which is contained in the coupled ring cavity. Using this method, the single-pass conversion efficiency is more than 25%. In contrast to SFG in an external cavity, the system is entirely self-stabilized with no electronic locking.

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Research output: Contribution to journal › Journal article – Annual report year: 2013 › Research › peer-review

Spectral properties of a broad-area diode laser with off-axis external-cavity feedback

Spectral properties, both the optical spectrum and the intensity noise spectrum, of a broad-area diode laser with off-axis external-cavity feedback are presented. We show that the optical spectrum of the diode laser system is shifted to longer wavelengths due to the external-cavity feedback. The intensity noise spectrum of the diode laser shows that the intensity noise is increased strongly by the external-cavity feedback. External-cavity modes are excited in the external cavity even in the off-axis configuration. The peak spacing of the intensity noise spectrum shows that single roundtrip external-cavity modes are excited. We believe that the four-wave mixing process in the broad-area diode laser is responsible for the establishment of the external-cavity mode.

Spectral properties, both the optical spectrum and the intensity noise spectrum, of a broad-area diode laser with off-axis external-cavity feedback are presented. We show that the optical spectrum of the diode laser system is shifted to longer wavelengths due to the external-cavity feedback. The intensity noise spectrum of the diode laser shows that the intensity noise is increased strongly by the external-cavity feedback. External-cavity modes are excited in the external cavity even in the off-axis configuration. The peak spacing of the intensity noise spectrum shows that single roundtrip external-cavity modes are excited. We believe that the four-wave mixing process in the broad-area diode laser is responsible for the establishment of the external-cavity mode.
The impact of external optical feedback on the degradation behavior of high-power diode lasers

The impact of external feedback on high-power diode laser degradation is studied. For this purpose early stages of gradual degradation are prepared by accelerated aging of 808-nm-emitting AlGaAs-based devices. While the quantum well that actually experiences the highest total optical load remains unaffected, severe impact is observed to the cladding layers and the waveguide. Consequently hardening of diode lasers for operation under external optical feedback must necessarily involve claddings and waveguide, into which the quantum well is embedded.
**Dansk LED - Museumsbelysning**

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**Dual-wavelength high-power diode laser system based on an external-cavity tapered amplifier with tunable frequency difference**
A dual-wavelength high-power semiconductor laser system based on a tapered amplifier with double-Littrow external cavity is demonstrated around 800 nm. The two wavelengths can be tuned individually, and the frequency difference of the two wavelengths is tunable from 0.5 to 10.0 THz. To our knowledge, this is the broadest tuning range of the frequency difference from a dual-wavelength diode laser system. The spectrum, output power, and beam quality of the diode laser system are characterized. The power stability of each wavelength is measured, and the power fluctuations of the two wavelengths are almost of opposite phase. The simultaneous emission of the two wavelengths is verified by a sum-frequency generation experiment in a bismuth triborate nonlinear crystal.

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Efficient concept for generation of diffraction-limited green light by sum-frequency generation of spectrally combined tapered diode lasers

In order to increase the power of visible diode laser systems in an efficient manner, we propose spectral beam combining with subsequent sum-frequency generation. We show that this approach, in comparison with second harmonic generation of single emitters, can enhance the available power significantly. By combining two distributed Bragg reflector tapered diode lasers we achieve a 2.5–3.2 fold increase in power and a maximum of 3.9 W of diffraction-limited green light. At this power level, green diode laser systems have a high application potential, e.g., within the biomedical field. Our concept can be expanded combining multiple diode lasers to increase the power even further.

Efficient generation of 3.9 W of diffraction-limited green light with spectrally combined tapered diode lasers

We propose an efficient concept increasing the power of diode laser systems in the visible spectral range. In comparison with second harmonic generation of single emitters, spectral beam combining with subsequent sum-frequency generation enhances the available power significantly. Combining two 1060 nm tapered diode lasers, we achieve a 2.5-3.2 fold increase of green light with a maximum power of 3.9 Watts in a diffraction-limited beam. At this level, diode lasers have a high application potential, for example, within the biomedical field. In order to enhance the power even further, our concept can be expanded combining multiple diode lasers.
External-cavity high-power dual-wavelength tapered amplifier with tunable THz frequency difference

A tunable 800 nm high-power dual-wavelength diode laser system with double-Littrow external-cavity feedback is demonstrated. The two wavelengths can be tuned individually, and the frequency difference of the two wavelengths is tunable from 0.5 to 5.0 THz. A maximum output power of 1.54 W is achieved with a frequency difference of 0.86 THz, the output power is higher than 1.3 W in the 5.0 THz range of frequency difference, and the amplified spontaneous emission intensity is more than 20 dB suppressed in the range of frequency difference. The beam quality factor $M_2$ is 1.22±0.15 at an output power of 1.35 W. The simultaneous oscillation of the two wavelengths is under test by the sum-frequency generation experiment in a bismuth triborate (BIBO) nonlinear crystal.
Frequency-doubled diode laser for direct pumping of Ti:sapphire lasers

A single-pass frequency doubled high-power tapered diode laser emitting nearly 1.3 W of green light suitable for direct pumping of Ti:sapphire lasers generating ultrashort pulses is demonstrated. The pump efficiencies reached 75 % of the values achieved with a commercial solid-state pump laser. However, the superior electro-optical efficiency of the diode laser improves the overall efficiency of the Ti:sapphire laser by a factor > 2. The optical spectrum emitted by the Ti:sapphire laser shows a spectral width of 112 nm (FWHM). Based on autocorrelation measurements, pulse widths of less than 20 fs are measured. These results open the opportunity of establishing diode laser pumped Ti:sapphire lasers for e.g. biophotonic applications like retinal optical coherence tomography or pumping of photonic crystal fibers for CARS microscopy.

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High Power Diode Lasers with External Feedback: Overview and Prospects

In summary, different external-cavity feedback techniques to improve the spatial beam quality and narrow the linewidth of the output beam from both BALs and TDLs are presented. Broad-area diode laser system with external-cavity feedback around 800 nm can produce several Watts of output power with a good beam quality. Tapered diode laser systems with external-cavity feedback around 800 and 1060 nm can deliver more than 2 W output power with diffraction-limited beam quality and can be operated in single-longitudinal mode. These high-brightness, narrow linewidth, and tunable external-cavity diode lasers emerge as the next generation of compact lasers that have the potential of replacing conventional high power laser systems in many existing applications.

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Laser system with wavelength converter
The present invention relates to an apparatus comprising a diode laser (10) providing radiation in a first wavelength interval, a radiation conversion unit (12) having an input and an output, the radiation converter configured to receive the radiation in the first wavelength interval from the diode laser at the input, the radiation conversion unit configured to convert the radiation in the first wavelength interval to radiation in a second wavelength interval and the output configured to output the converted radiation, the second wavelength interval having one end point outside the first wavelength interval. Further, the invention relates to a method of optically pumping a target laser (14) in a laser system, the laser system comprising a laser source providing radiation at a first frequency, the laser source being optically connected to an input of a frequency converter, the frequency converter configured to convert the radiation at the first frequency to a second, different frequency, the target laser arranged in optical communication with an output of the frequency converter, the method comprising the steps of emitting radiation from the laser source, receiving the radiation at the frequency converter, converting the radiation from the first frequency to the second frequency in the frequency converter, and providing the radiation at the second frequency at the target laser so that the target laser is optically pumped.

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Light distribution system comprising spectral conversion means
System (200, 300) for the distribution of white light, having a supply side (201, 301, 401) and a delivery side (202, 302, 402), the system being configured for guiding light with a multitude of visible wavelengths in a propagation direction P from the supply side to the distribution side, the system comprising a transport fibre (210, 310, 330, 410, 410a-d) and a spectral conversion fibre (220, 320, 420ad, 500, 600, 700), the transport fibre having a length extending from a first end (211, 311, 331) to a second end (212, 312, 332), and a spectral transmission characteristics, the transport fibre being operationally connected to the spectral conversion fibre having a length extending from an input end (221, 321) to an output end (222, 322), the spectral conversion fibre comprising a photoluminescent agent (511, 611, 711) for converting light of a first wavelength to light of a second, longer wavelength, a spectral conversion characteristics of the spectral conversion fibre being essentially determined by the spectral absorption and emission properties of the photoluminescent agent, the amount of photoluminescent agent, and the distribution of the photoluminescent agent in the spectral conversion fibre, wherein the first and second wavelengths are selected according to the spectral transmission characteristics of the transport fibre such that transmission loss in the transport fibre at the first wavelength is less than at the second wavelength. According to further aspects, a method of providing a light distribution system and a method of correcting the spectral transmission characteristics of a light distribution system are disclosed.

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Red Tunable High-Power Narrow-Spectrum External-Cavity Diode Laser Based on Tapered Amplifier

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Spectral beam combining of diode lasers with high efficiency
Based on spectral beam combining we obtain 16 W of output power, combining two 1063 nm DBR-tapered diode lasers. The spectral separation within the combined beam can be used for subsequent sum-frequency generation.

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Research output: Chapter in Book/Report/Conference proceeding – Article in proceedings – Annual report year: 2012 – Research – peer-review
Spectral Design Flexibility of LED Brings Better life

Light-emitting diodes (LEDs) are penetrating into the huge market of general lighting because they are energy saving and environmentally friendly. The big advantage of LED light sources, compared to traditional incandescent lamps and fluorescent light tubes, is the flexible spectral design to make white light using different color mixing schemes. The spectral design flexibility of white LED light sources will promote them for novel applications to improve the life quality of human beings. As an initial exploration to make use of the spectral design flexibility, we present an example: 'no blue' white LED light source for sufferers of disease Porphyria. An LED light source prototype, made of high brightness commercial LEDs applying an optical filter, was tested by a patient suffering from Porphyria. Preliminary results have shown that the sufferer could withstand the light source for much longer time than the standard light source. At last future perspectives on spectral design flexibility of LED light sources improving human being's life will be discussed, with focus on the light and health. The good health is ensured by the spectrum optimized so that vital hormones (melatonin and serotonin) are produced during times when they support human daily rhythm.
Antireflective sub-wavelength structures for improvement of the extraction efficiency and color rendering index of monolithic white light-emitting diode

We have theoretically investigated the influence of antireflective sub-wavelength structures on a monolithic white light-emitting diode (LED). The simulation is based on the rigorous coupled wave analysis (RCWA) algorithm, and both cylinder and moth-eye structures have been studied in the work. Our simulation results show that a moth-eye structure enhances the light extraction efficiency over the entire visible light range with an extraction efficiency enhancement of up to 26%. Also for the first time to our best knowledge, the influence of sub-wavelength structures on both the color rendering index (CRI) and the correlated color temperature (CCT) of the monolithic white LED have been demonstrated. The CRI of the monolithic white LED could be improved from 92.68 to around 94 by applying a cylinder structure, and the CCT could be modified in a very large range with appropriate design of the cylinder structure.
Diffusely radiating led light system

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Original language: English

Direct pumping of ultrashort Ti:sapphire lasers by a frequency doubled diode laser

A simple and robust diode laser system emitting 1.28 W of green light suitable for pumping an ultrafast Ti:sapphire laser is presented. To classify our results, the diode laser is compared to a standard, commercially available diode pumped solid-state (DPSS) laser system pumping the same oscillator. When using our diode laser system, the optical conversion efficiencies from green to near-infrared light reduces to 75 % of the values achieved with the commercial pump laser. Despite this reduction the overall efficiency of the Ti: sapphire laser is still increased by a factor > 2 due to the superior electro-optical efficiency of the diode laser. Autocorrelation measurements show that pulse widths of less than 20 fs can be expected with an average power of 52 mW when using our laser. These results indicate the high potential of direct diode laser pumped Ti: sapphire lasers to be used in applications like retinal optical coherence tomography (OCT) or pumping of photonic crystal fibers for CARS (coherent anti-stokes Raman spectroscopy) microscopy.

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Contributors: Müller, A., Jensen, O. B., Unterhuber, A., Le, T., Stingl, A., Hasler, K., Sumpf, B., Erbert, G., Andersen, P. E., Petersen, P. M.
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Edge emitters with external cavities: Chapter 15.1

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Experimental investigation of relative timing jitter in passively synchronized Q-switched lasers

Relative timing jitter between synchronized Q-switched lasers, or lack thereof, is important for stable sum-frequency generation. Experimental investigation of two passively synchronized lasers shows that the jitter is minimized when the free-running repetition rates of the two lasers are close to, but not exactly, matching. When the free-running repetition rates are matched, the jitter is significantly large. At the best operating point, the pulse-to-pulse period was 200 μs, while the relative jitter between the two lasers was 9 ns. If the effect of the master laser's pulse-to-pulse jitter is removed, the residual timing jitter between the two lasers was 6 ns, which corresponds to the lower limit set by pump power fluctuations and noise from spontaneous emission. © 2011 Optical Society of America.

Frequency-doubled DBR-tapered diode laser for direct pumping of Ti:sapphire lasers generating sub-20 fs pulses

For the first time a single-pass frequency doubled DBR-tapered diode laser suitable for pumping Ti:sapphire lasers generating ultrashort pulses is demonstrated. The maximum output powers achieved when pumping the Ti:sapphire laser
are 110 mW (CW) and 82 mW (mode-locked) respectively at 1.2 W of pump power. This corresponds to a reduction in optical conversion efficiencies to 75% of the values achieved with a commercial diode pumped solid-state laser. However, the superior electro-optical efficiency of the diode laser improves the overall efficiency of the Ti:sapphire laser by a factor > 2. The optical spectrum emitted by the Ti:sapphire laser when pumped with our diode laser shows a spectral width of 112 nm (FWHM). Based on autocorrelation measurements, pulse widths of less than 20 fs can therefore be expected.

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Contributors: Müller, A., Jensen, O. B., Unterhuber, A., Le, T., Stingl, A., Hasler, K., Sumpf, B., Erbert, G., Andersen, P. E., Petersen, P. M.
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Source: orbit
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Research output: Contribution to journal › Journal article – Annual report year: 2011 › Research › peer-review

**High-power dual-wavelength external-Cavity diode laser based on tapered amplifier with tunable terahertz frequency difference**
Tunable dual-wavelength operation of a diode laser system based on a tapered diode amplifier with double-Littrow external-cavity feedback is demonstrated around 800nm. The two wavelengths can be tuned individually, and the frequency difference of the two wavelengths is tunable from 0.5 to 5.0 THz. An output power of 1.54W is achieved with a frequency difference of 0.86 THz, the output power is higher than 1.3W in the 5.0 THz range of frequency difference, and the amplified spontaneous emission intensity is more than 20 dB suppressed in the range of frequency difference. To our knowledge, this is the highest output power from a dual-wavelength diode laser system operating with tunable terahertz frequency difference. © 2011 Optical Society of America.

**General information**
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Organisations: Diode Lasers and LED Systems, Department of Photonics Engineering
Contributors: Chi, M., Jensen, O. B., Petersen, P. M.
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Narrow line width operation of a 980 nm gain guided tapered diode laser bar

We demonstrate two different schemes for the spectral narrowing of a 12 emitter 980 nm gain guided tapered diode laser bar. In the first scheme, a reflective grating has been used in a Littman Metcalf configuration and the wavelength of the laser emission could be narrowed down from more than 5.5 nm in the free running mode to 0.04 nm (FWHM) at an operating current of 30 A with an output power of 8 W. The spectrum was found to be tunable within a range of 16 nm. In the second scheme, a volume Bragg grating has been used to narrow the wavelength of the laser bar from over 5 nm to less than 0.2 nm with an output of 5 W at 20 A. To our knowledge, this is the first time spectral narrowing has been performed on a gain guided tapered diode laser bar. In the Littman Metcalf configuration, the spectral brightness has been increased by 86 times and in the volume Bragg grating cavity the spectral brightness has been improved over 18 times when compared to the free running operation. These schemes could be also extended for other wavelengths of interest in the future.
Synchronized Q-switching between a quasi-three-level and a four-level laser

Synchronized Q-switching between quasi-three-level and four-level lasers is interesting for sum-frequency generation into the blue and ultraviolet. We report, for the first time, stable synchronized Q-switching between a quasi-three-level laser at 946 nm and a four-level laser at 1064 nm in an all passive approach. While timing jitter of the individual free-running lasers were on the order of 10 μs, the relative timing jitter, defined as one standard-deviation of the experimental data, was only 9 ns between the two synchronized pulses. The minimum delay between the two pulses was 64 ns during stable operation, which gave a 79% temporal overlap when normalized against the zero-delay scenario. Preliminary results show promise for non-linear frequency conversion, which could lead to high power pulsed blue and ultraviolet lasers.

Spectral narrowing of a 980 nm tapered diode laser bar

High power diode laser bars are interesting in many applications such as solid state laser pumping, material processing, laser trapping, laser cooling and second harmonic generation. Often, the free running laser bars emit a broad spectrum of the order of several nanometres which limit their scope in wavelength specific applications and hence, it is vital to stabilize the emission spectrum of these devices. In our experiment, we describe the wavelength narrowing of a 12 element 980 nm tapered diode laser bar using a simple Littman configuration. The tapered laser bar which suffered from a big smile has been "smile corrected" using individual phase masks for each emitter. The external cavity consists of the laser bar, both fast and slow axis micro collimators, smile correcting phase mask, 6.5x beam expanding lens combination, a 1200 lines/mm reflecting grating with 85% efficiency in the first order, a slow axis focusing cylindrical lens of 40 mm focal length and an output coupler which is 10% reflective. In the free running mode, the laser emission spectrum was 5.5 nm wide at an operating current of 30A. The output power was measured to be in excess of 12W. Under the external cavity operation, the wavelength spread of the laser could be limited to 0.04 nm with an output power in excess of 8 W at an operating current of 30A. The spectrum was found to be tunable in a range of 16 nm.
Tunable high-power narrow-spectrum external-cavity diode laser at 675 nm as a pump source for UV generation

High-power narrow-spectrum diode laser systems based on tapered gain media in external cavity are demonstrated at 675 nm. Two 2-mm-long amplifiers are used, one with a 500-µm-long ridge-waveguide section (device A), the other with a 750-µm-long ridge-waveguide section (device B). The laser system A based on device A is tunable from 663 to 684 nm with output power higher than 0.55 W in the tuning range, as high as 1.25 W output power is obtained at 675.34 nm. The emission spectral bandwidth is less than 0.05 nm throughout the tuning range, and the beam quality factor M2 is 2.07 at an output power of 1.0 W. The laser system B based on device B is tunable from 666 to 685 nm. As high as 1.05 W output power is obtained around 675.67 nm. The emission spectral bandwidth is less than 0.07 nm throughout the tuning range, and the beam quality factor M2 is 1.13 at an output power of 0.93 W. The laser system B is used as a pump source for the generation of 337.6 nm UV light by single-pass frequency doubling in a BIBO crystal. An output power of 109 µW UV light, corresponding to a conversion efficiency of 0.026%W⁻¹ is attained.
Widely Tunable High-Power Tapered Diode Laser at 1060 nm
We report a large tuning range from 1018 to 1093 nm from a InGaAs single quantum-well 1060-nm external cavity tapered diode laser. More than 2.5-W output power has been achieved. The tuning range is to our knowledge the widest obtained from a high-power InGaAs single quantum-well tapered laser operating around 1060 nm. The light emitted by the laser has a nearly diffraction limited beam quality and a narrow linewidth of less than 6 pm everywhere in the tuning range.

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1.38 W tunable high-power narrow-linewidth external-cavity tapered amplifier at 670 nm
A diffraction-limited narrow-linewidth diode laser system based on a tapered amplifier in external cavity is demonstrated. 1.38 W output power is obtained. The laser system is tunable from 659 to 675 nm.
All passive synchronized Q-switching of a quasi-three-level and a four-level Nd:YAG laser

Using an all passive approach, synchronized Q-switching of two Nd:YAG lasers, at 946 nm and 1064 nm, is reported. Two laser crystals are used to avoid gain competition, and stable operation is reported for the first time. The pulse trains are synchronized over a wide range of pump powers and a relative timing jitter of 36 ns is achieved. A minimum delay of 64 ns is observed between the two laser pulses, and by making the 946 nm pulse relatively long, a 79% temporal overlap is obtained when compared to the zero-delay scenario.
Autofluorescence of pigmented skin lesions using a pulsed UV laser with synchronized detection: clinical results

We report preliminary clinical results of autofluorescence imaging of malignant and benign skin lesions, using pulsed 355 nm laser excitation with synchronized detection. The novel synchronized detection system allows high signal-to-noise ratio to be achieved in the resulting autofluorescence signal, which may in turn produce high contrast images that improve diagnosis, even in the presence of ambient room light. The synchronized set-up utilizes a compact, diode pumped, pulsed UV laser at 355 nm which is coupled to a CCD camera and a liquid crystal tunable filter. The excitation and image capture is sampled at 5 kHz and the resulting autofluorescence is captured with the liquid crystal filter cycling through seven wavelengths between 420 nm and 580 nm. The clinical study targets pigmented skin lesions and evaluates the prospects of using autofluorescence as a possible means in differentiating malignant and benign skin tumors. Up to now, sixteen patients have participated in the clinical study. The autofluorescence images, averaged over the exposure time of one second, will be presented along with histopathological results. Initial survey of the images show good contrast and diagnostic results show promising agreement based on the histopathological results.

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Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, Optical Sensor Technology, Terahertz Technologies and Biophotonics, Lund University
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Efficient quasi-three-level Nd:YAG laser at 946 nm pumped by a tunable external cavity tapered diode laser

Using a tunable external cavity tapered diode laser (ECDL) pumped quasi-three-level Nd:YAG laser, a fivefold reduction in threshold and twofold increase in slope efficiency is demonstrated when compared to a traditional broad area diode laser pump source. A TEM00 power of 800 mW with 65% slope efficiency is obtained, the highest reported TEM00 power from any 946 nm Nd:YAG laser pumped by a single emitter diode laser pump source. A quantum efficiency of 0.85 has been estimated from experimental data using a simple quasi-three-level model. The reported value is in good agreement with published values, suggesting that the model is adequate. Improvement of the 946 nm laser due to the ECDL's narrow spectrum proves to be less significant when compared to its spatial quality, inferring a broad spectrum tapered diode laser pump source may be most practical. Experimental confirmation of such setup is given.

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Contributors: Cheng, H. P. H., Jensen, O. B., Tidemand-Lichtenberg, P., Andersen, P. E., Petersen, P. M., Sumpf, B., Erbert, G., Pedersen, C.
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High-power green light generation by second harmonic generation of single-frequency tapered diode lasers

We demonstrate the generation of high power (>1.5W) and single-frequency green light by single-pass second harmonic generation of a high power tapered diode laser. The tapered diode laser consists of a DBR grating for wavelength selectivity, a ridge section and a tapered section. The DBR tapered laser emits in excess of 9 W single-frequency output power with a good beam quality. The output from the tapered diode laser is frequency doubled using periodically poled MgO:LiNbO3. We investigate the modulation potential of the green light and improve the modulation depth from 1:4 to 1:50.

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Research output: Chapter in Book/Report/Conference proceeding Article in proceedings – Annual report year: 2010 Research peer-review

'No blue' LED solution for photolithography room illumination

This paper explored the feasibility of using a LED-based bulb as the illumination light source for photolithography room. A no-blue LED was designed, and the prototype was fabricated. The spectral power distribution of both the LED bulb and the yellow fluorescent tube was measured. Based on that, colorimetric values were calculated and compared on terms of chromatic coordinates, correlated color temperature, color rendering index, and chromatic deviation. Gretagmacbeth color charts were used as a more visional way to compare the two light sources, which shows that our no-blue LED bulb has much better color rendering ability than the YFT. Furthermore, LED solution has design flexibility to improve it further. The prototype has been tested with photoresist SU8-2005. Even after 15 days of illumination, no effect was observed. So this LED-based solution was demonstrated to be a very promising light source for photolithography room illumination due to its better color rendering in addition to energy efficiency, long life time and design flexibility.

General information
Publication status: Published
'No Blue' White LED

This paper explored the feasibility of making a white LED light source by color mixing method without using the blue color. This 'no blue' white LED has potential applications in photolithography room illumination, medical treatment and biophotonics research. A no-blue LED was designed, and the prototype was fabricated. The spectral power distribution of both the LED bulb and the yellow fluorescent tube was measured. Based on that, colorimetric values were calculated and compared on terms of chromatic coordinates, correlated color temperature, color rendering index, and chromatic deviation. Gretagmacbeth color charts were used as a more visual way to compare the two light sources, which shows that our no-blue LED bulb has much better color rendering ability than the YFT. Furthermore, LED solution has design flexibility to improve it further. The prototype has been tested with photoresist SU8-2005. Even after 15 days of illumination, no effect was observed. So this LED-based solution was demonstrated to be a very promising light source for photolithography room illumination due to its better color rendering in addition to energy efficiency, long life time and design flexibility. Additionally, the prototype is being implemented to treat a Porphyrria patient.

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Organisations: Nanophotonic Devices, Department of Photonics Engineering, Diode Lasers and LED Systems, RGB Sydfalster
Contributors: Ou, H., Corell, D. D., Dam-Hansen, C., Petersen, P. M., Friis, D.
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Photonics activities at DTU Fotonik

DTU Fotonik, Department of Photonics Engineering at the Technical University of Denmark has about 200 employees including 60 PhD students. The ambition is to be among the world’s leading University departments within photonics research, education and innovation. To fulfil this ambition, DTU Fotonik tries to attract excellent researchers and students from all over the world and to collaborate with world leading research institutes and companies. The activities span from quantum photonics, nanotechnology and metamaterials over nonlinear fiber optics, optical sensors and diode lasers & LED systems to optical communication systems and networks. The department publishes about 400 articles per year in leading international journals and conference proceedings. Much of the research is carried out in cooperation with Danish and international partners, in the latter case often with support from the European Union.

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Organisations: Department of Photonics Engineering, Terahertz Technologies and Biophotonics, Quantum Photonics, Optical Sensor Technology, Diode Lasers and LED Systems, High-Speed Optical Communication
Contributors: Jeppesen, P., Jepsen, P. U., Lodahl, P., Pedersen, C., Petersen, P. M., Oxenløwe, L. K.
Tunable high-power narrow-spectrum external-cavity diode laser based on tapered amplifier at 668 nm

A 668 nm tunable high-power narrow-spectrum diode laser system based on a tapered semiconductor optical amplifier in external cavity is demonstrated. The laser system is tunable from 659 to 675 nm. As high as 1.38 W output power is obtained at 668.35 nm. The emission spectral bandwidth is less than 0.07 nm throughout the tuning range, and the beam quality factor M2 is 2.0 with the output power of 1.27 W.

Two-wave mixing in broad-area semiconductor amplifier

Two-wave mixing in broad-area semiconductor amplifier
1.5 W green light generation by single-pass second harmonic generation of a single-frequency tapered diode laser

More than 1.5 W of green light at 531 nm is generated by single-pass second harmonic generation in periodically poled MgO:LiNbO3. The pump laser is a high power tapered laser with a distributed Bragg reflector etched in the ridge section of the laser to provide wavelength selectivity. The output power of the single-frequency tapered laser is 9.3 W in continuous wave operation. A conversion efficiency of 18.5 % was achieved in the experiments.

A general theory of two-wave mixing in nonlinear media

A general theory of two-wave mixing in nonlinear media is presented. Assuming a gain (or absorption) grating and a refractive index grating are generated because of the nonlinear process in a nonlinear medium, the coupled-wave equations of two-wave mixing are derived based on the Maxwell's wave equation. The coupled-wave equations can be decoupled as coupled-equations for the intensity and coupled-equations for the phase of both beams, and these two sets of coupled-equations can be solved analytically by using average total intensity in the medium instead of the total intensity. Compared to the previous theory of two-wave mixing, the theory presented here is more general and the application of the theory to the photorefractive materials, Kerr media and semiconductor broad-area amplifiers are described.
A new approach to asymmetric feedback in a segmented broad area diode laser

We present the demonstration of a non-critical setup for asymmetric feedback in a segmented broad area diode laser. We compare the dependence of the beam quality on the position of the dispersive element for standard spectral beam combining and our new non-critical setup. We find that our new approach is significantly less critical to the position of the dispersive element. It is shown that we can displace the dispersive element by at least 50% of the focal length of the collimating lens away from the Fourier plane without compromising performance. Furthermore, our approach provides the same high beam quality as is possible using off-axis spectral beam combining. This provides the possibility of achieving a high beam quality in a more compact setup than previously possible.
Catastrophic optical mirror damage in diode lasers monitored during single-pulse operation

Catastrophic optical mirror damage (COMD) is analyzed for 808 nm emitting diode lasers in single-pulse operation in order to separate facet degradation from subsequent degradation processes. During each pulse, nearfield and thermal images are monitored. A temporal resolution better than 7 µs is achieved. The thermal runaway process is unambiguously related to the occurrence of a “thermal flash.” A one-by-one correlation between nearfield, thermal flash, thermal runaway, and structural damage is observed. The single-pulse excitation technique allows for controlling the propagation of the structural damage into the cavity. We propose this technique for the analysis of early stages of COMD.

Design and Simulation of Next-Generation High-Power, High-Brightness Laser Diodes

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External cavity tapered diode pumped laser to generate pulsed UV light for autofluorescence diagnostics

General information
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Contributors: Cheng, H. P. H., Tidemand-Lichtenberg, P., Jensen, O. B., Andersen, P. E., Petersen, P. M., Pedersen, C.
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Light emitting diodes as an alternative ambient illumination source in photolithography environment

We explored an alternative light emitting diode (LED) - based solution to replace the existing yellow fluorescent light tubes (YFT) used in photolithography rooms. A no-blue LED lamp was designed and a prototype was fabricated. For both solutions, the spectral power distribution (SPD) was measured, the colorimetric values were calculated, and a visual comparison using Gretagmacbeth colorcharts was performed. The visual comparison showed that the LED bulb was better to render colors despite a low color rendering index (CRI). Furthermore, the LED bulb was tested in a photolithography room and there was no exposure to the photoresist even after 168 hours illumination.

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Contributors: Corell, D. D., Ou, H., Dam-Hansen, C., Petersen, P. M., Friis, D.
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New light with diodes: light for a brighter future

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Contributors: Thestrup Nielsen, B., Thorseth, A., Jensen, O. B., Petersen, P. M., Dam-Hansen, C., Chi, M., Kardynal, B., Ou, H.
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Photonics engineering in a new light
Photonics engineering is an exciting technology that increasingly influences our daily lives. Developing new light-emitting diode (LED) light sources considerably reduces the electricity used in lighting. In medicine, optical technology is enabling new therapies that improve health, and lasers have been one of the key enablers for developing modern information technology and telecommunication.

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**Tapered diode laser pumped 946 nm Nd:YAG laser**

We successfully implemented a 946 nm Nd:YAG laser based on a 808 nm tapered diode pump laser. The tapered diode is developed at the Ferdinand-Braun-Institute für Hochfrequenztechnik in Germany. Figure 2 shows the experimental setup and results of each pump source coupled into a 1.5 mm crystal and a 3 mm crystal in a cavity with 3% output coupling. We failed to achieve lasing in the 3 mm crystal with the BAL pump, but this was expected and agreed with numerical results. Absorption of the tapered pump is 84% and 63% for the 3 mm and 1.5 mm crystal respectively. In comparison with a BAL pumped laser, we show that tapered diode laser pumping potentially increase the power of 946 nm lasers by a factor of two and reduce the threshold by a factor of three.

**Threshold for strong thermal dephasing in periodically poled KTP in external cavity frequency doubling**

We present a measurement series of the efficiency of periodically poled KTP used for second-harmonic generation in an external phase-locked cavity. Due to the high absorption (0.01 cm⁻¹) in the PPKTP crystal at the pump wavelength a strong thermal dephasing of the periodically poled grating is observed for high pump powers. For four different resonator setups, it was experimentally found that a threshold parameter could be defined as the ratio between the focal intensity in the crystal and the single-pass conversion efficiency. The value of this threshold for the onset of strong thermal dephasing was found to be 1.41×10^10 W²m⁻² in our 30-mm long PPKTP sample. This threshold parameter marks the onset of thermally induced instability that leads to a degradation of the SHG conversion efficiency. Above the threshold the shape of the resonance peaks of the resonator changed from symmetrical into triangular making phase locking difficult.
Tunable high-power narrow-linewidth semiconductor laser based on an external-cavity tapered amplifier at 670 nm

A narrow-linewidth laser system based on a tapered semiconductor optical amplifier in external cavity is demonstrated. 800 mW output power is obtained, and the laser system is tunable from 655 to 679 nm.

A new pulsed 404 nm laser source for biomedical applications

High power 404 nm source based on second harmonic generation in PPKTP of a tapered external feedback diode laser
Nonlinear gain amplification due to two-wave mixing in a broad-area semiconductor amplifier with moving gratings

The two-wave mixing in a broad-area semiconductor amplifier with moving gratings is investigated theoretically, where a pump beam and a signal beam with different frequencies are considered, thus both a moving phase grating and a moving gain grating are induced in the amplifier. The coupled-wave equations of two-wave mixing are derived based on the Maxwell’s wave equation and rate equation of the carrier density. The analytical solutions of the coupled-wave equations are obtained in the condition of small signal when the total intensity is far below the saturation intensity of the amplifier. The results show that the optical gain of the amplifier is affected by both the moving phase grating and the moving gain grating, and there is energy exchange between the pump and signal beams. Depending on the moving direction of the gratings and the anti-guiding parameter, the optical gain may increase or decrease due to the two-wave mixing.

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Pulsed UV Laser for Fluorescence Diagnostics based on Non-Linear Frequency Conversion

General information
Publication status: Published
Organisations: Diode Lasers and LED Systems, Department of Photonics Engineering, Terahertz Technologies and Biophotonics, Optical Sensor Technology
Contributors: Cheng, H. P. H., Jensen, O. B., Andersen, P. E., Petersen, P. M., Pedersen, C.
Publication date: 2008
Peer-reviewed: No
Event: Poster session presented at Pulsed UV Laser for Fluorescence Diagnostics based on Non-Linear Frequency Conversion, Quantum and Nonlinear Optics PhD Summer School, Hven (SE), 2008.
Source: orbit
Source-ID: 250644
Research output: Contribution to conference → Poster – Annual report year: 2008 → Research

Pulsed UV-light source for auto-fluorescence diagnostics

General information
Publication status: Published
Organisations: Quantum Physics and Information Technology, Department of Physics, Optical Sensor Technology, Department of Photonics Engineering, Diode Lasers and LED Systems
Contributors: Tidemand-Lichtenberg, P., Pedersen, C., Cheng, H. P. H., Petersen, P. M., Buchhave, P.
Publication date: 2008
Peer-reviewed: Yes
Source: orbit
Source-ID: 232312
Research output: Contribution to conference → Poster – Annual report year: 2008 → Research → peer-review

Pulsed UV-light source for auto-fluorescence diagnostics

General information
Publication status: Published
Organisations: Optical Sensor Technology, Department of Photonics Engineering, Risø National Laboratory for Sustainable Energy, Diode Lasers and LED Systems, Quantum Physics and Information Technology, Department of Physics
Contributors: Tidemand-Lichtenberg, P., Pedersen, C., Cheng, H., Khopytar, D., Petersen, P. M., Buchhave, P.
Pages: FTuX3
Publication date: 2008

Host publication information
Title of host publication: Technical Digest
Theoretical investigation of two-wave mixing in a broad-area semiconductor amplifier with moving gratings

General information
Publication status: Published
Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, Risø National Laboratory for Sustainable Energy
Contributors: Chi, M., Huignard, J., Petersen, P. M.
Publication date: 2008
Peer-reviewed: No
Event: Abstract from Danish Optical Society Annual Meeting 2008, Nyborg, Denmark.
Electronic versions:
2008_85.pdf
URLs:
Source: orbit
Source-ID: 223209
Research output: Contribution to conference › Conference abstract for conference – Annual report year: 2008 › Research

808 nm tapered diode lasers optimized for high output power and nearly diffraction-limited beam quality in pulse mode operation

General information
Publication status: Published
Organisations: Laser Systems and Optical Materials, Optics and Plasma Research Department, Risø National Laboratory for Sustainable Energy, Optical Diagnostics and Information Processing
Contributors: Jensen, O. B., Klehr, A., Dittmar, F., Sumpf, B., Erbert, G., Andersen, P. E., Petersen, P. M.
Publication date: 2007

Host publication information
Title of host publication: High-power diode laser technology and applications 5
Place of publication: Bellingham
Publisher: International Society for Optical Engineering
Editor: Zediker, M.
ISBN (Print): 978-0-8194-6569-6
(SPIE Proceedings Series, 6456).
Electronic versions:
Postprint_Proc_SPIE_64560A.pdf
DOIs:
10.1117/12.700325
Source: orbit
Source-ID: 215828
Research output: Chapter in Book/Report/Conference proceeding › Article in proceedings – Annual report year: 2007 › Research › peer-review

External cavity second harmonic generation of an external cavity tapered laser (poster)

General information
Publication status: Published
Organisations: Laser Systems and Optical Materials, Optics and Plasma Research Department, Risø National Laboratory for Sustainable Energy, Optical Diagnostics and Information Processing, Technical University of Denmark
Contributors: Jensen, O. B., Holm, J., Sass, B. O., Andersen, P. E., Petersen, P. M.
Publication date: 2007
Peer-reviewed: No
Source: orbit
Source-ID: 215831
Generation of more than 300 mW diffraction-limited light at 405 nm by second-harmonic generation of a tapered diode laser with external cavity feedback

We have constructed a blue laser source consisting of a single-frequency tapered diode laser with external cavity feedback that is frequency doubled by a quasi-phase matched KTP (PPKTP) in a bowtie ring cavity and extract more than 360 mW of power at 405 nm. The conversion efficiency from fundamental laser power to second harmonic power is 35 %, while it is 64 % from coupled fundamental power to extracted blue light. Thermal effects and gray tracking set an upper limit on the amount of generated blue light.

General information
Publication status: Published
Organisations: Laser Systems and Optical Materials, Optics and Plasma Research Department, Risø National Laboratory for Sustainable Energy, Optical Diagnostics and Information Processing
Contributors: Jensen, O. B., Holm, J., Sumpf, B., Erbert, G., Andersen, P. E., Petersen, P. M.
Number of pages: 9
Publication date: 2007

Host publication information
Title of host publication: Proceedings of SPIE
Volume: 6455
Publisher: SPIE - International Society for Optical Engineering
Editor: Powers, P.
Electronic versions:
Postprint_Proc_SPIE_645503.pdf
DOIs:
10.1117/12.700276

Bibliographical note
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Source: orbit
Source-ID: 215830

New LED light sources and lamps for general illumination

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy, Optics and Plasma Research Department, Laser Systems and Optical Materials
Contributors: Dam-Hansen, C., Thestrup Nielsen, B., Pedersen, H. C., Petersen, P. M.
Pages: 220-228
Publication date: 2007

Host publication information
Title of host publication: Energy solutions for sustainable development. Proceedings
Publisher: Risø National Laboratory
Editors: Sønderberg Petersen, L., Larsen, H.
ISBN (Print): 978-87-550-3603-1
(Denmark. Forskningscenter Risoe. Risoe-R; No. 1608(EN)).
Keywords: Risø-R-1608, Risø-R-1608(EN)
Electronic versions:
ris_r_1608.pdf
Source: orbit
Source-ID: 216415

Research output: Chapter in Book/Report/Conference proceeding › Article in proceedings – Annual report year: 2007 › Research › peer-review
**Novel low-loss 3-element ring resonator for second-harmonic generation of 808nm into 404nm using periodically poled KTP**

**General information**
Publication status: Published
Organisations: Laser Systems and Optical Materials, Optics and Plasma Research Department, Risø National Laboratory for Sustainable Energy, Optical Diagnostics and Information Processing
Contributors: Holm, J., Jensen, O. B., Sumpf, B., Erbert, G., Andersson-Engels, S., Andersen, P. E., Petersen, P. M.
Publication date: 2007

**Host publication information**
Title of host publication: Nonlinear Frequency Generation and Conversion: Materials, Devices, and Applications 6
Place of publication: Bellingham
Publisher: International Society for Optical Engineering
Editor: Powers, P.
ISBN (Print): 978-0-8194-6568-9
(SPIE Proceedings Series, 6455).
DOIs:
10.1117/12.700544
Source: orbit
Source-ID: 215829
Research output: Chapter in Book/Report/Conference proceeding › Article in proceedings – Annual report year: 2007 › Research › peer-review

**Structure, stability, and spectra of lateral modes of a broad-area semiconductor laser**
We present a theoretical analysis of the lateral modes of a broad-area semiconductor laser. The structure of the modes are classified into four categories and the modes are traced in the frequency versus pump rate diagram. It is shown how the branches of the frequency tuning curves for the different types of modes are interconnected and how the intensity profiles develop along the branches. The main result of the paper is the presentation of a small-signal stability analysis which identifies the saddle-node and Hopf bifurcation points on the mode tuning curves. For stable modes we derive expressions for small-signal noise and modulation spectra and present numerical examples of the spectra.

**General information**
Publication status: Published
Organisations: Quantum and Laser Photonics, Department of Photonics Engineering, Laser Systems and Optical Materials, Optics and Plasma Research Department, Risø National Laboratory for Sustainable Energy
Contributors: Blaaberg, S., Petersen, P. M., Tromborg, B.
Pages: 959-973
Publication date: 2007
Peer-reviewed: Yes

**Publication information**
Journal: IEEE Journal of Quantum Electronics
Volume: 43
Issue number: 11
ISSN (Print): 0018-9197
Ratings:
Scopus rating (2007): SJR 2.116 SNIP 1.729
Web of Science (2007): Indexed yes
Original language: English
Electronic versions:
Blaaberg.pdf
DOIs:
10.1109/JQE.2007.904520

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Source: orbit
Source-ID: 204971
Research output: Contribution to journal › Journal article – Annual report year: 2007 › Research › peer-review
Two-wave mixing in a broad-area semiconductor amplifier

General information
Publication status: Published
Organisations: Laser Systems and Optical Materials, Optics and Plasma Research Department, Risø National Laboratory for Sustainable Energy
Contributors: Chi, M., Jensen, S., Huignard, J., Petersen, P. M.
Publication date: 2007

Host publication information
Title of host publication: Technical digest
Place of publication: Washington, DC
Publisher: Optical Society of America
DOIs:
10.1109/CLEO.2007.4453637
URLs:
Source: orbit
Source-ID: 215494
Research output: Chapter in Book/Report/Conference proceeding › Article in proceedings – Annual report year: 2007 › Research

Udvikling af LED lyskilder og lamper. Slutrapport for PSO 337-068
This report is the final and concluding report on the research and development project “Development of LED light sources and lamps” PSO no. 337-068 supported by Dansk Energi – Net. The project was a collaboration between Risø National laboratory, Louis Poulsen Lighting, Dong Energy, Laboratoriet Lys & Syn and RGB Lamps. The objective of this project was to pave the way for replacement of incandescent- and halogen lighting by LED lightning through development of prototypes for new types of LED products: light sources and lamps. The report summarizes and describes the main results of the project, which are: - a new LED light source with an efficacy of 51 lm/W and a CRI index of 92 that can replace an incandescent bulb. - two LED pendants/lamps, a LED table lamp and a chair with LED lighting developed by designers and researchers. - LED seminar and two exhibitions of the newly developed LED products and user test by questionnaires. - A new startup company “Morfoso” - Developed course on light and LED technology for designers - A new LED light laboratory for test and characterization of LED components and LED light sources and lamps.

General information
Publication status: Published
Organisations: Diode Lasers and LED Systems, Risø National Laboratory for Sustainable Energy
Contributors: Dam-Hansen, C., Petersen, P. M., Thstrup Nielsen, B., Holm, J., Andersen, J., Falleboe, H., Olsen, J., Flindt, C.
Number of pages: 37
Publication date: 2007

Publication information
Place of publication: Roskilde, Denmark
Publisher: Danmarks Tekniske Universitet, Risø Nationallaboratoriet for Bæredygtig Energi
ISBN (Print): 978-87-550-3598-0
Original language: English
Keywords: Risø-R-1606, Risø-R-1606(DA)
Electronic versions:
ris-r-1606.pdf
Source: orbit
Source-ID: 223215
Research output: Book/Report › Report – Annual report year: 2007 › Research

BRIGHTER EU-projekt

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Petersen, P. M.
Publication date: 2006
Peer-reviewed: No
Event: Abstract from Møde i Dansk Optisk Selskab, Risø, Denmark.
**External cavity setups for improving the beam quality of broad-stripe diode lasers**

**General information**
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Thestrup, B., Petersen, P.
Publication date: 2006
Peer-reviewed: No
Event: Abstract from Meeting at FISBA Optic AG, St. Gallen (CH), 27 Apr,

**Near-diffraction-limited segmented broad area diode laser based on off-axis spectral beam combining**

The beam quality of a 500-µm-wide broad area diode laser with five active segments has been improved beyond the beam quality of the individual segments. The principle of this new laser system is based on off-axis feedback in combination with spectral beam combining. By using a double-feedback scheme we are able to improve the beam quality of the laser by a factor of 23 from $M^2 = 55$ for the free-running diode laser to $M^2 = 2.4$ for the laser with feedback at a drive current of 2.2 A. The improved $M^2$ value is a factor of 3.4 below $M^2 = 8.2$ for a single free-running segment. This is the first time that the beam quality of a segmented broad area diode laser has been improved beyond the beam quality of the individual segments.

**General information**
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Jensen, O., Thestrup Nielsen, B., Andersen, P. E., Petersen, P.
Pages: 225-228
Publication date: 2006
Peer-reviewed: Yes

**Publication information**
Journal: Applied Physics B-Lasers and Optics
Volume: 83
Issue number: 2
ISSN (Print): 0946-2171
Ratings:
Scopus rating (2006): SJR 1.501 SNIP 1.322
Web of Science (2006): Indexed yes
Original language: English
DOIs: 10.1007/s00340-006-2159-4
Source: orbit
Source-ID: 309180
Research output: Contribution to conference › Conference abstract for conference – Annual report year: 2006 › Research

**Two-wave mixing in a broad-area semiconductor amplifier**

The two-wave mixing in the broad-area semiconductor amplifier was investigated, both theoretically and experimentally. In detail we investigated how the optical gain is affected by the presence of the two-wave mixing interference grating. In the experimental setup we are able to turn on and off the interference pattern in the semiconductor amplifier. This arrangement allows us to determine the two-wave mixing gain. The coupled-wave equations of two-wave mixing were derived based on the Maxwell's wave equation and rate equation of the carrier density. The analytical solutions of the coupled-wave equations were obtained in the condition of small signal and the total intensity is far below the saturation intensity of the amplifier. The results show that when the amplifier is operated below transparency we obtain an increase in the optical gain, and when the amplifier is operated above transparency we obtain a decrease in the optical gain. The experimental results obtained in an 810 nm, 200 µm wide GaAlAs amplifier show good agreement with the theory. A diffusion length of 2.0 µm is determined from the experiment.

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An external-cavity laser diode at 635 nm for laser display applications

Efficiency improvements

Title of host publication: Risø energy report 4. The future energy system - distributed production and use
Einsteins teorier bag udviklingen af laseren

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Petersen, P.
Pages: 13-16
Publication date: 2005
Peer-reviewed: Unknown

Publication information
Journal: Kvant
Volume: 16
Issue number: 2
ISSN (Print): 0905-8893
Original language: English
Source: orbit
Source-ID: 308041
Research output: Contribution to journal › Journal article – Annual report year: 2005 › Communication

External cavity setup for beam quality improvement of a broad-stripe segmented diode laser

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Thstrup, B., Petersen, P.
Publication date: 2005
Peer-reviewed: No
Electronic versions:
opl_16_2005.pdf
Source: orbit
Source-ID: 308691
Research output: Contribution to conference › Conference abstract for conference – Annual report year: 2005 › Research

Guiding of laser modes based on self-pumped four-wave mixing in a semiconductor amplifier

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Petersen, P., Samsøe, E., Blaaberg Jensen, S., Andersen, P. E.
Pages: 3340-3347
Publication date: 2005
Peer-reviewed: Yes

Publication information
Journal: Opt. Express
Volume: 13
Ratings:
Scopus rating (2005): SJR 3.412 SNIP 2.459
Web of Science (2005): Indexed yes
Original language: English
LED-forskning og udvikling i Danmark

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Petersen, P.
Publication date: 2005
Peer-reviewed: No
Event: Abstract from Seminar om lysdioder hos Lysteknisk Selskab, Ballerup (DK), 7 Dec, .
Source: orbit
Source-ID: 308739
Research output: Contribution to conference › Conference abstract for conference – Annual report year: 2005 › Research

New diode laser architectures and their applications in medicine

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Petersen, P.
Publication date: 2005
Peer-reviewed: No
Event: Abstract from Kolloquium at Southern University of Denmark, Odense (DK), 11 Oct, .
Source: orbit
Source-ID: 308738
Research output: Contribution to conference › Conference abstract for conference – Annual report year: 2005 › Research

Nye LED-lyskilder

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Petersen, P.
Publication date: 2005
Peer-reviewed: No
Event: Abstract from Besøg på Risø af Odense Erhvervsråd, Risø (DK), 18 May, .
Source: orbit
Source-ID: 308740
Research output: Contribution to conference › Conference abstract for conference – Annual report year: 2005 › Research

Optics and Plasma Research Department annual progress report for 2004
The Optics and Plasma Research Department performs basic and applied research within three scientific programmes: (1) laser systems and optical materials, (2) optical diagnostics and information processing and (3) plasma physics and technology. The department has core competencies in optical sensors, optical materials, biophotonics, fusion plasma physics, and industrial plasma technology. The department employs key technologies in micro- and nanotechnology for optical systems, temperature calibration, and infrared measurement techniques. The research is supported by several EU programmes, including EURATOM, by Danish research councils and by industry. A summary of the activities in 2004 is presented.

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy, Risø National Laboratory
Contributors: Bindslev, H., Lynov, J., Pedersen, C., Petersen, P. M., Skaarup, B.
Number of pages: 111
Publication date: 2005

Publication information
Place of publication: Roskilde
Second-harmonic generation of 405-nm light using periodically poled KTiOPO₄ pumped by external-cavity laser diode with double grating feedback

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Samsøe, E., Petersen, P., Andersson-Engels, S., Andersen, P. E.
Pages: 861-864
Publication date: 2005
Peer-reviewed: Yes

Publication information
Volume: 80
Ratings:
Scopus rating (2005): SJR 1.661 SNIP 1.426
Web of Science (2005): Indexed yes
Original language: English
DOIs:
10.1007/s00340-005-1810-9
Source: orbit
Source-ID: 308116
Research output: Contribution to journal › Journal article – Annual report year: 2005 › Research › peer-review

Self-injection locking of an extraordinarily wide broad-area diode laser with a 1000-µm-wide emitter

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Chi, M., Thestrup, B., Petersen, P.
Pages: 1147-1149
Publication date: 2005
Peer-reviewed: Yes

Publication information
Journal: Optics Letters
Volume: 30
ISSN (Print): 0146-9592
Ratings:
Scopus rating (2005): SJR 3.309 SNIP 2.547
Web of Science (2005): Indexed yes
Original language: English
DOIs:
10.1364/OL.30.001147
Source: orbit
Source-ID: 308031
Research output: Contribution to journal › Journal article – Annual report year: 2005 › Research › peer-review

Tunable high-power narrow-linewidth semiconductor laser based on an external-cavity tapered amplifier

General information
Udvikling af fremtidens LED-lyskilder

**General information**
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Petersen, P., Dam-Hansen, C.
Publication date: 2005
Peer-reviewed: No
Source: orbit
Source-ID: 308741
Research output: Contribution to conference › Conference abstract for conference – Annual report year: 2005 › Research

Excitation and amplification of lateral array modes in a broad area laser diode using asymmetric feedback

**General information**
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Thestrup, B., Petersen, P.
Publication date: 2004
Peer-reviewed: No
Source: orbit
Source-ID: 307004
Research output: Contribution to conference › Conference abstract for conference – Annual report year: 2004 › Research

Improvement of spatial and temporal coherence of a broad area laser diode using an external-cavity design with double grating feedback

**General information**
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Samsøe, E., Andersen, P. E., Andersson-Engels, S., Petersen, P.
Pages: 609-616
Publication date: 2004
Peer-reviewed: Yes

**Publication information**
Journal: Opt. Express
Volume: 12
Ratings:
Scopus rating (2004): SJR 2.944 SNIP 2.595
Web of Science (2004): Indexed yes
Improvement of the beam quality of a 1000 μm wind broad-area diode laser with self-injection phase locking in an external cavity

**General information**
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Chi, M., Thestrup, B., Petersen, P.
Pages: 33-37
Publication date: 2004

**Host publication information**
Title of host publication: High-power diode laser technology and applications 2
Place of publication: Bellingham, WA
Publisher: The International Society for Optical Engineering
Editor: Zediker, M.
(SPIE Proceedings Series, 5336).
DOIs: 10.1117/12.528313
Source: orbit
Source-ID: 307091

Improvement of the beam quality of a broad-area diode laser using double feedback from two external mirrors

In this letter, a symmetric double-feedback configuration, to improve the beam quality of broad-area diode lasers is demonstrated. With this configuration, a symmetric double-lobed far field can be obtained, and this configuration leads to good beam quality. The beam quality factor M-2 of a diode laser with the emitting area 1 mumx200 mum is improved by using both the asymmetric single feedback and the symmetric double feedback. M-2 values of 4.3 for the asymmetric single-feedback laser system and 3.3 for the symmetric double-feedback laser system are obtained, whereas the M-2 value of the freely running laser is 42. The far and the near fields are also measured and compared for the three conditions. (C) 2004 American Institute of Physics.

**General information**
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Chi, M., Bøgh, A., Thestrup, B., Petersen, P.
Pages: 1107-1109
Publication date: 2004
Peer-reviewed: Yes

**Publication information**
Volume: 85
Issue number: 7
ISSN (Print): 0003-6951
Ratings: Scopus rating (2004): SJR 3.908 SNIP 2.408
Web of Science (2004): Indexed yes
Original language: English
DOIs: 10.1063/1.1783017
Source: orbit
Source-ID: 307090
Lateral mode selection in a broad area laser diode by self-injection locking with a mirror stripe

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Thøstrup, B., Chi, M., Petersen, P.
Pages: 38-44
Publication date: 2004

Host publication information
Title of host publication: High-power diode laser technology and applications 2
Place of publication: Bellingham, WA
Publisher: The International Society for Optical Engineering
Editor: Zediker, M.
(SPIE Proceedings Series, 5336).
DOIs:
10.1117/12.529005
Source: orbit
Source-ID: 307092
Research output: Chapter in Book/Report/Conference proceeding › Article in proceedings – Annual report year: 2004 › Research › peer-review

Nonlinear optical effects in high power diode lasers (invited lecture)

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Petersen, P.
Publication date: 2004
Peer-reviewed: No
Event: Abstract from Colloquium, Ferdinana-Braun-Institut, Berlin (DE), 19 Nov, .
Source: orbit
Source-ID: 307609
Research output: Contribution to conference › Conference abstract for conference – Annual report year: 2004 › Research

Optics and Fluid Dynamics Department annual progress report for 2003
The Optics and Fluid Dynamics Department performs basic and applied research within three scientific programmes: (1) laser systems and optical materials, (2) optical diagnostics and information processing and (3) plasma and fluid dynamics. The department has core competences in: optical sensors, optical materials, optical storage, biophotonics, numerical modelling and information processing, non-linear dynamics, fusion plasma physics and plasma technology. The research is supported by several EU programmes, including EURATOM, by Danish research councils and by industry. A summary of the activities in 2003 is presented.

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Bindslev, H., Hanson, S. G., Lynov, J., Petersen, P. M., Skaarup, B.
Number of pages: 112
Publication date: 2004

Publication information
Place of publication: Roskilde
Publisher: Risø National Laboratory
ISBN (Electronic): 87-550-3301-6
Original language: English
(Denmark. Forskningscenter Risoe. Risoe-R; No. 1453(EN)).
Keywords: Risø-R-1453, Risø-R-1453(EN)
Electronic versions:
ris_r_1453.pdf
Source: orbit
Source-ID: 306871
Research output: Book/Report › Report – Annual report year: 2004 › Research
Spatial and spectral control of high-power diode lasers using phase conjugate mirrors

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Petersen, P., Løbel, M., Jensen, S.
Pages: 301-330
Publication date: 2004

Host publication information
Title of host publication: Phase conjugate laser optics
Place of publication: Hoboken
Publisher: Wiley-Interscience
Editors: Brignon, A., Huignard, J.
(Wiley Series in Lasers and Applications).
Source: orbit
Source-ID: 307610

High brightness laser source based on polarization coupling of two diode lasers with asymmetric feedback
In this letter, we show that polarization coupling and asymmetric diode-laser feedback can be used to combine two diode-laser beams with low spatial coherence into a single beam with high spatial coherence. The coupled laser source is based on two similar laser systems each consisting of a 1 mum x 200 mum broad area laser diode applied with a specially designed feedback circuit. When operating at two times threshold, 50% of the freely running system output power is obtained in a single beam with an M-2 beam quality factor of 1.6 +/- 0.1, whereas the M-2 values of the two freely running diode lasers are 29 +/- 1 and 34 +/- 1, respectively. (C) 2003 American Institute of Physics.

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Thestrup, B., Chi, M., Sass, B., Petersen, P.
Pages: 680-682
Publication date: 2003
Peer-reviewed: Yes

Publication information
Volume: 82
Issue number: 5
ISSN (Print): 0003-6951
Ratings:
Scopus rating (2003): SJR 3.772 SNIP 2.287
Web of Science (2003): Indexed yes
Original language: English
DOIs: 10.1063/1.1540218
Source: orbit
Source-ID: 305206

Improvement of brightness and output power of high-power laser diodes in the visible spectral region

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Samsøe, E., Malm, P., Andersen, P. E., Petersen, P., Andersson-Engels, S.
Pages: 369-375
Publication date: 2003
Peer-reviewed: Yes

Publication information
Journal: Optics Communications
Improvement of the beam quality of a diode laser with two active broad-area segments

The beam quality of a diode laser with two active segments was improved using an external cavity with collimating optics, a grating, and an output coupler. The beam quality of the output beam, which is the first-order diffractive beam from the grating, was improved by a factor of 2, and at least half of the freely running power of the laser was coupled out from the external cavity. The output power can be enhanced further by the feedback from the zeroth-order beam. The possibility of improving the beam quality further is discussed and a new double-external-cavity configuration is suggested.

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Chi, M., Thestrup, B., Mortensen, J., Nielsen, M., Petersen, P.
Pages: S338-S341
Publication date: 2003
Peer-reviewed: Yes

Publication Information
Volume: 5
Issue number: 5
ISSN (Print): 2040-8978
Ratings:
Scopus rating (2003): SJR 0.804 SNIP 0.962
Web of Science (2003): Indexed yes
Original language: English
DOIs:
10.1088/1464-4258/5/5/388
Source: orbit
Source-ID: 305862
Research output: Contribution to journal › Journal article – Annual report year: 2003 › Research › peer-review

Improving the focusing properties of a near-infrared high-power broad-stripe diode laser (poster)

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Thestrup, B., Petersen, P., Chi, M.
Publication date: 2003
Peer-reviewed: No
Event: Poster session presented at Danish Physical Society annual meeting 2003, Nyborg, Denmark.
Source: orbit
Source-ID: 305785
Research output: Contribution to conference › Poster – Annual report year: 2003 › Research

Improving the spatial and temporal coherence of high-power diode lasers using four-wave mixing in the gain material

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Petersen, P., Thestrup, B., Chi, M.
Pages: 529-534
Publication date: 2003
Optics and Fluid Dynamics Department annual progress report for 2002

The Optics and Fluid Dynamics Department performs basic and applied research within three scientific programmes: (1) laser systems and optical materials, (2) optical diagnostics and information processing and (3) plasma and fluid dynamics. The department has core competences in: optical sensors, optical materials, optical storage, biophotonics, numerical modelling and information processing, non-linear dynamics and fusion plasma physics. The research is supported by several EU programmes, including EURATOM, by Danish research councils and by industry. A summary of the activities in 2002 is presented.

Diodelasere

High-power diode lasers
Improvement of the beam quality of a diode laser with two active segments

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Chi, M., Thestrup, B., Pedersen, H., Petersen, P.
Pages: 689-690
Publication date: 2002

Host publication information
Title of host publication: Technical digest. Part 2
Place of publication: Bellingham, WA
Publisher: International Society for Optical Engineering
Editors: Consortini, A., Righini, G.
ISBN (Print): 0-8194-4569-7
(SPIE Proceedings Series, 4829).
Source: orbit
Source-ID: 304508
Research output: Chapter in Book/Report/Conference proceeding – Article in proceedings – Annual report year: 2002 – Research

Laserteknologier til Versamatrix' matrixproblem

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Petersen, P.
Publication date: 2002
Peer-reviewed: No
Event: Abstract from Forelæsning på Carlsberg Laboratoriet, København (DK), 26 Nov.
Source: orbit
Source-ID: 305071
Research output: Contribution to conference – Conference abstract for conference – Annual report year: 2002 – Research

Nonlinear guided modes in a high-power semiconductor laser

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Petersen, P.
Publication date: 2002
Peer-reviewed: No
Source: orbit
Source-ID: 305074
Research output: Contribution to conference – Conference abstract for conference – Annual report year: 2002 – Research

Optics and Fluid Dynamics Department annual progress report for 2001
The Optics and Fluid Dynamics Department performs basic and applied research within three scientific programmes: (1) laser systems and optical materials, (2) optical diagnostics and information processing and (3) plasma and fluid dynamics. The department has core competences in: optical sensors, optical materials, optical storage, biooptics, numerical modelling and information processing, non-linear dynamics and fusion plasma physics. The research is supported by several EU programmes, including EURATOM, by Danish research councils and by industry. A summary of the activities in 2001 is presented.

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Bindslev, H., Hanson, S. G., Lynov, J., Petersen, P. M., Skaarup, B.
Number of pages: 95
Phase locking of laser diode with microlens (poster)

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Chi, M., Thestrup, B., Petersen, P.
Publication date: 2002

Host publication information
Title of host publication: Book of abstracts
Place of publication: Roskilde
Publisher: Dansk Optisk Selskab; Forskningscenter Risø
Source-ID: 304817
Research output: Chapter in Book/Report/Conference proceeding – Annual report year: 2002 › Research

Polarization coupling of two broad area laser diodes with external feedback (poster)

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Thestrup, B., Chi, M., Sass, B., Petersen, P.
Publication date: 2002

Host publication information
Title of host publication: Programme. Abstracts. List of participants
Place of publication: Copenhagen
Publisher: HCØ Tryk
URLs:
http://www.nbi.dk/dfs/
Source-ID: 304118
Research output: Chapter in Book/Report/Conference proceeding – Annual report year: 2002 › Research

Power coupling of two broad area laser diodes with external feedback

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Thestrup, B., Chi, M., Sass, B., Petersen, P.
Pages: 665-666
Publication date: 2002

Host publication information
Title of host publication: Technical digest. Part 2
Place of publication: Bellingham, WA
Publisher: International Society for Optical Engineering
A novel diode laser system for photodynamic therapy

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Samsøe, E., Andersen, P. E., Petersen, P., Andersson-Engels, S., Svanberg, K.
Pages: 34-37
Publication date: 2001
Peer-reviewed: Unknown

Publication information
Journal: DOPS-Nyt
Volume: 16
Issue number: 4
Original language: English
Source: orbit
Source-ID: 303412
Research output: Contribution to journal › Journal article – Annual report year: 2001 › Communication

Center for Biomedical Optics and New Laser Systems

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Petersen, P.
Pages: 46
Publication date: 2001
Peer-reviewed: Unknown

Publication information
Journal: DOPS-Nyt
Volume: 16
Issue number: 4
Original language: English
Source: orbit
Source-ID: 303566
Research output: Contribution to journal › Journal article – Annual report year: 2001 › Communication

Development of diode laser systems for photodynamic therapy (poster)

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Samsøe, E., Malm, P., Andersen, P. E., Petersen, P., Andersson-Engels, S.
Publication date: 2001
Source: orbit
Source-ID: 303099
Research output: Contribution to conference › Poster – Annual report year: 2001 › Research

Fotorefraktive materiaer - et skoleeksempel inden for den ikke-lineære optik

General information
Publication status: Published
Novel diode laser system for photodynamic therapy

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Samsøe, E., Petersen, P., Andersen, P. E., Andersson-Engels, S., Svanberg, K.
Pages: 134-139
Publication date: 2001

Host publication information
Title of host publication: Laser-tissue interactions, therapeutic applications, and photodynamic therapy
Place of publication: Bellingham, WA
Publisher: International Society for Optical Engineering
Editors: Birngruber, R., Bergh, H. V. D.
ISBN (Print): 0-8194-4147-3
(SPIE Proceedings Series, v. 4433; Progress in Biomedical Optics and Imaging, v. 2, no. 33).
Source-ID: 303427
Research output: Chapter in Book/Report/Conference proceeding – Annual report year: 2001 – Research

New diode laser architectures using phase conjugators

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Petersen, P.
Publication date: 2000
Peer-reviewed: No
Event: Abstract from Endagsmøde i Dansk Optisk Selskab, Lyngby (DK), 30 Nov.
URLs:
http://www.dops.dk/annual00/Petersen.abstract00.htm
Source-ID: 302025
Research output: Contribution to conference – Conference abstract for conference – Annual report year: 2000 – Research

Nonlinear cross talk between gratings recorded in BaTiO₃ by mutually incoherent beam pairs

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Limeres, J., Carrascosa, M., Petersen, P., Andersen, P. E.
Pages: 5527-5533
Publication date: 2000
Peer-reviewed: Yes

Publication information
Journal: Journal of Applied Physics
Volume: 88
Phase conjugate high power laser diode arrays (Invited talk)

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Petersen, P.
Publication date: 2000
Peer-reviewed: No
Event: Abstract from International conference on applications of photonic technology (ICAPT 2000), Quebec City (CA), 12-16 Jun, .
Source: orbit
Source-ID: 302024
Research output: Contribution to conference › Conference abstract for conference – Annual report year: 2000 › Research

Stability of the single-mode output of a laser diode array with phase conjugate feedback
The stability of the output of a single-mode laser diode array with frequency selective phase conjugate feedback has been investigated experimentally. Both the long-term stability of the laser output and the sensitivity to feedback generated by external reflection of the output beam are examined. The output power and the center wavelength are found to be extremely stable in a 100 h stability measurement. External feedback of the output beam into the laser is seen to decrease both the spatial and the temporal coherence of the output significantly. We outline an approach to obtain a stable single-mode output when external feedback is present using spatial filtering in the path of the output beam. (C) 2000 American Institute of Physics.

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Juul Jensen, S., Løbel, M., Petersen, P.
Pages: 535-537
Publication date: 2000
Peer-reviewed: Yes

Publication information
Volume: 76
Issue number: 5
ISSN (Print): 0003-6951
Ratings:
Scopus rating (2000): SJR 4.328 SNIP 2.017
Web of Science (2000): Indexed yes
Original language: English
DOIs:
10.1063/1.125810
Source: orbit
Source-ID: 300730
Research output: Contribution to journal › Journal article – Annual report year: 2000 › Research › peer-review

A high power laser diode array with external phase conjugate feedback

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Petersen, P.
Publication date: 1999
Peer-reviewed: No
Experimental observation of nonlinear grating cross talk in multibeam photorefractive recording

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Limeres, J., Carrascosa, M., Andersen, P. E., Petersen, P.
Pages: 394-400
Publication date: 1999

Host publication information
Title of host publication: Advances in photorefractive materials, effects, and devices
Place of publication: Washington, DC
Publisher: Optical Society of America
Editors: Andersen, P., Johansen, P., Pedersen, H., Petersen, P., Saffman, M.
ISBN (Print): 1-55752-606-0
(OSA trends in optics and photonics series, v. 27).

High-power lasers for photodynamic therapy

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Petersen, P.
Publication date: 1999
Peer-reviewed: No
Event: Abstract from Symposium on biomedical optics, Lyngby, Denmark.

Nonlinear grating interactions in multibeam photorefractive recording: Theoretical investigation

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Limeres, J., Carrascosa, M., Agullo-Lopez, F., Andersen, P. E., Petersen, P.
Pages: 414-419
Publication date: 1999
Peer-reviewed: Yes

Publication information
Journal: Optical Society of America. Journal B: Optical Physics
Volume: 16
ISSN (Print): 0740-3224
Ratings:
Scopus rating (1999): SJR 2.052 SNIP 1.174
Original language: English

Optics in Denmark 1999: DOPS white book
Phase locking and frequency doubling of laser diode arrays

Phase locking of laser diode arrays using a photorefractive Rh:BaTiO$_3$ crystal (Invited paper)

Photorefractive holographic storage: Fundamental limits and new materials
Physical origin of laser frequency scanning induced by photorefractive phase-conjugate feedback

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Løbel, M., Petersen, P., Johansen, P.
Pages: 219-227
Publication date: 1999
Peer-reviewed: Yes

Publication information
Journal: Optical Society of America. Journal B: Optical Physics
Volume: 16
ISSN (Print): 0740-3224
Scopus rating (1999): SJR 2.052 SNIP 1.174
Original language: English
Source: orbit
Source-ID: 300603
Research output: Contribution to journal › Journal article – Annual report year: 1999 › Research › peer-review

Progress in high brightness laser diode arrays

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Petersen, P.
Publication date: 1999
Peer-reviewed: No
Event: Abstract from Meeting at Frunhofer Institut Lasertechnik, Aachen (DE), 12 Nov, .
Source: orbit
Source-ID: 299344
Research output: Contribution to conference › Conference abstract for conference – Annual report year: 1999 › Research

Reduction of photoexcited carriers modulation due to a long distance photoelectron pass in photorefractive Bi₁₂SiO₂₀

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Lyuksyutov, S., Buchhave, P., Vasnetsov, M., Andersen, P. E., Petersen, P.
Pages: 96-100
Publication date: 1999

Host publication information
Title of host publication: Advances in photorefractive materials, effects, and devices
Place of publication: Washington, DC
Publisher: Optical Society of America
Editors: Andersen, P., Johansen, P., Pedersen, H., Petersen, P., Saffman, M.
ISBN (Print): 1-55752-606-0
( OSA trends in optics and photonics series, v. 27).
Source: orbit
Source-ID: 300253
Research output: Chapter in Book/Report/Conference proceeding › Article in proceedings – Annual report year: 1999 › Research

Single mode laser diode array with external feedback

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Juul Jensen, S., Løbel, M., Petersen, P.
Publication date: 1999
Kinetics of higher order combinational gratings in photorefractive media: Diffusion regime

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Andersen, P. E., Petersen, P.
Pages: 2032-2036
Publication date: 1998
Peer-reviewed: Yes

Publication information
Journal: Optical Society of America. Journal B: Optical Physics
Volume: 15
ISSN (Print): 0740-3224
Original language: English
Source: orbit
Source-ID: 298538
Research output: Contribution to journal › Journal article – Annual report year: 1998 › Research › peer-review

New laser systems using phase conjugate feedback

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Petersen, P.
Publication date: 1998
Peer-reviewed: No
Event: Abstract from Nordic Graduate Physics program, visit to Risø, Risø, Denmark.
Source: orbit
Source-ID: 298132
Research output: Contribution to conference › Conference abstract for conference – Annual report year: 1998 › Research

Nonlinear cross talk between mutually incoherently recorded gratings in BaTiO3

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Limeres, J., Carrascosa, M., Andersen, P. E., Petersen, P.
Number of pages: 224
Publication date: 1998

Host publication information
Title of host publication: CLEO/Europe'98. Technical digest
Place of publication: Piscataway, NJ
Publisher: IEEE
Source: orbit
Source-ID: 298301
Research output: Chapter in Book/Report/Conference proceeding › Conference abstract in proceedings – Annual report year: 1998 › Research

Nonlinear self-defocusing in doped silica sono-gels (vol 81, pg 7728, 1997)

General information
Optical storage in photorefractive materials

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Petersen, P.
Publication date: 1998
Peer-reviewed: No
Event: Abstract from Materials for Optical Storage, Risø, Denmark.
Source: orbit
Source-ID: 298937
Research output: Contribution to conference » Conference abstract for conference – Annual report year: 1998 » Research

Optics for medical diagnostics

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Petersen, P., Andersen, P. E.
Number of pages: 54
Publication date: 1998

Host publication information
Title of host publication: 40 years of research at Risø: A platform for the future - interacting with industry and society.
Summary of presentations
Volume: Risø-R-1062(EN,DA)
Editors: Rosendahl, L., Lading, L.
ISBN (Print): 87-550-2407-6
Source: orbit
Source-ID: 298000
Research output: Chapter in Book/Report/Conference proceeding » Conference abstract in proceedings – Annual report year: 1998 » Research

Single-mode high-power semiconductor lasers using phase conjugation

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Løbel, M., Petersen, P., Johansen, P.
Pages: 6-10
Publication date: 1998
Peer-reviewed: Unknown

Publication information
Journal: DOPS-Nyt
Volume: 13
Issue number: 3
Original language: Danish
Single-mode operation of a laser-diode array with frequency-selective phase-conjugate feedback

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Løbel, M., Petersen, P., Johansen, P.
Pages: 825-827
Publication date: 1998
Peer-reviewed: Yes

Publication information
Journal: Optics Letters
Volume: 23
ISSN (Print): 0146-9592
Original language: English
Source: orbit
Source-ID: 298584
Research output: Contribution to journal › Journal article – Annual report year: 1998 › Research › peer-review

Single mode operation of laser diode arrays using frequency selective phase conjugate feedback

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Petersen, P., Løbel, M., Johansen, P.
Publication date: 1998

Host publication information
Title of host publication: Programme and book of abstracts
Place of publication: Limerick
Publisher: University of Limerick
Source: orbit
Source-ID: 297745
Research output: Chapter in Book/Report/Conference proceeding › Conference abstract in proceedings – Annual report year: 1998 › Research

Single-mode operation of laser diode arrays using photorefractive phase conjugators (Invited paper)

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Petersen, P., Løbel, M., Johansen, P.
Number of pages: 236
Publication date: 1998

Host publication information
Title of host publication: CLEO/Europe'98. Technical digest
Place of publication: Piscataway, NJ
Publisher: IEEE
Source: orbit
Source-ID: 297744
Research output: Chapter in Book/Report/Conference proceeding › Conference abstract in proceedings – Annual report year: 1998 › Research

Suppressing self-induced frequency scanning of a phase conjugate diode laser array with using counterbalance dispersion
Experimental results show that angular dispersion strongly influences the self-induced frequency scanning of a multimode broad-area diode laser array coupled to a photorefractive self-pumped phase conjugate mirror. Prisms or a dispersive grating placed in the external cavity opposing the material frequency dispersion of the phase conjugate BaTiO3 crystal suppress the frequency scanning and stabilize the center wavelength and the output power. We show that the dispersion
of the crystal is crucial for the mechanism of the frequency scanning. (C) 1998 American Institute of Physics.

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Løbel, M., Petersen, P., Johansen, P.
Pages: 1263-1265
Publication date: 1998
Peer-reviewed: No

Publication information
Volume: 72
Issue number: 11
ISSN (Print): 0003-6951
Original language: English
DOI:
10.1063/1.120605
Source: orbit
Source-ID: 298825
Research output: Contribution to journal › Journal article – Annual report year: 1998 › Research

Tunable single-mode operation of a high-power laser-diode array by use of an external cavity with a grating and a photorefractive phase-conjugate mirror

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Løbel, M., Petersen, P., Johansen, P.
Pages: 2000-2005
Publication date: 1998
Peer-reviewed: Yes

Publication information
Journal: Optical Society of America. Journal B: Optical Physics
Volume: 15
ISSN (Print): 0740-3224
Original language: English
Source: orbit
Source-ID: 298491
Research output: Contribution to journal › Journal article – Annual report year: 1998 › Research › peer-review

Dynamic grating formation in LiNbO₃:Fe crystals under influence of an externally applied magnetic field

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Johansen, P., Dam-Hansen, C., Petersen, P., Fridkin, V.
Pages: 555-564
Publication date: 1997

Host publication information
Title of host publication: Proceedings of the international conference on lasers'96
Place of publication: McLean, VA
Publisher: STS Press
Editors: Corcoran, V., Goldman, T.
Source: orbit
Source-ID: 296425
Research output: Chapter in Book/Report/Conference proceeding › Article in proceedings – Annual report year: 1997 › Research

En ny optikuddannelse i Danmark?

General information
Krystaller som harddiske

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Petersen, P., Dam-Hansen, C., Johansen, P.
Pages: 6-8
Publication date: 1997
Peer-reviewed: Unknown

Publication information
Journal: Geologisk Nyt
Issue number: 4
ISSN (Print): 0906-6861
Original language: Danish
Source: orbit
Source-ID: 296426
Research output: Contribution to journal › Journal article – Annual report year: 1997 › Communication

Laseren og nye perspektiver for vekselvirkning mellem lys og stof

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Petersen, P.
Publication date: 1997
Peer-reviewed: No
Event: Abstract from Kemisk Institut, Århus Universitet, Århus (DK), 23 Apr
Source: orbit
Source-ID: 296344
Research output: Contribution to conference › Conference abstract for conference – Annual report year: 1997 › Research

Lasers with phase conjugate feedback

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Petersen, P.
Publication date: 1997
Peer-reviewed: No
Event: Abstract from Depto. Fisica de Materiales, C-IV, Universidad Autonóma de Madrid, Madrid (ES), 9 Sep
Source: orbit
Source-ID: 296342
Research output: Contribution to conference › Conference abstract for conference – Annual report year: 1997 › Research

Local diffuse reflectance from three-layered skin tissue structures
New strong higher order spatial harmonic gratings induced by multiwave interaction in photorefractive Bi$_{12}$SiO$_{20}$

Nonlinear optics - a new field for organic and inorganic materials

Nonlinear self-defocusing in doped silica sono-gels
Optisk datalagring i ulineære materialer

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Petersen, P., Dam-Hansen, C., Johansen, P.
Pages: 4-7
Publication date: 1997
Peer-reviewed: No

Publication information
Journal: DOPS-Nyt
Volume: 12
Issue number: 4
Original language: Danish
Source: orbit
Source-ID: 296427
Research output: Contribution to journal › Journal article – Annual report year: 1997 › Research

Phase conjugate lasers

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Petersen, P.
Publication date: 1997
Peer-reviewed: No
Source: orbit
Source-ID: 296341
Research output: Contribution to conference › Conference abstract for conference – Annual report year: 1997 › Research

Ph.d. - uddannelsen er en national opgave

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Johansen, P., Petersen, P.
Publication date: 1997
Peer-reviewed: Unknown

Publication information
Journal: Berlingske Tidende. Univers
Issue number: 3. juni
Original language: Danish
Source: orbit
Source-ID: 296451
Research output: Contribution to journal › Journal article – Annual report year: 1997 › Communication

Spectral dependence of cross-talk between photorefractive gratings in Bi₁₂SiO₂₀ in diffusion regime

We report on experimental results showing a strong wavelength-dependence of cross-talk between photorefractive gratings simultaneously recorded in Bi₁₂SiO₂₀ crystals in the diffusion regime. We find unusually high cross-talk for two gratings with close spatial frequencies at wavelengths 488 and 476 nm. The results indicate that the density of free charge carriers does not directly follow light modulation at low spatial frequencies.

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Vasnetsov, M., Lyuksyutov, S., Buchhave, P., Andersen, P. E., Petersen, P.
The influence of dispersion on the self-induced scanning of a broad area diode laser with phase conjugate feedback

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Løbel, M., Petersen, P., Johansen, P.
Pages: 507-510
Publication date: 1997

Host publication information
Title of host publication: Proceedings. 1997 Topical meeting on photorefractive materials, effects and devices
Place of publication: Tokyo
Publisher: Optical Society of Japan
Source: orbit
Source-ID: 296890
Research output: Chapter in Book/Report/Conference proceeding – Annual report year: 1997 – Research

Theory of nonlinear multiple-grating interaction in diffusion-dominated photorefractive media: errata

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Pedersen, H., Andersen, P. E., Petersen, P., Johansen, P.
Pages: 989
Publication date: 1997
Peer-reviewed: Yes

Publication information
Journal: Optical Society of America. Journal B: Optical Physics
Volume: 14
ISSN (Print): 0740-3224
Original language: English
Source: orbit
Source-ID: 310622

Annual meeting of the Danish Optical Society. Book of abstracts

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Number of pages: 44
Publication date: 1996

Publication information
Place of publication: Roskilde
Biomedicinske anvendelser af optik

**General information**
- Publication status: Published
- Organisations: Risø National Laboratory for Sustainable Energy
- Number of pages: 42
- Publication date: 1996

**Publication information**
- ISBN (Print): 87-550-2215-4
- Original language: Danish
- Keywords: Risø-R-919(DA), Risø-R-919
- Electronic versions:
  - ris_r_919.pdf

**Biosensors based on an integrated twin-laser**

**General information**
- Publication status: Published
- Organisations: Risø National Laboratory for Sustainable Energy
- Contributors: Petersen, P.
- Publication date: 1996
- Peer-reviewed: No
- Event: Abstract from Paul Scherrer Institute, Zürich (CH), 27 Mar.
- Source: orbit
- Source-ID: 294724

**Dynamic grating formation in LiNbO₃ under the influence of an externally applied magnetic field**

**General information**
- Publication status: Published
- Organisations: Risø National Laboratory for Sustainable Energy
- Contributors: Johansen, P., Dam-Hansen, C., Petersen, P.
- Publication date: 1996
- Peer-reviewed: No
- Source: orbit
- Source-ID: 294728

**Fremtidens datalagring sker ved hjælp af hologrammer**

**General information**
- Publication status: Published
- Organisations: Risø National Laboratory for Sustainable Energy
- Contributors: Petersen, P., Dam-Hansen, C., Johansen, P.
- Pages: 4-5
- Publication date: 1996
- Peer-reviewed: Unknown
Grating couplers in optical waveguides

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Petersen, P.
Publication date: 1996
Peer-reviewed: No
Event: Abstract from Advanced topics in modern optics. Summerschool and workshop in optics, Humlebæk, Denmark.
Source: orbit
Source-ID: 295537
Research output: Contribution to conference › Conference abstract for conference – Annual report year: 1996 › Research

Har biomedicinsk optik en fremtid i Danmark

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Petersen, P.
Publication date: 1996
Peer-reviewed: No
Event: Abstract from Risø konference om biomedicinske anvendelser af optik, Risø (DK), 26 Sep.
Source: orbit
Source-ID: 294729
Research output: Contribution to conference › Conference abstract for conference – Annual report year: 1996 › Research

Hvidbogen 'Optik i Danmark'.

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Petersen, P.
Pages: 4-41
Publication date: 1996
Peer-reviewed: Unknown

Publication information
Journal: DOPS-Nyt
Volume: 11
Issue number: 1
Original language: Danish
Source: orbit
Source-ID: 295654
Research output: Contribution to journal › Journal article – Annual report year: 1996 › Communication

Laseren og nye perspektiver for vekselvirkning mellem lys og stof

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Petersen, P.
Publication date: 1996
Peer-reviewed: No
Event: Abstract from DOPS seminar om laserens anvendelser inden for fysik, biokemi og holografi. DTU, Lyngby, Denmark.
Source: orbit
Lysudbredelse i humant væv

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Andersen, P. E., Dam, J., Petersen, P.
Pages: 10-11
Publication date: 1996
Peer-reviewed: Unknown

Publication information
Journal: DOPS-Nyt
Volume: 11
Issue number: 3
Original language: Danish
Source-ID: 295039

Research output: Contribution to journal › Journal article – Annual report year: 1996 › Communication

Magnetophotorefractive effect in LiNbO₃:Fe crystals: theory and experiments

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Dam-Hansen, C., Johansen, P., Petersen, P., Fridkin, V.
Pages: 2286-2298
Publication date: 1996
Peer-reviewed: Yes

Publication information
Journal: Optical Society of America. Journal B: Optical Physics
Volume: 13
ISSN (Print): 0740-3224
Original language: English
Source-ID: 294943

Research output: Contribution to journal › Journal article – Annual report year: 1996 › Research › peer-review

Magnetophotorefractive effect in photovoltaic LiNbO₃:Fe

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Dam-Hansen, C., Johansen, P., Petersen, P.
Publication date: 1996
Peer-reviewed: No
Source-ID: 295543

Research output: Contribution to conference › Conference abstract for conference – Annual report year: 1996 › Research

Nonlinear crosstalk in photorefractive storage

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Petersen, P., Johansen, P.
Publication date: 1996
Peer-reviewed: No
Event: Abstract from International symposium on holographic memories, Vouliagmeni (GR), 14 May, .
Nonlinear self-refraction of Gaussian laser beams in silica sono-gels

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Petersen, P.
Publication date: 1996
Peer-reviewed: No
Event: Abstract from Advanced topics in modern optics. Summerschool and workshop in optics, Humlebæk, Denmark.
Source: orbit
Source-ID: 295534

Nonlinear self-refraction of Gaussian laser beams in silica sono-gels doped with copper tetrasulfonated phtalocyanine

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Petersen, P., Ramos, R., Johansen, P., Lindvold, L.
Pages: 202-209
Publication date: 1996

Host publication information
Title of host publication: High-power lasers: Gas and solid state lasers
Place of publication: Bellingham, WA
Publisher: The International Society for Optical Engineering
Editors: Letardi, T., Weber, H.
(SPIE Proceedings Series, 2788).
Source: orbit
Source-ID: 294805

Strong coupling between coherent gratings due to nonlinear spatial frequency mixing in Bi_{12}SiO_{20}

Nonlinear interactions between multiple coherent photorefractive gratings in Bi_{12}SiO_{20} are investigated. It is demonstrated that the nonlinear mixing, or cross talk, is strongly influenced by the intensity ratio kappa between the two object beams. The diffraction efficiency of a specific grating may be increased or strongly decreased depending on kappa. In the limit of a weak reference beam intensity compared to the sum of the object beam intensities, we derive an analytical expression for the cross talk valid for all kappa. Furthermore, we find the value of kappa yielding zero cross talk. We investigate the numerical calculations experimentally in a three-wave mixing setup and obtain good agreement between the experimental data and our predictions. Experimentally, we observe relative changes in the diffraction efficiency up to 500% due to nonlinear interactions between gratings

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Andersen, P. E., Buchhave, P., Petersen, P. M.
Pages: 185-192
Publication date: 1996
Peer-reviewed: Yes

Publication information
Journal: Optics Communications
Volume: 128
ISSN (Print): 0030-4018
Original language: English
DOIs:
10.1016/0030-4018(96)00193-9
Source: orbit
Source-ID: 167028
Theory of nonlinear multiple-grating interaction in diffusion-dominated photorefractive media

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Pedersen, H., Andersen, P. E., Petersen, P., Johansen, P.
Pages: 2569-2579
Publication date: 1996
Peer-reviewed: Yes

Publication information
Journal: Optical Society of America. Journal B: Optical Physics
Volume: 13
ISSN (Print): 0740-3224
Original language: English
Source: orbit
Source-ID: 294857

Twin-laser biosensor

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Petersen, P.
Publication date: 1996
Peer-reviewed: No
Source: orbit
Source-ID: 294775

Valg af optiske komponenter

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Petersen, P.
Publication date: 1996
Peer-reviewed: No
Event: Abstract from DOPS seminar om valg af optiske komponenter. DTU, Lyngby, Denmark.
Source: orbit
Source-ID: 294726

Basale mekanismer for lysudbredelse i væv

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Petersen, P.
Publication date: 1995
Peer-reviewed: No
Source: orbit
Source-ID: 293309

Enhanced nonlinear interaction between gratings in drift-dominated photorefractive Bi_{12}SiO_{20}
Fundamental properties of nonlinear combinations of gratings in Bi₁₂SiO₂₀ and their applications

Influence of an externally applied magnetic field on vectorial interaction in LiNbO₃:Fe crystals

Fundamental properties of photorefractive storage

Influence of an externally applied magnetic field on vectorial interaction in LiNbO₃:Fe crystals

An experimental investigation of the influence of an externally applied magnetic field on the dynamic grating formation in iron-doped lithium niobate is carried out. The diffraction efficiency and the two-beam gain depends strongly on the applied magnetic field. We observe changes in the two-beam gain and the diffraction efficiency of up to 40 and 75 %, respectively. The magnitude depends on the direction of the magnetic field. The interaction is believed to occur due to the anomalously high mobility of the nonthermalized free electrons responsible for the photovoltaic current, which in the vectorial interaction scheme causes the grating formation. A phenomenological description of the photovoltaic current including the photo-flail effect shows a linear dependence on the magnetic field, which does not explain the obtained experimental results.
Magnetic field effect on holographic grating formation in Fe:LiNbO$_3$

**General information**
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Dam-Hansen, C., Johansen, P., Fridkin, V., Petersen, P.
Pages: 264-267
Publication date: 1995

**Host publication information**
Title of host publication: Photorefractive materials effects and devices. Technical digest
Place of publication: Washington, DC
Publisher: Optical Society of America
Source: orbit
Source-ID: 293947
Research output: Chapter in Book/Report/Conference proceeding › Article in proceedings – Annual report year: 1995 › Research

Magnetic field enhancement of photovoltaic grating formation in iron-doped lithium niobate crystals

**General information**
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Dam-Hansen, C., Johansen, P., Petersen, P.
Publication date: 1995

**Host publication information**
Title of host publication: Dansk Optisk Selskabs årsmøde 1995. 10-års jubilæum. Abstracts
Place of publication: Roskilde
Publisher: DOPS. Forskningscenter Risø
Source: orbit
Source-ID: 293393
Research output: Chapter in Book/Report/Conference proceeding › Conference abstract in proceedings – Annual report year: 1995 › Research

Nonlinear combinations of gratings in Bi$_{12}$SiO$_{20}$: theory and experiments

**General information**
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Andersen, P. E., Buchhave, P., Petersen, P., Vasnetsov, M.
Pages: 1422-1433
Publication date: 1995
Peer-reviewed: Yes

**Publication information**
Journal: Optical Society of America. Journal B: Optical Physics
Volume: 12
ISSN (Print): 0740-3224
Original language: English
Source: orbit
Nonlinear combinations of gratings in drift-dominated recording in Bi$_{12}$SiO$_{20}$

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Andersen, P. E., Petersen, P., Buchhave, P.
Pages: 2453-2462
Publication date: 1995
Peer-reviewed: Yes

Publication information
Journal: Optical Society of America. Journal B: Optical Physics
Volume: 12
ISSN (Print): 0740-3224
Original language: English
Source: orbit
Source-ID: 293233
Research output: Contribution to journal › Journal article – Annual report year: 1995 › Research › peer-review

Nonlinear grating interaction in photorefractive Bi$_{12}$SiO$_{20}$
Recently significant crosstalk has been observed in a multibeam experiment in which gratings were previously thought to be independent. In this letter, it is shown that the crosstalk is due to a coherent nonlinear combination of the primary gratings, which causes additional peaks to occur in the diffraction pattern and changes the diffraction efficiency of the primary gratings explaining the apparent crosstalk. It is shown that the effect can be derived from the band transport model when all the terms in the expression for the generation of charge carriers are retained. Results are presented for a configuration consisting of a reference beam and two object beams and show experimental results that confirm the model.

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General information
Publication status: Published
Organisations: Department of Physics, Risø National Laboratory for Sustainable Energy, National Academy of Sciences of Ukraine
Contributors: Buchhave, P., Andersen, P. E., Petersen, P. M., Vasnetsov, M.
Pages: 792-794
Publication date: 1995
Peer-reviewed: Yes

Publication information
Volume: 66
Issue number: 7
ISSN (Print): 0003-6951
Original language: English
Keywords: CRYSSTALS
Electronic versions:
Buchhave.pdf
DOIs: 10.1063/1.114190
URLs: http://link.aip.org/link/?APPLAB/66/792/1

Bibliographical note
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Source: orbit
Source-ID: 252050
Research output: Contribution to journal › Journal article – Annual report year: 1995 › Research › peer-review

Nonlinear optical properties of photorefractive materials
Nonlinear optics at Risø National Laboratory

Optical phase conjugation and optical signal processing in photorefractive materials

Photorefractive devices
Properties of photorefractive materials: Linear- and nonlinear aspects

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Johansen, P., Pedersen, H., Dam-Hansen, C., Petersen, P.
Publication date: 1995
Peer-reviewed: No
Event: Abstract from DFS 95. Dansk Fysisk Selskab og Astronomisk Udvalg, Odense, Denmark.
Source: orbit
Source-ID: 293644

Temperature properties of laser-induced interference filters in lithium niobate

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Dam-Hansen, C., Johansen, P., Petersen, P.
Publication date: 1995
Peer-reviewed: Yes
Publication information
Journal: Optics Communications
Volume: 118
ISSN (Print): 0030-4018
Original language: English
Source: orbit
Source-ID: 293733

The influence of nonlinear interaction between gratings on light amplification in photorefractive BaTiO₃

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Petersen, P., Andersen, P. E., Johansen, P., Buchhave, P.
Pages: 320-323
Publication date: 1995

Host publication information
Title of host publication: Photorefractive materials effects and devices. Technical digest
Place of publication: Washington, DC
Publisher: Optical Society of America
Source: orbit
Source-ID: 293948

Amplitude and phase measurements in photorefractive time average interferometry

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Petersen, P.
Publication date: 1994
Peer-reviewed: No
Event: Abstract from Conference at Universidad de Cadiz 1994, Cadiz, Spain.
Source: orbit
Source-ID: 291896
Crosstalk in dynamic optical interconnects in photorefractive crystals
We have investigated the crosstalk between two neighboring gratings in photorefractive Bi12SiO20 optical interconnects. The gratings are induced by the interference between one reference beam and two object beams. By applying a suitable phase shift in one of the object beams, we can selectively switch off one of the gratings. The crosstalk between the two gratings is experimentally determined from the diffraction efficiency in the remaining grating before and after applying the phase shift. The magnitude of the crosstalk is determined by the intensity ratio between the reference beam intensity and the object beam intensity. Crosstalk can be avoided by choosing a certain intensity ratio between the reference and the object beams.

General information
Publication status: Published
Organisations: Department of Physics, Risø National Laboratory for Sustainable Energy
Contributors: Andersen, P. E., Petersen, P. M., Buchhave, P.
Pages: 271-273
Publication date: 1994
Peer-reviewed: Yes

Publication Information
Volume: 65
Issue number: 3
ISSN (Print): 0003-6951
Original language: English
Electronic versions:
Buchhave.pdf
DOIs: 10.1063/1.112368
URLs: http://link.aip.org/link/?APPLAB/65/271/1

Bibliographical note
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Source: orbit
Source-ID: 251837

Crosstalk in photorefractive optical interconnects due to nonlinear mixing of gratings

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Andersen, P. E., Petersen, P., Buchhave, P.
Pages: 11-12
Publication date: 1994
Peer-reviewed: Unknown

Publication Information
Volume: 5
Issue number: 12
Original language: English
Source: orbit
Source-ID: 291889

Research output: Contribution to journal › Journal article – Annual report year: 1994 › Research › Communication

Four-wave mixing in solid

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Petersen, P.
Publication date: 1994
Peer-reviewed: No
Event: Abstract from Conference at Universidad de Cadiz 1994, Cadiz, Spain.
Source: orbit
Source-ID: 291895
Research output: Contribution to conference › Conference abstract for conference – Annual report year: 1994 › Research

Multiple grating interactions in photorefractive optical interconnects

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Andersen, P. E., Petersen, P., Buchhave, P.
Pages: 65-66
Publication date: 1994

Host publication information
Title of host publication: Conference on lasers and electro-optics Europe
Place of publication: Piscataway, NJ
Publisher: The Institute of Electrical and Electronics Engineers
Source: orbit
Source-ID: 291929
Research output: Chapter in Book/Report/Conference proceeding › Article in proceedings – Annual report year: 1994 › Research

Nonlinear combinations of gratings in BSO

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Buchhave, P., Andersen, P., Petersen, P.
Publication date: 1994
Peer-reviewed: No
Source: orbit
Source-ID: 292035
Research output: Contribution to conference › Conference abstract for conference – Annual report year: 1994 › Research

Nonlinear grating interaction in photorefractive materials

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Petersen, P.
Publication date: 1994
Peer-reviewed: No
Event: Abstract from Universidad Autonomia, Madrid (ES), 8-10 Oct, .
Source: orbit
Source-ID: 291897
Research output: Contribution to conference › Conference abstract for conference – Annual report year: 1994 › Research

Nonlinear interactions between gratings in photorefractive crystals

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Petersen, P.
Publication date: 1994
Peer-reviewed: No
Source: orbit
Source-ID: 291893
Optical processing with photorefractive crystals

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Petersen, P.
Publication date: 1994
Peer-reviewed: No
Source: orbit
Source-ID: 291892
Research output: Contribution to conference » Conference abstract for conference – Annual report year: 1994 » Research

Photorefractive time-average interferometry and holographic optical elements for industrial sensors

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Petersen, P., Hanson, S.
Publication date: 1994
Peer-reviewed: No
Event: Abstract from BRITE-EURAM. Technical University of Denmark, Lyngby (DK), 7 Sep, .
Source: orbit
Source-ID: 291894
Research output: Contribution to conference » Conference abstract for conference – Annual report year: 1994 » Research

Polarization properties of a photorefractive Bi$_{12}$SiO$_{20}$ crystal and their application in an optical correlator

The polarization properties of Bi$_{12}$SiO$_{20}$ (BSO) crystals are investigated in detail theoretically and experimentally, and the results are used to describe the operation of an optical correlator for a particle image velocimeter (PIV) using a BSO crystal as the nonlinear optical element. The work is based on an extension of the optical beam-propagation (OBP) method to include all the significant optical properties of the BSO crystal when used in a two-wave mixing configuration, i.e., optical activity, field-induced birefringence, and anisotropic diffraction. The model is able to handle multiple gratings where the input beams do not have to be symmetric about the axis of propagation. Using the numerical model the polarization properties of the BSO crystal are analyzed and the operation of the correlator is explained. The model is able to take into account self-diffraction effects, and it is shown that these effects can have a significant influence in the setup employed for the optical correlator even when the diffraction efficiency is low. The predictions of the numerical model are verified by extensive experiments on the polarization state of the output of the correlator as a function of operating conditions and of the polarization state of the input beams

General information
Publication status: Published
Organisations: Department of Photonics Engineering, Department of Physics, Diode Lasers and LED Systems
Contributors: Edvold, B., Andersen, P. E., Buchhave, P., Petersen, P. M.
Pages: 1075-1089
Publication date: 1994
Peer-reviewed: Yes

Publication information
Volume: 30
Issue number: 4
ISSN (Print): 0018-9197
Original language: English
Electronic versions:
Edvold.pdf
DOIs:
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Properties of laser induced gratings in lithium niobate crystals

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Dam-Hansen, C., Johansen, P., Petersen, P.
Publication date: 1994
Peer-reviewed: No
Source: orbit
Source-ID: 292742
Research output: Contribution to conference › Conference abstract for conference – Annual report year: 1994 › Research

Quantitative measurement of the vibrational amplitude and phase in photorefractive time-average interferometry: A comparison with electronic speckle pattern interferometry

Time-average interferometry is dealt with using four-wave mixing in photorefractive Bi12SiO20. By introducing a proper sinusoidal phase shift in the forward pump beam it is possible to measure the amplitude and phase everywhere on a vibrating object. Quantitative measurements of the phase and amplitude of the vibrating structure are demonstrated in photorefractive time average interferometry. The photorefractive interferometer is compared with the performance of a commercial electronic speckle pattern interferometer (ESPI). It is shown that the dynamic photorefractive holographic interferometer improves the image quality considerably and is able to extend the measurable range for the acoustic vibration amplitude and frequency compared to what is obtainable with the ESPI equipment. Journal of Applied Physics is copyrighted by The American Institute of Physics.

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy, Technical University of Denmark
Contributors: Rohleder, H., Petersen, P. M., Marrakchi, A.
Pages: 81-84
Publication date: 1994
Peer-reviewed: Yes

Publication information
Journal: Journal of Applied Physics
Volume: 76
Issue number: 1
ISSN (Print): 0021-8979
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Source: orbit
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Research output: Contribution to journal › Journal article – Annual report year: 1994 › Research › peer-review

Ulineær optik

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Petersen, P., Skettrup, T.
Number of pages: 224
Higher spatial harmonics in nonlinear photorefractive interference filters

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Petersen, P., Johansen, P., Bruun, P., Pedersen, P.
Pages: 162-166
Publication date: 1993

Host publication information
Title of host publication: 1. International symposium on laser and optoelectronics technology and applications. Proceedings
Place of publication: Singapore
Publisher: Singapore National University
Editors: Chong, T., Lu, Y.
Source: orbit
Source-ID: 290915
Research output: Chapter in Book/Report/Conference proceeding – Annual report year: 1993 – Research

Photorefractive interference filters: Theory and application

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Johansen, P., Petersen, P.
Pages: 322-324
Publication date: 1992

Host publication information
Title of host publication: Nonlinear optics: Materials, fundamentals, and applications. Summaries of papers. Conference edition
Place of publication: Washington, DC
Publisher: Optical Society of America (1992 Technical Digest Series, 18).
Source: orbit
Source-ID: 290188
Research output: Chapter in Book/Report/Conference proceeding – Article in proceedings – Annual report year: 1992 – Research

Simple Theory for Degenerate Four-Wave Mixing in Photorefractive Media

General information
Publication status: Published
Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Petersen, P., Johansen, P.
Publication date: 1988
Peer-reviewed: Yes

Publication information
Journal: Optics Letters
ISSN (Print): 0146-9592
Original language: English
Projects:

**New light sources based on the nonlinearities of silicon carbide**
Shi, X., PhD Student, Department of Photonics Engineering  
Ou, H., Main Supervisor  
Petersen, P. M., Supervisor  
Rottwitt, K., Supervisor  
01/12/2018 → 30/11/2021  
Project: PhD

**PhD Project in Photonics Tecnologies for Treatment & Diagnostics of Alzheimer’s and Dementia**
Carstensen, M. S., PhD Student, Department of Photonics Engineering  
Petersen, P. M., Main Supervisor  
Broeng, J., Supervisor  
01/12/2018 → 30/11/2021  
Project: PhD

**D-Light, Energibesparende diodelaser belysning**
Jensen, O. B., Project Manager, Department of Photonics Engineering, Diode Lasers and LED Systems  
Petersen, P. M., Project Participant, Department of Photonics Engineering, Diode Lasers and LED Systems  
Thorseth, A., Project Participant, Department of Photonics Engineering, Diode Lasers and LED Systems  
Project ID: 70853  
01/09/2014 → 01/09/2017  
Collaborators: Gate 21, Danish Building Research Institute, Mads Odgård Design, Norlase ApS, Focus Lighting A/S  
Project: Research

**PigLED: PigLED - Optimal lighting system for pigs**
Light and vitamin D are essential for human and animal well-being. In this project, researchers using specially developed LED lighting will reduce the mortality in piglets, improve the welfare of sows during gestation, and thus improve the pig farmer’s economy.

The challenge of this project is to improve the statistics in pig production. Every year, approximately 9,000,000 piglets die during birth or before weaning - an alarmingly high figure, which is not compatible with sustainability or animal welfare. In addition, it costs about 1.8 billion Danish kroner in lost profits for the Danish pig producers.

Piglets need vitamin D. They are born with a low level of vitamin D and in the first three weeks the only receive the sow’s milk, which contains minimal amounts of vitamin D. Vitamin D is often referred to as the sunshine vitamin, since animals and humans produce vitamin D in the skin. We cannot bring sunlight into the pig sheds, but we can develop a light source, which contains the portion of the sunlight which produces vitamin D in the skin of pigs.

For more information see attached document in Danish

Jakobsen, J., Project Coordinator, National Food Institute, Research group for Bioactives – Analysis and Application  
Bang-Berthelsen, I., Project Participant, National Food Institute  
Petersen, P. M., Project Participant, Department of Photonics Engineering, Diode Lasers and LED Systems  
01/01/2017 → 30/09/2020  
Collaborators: Kongsdal Multisite A/S, University of Copenhagen, Photocat A7S  
Documents: PigLED tekst til DTU Hjemmeside  
Project: Research

**Tunbare lasere i det synlige og ultraviolette område**
Mortensen, J. L., PhD Student, Department of Physics  
Tidemand-Lichtenberg, P., Main Supervisor  
Buchhave, P., Supervisor  
Lodahl, P., Examiner  
Arie, A., Examiner  
Petersen, P. M., Examiner  
Forskningsrådsfinansiering  
01/06/2003 → 20/11/2006  
Award relations: Tunbare lasere i det synlige og ultraviolette område
**Ulineær Dynamik i Halvlederlasere**  
Blaaberg, S., PhD Student, Department of Photonics Engineering  
Rottwitt, K., Main Supervisor  
Petersen, P. M., Supervisor  
Tromborg, B., Supervisor  
Mark, J., Examiner  
Willatzen, M., Examiner  
Grisen, G., Examiner  
Risø (Løn)  
01/11/2002 → 30/01/2007  
Award relations: Ulineær Dynamik i Halvlederlasere  
Project: PhD

**Diode laser based lighting**  
Krasnoshchoka, A., PhD Student, Department of Photonics Engineering  
Jensen, O. B., Main Supervisor  
Petersen, P. M., Supervisor  
Technical University of Denmark  
15/04/2016 → 08/06/2019  
Award relations: Diode laser based lighting  
Project: PhD

**UV light source for next generation immunoassay analyzer**  
Rodenko, O., PhD Student, Department of Photonics Engineering  
Pedersen, C., Main Supervisor  
Fodgaard, H., Supervisor  
Petersen, P. M., Supervisor  
Tidemand-Lichtenberg, P., Supervisor  
Willy Lindegaard, A., Supervisor  
Lindvold, L. R., Examiner  
Laurell, F., Examiner  
Toivonen, J. I., Examiner  
Industrial PhD  
01/06/2015 → 30/09/2018  
Award relations: UV light source for next generation immunoassay analyzer  
Project: PhD

**Innovative White Light-emitting Diodes Light Source**  
Lu, W., PhD Student, Department of Photonics Engineering  
Ou, H., Main Supervisor  
Ou, Y., Supervisor  
Petersen, P. M., Supervisor  
Jensen, F., Examiner  
Chaussende, D., Examiner  
Friedel, B., Examiner  
Samfinansieret - Andet  
01/09/2014 → 06/12/2017  
Award relations: Innovative White Light-emitting Diodes Light Source  
Project: PhD

**Active Photonic Crystal Fibres for High Power Applications**  
Olausson, C. B. T., PhD Student, Department of Photonics Engineering  
Bjarklev, A. O., Main Supervisor  
Hansen, K. P., Supervisor  
Petersen, P. M., Examiner  
Ramachandran, S., Examiner  
Scott, A. M., Examiner  
ErhvervsPhD-ordningen VTU  
01/11/2007 → 24/08/2011  
Award relations: Active Photonic Crystal Fibres for High Power Applications  
Project: PhD
Syntetisering af nye typer interferensfiltre i fotorefraktive medier.
Dam-Hansen, C., PhD Student
Petersen, P. M., Main Supervisor
Johansen, P. M., Supervisor
Skettrup, T., Supervisor
Bozhevolnyi, S. I., Examiner
Risø (Løn)
01/03/1993 → 07/06/1996
Award relations: Syntetisering af nye typer interferensfiltre i fotorefraktive medier.
Project: PhD

Novel concepts for improving swept sources for Optical Coherence Tomography
Marschall, S., PhD Student, Department of Photonics Engineering
Andersen, P. E., Main Supervisor
Pedersen, C., Supervisor
Petersen, P. M., Examiner
Wojtkowski, M., Examiner
Andersson-Engels, S., Examiner
Anden EU-finansiering
01/11/2008 → 23/05/2012
Award relations: Novel concepts for improving swept sources for Optical Coherence Tomography
Project: PhD

Hybrid light emitting diode enhanced with emissive nanocrystals
Kopylov, O., PhD Student, Department of Photonics Engineering
Yvind, K., Main Supervisor
Kardynal, B., Supervisor
Petersen, P. M., Examiner
Ohlsson, B. J., Examiner
Knoch, J., Examiner
Forskningsrådsfinansiering
15/01/2010 → 15/01/2014
Award relations: Hybrid light emitting diode enhanced with emissive nanocrystals
Project: PhD

Fabrication and Characterization of Semiconductor Optical Devices
Larsson, D., PhD Student, Department of Photonics Engineering
Hvam, J. M., Main Supervisor
Yvind, K., Supervisor
Kristensen, A., Examiner
McInerney, J., Examiner
Petersen, P. M., Examiner
Forskningsrådsfinansiering
15/01/2003 → 30/04/2007
Award relations: Fabrication and Characterization of Semiconductor Optical Devices
Project: PhD

Window Pane Coating for photon harvesting
Buss, T., PhD Student, Department of Micro- and Nanotechnology
Kristensen, A., Main Supervisor
Smith, C., Supervisor
Petersen, P. M., Examiner
Buchwald, K., Examiner
Tumbull, G. A., Examiner
Institut, samfinansiering
15/11/2009 → 04/04/2013
Award relations: Window Pane Coating for photon harvesting
Project: PhD
Pulsed Blue and Ultraviolet Laser System for Fluorescence Diagnostics based on Nonlinear Frequency Conversion
Cheng, H. P. H., PhD Student, Department of Photonics Engineering
Pedersen, C., Main Supervisor
Andersen, P. E., Supervisor
Jensen, O. B., Supervisor
Petersen, P. M., Supervisor
Rottwitt, K., Examiner
Laurell, F., Examiner
Thomsen, J. W., Examiner
Institut, samfinansiering
15/01/2008 → 22/06/2011
Award relations: Pulsed Blue and Ultraviolet Laser System for Fluorescence Diagnostics based on Nonlinear Frequency Conversion
Project: PhD

Forster energy transfer in hybrid light emitting diode
Shirazi, R., PhD Student, Department of Photonics Engineering
Petersen, P. M., Main Supervisor
Kardynal, B., Supervisor
Forchhammer, S., Examiner
Fontoyont, M., Examiner
Miller, P., Examiner
1/3 DTU-stip, 2/3 FUR/andet
01/08/2009 → 23/09/2013
Award relations: Forster energy transfer in hybrid light emitting diode
Project: PhD

Polymer Based Nano Optics for Lab-On-A-Chip Micro System
Gersborg-Hansen, M., PhD Student, Department of Micro- and Nanotechnology
Kristensen, A., Main Supervisor
Petersen, P. M., Examiner
Drewsen, M., Examiner
Levy, U., Examiner
DTU-lønnet stipendie
15/12/2004 → 30/04/2008
Award relations: Polymer Based Nano Optics for Lab-On-A-Chip Micro System
Project: PhD

Halvlederkomponenter til optisk kommunikation
Yvind, K., PhD Student, Department of Photonics Engineering
Hvam, J. M., Main Supervisor
Birkedal, D., Supervisor
Hansen, O., Examiner
Petersen, P. M., Examiner
White, I. H., Examiner
DTU-lønnet stipendie
01/10/1999 → 12/01/2004
Award relations: Halvlederkomponenter til optisk kommunikation
Project: PhD

Composite Fibre and Solid-State Visible Light Source
Andersen, M. T., PhD Student, Department of Physics
Tidemand-Lichtenberg, P., Main Supervisor
Pedersen, C., Supervisor
Petersen, P. M., Examiner
Arie, A., Examiner
Dunn, M., Examiner
DTU, Samfinansiering
01/03/2006 → 23/09/2009
Award relations: Composite Fibre and Solid-State Visible Light Source
Project: PhD
Development of high-power diode laser sources for medical and industrial applications
Vijayakumar, D., PhD Student, Department of Photonics Engineering
Petersen, P. M., Main Supervisor
Jensen, O. B., Supervisor
Thestrup Nielsen, B., Supervisor
Tidemand-Lichtenberg, P., Examiner
Drewsen, M., Examiner
Krakowski, M., Examiner

denfattig finansiering
01/01/2008 → 22/06/2011
Award relations: Development of high-power diode laser sources for medical and industrial applications
Project: PhD

Super bright light-emitting diode
Fadil, A., PhD Student, Department of Photonics Engineering
Ou, H., Main Supervisor
Dam-Hansen, C., Supervisor
Petersen, P. M., Supervisor
Schmidt, M. S., Examiner
Paiella, R., Examiner
Okawa, K., Examiner
Forskningsrådfinansiering
01/07/2012 → 17/02/2016
Award relations: Super bright light-emitting diode
Project: PhD

Thin-film deposition an characterization of new solar cell materials
Cazzaniga, A. C., PhD Student, Department of Photonics Engineering
Schou, J., Main Supervisor
Pryds, N., Supervisor
Petersen, P. M., Examiner
Lunney, J., Examiner
Siebentritt, S., Examiner
Forskningsrådfinansiering
01/06/2013 → 30/09/2016
Award relations: Thin-film deposition an characterization of new solar cell materials
Project: PhD

Non-contact assessment of food quality using optical imaging methods
Kamran, F., PhD Student, Department of Photonics Engineering
Andersen, P. E., Main Supervisor
Petersen, P. M., Examiner
Carstensen, J. M., Examiner
Spigulis, J., Examiner
Forskningsrådfinansiering
15/01/2011 → 20/08/2015
Award relations: Non-contact assessment of food quality using optical imaging methods
Project: PhD

New light Sources for Biomedical Applications
Argyraki, A., PhD Student, Department of Photonics Engineering
Petersen, P. M., Main Supervisor
Dam-Hansen, C., Supervisor
Pedersen, C., Examiner
Spigulis, J., Examiner
Martiny, K. P. J., Examiner
Samfinansieret - Andet
15/12/2013 → 11/01/2018
Award relations: New light Sources for Biomedical Applications
Project: PhD
Advanced optical design for multicolored LED systems for lighting applications
Chakrabarti, M., PhD Student, Department of Photonics Engineering
Dam-Hansen, C., Main Supervisor
Petersen, P. M., Supervisor
Rottwitt, K., Examiner
Martinsons, C., Examiner
Pedersen, K., Examiner
Technical University of Denmark
01/01/2013 → 15/06/2016
Award relations: Advanced optical design for multicolored LED systems for lighting applications
Project: PhD

High-power green-yellow diode lasers for medical applications
Müller, A., PhD Student, Department of Photonics Engineering
Petersen, P. M., Main Supervisor
Andersen, P. E., Supervisor
Jensen, O. B., Supervisor
Rottwitt, K., Examiner
Drewsen, M., Examiner
Rafailov, E., Examiner
Technical University of Denmark
01/03/2010 → 15/08/2013
Award relations: High-power green-yellow diode lasers for medical applications
Project: PhD

Daylight as a Driver for Healthier Energy Optimization
Renovations of existing buildings have primarily focused on the energy consumption and thermal comfort. This project involves health as a priority design parameter, and through an exemplary case study, the project examines how essential health aspects are better served. The project focuses on facade design. The project involves daylight quality as a design parameter and focuses on the clearest glass quality on the market. Through a major housing, the study documents how aspects of health and energy are influenced by the quality of daylight/glass quality.
Volf, C., Project Manager, volfdesign.dk
Petersen, P. M., Project Participant, Department of Photonics Engineering, Diode Lasers and LED Systems
Thorseth, A., Project Participant, Department of Photonics Engineering, Diode Lasers and LED Systems
Markvart, J., Project Participant
Martiny, K., Project Participant
External Project ID: 348-018
01/03/2016 → 30/06/2018
Collaborators: volfdesign.dk, Danish Building Research Institute, Region Hovedstaden
Project: Research

D-Light: Energibesparende diodelaser belysning
Jensen, O. B., Project Participant, Department of Photonics Engineering, Diode Lasers and LED Systems
Petersen, P. M., Project Participant, Department of Photonics Engineering, Diode Lasers and LED Systems
Dam-Hansen, C., Project Participant, Department of Photonics Engineering, Diode Lasers and LED Systems
Project ID: 70853
External Project ID: 64014-0171
EUDP
01/09/2014 → 30/09/2017
Award relations: Energibesparende diodelaser belysning
Project: Research

LEDMET: Center for LED metrology
Dam-Hansen, C., Project Participant, Department of Photonics Engineering, Diode Lasers and LED Systems
Thorseth, A., Project Participant, Department of Photonics Engineering, Diode Lasers and LED Systems
Lindén, J., Project Participant, Department of Photonics Engineering, Diode Lasers and LED Systems
Poulsen, P. B., Project Participant, Department of Photonics Engineering, Diode Lasers and LED Systems
Petersen, P. M., Project Participant, Department of Photonics Engineering, Diode Lasers and LED Systems
Project ID: 70832
01/01/2014 → 31/12/2017
Project: Research
Energibesparende LED farveblandings belysningssystem med høj lyskvalitet
Dam-Hansen, C., Project Manager, Department of Photonics Engineering, Optics and Plasma Research Department, Diode Lasers and LED Systems, Laser Systems and Optical Materials
Petersen, P. M., Project Participant, Department of Photonics Engineering, Optics and Plasma Research Department, Diode Lasers and LED Systems, Laser Systems and Optical Materials
Poulsen, P. B., Project Participant, Department of Photonics Engineering, Risø National Laboratory for Sustainable Energy, Diode Lasers and LED Systems
Hansen, S. S., Project Participant, Department of Photonics Engineering, Diode Lasers and LED Systems
Thorseth, A., Project Participant, Department of Photonics Engineering, Optics and Plasma Research Department, Diode Lasers and LED Systems, Laser Systems and Optical Materials
Corell, D. D., Project Participant, Department of Photonics Engineering, Diode Lasers and LED Systems
Jensen, P., Project Participant, Department of Photonics Engineering, Optics and Plasma Research Department, Diode Lasers and LED Systems, Laser Systems and Optical Materials
Hansen, S. S., Project Participant, Department of Photonics Engineering, Diode Lasers and LED Systems
Petersen, P. M., Project Manager
Jensen, O. B., Project Participant
Andersen, P. E., Project Participant
Nielsen, B. T., Project Participant, Technical University of Denmark
Chi, M., Project Participant
Project ID: 70578
DTU - projekt Proof of Concept: DKK750,000.00
01/01/2012 → 31/12/2013
Award relations: Energibesparende LED farveblandings belysningssystem med høj lyskvalitet
Project: Research

WWW.BRIGHT.EU : Brighter - 1705125
High brightness laser diode technology is a key enabling technology for the modern information society, especially in the fields of health-care, telecommunications, infotainment, environment and security. Laser diodes offer high output power, compactness, robustness, and mass production capabilities. However, their use in the above mentioned domains is often limited by the difficulty to reach satisfactory performances on power and beam quality simultaneously. The term -high brightness- indicates exactly the capability of a high power laser diode to provide high beam quality. The brightness governs directly the performance of systems, such as the transmission span of an optical data link, the reliability of a diagnosis in fluorescence imaging of cancer, or the resolution of a laser projection display. Therefore, the need for high brightness laser diodes in these applications is currently strongly increasing. The WWW.BRIGHT.EU consortium proposes a long-term vision aiming at pushing the limits of the current laser diode technology towards higher brightness, and at demonstrating applications such as: 1) Laser sources for medical imagery for cancer diagnosis and intelligent therapy, 2) Optical amplifiers for telecommunication networks, 3) Compact source for projection display
Petersen, P. M., Project Manager
Jensen, O. B., Project Participant
Andersen, P. E., Project Participant
Nielsen, B. T., Project Participant, Technical University of Denmark
Chi, M., Project Participant
Project ID: 70614
External Project ID: info:eu-repo/grantAgreement/EC/FP7/035266
Forsk. EU - Rammeprogram: DKK72,210,680.00
01/10/2006 → 31/01/2010
Collaborators: Technical University of Denmark
Award relations: WWW.BRIGHT.EU : Brighter - 1705125
Project: Research

WWW.BRIGHT.EU
High brightness laser diode technology is a key enabling technology for the information society of tomorrow, especially in the fields of health-care, telecommunication, environment and security. The development and achievements of the information society rely on the smart use of information for applications such as imagery or telecommunications. The electron and the photon are the two main information carriers, the latter having taken an increased role since the end of the seventies, when engineers demonstrated the efficiency of optical fibre transmission. Since then, the demand for high brightness sources has increased continuously. Laser diodes already offer extraordinary compactness at a reasonable cost and now play a central role in telecommunications. However, their brightness still needs to be improved to spread their large-scale uptake across the Information Society; the main challenge is to couple more light power in smaller diameter fibres. The WWW.BRIGHT.EU consortium proposes a long-term vision aiming at pushing the limits of the current laser diode technology towards higher brightness, and at demonstrating applications such as 1) Medical imagery for cancer therapy, 2) Amplifiers for telecommunication networks. The approach consists of mobilising the expertise of the main European actors in the core laser diode core technologies, and coupling it with highly innovative optical technologies e.g. smart cavity concepts for higher efficiency and tuneability. Industrialisation constraints will be widely addressed through packaging and reliability studies."
Petersen, P. M., Project Manager, Department of Photonics Engineering
Jensen, O. B., Project Participant, Department of Photonics Engineering
Chi, M., Project Participant, Department of Photonics Engineering
Andersen, P. E., Project Participant, Department of Photonics Engineering
**A high-brightness diode laser bar system for industrial test**

The objective of this project was to develop a high-brightness diode laser bar system to be used for industrial testing. Diode laser bars are very efficient and high power laser sources with the major drawback being the poor beam quality and thus the low brightness. In this project, newly developed techniques based on off-axis spectral beam combination will be employed to improve the beam quality to close to the diffraction limit. This will lead to record-high values for the brightness of the laser system.

Petersen, P. M., Project Manager
Jensen, O. B., Project Participant, Department of Photonics Engineering
Thestrup Nielsen, B., Project Participant, Department of Photonics Engineering

**Etablering af LED-belysning i Rosenborg Skatkammer**

Nyström, H., Project Manager, De Danske Kongers Kronologiske Samlinger, Rosenborg Slot
Markussen, B., Contact Person, Lumodan ApS
Petersen, P. M., Project Participant, Department of Photonics Engineering
Dam-Hansen, C., Project Participant, Department of Photonics Engineering
Poulsen, P. B., Project Participant, Department of Photonics Engineering
Thorseth, A., Project Participant, Department of Photonics Engineering

Project ID: 70635
Forsk. Private danske - Fonde: DKK93,337.50
01/02/2010 → 31/12/2010
Collaborators: De Danske Kongers Kronologiske Samlinger, Rosenborg Slot, Lumodan ApS, I-NO, Kvorning Design & Kommunikation

**A new monolithic semiconductor laser based on nonlinear gain and refractive index : 1705114-1 STVF**

Petersen, P. M., Project Manager, Department of Photonics Engineering

**Intelligent styring af dynamisk LED belysning**

Laursen, F., Contact Person, Lighten ApS
Pedersen, S., Project Manager, Lighten ApS
Petersen, P. M., Contact Person, Department of Photonics Engineering
Dam-Hansen, C., Project Participant, Department of Photonics Engineering
Corell, D. D., Project Participant, Department of Photonics Engineering
Poulsen, P. B., Project Participant, Department of Photonics Engineering
Hansen, S. S., Project Participant, Department of Photonics Engineering
Thorseth, A., Project Participant, Department of Photonics Engineering
Logadóttir, Á., Project Participant, Danish Building Research Institute
Sjælland, B., Project Participant, Rockwool International

Project ID: 70670
Forsk. EU - Andre EU-midler: DKK1,312,766.00
01/01/2011 → 31/12/2012
Collaborators: Rockwool International, Lighten ApS, Danish Building Research Institute

Award relations: Intelligent styring af dynamisk LED belysning
Project: Research
Danish LED Network
Petersen, P. M., Project Manager, Department of Photonics Engineering
Dam-Hansen, C., Project Participant, Department of Photonics Engineering
Poulsen, P. B., Project Participant, Department of Photonics Engineering
Corell, D. D., Project Participant, Department of Photonics Engineering
Hansen, S. S., Project Participant, Department of Photonics Engineering
Thorseth, A., Project Participant, Department of Photonics Engineering
Project ID: 70624
Forsk. Andre statslige danske i øvrigt: DKK250,125.00
15/02/2010 → 31/12/2011
Collaborators: Osram A/S, Dansk Center for Lys
Award relations: Danish LED Network
Project: Research

Combined daylight and intelligent LED lighting : Getting the daylight into the buildings
The project aims to develop and demonstrate a new concept of intelligent LED lighting which complements and follows the
rhythm of daylight and thus bringing 'daylight' into buildings. It is based on LED technology's unique color characteristics
and high efficiency, allowing a concept which proveides both high-quality lighting and can be energy saving. New LED
lighting systems and combined with a new colos sensor system for control are developed. LED light source placement and
control strategies are analyzed and optimized through model calculations that include the daylight contribution. User
experience of the concept will be examined through demonstration setups and the potential energy savings specified
through measurements on these setups.
Dam-Hansen, C., Project Manager, Department of Photonics Engineering
Poulsen, P. B., Project Participant, Department of Photonics Engineering
Petersen, P. M., Project Participant, Department of Photonics Engineering
Corell, D. D., Project Participant, Department of Photonics Engineering
Hansen, S. S., Project Participant, Department of Photonics Engineering
Thorseth, A., Project Participant, Department of Photonics Engineering
Traberg-Borup, S., Project Participant, Danish Building Research Institute
Logadóttir, Á., Project Participant, Danish Building Research Institute
Orton, I. W., Project Participant, Ramboll Group AS
Pedersen, J. E., Project Participant, Energirådgiveren
Skovsgaard, T., Project Participant, Philips Lighting A/S
Project ID: 70631
Forsk. Andre statslige danske i øvrigt: DKK527,411.00
15/02/2010 → 31/12/2011
Collaborators: Philips Lighting A/S, Danish Building Research Institute, Ramboll Group AS, Energirådgiveren
Award relations: Combined daylight and intelligent LED lighting : Getting the daylight into the buildings
Project: Research

Hybrid lighting goes to school
Petersen, P. M., Project Manager, Department of Photonics Engineering
Dam-Hansen, C., Project Manager, Department of Photonics Engineering
Stubager, J., Project Manager, Department of Photonics Engineering
Poulsen, P. B., Project Participant, Department of Photonics Engineering
Corell, D. D., Project Participant, Department of Photonics Engineering
Hansen, S. S., Project Participant, Department of Photonics Engineering
Thorseth, A., Project Participant, Department of Photonics Engineering
Bjarklev, A., Project Participant, Roskilde University
Kjær, T., Project Participant, Roskilde University
Andersen, J., Project Participant, Roskilde University
Laursen, K., Project Participant, Designskolen Kolding
Ibsen, P., Project Participant, Ibsen el-anlæg A/S
Nielsen, B., Project Participant, Stevns kommune
Kristoffersen, M., Project Participant, Stevns kommune
Jørgensen, H. J., Project Participant, Stevns kommune
Project ID: 70676
Forsk. Private danske - Andre: DKK1,302,400.00
01/04/2011 → 31/03/2014
Collaborators: Stevns kommune, Designskolen Kolding, Ibsen el-anlæg A/S, Roskilde University
Award relations: Hybrid lighting goes to school
Project: Research
Kompakt og effektivt grønt diodelasersystem til medicinske anvendelser
Jensen, O. B., Project Manager, Department of Photonics Engineering
Petersen, P. M., Project Participant, Department of Photonics Engineering
Andersen, P. E., Project Participant, Department of Photonics Engineering
Müller, A., Project Participant, Department of Photonics Engineering
Project ID: 70577
Forsk. Andre statslige danske i øvrigt: DKK749,924.00
01/10/2011 → 31/03/2013
Award relations: Kompakt og effektivt grønt diodelasersystem til medicinske anvendelser
Project: Research

Nyt kompakt lasersystem til fremtidens højkvalitets displays
Thestrup Nielsen, B., Project Manager, Department of Photonics Engineering
Jensen, O. B., Project Participant, Department of Photonics Engineering
Petersen, P. M., Project Participant, Department of Photonics Engineering
Project ID: 70574
Forsk. Andre statslige danske i øvrigt: DKK749,000.00
30/06/2010 → 31/12/2011
Award relations: Nyt kompakt lasersystem til fremtidens højkvalitets displays
Project: Research

Activities:

High power diode lasers converted to the visible
Period: 11 Oct 2017
Ole Bjarlin Jensen (Invited speaker)
Anders Kragh Hansen (Invited speaker)
Peter E. Andersen (Guest lecturer)
Mathias Christensen (Guest lecturer)
André Müller (Invited speaker)
Mahmoud Tawfieq (Invited speaker)
Bernd Sumpf (Invited speaker)
Paul Michael Petersen (Invited speaker)
Department of Photonics Engineering
Diode Lasers and LED Systems
Copenhagen Center for Health Technology

Description
Invited talk at the conference including 2 page abstract to be published in IEEE Xplore.
Degree of recognition: International

Related event
2017 IEEE High Power Diode Lasers & Systems Conference
11/10/2017 → 12/10/2017
Coventry, United Kingdom
Activity: Talks and presentations › Conference presentations

UVB irradiation has a greater efficacy than photodynamic therapy on Enterococcus Faecalis
Period: 15 Sep 2017
Merete Markvart (Speaker)
Aikaterini Argyraki (Other)
Paul Michael Petersen (Other)
Thomas Bjarnsholt (Other)
Lars Bjørndal (Other)
UVB irradiation has greater efficacy than photodynamic therapy on Enterococcus Faecalis

Links:

Related event
18th Biennial European Society of Endodontology (ESE) Congress - Brussels, Belgium
14/09/2017 → ...
Keywords: UV LEDs, Photodynamic therapy, biofilms
Activity: Talks and presentations › Conference presentations

Energy efficient and high quality LED illumination in display cases: New lighting – New LEDs
Period: 16 Mar 2010 → 17 Mar 2010
Paul Michael Petersen (Speaker)
Department of Photonics Engineering
Diode Lasers and LED Systems
Description
Place: Stockholm, Sweden

Related external organisation
Unknown Organization
Activity: Talks and presentations › Conference presentations

LED - fremtidens belysning
Period: 3 Dec 2009 → 4 Dec 2009
Paul Michael Petersen (Organizer)
Department of Photonics Engineering
Diode Lasers and LED Systems
Links:
http://www.lednet.dk (REL-OA)

Related event
LED - fremtidens belysning
03/12/2009 → 04/12/2009
København, Denmark
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

LED - fremtidens belysning
Period: 3 Dec 2009 → 4 Dec 2009
Paul Michael Petersen (Chairman)
Department of Photonics Engineering
Diode Lasers and LED Systems

Description
LED - fremtidens belysning
Place: Ingeniørhuset, Kalvebods Brygge, København
Degree of recognition: National
Links:
Related event

LED - fremtidens belysning
03/12/2009 → 04/12/2009
København, Denmark
Activity: Attending an event › Participating in or organising a conference

Press clippings:

Test af batteridrevne lys: De er dårlige, og det dårligste gik i stykker under testen
Paul Michael Petersen & Dennis Dan Corell
20/11/2018

Description
Dårlig kvalitet spænder ben for det store potentiale, som elektroniske stearinlys har, mener to lyseksperter. Politiken har i samarbejde med DTU Fotonik testet led-bloklys.
Department of Photonics Engineering, Diode Lasers and LED Systems

Media coverage (1)

Test af batteridrevne lys: De er dårlige, og det dårligste gik i stykker under testen
20/11/2018
Politiken - Forbrug & Liv (National), Denmark, Web
Nanna Martensen
https://politiken.dk/forbrugogliv/forbrug/art6838220/De-er-d%C3%A5rlige-og-det-d%C3%A5rligste-gik-i-stykker-under-testen

Paul Michael Petersen & Dennis Dan Corell
Diode Lasers and LED Systems, Department of Photonics Engineering
Press/Media: Press / Media

Midt i en lysbrydningstid
Paul Michael Petersen
01/02/2013
Department of Photonics Engineering, Diode Lasers and LED Systems

Media contribution (1)

Midt i en lysbrydningstid
01/02/2013
Electra nr. 02, s. 34, Print
http://ipaper.ipapercms.dk/TEKNIQ/electra2013/electrafebuar2013/?Page=34
Link to full text
Paul Michael Petersen
Department of Photonics Engineering, Diode Lasers and LED Systems
Press/Media: Press / Media